sustainability

MDPI

Article

Green Finance, International Technology Spillover and Green Technology Innovation: A New Perspective of Regional Innovation Capability

Pengfei Cheng [1], Xiaofeng Wang [2,*], Baekryul Choi [1,*] and Xingang Huan [3]

[1] Department of International Trade, Jeonbuk National University, Jeonju 54896, Republic of Korea
[2] Agricultural Economics, Jeonbuk National University, Jeonju 54896, Republic of Korea
[3] Grain Economics Research Center, School of Economics and Trade, Henan University of Technology, Zhengzhou 450001, China
* Correspondence: wxf@jbnu.ac.kr (X.W.); brchoi@jbnu.ac.kr (B.C.)

Abstract: Regional green technological progress is an important driver of regional green technology innovations. To explore in depth the impact of green finance and international technology spillover on regional green technology innovation, this study incorporates green finance, international technology spillover, and green technology innovation into the same analytical framework. In addition, based on a new perspective of regional innovation capabilities, this study analyzes the impact of green finance and international green technology spillovers on green technology innovation. The data were collected in 30 Chinese provinces from 2003 to 2019 and analyzed by a panel fixed-effects model. The interaction between green finance, international technology spillover, and regional innovation capability was investigated to understand the impact of each interaction on green technology innovation. Second, regional innovation capability was used as an intermediary variable to identify its underlying mechanism. Finally, the spatial spillover effect of green technology innovation was analyzed using the spatial Durbin model. We found that: (1) green finance, import trade, outward foreign direct investment (OFDI), and regional innovation capability can promote regional green technology innovation, while inward foreign direct investment (IFDI) has an inhibitory effect on the innovation; (2) the interaction of green finance, international technology spillovers, and regional innovation capacity positively impacts green technology innovation; (3) green finance and international technology spillovers can promote green technology innovation by promoting regional innovation capabilities; (4) and green technology innovations have spatial spillover effects, and innovations in one region can promote the growth of green technologies in adjacent regions. This study provides a reference not only for China but also for other developing countries to promote green technology advancement and achieve sustainable development goals.

Keywords: green finance; technology spillovers; green technology innovation; regional innovation capability; intermediary effect; spatial spillover effect

Citation: Cheng, P.; Wang, X.; Choi, B.; Huan, X. Green Finance, International Technology Spillover and Green Technology Innovation: A New Perspective of Regional Innovation Capability. *Sustainability* **2023**, *15*, 1112. https://doi.org/10.3390/su15021112

Academic Editor: Luigi Aldieri

Received: 8 December 2022
Revised: 3 January 2023
Accepted: 4 January 2023
Published: 6 January 2023

1. Introduction

Sustainable development has become a common goal in the world as all countries face the problems of environmental pollution and energy shortages. Since the "reform and opening-up" program in 1978, China's economy has dramatically grown. However, environmental pollution, inefficient use of energy, and lack of innovation and development momentum are also becoming increasingly prominent. China's most significant challenge is how to find a balance between economic development and the associated environmental problems [1]. As the Chinese economy enters a period of structural transformation, sustainable development has become scholars' and policymakers' focus of attention. Green technology innovation is regarded as an important means of achieving that

[2]. According to Braun and Sway [3], green technology innovation can not only reduce pollution and energy consumption but can also promote an ecological environment for business. Taking economic development and environmental protection into account, green technology innovation has become an important way to break through the environmental and resource constraints and achieve economic growth [4].

Although many countries have gradually strengthened the guidance and support for green technology innovation, the level of green technology innovation is still low due to its own characteristics of low return, long cycle, and high risk, especially in developing countries. Against this background, the concept of green finance was introduced; it describes a new financial model integrating environmental protection and economic benefits that promotes green technology innovation. Green finance can guide the transfer of funds from traditional high-energy and high-pollution enterprises to environmental industries through capital allocation, which can reduce the financing costs of the enterprises that protect the environment and can increase the financing threshold of polluting enterprises to create a new economic structure—a green transition [5].

In addition to the knowledge stock within the region promoting green technology innovation, green technology spillover from outside the region is also an important factor in promoting regional green technology innovation. IFDI, OFDI, and international trade are important channels for the international circulation of resources, as well as important carriers and channels for advanced technology transfer between developing and developed countries [6, 7]. Some scholars have found that the technology and the knowledge of developed countries spread outward through international exchanges and cooperation, a process called international technology spillover [8]. Developing countries absorb such spillovers through import–digestion–imitation, which enables them to obtain advanced technologies at a lower cost [9]. In the context of sustainable development, the innovation drive has become the engine of China's economic growth, and opening up to the outside world and exploiting the spillover effects of international technologies are important ways for China to rapidly improve its green innovation capabilities [10]. However, the effective absorption and diffusion of international technology spillovers require a suitable environment [11]. For example, international technology spillovers during the early days of the reform and opening up program led to the formation of a technological progress model in China that focused on introducing knowledge and technology, but this model negatively impacted the industrial development of the country. An "emphasis on introduction and neglection of absorption" leads to a host country's dependence on imported technology, which is not conducive to the technological innovation of local enterprises. The root of this problem is a low capacity for absorption and independent innovation. Therefore, the absorptive capacity of the host country and regional innovation capacity are determinants of the full absorption and utilization of foreign knowledge and technology [12].

In summary, it is necessary to analyze the impact of green finance and international technology spillover on green technology innovation based on the perspective of regional innovation capacity. To investigate the impact of green finance and international technology spillovers on green technology innovation, we analyzed the data collected from 30 provinces in China, covering the period from 2003 to 2019, using a fixed-effects model. Then, we examined the impact of green finance, international technology spillovers, and regional innovation capabilities on green technology innovation using an interaction term. In addition, an intermediary effect model was used to further explore the intermediary role of regional innovation capability in green finance and international technology spillovers affecting green technology innovation. Finally, we assessed the spatial spillover effects of green technology innovations using the spatial Durbin model.

This study contributes to the existing literature in the following ways. First, we incorporate green finance, international technology spillovers, regional innovation capabilities, and green technology innovations into the same analytical framework to avoid estimation bias caused by a single channel, and we thereby make up for the shortcomings of the models which ignore the heterogeneity effects. Second, this study comprehensively analyzes the impact of international technology spillovers on green technology innovation, taking three variables into account: OFDI, IFDI, and import trade. Most studies have investigated its impact from a single-perspective view, considering one variable at a time. Third, the analysis of the interactions, intermediary effects, and spatial spillover effects that we conducted further clarifies the mechanism underlying the impact of green finance, international technology spillovers, and regional innovation capabilities on green technology innovation.

2. Literature Review

2.1. The Impact of Green Finance on Green Technology Innovation

Compared with traditional technological innovation, green technological innovation is characterized by long cycles, slow returns, and high risks. These characteristics make it difficult to support the green innovation activities of enterprises through endogenous financing. Enterprises, therefore, often turn to external financing methods with high costs, such as equity and debt financing [13]. However, many external investors and banks prefer traditional investments with significant economic benefits under imperfect capital market conditions, resulting in high external financing constraints for green innovation activities [14]. Green finance aims to provide market-oriented capital guarantees for green technologies, projects, and industries through capital allocation [15], and the implementation of green finance policies can further enhance the impact of green finance development [16]. Promoting the development of green finance and the growth of regional green technologies is therefore the key to regional sustainable development [17].

In recent years, green finance has received widespread attention from the academic community as an important way to promote green technology innovation and sustainable development. The studies claim that green finance mainly affects green technology innovation through the following channels: (1) Optimization of social capital allocation. Green finance can provide preferential credit interest rates to low-pollution, low-consumption, and energy-saving industries that protect the environment, thereby increasing the credit costs of enterprises in heavily polluting industries and guiding financial market funds to flow from heavily polluting to energy-saving and environmentally friendly industries [18]. (2) Provision of financial support. Green finance can provide significant financial support for environmental enterprises, alleviate the financing constraints green technologies face, and provide more trial-and-error capital for research and development (R&D) processes [19]. (3) Reduction in risk. Through a long-term risk-sharing financial system, green finance can effectively reduce liquidity risks [20]. (4) Information transfer. Green finance can reduce the cost of resource matching for green technology innovation. For example, green finance can reduce resource-matching costs by facilitating cooperation and information sharing between firms and financial institutions [21]. Accordingly, we propose Hypothesis 1.

H1a: Green finance can promote regional green technology innovation.

H1b: The interaction of green finance and regional innovation capacity can promote regional green technology innovation.

2.2. Research on the Influence of International Technology Spillover on Green Technology Innovation

The environmental problems caused by climate change as well as the role of green technologies in reducing environmental pollution are becoming increasingly evident. As multi-channel international technology spillovers improve the innovation capabilities of open economies [22], scholars have explored the impact of international spillovers from different channels on green technology innovation.

OFDI is an important channel for advanced international technology acquisition. This technology transfer process is called reverse technology spillover [23]. Green technologies can also be transferred through OFDI, accelerating green innovation in recipient countries [24]. According to previous studies, the green technology spillover of OFDI is mainly realized through the following methods: (1) Acquisition of green technology. When one country invests in another, it gains access to local intellectual resources, the leading technologies of local companies, and the achievements of R&D institutions. At the same time, subsidiaries are constrained by local environmental regulations and legal systems. They therefore raise awareness of green innovation in their home country while absorbing local technology spillovers [25]. (2) Human capital effects. Subsidiaries can hire local R&D personnel to enhance their technological innovation capabilities [26]. The labor flow between the parent company and its subsidiaries leads to a new knowledge spillover effect on the parent company and helps to promote the green technology progress of the parent company [27]. (3) R&D financial support. The profits earned through OFDI provide financial support for the parent company's R&D investment and ultimately promote green technology innovation in the home country [28]. In addition, some studies have found that China's investment in developed countries can cause reverse green technology spillover effects and promote China's green technology progress. However, the investment in developing countries has failed to drive progress in green technologies [29]. Accordingly, we propose Hypothesis 2.

H2: OFDI can promote green technology innovation.

Scholars widely support the technology spillover effect of IFDI. In recent years, due to the intensification of environmental pollution, more and more attention has been paid to the impact of the green technology spillover effects of IFDI on host countries. For example, Liu et al. [30] found that such spillovers can control environmental pollution and optimize industrial structures. In addition, Castellani et al. [31] found that IFDI invested in R&D activities can amplify the green spillover effects because it directly increases the local knowledge base and stimulates innovation. Earlier research shows that (1) IFDI can promote regional green technology innovation through personnel mobility, competition, and demonstration, as well as industry association effects [32]. (2) IFDI improves the host country's industrial structure through technology spillover effects and provides technical and financial support that stimulates progress in green technologies [33, 34]. Some scholars, however, hold different opinions. Pandeng et al. [35] find that FDI increases environmental pollution in the textile industry in China, validating the "pollution paradise" hypothesis. Arif et al. [36] believe that the inflow of IFDI promotes the expansion of the production activities of the host country, thereby aggravating environmental pollution. In addition, Hu et al. [37] found that labor-based IFDI does not lead to green technology spillovers. Cheng et al. [38] found that IFDI benefits the green growth of medium- and high-tech industries but has no significant impact on low-tech industries. Further, Wang et al. [39] suggest that the host country's level of marketization and innovation capacity are two key factors affecting the green spillover effect of FDI. Improving innovation capacity always promotes the diffusion of FDI green technology spillover effects in the host country. Similarly, Xu and Li. [40] find that FDI has a negative effect on green productivity when developing countries have low innovation capacity; when developing countries' innovation capacity exceeds a threshold, FDI can increase green productivity in the host country. Accordingly, we propose Hypothesis 3.

H3a: FDI can promote regional green technological progress.

H3b: FDI can inhibit regional green technological progress.

International trade not only promotes economic growth but is also an important channel for international technology spillover. Zhang et al. [41] believe that the green technology spillover brought about by import trade improves China's air environment. Prior research suggests that import trade can promote green technology innovation through the following channels: (1) Developing countries can benefit from international trade technology spillovers through trade exchanges, technology exchanges, and other activities, which helps to narrow the technology gap between developed and developing nations. These technologies also introduce new innovations to importing countries and promote domestic green innovation capabilities [42]. (2) Enterprises can improve their technological level and production efficiency by learning from trading partners. Moreover, diversified intermediate products that are complementary to domestic products aid the optimal allocation of resources and improve productivity [43]. (3) To obtain specific trade goods, developed countries often provide support such as key technologies and equipment [44]. Accordingly, we propose Hypothesis 4.

H4: Import trade can promote regional green technological progress.

Some scholars have suggested that international technology spillovers play an important role in the technological progress of the host country. This depends, however, on the host country's ability to absorb and integrate imported advanced technologies [45]. Similarly, Zhao et al. [46] found that regions with strong absorptive capacities can quickly transform the received spillover knowledge into economic output. They argue that the higher the absorptive capacity, the stronger the region's ability to transform knowledge spillovers into a green economy. Accordingly, we propose Hypothesis 5.

H5: The interaction between international technology spillovers (import trade, IFDI, and OFDI) and regional innovation capacity can promote green technological progress.

To summarize, the scholars have provided in-depth analyses of the relationships between green finance, international technology spillovers, and green technology innovations. However, most prior studies take a single perspective when exploring the impact of green finance or international technology spillovers on green technology innovation. In addition, most research is based on single-channel analyses and focuses on only OFDI, IFDI, or import trade. Finally, although regional innovation capabilities are important factors that determine a region's ability to absorb international technology spillovers and transform them into green technology innovations, they have so far received insufficient attention. Here, we therefore integrated green finance, international green technology spillovers (import trade, IFDI, and OFDI), and green technology innovation into a unified framework.

3. Methodology Specification and Variable Description

3.1. Model Construction

In the existing research, technology spillover production is usually described by a Cobb–Douglas production function and a trans-log production function. In order to facilitate the inspection and research needs, we established a C–D type green technology spillover effect model:

$$\mathrm{GT_{it}} = \mathrm{f(GF_{it}, RIC_{it}, IMS_{it}, OFDIS_{it}, IFDIS_{it})} \quad (1)$$

We then took logarithms on both sides of formula (1) to alleviate the heteroscedasticity and multicollinearity problems of the econometric model and to visually display the elastic coefficient relationship between the variables, and we derived the following baseline linear model:

$$\mathrm{LnGT_{it}} = \alpha_0 + \alpha_1\mathrm{LnGF_{it}} + \alpha_2\mathrm{LnRIC_{it}} + \alpha_3\mathrm{LnIMS_{it}} + \alpha_4\mathrm{LnOFDIS_{it}} + \alpha_5\mathrm{LnIFDIS_{it}} + \varepsilon_{it} \quad (2)$$

In order to further examine the impact of the interaction of green finance, international technology spillovers, and regional innovation capabilities on green technology innovation, we introduced the interaction term into the model:

$$\begin{aligned}\mathrm{LnGT_{it}} = {} & \alpha_0 + \alpha_1\mathrm{LnGF_{it}} + \alpha_2\mathrm{LnRIC_{it}} + \alpha_3\mathrm{LnIMS_{it}} + \alpha_4\mathrm{LnOFDIS_{it}} + \alpha_5\mathrm{LnIFDIS_{it}} \\ & + \alpha_6\mathrm{LnGF_{it}} \times \mathrm{LnRIC_{it}} + \alpha_7\mathrm{LnIMS_{it}} \times \mathrm{LnRIC_{it}} \\ & + \alpha_8\mathrm{LnOFDIS_{it}} \times \mathrm{LnRIC_{it}} + \alpha_9\mathrm{LnIFDIS_{it}} \times \mathrm{LnRIC_{it}} + \varepsilon_{it}\end{aligned} \quad (3)$$

where $\mathrm{LnGT_{it}}$ is the green technology innovation of province t in year i in China; $\mathrm{LnGF_{it}}$ is the green finance of province t in year i in China; $\mathrm{LnRIC_{it}}$ is the regional innovation capability; $\mathrm{LnIMS_{it}}$ is the import trade technology spillover; $\mathrm{LnOFDIS_{it}}$ is the OFDI technology spillover; $\mathrm{LnIFDIS_{it}}$ is the IFDI technology spillover; and ε_{it} is the error term.

3.2. Variable Description and Data Source

3.2.1. Green Technology Innovation

The green patent application data directly reflect green technology innovation [47]. We therefore used the number of green patent applications as a proxy indicator.

3.2.2. Green Finance

This study followed the method described in Li et al. [48]. In brief, we calculated the comprehensive evaluation indicators of green finance based on four dimensions: green credit, green securities, green insurance, and green investment.

3.2.3. Regional Innovation Capability

This paper used the regional innovation capability index provided by the "Report on China's Regional Innovation Capability" as a proxy indicator.

3.2.4. Green International Technology Spillover

This paper drew on the method used by Lichtenberg et al. [49] to measure the technological spillover effects of various channels (see equations 4–6).

The green international technology spillover (IMS_{it}) from the import channel was calculated as follows:

$$IMS_{it} = \frac{IM_{it}}{IM_t} \sum_{j=1}^{n} \left(\frac{EX_{jt}}{GDP_{jt}} \times ES_{jt}\right) \tag{4}$$

where IMS_{it} is the green international technology spillover generated through the import channel in province i in year t; ES_{jt} is the number of green patents in country j in year t; $\frac{EX_{jt}}{GDP_{jt}}$ is the proportion of country j's exports to its GDP in year t; and $\frac{IM_{it}}{IM_t}$ is the proportion of imports of goods in province i in the whole country.

The following formula was used to calculate the green international technology spillover ($IFDIS_{it}$) from the IFDI channel:

$$IFDIS_{it} = \frac{IFDI_{it}}{IFDI_t} \sum_{j=1}^{n} \left(\frac{IFDI_{jt}}{GDP_{jt}} \times ES_{jt}\right) \tag{5}$$

where $IFDIS_{it}$ is the green international technology spillover generated by IFDI in province i in year t; $\frac{IFDI_{jt}}{GDP_{jt}}$ is the proportion of investment in country j in year t (relative to its GDP); $\frac{IFDI_{it}}{IFDI_t}$ is the proportion of foreign capital utilized in province i in year t.

The green international technology spillover ($OFDIS_{it}$) from the OFDI channel was calculated as follows:

$$OFDIS_{it} = \frac{OFDI_{it}}{OFDI_t} \sum_{j=1}^{n} \left(\frac{OFDI_{jt}}{GDP_{jt}} \times ES_{jt}\right) \tag{6}$$

where $OFDIS_{it}$ is the green international technology spillover generated by OFDI in province i in year t; $\frac{OFDI_{jt}}{GDP_{jt}}$ is the ratio of China's investment in country j in year t (relative to its GDP); and $\frac{OFDI_{it}}{OFDI_t}$ is the non-financial foreign investment by province i in year t. The amount of direct investment accounts for the proportion of the whole country.

Due to data availability, this study only used samples collected in 30 Chinese provinces (autonomous regions and municipalities) from 2003 to 2019; data from Tibet, Hong Kong, Macao, or Taiwan were not included. Furthermore, we performed logarithmic processing on all the variables to mitigate the heteroscedasticity and multicollinearity problems in the econometric models and to visualize the elastic coefficient relationships among the variables. The basic summary statistics included the mean, standard deviation, and the minimum and maximum value for each variable (see Table 1).

Table 1. Basic statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
LnGT	510	2.750	0.791	0	4.509
LnGF	510	-0.892	0.218	-1.379	-0.101
LnRIC	510	1.439	0.142	1.186	1.775
LnIMS	510	-4.292	0.754	-6.399	-2.161
LnOFDIS	510	-2.781	1.069	-6	0.189
LnIFDIS	510	-2.679	0.712	-5.735	-1.309

Note: Dates are drawn from the China Statistical Yearbook (2003–2019), Statistical Bulletin of China's Outward Direct Investment (2003–2019), EPS China data, UN Comtrade, World Bank, and OECD.Stat.

4. Findings and Discussions

4.1. Baseline Results and Moderating Effect Results

To assure the robustness of the regression analysis, we added the variables of interest to the model one at a time. Table 2 shows that adding explanatory variables did not significantly change the coefficients, signs, and significance of each variable, indicating that our results are stable. The results in column 5 of Table 2 show that green finance, regional innovation capability, import trade, and OFDI have all significantly promoted China's regional green technology innovation during the study period (verifying hypotheses H1a, H2, and H4). The elasticity coefficient of regional innovation ability (1.002 at most) indicates that a 1% increase in regional innovation ability promotes green technology innovations by 1.002%. However, our analysis also demonstrates that IFDI inhibited regional green technology innovation (verifying Hypothesis H3b), a result supported by Behera and Sethi [50]. In addition, the regression results of the interaction term in columns 6–9 show that the interaction of green finance, international technology spillovers, and regional innovation capabilities promotes green technology innovation (verifying hypotheses H1b and H5). The reasons for this observation may be the following: (1) Green finance not only provides financing support for green industries and alleviates the financing difficulties green technologies face, it also raises the financing threshold for "highly polluting" enterprises. It thereby forces polluting enterprises to actively develop and introduce cleaner production technologies and provides strong support for the improvement of regional innovation capabilities and green technology innovation [51]. (2) In order to obtain specific trade goods, developed countries often provide support, such as key technologies and equipment Ref. [44]. In addition, as China is a major import trade country, enterprises can introduce environmentally friendly products with high technological content and then promote regional green technology innovation through learning and absorption. (3) The host country acquires and introduces green technologies by setting up subsidiaries in developed countries, and the exchange of personnel and technology between the parent company and its subsidiaries provides technical and talent support for the parent company's green technology innovation. (4) China's IFDI structure is still dominated by resource- and labor-intensive industries, which have so far not stimulated significant knowledge and technology spillovers [52]. In addition, foreign-funded enterprises do not necessarily introduce their cutting-edge technologies to the host country because they wish to maintain a competitive advantage. IFDI therefore does not directly promote green technology innovation in China. However, the host country can digest and assimilate the acquired technology and transform it externally into new usable knowledge [53]. The interaction between IFDI and regional innovation capabilities can thus stimulate green technology innovation. (5) Regional innovation capability is an important basis for a region's independent R&D and foreign technology absorption capabilities. China is also increasingly focusing on innovation capabilities and has declared its strategic goal of building an "innovative country". By continuously improving its regional innovation capabilities, the country provides effective support for green technology innovation.

Table 2. Baseline and moderating effect results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LnGF	0.914*** (5.16)	0.692*** (4.04)	0.647*** (3.77)	0.710*** (4.12)	0.723*** (4.20)	0.790*** (4.21)	1.009*** (5.62)	0.916*** (4.89)	0.816*** (4.85)
LnRIC		1.148*** (7.09)	1.109*** (6.84)	0.984*** (5.86)	1.002*** (5.97)	0.983*** (5.82)	0.964*** (5.87)	0.958*** (5.71)	0.994*** (6.09)
LnIMS			0.100** (2.23)	0.093** (2.08)	0.116** (2.49)	0.105** (2.20)	0.113** (2.49)	0.092* (1.95)	0.096** (2.11)
LnOFDIS				0.029** (2.65)	0.029** (2.64)	0.028** (2.55)	0.023** (2.16)	0.040** (3.43)	0.024** (2.31)
LnIFDIS					-0.047* (-1.78)	-0.046* (-1.73)	-0.058** (-2.22)	-0.051* (-1.93)	0.0001 (0.00)
$LnGF_{it} \times LnRIC_{it}$						0.730** (2.13)			
$LnIMS_{it} \times LnRIC_{it}$							0.617*** (4.61)		
$LnOFDIS_{it} \times LnRIC_{it}$								0.135** (2.52)	
$LnIFDIS_{it} \times LnRIC_{it}$									0.726*** (5.19)
Constant	2.826*** (14.48)	0.954** (2.96)	1.341*** (3.67)	1.621*** (4.29)	1.574*** (4.17)	1.945*** (34.90)	1.927*** (40.56)	1.944*** (39.54)	1.891*** (39.78)
Adj-R2	0.949	0.954	0.955	0.956	0.956	0.956	0.958	0.956	0.958
Cross-section fixed	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period fixed	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	510	510	510	510	510	510	510	510	510

Note: T-values are shown in parentheses; * 10% significant level; ** 5% significant level; *** 1% significant level.

4.2. Mediating Effect Analysis

In order to further explore the mechanism underlying the impact of green finance and international technology spillovers on green technology innovation, the following mediation effect model was constructed:

$$LnGT_{it} = a_0 + a_5 LnRIC_{it} + \varepsilon_{it} \quad (7)$$

$$LnRIC_{it} = b_0 + b_1 LnGF_{it} + b_2 LnIMS_{it} + b_3 LnOFDIS_{it} + b_4 LnIFDIS_{it} + \varepsilon_{it} \quad (8)$$

$$LnGT_{it} = c_0 + c_1 LnGF_{it} + c_2 LnRIC_{it} + c_3 LnIMS_{it} + c_4 LnOFDIS_{it} + c_5 LnIFDIS_{it} + \varepsilon_{it} \quad (9)$$

The results in Table 3 show that green finance, import trade, OFDI, and IFDI all positively impact regional innovation capabilities. This confirms that green finance, import trade, OFDI, and IFDI contribute to green technology innovation by promoting regional innovation capacity. The possible reasons for this observation are that (1) technology innovation projects have higher risks and longer cycles than general investment projects, and green finance improves regional innovation capacity and reduces the risk of innovation projects. (2) International trade can promote technology exchange between trading parties, and developing countries can improve regional innovation capacity through technology spillover from import trade. In addition, in order to adapt to the increasingly fierce competition in the international market, Chinese enterprises can increase their R&D investment or technology introduction to improve their core competitiveness, which in turn promotes regional innovation capacity. (3) Reverse technology spillovers from OFDI can bring advanced production technology and management experience to the home country and thereby provide technological and knowledge support to improve its innovation capacity [54]. (4) IFDI, as an important driver of technological progress, contributes to the improvement of regional innovation capacity, mainly through technology spillovers, human capital spillovers, industrial structure improvements, and agglomeration effects [55], which in turn promotes the growth of green technologies.

Table 3. Mediating effect results.

Variable	(1)	(2)	(3)	(4)	(5)
LnGF	0.194*** (4.00)				0.723*** (4.20)
LnRIC					1.002*** (5.97)
LnIMS		0.036** (2.81)			0.116** (2.49)
LnOFDIS			0.018*** (6.00)		0.029** (2.64)
LnIFDIS				0.016** (2.19)	-0.047* (-1.78)
Constant	1.631*** (30.61)	1.457*** (161.31)	1.461*** (71.42)	1.557*** (31.52)	1.574*** (4.17)
Adj-R2	0.176	0.209	0.157	0.162	0.956
Cross-section fixed	YES	YES	YES	YES	YES
Period fixed	YES	YES	YES	YES	YES
N	510	510	510	510	510

Note: T-values are shown in parentheses; * 10% significant level; ** 5% significant level; *** 1% significant level.

4.3. Spatial Spillover Effect Analysis

4.3.1. Spatial Econometric Model Setting

According to the Coe–Helpman model, a country's (or a region's) technological progress is influenced by import trade, FDI, and OFDI. In addition, we constructed the following spatial Durbin model, built on the spatial interaction model of Hu et al. [56], by relaxing the linearity assumptions inherent in the C–H model based on the results of the spatial effects model test:

$$\begin{aligned} \mathrm{LnGT}_{it} = \beta_0 + \rho \sum_{j=1}^{n} W_{ij}\,\mathrm{LnGT}_{it} + \beta_1 \mathrm{LnGF}_{jt} + \beta_2\,\mathrm{LnRIC}_{it} + \beta_3 \mathrm{LnIMS}_{it} \\ + \beta_4 \mathrm{LnOFDIS}_{it} + \beta_5 \mathrm{LnIFDIS}_{it} + \theta_1 W_{ij} \mathrm{LnGF}_{it} + \theta_2 W_{ij} \mathrm{LnRIC}_{it} \\ + \theta_3 W_{ij} \mathrm{LnIMS}_{it} + \theta_4 W_{ij} \mathrm{LnOFDIS}_{it} + \theta_5 W_{ij} \mathrm{LnIFDIS}_{it} + \varepsilon_{it} \end{aligned} \tag{10}$$

W is the spatial weight matrix: we used a geographic weight matrix (W1) and an economic–geographic weight matrix (W2); ϱ is the spatial autoregressive coefficient; $[\beta_1 - \beta_5]$ represents the spatial spillover coefficient of each explanatory variable; $[\theta_1 - \theta_5]$ is the respective parameter to be estimated; and ε_{it} is the error term.

4.3.2. Regression Results of Spatial Spillover Effects

Spatial Autocorrelation Test

Table 4 lists the results of Moran's I and Geary's C indices tests based on W1 and W2. The Moran's I and Geary's C indices are greater than 0, which led us to reject the original hypothesis of no spatial correlation. These results show that green technology innovation has a significant spatial spillover effect and suggest a spatial econometric analysis.

Table 4. Results of Moran's I and Geary's C indices tests.

Years	Geographic Weight Matrix(w1)				Economic–Geographic Weight Matrix(w2)			
	Moran's I	p-Value	Geary's C	p-Value	Moran's I	p-Value	Geary's C	p-Value
2003	0.089	0.152	0.802	0.082	0.054	0.036	0.902	0.047
2004	0.197	0.026	0.697	0.018	0.085	0.007	0.867	0.013
2005	0.14	0.078	0.752	0.033	0.116	0.001	0.83	0.001
2006	0.176	0.043	0.738	0.025	0.118	0.001	0.821	0.001
2007	0.215	0.02	0.681	0.011	0.12	0.001	0.838	0.002
2008	0.183	0.039	0.733	0.023	0.114	0.002	0.831	0.001
2009	0.208	0.025	0.726	0.02	0.114	0.002	0.835	0.001
2010	0.192	0.032	0.746	0.03	0.107	0.002	0.837	0.002
2011	0.212	0.021	0.728	0.025	0.097	0.004	0.848	0.004
2012	0.22	0.019	0.722	0.019	0.102	0.003	0.845	0.002
2013	0.198	0.03	0.76	0.035	0.096	0.005	0.845	0.002
2014	0.232	0.015	0.706	0.014	0.086	0.008	0.865	0.007
2015	0.252	0.01	0.683	0.008	0.105	0.003	0.852	0.003
2016	0.289	0.005	0.663	0.005	0.104	0.003	0.858	0.004
2017	0.276	0.006	0.697	0.01	0.092	0.006	0.87	0.008
2018	0.294	0.004	0.677	0.007	0.117	0.001	0.841	0.002
2019	0.26	0.009	0.701	0.012	0.121	0.001	0.83	0.001

Model Test

Table 5 lists the spatial spillover effect regression results. The LR and Wald test results indicate that the SDM model cannot degenerate into a SAR or SEM model. In addition, the Hausman test results indicate that the original hypothesis of random effects needs to be rejected. This analysis suggests the need for a fixed-effects SDM model.

Analysis of Spatial Spillover Effect Results

A comparison of the results of the spatial panel model and the ordinary linear OLS regression yields consistency in the signs and significance of all the coefficients, indicating that the results of the spatial panel model are robust. Second, ϱ is significantly positive at the 1% level in both the W1 and the W2 weight matrix, illustrating a significant spatial interaction of regional green technology innovation. Third, the largest value of ϱ was observed in the W2 weight matrix, which suggests that the economic–geographic weight matrix has a greater spatial effect than the matrix that only considers geographic factors. Moreover, each 1% increase in green technology innovations in a region induces a 0.668% increase in innovations in regions with near geographic–economic distance. To further explore these findings, we performed a spatial effect decomposition analysis based on the regression results of the W2 weight matrix.

Table 5. Spatial spillover effect regression results.

Variable	OLS	W1	W2
ρ		0.575***	0.668***
		(11.82)	(12.12)
LnGF	0.723***	1.003***	0.838***
	(4.20)	(5.83)	(4.90)
LnRIC	1.002***	0.926***	0.866***
	(5.97)	(5.75)	(5.24)
LnIMS	0.116**	0.046	0.085*

	(2.49)	(1.05)	(1.92)
LnOFDIS	0.029**	0.038***	0.034***
	(2.64)	(3.64)	(3.34)
LnIFDIS	-0.047*	-0.045*	-0.047*
	(-1.78)	(-1.83)	(-1.93)
WLnGF		0.306	0.113
		(1.11)	(0.36)
WLnRIC		-0.537	-0.117
		(-1.64)	(-0.28)
WLnIMS		-0.193***	-0.163**
		(-3.35)	(-2.45)
WLnOFDIS		-0.099***	-0.108**
		(-4.21)	(-2.96)
WLnIFDIS		0.122**	0.101*
		(2.51)	(1.82)
Constant	1.574***		
	(4.17)		
R^2	0.956	0.812	0.817
Hausman test	78.22	27.49	60.73
	[0.02]	[0.00]	[0.00]
Log likelihood		337.125	349.691
LR spatial lag test		38.44	19.21
		[0.00]	[0.00]
LR spatial error test		96.81	65.19
		[0.00]	[0.00]
Wald spatial lag test		38.56	18.90
		[0.00]	[0.00]
Wald spatial error test		59.73	34.87
		[0.00]	[0.00]
Cross-section fixed	Yes	Yes	Yes
Period fixed	Yes	Yes	Yes
N	510	510	510

Note: Z-values and t-values are shown in parentheses; P-values are shown in square brackets; * 10% significant level; ** 5% significant level; *** 1% significant level; W1 is the geographic weight matrix; W2 is the economic–geographic weight matrix.

Spatial Effect Decomposition Analysis

Table 6 displays the decomposition results of the direct and indirect effects of the SDM model based on the W2 weight matrix. The direct effect results show that the coefficients of green finance, regional innovation capacity, import trade, and OFDI are all significantly positive, indicating that all four factors significantly promote regional green technology innovation. However, this is not the case for IFDI. In addition, the coefficients and signs of the variables are consistent with the linear OLS results, which again proves the robustness of our results.

The results of the indirect effect analysis show that green finance available in one region can also promote green technology innovations in other regions. However, import trade and OFDI in one region do not stimulate innovations in other regions. The reasons for this observation may be that (1) higher geographical costs increase transaction costs, and neighboring regions can therefore not benefit from technology spatial spillover effects. (2) As the international intellectual property protection system becomes stricter and developed countries strengthen the protection of their advanced technologies, the cost of introducing such technologies in developing countries is rising. In addition, enterprises will adopt temporary "technology locks" to maintain their competitive advantage, which can lead to negative spillover effects on other regions Ref. [13].

Table 6. Spatial spillover effects under W2 weight matrix.

Variable	W2 weight matrix		
	Direct Effects	Indirect Effects	Total Effects
LnGF	0.906***	1.972***	2.878***
	(5.25)	(3.72)	(5.35)
LnRIC	0.904***	1.427	2.331*
	(5.54)	(1.08)	(1.72)
LnIMS	0.079*	-0.315*	-0.236
	(1.90)	(-1.95)	(-1.44)
LnOFDIS	0.026**	-0.245**	-0.219*
	(2.35)	(-2.04)	(-1.74)
LnIFDIS	-0.041***	0.209	0.168
	(-1.72)	(1.30)	(1.00)

Note: Z-values are shown in parentheses; * 10% significant level; ** 5% significant level; *** 1% significant level.

4.4. Robustness Tests

(1) To ensure the accuracy of the estimation results, this study used two-stage least squares (2SLS) to address possible endogeneity issues. According to Jing and Zhang [57], explanatory variables related to foreign openness (import trade, OFDI, and IFDI) are considered endogenous variables with their first-order and second-order lags as instrumental variables. The results are depicted in column 1 of Table 7.

(2) We referred to Lu et al. [58] to add macro control variables for robustness testing: human capital (proportion of higher education) and real GDP (logarithmic in 2000 as the base period) (see column 2 of Table 7).

(3) R&D input (in logarithmic form) was used as a proxy variable for regional innovation capacity (see column 3 of Table 7).

The results of the under-identification and the weak instrumental test indicated that the instrumental variables were correlated with the endogenous variables and that there were no weak instrumental variables (column 1 of Table 7). The p-value of the Sargan test was greater than 0.1, indicating that the selected instrumental variables were exogenous and that our panel IV estimation is valid. Furthermore, we compared the regression results in columns (1)-(3) of Table 7 with the baseline regression results and observed that the regression coefficients of the highlighted green technology innovation variables only changed in magnitude and significance. This demonstrates once more that our results are robust and reliable.

Table 7. Robustness test results.

Variable	(1)	(2)	(3)
LnGF	0.911***	0.650***	0.622***
	(5.52)	(3.77)	(3.49)
LnRIC	0.904***	0.837***	0.423***
	(5.55)	(4.96)	(5.49)
LnIMS	0.098*	0.075*	0.117**
	(1.70)	(1.72)	(2.49)
LnOFDIS	0.044*	0.026**	0.032**
	(1.78)	(2.41)	(2.95)
LnIFDIS	-0.017	-0.058**	-0.065***
	(-0.48)	(-2.20)	(-2.41)

HR		0.251** (2.35)	
LnPGDP		0.831*** (3.33)	
Constant	0.677 (1.55)	-1.102 (-1.10)	2.249*** (7.29)
R^2	0.956	0.958	0.955
Cross-section fixed	YES	YES	YES
Period fixed	YES	YES	YES
Under-identification test	120.732 [0.0000]		
Weak identification test	26.761		
Sargan statistic	2.569 [0.463]		
N	450	510	510

Note: T-values are shown in parentheses; P-values are shown in square brackets; * 10% significant level; ** 5% significant level; *** 1% significant level.

5. Conclusions

This study uses data from 30 provinces in China from 2003 to 2019 as the research sample. We used a fixed-effects model to analyze the impact of green finance and international technology spillovers on green technology innovation. In addition, the interaction term of green finance, international technology spillovers, and regional innovation capacity was introduced to explore the combined impact of the three factors on green technology innovation. Furthermore, the mechanism was tested using a mediating effect model with regional innovation capacity as the mediating variable. Finally, we assessed the spatial spillover effect of green technology innovation using the spatial Durbin model. We found that (1) green finance, import trade, OFDI, and regional innovation capacity can promote regional green technology innovation, while IFDI suppresses such effects. (2) The interaction of green finance, international technology spillovers, and regional innovation capacity positively impacts green technology innovation. (3) Green finance and international technology spillovers can promote green technology innovation by increasing regional innovation capacity. (4) Green technology innovation does lead to spatial spillover effects, and innovations in one region can promote the growth of green technologies in neighboring regions.

Based on the above findings, this paper puts forward the following recommendations. First, green finance needs to be developed. The Chinese government should strengthen its support for green finance, actively attract private capital, and leverage it to invest in green projects. Stronger financial guarantees for green industries and technology innovations through green finance should be provided, while attention needs to be paid to the spatial spillover effect of green finance, to the strengthening of inter-regional exchanges and cooperation, and to cross-regional green finance policies. Second, China needs to open up further to the outside world to benefit from international technology spillover effects. The government should strengthen policy guidance, encourage imports of high-tech and environment-friendly industries, expand trade cooperation with technologically developed countries, and increase the pulling effect of imported technology spillovers on China's regional green innovation; furthermore, polluting enterprises need to be encouraged to participate in OFDI, and technological exchanges and cooperation between such enterprises and foreign enterprises need to be promoted. Moreover, technology-acquiring OFDI needs to be increased to promote regional green technology innovation. The environmental threshold for introducing foreign investment needs to be raised, and the flow of foreign investment into technology R&D and environmental protection industries needs to be guided. Third, the government should further improve regional innovation capacities, promote the absorption and diffusion of international technology spillovers, and provide technical and talent support to green technologies. Fourth, attention needs to be paid to the spatial spillover effect of green technology innovation. Strengthening the dissemination and diffusion of green technologies in neighboring regions will also stimulate green technology innovations in China.

This research complements the existing literature concerning the comprehensive impact of green finance and international technology spillovers on green technology innovation. However, it is somewhat limited. First, this study does not analyze China by dividing it into different regions. There are significant economic, cultural, and institutional differences among the eastern, central, and western regions of China, which need to be further explored in future studies. In addition, we focused only on China. Other developing countries may have different results, and future studies may focus on other countries.

Author Contributions: Conceptualization, P.C.; data curation, X.W.; methodology, X.W.; writing—original draft, P.C.; writing—review & editing, B.C; project administration, X.H.; funding acquisition, X.H. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the high level talent fund project of Henan University of Technology, 2016SBS005; Fund Project of Henan University of Technology, 2018SKPY02.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available from the authors upon request.

Acknowledgments: The authors would like to express their gratitude to the JBNU writing center, which supports your research and publications, for the expert linguistic services provided.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Dong, X.; Fu, W.; Yang, Y.; Liu, C.; Xue, G. Study on the Evaluation of Green Technology Innovation Efficiency and Its Influencing Factors in the Central Plains City Cluster of China. *Sustainability* **2022**, *14*, 11012. https://doi.org/10.3390/su141711012.
2. Lee, S.-H.; Park, S.; Kim, T. Review on investment direction of green technology R & D in Korea. *Renew. Sustain. Energy Rev.* **2015**, *50*, 186–193. https://doi.org/10.1016/j.rser.2015.04.158.
3. Braun, E.; Wield, D. Regulation as a means for the social control of technology. *Technol. Anal. Strateg. Manag.* **1994**, *6*, 259–272. https://doi.org/10.1080/09537329408524171.
4. Yu, C.-H.; Wu, X.; Zhang, D.; Chen, S.; Zhao, J. Demand for green finance: Resolving financing constraints on green innovation in China. *Energy Policy* **2021**, *153*, 112255. https://doi.org/10.1016/j.enpol.2021.112255.
5. Fang, Y.; Shao, Z. Whether Green Finance Can Effectively Moderate the Green Technology Innovation Effect of Heterogeneous Environmental Regulation. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3646. https://doi.org/10.3390/ijerph19063646.
6. Coe, D.T.; Helpman, E. International R&D spillovers. *Eur. Econ. Rev.* **1995**, *39*, 859–887. https://doi.org/10.1016/0014-2921(94)00100-e.
7. Lichtenberg, F.R.; van Pottelsberghe de la P, B. International R & D Spillovers: A Re-Examination (No. w5668). *Natl. Bur. Econ. Res working paper.* **1996**, No.w5668. https://doi.org/10.3386/w5668.
8. Gries, T.; Grundmann, R.; Palnau, I.; Redlin, M. Technology diffusion, international integration and participation in developing economies-a review of major concepts and findings. *Int. Econ. Econ. Policy* **2018**, *15*, 215–253.
9. Lin, Y.; Zhang, P. Appropriate technology, technology choice and economic growth in developing countries. *China Econ. Q.* **2006**, *3*, 985–1006.
10. Wang, T.; Ding, Y.; Gao, K.; Sun, R.; Wen, C.; Yan, B. Toward Sustainable Development: Unleashing the Mechanism Among International Technology Spillover, Institutional Quality, and Green Innovation Capability. *Front. Psychol.* **2022**, Jul 29, *13*, 912355. https://doi.org/10.3389/fpsyg.2022.912355.
11. Peng, B.; Zheng, C.; Wei, G.; Elahi, E. The cultivation mechanism of green technology innovation in manufacturing industry: From the perspective of ecological niche. *J. Clean. Prod.* **2020**, *252*, 119711. https://doi.org/10.1016/j.jclepro.2019.119711.
12. Zhang, Y.; Zhao, F. Research on the impact of international technology spillovers and absorptive capacity on independent innovation in high-tech industries. *Financ. Res.* **2017**, *43*, 94–106.
13. Liu, Z.; Zhang, X.; Yang, L.; Shen, Y. Access to Digital Financial Services and Green Technology Advances: Regional Evidence from China. *Sustainability* **2021**, *13*, 4927. https://doi.org/10.3390/su13094927.

14. Jiang, S.; Liu, X.; Liu, Z.; Shi, H.; Xu, H. Does green finance promote enterprises' green technology innovation in China?. *Front. Environ. Sci.* **2022**, *10*, 981013. https://doi.org/10.3389/fenvs.2022.981013.
15. Mngumi, F.; Shaorong, S.; Shair, F.; Waqas, M. Does green finance mitigate the effects of climate variability: Role of renewable energy investment and infrastructure. *Environ. Sci. Pollut. Res.* **2022**, *29*, 59287–59299. https://doi.org/10.1007/s11356-022-19839-y.
16. Lee, C.-C.; Lee, C.-C. How does green finance affect green total factor productivity? Evidence from China. *Energy Econ.* **2022**, *107*, 105863. https://doi.org/10.1016/j.eneco.2022.105863.
17. Lv, C.; Shao, C.; Lee, C.-C. Green technology innovation and financial development: Do environmental regulation and innovation output matter?. *Energy Econ.* **2021**, *98*, 105237. https://doi.org/10.1016/j.eneco.2021.105237.
18. Hong, M.; Li, Z.; Drakeford, B. Do the Green Credit Guidelines Affect Corporate Green Technology Innovation? Empirical Research from China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1682. https://doi.org/10.3390/ijerph18041682.
19. Guo, Q.; Zhou, M.; Liu, N.; Wang, Y. Spatial Effects of Environmental Regulation and Green Credits on Green Technology Innovation under Low-Carbon Economy Background Conditions. *Int. J. Environ. Res. Public Health* **2019**, *16*, 3027. https://doi.org/10.3390/ijerph16173027.
20. Bai, J.; Chen, Z.; Yan, X.; Zhang, Y. Research on the impact of green finance on carbon emissions: Evidence from China. *Econ. Res. Ekon. Istraživanja* **2022**, *35*(1), 6965–6984. https://doi.org/10.1080/1331677x.2022.2054455.
21. Huang, Y.; Chen, C.; Lei, L.; Zhang, Y. Impacts of green finance on green innovation: A spatial and nonlinear perspective. *J. Clean. Prod.* **2022**, *365*, 132548. https://doi.org/10.1016/j.jclepro.2022.132548.
22. Hao, Y.; Ba, N.; Ren, S.; Wu, H. How does international technology spillover affect China's carbon emissions? A new perspective through intellectual property protection. *Sustain. Prod. Consum.* **2021**, *25*, 577–590. https://doi.org/10.1016/j.spc.2020.12.008.
23. Pathak, S.; Xavier-Oliveira, E.; Laplume, A.O. Influence of intellectual property, foreign investment, and technological adoption on technology entrepreneurship. *J. Bus. Res.* **2013**, *66*, 2090–2101. https://doi.org/10.1016/j.jbusres.2013.02.035.
24. Zhou, Y.; Jiang, J.; Ye, B.; Hou, B. Green spillovers of outward foreign direct investment on home countries: Evidence from China's province-level data. *J. Clean. Prod.* **2019**, *215*, 829–844. https://doi.org/10.1016/j.jclepro.2019.01.042.
25. Gao, Y.; Tsai, S.-B.; Xue, X.; Ren, T.; Du, X.; Chen, Q.; Wang, J. An Empirical Study on Green Innovation Efficiency in the Green Institutional Environment. *Sustainability* **2018**, *10*, 724. https://doi.org/10.3390/su10030724.
26. Qin, B.; Gao, Y.; Ge, L.; Zhu, J. The Influence Mechanism of Outward FDI Reverse Technology Spillovers on China's Green Innovation. *Technol. Econ. Dev. Econ.* **2022**, 1–32. https://doi.org/10.3846/tede.2022.17930.
27. Pan, X.; Li, M.; Wang, M.; Chu, J.; Bo, H. The effects of outward foreign direct investment and reverse technology spillover on China's carbon productivity. *Energy Policy* **2020**, *145*, 111730. https://doi.org/10.1016/j.enpol.2020.111730.
28. Luo, Y.; Salman, M.; Lu, Z. Heterogeneous impacts of environmental regulations and foreign direct investment on green innovation across different regions in China. *Sci. Total. Environ.* **2021**, *759*, 143744. https://doi.org/10.1016/j.scitotenv.2020.143744.
29. Zhu, S.; Ye, A. Does the Impact of China's Outward Foreign Direct Investment on Reverse Green Technology Process Differ across Countries?. *Sustainability* **2018**, *10*, 3841. https://doi.org/10.3390/su10113841.
30. Liu, Z.; Liu, G.; Han, X.; Chen, Y. Green Technology of Foreign Direct Investment on Public Health: Evidence from China. *Sustainability* **2022**, *14*, 13526. https://doi.org/10.3390/su142013526.
31. Castellani, D.; Marin, G.; Montresor, S.; Zanfei, A. Greenfield foreign direct investments and regional environmental technologies. *Res. Policy* **2022**, *51*, 104405. https://doi.org/10.1016/j.respol.2021.104405.
32. Hu, J.; Wang, Z.; Lian, Y.; Huang, Q. Environmental Regulation, Foreign Direct Investment and Green Technological Progress—Evidence from Chinese Manufacturing Industries. *Int. J. Environ. Res. Public Health* **2018**, *15*, 221. https://doi.org/10.3390/ijerph15020221.
33. Song, M.; Tao, J.; Wang, S. FDI, technology spillovers and green innovation in China: Analysis based on Data Envelopment Analysis. *Ann. Oper. Res.* **2015**, *228*, 47–64. https://doi.org/10.1007/s10479-013-1442-0.
34. Wang, Y.; Xie, L.; Zhang, Y.; Wang, C.; Yu, K. Does FDI Promote or Inhibit the High-Quality Development of Agriculture in China? An Agricultural GTFP Perspective. *Sustainability* **2019**, *11*, 4620. https://doi.org/10.3390/su11174620.
35. Pandeng, S.; Lin, H.E.; Jianlei, Z.; Longdi, C. The impact of technological innovation from domestic innovation, import and FDI channels on carbon dioxide emissions of China's textile industry. Industria Textila 2022, 73, 426-431, doi:10.35530/IT.073.04.202149.
36. Arif, U.; Arif, A.; Khan, F.N. Environmental impacts of FDI: Evidence from heterogeneous panel methods. *Environ. Sci. Pollut. Res.* **2022**, *29*, 23639–23649. https://doi.org/10.1007/s11356-021-17629-6.
37. Hu, J.; Wang, Z.; Huang, Q.; Zhang, X. Environmental Regulation Intensity, Foreign Direct Investment, and Green Technology Spillover—An Empirical Study. *Sustainability* **2019**, *11*, 2718. https://doi.org/10.3390/su11102718.
38. Cheng, Z.; Li, W. Independent R and D, Technology Introduction, and Green Growth in China's Manufacturing. *Sustainability* **2018**, *10*, 311. https://doi.org/10.3390/su10020311.
39. Wang, M.; Zhang, X.; Hu, Y. The green spillover effect of the inward foreign direct investment: Market versus innovation. *J. Clean. Prod.* **2021**, *328*, 129501. https://doi.org/10.1016/j.jclepro.2021.129501.
40. Xu, S.; Li, Z. The Impact of Innovation Activities, Foreign Direct Investment on Improved Green Productivity: Evidence From Developing Countries. *Front. Environ. Sci.* **2021**, *9*, 635261. https://doi.org/10.3389/fenvs.2021.635261.

41. Zhang, S.; Collins, A.; Etienne, X.; Ding, R. The Environmental Effects of International Trade in China: Measuring the Mediating Effects of Technology Spillovers of Import Trade on Industrial Air Pollution. *Sustainability* **2021**, *13*, 6895. https://doi.org/10.3390/su13126895.
42. Li, K.-Y.; Gong, W.-C.; Choi, B.-R. The Influence of Trade and Foreign Direct Investment on Green Total Factor Productivity: Evidence from China and Korea. *J. Korea Trade* **2021**, *25*, 95–110. https://doi.org/10.35611/jkt.2021.25.2.95.
43. Huang, Y.; Pei, J. Imported intermediates, technology spillover, and green development: Evidence from Chinese firms. *Front. Environ. Sci.* **2022**, *10*, 909055. https://doi.org/10.3389/fenvs.2022.909055.
44. Wang, X.; Wang, L.; Wang, S.; Fan, F.; Ye, X. Marketisation as a channel of international technology diffusion and green total factor productivity: Research on the spillover effect from China's first-tier cities. *Technol. Anal. Strat. Manag.* **2021**, *33*, 491–504. https://doi.org/10.1080/09537325.2020.1821877.
45. Wang, M.; Li, Y.; Li, J.; Wang, Z. Green process innovation, green product innovation and its economic performance improvement paths: A survey and structural model. *J. Environ. Manag.* **2021**, *297*, 113282. https://doi.org/10.1016/j.jenvman.2021.113282.
46. Zhao, S.; Jiang, Y.; Wang, S. Innovation stages, knowledge spillover, and green economy development: Moderating role of absorptive capacity and environmental regulation. *Environ. Sci. Pollut. Res.* **2019**, *26*, 25312–25325. https://doi.org/10.1007/s11356-019-05777-9.
47. Wu, G.; Xu, Q.; Niu, X.; Tao, L. How Does Government Policy Improve Green Technology Innovation: An Empirical Study in China. *Front. Environ. Sci.* **2022**, *9*, 799794. https://doi.org/10.3389/fenvs.2021.799794.
48. Li, W.; Fan, J.; Zhao, J. Has green finance facilitated China's low-carbon economic transition?. *Environ. Sci. Pollut. Res.* **2022**, *29*, 57502–57515.
49. Lichtenberg, F.R.; De La Potterie, B.V.P. International R & D spillovers: A comment. *Eur. Econ. Rev.* **1998**, *42*, 1483–1491.
50. Behera, P.; Sethi, N. Nexus between environment regulation, FDI, and green technology innovation in OECD countries. *Environ. Sci. Pollut. Res.* **2022**, *29*, 52940–52953. https://doi.org/10.1007/s11356-022-19458-7.
51. Wang, G.; Li, S.; Yang, L. Research on the Pathway of Green Financial System to Implement the Realization of China's Carbon Neutrality Target. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2451. https://doi.org/10.3390/ijerph19042451.
52. Li, Y.; Wu, Y.; Chen, Y.; Huang, Q. The influence of foreign direct investment and trade opening on green total factor productivity in the equipment manufacturing industry. *Appl. Econ.* **2021**, *53*, 6641–6654. https://doi.org/10.1080/00036846.2021.1947961.
53. Qin, B.; Gai, Y.; Ge, L.; Sun, P.; Yu, Y.; Zheng, Y. FDI, Technology Spillovers, and Green Innovation: Theoretical Analysis and Evidence from China. *Energies* **2022**, *15*, 7497. https://doi.org/10.3390/en15207497.
54. Cheng, P.; Huan, X.; Choi, B. The Comprehensive Impact of Outward Foreign Direct Investment on China's Carbon Emissions. *Sustainability* **2022**, *14*, 16116. https://doi.org/10.3390/su142316116.
55. Chai, B.; Gao, J.; Pan, L.; Chen, Y. Research on the Impact Factors of Green Economy of China—From the Perspective of System and Foreign Direct Investment. *Sustainability* **2021**, *13*, 8741. https://doi.org/10.3390/su13168741.
56. Hu, Y.; Dai, X.; Zhao, L. Digital Finance, Environmental Regulation, and Green Technology Innovation: An Empirical Study of 278 Cities in China. *Sustainability* **2022**, *14*, 8652. https://doi.org/10.3390/su14148652.
57. Jing, W.; Zhang, L. Environmental regulation, economic opening and China's industrial green technology progress. *Econ. Res. J.* **2014**, *49*, 34–47.
58. Lu, N.; Wu, J.; Liu, Z. How Does Green Finance Reform Affect Enterprise Green Technology Innovation? Evidence from China. *Sustainability* **2022**, *14*, 9865. https://doi.org/10.3390/su14169865.