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The Relationship Between Renminbi Exchange Rate Fluctuations and China's Import and Export Trade

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Abstract

Purpose: The renminbi (RMB) has appreciated alongside the elevation of China's economic status, leading to increased exchange rate volatility. Moreover, China's medical industry saw a surge in import and export trade volume, with trade related to epidemic prevention and control in the medical sector significantly increasing its share. The medical device trade, in particular, occupies a substantial portion of this trade. **Research design, data and methodology:** This paper focuses on the import and export value of medical devices in the medical industry as a case study to explore the impact of RMB exchange rate fluctuations on the import and export trade of the medical industry during the pandemic. Additionally, it investigates whether the import and export trade of the medical industry can be a contributing factor to the fluctuations in the RMB exchange rate. **Results:** Through an empirical study on the import and export values of medical devices in the medical industry over the past three years, as well as the RMB exchange rate, this paper establishes a VAR model and conducts a series of tests including stationarity tests and cointegration tests. **Conclusions:** The conclusion is that fluctuations in the RMB exchange rate have a long-term impact on China's medical industry's import and export trade.

Keywords : RMB Exchange Rate Fluctuations, Medical Industry, Import and Export Trade, VAR Model

JEL Classification Code : B27, B41, C58, F31

1. Introduction

As one of the fundamental elements of international finance, the exchange rate measures the value between two currencies, thereby determining the price of goods in international trade. It also serves as a tool for countries to intervene in their economies through policy implementation, making it a critical factor in foreign trade for any country. In recent years, with the increasing economic exchanges among countries worldwide, economic globalization has become an inevitable outcome, leading to a closer relationship between international finance and trade. For China, the Renminbi (RMB) exchange rate similarly affects the development of its import and export trade. As China's international influence gradually increases and its export scale ranks at the forefront of the world and continues to grow, RMB appreciation has become a hot topic internationally. According to traditional remittance and balance of payments theories, when the domestic currency

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appreciates (i.e., foreign currencies depreciate), domestic export trade decreases while import trade increases; conversely, export trade increases, and import trade decreases. Therefore, the price of China's export goods will inevitably rise, leading to a decrease in competitiveness and, to some extent, affecting China's economic development.

China has always paid attention to fluctuations in the exchange rate. The fluctuation of the RMB exchange rate and the adjustment of China's import and export trade structure has a negative correlation; that is, RMB appreciation and the decline in the RMB exchange rate lead to the optimization of our trade structure. RMB appreciation is beneficial for the country to import industries such as equipment, technology, and processes, enhance technological content, and promote industrial structure upgrades. China has primarily exported labor-intensive products, represented by apparel, textiles, and other products that do not require much technical content. Since any country can manufacture these products, they are very sensitive to exchange rate fluctuations. Once the RMB appreciates, it will severely affect the profits of these industries, forcing enterprises to seek new profits by developing new products and brands. In contrast, high-tech products with relatively high technical content, such as electronic devices, communications, and chemicals, have already gained a significant competitive advantage in China's foreign trade and are less affected by exchange rate fluctuations. Therefore, exchange rate fluctuations are conducive to promoting the upgrading of China's foreign trade structure and alleviating the problem of the huge trade surplus accumulated in China's balance of trade. However, it is essential to note that while RMB exchange rate changes can improve China's balance of trade, excessive fluctuations in the RMB can also lead to changes in domestic import goods, harming national welfare. Thus, stabilizing the currency value should become the norm for the RMB exchange rate policy, reducing reliance on foreign currencies, such as the US dollar. By increasing exports to countries other than the US and reducing imports from the US, the proportion of the RMB to the US dollar exchange rate can be reduced, making the RMB more independent and less dependent on the dollar.

However, in the current context of the continuous spread of COVID-19 and the normalization of trade frictions between China and the US, the impact of exchange rate changes on export trade may not necessarily align with theory due to other factors such as geographical distance, economic size, and comparative advantages. According to statistics from the United Nations Commodity Trade Organization (2020), 44% of global mask exports in 2018 came from China, with Germany (7%) and the US (6%) holding relatively small shares. Affected by the pandemic, the global demand for critical medical equipment from China surged during the outbreak in March 2020. However, due to the stagnation of China's economy, the supply of these devices declined. Nonetheless, a list released by China Customs in April 2020 showed that China's mask exports still reached a value of $9.43 billion from March to April (Fuchs et al., 2020).

This paper will use VAR model for macro analysis of China's medical industry before and after the pandemic, to preliminarily analyze and explore the relationship between the RMB exchange rate and China's medical industry import and export trade economy. By modeling with the RMB exchange rate fluctuation range and China's medical industry import and export data, this empirical analysis explores the bidirectional impact between the RMB exchange rate and China's medical industry import and export trade, providing references for China to withstand foreign exchange risks and develop medical products and equipment foreign trade during the pandemic.

2. Literature Review

Due to the rapid development of financial technology and the increasing openness of international financial markets by various countries, there has been an expansion in the scale of these markets. However, along with this expansion, there has also been an increase in the volatility and risks associated with financial markets. The foreign exchange market has become an essential component of financial markets as a result of the development of economic globalization, with exchange rates serving as a crucial price indicator in international economic activities. They play a role in regulating a country's balance of trade, thus having a significant impact on a nation's international trade. Exchange rate fluctuations are a complex economic phenomenon influenced by both political and macroeconomic factors, and numerous scholars have conducted in-depth research on the relationship between exchange rates and trade.

Before the pandemic, scholars conducted research on the relationship between the Renminbi (RMB) exchange rate and trade from various perspectives. Dobson and Masson (2009) focused on factors influencing the international use of currencies and emphasized aspects of China's financial system that needed to change before the RMB could become an important regional or global currency. They highlighted the need for reforms even though significant changes had been made and raised questions about whether authorities would encourage its international use and whether an economically influential entity with substantial party control could achieve international acceptance of its currency. Ahmad et al. (2019) explored the relationship between China's exchange rate, foreign direct investment (FDI)

inflows, and economic development. The results indicated that China's economy benefited from a lower exchange rate during this period, and there existed long-term and short-term direct relationships between FDI inflows and economic development at an overall level. Granger causality tests confirmed the long-term and short-term associations between these variables. GMM estimation with dummy variables for financial crises and RMB exchange rate policy fluctuations also supported the growth-promoting effects of exchange rate and FDI inflow. Li et al. (2015) found that the response of RMB prices to exchange rate changes was small, indicating a relatively high pass-through of exchange rates to foreign-currency-denominated prices, while the response of volumes was modest and significant. Furthermore, higher productivity exporters priced more to market, despite the still high pass-through. Other heterogeneity sources such as import intensity, distribution costs, destination-country income levels, and foreign ownership were also significant. Additionally, RMB appreciation reduced the likelihood of entering and staying in export markets.

Hooy et al. (2015), based on the Association of Southeast Asian Nations (ASEAN), found a significant positive impact of the real exchange rate of the Renminbi (RMB) on ASEAN's total exports to China. This effect was particularly aided by the exports of high and medium-technology manufactured goods, as well as component exports. Wang and Zhu (2016) discovered that the widely used USD/RMB exchange rate in trade settlements had a more pronounced impact on China's exports. In summary, a 1% RMB appreciation against the USD would lead to a 1.532% decrease in China's exports, while a 1% nominal effective exchange rate appreciation of the RMB would only result in a 0.42% decrease. Furthermore, an increase of 1% in USD/RMB exchange rate volatility would lead to a 0.579% decrease in China's exports. Zhang and Ouyang (2018) utilized matched samples from the Annual Survey of Industrial Firms (ASIF) and China Customs data from 2000 to 2006 to investigate firms' responses to RMB exchange rate fluctuations, including export activities and profitability. The study found that while RMB appreciation reduced firm exports, it improved firm profitability. The reduction in import costs and the upgrading of export structures were identified as reasons for the increased profitability due to RMB appreciation, with no evidence supporting the productivity channel. Mattoo et al. (2017) estimated the impact of China's exchange rate changes on the exports of developing countries to third-party markets. The level of competition between China and its competitors in developing countries in specific products and destinations played a crucial role in identifying strategies. Chiu and Ren (2019) applied a two-step differenced generalized method of moments (GMM) estimator to explore the linear and nonlinear relationships between trade balance, savings rates, and real exchange rates for China and its 102 trade partners from 1995 to 2014. The results showed that RMB depreciation had different effects on China's bilateral trade balances, depending on whether its trade partners were high-income or low-income countries. Savings rates had nonlinear effects on China's bilateral trade balances.

Chen et al. (2018) examined the impact of currency misalignment on China's exports and the spillover effects of these misalignments on exports of nine major Asian economies over time. It was found that the RMB continued to be mildly undervalued and overvalued over time (McKinnon & Schnabl, 2014). Cheung et al. (2016) studied the trade flow between China and the United States from 1994 to 2012 and found that the value of China's exports to the United States responded negatively to the real RMB, while imports responded positively. Furthermore, the combined price effects on exports and imports implied that an increase in the real value of the RMB would reduce China's trade surplus. Tang (2015) used a cointegrated vector autoregression (CVAR) model to investigate the relationship between China's real exchange rate (RER) and economic growth. It was found that China's economy did not benefit from the depreciation of the RMB, and there was no direct relationship between RER and economic growth in the long run. Interestingly, according to the empirical evidence, China's economy seemed to be stimulated by export expansion and foreign capital inflow, suggesting that the long-term equilibrium RER was jointly determined by foreign trade, foreign exchange reserves, and foreign direct investment. Xu et al. (2016) studied the impact of RMB exchange rate changes on the export behavior of multi-product firms in China using micro data from Chinese enterprises from 2000 to 2007. The study found that RMB real appreciation had a negative impact on both the export prices and export quantities of multi-product firms, with significant variations across firms of different productivity levels and within multi-product firms' product ladders. Additionally, RMB real appreciation reduced the export scope of multi-product firms and encouraged firms to shift their export sales to their best-performing products.

Thorbecke (2015) provides value-added exchange rate data for processed exports during the period 1993-2013 and reports that they significantly impacted exports. Despite a 36% RMB appreciation from early 2005 to the end of 2013, the depreciation of the currencies of supply chain countries mitigated the impact of RMB appreciation on the competitiveness of processed exports. Eichengreen and Tong (2015) studied the impact of RMB revaluation on corporate valuations, focusing on the sudden currency policy change announced by China on 9 July 2005 and its effect on 9,753 manufacturing firms in 44 countries. RMB appreciation had no significant impact on the average valuation of industry firms exporting to China. However,

this "null result" obscures the positive effect on firms exporting final products to China, while the impact on firms providing inputs for China's processing exports can be ignored. Thorbecke (2011) suggests mixed empirical evidence for the impact of RMB appreciation on China's exports, particularly for the largest export category, processed exports. Since much of the value-added in these goods comes from components produced in Japan, Korea, and other East Asian supply chain countries, controlling for the exchange rate changes of these countries is crucial. Xing (2012) analyzed the role of processing trade in China's bilateral trade balance and the impact of RMB appreciation on China's processing trade. The analysis was based on panel data of bilateral processing trade between China and its partner countries from 1993 to 2008. Empirical results showed that real RMB appreciation had a negative impact on both exports and imports in processing trade. Specifically, a 10% real RMB appreciation resulted in a 9.1% decrease in China's processing exports and a 5.0% decrease in processing imports. Based on these empirical findings, it can be concluded that the comprehensive impact of RMB appreciation on processing trade balance and China's overall trade balance would be limited. Smallwood (2019) used a flexible multivariate DCC-GARCH model to measure volatility and analyze the impact of exchange rate uncertainty on bilateral export growth to China's top ten export markets. It was found that exchange rate uncertainty had no impact on trade with the United States, which contrasted with the strong trade deterrence effect found in almost all other countries. The same approach was also used to analyze nominal uncertainty itself. In this case, it was found that China's inflation might be a positive factor contributing to risk, and in such an environment, many exogenous events (such as the Asian currency crisis) were associated with periods of increased RMB uncertainty.

Miao et al. (2013) studied the sensitivity of Chinese firm stock returns by industry classification to RMB exchange rate movements. Evidence of significant exposure was found in seven out of sixteen Chinese industries. Evidence of size asymmetry effects was also discovered. Furthermore, the characteristics of this exposure were explored, and significant exposure was found in non-exporting firms in some industries. The study particularly focused on time-varying exposure, which reported stronger exchange rate exposure in this context. Whalley and Chen (2013) discussed China's relatively new onshore and offshore RMB market dual structure. A significant feature of this structure was that both onshore and offshore exchange rates were market-determined, with the onshore rate anchored to the official spot rate, and the capital account was not convertible. Jin and Zang (2013) developed a statistical model using monthly data on foreign direct investment (FDI) into China from January 1997 to September 2012 and the real effective exchange rate (REER) index of the RMB. According to the empirical test results, RMB appreciation promoted foreign direct investment after the 2005 exchange rate system reform. This phenomenon was a result of changes in the types of foreign direct investment flowing into China in recent years. In the long term, an appropriate RMB appreciation and a more flexible exchange rate system would have a positive impact on China's monetary and micro-control policies. Xing (2006) argued that China's exchange rate policy played a crucial role in the prosperity of foreign direct investment (FDI). RMB depreciation and the policy of pegging the RMB to the US dollar both enhanced China's competitiveness in attracting foreign direct investment. Using Japan's foreign direct investment in nine manufacturing sectors in China from 1981 to 2002 as a background for hypothesis testing, empirical results showed that the real exchange rate between the RMB and the yen was one of the important variables determining Japan's direct investment in China. RMB depreciation significantly increased inflows of direct investment from Japan, and FDI exhibited elasticity in response to changes in the real exchange rate. Marquez and Schindler (2007) argued that despite China's larger share in world trade compared to Japan, little is known about how China's trade reacts to exchange rate changes. The study found that a 10% real appreciation of the RMB would reduce China's overall export share by nearly one percentage point, while the estimated response of imports was negligible and lacked precision.

After the COVID-19 pandemic, Wei et al. (2020) argue that the spillover effects of the Chinese Renminbi (RMB) exchange rate were influenced by internal financial reforms and external economic shocks. Additionally, the recent outbreak of COVID-19 disrupted this system and its impact on the RMB. Iqbal et al. (2020) used daily data on variables representing weather, COVID-19 cases in Wuhan, and the RMB exchange rate to analyze the coherence using methods like Wavelet Transform Coherence (WTC), Partial Wavelet Coherence (PWC), and Multiple Wavelet Coherence (MWC). The results revealed significant coherence between series at different time-frequency combinations. Overall, the findings suggested that higher temperatures had limited importance in controlling or mitigating new COVID-19 infections. There were phase asynchronies in coherence between the RMB exchange rate and COVID-19 at specific time-frequency points, indicating a negative but limited impact of the Wuhan COVID-19 outbreak on China's export economy.

Warren et al. (2023) evaluated the importance of exchange rates and exchange rate volatility on bilateral foreign direct investment (FDI) inflows using a gravity model with a sample of 40 countries from 2001 to 2019. They found that exchange rate volatility had a negative

impact on bilateral FDI inflows, while exchange rate depreciation had a positive and significant coefficient. Furthermore, variables related to the host country's GDP and the home country's GDP were positive and significant, demonstrating that the economic size of both the host and home countries remained actual factors in attracting FDI. Baek and Nam (2021) used the NARDL method to demonstrate the asymmetric effects of the Korean Won (KRW) on the real exchange rate of the Chinese Renminbi (CNY) in certain Korean export and import industries, although not all types. This asymmetric effect appeared to be industry-specific.

Xiao (2021) analyzed the impact of RMB exchange rate changes on China's textile and apparel industry's imports and exports using cointegration methods. The results showed a significant positive relationship between the real effective exchange rate and imports and exports, with a greater impact on exports. Additionally, there was mutual reinforcement between imports and exports. Xu and Lien (2020) studied the dynamic dependence of the US-China trade war on the Chinese Yuan (CNY) and its major trading partners' currencies using a combination of the Generalized Autoregressive Score-driven (GAS) model and copula methods. They found that US dollar appreciation and the global economic downside risks caused by the trade war were factors driving changes in exchange rate dependence between the CNY and its major trading partners' currencies. Ma and Wang (2019) used copula models to analyze and compare dependence structures, revealing consistency between rising commodity prices, the appreciation of the Australian Dollar, and the depreciation of the Chinese Renminbi. There was relatively high correlation among oil prices, the Australian Dollar, and the Chinese Renminbi during the period of 2010-2015. However, the strength of the relationship among oil prices, the Australian Dollar, and the Chinese Renminbi decreased from 2015 through 2018. Additionally, a weak association was observed between steam coal prices and the Chinese Renminbi, as well as a significant relationship between natural gas prices and the Chinese Renminbi. Dong et al. (2020) constructed a multi-region dynamic computable general equilibrium model to explore the impact of international oil price shocks and RMB exchange rate changes on China's macroeconomy. The results indicated that both the decline in international oil prices and RMB depreciation were beneficial to economic growth, with RMB depreciation having a more pronounced impact. The increase in international oil prices would further widen the output gap between prosperous and poor regions, while the decline in oil prices and RMB depreciation would narrow regional development disparities. Chen et al. (2020) used quantile regression analysis to find asymmetric effects of Economic Policy Uncertainty (EPU) on exchange rate volatility in China and heterogeneity among different markets. China's EPU had a positive and significant impact on exchange rate volatility at all quantiles. The impact of EPU on exchange rate volatility had mixed effects, with significant differences among various economies. The EPU of the United States, Europe, and Japan had significant effects, while the EPU of Hong Kong showed no significant correlation with exchange rate volatility.

Guo and Wang (2023) used time-frequency domain methods to study the spillover effects of the Chinese Renminbi (RMB) exchange rate among members of the Regional Comprehensive Economic Partnership (RCEP). They found significant interactions among currencies in the RCEP region, primarily driven by short-term spillovers, and these currencies reacted to significant economic and political events. Zhang and Chen (2023) summarized the reform of the Chinese Renminbi (RMB) exchange rate system as having gone through three phases approximately every decade. They analyzed the dominant and supportive reforms in each phase and reviewed their effects. Achieving a freely floating exchange rate would be the ultimate goal, but it would not be easily accomplished in the short term. During the transition period, they suggested arranging an annual target range for the real exchange rate of the RMB under the arrangement of the Currency Basket by the China Foreign Exchange Trade System (CFETS) and implementing necessary capital controls. Yang et al. (2023) examined how openness and economic fundamentals, both observable and unobservable, affected the long-term volatility of offshore exchange rates using the GARCH-MIDAS model. They found that trade openness reduced long-term volatility, while financial openness had no effect. Observable fundamentals, including indicators of growth, interest rates, and money supply, had a significant negative impact on offshore volatility. Liu and Lee (2022) studied the nonlinear relationship between interest rates and exchange rates between China and the United States using a rolling window approach. The results showed that adjustments in US interest rates had a stronger impact on the volatility of the China-US exchange rate than adjustments in China's interest rates. Additionally, the changes in the China-US exchange rate had a slightly stronger impact on US interest rates.

Zhou (2022) discussed the advantages and disadvantages of the internationalization of the Chinese Renminbi (RMB) on China's imports and exports. RMB internationalization can positively promote the adjustment of the national economic outcome and trade structure. Importantly, RMB internationalization can provide positive room for monetary policy. Chao (2021) argued that changes in China's imports and exports actually reflected the appreciation and depreciation of the RMB, closely related to the overall volume of China's imports and exports and the

corresponding foreign exchange measures. In general, RMB appreciation implies RMB strengthening, which benefits imports, while RMB depreciation implies RMB weakening and a decrease in export commodity prices, thus having a greater price advantage and benefiting exports.

3. Analysis of the Influence Mechanism of Financial Development of Countries along the "Belt and Road" on China's OFDI

3.1 Selection of Indicators and Data Description

3.1.1 Data Selection

The selection of data is the first and most important step in empirical analysis. This paper aims to explore the relationship between RMB exchange rate fluctuations and the import and export of medical devices. Furthermore, it examines the impact of RMB exchange rate fluctuations on the import and export of medical devices during the pandemic. Therefore, the time series data selected for this study are the monthly data of the RMB exchange rate and the value of medical device imports and exports from 2018 to 2020. This data covers two time periods: post-medical reform in 2018 and the outbreak of the pandemic in 2020, aligning with the needs of this study.

3.1.2 Data Sources

The monthly data of RMB exchange rates used in the empirical analysis are obtained from the National Bureau of Statistics official website, while the values of medical device imports and exports are sourced from the Resset Database. Additionally, other data used in this paper are from the China Industry Information Network, financial statements of listed medical industry companies in 2020, and other official data.

3.2 Model Establishment

Given that the correlation between exchange rate fluctuations and the value of medical device imports and exports can be reflected through their mutual interaction, this paper employs the VAR (Vector Autoregression) model for testing. Also, as this study explores the bidirectional relationship between exchange rate fluctuations and medical device imports and exports, three separate models are established.

In this paper, the variable of the exchange rate (USD to RMB) is defined as X, the total value of medical device exports is defined as Y1, and the total value of medical device imports is defined as Y2. Based on this, the following three autoregression models are constructed:

(1) With the RMB exchange rate as the dependent variable and the value of medical device imports and exports as independent variables, the model is constructed as:

$$X=\theta_0+\theta_1 Y_1+\theta_2 Y_2+\varepsilon_1$$

(2) With the value of medical device exports as the dependent variable, and the RMB exchange rate as an independent variable, the model is constructed as:

$$Y_1=\alpha_0+\alpha_1 X+\varepsilon_2$$

(3) With the value of medical device imports as the dependent variable and the RMB exchange rate as an independent variable, the model is constructed as:

$$Y_2=\beta_0+\beta_1 X+\varepsilon_3$$

ε represents the error correction term.

3.3 Empirical Analysis

3.3.1 Stationarity Test

The validity of traditional econometric analysis methods relies on the stationarity of variables within the model. When the model contains non-stationary time series, estimations and test statistics based on traditional econometric methods may lose their usual properties, leading to potentially incorrect conclusions. The stationarity of data variables is one of the basic requirements of traditional econometric analysis. Therefore, it is necessary to test the stationarity of data before establishing the model. Common unit root test methods include the PP test, DF, and ADF unit root tests, among which the ADF (Augmented Dickey-Fuller) unit root test is most commonly used. This paper will also adopt the ADF unit root test method to examine the stationarity of the variable series in this study.

Before testing for stationarity, it is necessary to process the data. To eliminate the impact of heteroscedasticity, the data of exchange rates, total value of medical device exports, and total value of medical device imports need to be logarithmically transformed. Taking logarithms does not change the co-integration relationship of the original series. Therefore, LnX, LnY_1, and LnY_2 are used to represent the logarithmically transformed exchange rates, total value of medical device exports, and total value of medical device imports, respectively.

Table 1: Exchange Rate ADF Test

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.721	0.415
Test critical values:	1% level		-3.564	
	5% level		-2.894	
	10% level		-2.621	
*MacKinnon (1996) one-sided p-values.				

The stationarity of LnX was tested, and as shown in Table 1, the ADF test statistic t-value for LnX is -1.721, with a corresponding p-value of 0.415, which is greater than the critical value of 0.05, failing the test. Therefore, the null

hypothesis cannot be rejected, indicating that the LnX series is non-stationary. It is necessary to continue with the ADF unit root test on the first difference of LnX.

Table 2: ADF Test of Export Values

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.245	0.635
Test critical values:	1% level		-3.446	
	5% level		-2.865	
	10% level		-2.621	
*MacKinnon (1996) one-sided p-values.				

Similarly, the stationarity of LnY_1 was tested. According to Table 2, the ADF test statistic t-value for LnY_1 is -1.245, with a corresponding p-value of 0.635, which is greater than the critical value of 0.05, failing the test. Therefore, the null hypothesis cannot be rejected, indicating that the LnY_1 series is non-stationary. It is necessary to continue with the ADF unit root test on the first difference of LnY_1.

Table 3: Import Value ADF Test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.712	0.007
Test critical values:	1% level	-3.564	
	5% level	-2.954	
	10% level	-2.621	
*MacKinnon (1996) one-sided p-values.			

Similarly, an ADF test was conducted for LnY_2. As shown in Table 3, the ADF test statistic t-value for LnY_2 is -3.712, with a corresponding p-value of 0.007, which is significantly lower than the critical value of 0.05. This allows us to reject the null hypothesis, indicating that the LnY_2 series is stationary.

Subsequently, ADF unit root tests were conducted on the first-difference series of LnX and LnY_1. The analysis was carried out using the statistical software Eviews 9. The first difference of the variables is represented by Δ, and the test results are presented in Table 4.

Table 4: ADF Unit Root Test Results for Each Variable

Variables	Statistics	1%critical value	5%critical value	10%critical value	Stationarity
ΔLnX	3.721	-3.634	-2.961	-2.617	Stationary
ΔLnY	6.614	-3.654	-2.987	-2.617	Stationary

As shown in Table 4, the ADF test values for the series ΔLnX and ΔLnY_1 are both below the critical value at the 5% significance level, which means that the null hypothesis can be rejected at a 95% confidence level, indicating that each differenced series is stationary. Consequently, the series LnX and LnY_1 are first-order integrated series, and cointegration tests can be conducted next.

3.3.2 Co-Integration Test

Table 5: Johansen Cointegration Test Results of Maximum Eigenvalue Statistics

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.378	14.838	14.258	0.041
At most 1 *	0.224	7.496	3.842	0.006

Table 6: Johansen Cointegration Test Trace Statistics Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.381	22.324	15.584	0.004
At most 1 *	0.215	7.487	3.838	0.006

Based on the results of the Johansen test presented in Tables 5 and 6, both the Max-Eigen statistic and the Trace statistic tests indicate that there is a unique cointegration relationship between the series LnX and LnY_1 at the 95% confidence level. This implies that there is a long-term equilibrium relationship between the exchange rate and medical device exports. Similarly, a cointegration test is conducted for LnX and LnY_2:

Table 7: Johansen Cointegration Test Results of Maximum Eigenvalue Statistics

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.297	13.051	14.265	0.074
At most 1 *	0.178	6.487	3.838	0.011

Table 8: Johansen Cointegration Test Trace Statistics Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.345	19.554	15.493	0.011
At most 1 *	0.185	6.476	3.842	0.012

The results of the Johansen test presented in Tables 7 and 8 indicate that both the Max-Eigen statistic and the Trace statistic tests show a unique co-integration relationship between the series LnX and LnY_2 at the 95% confidence level. This implies that there is a long-term equilibrium relationship between the exchange rate and medical device imports.

In summary, there exists a long-term equilibrium relationship between the exchange rate and the import and export of medical devices.

3.3.3 Vector Error Correction Model

Using the statistical software Eviews 9, a vector error co rrection model is established for the variable series LnX, Ln Y_1, and LnY_2. The test results are as reported in Table 9:

Table 9: Parameter Estimates of the VAR Model

	LnX	LnY_1	LnY_2
LnX(-1)	1.256	-4.712	-1.748
	(0.167)	(4.162)	(4.135)
	[7.182]	[-1.131]	[-0.432]
LnX(-2)	-0.463	3.359	2.587
	(0.175)	(4.089)	(4.078)
	[-2.648]	[0.815]	[0.556]
LnY_1(-1)	-0.0138	0.718	0.132
	(0.009)	(0.229)	(0.229)
	[-1.414]	[3.081]	[0.518]
LnY_1(-2)	0.005	0.0328	-0.112
	(0.011)	(0.246)	(0.242)
	[0.512]	[0.132]	[-0.424]
LnY_2(-1)	0.017	-0.135	0.0431
	(0.008)	(0.1978)	(0.195)
	[2.058]	[-0.678]	[0.221]
LnY_2(-2)	0.001	0.326	0.242
	(0.008)	(0.215)	(0.214)
	[0.158]	[1.586]	[1.155]
C	0.009	2.014	9.845
	(0.138)	(3.378)	(3.374)
	[0.063]	[0.587]	[2.915]
R^2	0.885	0.5195	0.166
Adj. R^2	0.848	0.404	-0.032
Sum sq. resids	0.001	0.412	0.395
S.E. equation	0.005	0.127	0.124
F-statistic	32.567	4.513	0.837
Log likelihood	125.575	24.584	24.821
Akaike AIC	-7.411	-1.112	-1.114
Schwarz SC	-7.091	-0.778	-0.789
Mean dependent	0.834	14.913	15.056
S.D. dependent	0.015	0.164	0.125

The co-integration model reveals the long-term convergent behavior among variables, while the error correction model reflects the short-term changes in variables when deviating from the long-term equilibrium state. As indicated in Table 9, the error correction model has a sufficiently large log-likelihood value of 125.575. Additionally, the AIC and SC values are relatively small, being -7.411 and -7.091 respectively, suggesting that the model fits the data well and has strong explanatory power.

3.3.4 Granger Causality Test

The above indicates the existence of a long-term stable cointegration relationship between LnX and LnY_1, LnY_2, i.e., there is a long-term impact of the exchange rate on medical device imports and exports. However, the short-term causal relationship of the exchange rate on medical device imports and exports is not determined. Therefore, this paper conducts a Granger causality test for the series LnX with LnY_1 and LnY_2.

Table 10: Granger Causality Test

Null Hypothesis:	F-Statistic	Prob.
LnY_1 does not Granger Cause LnX	0.1856	0.832
LnX does not Granger Cause LnY_1	0.189	0.825
LnY_2 does not Granger Cause LnX	1.334	0.281
LnX does not Granger Cause LnY_2	0.267	0.758
LnY_2 does not Granger Cause LnY_1	0.959	0.393
LnY_1 does not Granger Cause LnY_2	0.146	0.863

As known from Table 10, at a 10% significance level, LnX is not a Granger cause of LnY_1 and LnY_2, and likewise, LnY_1 and LnY_2 are not Granger causes of LnX. This means that, in the short term, the exchange rate does not mutually promote the total value of medical device exports and imports; similarly, in the short term, the total value of medical device exports and imports does not enhance the exchange rate.

To further examine whether the total value of medical device exports and imports constitutes a regression relationship with the exchange rate, a model is constructed using the exchange rate as the dependent variable and imports and exports as independent variables, employing the least squares estimation. The coefficients of the obtained regression equation are presented as follows.

Table 11: Regression Analysis Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.221	0.267	0.756	0.448
LnY_1	0.003	0.018	0.213	0.842
LnY_2	0.035	0.021	1.789	0.082
R^2	0.152	Mean dependent var		0.828
Adjusted R^2	0.095	S.D. dependent var		0.015
S.E. of regression	0.016	Akaike info criterion		-5.453
Sum squared resid	0.007	Schwarz criterion		-5.316
Log likelihood	95.651	Hannan-Quinn criter.		-5.405
F-statistic	2.763	Durbin-Watson stat		0.463
Prob.	0.076			

As shown in Table 11, the regression coefficients of LnY_1

and LnY_2 at the 0.05 significance level have p-values greater than 0.05, indicating that they do not pass the test. This suggests that currently, the total value of medical device exports and imports do not constitute a regression relationship with the exchange rate, implying that the total value of medical device exports and imports does not impact the exchange rate.

4. Conclusions and Implications

The empirical analysis results indicate that fluctuations in the RMB exchange rate have a long-term impact on the import and export trade of China's medical device industry, but no short-term effect. Additionally, the import and export trade of the medical device industry does not affect the fluctuations of the RMB exchange rate. Given the long-term upward trend of the Chinese economy and the RMB, the following suggestions are proposed for the import and export trade of the medical industry, considering the appreciation of the RMB exchange rate, from the perspectives of companies, the industry, and the nation.

The appreciation of the RMB exchange rate will inevitably increase the exchange rate risk in foreign trade activities for businesses. To mitigate risks, companies should first incorporate exchange rate risk into their cost budgets. Since exchange rate fluctuations generally range between 3%-5% within a certain period, companies can use this period as the trade activity duration, updating quotations if it exceed this limit. Secondly, businesses can utilize RMB for standardized settlements. As the RMB appreciates, international demand for it rises, and settling in RMB can reduce the differential caused by exchange rate fluctuations at settlement.

Additionally, businesses should effectively use import-export trade hedging. Typically, companies engaged in export trade are also involved in import trade. By controlling the financial inflows and outflows of both imports and exports, businesses can reduce losses during exchange rate fluctuations. For example, with RMB appreciation, export revenue decreases; at this point, companies should correspondingly reduce import costs to balance their finances and minimize losses. Furthermore, businesses can hedge risks with financial instruments such as forward or futures contracts. In unfavorable market conditions, after predicting market trends and signing trade contracts with customers, enterprises can buy or sell futures contracts that are the same, close or identical in time, equal in quantity, and opposite in direction to the subject matter, profiting in the opposite direction to compensate for spot market losses. All these methods can help businesses reduce profit losses caused by exchange rate fluctuations. Lastly, enterprises should actively seek and train professionals in exchange rate risk management. Having a department specializing in exchange rate risk can make it easier to identify and avoid risks.

The appreciation of the RMB makes it difficult for enterprises to export products. Customers are more likely to choose lower-priced products, and the appreciation of the currency reduces the price competitiveness of domestic products. Therefore, to retain customers, enterprises must not only ensure the best quality of products but also accelerate the pace of product upgrades. Due to the currency appreciation, the cost of importing raw materials is reduced, allowing businesses to import better raw materials at the same price, thereby upgrading their products to make them more comfortable, convenient, and cost-effective. This can help regain competitiveness lost due to exchange rate fluctuations. New products can become a feature of the enterprise, retaining a group of loyal customers.

The import and export trade of the medical industry primarily consists of the pharmaceutical and medical device sectors. Affected by the COVID-19 pandemic, China's medical industry has seen an increase in its share of foreign trade. However, in the long term, as the pandemic gradually comes under control and its impact diminishes, the appreciation of the RMB will suppress the export trade of the medical industry. In the pharmaceutical sector, China's export products are mainly chemical raw materials and drugs like penicillin salts, which largely depend on foreign markets. As for the medical device sector, although China's medical device foreign trade has great potential for development, the export products are still predominantly mid-to-low-end, and most products, despite being manufactured in China, rely on core technologies controlled by foreign enterprises. The appreciation of the RMB will reduce the competitiveness of these products, adversely affecting China's foreign trade. To mitigate this impact, the medical industry should actively develop products that are controlled domestically, such as traditional Chinese medicine (TCM). During the COVID-19 pandemic, TCM has been recognized for its effectiveness in treating patients, with raw materials and finished products primarily catering to the domestic market and having little to no Western substitutes, making TCM less affected by exchange rate fluctuations. For other medical products, innovation of China-specific products and making them necessities is a way to reduce the long-term impact of exchange rate fluctuations. Over time, this will lead to changes in the industrial structure of the medical industry, with China-specific products being less affected by exchange rates and increasing demand, leading to continuous market expansion and ultimately optimizing the industrial structure and further developing China's medical industry in foreign trade.

Additionally, with the appreciation of the RMB, the medical industry can take the opportunity to introduce

medical technology and patents, enhance the professional skills of medical personnel, and improve domestic medical service levels, thus establishing a better foundation for research and innovation.

China has seized the opportunity presented by the pandemic to develop its economy, turning losses into profits and enhancing its international status. The pandemic will eventually end, and the foreign trade related to pandemic prevention cannot be sustained for long. With the ongoing appreciation of the RMB, how to maintain a growth trend in foreign trade becomes an issue worthy of attention.

Nationally, the long-term appreciation trend of the RMB strongly supports China's economic development, but it is undeniable that it still affects China's trade balance. Exports will decrease with the appreciation of the exchange rate, while the competitiveness of foreign goods in the domestic market will increase, leading to an increase in imports. A decrease in one and an increase in the other exacerbate the trade balance issue. In response to these problems, the following suggestions are proposed:

Firstly, the nation can actively promote overseas investment development, including overseas mergers and acquisitions, establishing independent brands, investing in marketing channels, etc., and establishing long-term cooperative relationships domestically. The country can introduce relevant policies to promote foreign investment while reducing the risks of overseas investment in foreign politics, culture, and other aspects. Overseas investment not only drives exports but also helps alleviate domestic employment pressure. A decline in exports leads to reduced demand and production, forcing factories to lay off workers due to insufficient revenue. With the appreciation of the RMB, foreign investment decreases, leading to a severe shortage of job demands. Overseas investment can develop overseas markets, transfer surplus labor to foreign development, and solve the problem of labor surplus. At the same time, it allows deep integration into local markets to understand local needs, enabling timely trade structure adjustments.

Secondly, the country should not stop developing emerging markets, strengthen the development of new markets in countries along the "Belt and Road" initiative, and improve cooperation and trade exchanges with ASEAN and "Belt and Road" countries. Affected by the China-U.S. trade war, the European and American markets have shown unreliability, and as China strengthens, some countries will inevitably suppress China. Therefore, developing emerging markets is beneficial for China to maintain basic foreign trade activities during trade wars and ensure that China's trade balance does not suffer huge losses due to the trade war.

Finally, China has always had an export-driven economic structure. With the appreciation of the RMB leading to reduced exports, the country should adopt measures to adjust the economic structure, shifting from external demand to internal demand, and reducing dependence on exports for long-term economic growth.

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