

The Impact of the Digital Economy on Export Resilience

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ABSTRACT

The world is undergoing unprecedented changes. Ensuring the stability and security of exports is not only a strategic requirement for long-term national development but also a key foundation for building a new development paradigm and a necessary condition for supporting high-quality development. As the most dynamic and promising economic form of the present era, the digital economy has become both a "stabilizer" and an "accelerator" for achieving qualitative economic improvements and rational quantitative growth. This provides a new opportunity to enhance export resilience. Against the backdrop of policies promoting the digital economy and ensuring stable and quality-focused exports, the focus of China's export trade development has gradually shifted from promoting growth to mitigating fluctuations. Thus, exploring the impact of the digital economy on export resilience is of significant theoretical and practical importance. Using panel data from 260 Chinese prefecture-level cities spanning 2010 – 2021, empirical results based on key variable calculations reveal that the digital economy not only directly enhances export resilience but also promotes export resilience by fostering technological innovation.

KEYWORDS

Digital economy; Export toughness

1 Introduction

As one of the "three drivers" of economic growth, export trade plays an irreplaceable strategic role in boosting China's economic growth, employment, and international competitiveness as the world's largest export-oriented economy. Historically, China has been the most affected by trade frictions globally (Zhang Pengyang et al., 2023). With the rise of anti-globalization, global trade performance has weakened, and the complexity, severity, and uncertainty of the export environment have sharply increased. Rising protectionism and unilateralism directly impact China's exports. Strengthening export resilience is not only crucial for shaping new export competitive advantages but also an urgent issue in foreign trade that needs addressing.

The General Office of the State Council issued the Opinions on Promoting Stable Scale and Optimized Structure in Foreign Trade in 2023, which identified trade digitization, diversification, and industrial exchanges as key components of achieving stable exports. Similarly, the WTO's World Trade Report 2021 noted that the digital economy offers diverse solutions for faster and more inclusive economic recovery. Strengthening trade resilience through digitization enhances the capacity to withstand shocks. Against this policy backdrop, the question of whether the digital economy can enhance export resilience has become a pressing theoretical and practical issue under the overarching goal of "seeking progress while maintaining stability."

The policy emphasis on ensuring export security through digital economic development (Gong

Shiyang & Li Qian, 2023) has attracted significant academic attention. Zhang Chaoshuai et al. (2023) argued that classical and neoclassical trade theories (e.g., Ricardo and Heckscher-Ohlin models) emphasize specialization in production and exports but assume no uncertainty (Hirsch & Lev, 1971). Digitalization reduces uncertainty-induced export fluctuations by diversifying export products. Other studies suggest that the digital economy enhances global value chain resilience (Yang Renfa & Zheng Yuanyuan, 2023) and mitigates supply chain uncertainty, thereby stabilizing export growth (Zhang Pengyang et al., 2023). The authors first introduce parameters related to digitalization and uncertainty to construct a mathematical model, verifying the theoretical relationship between the two. Subsequently, based on the measurement of digital transformation and uncertainty in export supply chains, empirical analysis demonstrates that digital transformation significantly reduces export supply chain uncertainty, thereby functioning as an “export stabilizer” (Du Mingwei et al., 2022). The digital economy influences stages of instability in export supply chains—entry, reconfiguration, and exit—thereby reducing uncertainty in export supply chains. Finally, the effect is found to be stronger among export-oriented firms and firms with less diversified export networks.

Tie Ying et al. (2023) adopt firms’ digital asset imports as an exogenous shock to identify the impact of changes in input structure on the stability of export relationships. The results reveal that digital imports significantly enhance the stability of exports involving industrial robots, CNC machine tools, communication technologies, and automation equipment. Similarly, Shi Benye and Qi Ruiqing (2023) argue that the development of cross-border e-commerce improves firms’ export stability. The underlying mechanisms include reducing trade costs, enhancing technological innovation, and improving the quality of export products. The stabilizing effects are more pronounced for firms with lower productivity, smaller scale, multi-product exporters, and general trade firms (Gelb et al., 1979). Furthermore, cross-border e-commerce also facilitates product switching and resource reallocation through the “cost effect” and “competition effect” (Li Xiaoping et al., 2023).

Despite the increasing application of digital technologies such as big data, artificial intelligence, and the Internet of Things, few studies systematically analyze the mechanisms linking the digital economy to export resilience. Moreover, most existing studies focus on the micro-level impacts on enterprises, overlooking spatial influences on the relationship. Using data from 260 Chinese prefecture-level cities over the period 2010–2021, this study examines the direct effects of the digital economy on export resilience and the underlying mechanisms from a regional perspective.

2 Theoretical Analysis

The digital economy encompasses economic activities relying on digital computing technologies, such as digital communications, data processing, and e-commerce. It is characterized by efficient information flow, reduced transaction costs, and geographical flexibility, distinguishing it from traditional economies. Its hallmarks include extensive network connectivity, innovative technological applications, and data-driven decision-making. Export resilience refers to the ability of a country or region's export sector to maintain stability or growth despite external shocks, such as financial crises, trade wars, or global pandemics. This resilience reflects the resilience and adaptability of the export sector in the face of adversity, and is an important indicator of the external dependence of the economy and the overall health of the economy. Key determinants of export resilience include product and market diversification, supply chain flexibility, and enterprise innovation capacity.

The digital economy enhances export resilience through several mechanisms. First, technologies like e-commerce and digital payments lower transaction costs, improve market access, and enable

businesses to adapt flexibly to external shocks. Second, digitalization facilitates real-time market monitoring and swift responses to consumer demand changes, thereby improving adaptability to uncertainty.

Through technological innovation, the digital economy also strengthens export resilience. This effect is evident in several key areas. First, technological innovation, especially the application of information technology, innovations in information technology improve productivity and product quality, reducing costs and enhancing international competitiveness. Furthermore, digital platforms facilitate market diversification, reducing dependence on individual markets. Technologies like big data and artificial intelligence enable precise market analyses and demand forecasts, enhancing responsiveness to external shocks. By optimizing operations and expanding market strategies, the digital economy comprehensively improves export sector resilience. Based on these theoretical considerations, this study proposes the following hypotheses:

H1: The digital economy enhances export resilience.

H2: The digital economy promotes export resilience through technological innovation.

3 Research Design

3.1 Model Specification

Following the methods of Bai Peiwen and Zhang Yun (2021), this study constructs a two-way fixed effects model to test the direct effects outlined in the theoretical analysis. The model is specified as follows:

$$exqtres_{it} = \alpha_0 + \alpha_1 digiszf_{it} + \alpha_n X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3.1)$$

Here, i and t represent cities and years, respectively. The dependent variable, $exqtres_{it}$, reflects the export resilience of city i in year t . The core explanatory variable $digiszf_{it}$ represents the level of digital economic development. X_{it} includes a set of control variables; μ_i represents the unobserved factors that do not change over time in each city to control for regional fixed effects, and λ_t is used to control for the impact of common time trends on the resilience of city exports, that is, time fixed effects and ε_{it} is the error term.

To test the mediating effect of technological innovation between the digital economy and export resilience and avoid endogeneity issues stemming from stepwise regression methods, we construct the following mediation model:

$$diver_{it} = \beta_0 + \beta_1 digiszf_{it} + \beta_n X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3.2)$$

In the above formula, subscripts i and t represent city and year respectively, $diver_{it}$ represent the intermediate variable technological innovation.

3.2 Variable Selection

(1) Dependent Variable:

The dependent variable in this study is export resilience ($exqtres$), which reflects the ability of economic entities to withstand external disruptions and maintain stable export performance. This study uses the method proposed by Martin (2012) to calculate export resilience by comparing the actual growth trajectory of key economic variables (e. g., exports, employment) with their counterfactual growth paths in the absence of shocks.

(2) Core Explanatory Variable:

The core explanatory variable of this chapter is the digital economy index ($digiszf$). Considering the availability of city-level data and the comprehensiveness of the indicator system, this study adopts the methodology proposed by Bai Peiwen and Zhang Yun (2021) to construct the digital

economy indicator system, with reference to Yuan Chun et al. (2021) for data processing methods. First, all indicator data were standardized. Bartlett's sphericity test and the KMO test confirmed the suitability of the data for factor analysis. Second, principal component analysis (PCA) was conducted, identifying five principal components with a cumulative explanatory power of 78%. The eigenvalues of the first four principal components exceeded 1, while the eigenvalue of the fifth principal component was 0.935.

(3) Control Variables:

The control variables include: Economic Development Level (*lngdp*); Human Capital (*lnedu*); Government Intervention (*gov*); Actual Foreign Direct Investment (*fdi*); Current Assets of Enterprises Above Designated Size (*lnasset*); Transportation Accessibility (*traf*); Financial Development Level (*fin*); Import Scale (*imp*)

(4) Mediating Variable:

The mediating variable $diver_{it}$ represents technological innovation, measured by regional patent counts.

3.3 Empirical Results Analysis

Based on the baseline regression model established in this chapter, panel data from 260 prefecture-level cities in China spanning 2010–2021 is utilized to test whether the digital economy enhances export resilience. Table 1, columns (1)–(9), sequentially present the regression results after progressively incorporating control variables under fixed city and time effects. It is evident that the regression results remain largely consistent, with the coefficient in column (9) being 0.004, which is significantly positive at the 1% level. This provides preliminary evidence supporting the core conclusion of this chapter—that the digital economy enhances export resilience. Hypothesis H1 is thus validated.

Table 1 Baseline Regression of Digital Economy on Export Resilience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	<i>exqtres</i>								
<i>digizcf</i>	0.003** (2.07)	0.003*** (3.39)	0.005*** (3.21)	0.006** (2.26)	0.002** (2.11)	0.003** (2.25)	0.002** (2.12)	0.002** (2.11)	0.004*** (3.14)
<i>lngdp</i>		0.058*** (5.49)	0.058*** (5.48)	0.051*** (4.67)	0.052*** (4.58)	0.053*** (3.79)	0.053*** (3.77)	0.039*** (2.81)	0.038*** (2.63)
<i>lnedu</i>			-0.029 (-0.56)	-0.031 (-0.69)	-0.031 (-0.64)	-0.025 (-0.53)	-0.023 (-0.43)	-0.007 (-0.18)	0.003 (0.05)
<i>gov</i>				-0.096 (-1.58)	-0.097 (-1.53)	-0.098 (-1.56)	-0.103 (-1.62)	-0.075 (-1.26)	-0.079 (-1.23)
<i>fdi</i>					-0.015 (-0.15)	-0.018 (-0.19)	-0.021 (-0.22)	-0.023 (-0.24)	-0.062 (-0.63)
<i>lnasset</i>						0.119 (1.23)	0.121 (1.25)	0.146 (1.46)	0.129 (1.33)
<i>traf</i>							-0.000 (-0.63)	-0.000 (-0.59)	-0.000 (-0.38)
<i>fin</i>								-0.009** (-2.33)	-0.010** (-2.49)
<i>imp</i>									0.041** (2.34)
<i>Individual fixation</i>	YES	YES	YES	YES	YES	YES	YES	YES	YES
<i>Fixed time</i>	YES	YES	YES	YES	YES	YES	YES	YES	YES
<i>N</i>	3 120	3 120	3 120	3120	3120	3120	3120	3120	3120
<i>R</i> ²	0.325	0.339	0.336	0.337	0.337	0.337	0.337	0.335	0.336

The theoretical analysis in the previous section preliminarily explored the proposition that the digital economy may enhance export resilience through technological innovation. To further validate this, a mediating effect test is conducted in this section. To avoid the endogeneity issues associated with the stepwise approach that could compromise the reliability of the findings, the mediating model established in Equation (3.2) is employed to examine the mechanism between the digital economy and export resilience. The results of the mediating effect test are presented in Table 2.

Column (1) excludes control variables and fixed effects;

Column (2) incorporates control variables only;

Column (3) includes control variables and one-way fixed effects;

Column (4) incorporates control variables and two-way fixed effects. The results indicate that the coefficient of the digital economy on technological innovation is 0.255, which is significantly positive at the 1% level. This finding suggests that the digital economy enhances export resilience by promoting technological innovation. Hypothesis H2 is thus validated..

Table 2 Mediation Effect Test of Digital Economy on Export Resilience

	(1)	(2)	(3)	(4)
	<i>divers</i>	<i>divers</i>	<i>divers</i>	<i>divers</i>
<i>digizcf</i>	0.175 (1.42)	1.075*** (7.68)	0.728*** (6.83)	0.255*** (2.69)
<i>lnpgdp</i>		-5.976*** (-13.96)	-9.528*** (-22.89)	-0.272 (-1.03)
<i>lnedu</i>		10.156*** (4.59)	20.257*** (9.31)	17.557*** (7.03)
<i>gov</i>		50.525*** (17.58)	13.558*** (3.45)	33.657*** (9.35)
<i>fdi</i>		-32.758*** (-4.86)	-8.587 (-1.36)	14.544** (2.53)
<i>lnasset</i>		-6.287* (-1.76)	-14.826** (-4.06)	-77.254*** (-12.32)
<i>infra</i>		0.057 (1.48)	-0.025 (-1.43)	0.024 (0.38)
<i>fin</i>		1.514*** (7.73)	1.295*** (6.52)	-0.773*** (-3.42)
<i>imp</i>		-2.435** (-2.10)	5.687*** (4.89)	2.972 (1.51)
<i>Individual fixation</i>	YES	YES	YES	YES
<i>Fixed time</i>	YES	YES	YES	YES
<i>N</i>	312 0	312 0	3 120	3 120
<i>R²</i>	0.000 9	0.334 5	0.468 1	0.689 2

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4 Conclusions and Policy Recommendations

Against the backdrop of national policies vigorously promoting the development of the digital economy and enhancing the stability and quality of export trade, the focus of China's export trade development has gradually shifted from promoting growth to mitigating fluctuations. In this context, exploring the impact of the digital economy on export resilience holds significant theoretical and practical value. Using panel data from 260 prefecture-level cities in China spanning

2010–2021, and based on the calculation of key variables, the empirical results reveal that the digital economy not only directly enhances export resilience but also improves it indirectly by fostering technological innovation.

First Infrastructure Development: Governments should enhance digital infrastructure to ensure seamless access to high-quality digital services, including broadband expansion, optimized data centers, and robust cybersecurity measures. **Second Enterprise Support:** Policies should incentivize businesses to adopt advanced digital technologies, such as AI, big data analytics, and cloud computing, particularly in product development and market expansion. **Third Financial Incentives:** Establish special funds or tax incentives to support digital marketing and brand promotion in international markets, fostering market diversification and global competitiveness. **Fourth Supply Chain Optimization:** Encourage inter-enterprise collaboration and supply chain integration using digital technologies to improve responsiveness and flexibility, thereby enhancing national export resilience.

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