Proceedings of ICEMGD 2025 Symposium: Resilient Business Strategies in Global Markets
DOI: 10.54254/2754-1169/2025.CAU26607

The Impact of Opening-up on Digital Economy:A Perspective on Government Support

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Abstract. In the era of rapid globalization and accelerating digital transformation, understanding how external openness interacts with domestic digital development has become a pressing research question. Drawing on panel data from 29 Chinese provinces covering 2012-2022, this study examines the influence of opening-up on the development of the digital economy from the perspective of policy support, using a panel threshold effect model. The empirical results indicate three key findings: (1) opening-up exerts a significant negative impact on digital economy growth; (2) fiscal expenditure on science and technology acts as the sole threshold variable in this relationship—once such spending surpasses the identified threshold, the adverse effect of opening-up is markedly alleviated; (3) notable regional disparities exist, with strong negative effects observed in the eastern, western, and northeastern regions, while the impact in central China is statistically insignificant. These findings offer practical insights for optimizing the spatial layout of opening-up and refining policy support frameworks to foster high-quality development of the digital economy.

Keywords: Digital Economy, Opening-up, Government Support, Threshold Model

1. Introduction

As a central driving force of global economic transformation, the digital economy has become a key benchmark for assessing national competitiveness. In the context of deepening globalization, its growth depends not only on domestic technological innovation and market development, but also on the pace of opening to the outside world. Openness can inject external momentum into digital economy expansion through channels such as technology transfer, capital inflows, and talent exchange; however, it may also create challenges for domestic digital industries by fostering technological dependence or distorting market competition.

Against this backdrop, this study employs panel data from 29 Chinese provinces between 2012 and 2022, incorporating openness, the digital economy, and policy support into a unified analytical framework. By constructing a panel threshold effect model, it systematically explores the nonlinear influence of openness on digital economy development. The findings aim not only to enrich theoretical research on the interplay between openness and the digital economy but also to provide empirical insights for optimizing foreign investment strategies and refining policy support mechanisms to advance high-quality growth in the digital economy.

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2. Literature review

As a major driver of the new wave of global economic transformation, the digital economy relies not only on domestic technological innovation and market mechanisms but also on the degree of external openness. Existing studies, approaching the issue from different perspectives, have empirically examined its effects, with most finding that openness significantly enhances the acquisition and diffusion of digital technologies. From a provincial perspective, Zhao and Pang found that foreign direct investment (FDI) can effectively strengthen technological capabilities in "bottleneck" industries, though the impact varies across time and space, with stronger effects observed south of the Yangtze River and in earlier periods [1]. From an urban agglomeration perspective, Li et al. [2] highlighted that central cities attract multinational enterprises, which amplifies their spillover effects and generates positive externalities for digital economy growth in surrounding areas. At the firm level, FDI promotes digital transformation among host-country enterprises, particularly in those with stronger foreign control; however, its impact on firms pursuing non-online service digital transformation is limited [3].

Building on evidence of the positive influence of openness on the digital economy, scholars have further explored the underlying mechanisms, which can generally be grouped into three dimensions: factor flows, institutional alignment, and innovation. In terms of factor flows, openness facilitates the international circulation of technology, capital, data, and talent, thereby improving resource allocation efficiency in the digital economy [4]. Institutionally, digital economy development depends on a standardized regulatory framework covering data protection, intellectual property rights, and digital platform governance. Openness introduces external pressure to adopt international norms while also spurring domestic institutional innovation. For example, pilot programs for cross-border data transfer rules in free trade zones have generated valuable policy experience for nationwide adoption [5]. Regarding innovation, Peng et al. found that FDI directly enhances regional innovation capacity, thereby accelerating digital economy development [6].

In summary, while prior research has examined the relationship between openness and the digital economy, the precise mechanisms and transmission pathways remain underexplored. Building on this literature, the present study incorporates openness, the digital economy, and policy support into a unified analytical framework and employs a panel threshold effect model to investigate their nonlinear relationships, aiming to deepen theoretical understanding in this field.

3. Theoretical model and research hypotheses

Drawing on technology dependence theory, developing countries may, during the process of opening-up, become overly reliant on imported digital technologies due to existing technological gaps, resulting in path dependence on multinational corporations and, consequently, a suppression of domestic innovation capacity. According to heterogeneous firm trade theory, foreign-invested digital enterprises introduced through openness often possess stronger technological advantages, greater capital strength, and richer global operating experience. In market competition, these advantages can generate a "Matthew effect" crowding out domestic digital firms. Based on these theoretical channels, this study proposes the following hypothesis:

H1: Openness exerts a negative and inhibitory effect on digital economy development.

Endogenous growth theory posits that technological progress is not an exogenous given but can be actively fostered through policy interventions and resource investment. Innovation compensation theory argues that once government spending on science and technology reaches a certain threshold, it can enhance domestic firms' capacity to absorb, adapt, and re-innovate external technologies by

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building innovation infrastructure, thereby offsetting the negative influence of openness. Based on this reasoning, the second hypothesis is formulated:

H2: When fiscal expenditure on science and technology reaches a certain level, the inhibitory effect of openness on digital economy development can be mitigated.

According to resource-based theory, variations in regional resource endowments—such as industrial foundations, technological accumulation, human capital, and policy environments—lead to heterogeneous impacts of external shocks. In the openness–digital economy nexus, these differences determine both the capacity to cope with foreign investment shocks and the efficiency of transforming foreign technology spillovers, resulting in divergent regional effects. Accordingly, the third hypothesis is proposed:

H3: The impact of openness on digital economy development exhibits regional heterogeneity.

4. Model setting and description of variables

4.1. Research design

To examine the relationship between the opening-up and digital economy, this study establishes a regression model as shown in Equation (1). In this model, $digeco_{it}$ denotes the comprehensive index of digital economic development, fdi_{it} refers to foreign direct investment and X_{it} signifies a set of control variables. Here, i refers to provinces, t indicates the year, β represents the coefficients to be estimated, μ_i accounts for province fixed effects, and ε_i stands for the random error term.

$$digeco_{it} = \beta_0 + \beta_1 FDI_{it} + \theta X_{it} + \mu_i + \varepsilon_{it} \tag{1}$$

To further explore the impact mechanism of FDI under varying levels of government support, a threshold effect model is constructed with fiscal expenditure intensity on science and technology as the threshold variable, as shown in Equation (2). Here, $I(\cdot)$ represents an indicator function taking values of 1 or 0, and γ denotes the threshold value to be estimated.

$$digeco_{it} = \beta_0 + \beta_1 FDI_{it} * I(Tech_{it} \leq \gamma_1)$$

$$+\beta_2 FDI_{it} * I(\gamma_1 < Tech_{it} \leq \gamma_2) + \beta_3 FDI_{it} * I(Tech_{it} > \gamma_2) + \theta X_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

4.2. Variable selection

In this study, regional digital economy growth is used as the dependent variable. A composite index of the digital economy (digeco) is constructed based on three dimensions: digital infrastructure, digital industrialization, and industrial digitization. Relevant indicators are standardized and weighted using the entropy method to calculate the comprehensive index. The key explanatory variable is the level of foreign investment openness, measured by the degree of foreign capital openness (FDI), defined as the ratio of actual utilized foreign direct investment to gross domestic product, reflecting the economy's reliance on FDI. Fiscal expenditure intensity on science and technology (tech) serves as the threshold variable, calculated as the proportion of science and technology fiscal spending within the general public fiscal budget.

To more accurately isolate the net effect of openness and policy support on digital economy development, this study controls for other critical factors potentially influencing the digital economy, including patent authorization levels (patent), local government intervention intensity (govexp), and traditional infrastructure development measured by per capita urban road area (road).

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4.3. Data source and descriptive statistics

This study utilizes panel data from 29 Chinese provinces (excluding Xinjiang, Tibet, Hong Kong, Macau, and Taiwan) covering the period 2012 to 2022. The data are primarily drawn from various editions of the China Statistical Yearbook, China Fiscal Yearbook, China Communications Statistical Yearbook, and China Population and Employment Statistical Yearbook.

Table 1. Descriptive statistics of variables (N=319)

Variable	Mean	Std. Dev.	Max	Min
digeco	0.209	0.144	0.020	0.808
FDI	0.803	0.625	0.000	3.799
patent	15.166	17.178	0.774	92.819
road	16.714	5.061	4.080	28.000
govexp	0.206	0.090	0.083	0.565
tech	0.022	0.015	0.005	0.068

5. Analysis of empirical results

5.1. Benchmark regression

The baseline regression results on the impact of openness on the digital economy are presented in Table 2. The final model, which incrementally includes control variables, shows that the estimated coefficient for the core explanatory variable, FDI, is significantly negative. This negative effect remains robust and statistically significant at the 1% level even after controlling for all covariates, confirming Hypothesis 1.

Regarding control variables, an increase in patent authorization significantly promotes digital economy development, indicating that enhanced regional innovation vitality provides strong support for digital technology research and application. Increased local government intervention also significantly advances digital economy growth, suggesting that fiscal regulation and policy guidance by local authorities effectively mobilize resources to empower the digital economy. Additionally, improvements in traditional infrastructure positively affect digital economy expansion by laying the foundational conditions for digital infrastructure deployment and technology diffusion.

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Table 2. Regression results (N=319)

Variable	digeco			
	(1)	(2)	(3)	(4)
FDI	-0.114***	-0.064***	-0.057***	-0.039***
	(0.012)	(0.009)	(0.011)	(0.010)
patent		0.004***	0.005***	0.004***
		(0.001)	(0.001)	(0.001)
govexp			1.081***	1.260***
			(0.298)	(0.283)
road				0.014***
				(0.002)
Constant	0.301***	0.194***	-0.041	-0.315***
	(0.010)	(0.016)	(0.068)	(0.080)
Province fixed			Yes	
R^2	0.271	0.360	0.417	0.491

Note: Robust standard errors are in parentheses; ***, **, and * denote significance levels of 1%, 5%, and 10%, respectively, as in the table below.

5.2. Robustness test analysis

Three robustness checks were conducted, with the results presented in Table 3. (1) Excluding municipalities directly under the central government: Considering that Beijing, Shanghai, Tianjin, and Chongqing differ markedly from ordinary provinces in economic structure, policy support intensity, and digital economy foundations, their inclusion might bias the regression outcomes. To address potential heterogeneity, these four municipalities were removed and the model was re-estimated. (2) Controlling for potential omitted variables: To further mitigate bias from unobserved factors, the baseline model was augmented with an additional control—urbanization level—given its potential influence on digital infrastructure deployment and digital technology adoption. (3) Winsorization: All variables in the baseline regression were winsorized at the 1% level on both tails to eliminate the influence of extreme values, followed by re-estimation. Across all three robustness tests, the estimated coefficient of the key explanatory variable—openness—remains significantly negative at the 1% level, consistent with the baseline results, thereby confirming the robustness of the conclusions.

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Table 3. Robustness test results

Variable	(1)	(2)	(3)
	Excluding municipality samples	Adding control variable	Winsorizing
FDI	-0.034**(0.016)	-0.025***(0.007)	-0.039***(0.013)
patent	0.005***(0.001)	0.003***(0.001)	0.004***(0.001)
govexp	1.323***(0.322)	0.874***(0.231)	1.233***(0.276)
road	0.014***(0.003)	-0.006*(0.003)	0.014***(0.002)
urban		1.710***(0.218)	
Constant	-0.353***(0.095)	-0.932***(0.091)	-0.309***(0.081)
Province fixed		Yes	
N	275	319	319
R^2	0.499	0.598	0.497

5.3. Threshold effect test

This study first tests for the existence of panel thresholds. Under the digital economy context, the estimated threshold for the effect of openness on digital economy growth is shown in the Table 4. Using fiscal expenditure on science and technology as the threshold variable, the results pass the single-threshold test with a threshold value of 0.015, but fail to pass the double- and triple-threshold tests, indicating the presence of a single-threshold effect. When fiscal spending intensity on science and technology is less than or equal to 0.015, the negative impact of FDI on the digital economy is stronger, with a coefficient of -0.074 and statistically significant shown in Table 5. Once this threshold is exceeded, the adverse effect weakens and its statistical significance increases, suggesting that sufficient technological investment can mitigate the inhibitory influence of openness on digital economy development, thereby confirming Hypothesis 2.

Table 4. Results of threshold effect test

Threshold Variable	Model	Threshold	F-value	P-value
Tech	Single	0.015	11.950	0.037

Table 5. Threshold effect results

Threshold Variable	Threshold Value	I(lnFD $I_{it} \leq \gamma_i$)	I(lnFD $I_{it} > \gamma_i$)
Tech	0.015	-0.074** (0.015)	-0.028*** (0.015)

5.4. Heterogeneity analysis

The sub-regional regression results, as presented in the Table 6, indicate pronounced heterogeneity in the impact of openness on the digital economy. Significant negative effects are observed in the eastern, western, and northeastern regions (with eastern ≈ northeastern > western), whereas the effect in the central region is not statistically significant, thereby supporting Hypothesis 3. This pattern may be explained as follows: in the east, although foreign capital inflows are substantial, a portion is concentrated in low-value-added sectors, creating competition with domestic digital

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industries or fostering technological dependence; in the central region, smaller inflows combined with a weak digital economy base hinder the transformation of foreign technology spillovers into growth momentum; in the west, foreign investment is predominantly directed toward resource-based industries, which exhibit low compatibility with digital economic development; and in the northeast, as an old industrial base, slow industrial restructuring leads foreign capital to flow mainly into traditional industries, offering limited contribution to digital economy empowerment.

Table 6. Heterogeneity analysis

Variable	digeco			
	East	Middle	West	Northeast
FDI	-0.064***	-0.011	-0.048**	-0.068**
	(0.015)	(0.001)	(0.019)	(0.014)
patent	0.004***	0.007*	0.007**	-0.007
	(0.001)	(0.003)	(0.002)	(0.006)
govexp	2.376***	2.638*	1.406***	0.903**
	(0.477)	(1.136)	(0.414)	(0.113)
road	0.009*	0.017	0.016***	0.008
	(0.005)	(0.011)	(0.003)	(0.006)
Constant	-0.273***	-0.629***	-0.503***	-0.048
	(0.082)	(0.144)	(0.148)	(0.026)
Province fixed	Yes			
N	110	66	110	33
R^2	0.563	0.639	0.463	0.717

6. Conclusion and recommendation

6.1. Conclusion

Using panel data from 29 Chinese provinces spanning 2012-2022, this study reveals three main findings. First, openness to foreign markets exerts a consistent and significant inhibitory effect on the growth of the digital economy. Second, fiscal expenditure on science and technology serves as a single threshold moderator—once investment surpasses this critical value, the adverse impact of openness is notably mitigated, suggesting that sufficient technological funding can offset its restraining influence. Third, the effect varies markedly across regions: strong negative impacts are observed in the eastern, western, and northeastern areas, while the influence in central China is statistically insignificant.

6.2. Recommendation

Based on these results, the following policy implications are proposed: (1) improve the quality of opening-up by adjusting the structure of foreign capital inflows, directing investment toward high-value sectors such as digital infrastructure and core technology R&D, while curbing excessive inflows into low–value-added industries to reduce crowding-out effects; (2) increase fiscal allocations for science and technology, prioritizing the construction of innovation infrastructure and technology transfer platforms, and establish sustainable growth mechanisms favoring digital R&D

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and talent development; (3) adopt region-specific strategies—enhance the transformation of foreign technology spillovers in the east, strengthen the digital economy foundation in the central region to improve foreign investment appeal, promote integration of foreign capital with characteristic industries in the west, and guide investment in the northeast toward digital technology applications to facilitate industrial upgrading.

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