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The Impact of Outward Foreign Direct Investment on Green Technology Innovation: An Analysis of the Moderating Eff ect of Institutional Distance

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ABSTRACT:
Emerging markets are boosting global economic growth as globalization accelerates, causing fundamental and unexpected economic changes. Chinese outward foreign direct investment (OFDI) has transformed and upgraded the local economy and the global economy. Simultaneously, the intensifying focus on environmental concerns has underscored the critical importance of green technological innovation (GTI). Recognized as a cornerstone for achieving long-term, balanced economic growth and environmental sustainability, GTI aligns with China's strategic emphasis on sustainable development. Based on the Resource-Based View, OFDI can frequently facilitate technological transfer and diffusion, enhancing the accessibility of sustainable development and advanced green technologies. However, the relationship between OFDI and GTI is not merely linear, it is influenced by the interweaving and regulation of multiple complex factors. Based on institutional theory, institutional distance significantly moderates the relationship between OFDI and GTI, collectively creating a complex network that influences this relationship. The revelation of its internal mechanism cannot be ignored. This study utilizes Zero-Inflated Negative Binomial model to analyses how OFDI affects GTI with 515 listed multinational enterprises from the Shenzhen Stock Exchange database in China from 2012 to 2021. Additionally, empirical study examines how institutional distance moderates this relationship. The results demonstrate that: (1) OFDI has a significant positive influence on GTI; (2) Formal and informal institutional distances moderate the relationship between OFDI and GTI, which limits its progress. Based on these empirical results, several targeted policy recommendations are proposed: (1) continuously optimize the structure of OFDI to simultaneously enhance the quantity and quality of GTI; (2) improve the external institutional environment for investments and leverage the spillover effects of GTI; (3) facilitate collaboration with local institutions, encourage the exchange of knowledge and technology transfer, and mitigate resistance from informal institutions.
KEYWORDS:*Green Technology Innovation, Outward Foreign Direct Investment, Formal Institutional Distance, Cultural Distance*

1. INTRODUCTION

Within the context of the increasing gravity of the worldwide climate issue, it is imperative to pursue the goals established in the Paris Agreement, which entail a 42% decrease in emissions of greenhouse gases by 2030 (Wang et al., 2025). As the foremost carbon emitter globally, China confronts considerable environmental challenges (Xu et al., 2022). Balancing economic growth with the objective of carbon neutrality presents a significant challenge for China. Consequently, green technology innovation has become an essential strategy for alleviating pollution, decreasing usage of energy, improving environmental conditions, and boosting effectiveness in resource utilization (Cheng et al., 2020).
The pressing challenge of global climate change has intensified the prominence of environmental issues within modern economic and social frameworks. GTI has become an essential strategy for promoting sustainable development on both economic and social fronts. Over 130 nations globally have set ambitious “zero carbon” or “carbon neutrality” targets, solidifying green economic transformation as an international imperative. As the Chinese economy changes from rapid expansion to an emphasis on high-quality development, the government has prioritized GTI, incorporating it into the national "14th Five-Year Plan" and the Vision 2035 Blueprint (Hu et al., 2024). These frameworks emphasize pivotal importance of sustainable development and technological progress.
GTI is deeply rooted in the principles of ecological economics, functioning as a pivotal element within the broader framework of green innovation. It encapsulates a spectrum of technological advancements, including but not limited to process optimization, product lifecycle redesign, and sustainable production

methodologies. These innovations are characterized by their dual focus on enhancing resource utilization efficiency and mitigating the adverse impacts of industrial activities on ecological systems, such as pollution reduction and the minimization of environmental degradation.

Unlike traditional innovation paradigms that often prioritize economic gains at the expense of environmental well-being, GTI adopts an integrative approach that harmonizes ecological preservation with economic development imperatives. This is achieved by embedding ecological consciousness into the innovation process, ensuring strict adherence to environmental protection regulations and legal standards (Wei et al., 2023). Furthermore, GTI is not simply a reactive measure to environmental challenges but a proactive strategy that redefines the competitive landscape. It offers a transformative pathway to achieving the dual objectives of long-term environmental sustainability and economic performance enhancement, making it an indispensable driver of sustainable development within the context of modern industrial systems.

The Chinese innovation ecosystem still confronts limitations, including resource constraints and gaps in innovation capabilities when compared to developed countries. As China enhances its OFDI, positive impacts such as technology spillover, talent mobility, and industrial upgrading are anticipated to inject momentum into the nation's green technology innovation, addressing some of its current challenges. Within the context of economic globalization, stricter environmental regulations have led some multinational firms to shift production abroad, reducing domestic output, evading local environmental restrictions, and re-importing goods to China. Conversely, other companies harness OFDI to access advanced green production technologies, accelerating their own innovation in green practices.

Consequently, examining the influence of OFDI on GTI is absolutely essential. A closer examination of OFDI's impact on China's GTI aligns with the country's macroeconomic goals and provides meaningful guidance for enhancing regional innovation capacity, advancing green economic transformation, and promoting sustainable development and deficiencies in green technology innovation.

Although there has been significant scholarly attention on the direct economic and technological impacts of OFDI, limited research has specifically explored the reverse green technology spillover effects that may arise from OFDI, particularly from a micro-level perspective (Shao et al., 2024). To bridge the existing gap, this research investigates the relationship between OFDI and GTI from the perspectives of both companies and host countries. It aims to deepen our understanding of this relationship from a company perspective and address the under-researched area of host country effects. This study delves into how the host country's institutional environment, particularly formal institutional distance and cultural distance, moderates this relationship. Ultimately, it offers a novel viewpoint on how OFDI influences GTI.

2. LITERATURE REVIEW

2.1 OFDI and Green Technology Innovation

Based on the Resource-Based View, emerging markets MNEs often invest abroad to acquire host-country resources, including advanced technologies, skilled labor, or eco-friendly practices that enhance their green innovation capabilities (Shao et al., 2024). Scholarly studies on the factors influencing green technology innovation has extensively examined the role of OFDI (Shi et al., 2023). Certain studies propose that OFDI from developing countries may promote GTI within their domestic economies (Wang et al., 2024) and positively impact domestic GTI (Behera & Sethi, 2022; Li et al., 2022).

Recent researches have consistently shown that OFDI can significantly boost GTI (Li et al., 2022; Liu et al., 2021; Wang et al., 2024). For instance, research has indicated that OFDI can improve a country's green innovation capabilities, particularly in regions like those along the Belt and Road Initiative (Han et al., 2020). Additionally, studies have demonstrated that OFDI can positively affect the GTI of MNEs and their domestic parent firms (Shi et al., 2023). By fostering technological cooperation and knowledge sharing, OFDI can drive the quantity and quality of GTI (Shao et al., 2024; Wang et al., 2025). They collectively highlight the essential function of OFDI in propelling GTI at both the domestic and international levels. By facilitating knowledge transfer, technology diffusion, and international collaboration, OFDI can stimulate the advancement and execution of sustainable technology, ultimately contributing to a more sustainable future.

Drawing on the perspectives discussed above, the following hypothesis has been formulated:

Hypothesis 1 (H1): OFDI has a positive influence on the green technology innovation of Chinese multinational enterprises.

2.2 Institutional Distance and GTI

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Existing studies have explored the relationship between OFDI and sustainable development (Peng et al., 2023), revealing that green technology innovation is shaped not only by internal organizational factors but also by significant influences from the external environment (Lin & Xie, 2023; Wang et al., 2023; Xu et al., 2021).

Based on Institutional Theory, increases uncertainty, cultural friction, and operational costs, potentially hindering the assimilation and innovation of green technologies (Chen et al., 2018; Qi et al., 2021). This, in turn, institutional distance can affect cross-border green technology and practice transfer (Li, 2022). however, only a few studies have incorporated the institutional environment into the GTI research framework (Wang et al., 2022). In a study examining the extent to which the rigor of environmental regulations in host countries influenced the relationship between OFDI and GTI, it was revealed that the more stringent environmental regulations in host nations moderated the association between OFDI and GTI [9]. Furthermore, the diverse effects of environmental regulation on GTI indicate that at low levels of economic growth, such regulation hinders the progress of GTI (Du et al., 2021). Another related research found that economic policy uncertainty negatively moderates the relationship between environmental regulation and GTI (Li et al., 2021).

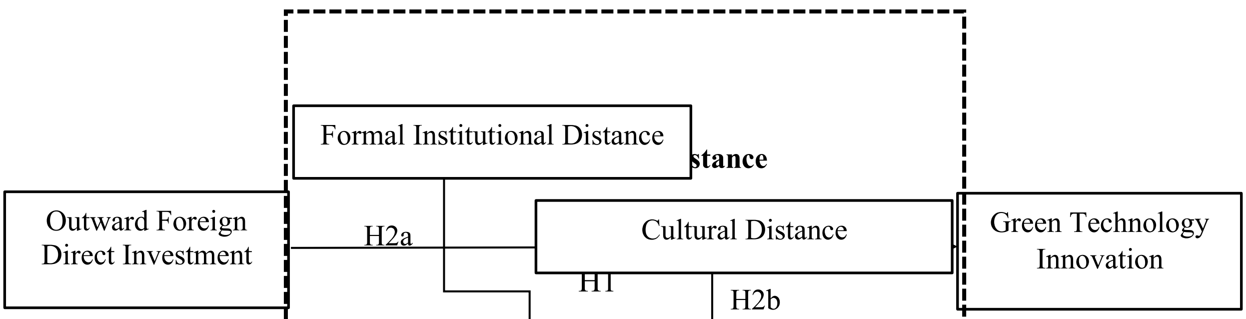
Enterprise green innovation activities are largely driven by local government regulations and membership in environmental organizations, which signify formal and informal institutions, respectively (Hu et al., 2021). Academic research categorizes institutional distance into formal and informal dimensions. Formal institutional distance refers to differences in economic policies, legal systems, and related factors between host and home countries (Kafouros et al., 2022). In contrast, informal institutional distance captures variations in values, behavioral norms, and cultural attributes, often described as cultural remoteness (She et al., 2023; Zheng et al., 2022). Accordingly, this study adopts the term cultural distance instead of informal institutional distance, as it effectively represents the core characteristics of informal institutions.

Prior research has not addressed the theoretical or empirical aspects of the interaction mechanism among institutional distance, OFDI, and GTI. To fill the gap, this study also explores how institutional distance moderates the relationship between OFDI and GTI. Therefore, the following hypotheses were established:

Hypothesis 2a (H2a): Formal institutional distance moderates the relationship between OFDI and green technology innovation.

Hypothesis 2b (H2b): Cultural distance moderates the relationship between OFDI and green technology innovation.

We developed a conceptual model that demonstrates the relationship between OFDI and GTI (refer to Figure 1).



Control variables:

Ownership, Diplomatic Relations
Technical level, Size, Age,
Environmental Protection,
Oversea Experience,
R&D, and Intangible

Figure 1 Research Framework

3. Data and Research Model

3.1 Sample Design

Given the accessibility and comprehensiveness of the data, this study examines publicly listed Chinese enterprises undertaking OFDI from 2012 to 2021, with a particular emphasis on those headquartered in Shenzhen. The choice of Shenzhen is both intentional and strategic, given its prominence as a hub for innovation and global commerce. Its unique economic environment, combined with its critical role in technological advancement and international trade, makes it an ideal case for analyzing the effects of OFDI on GTI. The research draws on data from the China Stock Market & Accounting Research (CSMAR) database, which offers detailed information on listed enterprises, including financial metrics, stock market activities, and corporate events. To alleviate the potential impact of sample bias and uphold the integrity of the empirical results, this research excluded investment transit locations and "return investment" springboard samples (Wu et al., 2022). It ultimately selected 515 MNEs listed in Shenzhen as the research samples.

3.2 Variables and measures

Dependent Variable-GTI

Green patent indicators offer a more intuitive measure of the extent and magnitude of green technology innovation (Sun et al., 2024). Building upon previous research, this study employs the total number of green patents granted to a listed MNE as an indicator of its GTI capability (Zhang & Jin, 2022). This metric includes both green invention patents and green utility model patents. We obtained data about green patent applications and authorizations from the Chinese Research Data Services Platform (CNRDS).

Independent Variable-OFDI

This study focuses on the OFDI activities of 515 MNEs that are publicly listed on the Shenzhen A-shares market in China. The data used in this research is also drawn from the CSMAR database, representing a diverse cross-section of Chinese enterprises engaged in international expansion. OFDI refers to the investment made by Chinese firms in foreign markets, encompassing various forms such as acquisitions, joint ventures, greenfield investments, or equity stakes in overseas subsidiaries (Unctad, 1996).

Moderator Variables

(1) Formal Institutional Distance

At present, a standardized method for assessing formal institutional quality and calculating institutional distance is lacking, with researchers mostly relying on the World Governance Indicator (WGI) to evaluate the institutional distance between nations (Borah et al., 2023; Correa da Cunha 2019; Dikova et al., 2019; Keig et al., 2019). Following the approach of previous scholars (Gaur & Lu, 2007; Liu et al., 2023), this study employs six factors of the World Governance Indicators to assess formal institutional distance,with the Kogut-Singh distance index being utilized to quantify the formal institutional distance (Kogut & Singh, 1988).

(2) Cultural Distance

Cultural distance between two countries is assessed by examining the disparity in their scores on cultural dimensions, as measured by the Geert Hofstede database. A smaller difference in scores indicates greater cultural similarity. This method is widely adopted in studies investigating cultural distance (Beugelsdijk et al., 2018; Fan et al., 2024; Kirkman et al., 2017). Following this approach, cultural distance was measured by also employing the Kogut-Singh index of distance in this study (Kogut & Singh, 1988; Park & Jin, 2024).

Control Variables

Drawing from Lin and Xie's methodology, this study included the following nine control variables from different angles to account for the possible influence of other factors (Lin & Xie, 2023; Zhang et al., 2023):

Table 1 Data Sources of Control Variable

Control Variable	**Acronyms**	**Data Sources**
Diplomatic Relations	DIP	Ministry of Foreign Affairs of the People's Republic of China
Technology	LnTECH	World Bank Open Data
Size	LnSize	《CSMAR》
Age	LnAge	
Ownership	OWN	
Environmental Protection	EP	
Oversea Experience	OE	
R&D	LnRD	
Intangible Assets	IA	

3.3 Descriptive statistics and Correlation

Table 2 presents the summary statistics, with the dependent variable, green technology innovation, showing a mean of 22.27 and a standard deviation of 37.23. The resulting coefficient of variation is 1.67, indicating substantial dispersion as it significantly exceeds 1. Moreover, the descriptive statistics for the control variables are consistent with theoretical and empirical expectations, further supporting the robustness of the dataset. The VIF values presented indicate that all variables have VIFs below 5. Furthermore, as most variables have VIFs close to 1, it can be concluded that the data do not exhibit significant multicollinearity concerns. The results of the correlation coefficients between the different variables as presented in Table 1 reveals that most of the variables are significantly correlated.

Table 2. Descriptive statistics and correlations

	Variable	**Mean**	**S.D.**	**VIF**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
y	GTI	22.27	37.23	1.4												
1	lnOFDI	12.17	2.12	1.62	1											
2	FID	2.80	1.65	1.89	0.006	1										
3	CD	7.60	1.52	1.33	0.021	0.413***	1									
4	OWN	0.70	0.46	1.25	0.177***	0.176***	0.025*	1								
5	DIP	5.36	2.76	1.15	0.085***	-0.286***	-0.101***	0.025*	1							
6	lnTECH	22.48	1.85	1.66	-0.005	0.557***	0.417***	0.099***	-0.17***	1						
7	lnSIZE	24.63	1.42	1.83	0.572***	0.043***	0.025*	0.282***	0.121***	0.057***	1					
8	lnAGE	3.01	0.23	1.18	-0.295***	0.125***	0.044***	-0.062***	-0.063***	0.064***	-0.221***	1				
9	EP	0.63	1.10	1.14	0.029**	-0.151***	-0.132***	0.061***	0.051***	-0.037***	0.104***	-0.187***	1			
10	OE	1.85	1.58	1.17	0.273***	-0.044***	0.001	0.051***	0.016	0.016	0.291***	-0.196***	0.01	1		
11	RD	3.67	4.76	1.17	0.008	-0.067***	0.068***	-0.311***	-0.072***	0.039***	-0.048***	-0.086***	0.007	0.14***	1	
12	IA	0.05	0.05	1.17	-0.031**	0.181***	0.089***	0.122***	0.096***	-0.068***	0.062***	-0.014	0.084***	-0.078***	-0.12***	1

3.4 Empirical model specification

This study focuses on the dependent variable, green technology innovation (GTI), measured by the count of green patents, which represents non-negative integer count data with a high prevalence of structural zeros, commonly termed zero-inflated data. To model such data effectively, negative binomial (NB) regression is widely regarded as a suitable analytical approach (Said, 2019). However, the high prevalence of zero values in the dataset may diminish the accuracy of the regression model in interpreting the data, as the excess zeros can lead to pronounced overdispersion (Andriyana et al., 2023).

The summary statistics of the dependent variable indicate overdispersion, a common issue where the variance exceeds the mean, leading to underestimated standard errors and inflated significance levels (Yasuda & Kotabe, 2021). To address this, the negative binomial (NB) regression is employed as it provides more efficient estimators by relaxing the mean-variance equality assumption, making it a more suitable choice in this context (Liu et al., 2023). Additionally, 30.14% of the dependent variable's values are zero, highlighting the potential for zero inflation. To rigorously evaluate the suitability of the NB model against the zero-inflated negative binomial (ZINB) model, the study employed the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) as model fit metrics. As summarized in Table 3, ZINB model yields smaller AIC and BIC values compared to the NB model, demonstrating a more optimal alignment with the data. Based on these results, the ZINB model was selected as the optimal modelling approach (Akaike, 1974; Schwarz, 1978). Stata 17 was used to perform the ZINB model using the "ZINB" command.

Table 3. The fitting outcomes of the NB and ZINB models

Estimation parameters	**NB**	**ZINB**
Log likelihood	-19424.292	-18979.35
AIC	38852.58	37966.69
BIC	38865.68	37992.88
Ln alpha	1.128***	0.150***

Notes: ***p<0.001; N=5150.

For this study, the ZINB model is formulated as follows:

Count Component model formulas:

$$\log\left(GTI_{ijt}\right) = \alpha_0 + \alpha_1 LnOFDI_{ijt} + \sum \beta\, con\_x_{ijt} \tag{3.1}$$

$$\log\left(GTI_{ijt}\right) = a_0 + a_1 LnOFDI_{ijt} + a_2 FID_{jt} + a_3 LnOFDI_{ijt} \times FID_{jt} + \sum \beta\, con\_x_{ijt} \tag{3.2}$$

$$\log\left(GTI_{ijt}\right) = b_0 + b_1 LnOFDI_{ijt} + b_2 CD_{jt} + b_3 LnOFDI_{ijt} \times CD_{jt} + \sum \beta\, con\_x_{ijt} \tag{3.3}$$

Among them:

i represents the MNEs, j denotes the host country, and t signifies the year.

GTI is an expected count value of the i-th observation; In this study, it is the dependent variable.

α_0, a_0, and b_0 are the regression coefficients of constant term; α_1, a_1, and b_1 are unknown parameters of the independent variable (OFDI).

a_2 and b_2 are the coefficients of moderators (FID and CD).

a_3 and b_3 are the coefficients of interaction terms.

Con_x_{ijt} are control variables, and β is an unknown parameter of the control variables.

Zero inflation Component model formula:

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 LnOFDI_{ijt} + \sum \gamma\, con\_x_{ijt} \tag{3.4}$$

Where:

π_i is the probability that the i-th observation belongs to the zero-expansion part.

β_0 is the coefficient of the constant term of the zero-expansion part, and β_1 is an unknown parameter of the independent variable of the zero-expansion part.

γ are unknown parameters of the control variables (Con_x_{ijt}).

4. Empirical Results

Table 4. ZINB results

	Model 1 GTI	Model 2 GTI	Model 3 GTI	Model 4 GTI	Model 5 GTI
lnOFDI	0.0640***	0.0639***	0.119***	0.0640***	0.240***
	(7.50)	(7.51)	(8.81)	(7.57)	(7.42)
DIP	0.0192***	0.0105*	0.0102*	0.0205***	0.0208***
	(4.31)	(2.22)	(2.15)	(4.57)	(4.65)
lnTECH	0.0355***	0.0617***	0.0607***	0.0148	0.00686
	(4.82)	(7.11)	(7.00)	(1.86)	(0.85)
lnSIZE	0.754***	0.758***	0.757***	0.752***	0.752***
	(46.93)	(47.39)	(47.22)	(47.17)	(47.29)
lnAge	-0.111*	-0.0835	-0.0801	-0.131*	-0.132*
	(-2.01)	(-1.51)	(-1.46)	(-2.38)	(-2.41)
OWN	-0.0291	-0.0300	-0.0285	-0.0237	-0.00775
	(-0.89)	(-0.92)	(-0.88)	(-0.73)	(-0.24)
EP	0.361***	0.343***	0.343***	0.373***	0.383***
	(25.15)	(23.61)	(23.88)	(26.10)	(26.78)
OE	0.133***	0.135***	0.132***	0.134***	0.135***
	(15.04)	(15.32)	(14.97)	(15.25)	(15.43)
RD	0.0236***	0.0228***	0.0234***	0.0225***	0.0239***
	(7.09)	(6.89)	(7.05)	(6.83)	(7.26)
IA	-1.497***	-0.863**	-0.834**	-1.816***	-1.704***
	(-5.23)	(-2.81)	(-2.73)	(-6.27)	(-5.90)
FID		-0.0559***	0.192***		
		(-5.57)	(3.95)		
LnOFDI×FID			-0.0193***		
			(-5.21)		
CD				0.0642***	0.367***
				(6.82)	(6.74)
LnOFDI×CD					-0.0233***
					(-5.63)
cons	-17.79***	-18.39***	-19.04***	-17.71***	-19.86***
	(-41.90)	(-41.99)	(-41.74)	(-42.07)	(-34.84)
ln alpha	-0.720***	-0.731***	-0.738***	-0.732***	-0.740***
	(-23.01)	(-23.32)	(-23.57)	(-23.40)	(-23.70)
Log likelihood	-17063.04	-17047.74	-17034.13	-17040.4	-17024.41
LR χ^2	3832.61***	3863.22***	3890.44***	3877.89***	3909.88***
N	5150	5150	5150	5150	5150

Notes: *p<0.05; **p<0.01; ***p<0.001;

Values in parentheses indicate the corresponding t-statistics.

4.1 Direct Effects Test

Model 1 in Table 4 reveals that the coefficient of LnOFDI is 0.0640, demonstrating statistical significance at the 1% level. This finding provides robust proof that OFDI positively impacts on the GTI of Chinese MNEs. The observed relationship substantiates the validity of H1, reinforcing the proposition that OFDI is a vital catalyst for improving green innovation skills inside these companies. Furthermore, the result is consistent with the conclusions drawn in prior studies (Han et al., 2020; Shi et al., 2023; Wang et al., 2024). OFDI facilitates Chinese MNEs' access to cutting-edge green technologies, processes, and management practices in countries with stringent environmental regulations or advanced innovation ecosystems. By engaging in cross-border operations, these enterprises can acquire valuable knowledge through collaborations, acquisitions, or supply chain integration. This knowledge, when absorbed and transformed, can fuel the development of green technologies in China.

Regarding control variables, Model 1 also indicated that host country technical level (lnTECH), diplomatic relations (DIP), firm size (lnSIZE), environmental protection (EP), overseas experience (OE), research and development funding (lnRD) have a significant positive influence on the GTI. The observed outcomes of the aforementioned control variables align with other studies. The regression analysis of firm age (AGE) indicated a statistically significant negative impact at the 10% level. This discovery indicates that new enterprises, motivated by the necessity to secure their position in the market, are more likely to innovate, thereby contributing to higher levels of innovation within Chinese MNEs.

4.2 Moderating Effects Test

Table 4 also shows the findings of the moderating effects test. In both Model 2 and Model 3, the coefficient of the moderator FID is significant at the 1% level. Simultaneously, Model 3 reveals a significant negative relationship between GTI and the interaction term LnOFDI×FID (beta = -0.0193, p <0.001). This shows that the relationship between OFDI and GTI is negatively moderated by formal institutional distance. In addition, the findings from Model 4 and Model 5 reveal that the coefficients of moderators have statistical significance (p <0.001). Additionally, the interaction term LnOFDI×CD in Model 5 has a negative and significant coefficient (beta = -0.0233, p <0.001), suggesting that cultural distance also negatively moderated the positive influence of OFDI on Chinese MNEs' green technology innovation. Therefore, H2a and H2b are substantiated. This conclusion aligns with the findings of prior research (Li et al., 2021; Shi et al., 2023).

MNEs operating in countries with strict environmental regulations often encounter significant pressure to adopt green technologies and sustainable practices. These regulations create a strong external incentive to innovate in ways that align with environmental protection and sustainability goals. However, this relationship may be weakened or negatively moderated when MNEs expand into nations with less stringent regulatory frameworks, where the external pressures to innovate in green technologies are diminished. In such environments, the lack of regulatory enforcement and incentives may reduce the urgency for MNEs to pursue green technological advancements, thus limiting their commitment to environmental sustainability. Furthermore, the variations in legal and regulatory environment between home and host countries can complicate the seamless transfer of knowledge and technologies acquired through OFDI. Inconsistent standards or regulatory requirements can create barriers that hinder the efficient sharing and adaptation of green innovations, ultimately limiting the potential benefits of OFDI in promoting green technology innovation.

In a similar vein, cultural distance can also negatively moderate the relationship between OFDI and GTI. Cultural differences often create significant barriers to effective communication, understanding, and knowledge transfer, which are critical for the successful adoption of advanced green technologies and practices. The misalignment of values, work practices, and attitudes toward environmental sustainability can exacerbate these challenges. For example, differences in decision-making processes, risk tolerance, and organizational culture may lead to inefficiencies in implementing green innovations (Domsa & Junghausz, 2024). Additionally, host-country employees may resist adopting new environmental protocols or practices introduced by foreign investors due to cultural unfamiliarity, lack of trust, or perceived disruption of local norms. This resistance can further restrict the successful realization of green innovation outcomes, as the effective transfer and integration of knowledge may be delayed or incomplete. As a result, understanding and addressing cultural distance is essential for MNEs to successfully navigate cross-border operations and fully capitalize on the potential benefits of green technology innovation.

4.3 Robustness Check

Table 5. Results of the robustness tests

	Model 6 GTI1	Model 7 GTI1	Model 8 GTI1	Model 9 GTI	Model 10 GTI	Model 11 GTI
lnOFDI	0.0731***	0.0869***	0.154***	0.0766***	0.0982***	0.191***
	(10.47)	(9.12)	(5.32)	(7.51)	(6.74)	(5.45)
FID		0.0248			0.0732	
		(0.69)			(1.42)	
LnOFDI×FID		-0.00477*			-0.00891*	
		(-2.05)			(-2.25)	
CD			0.159**			0.241***
			(3.17)			(4.16)
LnOFDI×CD			-0.0109**			-0.0148***
			(-2.90)			(-3.35)
Constant	-11.27***	-12.00***	-12.29***	-16.50***	-17.11***	-17.66***
	(-34.10)	(-32.13)	(-25.42)	(-33.02)	(-32.98)	(-27.76)
Control variables	Included	Included	Included	Included	Included	Included
Log likelihood	-7506.137	-7491.276	-7499.651	-14397.52	-14387.62	-14380.9
LR χ^2	2703.68***	2733.40***	2716.65 ***	2833.39***	2853.18***	2866.62***
N	5150	5150	5150	3991	3991	3991

Notes: *p<0.05; **p<0.01; ***p<0.001;
Values in parentheses indicate the corresponding t-statistics.

This study employed two methods for robustness testing: variable replacement and sample size manipulation. Firstly, in accordance with the methodology of previous research (Chen & Jin, 2023; Zhang & Jin, 2022), the measurement criteria for green technology innovation (GTI1) was quantified by first adding one to the sum of green invention patents and green utility model patents, followed by taking the natural logarithm of the result. Models 6, 7, and 8 in Table 5 indicate that the findings for hypothesis H1, H2a, and H2b are predominantly compatible with those shown in Table 4. Secondly, acknowledging that manufacturing serves as a foundational industry in China and represents a crucial measure of the nation's overall innovation capability (Dou & Gao, 2022), a particular emphasis was placed on manufacturing enterprises in this study. Given the increased focus on the manufacturing sector relative to non-manufacturing industries, this study thereby excluded non-manufacturing firms. As a result, the final dataset comprised 3,991 observations. Models 9 to 11 show that the independent and moderator variables maintain significant stability, hence corroborating all assumptions. The OFDI × FID coefficient in Model 10 exhibits marginal significance at the 5% level (β = -0.00891, p = 0.025), further strengthening the robustness of the study's conclusions.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

The empirical results indicate that OFDI positively influences green technology innovation. Furthermore, the findings also show that institutional distance moderate this positive relationship. As pivotal contributors to micro-level environmental protection and green governance, enterprises are essential in advancing the "dual carbon" goals. OFDI has become a strong driver for green technology innovation. Therefore, the government ought to reinforce rational guidance for enterprises, continuously optimize the OFDI structure, and promote diversified investment structures and refined, rationalized investment layouts. Priority should be given to increasing the green technology content of OFDI, overcoming green technology barriers, and conducting OFDI with a comprehensive consideration of the host country's locational characteristics, technological endowments, and institutional environment. To achieve this, the government should implement the following strategies:

Enterprises should be strongly encouraged to prioritize investments in green industries, focusing more capital on sectors related to environmental protection and the circular economy. This approach will support the ongoing green transformation of industrial structures, ensuring long-term sustainability and reducing the environmental impact of traditional industrial practices. To facilitate this transition, governments and financial institutions should provide targeted financial support, such as specialized loans, insurance schemes, and tax incentives tailored for cross-border green projects. These incentives can help businesses reduce the costs associated with institutional friction and secure the necessary funding for green technology innovation, which is essential for maintaining competitiveness in a rapidly evolving global market.

Before carrying on OFDI, it is crucial for businesses to carefully assess the institutional environment of the host country. This analysis should focus on identifying critical differences, such as variations in legal systems, environmental policies, and intellectual property regulations. Understanding these differences will allow firms to navigate challenges more effectively and make informed decisions about their investments. To address these challenges, international agreements, treaties, or global organizations should be leveraged to align institutional frameworks between home and host countries. Establishing "institutional adaptation service centers" in key regions could provide businesses with the necessary policy advice, compliance support, and risk management services to minimize institutional barriers. Furthermore, collaborating with local research institutions and businesses to co-develop green technologies can enable better utilization of local resources, fostering mutual benefits while driving innovation and sustainability.

Additionally, addressing the barriers posed by informal institutional distance is crucial. In order to improve understanding between different cultures and mitigate potential challenges, companies should invest in comprehensive training programs for their employees, focusing on the language, customs, and cultural nuances of the countries where they operate. This will not only enhance communication but also build respect for local traditions and values. Hiring local talent can further bridge cultural gaps, fostering stronger relationships and improving teamwork across borders. Collaborating with local institutions, promoting knowledge sharing, and facilitating technology transfer are other effective ways to reduce the resistance posed by informal institutions. To enhance these efforts, organizing events such as workshops, conferences, and networking sessions can provide opportunities for employees, partners, and stakeholders from different cultures to engage, collaborate, and strengthen cross-cultural cooperation. These strategies will ensure that enterprises can thrive in international markets while minimizing the adverse impacts of institutional and cultural differences on innovation and business development.

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