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Original Research

Does China's Two-Way FDI Coordination Improve Its Green Total Factor Productivity?

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Abstract

Since the 21st century, the green development impact of foreign direct investment (FDI) has attracted much attention from scholars. Especially, the influence of FDI-coordinated development on green total factor productivity (GTFP) is of great research significance. Using provincial-level panel data in China from 2011 to 2020 with an intermediary effect model and a threshold effect model, this study examines the impact of two-way FDI coordination development on GTFP. The results indicate that: (1) Two-way FDI coordination development significantly improves GTFP growth in China. Compared with the eastern region, the effects in central and western China are stronger. However, the effect in northeastern China is negative. (2) The mechanism test found that two-way FDI coordination development significantly improves GTFP through talent innovation, technological innovation, and institutional innovation. (3) The threshold analysis indicates that the impact on GTFP is stronger when research and development (R&D) intensity and urbanization are low. This study not only provides evidence for evaluating the impact of two-way FDI coordination development, but also provides a reference for promoting domestic green transformation.

Keywords: two-way FDI, green total factor productivity, intermediary effect, threshold effect

Introduction

Since the 21st century, China's economy has gradually shifted to focus on green and sustainable development. It is currently in a critical period of constructing a modern system. With the steady development of economic growth, its traditional development model has gradually exposed problems like pollution and low efficiency. "The Report to the 20th National Congress of the Communist Party of China" put forth that accelerating the green transition of the development mode and promoting low-carbon development are critical to the growth in total factor productivity (TFP). Concurrently, the "Outline of the People's Republic of China's 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035" also mentioned that green is a prerequisite for sustainable growth and the development path that China must take. Therefore, it is essential to promote the green transformation of its economy. At this stage, incorporating environmental factors into the calculation system of TFP and increasing GTFP are crucial for high-quality development.

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The steady advancement of the strategies of "bringing in" and "going out" by the Chinese government not only promoted the growth of international trade but also significantly increased the scale of inward FDI (IFDI) and non-financial outward FDI (OFDI). Currently, China is realizing the shift from "one-way investment" to "two-way investment". As reported, the actual use of foreign capital (flow) in China has grown from US$95.2 billion in 2008 to US$173.4 billion in 2021; OFDI (flow) in China has grown from US$55.91 billion in 2008 to US$178.82 billion in 2021, with a leap-forward development [1]. Many IFDI inflows cause resource consumption and pollutant emissions while bringing advanced technology, hindering green and sustainable development. OFDI can provide the home country with scarce resources and advanced technology, but excessive OFDI will easily lead to the hollowing out of industries. As a result, coordinated development of two-way FDI can help reduce environmental pollution by obtaining green technology spillover [2-3].

The benign interaction between IFDI and OFDI is an important way to construct a new development pattern of "dual circulation" in China during the new stage [4-5]. Clarifying the effect of two-way FDI coordination on GTFP growth is crucial to the development of targeted international investment and high-quality foreign trade and is also beneficial for promoting the rapid development of green economics. Therefore, the influence of FDI-coordinated development on GTFP is of great research significance, which is the research motivation and objective of this study. This study mainly focuses on the influence and details of the influence mechanism of the two-way FDI coordination on GTFP.

The rest of this paper is constructed as follows: firstly, it presents the literature review; secondly, it lists three main hypotheses; thirdly, it describes the methods, which introduces the research models, variables, and data sources; fourthly, it presents the main results; finally, it sums up the conclusions and provides suggestions.

Literature Review

In past years, the relationship between international investment and GTFP has received much attention in academia. Regarding the relationship between IFDI and GTFP, Li et al. (2016) [6] found that IFDI has an adverse impact on GTFP growth, but the interaction between fiscal decentralization and IFDI can promote GTFP growth. Wang et al. (2021) [7] investigated the relationship between IFDI and GTFP and found that IFDI significantly promotes the growth of local and surrounding GTFP. Using a three-stage DEA model, You and Xiao (2022) [8] found that IFDI significantly improved GTFP through technology and human capital spillover, but the impact varied among regions. However, the result of the study by Fu et al. (2018) [9] reflected that IFDI did not have a statistically significant impact on GTFP. Besides, the effects of IFDI on GTFP from different sources are not the same.

With the rapid increment of OFDI in China in the last decade, many scholars began to focus on the relationship between OFDI and GTFP. Yang et al. (2017) [10] used provincial panel data in China to reveal that the effects of OFDI on GTFP follow a law of increasing marginal efficiency. And the green productivity growth effect mainly occurs in the eastern and western regions instead of the central region. Zhu et al. (2019) [11] revealed that OFDI significantly promoted GTFP growth by providing core resources and advanced technology to the home country. Using provincial-level data from 2004-2020, Wang et al. (2023) [12] identified that OFDI promotes GTFP growth in China, and the impact is affected by the level of regional marketization. By using a dynamic threshold model, Guo (2023) [13] found that OFDI has a significant impact on its domestic GTFP growth only when green financial development exceeds a certain level and there is regional heterogeneity.

However, there are a few studies on the effect of two-way FDI coordination on GTFP. Most studies used different methods to examine the influence of IFDI or OFDI on GTFP separately [14]. Zhang et al. (2022) [15] considered the impact on TFP, but only separately analyzed IFDI or OFDI and not GTFP. Ma et al. (2022) [16] examined the effects of two-way FDI coordination on GTFP and conducted exhaustive robustness checks, but the impact mechanism was not investigated. Wang et al. (2022) [17] analyzed the impact mechanism on GTFP but simply used the industrial structure upgrading as an intermediary variable.

Currently, there are only a handful of studies on the impact of two-way FDI coordination on GTFP. Specifically, the following are the innovations in this study: First, this study fully considers the coordinated development of IFDI and OFDI and analyzes its impact on GTFP. Second, this study concentrates on how GTFP is affected by two-way FDI coordination and analyzes the nonlinear characteristics between them. In previous studies, few studies have examined the transmission mechanism of that impact. Third, this study uses R&D intensity and urbanization as the threshold variables to further study the nonlinear characteristics of this impact, which provides new evidence for a deep understanding of their relationship.

Theoretical Analysis and Assumptions

Influence of Two-Way FDI Coordination on GTFP

When the economy of the host country develops to a certain level, it will invest in other countries, leading to a substantial increase in OFDI. And OFDI will provide the home country with core resources and advanced

technologies through the reverse spillover, promoting green production and introducing high-quality IFDI [18-19]. Therefore, the progress of two-way FDI coordination development will influence GTFP of the home country.

First, two-way FDI coordination comprehensively improves GTFP by ensuring innovation activities and promoting the progress of green technology. On the one hand, two-way FDI can bring advanced environmental protection technologies to reduce pollutant emissions [4, 19]. At the same time, through competition effects and spillover effects, it will squeeze inefficient companies and raise the technology innovation level of the entire industry [20-21]. On the other hand, it is possible to transfer high energy consumption production, optimize the industrial structure, and obtain key technologies through reverse spillovers [18, 22]. The improvement of the technical level will enhance their competitiveness, and the fierce competition will promote the upgrading of the technical level, thereby improving GTFP.

Second, two-way FDI coordination development will improve GTFP by improving resource allocation efficiency. Obtaining technological spillovers through FDI can increase the marginal returns of factors and force high-input & low-output industries to transfer to regions with lower factor costs, thereby improving the resource allocation efficiency [23]. At the same time, improving resource allocation efficiency will promote the improvement of FDI quality [24], thereby enhancing GTFP. Then, Hypothesis 1 is put forward as follows:

H1: Two-way FDI coordination has a positive impact on GTFP.

Mechanism of Two-Way FDI Coordination Development in Improving GTFP

Talent innovation. Talents are the main body of technological innovation, and innovative talents are closely related to human capital levels and regional innovation capabilities [25]. Under the background of dual circulation, two-way FDI coordination can optimize the employment structure and bring advanced production technology, which helps improve green productivity. In the new stage, increasing the investment and training of innovative talents is conducive to driving GTFP growth.

Technological innovation. The two-way FDI coordination has promoted the development of technological innovation and then significantly influenced GTFP growth, which is a key indicator to measure high-quality economic growth [26]. Technological innovation helps to localize global advanced technology, promote the upgrading of domestic traditional production technology, and improve green production efficiency [27].

Institutional innovation. FDI not only brings advanced production technology, but also promotes system innovation. Institutional innovation promotes domestic technological innovation, which encourages the development of production technology and industrial transformation and upgrading [28]. Reasonable institutional innovation can meet the requirements of regionally coordinated development and promote factor expansion and regional economic growth [29]. Therefore, the improvement of institutional innovation levels can encourage high-quality economic development, thereby raising GTFP.

Innovation elements are crucial for the transformation of industrial structures, and they are the essential resources that affect innovation activities. Effective allocation of innovation elements can accelerate technological innovation, thereby influencing GTFP [30]. Based on this, this study proposes Hypothesis 2:

H2: Two-way FDI coordination indirectly affects GTFP through talent innovation, technological innovation, and institutional innovation.

Threshold Effect Analysis on GTFP

Two-way FDI coordination development has an impact on GTFP, and the impact is also correlated with urbanization and R&D intensity. The embodiment of urbanization is population citizenization. In the process of transforming the rural population into the urban population, new consumption hotspots will be formed, which will encourage green production technology and the upgrading of industrial structures. But once the population and industry development reach a certain level, it will greatly increase the degree of environmental pollution. The government and enterprises will incur more costs to control the environment, which will offset some of the benefits obtained from technological innovation. At this time, the effect will be weakened [31]. Therefore, this effect is affected by the level of urbanization, and there may be thresholds.

Technological progress always promotes economic growth. The increment of technology brought about by R&D investment is the driving force behind technological innovation, which has a positive impact on production efficiency [32-33]. The improvement of R&D intensity can increase the knowledge reserve, and talents are not only the core of improving green technology production but also the basis for enterprises to carry out innovative activities. Appropriate R&D investment can rationally allocate resources, thereby improving the GTFP. When the R&D intensity exceeds a certain level, the impact of two-way FDI coordination on GTFP will weaken. Inefficient R&D will instead cause resource waste, which will have a negative impact on the GTFP. Then, this study proposes Hypothesis 3:

H3: There is a threshold effect on the influence of two-way FDI coordination on GTFP.

Methods

Models

Benchmark Model

To verify the Hypothesis 1, the Equation (1) is constructed.

$$GTFP_{it} = \beta_0 + \beta_1 IDFDI_{it} + \delta_1 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Here, i represents each province, t represents the year, $GTFP_{it}$ is the GTFP of province i in year t. IDFDI represents the two-way FDI coordination; X represents a series of control variables, including environmental regulation (Reg), population density (lnpopd), industry Structure (Is), degree of opening to outside world (Open), economic development level (lnEco). Besides, μ_i is province fixed effect, λ_t is year fixed effect, ε_{it} represents error term. Here, β_1 is the focus of this study. If is β_1 greater than 0, the two-way FDI coordination is conducive to improving GTFP.

Mediating Effect Models

To verify Hypothesis 2, the following models are constructed to reveal the influence mechanism of two-way FDI coordination on GTFP growth.

$$M_{it} = \beta_0 + \beta_1 IDFDI_{it} + \delta_1 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$GTFP_{it} = \beta_0 + \beta_1 IDFDI_{it} + \beta_2 M_{it} + \delta_1 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

M_{it} is intermediary variables, including talent innovation, technological innovation, and institutional innovation. Equation (2) is the regression model of two-way FDI coordination for each intermediary variable, and Equation (3) is that model of two-way FDI coordination and the mediator variable on GTFP growth.

Threshold Effect Model

According to Hansen (2002) [34], we conduct the Equation (4) to verify Hypothesis 3. Taking R&D intensity and urbanization level as threshold variables, Equation (4) is constructed to analyze further that nonlinear impact on GTFP.

$$GTFP_{it} = \varphi_0 + \varphi_1 IDFDI_{it} \times I(ABP_{it} \le \gamma_1) + \varphi_2 IDFDI_{it} \times I(\gamma_1 < ABP_{it} \le \gamma_2) + \cdots + \varphi_n IDFDI_{it} \times I(\gamma_{n-1} < ABP_{it} \le \gamma_n) + \varphi_{n+1} IDFDI_{it} \times I(ABP_{it} > \gamma_n) + \delta X_{it} + \varepsilon_{it} \quad (4)$$

Here, I (…) is an indicative function; and ABP is a threshold variable, representing urbanization or R&D intensity. γ_1, γ_2, ..., γ_n represent n thresholds, and the value is 1 when the condition in brackets is satisfied, otherwise 0.

Variables

Explained Variable

Energy consumption and environmental pollution are considered in the traditional TFP for accounting in this research. Referring to Meng & Qu (2022) and Zhan (2022) [35-36], the Global Malmquist-Luenberger index is calculated, and the data for GTFP is obtained. The output and input indicators used in calculating GTFP are as follows:

Output indicators include expected and non-expected output. The expected output is measured by the GDP of each province, and the actual GDP is obtained by using 1999 as the base year. Non-expected output: discharges of industrial wastewater discharge, industrial sulfur dioxide, industrial smoke and dust are used as indicators. The entropy weight approach is used to normalize the above indicators to obtain a comprehensive non-expected output index.

Input indicators include capital, labor, and energy. The number of employees in each province is considered as labor input, the energy consumption is used to represent energy input, and the capital stock represents capital input. Referring to Zhang and Li (2020) [37], the perpetual inventory method is applied to estimate the capital stock:

$$K_{it} = I_{it} + (1 - \delta_{it}) K_{it-1} \quad (5)$$

K_{it} and K_{it-1} represent the capital stock of province i in year t and t-1, respectively; I_{it} is the amount of investment in fixed assets; δ_{it} represents the depreciation rate (9.6%). In this study, the price index of fixed asset investment in 1999 is used to deflate, and the constant price of gross fixed capital formation is calculated.

Explanatory Variable

Referring to Huang et al. (2018) [38], the two-way FDI coordination (IDFDI) is calculated through the following formulas:

$$C_{it}(IO) = \frac{IFDI_{it} \times OFDI_{it}}{(\alpha IFDI_{it} + \beta OFDI_{it})^{\gamma}} \quad (6)$$

C_{it} (IO) represents the coupling degree of IFDI and OFDI for province i at year t, and the larger the value, the stronger the coupling degree; IFDI and OFDI are represented by the stock of IFDI and OFDI. At present, China emphasizes both "going out" and "bringing in", then $\alpha = \beta = 0.5$. γ is an adjustment parameter, which is set to 2 according to Huang et al. (2018) [38]. Since the coupling degree only reflects the response degree of the subsystem and ignores the development level of each variable, it is necessary to introduce the

IDFDI variable show the coordination development of IFDI and OFDI:

$$IDFDI_{it} = \left[C_{it}(IO) \times \frac{IFDI_{it} + OFDI_{it}}{2} \right]^{\frac{1}{2}} \quad (7)$$

Intermediary Variables

As an important embodiment of innovation ability, innovation factors are an essential driving force for improving GTFP. This study selects talent innovation, technological innovation, and institutional innovation as intermediary variables, and uses the entropy approach to determine their weights to obtain the final data. Table 1 presents the index system of intermediary variables in this study.

Threshold Variables

This study uses the ratio of internal R&D expenses to GDP as an indicator to measure R&D intensity in each province. The higher the R&D intensity, the more resources are invested in related innovation activities. Referring to Chen et al. (2022) [39] and Muroishi and Yakita (2022) [40], the urbanization is expressed by the proportion of the permanent urban population to the population in each province. The larger the ratio, the higher the urbanization level in that province.

Control Variables

Considering data availability, the intensity of environmental regulation is presented by the ratio of the investment amount in industrial pollution control to the industrial added value. Population density (popd) is defined by the ratio of the population to the area of each province, and its logarithm is taken. Industrial structure (is), described by the ratio of the output value of the tertiary industry to that value of the secondary industry. The degree of opening to the outside world (open) is represented by the ratio of total import and export of each province to GDP. The degree of economic development (eco) is measured by per capita GDP, and its logarithm is taken.

Data Description

Considering data availability, a sample period from 2011 to 2020 and 30 provinces in mainland China (except Tibet) were selected. The data are derived from the Easy Professional Superior (EPS) database, the China Environment Statistical Yearbook, the Energy Statistical Yearbook, the China Science & Technology Statistical Yearbook, and the China Statistical Yearbook. Table 2 reports the summarized statistics.

Table 2. Summary of Descriptive Statistics.

Variables	N	Mean	S. D	Min	Max
GTFP	300	0.955	0.120	0.528	1.425
IDFDI	300	0.240	0.147	0.009	0.640
Reg	300	0.004	0.004	8.50e-05	0.031
lnPopd	300	5.470	1.290	2.062	8.275
Is	300	1.219	0.696	0.518	5.297
Open	300	0.266	0.296	0.008	1.548
lnEco	300	9.321	0.463	8.542	10.760

Table 1. Construction of the Intermediary Variable Index System.

Level 1 Indicator	Level 2 Indicator	Unit	Properties
Talent innovation	Full-time equivalent for high-tech industries R&D staffs	Person year	+
	Full-time equivalent for high school R&D staffs	Person year	+
	Full-time equivalent for R&D personnel in industrial enterprises above designated size	Person year	+
	Number of patent authorizations	1	+
Technological innovation	R&D expenditure of industrial enterprises above designated size	10,000 yuan	+
	Expenditures for new product development in high-tech industries	10,000 yuan	+
	Number of R&D projects of industrial enterprises above designated size	1	+
	Technology Market Turnover	10,000 yuan	+
Institutional innovation	Investment in industrial pollution control	10,000 yuan	+
	Financial Regulatory Expenses	10,000 yuan	+
	Local financial medical and health expenditure	10,000 yuan	+

Results and Discussion

Benchmark Regression

In this study, Hausman test was performed (p = 0.00) and fixed effect model was selected for analysis. In Table 3, the benchmark regression results based on Equation (1) are listed. Columns (1) to (6) are the regression results of sequentially adding control variables. As in Column (1), the coefficient of IDFDI is 0.390 and significant at the 1% level. After sequentially adding control variables, the coefficient is still significantly positive, indicating that two-way FDI coordination is a vital force for promoting GTFP growth. Two-way FDI promotes the rational allocation of factors, which is conducive to the "bring in" and "go out" of enterprises. Therefore, the beneficial interaction of two-way FDI will improve the green production efficiency of enterprises.

As for the control variables, the coefficient of environmental regulation (Reg) is not statistically significant, indicating that it does not have an obvious impact on GTFP. According to Column (6), the coefficient of population density (lnPopd) is positive but not significant. In the past decade, the public's awareness of environmental protection has grown, which has greatly offset the negative impact of population agglomeration. The coefficient of industrial structure (Is) is 0.140 and significant. It shows that the upgrading of industrial structures improves China's GTFP. At present, China's economic structure is changing from extensive to intensive, which has a positive impact on GTFP. Besides, the coefficient of openness (Open) is positive and significant. It indicates that openness has significantly stimulated GTFP growth. The coefficient for economic development (lnEco) is positive and significant. Specifically, with social progress, the benign interaction between economic development and environmental protection becomes gradually dominant, and production is no longer carried out at the cost of damaging the environment. Therefore, Hypothesis 1 is established.

Endogeneity and Robustness Tests

Endogeneity Test

There may be a time lag between two-way FDI and its effect, therefore the changes in GTFP may have a time-lag effect. Referring to Li and Deng (2016) [41], this study uses the one-stage lag of two-way FDI coordination as an instrumental variable for endogeneity testing and results are presented in Column (1) of Table 4. The coefficient of two-way FDI with a one-period lag has not changed from its coefficient in Column (6) of Table 3 and is still significant, which indicates that there are no endogeneity problems.

Table 3. Benchmark Regression Results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
IDFDI	0.390***	0.379***	0.321***	0.322***	0.340***	0.259**
	(0.090)	(0.095)	(0.117)	(0.115)	(0.115)	(0.109)
Reg		1.366	1.719	1.775	1.944	1.035
		(3.760)	(3.840)	(3.654)	(3.690)	(3.561)
lnPopd			0.351	0.505**	0.583**	0.210
			(0.229)	(0.238)	(0.264)	(0.262)
Is				0.098***	0.114***	0.140***
				(0.035)	(0.037)	(0.038)
Open					0.073	0.153**
					(0.072)	(0.066)
lnEco						0.340***
						(0.067)
Constant	0.860***	0.863***	-1.629	-3.097*	-3.805*	-4.912***
	(0.032)	(0.032)	(1.615)	(1.750)	(1.991)	(1.867)
Obs.	300	300	300	300	300	300
R^2	0.627	0.627	0.632	0.646	0.647	0.673

Notes: Values in brackets are standard deviations. ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively (same below).

Table 4. Endogeneity and Robustness Test.

	(1)	(2)	(3)
Variables	GTFP	GTFP2	GTFP
L.IDFDI	0.257** (0.113)		
IDFDI		0.224*** (0.0304)	0.221* (0.115)
Control Variables	Yes	Yes	Yes
Province-Year fixed effects	Yes	Yes	Yes
Constant	-6.216*** (2.107)	-1.045*** (0.354)	-5.191*** (1.929)
Obs.	270	300	280
R^2	0.718	0.993	0.667

Robustness Tests

(1) Change the method of calculating the explained variable

To confirm the reliability of the empirical results, this study uses the entropy method to recalculate GTFP and obtains a new GTFP (GTFP2) for analysis. Column (2) of Table 4 presents the regression result based on new GFTP, which is still significant.

(2) Eliminate extreme sample values

To reduce the interference of extreme values, the data from Guangdong (the highest level) and Qinghai (the lowest level) are excluded from the whole sample. Then, the analysis is performed again, and results are presented in Column (3). The coefficient (0.221) is still positive and significant at the 10% level. As far as the estimation results are concerned, the coefficients and significance of the primary variables are consistent with the earlier findings, showing that the effects of two-way FDI coordination on GTFP are strong and robust.

Heterogeneity Test

Since two-way FDI coordination differs significantly among regions in China, its impact on GTFP is with huge variety. To further investigate its impact on GTFP, according to the National Bureau of Statistics of China, this study divides the samples into four categories: eastern, central, western, and northeastern[1]. The results are provided in Table 5.

As for the eastern region, the coefficient of two-way FDI coordination is negative but not significant. The eastern region has traditionally been a pioneer in high-tech sectors and has a relatively complete infrastructure. Once economic development has reached a certain level, two-way FDI coordination does not significantly affect GTFP. In the central region, the coefficient of two-way FDI coordination is positive and significant, indicating it has positively promoted GTFP. As far as the western region is concerned, the result indicates two-way FDI coordination has a positive impact on GTFP. Therefore, the coordinated development of two-way FDI significantly improves GTFP, and the effect is more evident in the central region. Specifically, the economy in the central region is fast and resources are sufficient, which makes it have stronger technology absorption capabilities than other the two regions. Therefore, its impact on GTFP is stronger.

As for the northeastern region, the coefficient of two-way FDI coordination is negative and significant. The reason may be that its regional economy is mainly based on heavy industry and its two-way FDI coordination is lagging. As the old industrial base, many industries in northeastern China are still dominated by traditional manufacturing, which affects their green production efficiency. In addition, its technological innovation and green output are small, which offsets its positive impact on GTFP. Therefore, the overall effect is negative.

Influence Mechanism Test

By constructing an intermediary effect model and introducing talent innovation (TalI), technological innovation (TechI), and institutional innovation (InstiI), this study examines the impact mechanism of two-way FDI coordination development on GTFP, and the results are in Table 6.

As in Column (1), the coefficient of IDFDI is 0.158 and significant at the 1% level, indicating that two-way FDI coordination significantly promotes talent innovation. Column (2) shows that both variables IDFDI and TalI have positive impacts on GTFP, and the coefficient of IDFDI (0.206) is smaller than the benchmark regression results in Column (6) of Table 3 (0.259). It indicates that talent innovation plays a mediating role. That is, two-way FDI coordination improves GTFP through talent innovation. Column (3) shows that the coefficient of IDFDI on technological innovation is significantly positive, which reveals two-way FDI coordination improves the level of technological innovation. Column (4) shows that the impact of IDFDI and TechI on GTFP is significant, and the coefficient of IDFDI (0.179) is less than that in the benchmark model, demonstrating that the impact of IDFDI is influenced by technological innovation. Results in Column (5) indicate that two-way FDI coordination (IDFDI) significantly promotes institutional innovation. Column (6) shows that the coefficients of IDFDI and InstiI are both significantly positive, and the coefficient

[1] The eastern region includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; the central region includes Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan; the western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang; the northeastern region includes Liaoning, Jilin, and Heilongjiang.

Table 5. Heterogeneity Test.

Variables	Eastern	Central	Western	Northeastern
IDFDI	-0.055	0.730***	0.557***	-0.463**
	(0.098)	(0.125)	(0.143)	(0.215)
Control Variables	Yes	Yes	Yes	Yes
Constant	1.850***	-0.316	2.321***	0.485
	(0.596)	(0.705)	(0.718)	(1.205)
Obs.	100	60	110	30
R^2	0.545	0.834	0.530	0.755
Region fixed	NO	NO	NO	NO
Year fixed	YES	YES	YES	YES

Table 6. Influence Mechanism Test.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	TalI	GTFP	TechI	GTFP	InstiI	GTFP
IDFDI	0.158***	0.206*	0.243***	0.179*	0.112*	0.232**
	(0.044)	(0.105)	(0.053)	(0.106)	(0.068)	(0.106)
TalI		0.338**				
		(0.165)				
TechI				0.331**		
				(0.145)		
InstiI						0.244***
						(0.073)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Province and Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.078	-4.548**	-0.777	-4.655**	0.446	-5.021***
	(0.698)	(1.873)	(0.803)	(1.858)	(0.862)	(1.803)
Obs.	300	300	300	300	300	300
R^2	0.957	0.680	0.918	0.682	0.821	0.682

of IDFDI (0.232) is less than that in the benchmark model, indicating that institutional innovation plays a mediating role. Then, Hypothesis 2 holds.

Threshold Feature Analysis

Taking R&D intensity and urbanization as threshold variables, this study conducts a threshold test based on Equation (4) and investigates the nonlinear relationship between two-way FDI coordination and GTFP. According to Table 7, when R&D intensity is used as the threshold variable, it just passes the single threshold test. Therefore, there is a single threshold, and the value is 0.008. When urbanization is utilized as the threshold variable, both the single and double thresholds have passed the significance test. Therefore, there is a double threshold, and the values are 0.508 and 0.621, respectively.

According to Table 8, when the R&D intensity is lower than 0.008, the coefficient of two-way FDI coordination is 1.147 and significant, indicating that two-way FDI coordination improves GTFP growth. But once the R&D intensity exceeds 0.008, the coefficient becomes smaller (0.366), indicating that the impact diminishes as the R&D intensity increases. When the R&D exceeds a certain level, it will crowd out the resource input of enterprises in other aspects, weakening the positive impact on GTFP.

The results show that when the urbanization level is lower than 0.508 (first threshold), the coefficient

Table 7. Threshold Effect Analysis.

Threshold variable	Threshold	Estimated value	95% confidence interval	F value	P value	BS times
R&D intensity	Single	0.008	[0.007,0.008]	33.31*	0.077	300
	Double	0.025	[0.020,0.025]	10.86	0.203	300
Urbanization	Single	0.508	[0.508,0.509]	20.44**	0.027	300
	Double	0.621	[0.610,0.622]	24.04***	0.000	300
	Triple	0.840	[0.832,0.843]	3.85	0.847	300

of two-way FDI coordination is 0.443 and significant. When the urbanization level is between the two thresholds, the coefficient of two-way FDI coordination decreases to 0.187. However, when the urbanization level crosses the second threshold, the coefficient decreases to -0.419 and still significant. This shows that the higher the urbanization, the smaller the effect, and it will have a negative effect when it reaches a certain level. An increase in urbanization level can bring more employment opportunities and more rapid economic development. But when the urbanization reaches a certain level, there will be some negative effects. On the one hand, excessive population agglomeration creates the unbalanced allocation of economic factors, resulting in lower production efficiency. On the other hand, the rapid advancement of population urbanization has increased the pressure on the environment.

In summary, the impact of the two-way FDI coordination on GTFP is not only restricted by R&D intensity but also affected by the level of urbanization and presents an obvious nonlinear effect. Overall, only when R&D intensity and urbanization are maintained at a certain level can the impact be maximized.

Table 8. Regression Results of the Threshold Effects.

	(1)	(2)
Variables	R&D intensity	Urbanization
IDFDI ($qit \leq \lambda_1$)	1.147***	0.443***
	(0.178)	(0.0656)
IDFDI ($qit > \lambda_1$)	0.366***	
	(0.0568)	
IDFDI ($\lambda_1 < qit \leq \lambda_2$)		0.187***
		(0.0595)
IDFDI ($qit > \lambda_2$)		-0.419***
		(0.142)
Control variables	Yes	Yes
Province and year fixed effects	Yes	Yes
Constant	1.261***	0.664***
	(0.212)	(0.226)
Obs.	300	300
R^2	0.349	0.397
Year	10	10

Note: IDFDI indicates the two-way FDI coordination, λ_1 and λ_2 respectively indicate the first and second threshold values; the values in brackets are standard deviations; *, ** and *** respectively represent 10%, 5% and 1% significant level.

Conclusions and Suggestions

In China's new stage of vigorously promoting green economic transformation, this study has important significance in investigating the effects of two-way FDI coordination on GTFP. Utilizing provincial data from 2011 to 2020, this study investigates the impact and influence mechanisms of two-way FDI coordination development on GTFP. This research finds that: first, two-way FDI coordination has significantly improved GTFP and there is spatial heterogeneity. Compared with the eastern region, the impact is more obvious and significant in the central and western regions, but the effect in northeastern China is negative; second, the mediation effect test finds that two-way FDI coordination promotes GTFP growth through talent innovation, technological innovation, and institutional innovation; third, there are some constraints on the effects of two-way FDI coordination. When the level of urbanization or R&D intensity is maintained at a certain level, the two-way FDI coordination has a great impact on GTFP.

Based on the foregoing conclusions, this research provides the following suggestions:

First, the central government should implement a differentiated development strategy. The government should face up to the reality of unbalanced regional development in China and promote regional green transformation while accelerating two-way FDI coordination. For example, the infrastructure conditions in eastern China are relatively complete, which can promote R&D in green technology. The central region needs to actively undertake the industrial transfer of the eastern region and accelerate transformation and upgrading. As well, it should improve the utilization rate

of green technology and guide the industrial structure to develop in a low-carbon production direction. However, in the western and northeastern regions, it is important to strengthen infrastructure construction and create favorable conditions for the coordinated development of FDI.

Second, the government and enterprises should focus on realizing the rational allocation of different innovation elements. For example, the government should carry out deep system innovation, increase the attraction intensity of IFDI, and encourage domestic enterprises to speed up the progress of technological innovation. And enterprises should pay attention to personnel training and provide a larger platform for innovative talents. Only when the government and enterprises work together can they attract plenty of talent and create a warm environment for conducting innovation activities.

Third, the government should rationally plan and manage the development of R&D intensity and urbanization level. According to our study, the impact on GTFP is stronger when research and development (R&D) intensity and urbanization are low. Therefore, relevant government departments should fully consider the suitable level of R&D intensity and the level of urbanization, and effectively play the role of two-way FDI coordination development in improving the growth of GTFP.

Finally, even though the amount of OFDI exceeds IFDI in China since 2015, the central government should adhere to the coordinated development of "bringing in" and "going out". On one hand, the government should increase the quality supervision of IFDI to improve the overall quality of foreign investment and achieve the goal of high-quality development. On the other hand, the government should actively guide enterprises to make overseas investments reasonably and adequately. The high-quality outward investment will not only bring back scare resources and advanced technology, but also achieve the goal of efficient use of the surplus fund. By releasing the kinetic energy for the two-way FDI coordination, it provides support for the green transformation in China.

This study investigates the impact and the impact mechanism of two-way FDI coordination on GTFP through the Chinese case and provides adequate suggestions for green economic development. Even though the empirical analysis in this study is based on Chinese data, this study also provides valuable experience to those developing countries that follow the Chinese development pattern or have similar economic conditions.

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Conflicts of Interest

The authors declare no conflict of interest.

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