Frontiers in Economics and Management Volume 6 Issue 9, 2025
ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

The "Trade Engine" Effect of Digital Financial Inclusion: Evidence from China's Provincial Panel Data

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Abstract

With its distinct advantages in digital technology, digital financial inclusion has opened new avenues for the growth of China's foreign trade. It has emerged as a vital and indispensable force in driving the sector's advancement. Based on panel data from 30 provinces in China from 2011 to 2022, this paper explores the impact of digital financial inclusion on China's foreign trade development. The findings demonstrate that digital financial inclusion significantly contributes to the growth of China's foreign trade. Moreover, marketization and stronger financial supervision further amplify its positive impact. A deeper analysis reveals that digital financial inclusion has a more pronounced effect in the central and western regions compared to the eastern region. Additionally, the breadth of coverage, depth of services, and level of digitization in digital financial inclusion all play a crucial role in accelerating the development of China's foreign trade. In light of these findings, the Chinese government should prioritize the advancement of digital financial inclusion by strengthening supportive policies and enhancing the legal framework. By doing so, it can fully leverage digital financial inclusion's potential to drive the growth of China's foreign trade.

Keywords

Digital Financial Inclusion; Foreign Trade Development; Marketization; Financial Regulation.

1. Introducation

Amid rapid technological advancement and widespread Internet adoption, traditional financial models are facing unprecedented disruption and challenges. In order to cope with a series of risks in the future financial environment, digital financial inclusion has gradually become an important direction of China's financial system reform. Digital financial inclusion relies on digital technology to form a comprehensive financial system, which can reach a wider range of people by expanding the supply boundary of financial products, significantly improving financial production efficiency, accelerating capital circulation, and significantly reducing transaction costs, injecting strong impetus into the steady progress and development of the financial industry [4]. In 2013, the Third Plenary Session of the 18th Central Committee of the Communist Party of China proposed to "develop financial inclusion", and financial inclusion became a national strategy. In 2015, the first national plan for financial inclusion was introduced. The Action Plan for Promoting the High-Quality Development of Digital Finance, issued in November 2024, emphasizes the need to focus on strengthening the application of digital technology in areas such as financial inclusion, consolidating the foundation of digital finance, creating an efficient and safe payment environment, cultivating a high-quality financial data market, and building digital financial infrastructure. Driven by national policies, economic development, and market demand, China's digital financial inclusion has developed rapidly and

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

has become a key factor in promoting the soundness of the national financial market and enhancing the vitality of economic development [23].

In the process of China's transformation to high-quality economic development, foreign trade has provided a strong driving force. In 2020, the State Council issued the "Implementation Opinions of the General Office of the State Council on Promoting the Innovative Development of Foreign Trade", which emphasized the need to optimize the structure of foreign trade, improve the quality of foreign trade, and innovate the development of trade. However, since the global pandemic of novel coronavirus pneumonia in late 2019, the world economy has suffered a severe recession. This crisis has not only accelerated economic contraction but also fueled deglobalization tendencies in certain nations, significantly impacting the development of China's foreign trade sector [17]. At the same time, due to the continuous rise in China's labor and raw material costs, overseas companies that originally intended to enter the Chinese market have turned their attention to Southeast Asia, bringing more uncertainty to the development of China's foreign trade. Furthermore, the escalating "Sino-US trade war" and successive discriminatory policies targeting China have significantly undermined the stability of China's foreign trade market. These developments are likely to exert profound and lasting impacts on China's trade relations and economic positioning. As a result, China has begun focusing on the implementation of the "domestic and international cycle", trying to promote the domestic market to drive the international market and form a new core competitiveness, of which foreign trade is a key link [2].

Utilizing panel data from 30 provinces in China (excluding Tibet) spanning 2011 to 2022, this paper constructs a two-way fixed-effect model to empirically analyze the impact of digital financial inclusion on China's foreign trade development. On this basis, from the perspectives of marketization degree and financial supervision intensity, this paper explores the role of digital financial inclusion on China's foreign trade in the past 12 years. Furthermore, this paper analyzes the differential impact of digital financial inclusion on the development of China's foreign trade from the perspective of regional heterogeneity and the development of digital financial inclusion. While existing literature has extensively examined digital financial inclusion, its specific impact on China's foreign trade remains underexplored. This study addresses this research gap by systematically analyzing how digital financial inclusion influences China's foreign trade development, thereby contributing new insights to the field. In addition, this research paper provides targeted suggestions for the formulation of national policies, which can help optimize the policy of digital financial inclusion and promote the sustainable development of China's foreign trade.

2. Literature Review

As an innovative financial model, digital financial inclusion is increasingly seen as a potential way to solve the above-mentioned dilemmas due to its convenience, low cost, and ubiquity. Despite the continuous emergence of relevant research, there is a lack of systematic summary and analysis of the relationship between digital financial inclusion and China's foreign trade. Therefore, this paper will review the existing literature to discuss the development of digital financial inclusion in China's foreign trade, and provide theoretical support for future policy research and practice.

In view of the limitations of traditional financial models and the potential of digital technology, the development of digital financial inclusion can improve the financial inclusion of society, enhance the liquidity of funds in the market, and enhance market vitality. At the same time, digital financial inclusion has also promoted the digital transformation of the economy, accelerated the digitalization process of other finance-related industries, and improved overall efficiency and competitiveness. Zhang et al. [24] suggest that digital financial inclusion and its

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

sub-dimensions play a direct role in promoting China's high-quality economic development. Zhou [27] demonstrated that the advancement of digital financial inclusion enhances the efficient allocation of financial products and services, while simultaneously improving financial service accessibility and inclusivity. In agriculture, Sun [14] has shown that the digital economy has significantly enhanced the modernization process of China's agriculture and rural areas by promoting the upgrading of the agricultural industrial structure, expanding the coverage of digital financial inclusion, and deepening scientific and technological progress. Zhang and Tu [26] demonstrated that the development of digital financial inclusion can significantly narrow the income gap between urban and rural residents, and further promote the balanced development of the economy. Regarding tourism, Ma et al. [12] found that digital financial inclusion effectively transcends the geographical constraints inherent in traditional financial systems. By lowering service costs and enhancing financial inclusivity, it facilitates broader access to financial services, which in turn reduces household liquidity constraints and stimulates tourism consumption expenditures. In terms of manufacturing, Lin and Zhao [9] proposed that digital financial inclusion can improve the resource utilization efficiency of the manufacturing industry, enhance its resilience, and at the same time provide a guarantee for the maintenance and enhancement of the core competitiveness of enterprises, and improve their self-regulation ability in the face of shocks.

As an important tool to promote economic development, digital financial inclusion has played an increasingly significant role in promoting import and export development, enhancing enterprises' import and export capacity and attracting foreign direct investment in recent years. As highlighted by Yang and Zhu [20], the development of digital financial inclusion can significantly promote the improvement of export comparative advantage based on the two dimensions of production and market, combined with the price and quality of export products, the demand level of export products and market coverage. Cheng et al. [1] argues that digital financial inclusion can not only improve the scale of China's exports, but also improve the technical content of China's export products with the help of spatial econometric models. In terms of improving the import and export capacity of enterprises, Jiang and Liu [7] proposed that the development of digital financial inclusion has significantly promoted the expansion of China's manufacturing product imports, and the development of digital financial inclusion has promoted the import of products in general trade mode to a greater extent. Hu and Lu [6] found that digital financial inclusion can effectively reduce enterprises' dependence on export business without any weakening of their export competitiveness. In addition, they found it can also widely promote the improvement of enterprise mark-up rate, helping enterprises to obtain more lucrative profit margins in the market. Regarding foreign direct investment attraction, Guo et al. [5] demonstrated that digital financial inclusion has effectively improved the investment carrying capacity of urban areas by virtue of its unique advantages, and further promoted the improvement of investment efficiency in the real economy on this basis.

Against the backdrop of ever-deepening economic globalization, China's foreign trade plays a pivotal role in the global economic landscape, prompting extensive scholarly research into its key determinants. From a domestic perspective, policy factors are instrumental in shaping foreign trade performance. Dai and Zhang [3] highlighted that the government can promote the development of foreign trade and the international competitiveness of the economy by formulating and effectively implementing a foreign trade development strategy that suits the national conditions, coupled with a series of scientific and reasonable policy measures. Meanwhile, in the context of the digital economy's expansion, digital transformation has emerged as both a critical theme and an imperative for corporate survival and growth. As Yang and Yang [21] argued, advancing enterprise digital transformation serves as a fundamental driver for realizing the full potential of the digital economy. Yu and Yin [22] observed that improving the degree of digitalization can open up a convenient channel for enterprises to enter

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

new export markets, effectively expand the coverage of export markets, and realize the extension of the breadth of export markets. At the same time, it can also maximize the potential of the existing export market and further deepen the penetration and development of the market.

Additionally, the challenges of trade protectionism and geopolitical risks are also factors restricting the development of China's foreign trade. Wang et al. [18] asserted that sluggish economic growth in several major economies-compounded by trade frictions and rising domestic factor costs-has triggered the relocation of certain industrial and supply chains. Consequently, order losses have become a pressing issue, significantly constraining export-scale expansion. At the same time, exchange rate factors have also affected the development of China's foreign trade. Lin and Zhang [10] argued that an imbalance in the RMB exchange rate is very likely to lead to a reduction in welfare levels or a loss of economic efficiency. This is likely to have a significant impact on the macroeconomic field, market expectations, and foreign trade and investment activities.

Existing research has extensively explored the relationship between digital financial inclusion and economic development, yielding valuable insights. However, few studies have examined its impact on China's foreign trade. Compared to existing research, this paper makes two key contributions. First, it examines the underexplored relationship between digital financial inclusion and China's foreign trade, employing a data-driven modeling approach to analyze their interaction—thereby addressing a critical gap in the literature. Second, by investigating the mechanisms through which digital financial inclusion influences foreign trade (including marketization levels and financial regulation), this study establishes a theoretical framework and empirical foundation for future research, advancing discourse in both digital finance and trade policy.

3. Model Setting and Variable Selection

(1) Model setting

In order to test the relationship between digital financial inclusion and China's foreign trade, this paper first constructs the following two-way fixed-effect model:

$$y_{it} = \beta_0 + \beta_1 X_{1it} + \ldots + \theta Z_{it} + \eta_i + \mu_t + \varepsilon_{it} \quad i = 1,2,\ldots,n; \quad t = 1,2,\ldots,T \tag{1}$$

Among them, i and t represent the province and year, respectively, y_{it} indicates the level of imports and exports of goods by province i in the t year, X_{it} indicates the level of digital inclusive financial development of the province i in the t year, Z_{it} represents a vector group of control variables, η_i、$\mu_t$representing the fixed effect of provinces and the fixed effect of years, respectively; ε_{it} is the standard error term.

In addition, this paper constructs a moderating effect model:

$$y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 M_{1it} + \beta_3 X * M_{it} + \theta Z_{it} + \eta_i + \mu_t + \varepsilon_{it}$$
$$i = 1,2,\ldots,n; t = 1,2,\ldots,T \tag{2}$$

Among them, i and $t$represent the province and year, respectively, M_{it}indicates the moderating variable for the province i of the t year, these include: marketization level and financial supervision, θZ_{it} represent the vector group of control variables, and η_i、μ_t represent the fixed effect of provinces and years, respectively. $\varepsilon_{it}$is the standard error term.

(2) Variable selection

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

Table 1 lists the main variables in this document.

1) Level of import and export of goods (lnTRADE)

The level of import and export of goods is the explanatory variable in this paper. Drawing on the research by Liu Dianguo and Zhang Youjia [11], this paper uses the proportion of the value of export trade in goods to GDP to measure the level of import and export of goods (lnTRADE).

2) Development level of digital financial inclusion (digital)

The development level of digital financial inclusion is the core explanatory variable of this paper. Based on the research of Tao Xionghua and Li Minfang [15], this paper uses the Peking University Digital Financial Inclusion Master Index as a proxy variable for the development level of digital financial inclusion (digital).

3) Marketization and financial regulation

This paper employs marketization level (market) and financial regulation (regulation) as moderating variables. Following Jin et al. [8], we measure marketization using the Fan Gang Marketization Index. For financial regulation, this paper adopts Wang Bofeng's [16] approach, operationalizing regulatory intensity as the ratio of financial regulatory expenditure to value-added in the financial sector.

4) Control variables

According to Wu Xiaofeng [19], Qin Meng et al. [13], the following variables are controlled in the model: government intervention (govern), urbanization (urban), infrastructure (infra), level of economic development (lngdpper), and industrial structure (second).

Table 1. Description of the main variables

Variable symbol	Variable symbol	Variable definitions
lnTRADE	Level of import and export of goods	Export trade/GDP, taken as the natural logarithm
digital	The level of development of digital financial inclusion	Peking University Digital Financial Inclusion Master Index
market	Market-oriented level	Fan Gang Marketization Index
regulation	Financial regulatory intensity	Financial Regulatory Expenditures/Value Added of the Financial Sector
govern	Government intervention	Fiscal spending/GDP
urban	Urbanization	Urbanization rate
infra	Infrastructure	Road and rail density
lngdpper	Level of economic development	GDP per capita, taken as the natural logarithm
second	Industrial structure	Proportion of added value of the secondary industry

5) Data Sources

The analysis utilizes panel data from 30 Chinese provinces (Tibet excluded) for the years 2011-2022. The corresponding data are from the China Macroeconomic Database, the China Financial Database, and the China Statistical Yearbook.

(3) Descriptive statistical analysis

Table 2 presents the descriptive statistics for all main variables. The digital financial inclusion index exhibits substantial regional variation (mean = 243.928, range = 18.330-460.691), reflecting significant disparities in development across provinces. Urbanization levels average 60.118%, indicating considerable progress in China's urban development initiatives.

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Table 2. Descriptive statistics

Variable	Number of samples	Average value	Standard deviation	Minimum	Maximum
lnTRADE	360	6.764	0.964	3.721	8.861
digital	360	243.928	107.640	18.330	460.691
market	360	8.150	1.946	3.359	12.864
regulation	360	0.011	0.014	0.000	0.112
govern	360	0.247	0.102	0.107	0.643
urban	360	60.118	12.055	35.030	89.600
infra	360	0.992	0.525	0.092	2.292
lngdpper	360	10.909	0.452	9.706	12.156
second	360	42.351	8.777	15.800	59.000

4. Analysis of Empirical Results

(1) Basic regression results

Table 3 shows the benchmark regression results of the development level of digital financial inclusion and the development of foreign trade. Column 1 of Table 3 shows the test results of digital financial inclusion on foreign trade without adding any control variables and only controlling for a fixed effect of time. Column 2 shows the test results without any control variables, control time, and regional fixed effects. Column 3 shows the results of the test with all control variables added and only the fixed effect of control time is added. Lastly, Column 4 shows the test results with all control variables added and fixed effects at time and region. Given its superior model fit (as shown in Column 4), we employ these results as our baseline regression for analysis. The enhanced goodness-of-fit indicates greater explanatory power regarding foreign trade development, making this specification particularly suitable for examining the relationship between digital financial inclusion and foreign trade growth.

Table 3. Baseline estimates

lnTRADE	(1)	(2)	(3)	(4)
digital	0.010***	0.005**	0.012***	0.009***
	(0.002)	(0.002)	(0.023)	(0.003)
govern			0.464	1.763*
			(0.789)	(0.953)
urban			0.034***	0.241**
			(0.009)	(0.012)
infra			0.668***	0.700***
			(0.170)	(0.231)
lngdpper			-0.652***	-0.419
			(0.249)	(0.281)
second			0.122*	0.012
			(0.007)	(0.008)
Constant terms	6.412***	6.651***	10.111***	7.972***
	(0.140)	(0.102)	(2.344)	(2.719)
Time effect	Yes	Yes	Yes	Yes
Regional effects	No	Yes	No	Yes
N	360	360	360	360
R^2	0.130	0.143	0.185	0.193

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively; In parentheses are robust standard errors.

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

The results of Column 4 show that for every 1 unit increase in the development level of digital financial inclusion, the development level of China's foreign trade will increase significantly by 0.9%. Digital financial inclusion has effectively lowered the threshold for financial services through the Internet, mobile payment and other means, so that more small and medium-sized enterprises can easily obtain financing and enter the international market more easily. Digital financial inclusion not only significantly improves settlement efficiency and reduces time and transaction costs, but also provides more high-quality platforms for access to international markets. With the help of these platforms, more enterprises can reach global consumers, greatly reducing the difficulty of entering international markets and strongly promoting foreign trade. In addition, digital financial inclusion provides enterprises with diversified financial tools and services to prevent foreign trade risks, providing strong support for the development of China's foreign trade.

Empirical results demonstrate that government intervention has exerted a statistically significant positive effect on China's foreign trade development. The Chinese government has significantly promoted the high-quality development of foreign trade by formulating various policies and regulations to provide clear guidance for enterprises [3]. The government issues innovation policies to promote the development of domestic enterprises' products and technologies and attract the global market. At the same time, the government has adopted measures such as export subsidies and tax rebates to reduce the cost of enterprises and make their products more competitive in the global market. In addition, the Chinese government actively participates in international trade negotiations, signs trade agreements, opens up new markets for domestic enterprises, and reduces trade barriers. The support of fiscal policy and monetary policy has promoted the development of China's economic market and increased the level of China's foreign trade development.

The development of urbanization has played a significant role in promoting the growth of China's foreign trade development. As the rural population migrated to the cities, they brought a large number of laborers to the market, making the domestic market more dynamic. The development of urbanization has led to the rapid development of urban service industries, greatly improved trade efficiency, and promoted the development of foreign trade. At the same time, the development of urbanization has promoted the agglomeration of industries, formed a relatively complete industrial chain and supporting service system, and increased the competitiveness of enterprises.

China’s foreign trade has advanced significantly, thanks to substantial improvements in infrastructure.. Improvements in transportation infrastructure have dramatically shortened the transportation time and cost of goods, and accelerated the flow of trade [25]. The advanced communication infrastructure enables foreign trade enterprises to communicate with global customers in real time and efficiently, reduce the cost of information difference, and attract more international orders. Advances in energy infrastructure have made energy harvesting faster and more efficient, increasing the stability of the supply of products in international markets.

(2) Moderating effect results

Table 4 shows the results of the moderating effect of marketization level and financial regulation on the development of China's foreign trade. Column 1 of Table 4 shows the test results of the marketization level on the development of foreign trade without adding any control variables and only controlling for the fixed effect of time. Column 2 shows the test results of the marketization level on the development of foreign trade under the condition of adding not only control variables, but also time and regional fixed effects. Column 3 shows the test results of financial supervision on the development of China's foreign trade without adding any control variables and only controlling for the fixed effect of time. Column 4 shows the test results of financial supervision on the development of China's foreign trade under the condition

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

of adding all control variables, control time and regional fixed effects. Among them, because the model in column 2 and column 4 has a higher goodness of fit and stronger explanatory power for the development of foreign trade, columns 2 and 4 are used to explore the regulatory effect of marketization level and financial supervision in the process of digital financial inclusion affecting the development of China's foreign trade, respectively.

Table 4. Moderating effect results

lnTRADE	(1)	(2)	(3)	(4)
c_digital	0.002 (0.003)	0.005* (0.003)	0.005** (0.002)	0.009*** (0.003)
c_market	-0.048 (0.034)	-0.728* (0.038)		
c_digital×c_market	1.292×10^{-4} (9.320×10^{-5})	2.186×10^{-4}** (1.045×10^{-4})		
c_regulation			8.134*** (1.239)	7.590*** (1.261)
c_digital×c_regulation			0.017* (0.009)	0.015* (0.009)
Constant terms	7.187*** (0.571)	6.650** (3.194)	7.885*** (0.427)	9.914*** (2.802)
Control variables	No	Yes	No	Yes
Time effect	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes
N	360	360	360	360
R^2	0.156	0.212	0.246	0.278

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively. In the parentheses are robust standard errors.

From the table, the estimation coefficients of c_digital×c_market and c_digital×c_regulation are significantly positive at the levels of at least 5% and 10%, indicating that the improvement of marketization and financial supervision can significantly strengthen the impact of digital financial inclusion on the development of China's foreign trade.

Marketization and digital financial inclusion are mutually reinforcing, driving progress and shaping each other's development. The development of marketization has improved the financial market, various laws and regulations have been continuously improved, and the regulatory system has gradually matured, creating a good development environment and atmosphere for the application of digital financial inclusion. At the same time, the higher the level of market-oriented development, the more digital financial inclusion can participate in the market and play a role, thereby accelerating the development of China's foreign trade. Since marketization plays a role in connecting digital financial inclusion and China's foreign trade through the allocation of market resources and the regulation of the financial market, it is of great significance to study the regulatory significance of marketization on the relationship between digital financial inclusion and the development of China's foreign trade.

Financial regulation establishes and improves the legal system, standardizing digital financial inclusion operations to ensure transparency and security while safeguarding consumer and enterprise rights. By reducing financial risks and combating illegal activities, it strengthens market integrity and enhances domestic trade confidence. At the same time, financial regulation, through monitoring various indicators of domestic trade, can promptly identify and address issues, thereby effectively stabilizing the financial market and maintaining a good

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

market order, ensuring the smooth conduct of trade activities. Additionally, government-issued innovative policies have promoted the reform of digital financial inclusion, encouraging financial institutions to implement diversified portfolios that better integrate digital financial inclusion with foreign trade. Wang Bofeng [16] highlighted that the current intensity of financial regulation in China is in a state conducive to the growth of the real economy, which has improved the liquidity of funds in digital financial inclusion. Therefore, this paper selects marketization and financial regulation as the moderating variables between digital financial inclusion and the development of China's foreign trade.

(3) Heterogeneity Analysis Results

This paper analyzes the heterogeneity of digital financial inclusion on the development of China's foreign trade from two aspects: regional heterogeneity and dimensional heterogeneity. To account for regional heterogeneity, the sample is divided into two groups: the eastern region and the central and western regions. The corresponding results are presented in Table 5. In terms of dimensional heterogeneity, the analysis of the heterogeneity of digital financial inclusion on China's foreign trade is conducted based on coverage breadth (width), usage depth (depth), and digitalization level (degree). The corresponding results are presented in Table 6.

Table 5. Heterogeneity analysis results

lnTRADE	Eastern Region	Central and Western Region
digital	0.004 (0.002)	0.018*** (0.005)
govern	-0.846 (0.853)	1.457 (1.586)
urban	0.012 (0.009)	-0.137*** (0.035)
infra	1.151*** (0.262)	0.064 (0.338)
lngdpper	-1.214*** (0.226)	0.265 (0.525)
second	0.031*** (0.008)	0.013 (0.011)
Constant terms	17.233*** (2.258)	8.118 (5.112)
Time effect	Yes	Yes
Regional effects	Yes	Yes
N	156	204
R^2	0.610	0.278

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%. In the parentheses are robust standard errors.

As shown in Table 5, digital financial inclusion exhibits a positive yet statistically insignificant effect on foreign trade development in China's eastern region. In contrast, its impact is both positive and statistically significant in the central and western regions. One possible reason for this is that the eastern region benefits from strong government policy support and has a solid economic foundation, with a well-established and comprehensive financial infrastructure and advanced digital technology. Therefore, the development of digital financial inclusion has a relatively smaller and less noticeable effect in the eastern region compared to the central and

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

western regions. Zhou Jinhong [27] stated that, compared to other regions, digital financial inclusion tends to play a more crucial role in remote and economically underdeveloped central and western regions. The central and western regions started relatively late in terms of digital technology and need some time to bridge the technological gap, which accelerates their acceptance of digital financial inclusion as a new and innovative concept. Moreover, digital financial inclusion offers distinct advantages in its application scenarios across the central and western regions. Supported by strong national policies, the adoption of digital financial inclusion technologies has accelerated significantly in these areas. Consequently, its developmental impact is particularly pronounced in the central and western regions.

A dimensional heterogeneity analysis is presented in Table 6.

Table 6. Heterogeneity analysis results

lnTRADE	(1)	(2)	(3)
width	6.224×10^{-4} (0.004)		
depth		0.005*** (0.001)	
degree			0.003*** (0.001)
Constant terms	5.298** (2.881)	-2.447** (2.641)	6.366** (2.646)
Control variables	Yes	Yes	Yes
Time effect	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes
N	360	360	360
R^2	0.166	0.197	0.189

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%. In the parentheses are robust standard errors.

Based on Table 6, it can be seen that coverage breadth (width), usage depth (depth), and digitization degree (degree) have a positive impact on the development of foreign trade, and the impact of usage depth (depth) and digitization degree (degree) is more significant. This may be because the increase in coverage breadth indicates that financial services transcend geographical limitations and reach every corner, providing people from all social strata with the opportunity to enjoy the convenience brought by digital financial inclusion, thereby contributing to the balanced development of the overall economy and promoting the development of China's foreign trade. Yang Huimei and Zhu Weichao [20] proposed that the depth of digital financial usage is a key indicator to measure the degree of practical application of digital financial inclusion in reality; the digitization degree of inclusive finance is a potential supporting factor for the robust development of digital financial inclusion. The deepening of usage depth and digitization degree means that people are using digital financial inclusion services more frequently, and enterprises are making more comprehensive use of various financial tools. This also makes the financial service process more automated, greatly reducing time costs and improving trade efficiency. The deepening of these degrees helps institutions use advanced technology for detection and monitoring, reducing the risks of China's foreign trade and providing safe and reliable protection for transactions.

(4) Robustness Test Results

In this paper, robustness tests were conducted by excluding special years and municipalities directly under the central government, and the digital financial inclusion level with a one-

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

period lag was selected as an instrumental variable for endogeneity testing. Table 7 presents the results of the robustness tests in this study.

Table 7. Robustness test results

	OLS	OLS	IV-2SLS	IV-2SLS
	Explanatory variables	Explanatory variables	Phase 1	Phase 2
digital	0.007** (0.003)	0.009*** (0.003)		0.007** (0.003)
L_digital			0.704*** (0.044)	
Constant terms	7.965** (2.979)	6.696** (3.277)	59.966 (43.958)	6.198** (2.994)
Kleibergen-Paap rk LM statistic				85.06***
Stock-Wright LM S statistic				8.35***
Control variables	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes
N	300	312	330	330
R^2	0.204	0.191	0.998	0.929

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%. In the parentheses are robust standard errors.

1) Exclusion of Special Years

Due to the COVID-19 pandemic causing a global economic recession, China's foreign trade suffered a severe blow. To avoid the bias in results caused by exogenous shocks, this paper excludes the data from 2020 and 2021 and re-verifies the baseline regression results. Column 1 in the table shows the regression results of digital financial inclusion on China's foreign trade after excluding the special years. The results indicate that digital financial inclusion significantly promotes the development of China's foreign trade, demonstrating the robustness of the results.

2) Exclusion of Municipalities Directly Under the Central Government

Due to the differences in administrative models between municipalities directly under the central government and other provinces, to avoid the potential discrepancies caused by these administrative differences, this paper excludes the four municipalities directly under the central government-Beijing, Tianjin, Shanghai, and Chongqing-and then conducts the regression test again. Column 2 in the table shows the regression results of digital financial inclusion on China's foreign trade after excluding the municipalities directly under the central government. The results indicate that digital financial inclusion can significantly promote the development of China's foreign trade, demonstrating that the results are similarly robust.

3) Endogeneity Test

To avoid the interference of endogeneity issues on the research results, we conducted an instrumental variable method test. This paper selects the one-period lagged digital financial inclusion level as the instrumental variable. Since the one-period lagged digital financial inclusion level is closely related to the current digital financial inclusion level, and the development of current foreign trade does not affect the previous period's foreign trade, it satisfies the relevance and exclusivity principles for selecting instrumental variables. The results, as shown in columns 3 and 4, indicate that the coefficient of the instrumental variable

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

is still positively significant, suggesting that there is no endogeneity issue with the results. Additionally, the Kleibergen-Paap rk LM statistic and the Stock-Wright LM S statistic test results are significant, indicating that the instrumental variable is not a weak instrument, and the results are robust.

5. Conclusion and Recommendations

Based on the panel data of 30 provinces in China (excluding Tibet) from 2011 to 2022, this paper constructs a two-way fixed-effect model to empirically analyze the impact of digital financial inclusion on China's foreign trade development. The results show that digital financial inclusion has a significant role in promoting the development of China's foreign trade. Marketization and financial supervision have a significant positive impact on the development of digital financial inclusion on China's foreign trade. The level of digital financial inclusion in the central and western regions to promote China's foreign trade is higher than that in the eastern region, and the breadth, depth of use, and digitalization can also significantly accelerate the development of China's foreign trade.

Based on the above empirical results, on the one hand, the research framework of digital financial inclusion can be enriched. Previous literature on digital financial inclusion rarely touches on the impact of this field on China's foreign trade, and this paper fills the theoretical gap of digital financial inclusion to a certain extent. On the other hand, this paper can provide some optimization suggestions for the government to formulate policy guidelines. In addition, the research on the differences between foreign trade enterprises of different sizes, such as large multinational enterprises and small and medium-sized foreign trade enterprises, will have a deeper logical portrayal of the relationship between digital finance and the development of China's foreign trade, which can be used as the direction of future discussion.

Based on the above conclusions, this paper puts forward the following suggestions: First, deepen market-oriented reform and optimize the business environment. The government should further advance the 'streamlining administration, delegating powers, and improving services' reforms by simplifying administrative procedures, reducing institutional transaction costs for enterprises, and fostering a more favorable development environment for digital financial inclusion and foreign trade firms. These measures will help facilitate the organic and sustainable growth of China's foreign trade through digital financial inclusion. In the field of digital financial inclusion, monopolies rely on their own resource advantages to set market thresholds, making it difficult for new enterprises to conduct business and suppressing their innovation vitality. Therefore, the government should crack down on industry monopolies, promote fair competition in the market, and inject new vitality into digital financial inclusion and foreign trade enterprises.

Second, improve the financial regulatory framework. By establishing and improving risk assessment and early warning mechanisms, governments can identify and mitigate digital financial inclusion risks in a timely manner, prevent risk spillover, and ensure the security of China's foreign trade market and consumers' confidence in using digital financial inclusion tools. The government should crack down on illegal fundraising, fraud and other activities that use digital financial inclusion to maintain order in the financial market. The relevant financial regulatory authorities should clarify the responsibilities of each department in view of the characteristics of the cross-border integration of digital financial inclusion, so as to avoid a regulatory vacuum and duplication of supervision. At the same time, the financial regulatory authorities need to coordinate and cooperate with other relevant departments to form a joint regulatory force to protect the orderly and healthy development of digital financial inclusion in an all-round way.

ISSN: 2692-7608 DOI: 10.6981/FEM.202509_6(9).0019

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