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환율 변동성과 양자 무역 흐름: 중국을 중심으로

Exchange Rate Volatility and Bilateral Trade Flow: Evidence from China

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| 목 차 |

국문초록

본 연구는 중국의 대외무역정책 조치가 중국에 미치는 영향을 살펴보고자 하며 중국의 양자 무역이 실질실효환율의 움직임에 크게 영향을 받는다는 것으로 나타났다. 또한, 총무역흐름과 환율변동의 관계를 분석한 결과 실질환율의 하락이 중국의 수출량을 증가시키고 수입량을 소폭 감소시키는 것으로 나타났다. 또한 중국의 수출량은 환율수준에 비해 환율변동성에 대한 민감도가 높은 것으로 나타났으며, 나아가 세분화된 무역흐름에 대한 실증결과는 상품마다 환율변동에 따라 상이한 영향을 받고 있음을 시사하고 있다. 자본재와 소비재는 서로 다른 가공 단계에 있으므로 환율 하락으로 인해 수출입에 부정적인 영향을 미치지 않은 것으로 나타났다.

〈주제어〉 실질환율, 양자무역, 중력모형

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Ⅰ. Introduction

China's rapid economic development, driven by its reform and opening-up policies, has elevated its position as a significant player in world trade. According to the World Bank, China has emerged as one of the largest markets globally, boasting the highest export scale in global goods trade and the second-largest in imports. Over the years, China has undergone three crucial exchange rate reforms. It all started with the "exchange rate unification of Renminbi" in 1994, followed by the adoption of a single and managed floating exchange rate regime based on market supply and demand elasticity. Subsequently, in 2005, the exchange rate system was further improved by incorporating a basket of multi-currencies. Finally, the People's Bank of China implemented a managed floating exchange rate system in 5, reforming its quotation mechanism and adjusting with a basket of currencies for the central parity rate of the exchange rate. As a result, the Chinese yuan's marketization and internationalization have accelerated, leading to profound effects on China's export and import activities (Zhang and Sato, 2012).

Utilizing China's data, this study illuminates novel insights into the mechanisms and timing of exchange rate movements' impact on bilateral trade, encompassing both exports and imports. While some experts categorize China as a currency manipulator, asserting that its government unfairly leverages a competitive edge through exchange rate reductions to bolster its trade surplus, a deeper investigation into the correlation between China's Real Effective Exchange Rate (RER) fluctuations and its trade flows is warranted. Further exploration of this relationship is essential for a comprehensive understanding.

This paper aims to shed light on the role of RER movements in bilateral trade using a gravity approach, estimated through Santos Silva and Tenreyro's PPML (Poisson Pseudo Maximum Likelihood) method (2006). Building upon the work of Caglayan and Demir (2019) and Romelli et al. (2018), this paper focuses on the limited influence of other factors on bilateral trade while studying the impact of exchange rate fluctuations on imports and exports.

Ⅱ. Literature Review

Literature and empirical analysis examining the impact of exchange rate movements on trade flows have not provided robust evidence regarding the magnitude of effects and differences in trade structures (Baek, 2012; Soleymani and Chua, 2014). One primary reason for this is the lack of analysis concerning the relationship between exchange rate volatility and bilateral trade flow. Existing research has mainly focused on the effects of real exchange rate (RER) depreciation or volatility at the aggregate level, based on the theoretical frameworks of the Marshall-Lerner condition or J-curve effects (Halicioglu, 2008; Bahmani-Oskooee and Harvey, 2014; Moslares and Ekanayake, 2018). Consequently, these studies have not adequately considered supply chain position or industrial effects, nor have they examined the exchange rate's potential as an industrial policy tool. The inconclusive findings regarding the adverse effects of RER volatility have highlighted the need for a new equilibrium approach to understand the underlying mechanisms of exchange rates.

Moslares and Ekanayake (2018) analyzed quarterly export data from Baltic countries to their major trading partners. Their findings revealed that the volatility of the Real Effective Exchange Rate (RER) has varying effects in both the short and long terms, with significant differences observed among different countries. This echoes the research by Sauer and Bohara (2001), who utilized an extensive panel dataset to explore the link between RER volatility and export volume, while also accounting for cross-country disparities. Their results indicated that exchange rate volatility disproportionately impacts the trade flow of developing nations compared to industrialized ones. These insights underscore that the influence of exchange rate fluctuations on foreign trade varies greatly depending on a country's economic circumstances. Hence, when crafting an exchange rate policy, factors such as the nation's economic development level and financial market conditions must be carefully considered.

In sum, previous studies underscore the necessity for further empirical evidence regarding the trade effects stemming from RER movements. Building on the work of Caglayan and Demir (2019), our study delves into the ramifications of changes in RER levels and volatility on aggregate trade flow. Additionally, we apply a gravity model approach to analyze the trade structure of China.

Ⅲ. Hypothesis

There is a lack of consensus among scholars regarding the country characteristics and the relationships between export volume, exchange rate depreciation, and appreciation. Developed countries primarily engage in trade of manufactured products with high production technology, making their export volume less affected by price changes. In contrast, developing countries, constrained by economic conditions, mainly produce low-elasticity intermediate goods and raw material products, where RER changes significantly impact their export. Thus, under normal circumstances, exchange rate devaluation mainly affects developing countries' exports (Aziz, 2008; Halicioglu, 2008).

China's economic growth relies on resource-intensive manufacturing and lower-paid labor, and it is still classified as a developing country by the World Bank. The majority of China's exports consist of capital goods and consumer goods, with intermediate products and raw materials accounting for a minority. China's export products are concentrated within the primary stage of the supply chain, exhibiting low demand elasticity and higher sensitivity to currency depreciation. Based on this, the following hypothesis is presented:

Hypothesis 1: Holding everything else constant, the higher the real exchange rate depreciation (appreciation), the more likely China's bilateral export will increase (decrease).

Similarly, the literature on the impact of exchange rate levels on imports indicates that domestic currency depreciation can lead to an increase in the unit import price, raising production costs for companies reliant on imports, thus reducing imports. On the other hand, RER appreciation may accelerate imports (Blaum, 2017). Moreover, studies on the relationship between RER depreciation and import volume show that the negative impact of RER depreciation on import volume is significant in developing countries but shows no significant effects on import volume in developed countries (Bacchetta and Van Wincoop, 2003; Baek, 2012).

According to DOTS data, capital goods occupy a large part of China's import volume, followed by raw materials and intermediate goods, with consumer goods being the smallest category. To improve China's position in the global trade and

manufacturing industry chain, a shift is required from low-level advantages, such as labor costs, to high-level advantages, like R&D and technological innovation. Consequently, despite China's designation as a developing country, its import structure is biased towards higher demand elasticity products. Thus, the second hypothesis states:

Hypothesis 2: Holding everything else constant, the higher the real exchange rate depreciation (appreciation), the more likely China's bilateral imports will decrease (increase).

China established a single and managed floating exchange rate regime based on the value of the US dollar in 1994. Since 2005, China has implemented a managed and floating exchange rate system with reference to various currencies. The yuan's real exchange rate and the US dollar have been continuously and slowly appreciating over a period of about ten years. Through the reform of the exchange rate system, China's general terms of trade have improved, encouraging enterprises to adjust the structure of foreign trade products and transition from traditional labor-intensive processing. This phenomenon of industries driving trade has prompted an upgrade of China's industrial structure. However, since small and medium-sized firms still dominate the economy, China cannot be classified as a developed country. Therefore, the study also presents the following hypothesis:

Hypothesis 3: Holding everything else constant, real exchange rate volatility may negatively impact China's bilateral export and/or import.

Ⅳ. Methodology

1. Data

This paper aims to investigate the impact of the RER (Real Effective Exchange Rate) movement on China's bilateral trade flow with a focus on its top 10 major trading partners. China, being one of the largest economies, engages in trade relations with over 200 countries worldwide. The study specifically selects its top

trading partners based on China's trade volume country ranking. These major trading partners include Australia, Brazil, Germany, the Netherlands, Japan, Korea, Singapore, South Africa, Russia, and the United States.

To measure the RER and RER volatility on a yearly basis, the study utilizes monthly data from the International Monetary Fund (IMF) on bilateral nominal exchange rates and the Consumer Price Index (CPI) index. Moreover, the study gathers yearly data on aggregate exports and imports from the Directions of Trade Statistics (DITS). Additionally, sub-sector trade data at various processing stages is obtained from the World Integrated Trade Solution (WITS). Alongside the major variables, the study incorporates control variables based on Anderson and van Wincoop's standard gravity model (2003). These control variables encompass trade, GDP, population, area, distance, common language, and the presence of Free Trade Agreements (FTA).

The sample periods selected for the empirical analysis are designed to capture the effects of recent changes in the exchange rate system reform and to account for the increasing trade flow trends since China's late 2000s. Due to limited data availability for trade after 2018, the chosen sample period spans from 2000 to 2018, resulting in a sample size of 190.

2. Variables

1) Dependent Variables

We conduct an analysis to test the hypothesis by calculating the sectoral intra-industry trade and aggregate trade between China and its trading partners. The dependent variable, trade flow (TF), comprises both export volume and import volume. When considering the Marshall-Lerner condition and J-curve effect, it becomes evident that imports and exports often react differently to exchange rate movements.

To obtain the bilateral export and import volume data, we referred to the Directions of Trade Statistics (DOTS). Earlier research has highlighted that due to the nature of the industries involved, import and export reactions to changes in exchange rates vary significantly across sectors (Baek, 2014; Soleymani and Chua, 2014; Aftab, Ahmad, Ismail, and Ahmed, 2016).

2) Independent Variables

Countries continuously adjust their currency exchange rate systems to promote domestic economic and financial development, adapting to the dynamic global economic and financial landscape. In this context, bilateral exchange rate relations between trading partners also undergo constant changes. Exchange rates are generally categorized as nominal exchange rates and Real Effective Exchange Rates (RER).

When studying exchange rate movements, researchers often analyze changes in RER and its volatility independently, specifically focusing on RER depreciation (or appreciation) and its overall instability. One of these main variables is the RER, which is defined as the annual real exchange rate between China (i) and country j. This variable is calculated as follow:

$$REX_{ijt} = \frac{BEX_{ijt} * CPI_{jt}}{CPI}$$

In this context, the variable BEX represents the monthly average bilateral exchange rate between China (i) and country j, measured as RMB per unit of foreign currency. BEX is derived using the nominal exchange rate of China and country j against USD, with data sourced from the International Monetary Fund (IMF). Additionally, CPI stands for the consumer price index, based on data from the IMF, and it is used to compare price levels in China (i) and country j, with a base period of January 2010.

The data from the International Monetary Fund (IMF) was utilized and processed using the expression provided below to assess the uncertainty of the Real Effective Exchange Rate (RER). The data was also supplemented with information from the studies conducted by Qiu, Das, and Reed in 2019, and Caglayan and Demir in 2019. The second independent variable, VOL, represents the volatility of RER between China and country J. The definition of VOL is as follows:

$$VOL_{ijt} = STDEV\left[\ln\left(REX_{ijt,s}\right) - \ln\left(REX_{ijt,s-1}\right)\right], s = 1, \cdots, 12$$

The first step involves computing the logarithm of the monthly Real Effective Exchange Rate (RER) first difference, followed by the calculation of its annual standard deviation. This volatility measurement is crucial for mitigating potential biases arising from trends that impact the exchange rate series. The level of RER volatility can significantly influence the uncertainty of bilateral trade flow. High RER volatility hampers policymakers' ability to accurately predict market developments and increases the risk associated with decision-making (Chit, Rizov, and Willenbockel, 2010; Caglayan and Di, 2010). Consequently, an increase in RER volatility will lead to a reduction in both export and import volumes.

3) Control Variables

Terms of Trade (TOT) refers to the measurement of a country's trade performance in relation to its annual net barter terms of trade index, obtained from the World Bank. TOT is commonly expressed as a trade terms index and holds particular significance in bilateral trade. These indicators reflect a country's foreign trade status, making it an essential element in the standard gravity equation. Empirical research suggests that an improvement in a country's trade terms may lead to an increase in its foreign trade (Ros, 2013; Romelli, Terra, and Vasconcelos, 2018).

Gross Domestic Product (GDP) represents the annual nominal economic output of a country, obtained from the World Bank. It serves as an indicator of a country's economic strength, which directly impacts foreign trade. The basic gravity model comprises GDP and distance variables. Theoretically and based on empirical analysis, a higher GDP in a trading country translates to stronger purchasing power for goods and increased demand for imports (Qiu, Das, and Reed, 2019). Consequently, as China's GDP grows, its trade volume is likely to increase.

Population (POP) refers to the total population of the trading country. A larger population usually implies a higher demand for commodities, which can have a positive effect on the volume of imports. Additionally, a larger population base means a greater labor force and enhanced societal capacity, which may lead to increased production for foreign trade (Martínez-Zarzoso and Nowak-Lehmann, 2003; Caglayan and Demir, 2019). Thus, population size may have a positive impact on exports.

Surface Area (AREA) indicates the geographical size of a country. A larger surface area often results in higher domestic transportation costs. According to the factor endowment theory, countries with larger areas and abundant resources tend to have lower motivation for engaging in foreign trade activities (Huchet-Bourdon and Korinek, 2011; Caglayan and Demir, 2019). Therefore, the coefficient of AREA is expected to show a negative sign.

Distance (DIST) represents the geographical distance between China and its trading partner. Geographical distance is a crucial factor in bilateral trade. Excessive distance between trading countries significantly increases the transportation cost of goods, leading to higher prices of imported goods, reduced domestic demand, and increased difficulties in international trade (Caglayan and Demir, 2019). Thus, the relationship between geographical distance and trade flow is likely to be negative.

Common Official Language (COMLAN) is a dummy variable, taking the value of 1 if the trading partner shares a common official language with China. Having a common language can bridge cultural gaps, facilitate communication, and potentially positively influence trade volume (Martínez-Zarzoso and Nowak-Lehmann, 2003; Caglayan and Demir, 2019).

Free Trade Agreement (FTA) is a dummy variable indicating whether a country has signed a free trade agreement with China. Such agreements eliminate certain tariffs and lower non-tariff barriers in international trade between the two countries, leading to enhanced trade efficiency and development levels. FTAs are legally binding for both signatories, ensuring the guaranteed development of international trade and increased bilateral trade (Martínez-Zarzoso and Nowak-Lehmann, 2003; Truong, Dong, and Nguyen, 2019). Overall, these variables play crucial roles in understanding and predicting the dynamics of China's international trade relationships.

3. Model

In the original gravity model, only two variables, GDP and distance, were considered as factors affecting bilateral international trade. However, with the increasing research on bilateral trade flows, the gravity model has been extensively applied, and the factors influencing trade value have been enriched.

To examine the impact of the RER (Real Exchange Rate) movement on exports and imports, this paper adopts models based on the standard gravity model proposed by Anderson and van Wincoop (2003). The first model assesses aggregate exports and imports. To analyze China's trade structure, Truong, Dong, and Nguyen (2019) classified industries according to the World Integrated Trade Solution (WITS) of the World Bank, grouping goods into four categories: capital goods, consumer goods, intermediate goods, and raw materials. The second model tests the impact of RER movements on exports and imports of different product types.

To address the heteroscedasticity problem of the gravity model, the Poisson pseudo-maximum-likelihood (PPML) method is employed, as demonstrated in Silva and Tenreyro's (2006) research. Therefore, the two models with year-fixed effects are estimated using the PPML method to test the hypothesis.

Ⅴ. Empirical Results

We present the results of a regression analysis focusing on the configuration of exchange rate movements in bilateral export and import, along with an analysis of product heterogeneity at different processing stages.

1. Regression Results

1) Real Exchange Rate and Aggregate Trade Flow

〈Table 1〉 presents the results of the impact of real exchange rate movements on bilateral aggregate exports and imports, estimated using model (1) with Poisson Pseudo Maximum Likelihood regression. Columns (1) to (3) display the regression results for the aggregated export volume, while columns (4) to (6) focus on China's bilateral import volume from country i. The key variables analyzed are the real exchange rate (RER) and its volatility (VOL).

The study examines the effect of RER levels in columns (1) and (4), and exchange rate volatility in columns (2) and (5), providing robust evidence for the

results presented in columns (3) and (6). In addition to these variables, the analysis incorporates other relevant factors that may influence trade flows, such as changes in terms of trade, GDP, population, distance, area, common language, and FTA.

〈Table 1〉 Exchange Rate Movement and Trade Flow

Variable	Export			Import		
	(1)	(2)	(3)	(4)	(5)	(6)
REX_{ijt}	0.005*** (0.001)		0.004*** (0.001)	-0.010*** (0.002)		-0.011*** (0.003)
VOL_{ijt}		-1.135*** (0.242)	-0.988*** (0.236)		0.002 (0.464)	-0.428 (0.439)
$lnTOT_{jt}$	0.087*** (0.012)	0.098*** (0.012)	0.091*** (0.013)	0.032 (0.023)	0.015 (0.025)	0.034 (0.024)
$lnGDP_{jt}$	0.089*** (0.004)	0.097*** (0.004)	0.086*** (0.004)	0.091*** (0.008)	0.058*** (0.007)	0.089*** (0.008)
$lnPOP_{jt}$	-0.002 (0.004)	-0.014*** (0.003)	-0.003 (0.004)	-0.023** (0.011)	0.010 (0.009)	-0.023** (0.011)
$INDIST_{ij}$	-0.071*** (0.006)	-0.052*** (0.004)	-0.065*** (0.006)	-0.043*** (0.012)	-0.078*** (0.008)	-0.040*** (0.012)
$ln(AREA_iAREA_j)$	-0.004 (0.002)	-0.010*** (0.002)	-0.005** (0.003)	0.006 (0.004)	0.017*** (0.005)	0.006 (0.004)
$COMLAN_{ij}$	0.137*** (0.017)	0.075*** (0.011)	0.109*** (0.017)	0.132*** (0.032)	0.216*** (0.038)	0.120*** (0.035)
FTA_{ijt}	-0.015** (0.007)	-0.012* (0.007)	-0.015** (0.006)	0.013 (0.016)	0.006 (0.016)	0.013 (0.016)
Year-effect	yes	yes	yes	yes	yes	yes
Observation	190	190	190	190	190	190
R^2	0.948	0.950	0.954	0.798	0.782	0.799

Note: * p〈0.1; ** p〈0.05; *** p〈0.01. Robust standard errors are in the parenthesis.

The results in column (1) and column (3) indicate that the coefficients of RER (Real Exchange Rate) are positive and statistically significant. These findings suggest that RER depreciation or an increase in the value of the Chinese yuan has a positive effect on China's bilateral exports, supporting hypothesis 1. On the other hand, in column (4) and column (6), it is observed that real exchange rate depreciation of RMB (Renminbi) adversely affects China's bilateral imports at a 1% significant level, supporting hypothesis 2. Additionally, an appreciation of RER

can slow down exports and increase imports. These results align with the elasticity theory and empirical analyses indicating that when the Marshall-Lerner condition is met, real exchange rate depreciation can boost exports and reduce imports (Irandoust, Ekblad, and Parmler, 2006).

Conversely, the coefficients of VOL (volatility) in column (2) and (3) are significantly negative. This finding suggests that RER's volatility may harm the volume of bilateral exports, supporting hypothesis 3. This result is consistent with the risk-averse assumption-based theory, indicating that an increase in exchange rate volatility may raise the risk in export behavior, leading decision-makers to prefer risk-averse strategies, thereby reducing export demand (Arize, Osang, and Slottje, 2000; Serenis, 2013). However, based on column (5) and column (6), real exchange rate volatility shows no significant bilateral import effect in China. This result may be attributed to the presence of foreign exchange substitutes or the company's sensitive response, thereby weakening the impact of RER volatility on the volume of imports.

The estimates of control variables related to the standard gravity model align with expectations. China tends to export more to countries with favorable trade terms, higher GDP, those with whom they have signed free trade agreements (FTA), or share the same official language. Similarly, China tends to import more from countries with higher GDP or those sharing the same official language. Conversely, imports are lower from countries with larger populations, and trade tends to be lower with more distant and larger countries.

However, the coefficients of FTA are significant and negatively impact the export volume, which seems impractical. Notably, based on World Bank statistics, only South Korea and Australia have signed FTA contracts with China among its major partners. The China-South Korea FTA was signed in June 2015, and the following year saw significant disruptions in foreign trade between the two countries due to the THAAD issue.

In conclusion, the findings reveal a significant increase in export volume with RER depreciation, while higher RER volatility has led to changes in market pricing and a decrease in aggregate export volume. Therefore, a country is more likely to improve its trade balance through RER depreciation, but a stable RER may be more beneficial in promoting long-term export volume.

2) Real Exchange Rate and Trade Structure

In this study, we utilized the World Integrated Trade Solution (WITS) to categorize goods into four groups, namely capital goods, consumer goods, intermediate goods, and raw materials, based on their respective processing stages. The results of the analysis are presented in Tables 2 and 3, where parameter estimates of the impact of real exchange rate movements on various trade structures are displayed for each processing stage.

〈Table 2〉 Exchange Rate Movement and Export Structure

Variable	Capital goods	Consumer goods	Intermediate goods	Raw materials
REX_{ijt}	0.013*** (0.001)	0.008*** (0.002)	0.005*** (0.001)	0.010*** (0.002)
VOL_{ijt}	-1.271*** (0.256)	-1.891*** (0.312)	-0.998*** (0.220)	-1.283*** (0.309)
$lnTOT_{jt}$	0.050*** (0.014)	0.028 (0.017)	0.053*** (0.013)	0.068*** (0.017)
$lnGDP_{jt}$	-0.002 (0.006)	0.011 (0.007)	-0.004 (0.005)	0.013** (0.007)
$lnPOP_{jt}$	0.028*** (0.005)	0.004 (0.005)	0.025*** (0.005)	0.019*** (0.005)
$INDIST_{ij}$	-0.054*** (0.005)	-0.050*** (0.007)	-0.045*** (0.004)	-0.108*** (0.007)
$ln(AREA_i AREA_j)$	-0.012*** (0.003)	0.021*** (0.004)	-0.012*** (0.003)	-0.023*** (0.004)
$COMLAN_{ij}$	0.088*** (0.021)	0.098*** (0.023)	0.046** (0.019)	0.099*** (0.028)
FTA_{ijt}	0.008 (0.011)	-0.004 (0.012)	0.023** (0.010)	-0.019 (0.016)
Year-effect	yes	yes	yes	yes
Observation	190	190	190	190
R^2	0.854	.739	0.836	0.831

Note: * p〈.1; ** p〈.05; *** p〈.01. Robust standard errors are in the parenthesis.

〈Table 2〉 presents the impact of exchange rate depreciation, appreciation, and fluctuations on the export volume of commodities at various processing stages. In 〈Table 2〉, column (1) measures the export volume of capital goods as the

dependent variable, while column (2) uses the export volume of consumer goods. Similarly, columns (3) and (4) measure the export volume of intermediate goods and raw materials as dependent variables.

The findings in columns (1)-(4) indicate that the coefficients of the Real Effective Exchange Rate (RER) are positively significant at the 1% level. This result suggests that RER depreciation or appreciation significantly influences China's exports across all processing stages, supporting the elasticity theory. Accordingly, RER depreciation tends to promote exports and inhibit imports when the Marshall-Lerner condition holds. The depreciation of RER may also impact the pricing to market strategy, facilitating entry into export markets (Cimoli, Fleitas, and Porcile, 2011). Furthermore, the export volume of capital goods exhibits the highest sensitivity to exchange rate depreciation. Capital goods, including machinery and production equipment, represent fixed capital and possess higher elasticity, making China's capital goods exports particularly susceptible to RMB appreciation.

Moreover, columns (1)-(4) demonstrate that the coefficients of RER volatility are negatively significant. This finding indicates that RER volatility has a detrimental effect on China's export volume across all types of goods, providing robust evidence in support of hypothesis 3 that exchange rate volatility negatively impacts exports.

〈Table 3〉 Exchange Rate Movement and Import Structure

Variable	Capital goods	Consumer goods	Intermediate goods	Raw materials
REX_{ijt}	0.019***	0.023***	-0.003**	-0.002**
	(0.002)	(0.003)	(0.001)	(0.001)
VOL_{ijt}	-2.603***	-3.544***	-1.535***	1.005***
	(0.438)	(0.533)	(0.269)	(0.318)
$lnTOT_{jt}$	0.297***	0.124***	0.059***	0.081***
	(0.024)	(0.024)	(0.015)	(0.014)
$lnGDP_{jt}$	0.034***	0.020**	0.008	0.008*
	(0.009)	(0.010)	(0.005)	(0.005)
$lnPOP_{jt}$	0.023***	0.023***	0.012***	0.007*
	(0.008)	(0.008)	(0.004)	(0.004)
$INDIST_{ij}$	-0.092***	-0.145***	-0.037***	0.003
	(0.010)	(0.014)	(0.006)	(0.007)
$ln(AREA_iAREA_j$	-0.032***	-0.059***	-0.015***	-0.027***
	(0.005)	(0.006)	(0.003)	(0.003)

$COMLAN_{ij}$	0.245*** (0.039)	0.414*** (0.044)	0.071*** (0.023)	-0.096*** (0.025)
FTA_{ijt}	0.040** (0.019)	0.020 (0.022)	0.026** (0.011)	-0.002 (0.016)
Year-effect	yes	yes	yes	yes
Observation	190	190	190	190
R^2	0.843	0.788	0.771	0.911

Note: * p〈0.1; ** p〈0.05; *** p〈0.01. Robust standard errors are in the parenthesis.

〈Table 3〉 presents the results regarding the impact of exchange rate changes on imports between China and other countries at four stages of processing. The dependent variable is the import volume of capital goods in column (1) and consumer goods in column (2). Additionally, in columns (3) and (4), the dependent variable is the import volume of intermediate goods and raw materials.

The findings in columns (1) and (2) reveal that the coefficients of the Real Effective Exchange Rate (RER) are positive and statistically significant at the 1% level. This indicates that RER depreciation significantly boosts the import volume of capital and consumer goods. Conversely, in columns (3) and (4), the RER coefficient is negative and significant at the 5% level, implying that the depreciation of RER may adversely affect the import of intermediate goods and raw materials. This finding aligns with some micro-level research suggesting that currency depreciation relaxes foreign exchange restrictions and enables domestic companies to import capital products needed to expand their production capacity (Blaum, 2017). The import volume of consumer goods would increase with RER depreciation when the unit price of imported raw materials or intermediate goods required for domestic production results in a less profitable margin than directly importing consumer goods (Bacchetta and Van Wincoop, 2003).

As depicted in 〈Table 3〉, the coefficients of Exchange Rate Volatility (VOL) are significant and negative in columns (1), (2), and (3), but positive in column (4). Consequently, exchange rate volatility significantly harms the import of all these types of goods except raw materials. The higher exchange rate volatility results in a hard pass-through of exchange rates into import prices, consistent with existing literature. The relationship between the RER and import volume may also be affected by multilateral resistance terms (Bahmani-Oskooee and Karamelikli, 2019). In other words, the depreciation of the RER or the volatility of RER has

not always negatively impacted imports. Although currency depreciation may lead to a rise in the price of imported goods, international trade within economic globalization is often influenced by multiple markets simultaneously. The same product or its alternatives can be sold in other countries or home countries concurrently.

Ⅵ. Conclusion

The findings from both disaggregated and aggregate data are consistent. China's bilateral trade is sensitive to RER movements. Analyzing the relationship between aggregated trade flow and exchange rate movements, this paper finds that the depreciation of the real exchange rate increases China's export volume while slightly decreasing its import volume, which aligns with our hypotheses. Additionally, exchange rate volatility has a significant negative impact on China's exports but does not show a significant effect on aggregated imports. This result may be attributed to the existence of foreign exchange substitutes or the companies' sensitive response, which weakens the impact of exchange rate volatility on imports.

Furthermore, significant heterogeneous effects of exchange rate depreciation were found for the export and import of various products. Notably, exchange rate depreciation had contrasting effects on imported goods at different processing stages. The depreciation of RMB (Renminbi) showed a significantly positive impact on China's bilateral export at all processing stages, a result that remains robust when considering aggregate exports. Exchange rate depreciation also had a significantly positive impact on China's import volume of capital and consumer goods while negatively impacting the import of intermediate goods and raw materials. The increase in import unit prices due to currency depreciation could result in a decline in raw material and intermediate goods input due to their lower price elasticity. Conversely, domestic companies may purchase more capital goods and consumer goods to improve production efficiency (Blaum, 2017). Additionally, exchange rate volatility negatively affected the export volume of all goods and significantly harmed the import of all types of goods except raw materials, likely due to the multilateral resistance terms.

However, there are several crucial aspects that this study still needs to

address. Firstly, it should delve into the intricate dynamics between exchange rate depreciation, exchange rate appreciation, and their symmetric or asymmetric effects on trade. Gaining a comprehensive understanding of the underlying conditions that drive asymmetric trade flows is of paramount importance.

Secondly, A deeper and more nuanced examination of how fluctuations in exchange rates impact the trade structure is justified. Consideration of alternative industry classification methods could enhance the depth of analysis. As an illustrative example, China's custom database offers the opportunity to categorize processing trade into three distinct types: import-and-assembly processing trade, as well as pure processing trade.

Lastly, devoting research efforts to devising effective solutions for mitigating the impact of multilateral resistance is essential for fostering enduring bilateral trade and achieving sustained economic stability. Developing innovative methods to address this challenge is a critical step toward establishing a foundation of lasting trade relationships.

Reference

Aftab, M., Ahmad, R., Ismail, I., and Ahmed, M.(2016). "Does exchange-rate uncertainty matter in the Malaysia-EU bilateral trade? An industry level investigation," *Empirica*, Vol.43 No.1, pp. 461-485.

Anderson, J. E. and van Wincoop, E. (2003). "Gravity With Gravitas: a Solution to the Border Puzzle," *American Economic Review* Vol.93 No.1, pp. 170-192.

Arize, A. C., Osang, T., & Slottje, D. J. (2000). "Exchange-rate volatility and foreign trade: evidence from thirteen LDC's," *Journal of Business & Economic Statistics*, Vol.18 No.1, pp. 10-17.

Aziz, N. (2008). "The role of exchange rate in trade balance: Empirics from Bangladesh," *University of Birmingham*, UK, pp. 1-25.

Bacchetta, P., & Van Wincoop, E. (2003). "Why do consumer prices react less than import prices to exchange rates?" *Journal of the European Economic Association*, Vol.1 No.2-3, pp. 662-670.

Baek, J. (2012). "Exchange rate sensitivity of Korea-US bilateral trade: Evidence from industrial trade data," *Journal of Korea Trade*, Vol.16 No.3, pp. 1-21.

Baek, J. (2014). "Exchange rate effects on Korea-US bilateral trade: A new look," *Research in Economics*, Vol.68 No.3, pp. 214-221.

Bahmani-Oskooee, M., & Harvey, H. (2014). "US-Indonesia trade at commodity level and the role of the exchange rate," *Applied Economics*, Vol.46 No.18, pp. 2154-2166.

Bahmani-Oskooee, M., & Karamelikli, H. (2019). "Exchange rate volatility and Japan-US commodity trade: An asymmetry analysis," *The World Economy*, Vol.42 No.11, pp. 3287-3318.

Blaum, J. (2017). "Importing, Exporting and Aggregate Productivity in Large Devaluations," *Unpublished Manuscript*, *Brown University*.

Caglayan, M., & Demir, F. (2019). "Exchange rate movements, export sophistication and direction of trade: the development channel and North-South trade flows," *Cambridge Journal of Economics*, Vol.43 No.6, pp. 1623-1652.

Caglayan, M., & Di, J. (2010). "Does real exchange rate volatility affect sectoral trade flows?" *Southern Economic Journal*, Vol.77 No.2, pp. 313-335.

Chit, M. M., Rizov, M., & Willenbockel, D. (2010). "Exchange rate volatility and exports: New empirical evidence from the emerging East Asian economies," *World Economy*, Vol.33 No.2, pp. 239-263.

Cimoli M., Fleitas S., Porcile G. (2011), "Real Exchange Rate and the Structure of Exports," *MPRA Paper* No. 37846, pp. 1-24

Halicioglu, F. (2008). "The bilateral J-curve: Turkey versus her 13 trading partners," *Journal of Asian Economics*, Vol.19 No.3, pp. 236-243.

Huchet-Bourdon, M., & Korinek, J. (2011). "To what extent do exchange rates and their volatility affect trade."

Irandoust, M., Ekblad, K., & Parmler, J. (2006). "Bilateral trade flows and exchange rate sensitivity: Evidence from likelihood-based panel cointegration," *Economic Systems*, Vol.30 No.2, pp. 170-183.

Martínez-Zarzoso, I., & Nowak-Lehmann, F. (2003). "Augmented Gravity Model: An Empirical Application to Mercosur-European Union trade flows," *Journal of Applied Economics*, Vol.6 No.2, pp. 291-316.

Moslares, C., & Ekanayake, E. M. (2018). "The effect of real exchange rate volatility on exports in the baltic region," *The International Journal of Business and Finance Research*, Vol.12 No.1, pp. 23-38.

Qiu, B., Das, K. K., & Reed, W. R. (2019). "The Effect of Exchange Rates on Chinese Trade: A Dual Margin Approach," *Emerging Markets Finance and Trade*, pp. 1-23.

Romelli, D., Terra, C., & Vasconcelos, E. (2018). "Current account and real exchange rate changes: The impact of trade openness," *European Economic Review*, Vol.105, pp. 135-158.

Ros, J. (2013). "Latin America's trade and growth patterns, the China factor, and Prebisch's nightmare," *Journal of Globalization and Development*, Vol.3 No.2, pp. 1-16.

Sauer, C., & Bohara, A. K. (2001). "Exchange rate volatility and exports: regional differences between developing and industrialized countries," *Review of International Economics*, Vol.9 No.1, pp. 133-152.

Serenis, D. (2013). Does exchange rate volatility hinder export flows for South American countries?. *Applied Economics Letters*, 20(5), 436-439.

Silva, J. S., & Tenreyro, S. (2006). "The log of gravity," *The Review of Economics and statistics*, Vol.88 No.4, pp. 641-658.

Soleymani, A., & Chua, S. Y. (2014). "How responsive are trade flows between Malaysia and China to the exchange rate? Evidence from industry data," *International Review of Applied Economics*, Vol.28 No.2, pp. 191-209.

Truong, H. Q., Dong, C. V., & Nguyen, H. H. (2019). "Determinants of trade flows and trade structure between Korea and ASEAN," *East Asian Economic Review*, Vol.23 No.1, pp. 55-88.

Zhang, Z., and Sato, K. (2012). "Should Chinese Renminbi be blamed for its trade surplus? A structural VAR approach", *The World Economy*, Vol.35 No.5, pp. 632-650.

Exchange Rate Volatility and Bilateral Trade Flow: Evidence from China

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Abstract

Our study aims to explore the impact of China's foreign trade policy measures on the real exchange rate movement. We seek to provide specific references for the formulation of exchange rate and trade-related strategies. Our results indicate that China's bilateral trade is significantly influenced by movements in the Real Effective Exchange Rate (RER). When analyzing the relationship between aggregated trade flow and exchange rate movements, this paper finds that the depreciation of the real exchange rate leads to an increase in China's export volume and a slight decrease in its import volume. Moreover, China's export volume exhibits higher sensitivity to exchange rate volatility compared to the exchange rate level.

Furthermore, the empirical findings regarding disaggregated trade flow suggest that different goods are affected differently by exchange rate movements. Capital goods and consumer goods, being in different stages of processing, show no negative impact on their import and export due to exchange rate depreciation. Consequently, we recommend deepening the industry's reform by improving production efficiency and transitioning the industrial structure to a higher processing stage. This approach can effectively reduce the negative impact of exchange rate depreciation.

〈Key Words〉 Real Exchange Rate, Bilateral Trade, Gravity Model