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The Mechanism of RMB Exchange Rate Policy Affecting China's Digital Trade

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Abstract: Among the many economic policies of the government, exchange rate policy is one of the most important policies, especially in foreign trade and digital trade. This paper examines the impact of our country's exchange rate policy on its digital trade. The study finds that when the RMB depreciation policy is implemented, it has a significant positive impact on the development of digital trade in our country, and this conclusion is still valid after the robustness test. According to the analysis of the mediation effect model, e-commerce enterprises are the intermediary channel for the depreciation of RMB to promote the development of digital trade in our country. After heterogeneity analysis, it is found that the impact of RMB exchange rate policy on digital trade will have different characteristics in different regions, and the impact on the eastern region is the most obvious. Moreover, its exchange rate policy still has a certain lag effect. The study provides valuable insights for coordinating exchange rate policies and digital trade in developing countries.

Keywords: exchange rate policy; digital trade; e-commerce enterprises; Digital economy

1. introduction

How the government uses policy tools (such as exchange rate management, fiscal expenditure) to effectively guide the development of digital trade, make up for the shortcomings and shortcomings of the market itself and cope with regional development imbalances is one of the key issues of public economics. However, in practice, there are many challenges and risks: relying solely on exchange rate policy may distort market harmony and cause international friction, unreasonable fiscal expenditure can easily lead to efficiency loss and resource misallocation, and regional development imbalance will weaken the effect of unified policy. Therefore, it is of urgent theoretical and practical significance to scientifically evaluate exchange rate policies, identify effective transmission paths, and design precise government policies that adapt to regional differences.

The existing literature has carried out rich discussions on digital trade, but there are still certain research gaps. First, there is little literature analyzing the relationship between China's exchange rate policy and digital trade. Second, the research on the conduction mechanism is insufficient and imperfect. Although some scholars have pointed out that digital platforms can reduce transaction friction, there has been no study to quantify the role of e-commerce companies as a bridge between exchange rate policy and digital trade. Third, most existing studies use cross-sectional data or short-term time series, which is difficult to capture the cross-temporal development of digital trade.

The 2022 "14th Five-Year Plan for the Development of China's Digital Economy" clearly proposes to "cultivate new forms of digital trade". However, from the government's point of view, it is difficult to grasp the relationship between policy and market. In this context, the direct effect of quantitative exchange rate policy and the intermediary effect of e-commerce enterprises can provide a scientific basis for playing a good "combination punch" of policy tools. This study uses Chinese provincial panel data as a sample to try to break through the above limitations. First, based on the panel data from 2013 to 2022, the two-way fixed-effect model is used to control regional heterogeneity and temporal trends to alleviate endogenous problems. Second, by constructing an intermediary effect model, e-commerce enterprises are included in the transmission chain of exchange rate policy affecting digital trade, and the impact path of "exchange rate changes→ expansion of e-commerce entities→ digital trade growth" is revealed. Third, combined with China's "dual circulation" strategy and the practice of digital economy development, analyze the synergistic impact of government policy variables such as fiscal expenditure and foreign investment and market forces.

The marginal contribution lies in the systematic analysis of the impact of exchange rate policy on the new format of digital trade, revealing that market intermediation is a key factor in the effective transmission of policy, and also emphasizing the synergy between other policy design and market forces. Analyze the heterogeneity and root causes of policies, and provide an empirical basis for the government to implement precise regional coordination policies. It provides a theoretical reference for how the government can more effectively use policy combinations to intervene in the digital economy era.

2. Literature review

At present, the discussion on digital trade presents diverse views in domestic and foreign academic circles, mainly focusing on new quality productivity, cross-border trade, and more stainable development and the improvement of the framework of digital trade rules have been extensively discussed, and many important theoretical achievements have been achieved. In our country, the development path, policy optimization and industry practice of digital trade have become the focus of research. From the perspective of enterprises, Zhou et al (2025) used the double difference method to test the impact of the establishment of the comprehensive pilot zone on the new quality productivity of export enterprises, found that the influencing factors were significantly different, and proposed that the comprehensive pilot zone mainly affects the new quality productivity of export enterprises through enterprise financing constraints and promoting the digital transformation of enterprises[1]。 Yu et al. (2025) used a discrete-time survival analysis model to investigate the sustainable impact of

trade digitalization on the export relationship of enterprises from the perspective of supply and demand matching, and the study showed that the economic development level, demand level, and breadth of differentiated products of trade digitization enterprises are directly proportional to the export level of enterprises and the export destination, which provides an empirical basis for how to carry out digital trade[2]。

From the perspective of economies and foreign trade, Yu et al. (2025) quantified the digital governance differences in 20 economies in the Asia-Pacific region from 2012 to 2021 under the framework of the regional digital trade integration index, and tested their impact and mechanism on digital service exports[3]。 Wei et al. (2025) used the Topsis model to calculate the digital trade index and the regional foreign trade high-quality development index, and analyzed the dialectical relationship between digital trade and foreign trade high-quality development, and the results showed that digital trade can promote the high-quality development of regional foreign trade[4]。Yang et al. (2025) empirically analyzed the significant inhibitory effect of dual digital trade barriers on digital trade trade using multi-country panel data, and that this inhibitory effect is heterogeneous in terms of barriers and industries, providing empirical evidence for our country to effectively respond to digital trade barriers and release the potential of digital trade[5]。

From the perspective of regional heterogeneity, Yu et al. (2025) used micro-enterprise data to find that the development of digital trade in services will lead to the generation of competitive effects, and there is an inverse relationship between R&D constraints and R&D substitution, which provides micro-evidence for the development of digital trade in services[6]。Ye et al. (2025) combined with 30 provincial data in our country to examine the basic effects, intermediary effects, spatial effects and regional heterogeneity of digital trade and technological innovation on the climbing of the manufacturing value chain, and found that technological innovation is the intermediary channel for digital trade to promote the rise of the manufacturing value chain. From the perspective of regional heterogeneity, the influence effect shows a decreasing trend from the east to the west of our country, which puts forward theoretical support for the development of digital trade in our country to pay attention to spatial linkage and promote the coordinated development of East and West[7]。Lu et al. (2025) used provincial panel data to construct an index system for the development level of digital trade, and analyzed the development laws and trends of digital trade from the perspective of new quality productivity. The study finds that although there are differences in development between regions, the overall level of digital trade is still increasing year by year, and the paper puts forward suggestions to narrow the gap between regions and fully release the development potential of digital trade[8]。Han (2025) used multiple linear regression models and mediation effects models to analyze the relationship between the opening up of trade in digital services and the upgrading of the global value chain of China's high-tech manufacturing industry, and the results showed that the opening up of trade in digital services has a significant role in promoting the upgrading of the global value chain of high-tech manufacturing from the innovation level and the industrial level, and the heterogeneity analysis finds that capital intensity and high integration make the driving effect more obvious[9]。 Duan et al. (2025) empirically tested its impact on the complexity of export technology by measuring the development level of digital trade in prefecture-level cities, and found that the two are significantly positively correlated, and the relationship between the

two will be heterogeneous due to geographical location and other reasons[10]。

International research has also yielded considerable results in the development of digital trade. Qin Zhu et al. (2025) examined 257 cities in China from the perspective of digital finance to measure urban digital trade (DT), and the results showed that digital trade significantly improves corporate ESG performance by promoting green technology innovation and enterprise output, as well as reducing agency costs. In addition, this promotion effect is more obvious in cities with a high level of digital finance, strong non-resource dependence, and a high degree of regional coordinated development[11]。Bian Z et al. (2025) used the panel data of prefecture-level cities in China to analyze the relationship between new digital trade and high-quality economic development from the perspective of industrial structure optimization, and the analysis results showed that digital trade has a positive impact on the industrial structure, and put forward new insights for local governments to formulate digital trade policies to optimize the industrial structure[12]。Dai S et al. (2025) constructed a fixed-effect model and found that digital trade significantly improved green total factor productivity, and both trade openness and FDI actively regulated this relationship, amplifying the impact of digital trade on urban green transformation, and decreasing from the east to the west of our country[13]。Shah H A M et al. (2024) used nearly three decades of BRICS panel data based on econometric methods such as FMOLS and DOLS to confirm that international digital trade, green technology innovation, and renewable energy can significantly help reduce their ecological footprint in BRICS countries or regions[14]。Wan et al. (2024) found that in addition to direct effects, digital trade will also promote the optimization and upgrading of manufacturing through four introduction paths: technological innovation, transaction costs, consumer demand, and human capital, which has a particularly obvious impact on the central and western regions. And when digital trade exceeds a certain threshold, it will accelerate the positive impact of digital trade on the optimization and upgrading of the manufacturing industry[15]。Emily J et al. (2024) found that a new wave of Singapore-led digital trade agreements has expanded the scope of digital trade, hoping to serve as the digital hub of the global economy in the future, and have a voice and control in the field of digital trade rules to promote digital interconnection[16]。Liu et al. (2024) analyzed the relationship between financial and digital trade and resource footprint based on data from MINT countries from 2005 to 2022, and found that financial development will increase the mineral resource footprint. Digital trade enhances resource sustainability, but reduces the mineral resource footprint[17]。

To sum up, many scholars have conducted extensive research on digital trade, mainly focusing on cross-border trade, industrial structure, environmental sustainable development, and digital trade rules. However, it is not difficult to see that the general feature of current research is to use digital trade as an explanatory variable to analyze what impact its development will have, and the theoretical system is more "result-oriented". In this context, this paper takes digital trade as an interpreted variable, and specifically studies what factors affect the development of digital trade. What is the influence mechanism and transmission path? In addition, the current literature has insufficient analysis of the dialectical relationship between exchange rate fluctuations and digital trade, which is reflected in the lack of analysis of the synergistic mechanism between RMB exchange rate, digital intelligence and financial effects, regional development effects, and digital trade. Based on this, the influencing factors

are included in the same analysis framework, the mechanism relationship between the three is sorted out, and the impact of the RMB exchange rate, digital intelligence effect, financial effect, and regional development effect on digital trade is empirically demonstrated, hoping to make a marginal theoretical contribution to better promoting the development of digital trade in the era of digital economy.

3. Fundamentals of mathematical models

3.1. mathematical models

3.1.1. Direct influence of independent variables on dependent variables.

The direct effect of RMB exchange rate policy on digital trade is in the form of a normally elastic demand function (1):

$$DT = A_d \cdot (P^*)^{-\eta} \quad (1)$$

Where $P^* = \frac{P}{E}$, Substituting it into equation (1) to get it:

$$DT = A_d \cdot (\frac{P}{E})^{-\eta} \quad (2)$$

Where

DT:Digital trade demand

A_d: Demand scale parameter, constant（$A_d > 0$）

P^*: Foreign currency prices for digital trade products, constant (short-term rigidity)

E: RMB exchange rate policy

P:The local currency price of digital trade products, constant (short-term rigidity)

η: Price elasticity of demand, constant（$\eta > 1$）

Rewrite the function to exponential form:

$$DT = A_d \cdot (P)^{-\eta} \cdot E^{\eta} \quad (3)$$

Derivation of equation (3):

$$\frac{dDT}{dE} = A_d \cdot (P)^{-\eta} \cdot \eta E^{\eta-1} = \frac{DT}{E^{\eta}} \cdot \eta E^{\eta-1} = DT \cdot \eta \cdot \frac{E^{\eta-1}}{E^{\eta}} = \eta \cdot \frac{DT}{E} \quad (4)$$

$$\frac{dDT}{dE} > 0 \text{（}\eta > 0, \ DT > 0, E > 0\text{）} \quad (5)$$

Because equation (5) is greater than zero, it can be proved that the exchange rate policy of RMB depreciation has a significant direct positive impact on the development of digital trade.

3.1.2. The effect of independent variables on mediating variables.

Based on the platformization characteristics of digital trade, this study constructs an extended form (6) based on the classical normally elastic demand function:

$$DT = A_0 \cdot N^{\beta} \cdot (P^*)^{-\eta} \quad (6)$$

Where $P^* = \frac{P}{E}$, Substituting it into equation (6) to get the result:

$$DT = A_0 \cdot N^{\beta} \cdot (\frac{P}{E})^{-\eta} \quad (7)$$

Assuming that the number of e-commerce enterprises is affected by the exchange rate policy, the relationship can be expressed as:

$N = K \cdot E^{\gamma}$ （8）

Where

A_0：Basic trade efficiency (when there is no e-commerce enterprise), constant（$A_0 > 0$）

N：Number of e-commerce businesses.

K：The scale parameter of the enterprise entry into the equation, constant（$K > 0$）

γ：The scale parameter of the enterprise entry into the equation, constant（$\gamma > 0$）

A_0：Basic trade efficiency without e-commerce enterprises, constant（$A_0 > 0$）

β：The elasticity of the number of e-commerce enterprises to efficiency, constant($\beta > 0$)

Derived from equation (8):

$\frac{\partial N}{\partial E} = K \cdot \gamma \cdot E^{\gamma-1}$ （9）

$\frac{\partial N}{\partial E} > 0$ （10）

Because the equation (10) is greater than zero, it can prove that the exchange rate policy of RMB depreciation promotes the development of e-commerce enterprises.

Derivation of equation (7):

$\frac{\partial DT}{\partial N} = A_0 \cdot \beta \cdot N^{\beta-1} \cdot (\frac{P}{E})^{-\eta}$ （11）

$\frac{\partial DT}{\partial N} > 0$ （12）

Because equation (12) is greater than zero, it can be proved that the development of e-commerce enterprises will promote the development of digital trade.

3.1.3. After controlling for the mediating variables, the direct effects of the independent variables on the dependent variables were analyzed again.

Derivation of equation (7):

$\frac{\partial DT}{\partial E} = \frac{\partial DT}{\partial N} \cdot \frac{\partial N}{\partial E}$ （13）

$\frac{\partial DT}{\partial E} = \left[A_0 \cdot \beta \cdot N^{\beta-1} \cdot (\frac{P}{E})^{-\eta}\right] \cdot (K \cdot \gamma \cdot E^{\gamma-1})$ （14）

$\frac{\partial DT}{\partial E} > 0$ （15）

Because the equation (15) is greater than zero, it can be proved that the exchange rate policy of RMB depreciation promotes the development of digital trade through e-commerce enterprises.

4. Mechanism analysis of RMB exchange rate policy, e-commerce enterprises, and digital trade relations

4.1. The direct impact of RMB exchange rate policy on digital trade

The direct impact of the RMB exchange rate policy on the development of digital trade can be summarized as follows: First, the RMB exchange rate policy can directly affect the development of digital trade by affecting the cost of cross-border trade, if the appreciation policy is implemented, it will increase the purchasing power of the local currency, enhance the import capacity of cross-border e-commerce, attract consumers to purchase high-quality and low-cost goods through digital platforms, and promote the growth of digital trade volume; If depreciation policies are implemented, digital trade exports may increase. Second, the foreign exchange risk management of enterprises will be affected by exchange rate policies, and the depreciation of RMB is expected to prompt export enterprises to accelerate the layout of digital channels, such as locking forward exchange rates through digital platforms, optimizing settlement processes, and reducing the risk of exchange rate fluctuations, thereby improving the efficiency of digital trade. Third, the RMB exchange rate will affect foreign investment in China's digital infrastructure, reduce the cost of foreign investment in China, attract digital service providers such as multinational e-commerce platforms, payment systems, and related technology hardware to increase investment in China, improve China's digital trade system, and indirectly expand the scale of digital trade[1-4]. Based on this, hypotheses are proposed:

H1: The exchange rate policy of RMB depreciation has a significant direct impact on the development of digital trade.

4.2. The intermediary role of e-commerce enterprises

The RMB exchange rate policy can be indirectly reflected in digital trade by affecting the behavior of e-commerce enterprises. First, the exchange rate policy changes the digital trade strategy of enterprises through the cost transmission mechanism. If the depreciation of the RMB increases the export volume of goods, it will attract more e-commerce companies to settle in cross-border e-commerce platforms, take advantage of low prices to expand the international market, and expand the volume of digital trade. Second, through technological innovation, e-commerce enterprises can transform the impact of exchange rates into digital trade efficiency improvements, and the innovation of payment tools will reduce consumers' purchase hesitation due to exchange rate fluctuations, such as Alipay's multi-currency payment and instant exchange rate conversion functions. third, exchange rate fluctuations may change logistics costs, e-commerce companies use big data to predict exchange rate trends and consumer preferences, so as to guide enterprises to carry out reasonable stocking pricing and marketing strategies; In addition, e-commerce companies can further improve the efficiency and quality of digital trade by compressing delivery cycles through intelligent logistics networks that are different from traditional logistics[5-6].

The sustained growth of digital trade requires e-commerce companies as the key carrier. First, the expansion of the number of e-commerce enterprises directly expands the scale of

digital trade entities. Second, e-commerce enterprises upgrade technology to optimize user experience and improve order conversion rate and repurchase rate. Third, improve the e-commerce ecosystem and lower the threshold for digital trade, promote the integration of small and medium-sized enterprises into the global value chain, and realize the inclusive development of digital trade. Based on this, hypotheses are proposed:

H2: The exchange rate policy of RMB depreciation has an impact on digital trade through the intermediary role of e-commerce companies.

5. Design and empirical analysis

5.1. Variable description

Interpreted variable

Variable explained: Digital trade. Drawing on the practice of measuring digital trade by Ye Linli (2022), Zhang Kai et al. (2023), a comprehensive evaluation index system composed of 5 first-level indicators and 18 second-level indicators (see Table 1) is constructed, and the entropy method is used to calculate the comprehensive evaluation level of digital trade in each province[7-10].

Table 1. Digital trade indicator system

	First-level indicators	Secondary indicators
Digital trade	Digital infrastructure	Internet broadband access users (10,000 people)
		Internet broadband access ports (10,000)
		Length of long-distance fiber optic cable lines (km)
		Number of domain names (10,000)
		Number of pages (10,000)
	The level of trade in the digital industry	Information service owner business income (100 million yuan)
		Total telecommunications business volume (100 million yuan)
		Software business revenue (10,000 yuan)
		Number of Businesses with E-commerce Transaction Activities (units)
		E-commerce procurement amount (100 million yuan)

	Industrial digital trade level	Online retail sales (100 million yuan)
		E-commerce sales (100 million yuan)
	Digital technology level	Number of domestic patent applications authorized (items)
		R&D funds for industrial enterprises above designated size (10,000 yuan)
		Technology market turnover (100 million yuan)
	Trade potential	Total retail sales of consumer goods (100 million yuan)
		Total import and export value (100 million yuan)
		Per capita disposable income of all residents (10,000 yuan)

Core explanatory variables

RMB exchange rate policy is the core explanatory variable, and the RMB exchange rate against the US dollar (annual average price) is selected to represent the RMB exchange rate policy. First, as a world currency, the US dollar has a great influence in the world; Second, the annual average exchange rate can more fully reflect the overall level of the exchange rate in a year, which can effectively avoid misunderstandings caused by short-term fluctuations[11-12].

Mediating variables

Number of enterprises with e-commerce transaction activities: The core of digital trade is trade activities through the Internet and digital technology, and e-commerce is one of the main forms of digital trade. The number of enterprises with e-commerce transaction activities as an intermediary variable can clearly show the impact of RMB exchange rate policy on digital trade.

Control variables

Local finance, commercial services and other affairs expenditure needs to be taken into account as one of the important redistribution policies of the government; The per capita consumption expenditure of all residents, as one of the important sources of tax revenue for the government, is also one of the important considerations of public economics. Students in ordinary colleges and universities can reflect the country's education level and ability, and are also an important source of talents for the country and the government. The total investment of foreign-invested enterprises can reflect the government's investment promotion policies and capabilities. The above variables are important areas where the government can intervene and need to be considered in research[13-16].

5.2. Model setting

In order to analyze the impact of RMB exchange rate policy on digital trade, the

benchmark model (1) is constructed.

$$dig_{it} = \alpha_0 + \alpha_1 exc_{it} + \alpha_2 fis_{it} + \alpha_3 con_{it} + \alpha_4 col_{it} + \alpha_5 fdi_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

The interpreted variable dig it represents the level of digital trade development in region i in year t. The core explanatory variable exc it is the RMB exchange rate policy. The fis it refers to the expenditure of local finance and commercial services、 con it is the per capita consumption expenditure of all residents、col it is the number of students in ordinary colleges and universities、fdi it is the total investment of foreign-invested enterprises。γis a time-fixed effect，μis a regional fixed effect，ε is a random error term.

Mediation effect model

In order to analyze the indirect influence mechanism of e-commerce enterprises in RMB exchange rate policy and digital trade development, model (2) and model (3) are constructed to test the mediating effect.

$$eco_{it} = \gamma_0 + \gamma_1 exc_{it} + \gamma_2 fis_{it} + \gamma_3 con_{it} + \gamma_4 col_{it} + \gamma_5 fdi_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (2)$$

$$dig_{it} = \theta_0 + \theta_1 exc_{it} + \theta_2 eco_{it} + \theta_3 fis_{it} + \theta_4 con_{it} + \theta_5 col_{it} + \theta_6 fdi_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (3)$$

eco it indicates the number of e-commerce businesses in region i in year T.Other variable definitions are consistent with the baseline model.

Data sources

This paper takes provinces and cities across the country as research samples (Hong Kong, Macao, Taiwan, and Tibet are not included due to lack of data), and the research period is 2013-2022. The research data mainly come from the National Bureau of Statistics of China and the China Statistical Yearbook.The data were dimensionless using formulas（$Z_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$）.

6. Empirical analysis of the process and results

6.1. Baseline regression results

In order to test the direct impact of RMB exchange rate policy on digital trade, a fixed-effect panel model is constructed, and the regression results are shown in Table 2. The direct impact of RMB exchange rate policy on digital trade is significantly positive at the level of 1%, indicating that the exchange rate policy of RMB depreciation can promote the development of China's digital trade. The empirical results show that for every 1 unit of RMB depreciation, the scale of digital trade increases significantly by 2.900 units. This result validates the hypothesis that H1, that is, the exchange rate policy of RMB depreciation has a significant positive direct effect on digital trade. This paper argues that the exchange rate policy of the first RMB depreciation can reduce the price of export commodities, and the reduction of commodity prices will enhance the export prices of local products, enhance the competitiveness of cross-border e-commerce in the international market, and significantly promote the development of digital trade. Second, the exchange rate policy of RMB depreciation can attract foreign investment to a certain extent, especially digital trade foreign investment, because of the depreciation of RMB, the purchasing power of foreign currency in our country has been relatively improved, and it can also promote the development of digital trade. In terms of control variables, the expenditure coefficient of local finance and commercial services is close to the significance level of 10%, indicating that local financial

support has a marginal promotion effect on digital trade, indicating that the government's relevant fiscal policy support has a certain stimulating effect on digital trade.

The coefficient of students in ordinary colleges and universities is not significant, reflecting the potential problems between education public policy and industrial development, and the output of education policy and the market demand of digital trade may not match, which provides a practical need for deepening the reform of the education field and promoting the public policy design of the integration of industry and education.

Table 2. Baseline regression results

variable	Model (1) dig
exc	2.900*** （0.623）
fis	0.166* （0.056）
con	0.653 （0.452）
col	-0.568 （0.324）
fdi	0.214 （0.142）
cons	0.237*** （0.820）
Fixed effect	be

Note 1: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses.

6.2. Robustness test

The robustness test is shown in Table 3. Considering the political and economic particularity of China's municipalities, this paper excludes the samples of municipalities (Beijing, Shanghai, Tianjin, and Chongqing) and returns (Model 2). Secondly, due to the rapid development of digital trade in China, the shortened sample period method is used to retain the data from 2018 to 2022 for empirical analysis (model 3). After empirical testing, it is found that the two results are consistent with the benchmark regression results of this paper, which reinforces the core conclusion of this paper, that is, the exchange rate policy of RMB depreciation can promote the development of China's digital trade[17-19].

Table 3. Robustness test results (excluding municipalities directly under the Central Government and changing sample period)

variable	Models (2) dig	Models (3) dig
exc	4.127*** （0.752）	5.273*** （2.458）
cons	0.570** （0.149）	-3.450*** （2.911）
Fixed effect	be	be

Note 2: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses.

Increase the real effective exchange rate (REER) of RMB for the soundness test (Model

4). In this paper, the explanatory variable is replaced by the actual effective exchange rate of RMB for robustness testing. Table 4 shows the test results, and from the empirical results in the second column, it can be seen that the depreciation of RMB is still positive for the development of digital trade after changing the explanatory variable to the real effective exchange rate of RMB, so the conclusion is stable。

Table 4. Robustness test results (change explanatory variables)

variable	you Models (4)
reer	2.080*** （0.437）
cons	0.529*** （0.109）
Controls	be

Note 3: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses.

6.3. Mediation effect analysis

Table 5 model (6) reports the impact of RMB exchange rate policy on intermediary variables. The coefficient of the RMB exchange rate policy is 1.527, indicating that the RMB depreciates by 1 unit and the number of e-commerce enterprises increases significantly by 1.527 units. The depreciation of RMB reduces the price of export goods, enhances the price competitiveness of small and medium-sized enterprises in the international market, and attracts more enterprises to expand their business through cross-border e-commerce platforms, thereby expanding the scale of e-commerce entities.

Table 5 model (7) reports the impact of mediating variables on digital trade. The coefficient of the number of e-commerce enterprises is 0.359, indicating that for every 1 unit increase in the number of e-commerce enterprises, the scale of digital trade increases significantly by 0.359 units. The gathering of e-commerce enterprises to form a scale effect will improve the efficiency of digital trade through platform traffic growth and technology spillover. After adding the intermediary variable, the RMB exchange rate policy coefficient became lower than that of the benchmark model, indicating that the number of e-commerce transaction enterprises had a partial mediating role between the RMB exchange rate policy and China's digital trade.

Government policy design must fully consider how to effectively incentivize intermediate nodes, and cultivating suitable market intermediaries may be a more sustainable strategy than relying solely on exchange rate policy adjustments or financial subsidies.

Table 5. Results of mediating effect analysis

variable	**Models(5) dig**	**Models (6) eco**	**Models(7) dig**
exc	2.900*** （0.623）	1.527*** (0.307)	3.001*** （0.490）
eco			0.359*** （0.153）
Control variables	Yes	Yes	Yes
cons	0.237*** （0.820）	-1.357*** （0.149）	0.537*** （0.128）

Fixed effect	be	be	be

Note 4: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses.

6.4. Bootstrap (self-service sampling) test of mediating effects

In order to verify the robustness of the indirect path of RMB exchange rate policy affecting digital trade through e-commerce enterprises, this paper uses the Bootstrap method to conduct 1000 repeated sampling. The direct effect confidence interval does not contain 0, and the direct effect coefficient is positive, indicating that there is a partial mediating effect. The indirect effect is significant at the 5% level, indicating that the exchange rate policy of RMB depreciation exists steadily through the indirect promotion of digital trade by e-commerce enterprises, and hypothesis 2 is true. It shows that the policy needs to take into account both direct and indirect paths, and amplify the effect of the exchange rate policy of RMB depreciation on digital trade through the two-wheel drive of enterprise support and ecological optimization.

Table 6. Bootstrap test results for mediating effects

Effect type	coefficient	Standard error	P-value	95% confidence interval
Direct effect	2.634	0.851	0.010	1.0247,4.2107
Indirect effects	1.068	0.620	0.029	0.201,1.150

6.5. Endogenous test

In order to effectively solve the potential endogenous problem of the model, this paper adopts the system generalized moment estimation (System GMM) method, selects appropriate instrumental variables based on the characteristics of the dynamic panel, uses the lag term of the 2-3 period of digital trade as the endogenous variable tool, and selects the nominal generalized US dollar index as the exogenous instrument variable. The lagging term is related to the current period but independent of future shocks (satisfying correlation); The nominal broad US dollar index is not affected by China's provincial economy (satisfying exogenousness). Table 7 shows that digital trade has strong sustainable development. The RMB exchange rate coefficient is positive, indicating that the depreciation of RMB promotes the development of digital trade[20-25].

Table 7. Endogenous treatment (system GMM estimation)

variable	Models(8) dig
Digital Trade (T-1)	0.561***
	（0.310）
RMB exchange rate	0.367***
	（0.249）
Nominal broad US dollar index	-3.088***
	（0.951）
Constant number	1.200*
	（0.934）
Controls	be

Note 5: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively,

with standard error in parentheses.

It can be seen from Table 8 that AR(1) has a significant test and supports dynamic panel setting. The AR(2) test is not significant, which meets the core assumptions of GMM estimation. The Hansen test supports the exogenous hypothesis of the instrumental variable, and the model effectively overcomes the endogenousness problem, and the estimation results are consistent and reliable.

Table 8. Diagnostic results of GMM model of endogenous treatment system

Types of inspections	Z-value	P-value	χ^2
AR(1) test	-3.02	0.007	
AR(2) test	0.58	0.507	
Hansen test		0.497	13.070

7. analysis

7.1. Heterogeneity analysis

China is divided into eastern, central, western and northeastern regions to examine the heterogeneity of RMB exchange rate policy and e-commerce enterprises on the development of digital trade, and the analysis is as follows.

From Table 9 to Table 12, the total effect of RMB exchange rate depreciation policy is significant in the eastern, central and western regions, but has almost no impact in the northeast region. The eastern region has systematic digital infrastructure construction and services, with a high degree of digitalization of various industries, deeper integration with digital trade, and stronger policy transmission capabilities. In recent years, the manufacturing industry in the eastern region has been transferred to the central and western regions, which has accelerated the construction and improvement of digital trade infrastructure in the central and western regions to a certain extent, so that the effect of RMB depreciation can be transmitted to the central and western regions through trade, and the role of digital trade development in the central and western regions has become more and more significant. The western region may take the depreciation of the RMB as an opportunity to develop cross-border digital trade and promote the development of China's digital trade by opening up the Central Asian market. In contrast, the development of digital trade in Northeast China is almost not affected by the depreciation of the RMB, reflecting the constraints of the traditional industrial structure on digital trade.

From the empirical results in columns 3 and 4 of Table 10, the impact of the exchange rate policy of RMB depreciation in the eastern region on digital trade is positive, indicating that RMB depreciation will indirectly promote the development of digital trade through e-commerce enterprises. From the empirical results in columns 3 and 4 of Table 10, the impact of RMB exchange rate policy on intermediary variables is positive, indicating that the exchange rate policy of RMB depreciation has a promoting effect on e-commerce enterprises. However, the impact of RMB exchange rate policy and intermediary variables on digital trade is not significant, which shows that the development of digital trade in the central

region will be affected by the total impact of RMB depreciation, but it will not be passed on through e-commerce enterprises. From the empirical results in columns 3 and 4 of Table 11, the situation is similar between the western and central regions. There is a big gap between e-commerce enterprises and digital infrastructure in the central and western regions and the east, and various resources need to be integrated. Judging from the empirical results in columns 3 and 4 of Table 12, the northeast region does not seem to be affected by the RMB exchange rate policy.

Table 9. Eastern China

variable	Models(9) dig	Models(10) eco	Models(11) dig
exc	5.028*** （0.921）	2.019*** （0.507）	3.031** （0.790）
eco			0.549*** （0.400）
Control variables	be	be	be
Fixed effect	be	be	be

Note 6: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses

Table 10. Central China

variable	Models(12) dig	Models(13) eco	Models(14) dig
exc	3.040*** （2.011）	1.049* （0.901）	3.001*** （2.094）
eco			0.304 （0.440）
Control variables	be	be	be
Fixed effect	be	be	be

Note 7: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses

Table 11. Western China

variable	Models(15) dig	Models(16) eco	Models(17) dig
exc	2.988*** （0.649）	3.001*** （0.107）	3.733*** （0.887）
eco			0.390 （0.201）
Control variables	be	be	be
Fixed effect	be	be	be

Note 8: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses

Table 12. Northeast China

variable	Models(18) dig	Models(19) eco	Models(20) dig
exc	-2.012 （1.931）	0.320 （0.659）	-2.013 （1.964）
eco			0.380 （0.293）
Control variables	be	be	be
Fixed effect	be	be	be

Note 9: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively,

with standard error in parentheses

7.2. Lag analysis

In the lag period, for every unit of RMB depreciation, digital trade increased by 4.297 units, but with the prolongation of time, the total effect decreased, indicating that the timeliness of exchange rate transmission decreased. The impact of RMB exchange rate policy on e-commerce enterprises has gradually weakened with the prolongation of time; The intermediary carrier remains relatively stable, indicating that the exchange rate policy of RMB depreciation is very resilient to the promotion of digital trade through e-commerce enterprises.

This provides important enlightenment for public policymaking: that is, exchange rate policy, as a relatively short-term stimulus tool, needs to be combined with more durable intervention policies (increasing fiscal revenue, improving infrastructure, institutional reform to optimize the business environment, etc.) to achieve long-term sustainable development of digital trade.

Table 13. Results of lag effect analysis

Effect	variable	Models(21) dig	Models(22) eco	Models(23) dig
One period late	exc is delayed by one period	4.297*** （1.037）	3.007*** （0.659）	3.961*** （1.389）
	eco			0.549*** （0.308）
Two phases of delay	exc is delayed by two phases	3.190*** （0.549）	0.307*** （0.295）	2.076*** （0.273）
	eco			0.770*** （0.668）
Delayed by three phases	exc is delayed for three phases	1.935*** （0.623）	0.138*** （0.102）	2.634*** （0.561）
	eco			0.632*** （0.237）
Control variables	be	be	be	be
Fixed effect	be	be	be	be

Note 10: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with standard error in parentheses

8. conclusions and policy recommendations

8.1. Research conclusions

This study evaluates the impact of China's exchange rate policy on its digital trade development from the perspective of public economics, reveals the transmission role of e-commerce enterprises (market intermediaries), and analyzes the regional heterogeneity of exchange rate policy, as well as the policy formulation and regional governance challenges reflected by it. The main conclusions are as follows: First, the depreciation policy of RMB exchange rate significantly promotes the development of digital trade, and this effect remains stable in the robustness test of excluding the sample of municipalities directly under the Central Government and shortening the sample period. The exchange rate policy of RMB depreciation promotes the expansion of digital trade through direct paths such as improving export price competitiveness, attracting foreign investment, and promoting digital

infrastructure construction. Second, e-commerce enterprises play an intermediary role between the depreciation of RMB and the development of digital trade, which is reflected in the indirect path of RMB depreciation to promote the expansion of e-commerce entities and then the growth of digital trade scale. Third, policy synergies need to be strengthened, the marginal promotion effect of local financial support on digital trade and the potential of foreign investment have not been fully released, and there may be a structural mismatch between higher education resources and digital trade demand, highlighting the need for policy tool optimization. Fourth, regional differentiation is significant, and the unified exchange rate policy faces constraints such as institutional and insufficient supply of public goods in underdeveloped areas.

8.2. policy recommendations

Optimize exchange rate policy management and strengthen public governance and services

The central bank should establish a regular communication mechanism to convey the intention and purpose of exchange rate policy to digital trade stakeholders, reduce the uncertainty cost of policy, and improve the transparency of public governance. Led by the State Administration of Foreign Exchange and cooperated with major financial institutions to create a low-cost and low-threshold exchange rate public information platform and training system for digital trade entities, reducing market failures caused by information asymmetry. In addition, the government can include digital trade enterprises in the scope of foreign exchange hedging policy support to assist enterprises in using financial derivatives to hedge exchange rate risks. For example, the "Exchange Rate Fluctuation Buffer Fund" can be piloted in the Shanghai Free Trade Zone to subsidize the cross-border payment and settlement costs of digital trade platforms, reduce the cost pressure of enterprises, and further amplify the price advantage brought about by the depreciation of the RMB.

Focus on market empowerment and public goods supply to improve the accuracy of fiscal expenditure

Focus on supporting e-commerce enterprises (market intermediaries) to develop and apply technologies that can improve the efficiency of digital trade, such as intelligent pricing, blockchain settlement, etc., reduce their innovation costs as much as possible to promote technological progress and innovation, and provide tax incentives such as income tax deductions and value-added tax refunds to enterprises to promote the healthy development of digital trade. For targeted investment in key digital trade public goods, local governments need to further optimize the structure of fiscal expenditure, such as funding the development of efficient and secure cross-border payment systems, supporting the establishment of data security certification and compliance service systems in line with international rules, advocating digital trade enterprises to increase logistics and data resource sharing, and enhancing the overall international competitiveness of digital trade enterprises.

Implement differentiated regional coordination policies

From the perspective of heterogeneity, the eastern region should further strengthen technology spillover and high-end services, and while developing itself, it can also drive the development of other regions, such as setting up digital innovation funds in strategic regions such as the Yangtze River Delta or Hong Kong, Zhuhai and Macao, etc., to support

e-commerce platforms and major universities to jointly develop advanced algorithms or settlement systems. For the central and western regions, they can apply for special bonds for digital infrastructure construction from the central government, establish logistics hubs or even international logistics hubs (mainly for Central Asia); Local governments can also require e-commerce enterprises to undertake the construction of county logistics outlets and further play the intermediate role of e-commerce enterprises. The northeast region should further break down structural barriers, strengthen the cultivation of new digital trade entities, further accelerate the digital transformation of traditional industries, further develop cross-border e-commerce in equipment manufacturing, pilot cross-border e-commerce parks in cities such as Shenyang or Dalian, and introduce advanced management experience and technology from cities such as Shenzhen and Hangzhou. Give the northeast region a characteristic transformation road.

Optimize the human resource training and governance network

The central government should actively promote the establishment of an efficient, low-cost, and practical online international digital trade dispute settlement mechanism under the framework of the International Commercial Court, and provide legal aid, subsidies and support for enterprises.

Deepen the role of digital yuan in digital trade

Carry out digital RMB entry payment and settlement pilots in free trade zones and cross-border e-commerce comprehensive experimental zones, explore its application to B2B and B2C digital trade scenarios, reduce exchange rate conversion friction and settlement problems, and improve transaction efficiency and capital liquidity. Encourage major cross-border e-commerce platforms, payment institutions, and logistics enterprises to access the digital RMB system and provide customers with one-stop services. Research on the use of digital yuan to achieve automatic payments based on conditions, reduce cross-border trade disputes, and improve trust.

Empower regulatory technology and improve governance efficiency

Integrate the departmental data of customs, taxation, foreign exchange, and market supervision and administration bureaus, and use advanced technologies such as big data, artificial intelligence, and blockchain to realize intelligent supervision of the whole process of digital trade, improve regulatory efficiency, and reduce costs. AI can be used to automatically identify regulatory requirements in different target markets, generate compliance reports, and reduce the compliance threshold and risks of enterprises going overseas. Explore the establishment of cross-border regulatory data sharing and security verification mechanisms, promote mutual recognition of supervision, and create a smoother cross-border environment for digital trade.

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