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THE IMPACT OF TWO-WAY FDI INTERACTIVE DEVELOPMENT ON CHINA'S DIGITAL ECONOMY

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Abstract: Distinct from the existing literature that predominantly focuses on the economic impact of either FDI or OFDI in isolation, this study examines the synergistic effects and coordinated development of two-way FDI on the digital economy across Chinese provincial regions. The findings reveal that the coordination of two-way FDI exerts a positive influence on the digital economy. This impact mechanism exhibits a distinct threshold effect, moderated by two key threshold variables: the level of local trade openness and the characteristics of the industrial structure. Notably, the facilitative effect of two-way FDI coordination is more pronounced within the Yangtze River Economic Belt, whereas in regions outside the Belt, it still contributes to the growth of the digital economy but with statistically weaker significance. This research not only offers policy implications for China's foreign trade and digital economic development but also elucidates the underlying mechanisms and threshold conditions involved. It provides valuable insights for regional economic and digital advancement in China, while also serving as an important supplement to the literature on two-way FDI.
Keywords: Foreign Direct Investment (FDI); Outward Foreign Direct Investment (OFDI); Digital economy; Threshold model

1 INTRODUCTION

Two-way FDI, which connects domestic and international markets and technologies, is increasingly recognized as a systemic enabler of China's digitalization and a strategic tool for overcoming development challenges. Rather than acting in isolation, IFDI and OFDI work together to promote corporate digital transformation through coordinated development [1]. IFDI offers domestic firms access to advanced digital technologies, managerial expertise, and global networks via spillover, demonstration, and competition effects [2,3]. Meanwhile, OFDI allows firms to integrate into global innovation hubs, acquire complementary knowledge and technologies, and enhance their talent base [4]. International experience also refines firms' digital transformation strategies through feedback mechanisms [5]. As a result, two-way FDI functions as a self-reinforcing digital engine: knowledge gained abroad strengthens domestic capabilities, which in turn encourages deeper outward investment [6]. This synergy fosters more comprehensive digital transformation at the firm level. Examining how two-way FDI collectively drives digital transformation is therefore of major theoretical and practical relevance, especially for understanding how firms in an open economy can accelerate digital upgrading, overcome resource constraints, and achieve technological leapfrogging.

The existing literature examines the individual roles of IFDI and OFDI, overlooking the significant impact of their coordinated development. More importantly, existing research predominantly focuses on the digital economy's influence over two-way FDI, paying scant attention to the inverse relationship. This paper makes a critical contribution to the literature by investigating the effect that coordinated two-way FDI exerts on the development of the digital economy.

2 THEORETICAL BACKGROUND AND HYPOTHESIS

IFDI generates forward technological spillovers, while OFDI facilitates reverse technology transfer [7]. IFDI and OFDI do not operate in isolation but exhibit synergistic coexistence. This two-way FDI interaction accelerates the digital transformation of China's industries, thereby optimizing the industrial structure, enhancing digital innovation capabilities, and promoting coordinated regional economic development. Furthermore, the coordinated development of two-way FDI significantly contributes to China's digital economy and high-quality development by leveraging technological spillover effects, intensifying market competition, and driving industrial upgrading [8]. Therefore, we hypothesize as follows:

Hypothesis 1. The coordinated development of two-way FDI exerts a positive promoting effect on the digital economy.

While existing literature often assumes a linear positive relationship between two-way FDI coordination and digital economy development, this study proposes a nonlinear relationship contingent on macroeconomic thresholds. Drawing on threshold effect theory, we argue that trade openness and industrial structure serve as critical threshold variables determining the actual impact. The positive effects of two-way FDI coordination become significantly stronger only after these variables surpass certain tipping points. Trade openness serves as a fundamental channel condition like low openness inhibits knowledge flows and technology spillovers, whereas high openness facilitates the cross-border exchange of digital technologies and innovative ideas, thereby amplifying the synergistic effects of FDI [9]. Similarly,

industrial structure determines absorptive capacity for digital technologies. Traditional sector-dominated economies lack the foundation to assimilate advanced digital spillovers, whereas advanced industrial structures with greater shares of high-end services and manufacturing provide the necessary ecosystem for digital innovation, enabling regions to fully harness two-way FDI benefits [10]. Therefore, we hypothesize as follows:

Hypothesis 2. The promoting effect of two-way FDI coordination on the digital economy is subject to a threshold effect.

Two-way FDI facilitates the optimization of firms' locational advantages. Inward FDI drives host countries to enhance their digital infrastructure, increase the supply of digital talent, and refine digital governance policies. These improvements in the external environment reduce the institutional costs and technological barriers associated with digital transformation for domestic firms, thereby strengthening the locational attractiveness for digital investment within the home country. Concurrently, through OFDI, firms enter countries with advanced digital capabilities, gaining direct access to sophisticated digital industrial clusters, mature technology markets, and open innovation networks. This strategic locational embedding enables firms to acquire digital production factors at lower costs and subsequently transfer the knowledge and practices learned overseas back to their domestic operations, ultimately enhancing their overall digital efficiency [11]. Therefore, we hypothesize as follows:

Hypothesis 3. The promoting effect of two-way FDI coordinated development on the digital economy exhibits regional heterogeneity.

3 RESEARCH DESIGN

3.1 Baseline Model

To investigate the impact of two-way FDI coordinated development on the digital economy, this paper establishes the following baseline regression model:

$$lnDig_{it} = \mu_i + \beta_1 lnD_{it}(IO) + \beta_2 lnX_{it} + \sigma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

Based on the results of the Hausman test, this paper employs a two-way fixed effects panel model for regression. In Equation (1), i denotes the Chinese province, t denotes the year, Dig_{it} represents the development level of the digital economy, $D_{it}(IO)$ represents the coordinated development level of two-way FDI, and X_{it} represents a set of control variables, namely trade openness $Open_{it}$, industrial structure Ind_{it}, level of government intervention Gov_{it}, financial development level Fin_{it}, and population quality Hrq_{it}. β_1 is the elasticity coefficient of the core explanatory variable: the coordinated development level of two-way FDI, β_2 represents the elasticity coefficients of the control variables, μ_i is the constant term, σ_i and γ_t represent the individual fixed effects and year fixed effects, respectively, and ε_{it} denotes the random error term.

This paper also employs two threshold models to investigate whether the impact of two-way FDI coordinated development on the digital economy exhibits a threshold effect.

$$\begin{aligned} lnDig_{it} &= \mu_i + \beta_3 lnD_{it}(\mathrm{IO}) I(lnOpen_{it} \le \gamma) \\ &+ \beta_4 lnD_{it}(IO).I(lnOpen_{it} > \gamma) + \beta_5 X_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

$$\begin{aligned} lnDig_{it} &= \mu_i + \beta_6 lnD_{it}(\mathrm{IO}) I(lnInd_{it} \le \gamma) \\ &+ \beta_7 lnD_{it}(IO).I(lnInd_{it} > \gamma) + \beta_8 X_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

Among these, trade openness $Open_{it}$ and industrial structure Ind_{it} serve as the threshold variables. $I(.)$ is an indicator function that takes the value of 1 when $q_{it} \le \gamma$, and 0 otherwise. Here, γ represents the threshold value. The definitions of the remaining variables are consistent with those provided earlier.

3.2 Variables

Regarding the measurement the dependent variable Dig_{it}, this paper employs the entropy method to construct an index based on 19 secondary indicators across three dimensions for each Chinese province: digital infrastructure development, digital industrialization, and industrial digitalization [12,13]. To measure the core explanatory variable $D_{it}(IO)$, this paper adopts the physics-based capacity coupling model, consistent with mainstream literature and formalized in Equation (4).

$$C_{it}(IO) = \frac{IFDI_{it} * OFDI_{it}}{(\alpha IFDI_{it} + \beta OFDI_{it})^{\gamma}} \quad (4)$$

Here, both α and β are set to 0.5, γ is an adjustment coefficient, generally ranging between 2 and 5, and this study assigns it a value of 2. It is important to note that the coupling degree $C_{it}(IO)$ only reflects the intensity of interaction between systems, whereas the coordination degree can capture not only this interaction intensity but also the respective development levels of each system. Therefore, a coupling coordination development index is further introduced. The calculation formula for the Two-way FDI Coordination Development Index is as follows:

$$D_{it}(IO)=C_{it}(IO)*\left[\frac{IFDI_{it}+OFDI_{it}}{2}\right]^{\frac{1}{2}}=\left[\frac{IFDI_{it}*\ OFDI_{it}}{\frac{IFDI_{it}+OFDI_{it}}{2}}\right]^{\frac{1}{2}} \quad (5)$$

In the selection of control variables, this paper primarily adopts the following approach: Trade Openness $Open_{it}$: Measured as the ratio of a province's total import and export value to its GDP. Provinces with greater trade openness have better access to advanced foreign business models and digital management expertise, thereby fostering the development of their digital economy. Industrial Structure Ind_{it}: Measured as the ratio of the output value of the tertiary industry to that of the secondary industry within a province. The digital economy is inherently rooted in the tertiary sector. A more advanced industrial structure provides fertile ground for the digital economy to thrive. Government Intervention Gov_{it}: Measured as the ratio of a province's general public budget expenditure to the national GDP of that year. The government's sustained promotion of the digital strategy plays a direct and substantial role in driving the growth of the digital economy. Financial Development Level Fin_{it}: Measured as the ratio of the year-end loan balance of financial institutions in a province to its GDP. The development of the digital economy relies on a high level of financing. A robust financial environment is conducive to the growth of digital industries. Population Quality Hrq_{it}: Measured by the ratio of the number of people with higher education to the average years of schooling in a province. A high-quality talent pool provides the intellectual and technical support essential for the advancement of the digital economy.

4 RESEARCH AND DISCUSSION

4.1 Data Description

This study utilizes provincial-level data from China spanning the years 2011 to 2022 (excluding Tibet). The data are sourced from the National Bureau of Statistics of China, the China Statistical Yearbook, provincial statistical yearbooks, China Stock Market & Accounting Research Database (CSMAR), Chinese Research Data Services (CNRDS), the Ministry of Industry and Information Technology and the National Information Center's China Interprovincial Information Society Index. The descriptive statistics of the variables are presented in Table 1.

Table 1 Variable Table

		(1)	(2)	(3)	(4)	(5)
Variable type	**Variables**	**N**	**mean**	**sd**	**min**	**max**
Explained variable	$lnDig_{it}$	360	0.131	0.111	0.0145	0.702
Explanatory variable	$lnD_{it}(IO)$	360	11.69	8.423	0.0867	39.22
Control variable	$lnOpen_{it}$	360	0.248	0.270	0.00172	0.848
	$lnInd_{it}$	360	0.133	0.417	-0.658	1.667
	$lnGov_{it}$	360	0.0330	0.0158	0.00678	0.0868
	$lnFin_{it}$	360	1.510	0.443	0.670	2.770
	$lnHrq_{it}$	360	-1.975	0.413	-2.925	-0.683

4.2 Fixed Effects Regression

In Table 2, Column (1) presents the baseline regression results, while Column (2) introduces control variables based on this baseline. The results from both columns indicate that the coordinated development of two-way FDI promotes the digital economy, providing preliminary support for Hypothesis 1 of this study.

Table 2 Regression and Test Results

	(1)	(2)	(3)	(4)
	FE	**FE**	**GMM**	**Robust**
Variables	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$
$lnD_{it}(IO)$	0.394***	0.062***	0.133***	
	(0.028)	(0.024)	(0.046)	
$l.\ lnDig_{it}$			0.082***	
			(0.018)	
$lnC_{it}(IO)$				0.031***
				(0.012)
$lnOpen_{it}$		0.164***	0.223***	0.164***

	(1)	(2)	(3)	(4)
	FE	**FE**	**GMM**	**Robust**
		(0.023)	(0.069)	(0.023)
$lnInd_{it}$		0.162***	0.061	0.162***
		(0.055)	(0.049)	(0.055)
$lnGov_{it}$		0.712***	0.572***	0.712***
		(0.037)	(0.077)	(0.037)
$lnHrq_{it}$		0.238***	0.248***	0.238***
		(0.061)	(0.054)	(0.061)
$lnFin_{it}$		0.274***	0.243*	0.275***
		(0.089)	(0.129)	(0.089)
Cons	-3.168***	0.814***	0.034	0.814***
	(0.065)	(0.202)	(0.088)	(0.202)
N	360	360	336	360
R^2	0.365	0.770	None	0.770

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

According to the regression results, without control variables, a 1% increase in the degree of two-way FDI coordination leads to a 0.394% rise in the development level of the digital economy. After including control variables, the coefficient decreases to 0.062%, which remains statistically significant at the 1% level. The coefficients of the control variable group are all positive and significant.

4.3 Endogeneity And Robustness Tests

To address endogeneity concerns, this study employs the Generalized Method of Moments (GMM) to estimate Equation (1). The GMM approach relies on moment conditions without requiring distributional assumptions, effectively handling endogeneity issues. Key diagnostic tests support the model validity: no significant AR (1) serial correlation was found, while AR (2) was significant. Both Sargan and Hansen test statistics met acceptable thresholds. These results confirm the validity of the instrumental variables, with the two-period lagged dependent variable treated as strictly exogenous. The GMM results in Table 2, column (3) show that two-way FDI coordination maintains a statistically significant positive effect at 5% level on digital economy development, confirming its promotive role.
To test the robustness of the findings, the regression is re-run by employing a different measure of the core explanatory variable. We substitute the coupling degree of two-way FDI $C_{it}(IO)$ for the coordinated development level $D_{it}(IO)$ in the regression. The results are presented in column (4) of Table 2. The results indicate that the variable continues to exert a positive influence on the digital economy at the 5% significance level. Specifically, a 1% increase in the two-way FDI coupling degree leads to a 0.031% rise in the digital economy, demonstrating the robustness of our empirical findings.

4.4 Threshold Effect Regression

Prior to conducting the threshold regression, we tested the statistical significance of the threshold effect. The results indicate that while the single-threshold hypothesis is not significant, the dual-threshold hypothesis is statistically significant p<0.05, confirming a dual-threshold effect. The testing procedure followed Hansen's method, employing 300 bootstrap replications and 300 grid searches, with data winsorized at the 1% level within threshold groups.

Table 3 Threshold and Heterogeneity Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	Th1	Th2	Rg1	Rg1	Rg2	Rg2
Variables	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$	$lnDig_{it}$
$lnD_{it}(IO)$			0.625***	0.094**	0.327***	0.029
			(0.043)	(0.041)	(0.037)	(0.030)
$lnOpen_{it}$		0.188***		0.111***		0.170***
		(0.022)		(0.027)		(0.030)
$lnInd_{it}$	0.051			-0.427***		0.309***
	(0.055)			(0.094)		(0.066)
$lnGov_{it}$	0.715***	0.691***		1.072***		0.700***

	(1)	(2)	(3)	(4)	(5)	(6)
	Th1	Th2	Rg1	Rg1	Rg2	Rg2
	(0.036)	(0.034)		(0.075)		(0.045)
$lnHrq_{it}$	0.185***	0.135**		0.446***		0.140*
	(0.061)	(0.060)		(0.090)		(0.082)
$lnFin_{it}$	0.241**	0.443***		0.504***		0.213
	(0.094)	(0.081)		(0.091)		(0.132)
$lnD_{it}(IO)0$	0.060	0.096***				
	(0.038)	(0.023)				
$lnD_{it}(IO)1$	0.214***	0.015				
	(0.030)	(0.023)				
$lnD_{it}(IO)2$	0.081***	0.237***				
	(0.022)	(0.031)				
Cons	0.254	0.496***	-3.713***	2.173***	-3.048***	0.683***
	(0.208)	(0.190)	(0.109)	(0.390)	(0.081)	(0.246)
N	360	360	132	132	228	228
R^2	0.782	0.807	0.642	0.905	0.263	0.753

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The threshold regression results from Equations (2) and (3), presented in Columns (1) and (2) of Table 3, reveal that the effect of two-way FDI coordination on the digital economy is nonlinear and constrained by the level of trade openness $Open_{it}$. At a low level of trade openness, specifically at or below -3.0794, the coefficient for two-way FDI is an insignificant 0.060, indicating its promoting effect fails to materialize in a relatively closed economic environment. As trade openness increases to a moderate level between -3.0794 and -1.5844, the coefficient rises significantly to 0.214, marking a period of optimal synergy. However, when trade openness exceeds a high threshold of -1.5844, the promoting effect diminishes, with the coefficient declining to 0.081, though it remains statistically significant. These findings underscore that only through deep synergy between trade and two-way FDI policies can the composite driving effect on the digital economy be maximized.

Using industrial structure Ind_{it} as the threshold variable reveals two significant thresholds, 0.2793 and 1.0173, dividing the sample into three distinct regimes. At a low industrial structure level, specifically at or below 0.2793, two-way FDI exerts its strongest positive effect with a coefficient of 0.237. However, as industrial structure upgrades into the intermediate range between 0.2793 and 1.0173, the promoting effect not only diminishes but becomes statistically insignificant, indicating a structural bottleneck during this transitional phase. When industrial structure advances beyond 1.0173, where the tertiary sector becomes dominant, the positive effect of two-way FDI reemerges, registering a significant coefficient of 0.096, though weaker than in the initial stage. This nonlinear pattern underscores how industrial structure evolution shapes the investment environment, suggesting policies must align with specific developmental stages to maximize two-way FDI's digital economy benefits.

4.5 Heterogeneity Analysis

The sample is divided into the Yangtze River Economic Belt and non-YREB subgroups. YREB Regression results are reported in Columns (3)-(4) and (5)-(6) of Table 3 for the two regions, respectively. Without control variables, coordinated two-way FDI development shows a statistically significant positive impact in both regions, though the coefficient is larger for the YREB. This regional heterogeneity can be attributed to the YREB's superior digital infrastructure, more advanced industrial structure, and greater concentration of digital innovation talent. After including control variables, the effect remains significantly positive in the YREB but becomes statistically insignificant in the non-YREB. This suggests that in less developed non-YREB regions, the market environment is less mature, and the positive spillovers from two-way FDI are more dependent on macro-level factors rather than deep market-driven synergy. Therefore, for non-YREB regions, enhancing digital infrastructure, optimizing industrial structure, and improving the business environment are essential to unlocking the potential benefits of two-way FDI coordination.

5 CONCLUSION AND IMPLICATION

This study employs provincial-level data from China to examine the impact of coordinated two-way FDI development on the digital economy. The findings indicate that coordinated two-way FDI exerts a positive influence on the digital economy, with its effects varying according to local trade openness and industrial structure. Specifically, the promoting effect of two-way FDI is most pronounced when trade openness is at a moderate level -3.0794~-1.5844. When industrial structure serves as the threshold variable, the effect is significant at both low $\leq$0.2793 and high >1.0173

levels of industrial sophistication but encounters a structural bottleneck during the transitional phase 0.2793~1.0173. These results suggest that the effectiveness of two-way FDI is jointly shaped by external openness conditions and internal industrial structure. Furthermore, the positive impact of coordinated two-way FDI is more substantial in the YREB, whereas in non-YREB regions, this effect is less evident, largely due to underdeveloped digital infrastructure.

Therefore, this study proposes the following policy recommendations. First, integrate two-way FDI policies with the national innovation strategy. Local governments should coordinate inbound and outbound FDI to leverage external innovation resources. Second, align FDI policy with industrial digitalization. Given the threshold effect of industrial structure, policymakers should utilize tools like industrial guidance funds to attract digital-intensive FDI that matches local advantages. Finally, adopt regionally differentiated approaches. The Yangtze River Economic Belt should pursue higher-level opening-up in high-end manufacturing and digital services, while other regions should prioritize strengthening digital infrastructure, cultivating talent, and upgrading traditional industries to establish a foundation for two-way FDI synergy.

COMPETING INTERESTS

The author has no relevant financial or non-financial interests to disclose.

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