

The Impact of Digital Finance on International Low Carbon Trade Competitiveness

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Abstract

Turning into a trader of quality is the key to promoting the efficiency and dynamics of China's economy, and is also an important support for the realization of socialist modernization. In the low-carbon era, the construction of a trader of quality needs to consider low-carbon economic indicators. Meanwhile, China's financial industry has entered the digital stage, and the rapid development of digital finance has had a significant impact on trade and social economy. Low carbon economy and digital finance bring new requirements and opportunities for trade development. It has become an important issue to study how digital finance can help enhance the low carbon trade competitiveness. Based on the data of 30 provinces in China from 2011 to 2022, this paper studies the impact of digital finance on the competitiveness of international low-carbon trade. Through theoretical analysis and empirical tests, the study finds that: (1) Digital finance significantly promotes international low carbon trade competitiveness; (2) The depth and the digitization degree of digital finance have a positive impact on competitiveness; The study also provides theoretical support and practical guidance for the development of PPP (Purchase Power Parity), helping governments and the private sector to better grasp the opportunities of digital finance and low-carbon economy, and design more forward-looking and sustainable PPP projects. Meanwhile, the study also provides an important reference for optimizing the regional layout of PPP projects, promoting technological innovation and formulating relevant policies, which helps to achieve a win-win situation for both economic and social benefits.

Keywords

Digital Finance; Low Carbon Trade Competitiveness; Two-way Fixed Effects Model

1. Introduction

In 2013, China became the world's largest country in trade in goods, and by 2020, it will rank first in the world in terms of total trade in goods and services. However, China's foreign trade still suffers from the problem of "big but not strong", and there is much room for improvement in terms of the quality of development and the level of efficiency. In this regard, the report of the 20th CPC National Congress put

forward the strategic plan of accelerating the construction of a strong trade country. With the development of economic globalization, global environmental problems have become increasingly serious, and the 2015 Paris Agreement has set global climate change targets and established a new “bottom-up” emission reduction mechanism. In this context, parties have announced or revised their emission reduction targets, and China has also proposed a “double carbon” target (Wang Hailin et al., 2020). However, some countries use “carbon intervention” to shape their leadership core and seize the moral high ground, and impose “carbon tariffs” to shift the responsibility for emission reduction and set up trade barriers (Zhang Rui et al., 2021), e.g., the implementation of the European Union's Carbon Border Adjustment Mechanism (CBAM), which will affect Chinese exports to the EU and may change the rules of international trade (Luo Luo et al., 2021). For example, the implementation of the EU's carbon border adjustment mechanism will affect China's exports to the EU and may change the rules of international trade (Luo Bixiong et al., 2023). Therefore, in the low-carbon era, the construction of a strong trade country and the enhancement of trade competitiveness need to consider low-carbon economic indicators (Wang Yu, 2013). China's financial industry has entered a new stage of digitization, and digital finance has shown vigorous development, injecting new kinetic energy for economic transformation and upgrading. The advent of the low-carbon economy era has put forward new requirements for trade development, and the emergence of digital finance has brought new opportunities and challenges for trade development. Whether digital finance can drive trade to meet the new requirements of the low-carbon economy era and boost the construction of a strong trading nation is a topic that needs to be studied urgently.

Existing literature mostly studies the impact of digital finance on financing constraints, enterprise innovation and income disparity, with fewer studies on digital finance and carbon emissions, while the research on digital finance and carbon emissions in international trade, especially low-carbon trade competitiveness, is obviously insufficient. Therefore, this study tries to organically combine digital finance, low carbon and trade competitiveness, and on this basis, explores the role of technological innovation in the impact of digital finance on low carbon trade competitiveness, further extends the research field of digital finance, and also enriches the research results in the field of trade competitiveness to a certain extent, so as to further help the construction of a strong trade country and realize the “dual carbon” goal by providing theoretical support. It also enriches the research results in the field of trade competitiveness to a certain extent, and provides theoretical support for further assisting the construction of a strong trade country and realizing the “dual carbon” goal. The construction of low-carbon economy itself has the attribute of public goods, which requires the guidance of the government and the extensive participation of enterprises, and is suitable for the operation mode of PPP, while the PPP project has the problems of large capital demand and difficult risk

management, and also pays more attention to the environmental protection and sustainable development, so this study also provides the thinking and support for the development of the PPP project.

2. Literature Review

Studies related to digital finance and low-carbon trade competitiveness can be categorized into two aspects: low-carbon and trade.

2.1. Digital Finance in Low-carbon Aspect

In the low-carbon aspect, the mainstream view supports that digital finance has a positive effect on reducing carbon emissions. Specific paths of action include: digitization of residents' consumption, facilitation of financial services (Fan Qingqian and Feng Sixian, 2022), industrialization of digital and digitization of industry (Guo Guixia and Zhang Yao, 2022; Wang Yuanbin et al., 2022), technological innovation (Zeng Liangen et al., 2025; Li Bo and Quan Ying, 2023), and green financial development (Feng Suling et al., 2023), industrial structure upgrading (Wang Fatao and Liu Yatong, 2023), regional energy consumption (Ouyang et al., 2018), etc., and the breadth of coverage and depth of use contribute more significantly to carbon emission reduction (Feng Suling et al., 2023). In the field of subdivided industry sectors, digital finance is the main path for the construction of strategic integrated pilot zones to reduce the carbon emission level of electricity consumption (Chang Haoliang et al., 2023); digital finance can effectively reduce the intensity of carbon emissions from agriculture, while urbanization (Cheng Qiuwang et al., 2022), and marketization can improve the carbon reduction effect of digital finance (Su Peitian et al., 2023). For carbon emissions in the manufacturing industry, the impact of digital finance presents a staged character, with the initial stage leading to an increase in carbon emissions through scale expansion, and the later stage realizing the emission reduction effect through the promotion of green technological innovation of enterprises (Wang Jun et al., 2022). From the micro-enterprise level, the development of digital lending platforms can greatly enhance the efficiency of financial services, provide loans for micro and small enterprises, solve the problem of capital turnover, and boost micro and small enterprises to carry out green innovation in business models, thus promoting carbon emission reduction (Pizzi et al., 2021). In addition, the impact of digital finance on carbon emissions varies in different regions (Kang Mann and Du Yunwei, 2023), and it is more obvious in the eastern part of China (Liao Zhenzhen and Ru Shaofeng, 2022), the regions with higher material capital investment as well as higher education level (Wang Shoukun and Fan Wencheng, 2022).

2.2. Digital Finance Affects Trade

Digital finance affects trade competitiveness in terms of trade scale and trade structure. From the perspective of the impact of digital finance on trade scale, the aca-

demographic community generally agrees that digital finance can effectively promote the expansion of trade scale. In terms of exports, digital finance promotes enterprise exports by reducing enterprise financing constraints, improving the regional innovation environment, boosting the productive service industry (Chen Xu and Qiu Bin, 2021), and enhancing the efficiency of SMEs' working capital utilization, etc., and is more capable of “delivering charcoal in the west” and “adding flowers on the cake” in the regions with better financial soft environment. “Icing on the cake” (Zhang Mingxin et al., 2022), therefore, the greater the gap between China and other countries in digital finance, the more unfavorable to China's exports (Li Yunpeng, 2021). In terms of imports, digital inclusive finance promotes the expansion of the scale and quality of corporate import trade (Xu Jiayun, 2022) by boosting domestic consumption (Zhang Pengyang et al., 2022) and easing the financing constraints of enterprises (Xu Jiayun, 2022), and it has a positive effect on the overall situation of international import trade (Qiu Leining et al., 2023). In terms of the impact of digital finance on trade structure, scholars have found that digital finance to promote trade has significant differences on different industries and different enterprises, the industry's dependence on external financing (Fan Zhaobin and Zhang Liuqing, 2017), enterprise ownership and enterprise size (Zhang Mingxin et al., 2021), the enterprise's wage level, the level of the enterprise's human capital, and the locational advantage of the city where the enterprise is located (Pan et al., 2021), etc. all have an impact on the extent of the role of digital finance in promoting export trade. The development of digital finance also significantly promotes the upgrading of the city's export structure, and its effect is dynamically strengthened (Zhang Yingying et al., 2023).

3. Theoretical Assumptions

Low-carbon trade competitiveness is used to measure the ability of a country (region) to obtain incremental trade competitive advantage in a carbon-constrained environment, which not only reflects the competitive position of an economy in international trade, but also reflects the effectiveness of carbon emission reduction of its trade and production activities (Hu Jianbo et al., 2023). Digital finance has two main functions: “incremental supplementation” and “stock optimization” (Tang Song et al., 2020). The former refers to efficiently receiving capital from the market and providing it to the demand side. When carrying out international trade, enterprises need financial institutions to provide basic financial support, including account management, cross-border payment and other core businesses, and the advantages and disadvantages of these financial services will have a direct impact on the transaction costs of enterprises (Ito and Chinn, 2014; Eichengreen et al., 2017). On the one hand, relying on the Internet, digital finance can accelerate the credit approval of financial institutions (Li Chuntao et al., 2020), break the physical outlets and artificial limitations, reduce the enterprise to reduce the time consumption as well as the cost

of the enterprise in the process of information acquisition and transaction, and improve the efficiency of financial resource allocation (Tang Song et al., 2019); on the other hand, with the technical support of big data, artificial intelligence and other technologies, the digital finance, by processing massive information (Gomber et al., 2018), exerts the long-tail effect and incorporates SMEs with diverse and complex needs into the financial market, and digital finance makes corporate financing more convenient by bypassing traditional banks (Feng Si-Xian and Guo Ren-Jing, 2019), which reduces the dependence of corporations on bank credit and broadens the financing channels (Li Jia and Duan Shurong, 2022); the incremental capital directly promotes product exports and low-carbon transformation, and enhances low-carbon trade competitiveness. The latter refers to the all-round improvement of the business structure of traditional financial institutions to enhance quality and efficiency. The credit openness and transparency characteristics of digital finance can reduce the information asymmetry between financial institutions and enterprises, appropriately match the supply side of funds with the demand side, and improve the mismatch of credit resources (Laeven et al., 2015); continuously narrow down or even remove items that are more likely to cause harm after accurate assessment of covered activities, and circumvent the adverse selection in the financial market and the moral risk problems (Demertzis et al., 2018); digital finance screens low-carbon enterprises and projects based on technical support, especially its establishment of green credit services, including nuclear power, wind power and photovoltaic power generation and other green industries, prioritizes the issuance of credit resources to environmentally friendly low-carbon enterprises, and guides the flow of funds to new energy, high-end manufacturing and other industries (Ouyang Wenjie and Lu Minfeng, 2023). Therefore, digital finance can provide effective financial support for the low-carbon industries that need to be vigorously developed under the goal of “dual-carbon” as well as the low-carbon transformation of traditional industries, thus promoting the enhancement of low-carbon trade competitiveness. The research hypothesis is proposed: digital finance has a positive role in promoting low-carbon trade competitiveness.

4. Model Setup

Based on the above analysis, the fixed effect model of digital finance and low carbon trade competitiveness is established with reference to Hu Jianbo (2023) et al:

$$LCTC_{it} = \alpha_0 + \alpha_1 DF_{it} + \alpha_2 C_{it} + \delta_i + \theta_t + u_{it} \quad (1)$$

As shown in Equation (1), where the DF variable is the digital finance index of province i in year t , α_1 is the core coefficient, representing the impact of digital financial development on low-carbon trade competitiveness, if α_1 is positive, it means that digital financial development promotes low-carbon trade competitiveness, and vice versa there is an inhibitory effect. Cit refers to a set of control variables, δ_i and θ_t represent the province and year fixed effects respectively and u_{it} is the error term.

5. Analysis of Regression Results

Table 1.Regression results of the impact of Peking University's digital finance on low-carbon trade competitiveness

	(1) LCTC	(2) LCTC	(3) LCTC	(4) LCTC	(5) LCTC
DF	1.104*** (3.94)	0.855*** (2.93)			
CB			0.596 (1.55)		
UD				0.440** (2.53)	
DL					0.232** (2.06)
lnPgdp		0.107 (1.20)	0.095 (0.99)	0.156* (1.77)	0.149* (1.69)
lnOS		0.006 (1.03)	0.008 (1.26)	0.008 (1.30)	0.009 (1.41)
lnTH		0.081*** (4.17)	0.088*** (4.50)	0.081*** (4.11)	0.083*** (4.21)
lnRD		0.044*** (1.11)	0.036** (0.90)	0.036 (0.91)	0.039*** (0.99)
lnIC		0.020 (0.76)	0.019 (0.70)	0.018 (0.69)	0.020 (0.75)
_cons	0.299*** (15.15)	-1.122 (-1.24)	-1.020 (-1.05)	-1.615* (-1.81)	-1.548* (-1.73)
N	360	360	360	360	360
R ²	0.267	0.314	0.300	0.309	0.304
year	YES	YES	YES	YES	YES
province	YES	YES	YES	YES	YES

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Table 1 demonstrates the regression results of the impact of Digital Financial Inclusion (DF) on the Low Carbon Trade Competitiveness Index at BYU. The explanatory variables in columns (1) and (2) are the low carbon trade competitiveness index (LCTC) based on carbon productivity. As shown in column (1), the regression coefficient of DF in the empirical model that does not incorporate other potential influences is 1.104, which is significant at 99% confidence interval, which initially confirms that if focusing only on the direct association between digital finance and low carbon trade competitiveness, the former's enhancement effect on the latter is statistically significant; in column (2), in the baseline regression model that incorporates the key control variables, such as industrial structure In column (2), in the benchmark regression model incorporating key control variables such as industrial structure, the regression coefficient of DF is 0.855, which is still at the 1% significance level. This result supports the core hypothesis, and provides a double-validated empirical basis for the empowered green trade transformation of digital finance, after eliminating the possibilities of observational errors and omitted variable bias.

In addition, the Peking University Digital Financial Inclusion (DF) index consists of

three dimensions: breadth of coverage (CB), depth of use (UD), and degree of digitization (DL), and the effects of these dimensions on international LCTC competitiveness and their variability need to be further investigated. The table also reports the regression results of the three dimensions on carbon productivity low carbon trade competitiveness.

Except for the breadth of digital financial coverage, which has a non-significant effect on carbon productivity Low Carbon Trade Competitiveness in the fixed-effects model, both depth of use and digitization clearly contribute positively to international Low Carbon Trade Competitiveness. In addition, from the regression coefficients, the depth of use has the most significant driving effect on international low-carbon trade competitiveness, followed by the breadth of coverage, which indicates that the depth of use better reflects the deep integration of digital financial tools with low-carbon trade scenarios, and even if the scope of digital financial coverage is expanded, the pull of low-carbon trade is limited if there is a lack of in-depth application.

6. Conclusion and Recommendations

6.1 Research Conclusion

Based on the panel data of 30 provinces in China from 2011 to 2022, this paper develops an in-depth analysis of how digital finance affects the competitiveness of international low-carbon trade and the transmission mechanism behind it. The empirical results combined with practical cases lead to the following conclusions:

First, digital finance exhibits a significant positive effect on enhancing international low-carbon trade competitiveness. This means that with the continuous development and improvement of digital finance, its role in international trade is becoming more and more important, especially in the promotion of low-carbon trade, digital finance is not only effective in the result-oriented low-carbon trade competitiveness such as carbon productivity and import and export trade volume, but also enhances low-carbon trade competitiveness in terms of the development environment, the development capacity, the trade structure and other reasons.

Second, in the three dimensions of digital finance, the promotion effect on international low-carbon trade competitiveness shows some differences. The promotion effects are, in descending order, the depth of use, the breadth of coverage, and the degree of digitization, indicating that, compared with the coverage and degree of digitization of digital finance, improving the ability of international trade subjects to use digital finance can more fully bring into play the efficacy of digital finance in enhancing the competitiveness of international low-carbon trade.

6.2 Research Implications

(1) PPP model strengthens the strategic position of digital finance and creates a new engine for low-carbon trade development

Under the current background of accelerated restructuring of the global low-carbon economic pattern, the deep integration of digital finance and international trade is giving rise to a new development paradigm. The research in this paper verifies the enabling effect of digital finance on low-carbon trade, while the PPP model can combine the public sector's policy support and the private sector's technological innovation to accelerate the application of digital finance in low-carbon trade. Therefore, the government and enterprises should cooperate through the PPP model to promote the wide application of digital finance in low-carbon trade. The government can encourage enterprises to utilize digital financial tools (e.g., green finance, carbon trading platforms, etc.) to enhance carbon productivity and trade efficiency through policy guidance and financial support.

(2) Implement the strategy of prioritizing in-depth development, and build a development system of layered advancement.

In view of the differences in the role of digital finance in different dimensions, it is recommended to adopt a hierarchical promotion strategy from the depth of use to the breadth of coverage to the degree of digitization, and to promote the transformation of digital finance from the application of tools to the empowerment of the system.

PPP projects should focus on increasing the depth of use of digital financial tools by enterprises and trade agents, rather than just expanding coverage. Training, technical support and incentives can be provided to help enterprises and trade agents better understand and utilize digital financial tools.

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