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國際學碩士學位論文

**Currency Manipulator:  
China's FX Policy Response to  
US-China Trade Imbalance**

환율조작국:

미중 무역 불균형에 대한 중국의 FX 정책 대응

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서울대학교 國際大學院  
國際學科 國際地域學專攻

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**Currency Manipulator:  
China's FX Policy Response to  
US-China Trade Imbalance**

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**Graduate School of International Studies**

**Seoul National University**

**Area Studies Major**

**Jin Zeming**

## Abstract

Using the measurement model and empirical analysis, this paper analyses whether there is a statistically dependent relationship between USD-CNY exchange rate and trade imbalance and discusses the influence degree and direction between RMB exchange rate and US-China trade deficit. The imbalances between the exchange rate of RMB and US-China trade have been a hot issue. During 2003-2019, USD-CNY exchange rate exhibits a trend in appreciation, meanwhile, the US-China trade imbalances also significantly expand. This paper adopts Ordinary Least Square, Augment Dickey-Fuller test, and Granger causality test to do research, reaching the following conclusions:

1. The USD-CNY exchange rate presents a digitally negative relationship with US-China trade imbalances. This phenomenon means that when the RMB's exchange rate appreciates, the US-China trade deficit will expand. This conclusion is contrary to the opinion which is America can ease their US-China trade deficit when the RMB's exchange rate appreciate.
2. The huge imbalances between RMB's exchange rate and US-China trade have multiple causes, such as US GDP, PCE, GPDI, and GCEGI, etc. The elasticity in which these factors impact on US-China trade is greater than the impact caused by the RMB's exchange rate. It is unreasonable to purely focus on the exchange rate of RMB.

3. There exists a one-way causality between the exchange rate of RMB and US-China trade.
4. Product Competitiveness is the main reason of trade imbalance.

**Keywords:** USD-CNY exchange rate; US-China trade deficit; Product Competitiveness

**Student Number:** 2016-25454

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## **Chapter 1. Introduction**

### **1.1 Research Background and Significance**

Since the reform and opening up in 1978, China's economic system has gradually changed from plan-led to market-led. Due to the cost advantages, Chinese commodities rapidly gained a leading position in the world trade market. In recent years, China's rapidly growing balance of payments surplus has become the target of accusations by western developed countries represented by the United States to defend their trade deficits. The depreciation of the exchange rate benefits the country's exports is the consensus of practice in the international community. Western developed countries believe that the RMB exchange rate is undervalued, and there are many calls for the RMB exchange rate to appreciate.

In October 2018, the U.S. Treasury Department released in the first half of 2018 the international economic and exchange rate policy report that the main U.S. trading partners did not manipulate the exchange rate to gain unequal trade advantages, including China. This is the fourth time since Trump assumed the presidency of the United States that the United States has determined that China has not manipulated the exchange rate, but it has still included China and the other six countries on the exchange rate policy test list.

Since March 2018, China and the United States have continually upgraded the "trade war" through additional tariffs. The United States imposes tariffs on commodities exported by China's steel, aluminum foil, machinery, medicine, and

other industries, and threatens to raise tax rates in just a few months. China responded by imposing tariffs on goods imported from industries such as the US automobile, chemical industry, aircraft, and soybeans. On the other hand, the economic and trade consultations between the two sides are continuing, and a consensus was reached in Washington on taking effective measures to substantially reduce the US trade deficit with China. But in the future, the United States issued a strategic statement contrary to the Washington consensus and continued to increase the list of Chinese goods subject to tariffs. As of the writing of this paper, there is still no clear direction as to where the US-China trade war will go.

Overall, the RMB exchange rate issue has become an important and controversial topic in US-China relations. In recent years, the exchange rate of RMB against the US dollar has shown a complex development trend. From 2001 to 2004, the USD-CNY exchange rate contained highly stable.

From 2005 to 2010, the renminbi exchange rate generally developed in a rapid appreciation trend, and only remained stable from 2009 to 2010. From 2010 to 2014, the renminbi exchange rate developed in a trend of volatile appreciation. Although it depreciated slightly in certain periods, it continued to break through the previous highs and reached the highest point in the observation period at the beginning and the end of 2014.

From 2015 to 2017, the RMB exchange rate first depreciated and then increased, and its depreciation range reached about 12%. Although the RMB exchange rate has resumed appreciation since the second quarter of 2017, it has not yet dropped back



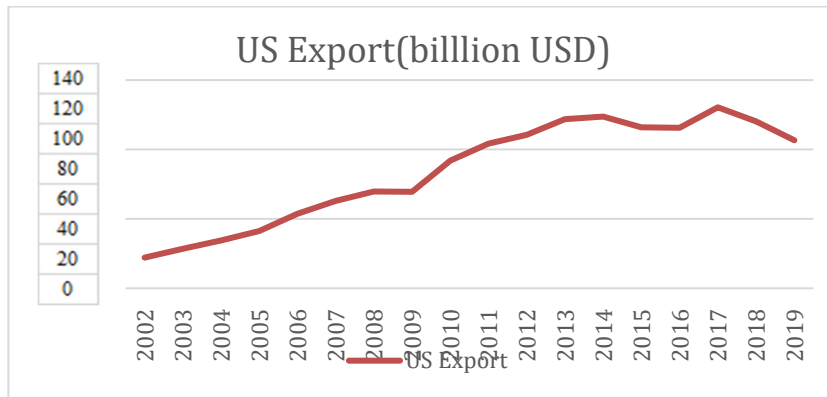
to its highest point in the previous period. At the same time, the US trade deficit with China continued to increase rapidly. Since 2001, the U.S. trade deficit with China has surpassed \$ 100 billion and exceeded \$ 350 billion. It has maintained growth every year except 2009 and has maintained a high of US \$ 300 billion for six years. Although the US Treasury Department has not officially listed China as a "currency manipulator," US-China trade frictions continue to increase.

After Trump took office, the confrontation between the US and China on the RMB exchange rate and the US-China "trade war" has become one of the core issues of world political and economic concern. The western developed countries represented by the United States continue to accuse the RMB exchange rate of being undervalued. The demand for the RMB to appreciate to reduce the country's trade deficit with China continues to be heard.

In the past 19 years, the absolute value of US exports to China has increased by 111.187 billion US dollars, an increase of 579.63%. In general, except for the years of systemic global trade weakness and weak recovery caused by the international financial crisis, US exports to China have shown an upward trend. Figure 1-2 reflects the changes in US trade imports from China.

Figure 1-1, Figure 1-2 and Figure 1-3, drawn according to Table 1-1, intuitively reflect the trend of these trade changes during the 19 years. Figure 1-1 reflects the changes in US trade exports to China.

Figure 1-1. US Export Index (2002-2019)



Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

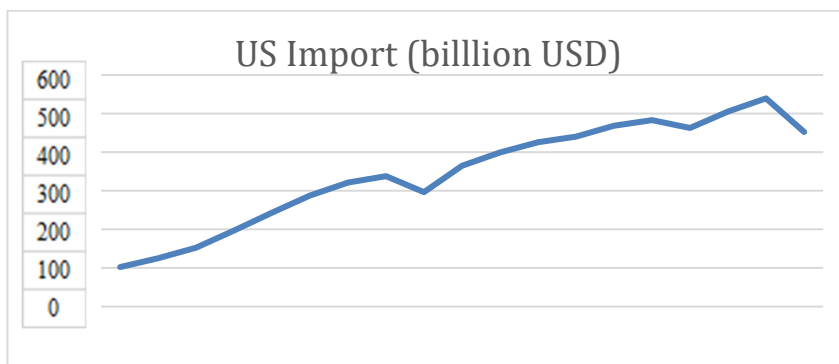
As can be seen from Figure 1-1, U.S. exports to China have maintained a growing trend since 2003, and the growth rate has been accelerating according to the slope. From 2008 to 2010 and from 2014 to 2016, US exports to China remained stable and fell slightly, but the gap was not large. In 2003, US exports to China amounted to 19.1 billion USD, while in 2019 this figure increased dramatically to 130.3 billion USD.

In the past 19 years, the absolute value of US exports to China has increased by 111.1 billion US dollars, an increase of 579.63%. In general, except for the years of systemic global trade weakness and weak recovery caused by the international financial crisis, US exports to China have shown an upward trend. Figure 1-2 reflects the changes in US trade imports from China.

As can be seen from Figure 1-2, since 2003, US imports from China have maintained a growing trend. In 2009 and 2016, US imports from China fell slightly, but the gap was not large. In 2003, the US import trade volume from China was \$ 102.2 billion, while in 2019 the US import trade volume from China was \$ 505.5 billion. The absolute value of U.S. imports from China increased by \$ 40.3 billion in 17 years, an increase of about 394.33%, which is lower than the increase in U.S. exports to China in ten years.

Generally speaking, the time for the US imports from China to coincide with the decline in US exports to China is basically due to the impact of the global economy. These two figures show that from the standpoint of the United States, the absolute value of both its exports to China and its imports from China increased significantly, reflecting the US-China trade. The continuous closeness and deepening of China also reflect that the two largest economies in the world are still severely affected by global systemic risks.

Figure 1-2. US Import Index (2001-2019)



Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

Combining Figure 1-1 and Figure 1-2, it can be seen that U.S. imports from China have far exceeded U.S. exports to China over the years, so U.S. trade with China has been in a deficit from 2001 to 2019. Figure 1-3 reflects this situation.

Figure 1-3. Combined US- China Trade Details (2001-2019)

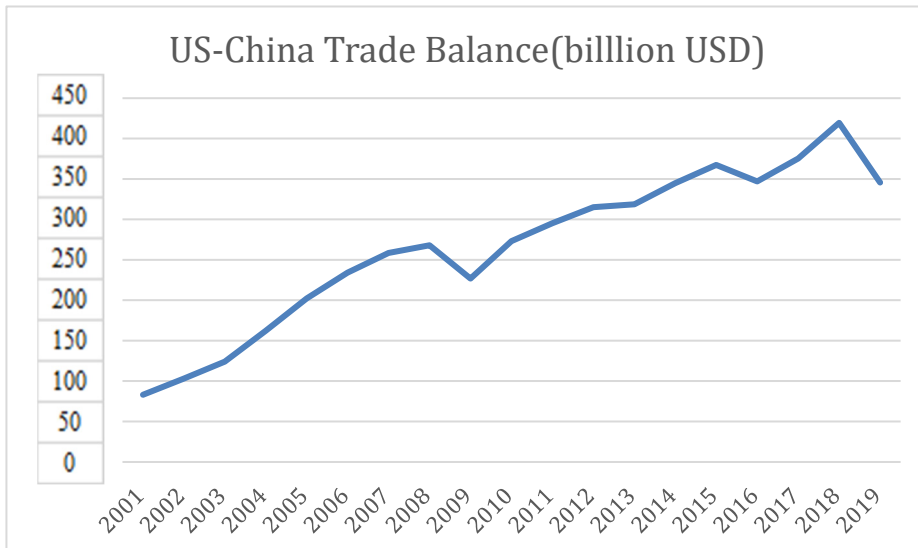


Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

The trade deficit reflected in Figure 1-3 is represented by a line chart, that is, Figure 1-4. It can be clearly seen that the US trade deficit with China has maintained growth except for 2009 and 2016. In 2001, the US trade deficit with China was \$830.9 billion, while in 2019 this figure became \$375.2 billion.

In 19 years, it increased by \$292.1 billion, an increase of about 351.56%. For the United States, the increase in the US trade deficit with China over the past 19 years has exceeded the increase in the US deficit with any economy other than China.

Figure 1-4. US-China Trade Balance (2001-2019)

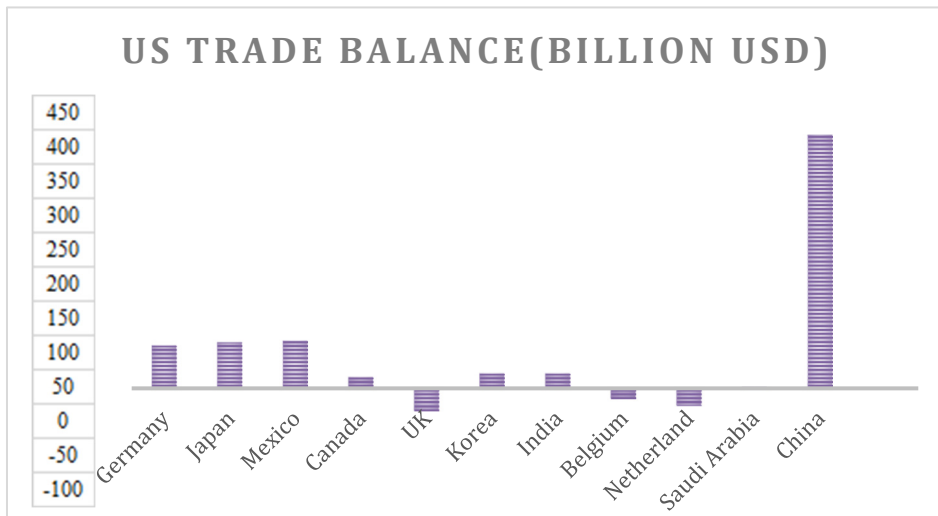


Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

## 1.2 US Foreign Trade Balance

Table 1-2, which is based on data extracted from the website of the US Census Bureau, shows the balance of trade exports, trade imports, and US trade balances between the United States and major trading partners in 2019. The main trading partners include Germany, United Kingdom, Belgium, the Netherlands, China, Japan, South Korea, India, Saudi Arabia, Canada, Mexico, and other close neighbors of the United States, almost covering the world's most important economies. Among them, the five countries of China, Japan, Germany, South Korea, and India were all included in the exchange rate policy monitoring list in the first half of the 2018 international economic and exchange rate policy report released by the US Treasury in October 17, 2018.

Figure 1-5. US Trade Balance with Partners (2019)



Data Source: <https://www.census.gov/foreign-trade/balance/index.html#>

From Figure 1-5, it can be seen that the US-China trade deficit in 2019 far exceeded that of the U.S. and other major trading partners. The U.S. trade deficit with Mexico, the second-largest deficit country, was only \$ 71.0 billion, while the US-China trade deficit The amount is as high as \$375.2 billion, the US-China trade deficit exceeds the US-Mexico trade deficit of \$304.1 billion.

The US-China trade deficit not only far exceeds the US-Mexico trade deficit, but also exceeds the sum of the above-mentioned trade deficits of the ten countries except China. In terms of volume, China is the largest trading partner of the United States and a trading partner that has a decisive influence on the US trade balance.

### **1.3 USD-CNY Exchange rate and US-China Trade Imbalance**

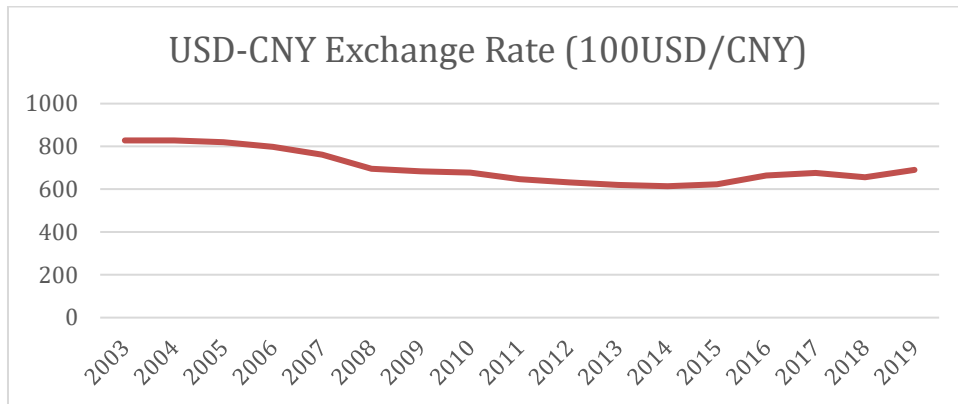
The data extracted from the website of the State Administration of Foreign Exchange and China Currency Network are used to make Table 1-3, which is a summary table of the monthly rate of USD-CNY from 2003 to 2019, using the direct price method and obtaining the average value of the RMB exchange rate each year.

Figure 1-6 shows the average exchange rate of RMB against the US dollar from 2003 to 2019 in the form of a line chart.

It can be seen from the figure that from 2003 to 2005, the exchange rate of the RMB against the US dollar has remained highly stable. Since 2005, the slope of the line chart has changed significantly, and the RMB has appreciated rapidly against the US dollar. After 2009, the rate of appreciation declined, while maintaining the trend of appreciation but basically stable.

From 2015, the RMB first decreased and then increased, and its impairment rate reached about 12%. Although the renminbi exchange rate has resumed appreciation from the second quarter of 2019, it has not yet dropped back to the highest point in the previous period. During the 17 years, the RMB exchange rate has appreciated by about 22.54% against the US dollar. In April 2018, although the United States did not replace China as a currency manipulator, China is still subject to monitoring.

Figure 1-6. USD-CNY Exchange Rate (2003-2019)



Data Source: [http://www.safe.gov.cn/wps/portal/sy/tjsj\\_hlzjj\\_inquire](http://www.safe.gov.cn/wps/portal/sy/tjsj_hlzjj_inquire)

<http://www.chinamoney.com.cn/fe/Channel/17383>

Comparing Figure 1-4 and Figure 1-6, while the USD-CNY exchange rate contained stable from 2003 to 2005, and US-China trade deficit continued to increase and accelerated after 2005, as reflected in the change in the slope of the curve.

During the accelerated appreciation of RMB from 2005 to 2008, while the US trade imbalance with China continued to increase, the growth rate decreased slightly, the accelerated appreciation of the renminbi exchange rate during this period also related to the timing of China's exchange rate reform in 2005.

However, when the RMB maintained its appreciation trend from 2009 to 2010, the US trade deficit with China showed a V-shaped change, and both the drop and the rebound were very obvious. From 2010 to 2015, the renminbi continued to appreciate, while the US-China trade balance continued to increase, keeping up.



Since 2016, the renminbi has depreciated slightly, and the U.S. trade deficit with China has shown a V-shaped change. Both the drop and the rebound have been very obvious.

The exchange rate of RMB against the US dollar and the US trade deficit shows a trend of development in stages. Overall, there isn't a significant correlation. However, there is a certain positive correlation in certain time intervals. Therefore, that is hard to determine it has an inherent statistical dependence between the two from the surface trend or not.

## Chapter 2. Is China Really a Currency Manipulator?

### 2.1 Literature Review

#### 2.1.1 Was RMB underestimated?

One of the contents of the Washington Consensus reached in 1989 is to adopt a competitive exchange rate system, which essentially requires the exchange rate liberalization. The Washington Consensus pointed out that an exchange rate higher than its equilibrium state may mean an external imbalance, while the exchange rate lower than the equilibrium state will lead to an internal imbalance. The final result of the exchange rate deviation from equilibrium will be high inflation, which will hurt harm economic growth (Ba Shusong, 2010)<sup>1</sup>.

John Williamson (2006)<sup>2</sup> believes that with domestic trade as a starting point, countries need a unified currency exchange rate system. The exchange rate should be sufficiently competitive to stimulate the rapid growth of non-traditional sectors and ensure that these export sectors will also remain competitive in the future.

Huang Yiping (2010)<sup>3</sup> refuted Paul Krugman's research conclusions from various aspects. He believes that the rapid appreciation of the RMB will destroy the global economy. Paul Krugman's<sup>4</sup> research is unreasonable. Huang Yiping's view is that if

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<sup>1</sup> 巴曙松、王志峰，当前人民币汇率争议及汇率形成机制改革方向：文献综述[J].浙江金融，2010，8：7-9.

<sup>2</sup> Williamson,J. The strange history of the Washington consensus[J].Journal of Post Keynesian Economics,2004,27(2): 195-206.

<sup>3</sup> 黄益平，冷静思辨人民币汇率[J].中国经贸，2010，4：55-56.

<sup>4</sup> Krugman, P. Will there be a Dollar crisis?[J].Economic Policy,2007,22(7): 435-467.

the Chinese government responds to Paul Krugman's substantial appreciation of the renminbi, the global economy will not only be 1.5% higher than the current growth level but may decline by 1.5% from the current level. He pointed out that investment bank Goldman Sachs used a world-wide exchange rate equilibrium model for testing. The result was that the RMB was undervalued by only about 15%. He believed that the RMB was moderately undervalued.

In 2009, Hu Zuliu pointed out that Paul Krugman's views on the RMB exchange rate are extreme. At the same time, he believes that to make China's economy develop better, China should adopt a more flexible exchange rate policy, which can make China's economic development avoid sharp fluctuations and real asset price bubbles.

Lin Yifu<sup>1</sup> has repeatedly expressed his views on the RMB exchange rate. In 2005, he felt that the RMB was undervalued by a small amount, but only by about 5%. In 2007, Lin Yifu stated that the RMB did not deviate significantly from its equilibrium exchange rate, so there was no room for substantial growth. In 2009, Lin Yifu firmly rejected the practice of renminbi forced appreciation to balance the world economy. He believes that the appreciation of the RMB will stifle the recovery of the global economy. The appreciation of the renminbi will actually raise the price of Chinese exports, which will curb US consumer demand.

Since most of China's goods exported to the United States are not produced in the United States, the appreciation of the RMB will not reduce the US trade deficit with

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<sup>1</sup> 林毅夫, 关于人民币汇率问题的思考与政策建议[J].世界经济, 2007,3: 3-12.

China. Therefore, American consumers need to pay more for imported goods, even if they do not buy Chinese goods, they will buy goods from other countries.

In 2011, Yang Liu<sup>1</sup> proposed that the valuation of the RMB exchange rate differed widely from 1998 to 2003, and it was difficult to find an explanation in academic theory. He believes that western countries such as Japan and the United States are accustomed to proceed from their own perspectives or intentions and face the RMB exchange rate with a politicized attitude. In 2017, Lin Yifu stated that he did not support the full liberalization of the RMB capital account. Regarding the phenomenon of an abnormal flow of RMB funds in China at that time, Lin Yifu pointed out that there has been a consensus in the industry that the RMB capital account should be managed as necessary, and from the perspective of the real economy, the RMB should appreciate in the long run.

The United Nations Conference on Trade and Development published a research report in Switzerland in January 2011, which pointed out that the cumulative effective appreciation of the renminbi's real effective exchange rate in unit labor costs since 1995 has been close to 100%, and the current currency value has not been underestimated;

The actual effective exchange rate of the RMB has been calculated by the consumer price index since 1995. The cumulative appreciation has been close to 30%.

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<sup>1</sup> 刘洋、陈守东和吴萍, 中美双边贸易汇率弹性与收入弹性的新变化——基于 TVP-VECM 时变协整模型[J].经济问题探索, 2018, 10: 163-170.

The research group of the of Tianjin University (2010)<sup>1</sup> demonstrated from various aspects that the RMB exchange rate was not underestimated. They believe that after the outbreak of the global financial crisis in 2008, China's development momentum is good on a macro level, but China's own form of trade is also changing at the same time, especially in terms of import volume and speed.

The research team collected statistical data from 37 countries in the whole year of 2009, of which about 40% of the country's exports to China reflected the growth trend. Eurozone exports to China, which were severely impacted by the European debt crisis, only fell by about 15.3%, higher than the overall Eurozone exports of about 5%. For the United States, the world's largest economy, its overall exports fell by 17%, but US exports to China fell by only 0.22%, far higher than its overall export decline.

China is not only an important export destination for Asian countries such as South Korea and Japan but also a major export destination for countries such as the European Union and the United States. This actual situation is very different from the view that some officials and scholars believe that the current RMB exchange rate is undervalued or even greatly undervalued.

In addition, after the outbreak of the world financial crisis in 2008, China suffered from systemic risks such as shrinking global trade and depreciation of major currencies, and its exports declined significantly. This phenomenon also reveals

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<sup>1</sup> 天大研究院课题组、王元龙，破解人民币汇率难题的应对之策——兼评人民币汇率低估论[J].经济研究参考，2010，42：4-12.

whether the imbalance of RMB exchange rate has little effect on China's export changes. If the RMB exchange rate is indeed undervalued, China can benefit from it.

But within two months of the crisis, China's export growth has rapidly dropped from 20% to minus 30%, with a decline of 50%, which can be described as a cliff-like decline. The research group also pointed out that the RMB exchange rate is overvalued if it refers to a basket of currencies.

### 2.1.2 If RMB appreciates, the trade deficit could be solved?

In international finance, the doctrine of exchange rate affecting the balance of payments mainly includes elastic analysis, currency analysis, and absorption analysis. What these doctrines have in common is that although the premise of recognizing exchange rate depreciation to improve a country's trade balance is very complicated, they basically agree that trade balances can be changed due to exchange rate depreciation (Ba Shusong, 2010)

Shen Guobing (2005)<sup>1</sup> used data from 1994 to 2002<sup>2</sup> for empirical results. The results show that there is no stable relationship between the nominal or real RMB exchange rate and the US-China trade balance. The empirical results using monthly data from 1998 to 2003 show that there is no long-term and stable cointegration relationship between the RMB exchange rate and the US-China trade balance.

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<sup>1</sup> 沈国兵, 美中贸易收支与人民币汇率关系: 实证分析[J].当代财经, 2005, 1: 43-47.

<sup>2</sup> 沈国兵、杨毅, 人民币实际有效汇率与中国贸易收支关系—1990-2004 月度数据分析[J].经济研究, 2005, 5: 11-16.

Therefore, Shen Guobing believes that it is impossible to determine whether the changes in the RMB exchange rate will affect the trade balance. The US-China trade deficit cannot be adjusted solely by changes in the RMB exchange rate.

The theory of RMB appreciation is not only an economic issue but also an international political issue. Naturally, changes in the RMB exchange rate cannot solve the trade deficit between China and the United States. He Liping, Fan Yanhui, and Fan Xiaohang (2006) combined time trend variables to empirically examine the potential relationship between the ratio of the US current account deficit to GDP and the real effective exchange rate index of the US dollar from 1980 to 2004.

The empirical results show that since 1990, the role of exchange rate variables and time trend variables has been on the rise and fall, the role of exchange rate variables has decreased significantly, and the role of time trend variables has become more significant. This result indicates that there is a possibility that the relationship between the US dollar exchange rate and the US current account balance is clearly different from that described in general theory. Their view is that it is difficult for the appreciation of the renminbi to help the US adjust its balance of payments deficit. Similarly, the reduction of the US current account deficit cannot be carried out through the devaluation of the US dollar.

Xiao Geng (2007)<sup>1</sup> believes that the US unilateral attention to the RMB exchange rate adjustment mechanism has no effect on improving China's trade imbalance.

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<sup>1</sup> 肖耿, 从结构与制度视角解释中国汇率政策和外部经济失衡[J].经济与管理, 2007, 7-8: 16-22.

Xiao Geng pointed out that China and other Asian countries have a special problem of coexistence of labor surplus and capital surplus.

China's per capita wealth stock is not high, but China can in fact send excess capital to countries with large capital stocks such as the United States, thereby providing financing support for excessive consumption by countries with large capital stocks such as the United States. This is an essential issue that really needs attention. The RMB exchange rate issue will divert people's attention and make people ignore the essence.

Based on international price competition, Wang Sheng and Li Saijun (2009) established a research framework for the exchange rate transmission effect of RMB and used this framework to empirically study the degree of exchange rate transmission of Chinese export prices to the United States. Their empirical research using vector error correction models and cointegration techniques concluded that China's export prices to the United States are greatly affected by international price competition, and the exchange rate of the RMB exchange rate is not high.

Therefore, the appreciation of the RMB to improve the effectiveness of the US-China trade imbalance policy will be greatly weakened by the incomplete exchange rate transmission weakening the effect of expenditure transfer. Paul Krugman (2010)<sup>1</sup> called on the US government to take tougher measures against China, and Ronald McKinnon (2010)<sup>2</sup> expressly opposed this view.

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<sup>1</sup> Krugman, P. Will there be a Dollar crisis?[J].Economic Policy,2007,22(7): 435-467.

<sup>2</sup> Mckinnon.R. & Schnabl,G. The case for stabilizing China's Exchange Rate: Setting the stage for fiscal expansion[J].China & World Economy,2010,17(1): 1-32.



The research group of Tianjin University (2010) believes that it is untenable to equate the trade surplus with the undervalued RMB exchange rate. The research group pointed out that the key to US-China trade imbalances stems from many economic problems of the United States itself, such as the unequal status of US-China trade, the low domestic saving rate of the United States, and the US dollar as the main international reserve currency, rather than directly from the RMB exchange rate. This view is similar to Ronald McKinnon's.

The research group also believes that one of the important reasons for the US-China trade imbalance is that the two countries have not adopted a unified statistical method when measuring the actual trade situation. US statistics may greatly overestimate the imbalance between the two countries. The US overestimation can be reflected from four perspectives:

The first is that there are differences in import and export statistical standards that prevent the value of exports and imports from being accurately estimated. The second is that the US has ignored the value-added factors. The third is that the US did not consider service trade in its statistics, and only included merchandise trade. Finally, a large proportion of Chinese goods are re-exported to central and north America and south America through the US as an intermediary. It is unreasonable for the US to include this part of re-exports in China's exports to the United States. The research group believes that the processing trade surplus is the main reason for China's trade surplus.

In general, domestic scholars have used different econometric models and statistical methods for many years to study the RMB exchange rate and US-China trade issues from various perspectives. The research conclusions of domestic scholars are mostly that the exchange rate fluctuation of the RMB has a weak effect on the trade imbalance between the two countries. The trade deficit of the US is more derived from the US's own economy or expansion needs. At the same time, some scholars believe that the impact of the RMB exchange rate change on the trade between the two countries is different in the short and long term. The general conclusion is that the long-term impact is more serious than the short-term.

In general, China's exchange rate level coincides with economic fundamentals. China does not deliberately suppress the RMB exchange rate and use it to compete for exports. So China is obviously not a currency manipulator.

## **2.2 Modeling**

### 2.2.1 Models review

Based on the theoretical conclusion above, I will use the data for empirical analysis.

Over the years, there are many theories that explain the impact of exchange rate changes on the trade balance. The most popular ones are Marshall-Lerner condition, J- Curve effect, and Absorption Analysis.

The current situation in which changes in a country's exchange rate affects the country's balance of payments can be simply understood as follows: under the direct pricing method, if the country's exchange rate falls, it means that the foreign

currency depreciates and the local currency appreciates. The appreciation of the local currency will cause the relative price of domestic commodities to rise and suppress exports, but at the same time, the depreciation of foreign currencies also means that the relative price of foreign commodities will fall, which will benefit domestic imports.

Of course, this mechanism of exchange rate changes affecting the balance of payments will have a certain time lag, that is, the J curve effect, and it is also constrained by factors such as the elasticity of demand for import and export commodities and the sensitivity to exchange rate changes. Secondly, changes in imports and exports caused by the appreciation of the local currency may further affect the country's industrial transfer, adjustment, and upgrades, which in turn will adversely affect the country's foreign trade product structure. Third, the appreciation of the local currency also directly affects a country's foreign exchange reserves.

To sum up, exchange rate changes can directly or indirectly affect the balance of payments through a variety of channels. This mechanism of influence is difficult to be generalized due to various factors such as time and flexibility. The balance of payments is not determined solely by the exchange rate. It is also directly affected by factors such as the economic structure and product competitiveness of the two countries. The focus of this article will be the impact of exchange rates on national revenue and expenditure.

### 2.2.2 Models contribution

First, from a macroeconomic perspective,  $GDP=C + I + G + NX \rightarrow NX=GDP - C - I - G$

trade deficit is directly related to consumption, investment, and government spending.

There is an inextricable link between consumption and international trade. Consumption is a prerequisite for international trade. For a trader, only when there is a demand for the traded commodity, he will decide to conduct or continue to trade. Traders will not be interested in this commodity trade if no one comes to consume it. International trade is a way to achieve and expand consumption. Commodities consumed by consumers can come from domestic production on the one hand and foreign production, on the other hand, this must go through international trade. It is precise because of this interdependent relationship between them that determines the mutual influence between consumption and international trade.

As the two major factors driving economic growth, investment and consumption must maintain an appropriate balance in the economic operation. This is because consumer demand and investment demand are mutually constrained and determined by each other. Under the condition that the total amount of regional funds is generally stable, the growth of investment demand is constrained by the growth of consumer demand. Under the market economy, the growth of investment demand is ultimately realized by the growth of consumer demand. Investment demand provides goods for consumer demand. Supported by consumer demand, the new production capacity formed by investment demand will be a lot of waste. Whether it is solely driven by

investment demand or economic growth by consumer demand, it is impossible to continue.

And government spending also affects investment and consumption. For example, If an increase in government spending or a decrease in tax revenues leads to a deficit that is financed by increased borrowing, then the borrowing can increase interest rates, leading to a reduction in private investment.

Based on eliminating seasonal and irregular variables and performing stationarity tests on variables, I will use the ordinary least squares to estimate the statistical dependence of the dependent variables and independent variables. At the same time, I will verify whether there is Granger causality between the RMB exchange rate and the US-China trade deficit.

### 2.3 Regression

This article involves ordinary least square, augmented Dickey-Fuller test, and Granger causality test.

$$Q = \sum_{i=1}^n (Y_i - Y_i')^2 \quad (a)$$

The ADF test is a method of unit root test. It is expanded based on the DF test and is completed by the following three models:

Model 1:

$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^m \beta_i \Delta X_{t-i} + \epsilon_t \quad (b)$$

Model 2:

$$\Delta X_t = \alpha + \delta X_t - 1 + \sum_{i=1}^m \beta_i \Delta X_t - i + \epsilon_t \quad (c)$$

Model 3:

$$\Delta X_t = \alpha + \beta t + \delta X_t - 1 + \sum_{i=1}^m \beta_i \Delta X_t - i + \epsilon_t \quad (d)$$

Cointegration is a statistical representation of this equilibrium relationship, assuming that the long-term stable equilibrium relationship between X and Y is described as follows:

$$Y_t = \alpha_0 + \alpha_1 X_t + \mu t \quad (e)$$

$$\mu t = Y_t - \alpha_0 - \alpha_1 X_t \quad (f)$$

The linear combination is called an I (0) sequence, at which time the variables X and Y are cointegrated.

The basic step of Granger causality test is to estimate the following regression equation for two variables Y and X:

$$Y_t = \sum_{i=1}^m \alpha_i X_{t-i} + \sum_{i=1}^m \beta_i Y_{t-i} + \mu_1 t \quad (g)$$

$$X_t = \sum_{i=1}^m \lambda_i Y_{t-i} + \sum_{i=1}^m \delta_i X_{t-i} + \mu_2 t \quad (h)$$

Table 2-1 and Table 2-2 are the original data required for empirical analysis

Table 2-3 is a summary table of monthly RMB-dollar median prices from 2003 to 2019

Table 2-1 shows the monthly US trade deficit with China from 2003 to 2019

Table 2-2 shows that from 2003 to 2019, GDP, PCE, GPDI, and GCEGI are government consumption expenditures and investments.

The source of the data for the RMB-USD median price is the website of the State Administration of Foreign Exchange and China Currency Network. The renminbi exchange rates used in this paper are all nominal exchange rates. Compared with the real exchange rate, the nominal exchange rate is more affected by the reform of the exchange rate formation mechanism and macroeconomic policy tools, and it is more conducive to reflecting the direct effect of exchange rate changes on the trade balance.

The data source of the US trade deficit with China is from the website of the US Bureau of Statistics.

The source of US domestic production, consumption, and investment data is the US Department of Commerce website. Since Table 2-2 is quarterly data, the monthly data of Table 2-3 and Table 2-1 are integrated into quarterly data for unified measurement, and then made tables 2-3 and 2-4. I adopted the Census X12 seasonal adjustment method to Table 2-2, 2-3, and adjust the data in Table 2-4.

The purpose of the seasonal adjustment method is to remove seasonal and irregular changing factors from the original time series is to obtain the potential trend-cycle component of the original time series.

The trend-cycle component can more objectively reflect the development law of economic time series without being disturbed by seasonal changes.

The Census X12 method is based on the X-11 seasonal adjustment method proposed by the US Census Bureau in 1965, and adopts the following four model forms:

(1) Multiplication mode  $Yt = TCt * St * It$  (j)

(2) Addition mode  $Yt = TCt + St * It$  (k)

(3) Logarithmic addition mode

$$\log(Yt) = \log(TCt) + \log(St) + \log(It) \quad (m)$$

(4) Pseudo-logarithmic addition mode  $Yt = TCt * (St + It - 1)$  (n)

t represents the year, Y, TC, S, and J represent the original time series, trend-cycle components, seasonal change factors, and irregular change factors, respectively.

The above model expands the sequence through prediction and reverse speculation, and decomposes Yt into TCt, St, It.

Currently, the multiplication model is the most widely used among the above four models. This time, I used the multiplication model for empirical data. The adjusted data are shown in Table 2-5, Table 2-6, and Table 2-7.

The quarterly adjusted quarterly RMB exchange rate data trend of Census X12 is similar to Figure 2-6 and has also experienced super stable, rapid appreciation, shock



appreciation, and slight depreciation. The average value of the RMB exchange rate in the fourth quarter of 2017 increased by about 20% compared with the average value in the first quarter of 2003. The Census X12 quarterly adjusted US-China trade deficit data trend is similar to Figures 3-4. It also declined slightly in 2001 and 2018, but overall it is still expanding rapidly.

The average value of the U.S.-China trade deficit in the fourth quarter of 2019 increased from the average value in the first quarter of 2003 by approximately 361.74%. In the fourth quarter of 2019, the US GDP, household consumption expenditure, domestic private investment, government consumption expenditure, and investment data increased by approximately 36.65%, 44.48%, 31.52%, and 14.52%, respectively. From the data for the first quarter of 2003. And from 2003 to 2019, although the above data declined slightly in individual periods, the decline was not large. All of this reflects that the domestic demand in the United States has been expanding for 17 years.

## 2.4 Interpretation

### 2.4.1 OLS

In this paper, statistical software Eviews10 is used as an analysis tool. Firstly, discuss whether there is a statistical dependence between the variables:

$$\begin{aligned} LOG(TD) = & C(1) + C(2)*LOG(ER) + C(3)*LOG(GDP) + C(4)*LOG(PCE) \\ & + C(5)*LOG(GPDI) + C(6)*LOG(GCEGI) + c \end{aligned} \quad (p)$$

Table 2-8. Explanation of Variables in Multiple Linear Regression Model

Variable	Variable property	Meaning
TD	Dependent Variables	US-China Trade Balance
ER	Independent Variables	USD-CNY Exchange Rate
GDP	Independent Variables	US GDP
PCE	Independent Variables	US PCE
GPDI	Independent Variables	US GPDI
GCEGI	Independent Variables	US GCEGI
C(1)	Constant Term	
C(2)-C(6)	Explanatory Variable Coefficient	
c	Random error term	

Note: The original unit of the dependent variable and the other independent variables except the average exchange rate of RMB against the US dollar is one million US dollars. To improve the accuracy of the model, the logarithm of the dependent variable and the independent variable are both taken.

In order to reduce the effect of multicollinearity of the explanatory variables on the regression results, and at the same time ensure that both the explained variables and the explanatory variables are stationary time series, the logarithmic first-order difference of the above variables has an economic meaning of the rate of change of the above variables. The ADF test is performed on the variable after taking the logarithm and first-order difference, and the results are as follows,

Table 2-9. Variable ADF Test Results

Variable	ADF Statistics	Critical value at 1% significance level	Critical value at 5% significance level	Critical value at 10% significance level
TD	-6.130154	-3.533204	-2.90621	-2.590628
ER	-3.357691	-3.542097	-2.910019	-2.592645
GDP	-4.612453	-3.533204	-2.90621	-2.590628
PCE	-2.768079	-3.534868	-2.906923	-2.591006
GPDI	-4.37353	-3.533204	-2.90621	-2.590628
GCEGI	-2.384017	-3.534868	-2.906923	-2.591006

According to the ADF test results, variables above have no unit root at a 90% confidence level, which is a stationary time series. The logarithmic and first-order difference variables are used to obtain the following regression results through Eviews10:

Table 2-10. Empirical Results of Multiple Linear Regression Model

Statistical indicators	Data
Coefficient C(2)	-0.662794
Coefficient C(3)	-8.066319
Coefficient C(4)	1.677168
Coefficient C(5)	2.202691
Coefficient C(6)	6.775972
T Test Statistics-C(2)	-1.509164
T Test Statistics-C(3)	-3.536586
T Test Statistics-C(4)	5.409007
T Test Statistics-C(5)	2.719435
T Test Statistics-C(6)	3.665742
coefficient of determination -R <sup>2</sup>	0.430696
Adjusted Coefficient of Determination	0.384032
Dubin Watson Statistics -DW	1.915984
F Test Statistics	9.229673

The regression results show that C (2) and C (3) are negative, indicating that the change in the RMB exchange rate is negatively correlated with changes in US GDP and changes in the US trade deficit with China.

C (4), C (5), and C (6) are positive, indicating that the changes in US household consumption expenditures and government consumption expenditures are positively correlated with changes in domestic private investment and changes in the US trade deficit with China.

The T test statistics of the independent variables LOG (ER), LOG (GDP), LOG (PCE), LOG (GPDI), and LOG (GCEGI) are significant at a 90% confidence level, that is, they pass the variable significance test.

The F test statistic of the equation is significant at a 90% confidence level, that is, it passes the significance test of the overall linearity of the equation.

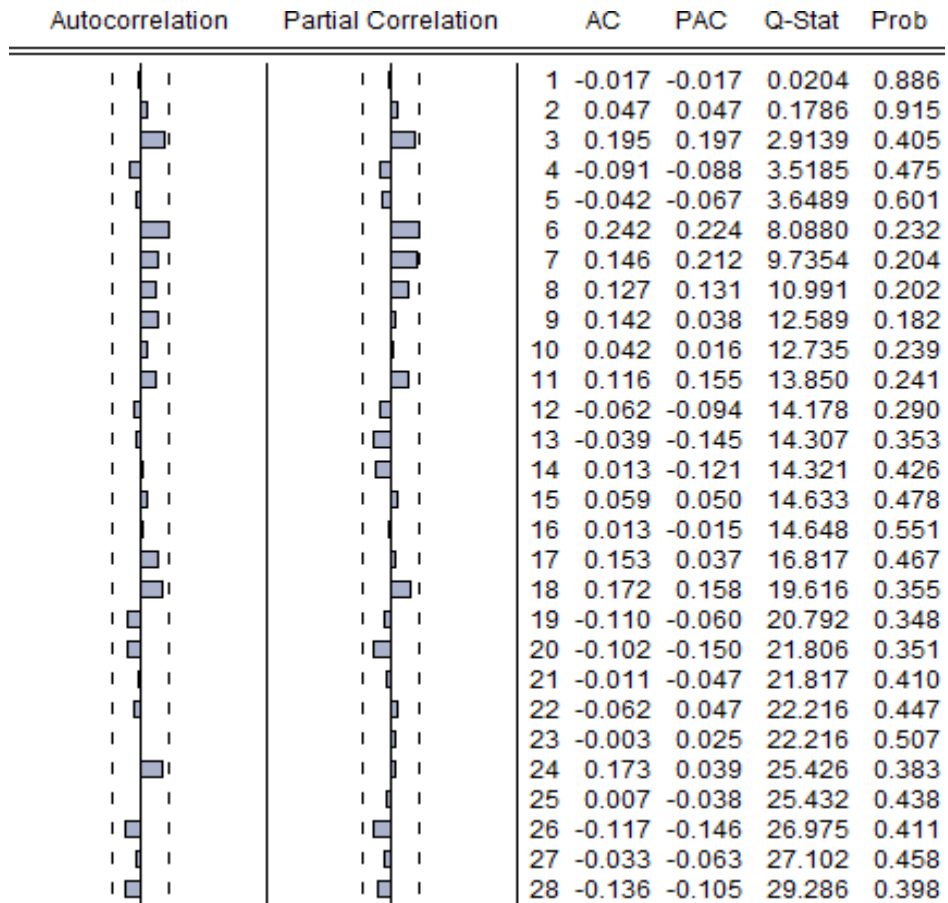
The Durbin-Watson stat of the model is 1.915984.

From the Figure,  $(du) < (DW \text{ statistical value}) < (4-du)$

(Du) is approximately equal to 1.61, so there is no first-order autocorrelation in the model.

The autocorrelation coefficients, partial autocorrelation coefficients and correlation graphs of the model residual sequence are as follows:

Figure 2-1. Multivariate Linear Regression Model Residual Sequence Correlation Diagram



This shows that the model does not have a high-order sequence correlation.

Carrying out the White heteroscedasticity test on the model can obtain the F test statistic of 0.663375, and the corresponding P value is 0.8398, that is, the model has no heteroscedasticity.

The model's coefficient of determination and the adjusted coefficient of determination are 0.430696 and 0.384032.

Considering that the model is an explanatory model and the logarithm of the variables is a first-order difference at the same time, the coefficient of determination and the coefficient of adjustment after adjustment is within a reasonable range.

#### 2.4.2 ADF Test and Granger Causality Test

By conducting the ADF unit root and cointegration test on the seasonally adjusted quarterly RMB exchange rate time series and the quarterly US-China trade deficit time series, I found that the two series above are second-order single integers. That is, the two pairs of sequences are of the same order and have a cointegration relationship. So I can test whether the above two sequences have Granger causality.

Table 2-11. ADF Test Result

Variable	ADF Statistics	Critical value at 1% significance level	Critical value at 5% significance level	Critical value at 10% significance level
TD	-3.803033	-3.540198	-2.909206	-2.592215
ER	-3.256423	-3.533204	-2.90621	-2.590628

Table 2-12. Johansen Cointegration Test Results

Null hypothesis	Trace Statistics	5% threshold	Max-Eigen Statistic	5% threshold
no cointegration relationship	48.15064	15.49471	37.781	14.2646
At most one cointegration relationship	10.36964	3.841466	10.36964	3.841466

The number of lag periods is very sensitive to the Granger causality test. When the Granger causality test does not change with the number of lag periods and maintains certain stability, the Granger causality test can be determined according to the test results. The seasonally adjusted quarterly RMB exchange rate time series and the quarterly US-China trade deficit are tested separately from lag period 1 to lag period 2. The results are as follows:

Table 2-13. Granger Causality Test Results

Null hypothesis	F Statistics	P value of lag phase I	F Statistics	P value of lag phase II
US trade deficit with China changes is not Granger reasons for USD-CNY exchange rate changes	2.64946	0.1085	3.44066	0.0384
USD-CNY exchange rate changes is not Granger reasons for US trade deficit with China changes	0.30718	0.5813	0.75455	0.4746

Test results above show that USD-CNY exchange rate changes are not Granger reasons for the US trade deficit with China changes. While the US trade deficit with China changes is Granger reasons for USD-CNY exchange rate changes.

## 2.5 Product competitiveness and Trade Balance

Personally, I see product competitiveness as the core reason for the US-China trade gap.

### 2.5.1 US- China Trade Products Structure

First of all, judging from the actual data classification, the trade between China and the United States has some outstanding features in terms of commodity structure. Based on the general analysis ideas, the characteristics of the two countries in the trade commodity structure are mainly reflected in the strong complementarity.

Specifically, the reasons for this complementarity are mainly based on the differences in resource endowments and differences in the density of factors, etc., resulting in differences in economic development, development stages, industrial structure, demand characteristics, consumption levels, etc. The flow between different regions has resulted in the complementary presentation of commodity structures in trade.

This complementarity of commodity structure in trade specifically includes several aspects:

First, it is the complementarity of resource endowments and factors. Regarding resource endowments and factor markets, the gap between China and the United States is relatively large. According to Professor Lin Yifu's point of view, China has comparative advantages in labor-intensive and resource-intensive industries. This is due to China's better natural resource endowments and cheap and sufficient labor resources.

The United States is the world's top power, with obvious advantages in all aspects. Compared with China, the United States has a comparative advantage in terms of software elements, especially in high-tech, capital, management, etc. The



accumulation of soft resource endowments has led to its structural characteristics of import and export products in international trade.

Secondly, it is the complementarity of the industrial structure. Since the founding of the People's Republic of China, China has been exploring an economic development path with Chinese characteristics. From the reform and opening up in 1978 to the present, China has been continuously and limitedly devoted to the development of key industries that are at stake in the national economy and people's livelihood based on its own economic development foundation and social characteristics.

First, solve the main contradictions, develop key industries to improve water conservancy, energy, transportation, and other industries. And continue to lead in the fields of machinery, electronics, petrochemicals, construction, automobiles, high-tech, etc., forming a connection between the three major industries.

Therefore, in the course of development, in different historical periods, the import and export structure of China and the United States actually reflected the changes in the industrial structure of the two countries, which is a direct manifestation of industrial policy and economic orientation in the field of foreign trade.

Finally, it is the complementarity of the market structure. The explanation for the formation of international trade is the economic exchanges caused by differences in resource endowments. The United States is the world's largest power, with outstanding strength in all aspects. Its necessary production expansion and the global

profit-seeking of massive capital require them to use every resource in the world to tap the value of economic growth.

China also is the largest developing country in the world, with the largest population in the world, a broad base industry audience, the rapid development of emerging industries, the world's largest consumer market, and the largest potential industrial consumer market in the future. Many countries will develop the Chinese market as an important strategy.

In other words, in terms of the market, what we thought was a large population base and a weak foundation, but now it has become an advantage. Coupled with China's rapid economic growth in recent decades, the economic and trade exchanges between China and the United States, and even all other countries, are long-term equilibrium evolution of the regional supply and demand market. These complex economic and trade exchanges reflect the uniqueness of China's market situation. That is, the Chinese market has effectively achieved resource complementarity and supply-demand balance with other countries promoted common prosperity, and achieved mutual benefit and win-win results.

From the specific product structure of the US-China trade, corresponding to the above structural analysis of the US-China trade, China currently exports a large number of labor-intensive products such as footwear, toys, and clothing to the United States. This also matches the industrial structure and economic characteristics of the two countries.

Among them, textiles and apparel, resource products, and light industrial products are the categories with a large proportion of China's exports. U.S. exports to China are mainly concentrated in technology-intensive and capital-intensive industries, such as automobiles, machinery, aircraft, electronic information, and other products, in addition to a small amount of cotton, fertilizer, wheat, wood, paper, metal, and minerals, etc. , and a very limited number of technology transfers.

### 2.5.2 Cause analysis

First, the internal structure of the US economy is unbalanced. The U.S. economy is highly developed, residents and sectors have strong spending power, low willingness to save, and solidified consumption habits. Therefore, assuming that the U.S. economy is sluggish but does not hinder the overall consumption capacity and purchasing power of its country, what its domestic economy cannot provide, only can turn to imports or foreign investment.

At the same time, the United States has already crossed the stages of primary processing and low-level manufacturing. At present, the domestic real economy and the virtual economy are seriously unbalanced. The labor force and industrial development stage do not support the development of extreme physical manufacturing, so some of its domestic necessities must also be imported from abroad to meet demand.

Although China is the main exporter of such commodities in the United States, the exchange rate elasticity of labor-intensive products has increased in recent years. China's labor force advantage is no longer in the past, and China does not have an

absolute substitute production capacity for such products. The large selection of products of the same type and the same utility and the already limited profit margin of labor-intensive products are also affected to a certain extent by the appreciation of the RMB.

In this case, the RMB appreciates, the US and China may still have a surplus in some product areas, although this surplus is shrinking, so the RMB exchange rate will not be the main cause of the US-China trade surplus, even if it has an impact, the United States can control the degree of trade surplus based on its own characteristics and options.

Second, China's industrial structure has been continuously upgraded. With the continuous changes in the world pattern, the process of global integration is accelerating, and the integration of the industrial chain is gradually deepening. After years of development of the primary industry, China has gradually entered the high-end manufacturing industry, and the high-end smart manufacturing industry has developed vigorously and made progress.

In recent years, China's international positioning and division of labor have quietly changed, gradually shifting from elementary to intermediate and advanced. In addition to primary industrial manufacturing and processing trade, China has gradually emerged in the export of manufactured products in the mid-to-high-end sector, and the proportion of capital-intensive and technology-intensive products has risen. This change will also bring a significant trade surplus effect after the development stage is upgraded.

Third, the US's special trade strategy. As a superpower, the United States focuses on ecological construction internally and has perfect environmental protection laws. It advocates the use of external resources and the least environmental cost to achieve economic development and people's prosperity.

Therefore, industries that have a direct impact on the environment and have a strong environmental and ecological negative externality are restricted to the United States within the region, and they advocate substitution by directly importing finished products. And China is in a critical period of industrial restructuring, high-end manufacturing and environmental protection are our aspects of concern.

But generally speaking, the driving force for pursuing benefits is still greater than the demand for environmental protection, and it is also the pillar of GDP in some regions. Therefore, China's exports to the United States are still very large, which seems acceptable to both parties. The United States not only saves its own resources by importing large amounts but also prioritizes the development of its own high-tech industries and maximizes the "resource conversion benefits". Therefore, the trade balance of this type of product is large in US income elasticity but not significant in the exchange rate.

Fourth, the key elements of US trade barriers. An important part of the US-China trade deficit is daily commodities. In addition, manufacturing commodities on the one hand are the products with the highest proportion of China's surplus, and on the other hand, are the products with the highest share of the US export to China, mainly high-tech machinery.

It can be seen that my country's import demand is mainly concentrated on producing technologically advanced products. China is in the primary stage of socialist development. High-tech and technological innovation have been striving forward, but it is far behind the United States. There is still a large number of high-tech products imported, technical support, and patent demand.

The United States leads the world in the comprehensive strength of high-tech R&D and application. In order to protect its own interests, maintain its competitive advantages between countries, and even involve certain political purposes, it will naturally restrict the export of high-tech products, technologies, and patents to China. In particular, advanced technology and equipment that are urgently needed for China's economic development.

Successive U.S. government hawks have always advocated restricting China, and have also thrown out the "China threat theory," believing that high-tech exports will threaten U.S. national security and break U.S. technological superiority. Of course, high-tech products are also exported in China, but the level is not enough, and the volume is not large. In the case of strict export blockages in the United States, there is naturally a corresponding trade surplus, and technology-intensive products are usually capital-intensive products, and the unit price of the product relatively high, the US restrictions will also have a magnifying effect on its overall trade deficit with China.

Fifth, FDI transfer surplus. Foreign direct investment also has a great impact on the trade surplus. In 2016, my country's actually utilized foreign capital was \$125 billion, a 140-fold increase from 1983.

In the past three decades, with the rise of China's economy, the opportunities for economic development have been paid attention to and deepened by global investors. China has become one of the countries with the most FDI. The survey results show that from 2017 to 2019, China is not only the most important source of investment for cross-border investment but also the best investment destination after the United States, which is clearly ahead of other economies.

The main reason for FDI flowing into China is that China has experienced a long development phase with OEM and primary processing roles in the development process. Other Asian countries, such as South Korea and Japan, have developed more than China. There is a need for upgrading the internal industrial structure, so natural labor-intensive industries will be transferred to China to do this, which is also in line with the actual situation of China's corresponding development stage.

However, the main purpose of these FDI flows into China is not to promote technological development, but to use China's cheap labor to build factories for production and export the manufactured products to the United States and other countries. Since the United States uses the method of trade statistics of origin exports, this part of the trade balance should belong to east Asian countries is counted as China's export balance, and the trade surplus created by FDI accounts for an increasing proportion of China's total surplus.

## **Chapter 3. Conclusion**

### **3.1 Summary**

Through the results of multiple linear regression and Granger causality test, the following conclusions could be drawn:

1. The exchange rate of RMB against the US dollar has a negative correlation with the US trade deficit with China. That is, as the exchange rate of RMB against the US dollar continues to decline, the US trade deficit with China will continue to increase.

This statistically negative correlation means that the appreciation of the renminbi against the US dollar will widen the US trade deficit with China, which is contrary to the view that the US has consistently demanded that the appreciation of the renminbi ease the huge trade deficit.

The reason may be that the balance of trade depends on the combined role of imports and exports.

From a macro perspective, the appreciation of the renminbi will indeed impact traditional products with low added value and traditional industries dominated by labor-intensive enterprises. But at the same time, it will force China's industrial transfer, adjustment, and upgrade in a market-oriented manner.

Microscopically, the appreciation of the renminbi also helps Chinese companies to obtain better resources, technology, and knowledge, which in turn promotes the improvement of Chinese companies' productivity and product competitiveness and expands exports.



In addition, some Chinese products, such as photovoltaic modules, have a relatively stable share in the world market and have obvious price advantages. The appreciation of the renminbi, while slightly increasing the terminal selling price, can also enable companies to reduce anti-dumping or anti-dumping against Chinese products in western countries. Subsidies review pressure, thus solidifying the export share.

2. The results of multiple linear regression show that there are many reasons for the huge US trade deficit with China. The US GDP, PCE, GPDI, and GCEGI all have huge impacts on the US trade deficit with China. The elasticity of the deficit is greater than the elasticity of the USD-CNY exchange rate with respect to the US-China trade deficit. Therefore, aside from other possible reasons, it is unreasonable to simply blame the US-China trade deficit on the USD-CNY exchange rate.

3. Granger causality test results show that the change in the RMB exchange rate during the two lags is not the Granger cause of the change in the US trade deficit with China. While The change in the US trade deficit with China is the Granger reason for the change in the RMB exchange rate.

### **3.2 Contributions**

Based on the growing US-China trade war, this paper reviews the development trend of the RMB exchange rate and the US-China trade deficit from 2001 to 2019 and uses the ordinary least squares estimation method and Granger causality test to

analyze the RMB exchange rate and the statistical dependence of the US-China trade deficit.

On January 15, China and the United States formally signed the first-stage economic and trade agreement. Two days before, on January 13, the US Treasury Department released a semi-annual report on the macroeconomic and foreign exchange policies of major US trading partners. The report said that the recognition of China as a "currency manipulator" was canceled, but China was still on the watch list. This also verifies the accuracy of my conclusion.

Recently, there are a lot of researches on the US-China trade deficit and USD-CNY exchange rate, but this article selects PCE, GPDI, GCEGI in the model construction based on the previous literature empirical research ideas, and the monthly and quarterly data from 2001 to 2019 are used as explanatory variables.

Also, one of the conclusions of this article is that the appreciation of the renminbi against the US dollar will make the US-China trade deficit widen, contrary to the view that the US has consistently demanded that the appreciation of the renminbi alleviate the huge trade deficit. This article gives preliminary thoughts on the reasons that may lead to this conclusion.

### **3.3 Limitations**

There are two main limitations of data in my article.

First, the statistical calibers of China and the United States are different. There are different standards and standards in the statistics of foreign trade between China and the United States, which leads to great controversy on trade surplus and deficit data.

Most of the goods exported by our country are not directly delivered, but need to be re-exported in the middle, which leads to statistical errors. In addition, customs work principles and differences in quotation methods are also the reasons for the differences in trade data.

Second, due to the limited data sources and unreliable authenticity, I did not choose various data from China. This is essential in more in-depth research.

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## Appendixes

Table 1-1 US-China Trade Balance (2003-2019) (billion USD)

Year	2003	2004	2005	2006	2007	2008
US Export	28.4	34.4	41.2	53.7	62.9	69.7
US Import	152.4	196.7	243.5	287.8	321.4	337.8
Balance	124.1	162.3	202.3	234.1	258.5	268.0
Year	2009	2010	2011	2012	2013	2014
US Export	69.5	91.9	104.1	110.5	121.7	123.7
US Import	296.4	365.0	399.4	425.6	440.4	468.5
Balance	226.9	273.0	295.2	315.1	318.7	344.8
Year	2015	2016	2017	2018	2019	
US Export	115.9	115.6	130.4	120.1	106.6	
US Import	483.2	462.6	505.6	539.7	452.2	
Balance	367.3	347.0	375.2	419.5	345.6	

Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

Table 1-2. Basic Conditions of Trade Revenue and Expenditure of the United States and Major Trading Partners in 2019 (billion USD)

Trade Partners	Germany	Japan	Mexico	Canada	UK
US export	53.5	67.7	243.0	282.4	563.3
US import	117.7	136.5	314.0	300.0	530.7
Trade balance	64.3	68.8	71.1	17.6	-32.5
Korea	India	Belgium	Netherland	Saudi Arabia	China
48276.06	25.7	29.9	42.2	16.3	130.4
71,164.10	48.6	15.1	17.7	18.9	505.6
22888.04	22.9	-14.8	-24.5	02.6	375.2

Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>



Table 2-1. US-China Trade Balance (2003-2019) (billion USD)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
January	9.3	11.5	15.3	18.0	21.3	20.6	20.6	18.3	23.4
February	7.6	8.3	13.9	13.8	18.5	18.4	14.2	16.5	18.9
March	7.7	10.4	12.8	15.7	17.3	16.1	15.6	16.9	18.0
April	9.4	12.0	14.9	17.2	19.5	20.3	16.8	19.3	21.6
May	9.9	12.2	15.8	17.9	20.2	21.4	17.5	22.3	24.9
June	10.0	14.1	17.6	19.7	21.5	21.7	18.4	26.1	26.5
July	11.4	14.9	17.7	19.8	23.9	25.0	20.4	25.9	27.0
August	11.7	15.4	18.7	22.1	22.9	25.6	20.3	28.2	29.0
September	12.7	15.6	20.1	23.1	24.1	27.8	22.1	28.1	28.0
October	13.7	16.8	20.5	24.5	26.0	27.9	22.7	25.7	28.1
November	10.8	16.7	18.6	23.2	24.2	23.1	20.2	25.1	26.8
December	9.9	14.2	16.3	19.1	19.1	20.0	18.1	20.7	23.1
Year	2012	2013	2014	2015	2016	2017	2018	2019	
January	26.1	27.8	28.1	29.1	28.9	31.4	35.9	34.5	
February	19.3	23.6	20.9	22.8	28.0	23.1	29.3	24.8	
March	21.6	17.8	20.5	31.3	20.9	24.5	25.7	20.7	
April	24.5	24.2	27.4	26.8	24.3	27.7	27.8	26.9	
May	26.0	27.9	29.0	30.3	29.0	31.9	33.5	30.2	
June	27.5	26.7	30.3	31.8	29.7	32.6	33.8	30.0	
July	29.4	30.1	31.0	31.7	30.3	33.6	37.0	32.8	
August	28.7	29.8	30.5	35.0	33.8	35.0	38.6	31.8	
September	29.1	30.6	35.8	36.3	32.5	34.5	40.3	31.6	
October	29.4	28.7	32.7	33.0	31.2	35.2	43.1	31.3	
November	29.0	27.1	30.4	31.3	30.6	35.4	37.9	26.4	
December	24.5	24.5	28.2	27.9	27.7	30.8	36.8	24.8	

Data Source: <https://www.census.gov/foreign-trade/balance/c5700.html>

Table 2-2. US GDP, PCE, GPDI, GCEGI (2003-2019)

Million USD	Gross domestic product	Personal consumption expenditures	Gross private domestic investment	Government consumption expenditures and gross investment
2003.1	3,160.821	2,079.851	571.315	636.568
2003.2	3,177.576	2,085.190	569.265	649.101
2003.3	3,167.527	2,092.812	559.148	648.646
2003.4	3,176.317	2,124.783	531.720	658.092
2004.1	3,205.565	2,131.145	550.694	667.818
2004.2	3,223.251	2,142.032	556.229	674.219
2004.3	3,238.942	2,157.011	556.153	679.440
2004.4	3,241.004	2,168.588	555.164	684.286
2005.1	3,257.792	2,178.132	559.869	682.073
2005.2	3,288.022	2,202.377	562.821	692.805
2005.3	3,343.089	2,234.847	582.723	692.810
2005.4	3,382.178	2,252.204	603.285	696.581
2006.1	3,401.627	2,274.104	603.632	698.484
2006.2	3,426.562	2,288.867	625.217	702.481
2006.3	3,487.594	2,334.459	647.654	702.057
2006.4	3,524.770	2,352.306	666.090	703.523
2007.1	3,543.174	2,377.863	657.627	704.736
2007.2	3,572.939	2,396.308	664.466	710.243
2007.3	3,593.360	2,405.335	684.410	707.676
2007.4	3,636.530	2,432.306	693.457	713.374
2008.1	3,647.396	2,445.256	688.929	716.031
2008.2	3,650.658	2,459.527	681.900	717.607
2008.3	3,679.233	2,484.602	665.758	722.271
2008.4	3,681.506	2,497.664	659.632	720.686
2009.1	3,709.666	2,506.151	668.675	726.759
2009.2	3,734.617	2,517.290	664.530	732.012
2009.3	3,747.946	2,520.450	651.303	734.953
2009.4	3,722.363	2,515.242	629.368	737.997
2010.1	3,740.839	2,519.485	618.156	743.745
2010.2	3,722.911	2,501.274	600.943	754.040
2010.3	3,644.246	2,471.181	547.510	758.971
2010.4	3,593.755	2,462.708	484.420	760.136
2011.1	3,588.890	2,451.594	455.137	774.000
2011.2	3,600.619	2,466.466	451.170	778.250
2011.3	3,635.475	2,466.201	487.388	776.706
2011.4	3,651.211	2,479.422	503.225	771.070

2012.1	3,686.483	2,499.597	529.227	776.552
2012.2	3,711.365	2,515.771	546.426	775.883
2012.4	3,734.750	2,541.532	541.536	767.881
2013.1	3,720.325	2,554.281	531.479	753.054
2012.2	3,747.389	2,559.419	551.993	752.249
2013.3	3,755.287	2,570.559	553.506	747.502
2013.4	3,797.564	2,579.194	593.436	744.570
2014.1	3,822.759	2,594.756	607.399	740.929
2014.2	3,840.604	2,599.158	622.286	737.345
2014.3	3,845.201	2,606.030	620.505	735.214
2014.4	3,846.064	2,613.301	615.547	728.067
2015.1	3,872.970	2,625.575	635.762	720.144
2015.2	3,880.390	2,630.982	643.572	716.558
2015.3	3,910.334	2,643.284	664.196	712.989
2015.4	3,948.482	2,665.556	673.010	707.863
2016.1	3,939.393	2,678.346	663.127	706.800
2016.2	3,983.956	2,701.279	687.657	708.667
2016.3	4,034.878	2,727.466	706.611	712.377
2016.4	4,055.056	2,761.306	704.335	711.260
2017.1	4,087.493	2,786.322	726.357	713.932
2017.2	4,115.222	2,806.987	727.824	719.971
2017.3	4,131.897	2,826.142	731.377	722.063
2017.4	4,136.905	2,844.818	719.798	722.560
2018.1	4,142.893	2,857.637	712.460	725.797
2018.2	4,165.879	2,884.432	707.559	724.083
2018.3	4,194.537	2,904.525	711.812	724.984
2018.4	4,212.855	2,925.530	726.430	725.296
2019.1	4,225.810	2,939.510	724.249	724.157
2019.2	4,257.771	2,963.240	731.169	723.808
2019.3	4,290.974	2,979.144	744.134	724.991
2019.4	4,321.624	3,008.807	752.763	730.379

Data Source: <http://www.bea.gov/>

Table 2-3. USD-CNY Quarter Exchange Rate (2003-2019)

(100USD/CNY)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
1st Quarter	827.71	827.7	827.65	805.04	776.11	716.1	683.6	682.69	658.4
2ndQuarter	827.7	827.69	827.65	801.25	767.6	695.67	682.96	682.34	650.19
3rd Quarter	827.71	827.67	814.1	796.7	756.05	683.99	683.1	677.13	641.79
4th Quarter	827.69	827.65	808.29	786.41	743.07	683.42	682.76	666.02	634.18
Year	2012	2013	2014	2015	2016	2017	2018	2019	
1st Quarter	630.83	627.91	611.76	613.73	653.01	688.54	634.25	674.47	
2ndQuarter	630.69	620.53	615.82	612.02	653.17	685.64	639.87	680.76	
3rd Quarter	633.45	616.74	615.68	626.38	666.54	666.75	681.15	700.59	
4th Quarter	629.99	613.08	613.7	638.76	683.33	660.94	691.85	704.92	

Data Source: <http://www.bea.gov/>

Table 2-4. US-China Quarter Trade Balance (2013-2019)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
1st Quarter	24.6	30.2	42.0	47.5	57.1	55.2	50.4	51.7	60.3
2ndQuarter	29.3	38.4	48.3	54.8	61.2	63.4	52.7	67.7	73.0
3rd Quarter	35.8	46.0	56.5	65.0	70.9	78.5	62.8	82.2	84.0
4th Quarter	34.4	47.7	55.4	66.8	69.3	71.0	61.0	71.4	78.0
Year	2012	2013	2014	2015	2016	2017	2018	2019	
1st Quarter	67.0	69.2	69.5	83.2	77.9	78.9	90.8	80.0	
2ndQuarter	78.0	78.7	86.7	89.0	83.0	92.2	95.1	87.1	
3rd Quarter	87.2	90.5	97.3	103.0	96.7	103.1	115.9	96.2	
4th Quarter	82.9	80.3	91.3	92.2	89.5	101.4	117.8	82.4	

Data Source: <http://www.bea.gov/>

Table 2-5. USD-CNY Quarter Exchange Rate after Census X12 (2003-2019)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
1st Quarter	827.64	827.6	827.62	827.66	827.69	805.14	776.26	716.28	683.81
2ndQuarter	827.6	827.54	827.5	827.49	827.54	801.26	767.72	695.78	683.02
3rd Quarter	827.75	827.72	827.66	827.52	813.91	796.54	755.87	683.79	682.77
4th Quarter	827.84	827.95	828.03	827.97	808.44	786.36	742.95	683.36	682.93
Year	2012	2013	2014	2015	2016	2017	2018	2019	
1st Quarter	682.82	658.53	630.78	627.48	610.77	612.25	651.02	686.18	
2ndQuarter	682.39	650.23	631.02	621.4	617.39	614.1	655.82	688.73	
3rd Quarter	676.62	641.15	632.78	616.31	615.63	626.8	667.33	667.63	
4th Quarter	666.41	634.68	630.37	613.06	613.16	637.7	681.85	659.31	

Data Source: Table 2-3

Table 2-6. US-China Quarter Trade Balance after Census X12 (2003-2019)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
1st Quarter	21.3	22.4	28.9	35.2	48.5	54.8	66.3	65.0	60.0
2ndQuarter	19.6	24.8	30.1	39.5	50.0	57.1	64.3	66.6	54.8
3rd Quarter	21.2	26.9	31.8	41.2	51.0	58.7	63.4	69.2	55.0
4th Quarter	20.9	28.2	32.8	45.3	52.2	62.3	64.5	66.5	58.0
Year	2012	2013	2014	2015	2016	2017	2018	2019	
1st Quarter	61.8	71.5	78.8	80.5	80.2	95.0	88.5	89.6	
2ndQuarter	69.4	73.9	78.3	79.2	87.5	90.5	84.5	94.0	
3rd Quarter	72.0	74.1	77.5	80.6	86.8	91.9	86.7	92.7	
4th Quarter	68.8	75.9	81.0	78.7	89.7	90.4	87.3	98.6	

Data Source: Table 2-4

Table 2-7. US GDP, PCE, GPD, GCEGI after Census X12 (2003-2019)

	Gross domestic product	Personal consumption expenditures	Gross private domestic investment	Government consumption expenditures and gross investment
2003.1	3,162.0	2,080.7	571.8	637.9
2003.2	3,179.2	2,087.0	569.1	647.2
2003.3	3,164.7	2,091.1	558.8	649.3
2003.4	3,176.5	2,124.0	531.9	658.1

2004.1	3,206.4	2,131.9	551.0	669.1
2004.2	3,225.0	2,143.6	556.2	672.5
2004.3	3,236.4	2,155.5	555.8	679.8
2004.4	3,241.2	2,167.8	555.1	684.5
2005.1	3,258.0	2,178.9	560.5	683.1
2005.2	3,290.1	2,203.7	562.8	691.5
2005.3	3,341.2	2,233.5	582.1	692.6
2005.4	3,381.5	2,251.6	602.9	696.9
2006.1	3,401.6	2,274.9	604.9	699.5
2006.2	3,429.0	2,289.9	625.2	701.6
2006.3	3,456.6	2,309.3	634.1	704.5
2006.4	3,485.6	2,334.1	646.5	702.5
2007.1	3,525.8	2,353.2	668.2	704.5
2007.2	3,545.1	2,378.6	657.9	704.4
2007.3	3,572.5	2,395.0	663.6	709.0
2007.4	3,589.7	2,405.3	682.3	708.0
2008.1	3,639.6	2,433.0	696.4	714.7
2008.2	3,648.4	2,445.8	689.4	715.8
2008.3	3,650.3	2,458.4	681.0	716.0
2008.4	3,674.2	2,484.7	662.9	722.5
2009.1	3,687.0	2,498.1	663.2	722.4
2009.2	3,709.5	2,506.5	668.9	726.7
2009.3	3,734.3	2,516.6	663.4	730.2
2009.4	3,741.5	2,520.6	648.5	734.8
2010.1	3,730.4	2,515.3	633.2	740.4
2010.2	3,739.7	2,519.7	618.2	743.4
2010.3	3,722.5	2,501.0	599.7	752.1
2010.4	3,637.1	2,471.4	545.2	758.5
2011.1	3,603.0	2,462.3	487.7	763.1
2011.2	3,587.1	2,451.8	455.0	773.5
2011.3	3,600.2	2,466.6	449.8	776.1
2011.4	3,628.6	2,466.2	485.7	776.2
2012.1	3,660.3	2,479.0	506.8	774.3
2012.2	3,684.7	2,499.9	529.1	776.0
2012.4	3,710.9	2,516.0	544.3	773.8
2013.1	3,728.5	2,541.3	539.8	767.5
2012.2	3,728.2	2,554.0	535.5	755.9
2013.3	3,746.2	2,559.8	551.9	751.8
2013.4	3,754.3	2,570.8	551.2	745.5
2014.1	3,792.6	2,578.8	591.7	744.4
2014.2	3,829.6	2,594.5	611.7	743.4
2014.3	3,842.6	2,612.6	613.8	711.5
2014.4	3,842.6	2,612.6	613.8	728.2

2015.1	3,879.1	2,625.5	639.9	721.9
2015.2	3,880.3	2,631.3	643.8	716.2
2015.3	3,906.6	2,644.1	661.5	711.5
2015.4	3,946.6	2,664.3	671.6	708.2
2016.1	3,945.3	2,678.4	666.9	708.0
2016.2	3,984.2	2,701.6	687.9	708.4
2016.3	4,029.7	2,728.6	703.7	711.1
2016.4	4,053.8	2,759.6	703.5	711.7
2017.1	4,094.1	2,786.7	729.8	714.8
2017.2	4,115.7	2,807.2	728.2	719.9
2017.3	4,125.4	2,827.3	728.3	721.0
2017.4	4,136.1	2,842.8	719.3	722.9
2018.1	4,150.2	2,858.4	715.3	726.6
2018.2	4,166.0	2,884.5	708.3	724.0
2018.3	4,187.8	2,905.8	708.8	724.1
2018.4	4,211.9	2,923.1	725.9	725.5
2019.1	4,233.5	2,940.8	726.9	724.8
2019.2	4,257.7	2,963.0	732.3	723.8
2019.3	4,284.1	2,980.5	741.0	724.2
2019.4	4,320.9	3,006.2	752.0	730.5

Data Source: Table 2-2

Dependent Variable: T		Method: Least Squares		
Date: 03/21/20 Time: 17:18		Sample (adjusted): 2003Q2 2019Q4		
Included observations: 67 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009648	0.007752	1.244580	0.2180
E	-0.662794	0.439180	-1.509164	0.1364
A	-8.066319	2.280821	-3.536586	0.0008
PI	1.677168	0.310069	5.409007	0.0000
GCI	2.202691	0.809981	2.719435	0.0085
PC	6.775972	1.848459	3.665742	0.0005
R-squared	0.430696	Mean dependent var	0.022835	
Adjusted R-squared	0.384032	S.D. dependent var	0.045675	
S.E. of regression	0.035847	Akaike info criterion	-3.733813	
Sum squared resid	0.078387	Schwarz criterion	-3.536378	
Log likelihood	131.0827	Hannan-Quinn criter.	-3.655688	
F-statistic	9.229673	Durbin-Watson stat	1.915984	
Prob(F-statistic)	0.000001			



Heteroskedasticity Test: White				
F-statistic	0.663375	Prob. F(20,46)	0.8398	
Obs*R-squared	14.99847	Prob. Chi- (20)	0.7765	
Scaled explained	12.29251	Prob. Chi- (20)	0.9056	
Test Equation:		Dependent Variable: RESID^2		
Method: Least Squares		Date: 04/04/20 Time: 13:09		
Sample: 2003Q2 2019Q4		Included observations: 67		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000318	0.001023	0.310553	0.7575
E^2	-1.287686	1.615192	-0.797234	0.4294
E*A	-9.830515	20.45569	-0.480576	0.6331
E*PI	1.255703	2.501623	0.501955	0.6181
E*GCI	8.041779	7.408302	1.085509	0.2834
E*PC	10.96367	18.58844	0.589811	0.5582
E	-0.051677	0.065956	-0.783517	0.4373
A^2	-74.91195	65.08307	-1.151021	0.2557
A*PI	17.68701	15.99086	1.106070	0.2744
A*GCI	38.74124	33.69171	1.149875	0.2561
A*PC	126.9987	103.2270	1.230286	0.2248
A	-0.256576	0.312998	-0.819738	0.4166
PI^2	-0.954125	1.024276	-0.931512	0.3565
PI*GCI	-6.773403	5.028805	-1.346921	0.1846
PI*PC	-17.05556	10.16694	-1.677550	0.1002
PI	0.033495	0.039752	0.842588	0.4038
GCI^2	-1.247865	7.405096	-0.168514	0.8669

GCI*PC	-52.00028	24.57043	-2.116377	0.0398
GCI	0.248343	0.102332	2.426834	0.0192
PC^2	-62.69016	49.61796	-1.263457	0.2128
PC	0.417784	0.372210	1.122441	0.2675
R-squared	0.223858	Mean dependent	0.001170	
Adjusted R-squared	-0.113595	S.D. dependent var	0.001658	
S.E. of regression	0.001749	Akaike info	-9.608440	
Sum squared resid	0.000141	Schwarz criterion	-8.917417	
Log likelihood	342.8827	Hannan-Quinn	-9.335001	
F-statistic	0.663375	Durbin-Watson stat	2.002812	
Prob(F-statistic)	0.839832			

Pairwise Granger Causality Tests			
Date: 04/05/20		Time: 10:05	
Sample: 2003Q1 2019Q4			
Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Prob.
TD_SA does not Granger Cause ER_SA	67	2.64946	0.1085
ER_SA does not Granger Cause TD_SA		0.30718	0.5813

Pairwise Granger Causality Tests			
Date: 04/05/20		Time: 10:06	
Sample: 2003Q1 2019Q4			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
TD_SA does not Granger Cause ER_SA	66	3.44066	0.0384
ER_SA does not Granger Cause TD_SA		0.75455	0.4746

## <국문 초록>

### 환율조작국: 미중 무역 불균형에 대한 중국의 FX 정책 대응

본 논문은 측정 모델과 경험적 분석을 사용하여 USD-CNY 환율과 무역 적자 사이의 통계적 의존 관계가 있는지 분석하고 환율과 미-중 무역 적자 사이의 영향 정도와 방향에 대해 논의합니다. 미-중 무역은 뜨거운 이슈로 2001-2019 년 사이에 USD-CNY 환율은 상승 추세를 보이며, 한편 미-중 무역 불균형도 크게 확대되었습니다. 본 논문은 Ordinary Least Square, Augment Dickey-Fuller Test 와 Granger Causality Test 를 사용하여 주로 아래 결론을 도출 하였다:

1. USD-CNY 환율은 미-중 무역 불균형과 부정적인 관계를 나타냅니다. 이 현상은 CNY 환율이 감사 될 때 미국-중국 무역 적자가 확대 될 것이라는 것을 의미합니다. 이 결론은 미국의 인민폐 환율이 감사되면 미중 무역 적자를 완화 할수 있다는 의견과 상반됩니다..

2. USD-CNY 환율과 미중 무역의 불균형은 미국 GDP, PCE, GPDI, GCEGI 등 여러 가지 원인이 있다. 이러한 요인들이 미중 무역에 대한 영향은 인민폐의 환율에만 초점을 맞추는 것은 부당합니다.

3. USD-CNY 환율과 미중 무역 간에는 일방적 인 인과 관계가 존재합니다.

4. 제품 경쟁력은 무역 불균형의 주요 원인입니다.

**주요어:** USD-CNY 환율, 미-중 무역, 제품 경쟁력.

**학번:** 2016-25454