

Article

The Impact of Green Institutional Pressure from Local Governments on Corporate Innovation: An Empirical Evidence from Foreign-Invested Enterprises in China

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Abstract: The natural environment of the human world has been deteriorating over the past few decades, and policies to protect the environment are receiving increasing attention from governments worldwide. The question of how green institutional pressures from local governments impact corporate behaviors, especially innovation behaviors, is a critical issue. However, the link between local governments' institutional pressures and corporate innovative behaviors remains a matter of some dispute. This paper compiles data from foreign-invested enterprises in China, using the frequency of green development terms in the Chinese local governments' annual reports as a key variable, and discusses the influence of local governments' green institutional pressure on corporate innovation. The conclusions of this paper demonstrate that local governments' institutional pressure has a promoting effect on corporate innovation, while the home country's level of green knowledge reservoir has a negative moderating effect on this influence. Moreover, this conclusion exhibits heterogeneity across corporate nature, industry attributes, location characteristics, export experience and home country type.

Keywords: institutional pressure; corporate innovation; green knowledge of the home country; foreign-invested enterprises



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1. Introduction

In the past three decades, China's economy has experienced rapid development, and it has now become the world's second-largest economy and the second-largest energy-consuming country globally, with fossil fuel consumption accounting for the majority of its energy consumption. Currently, pollution caused by fossil fuel combustion constitutes the main contributor to air pollution in China [1]. At present, the level of pollution in China is serious, which directly constrains its future development and poses a direct threat to the health of the population. In view of the significant impact of pollution on people's lives and property, governments at all levels in China, especially the central government, have taken action. They have addressed environmental issues by enacting a series of laws and regulations, as well as implementing stricter enforcement measures [2].

In December 2005, the central government issued the "Decision of the State Council on Implementing the Scientific Outlook on Development and Strengthening Environmental Protection", which incorporated environmental protection in the cadre evaluation system to strengthen local environmental protection. Environmental performance was also included as one of the standards for the promotion of local cadres [3]. As local officials in China are often appointed by the higher level of government, the evaluation of cadres has a significant impact on the performance of local governments. In the past, the growth

of local GDP was the main criterion for evaluating the political ability of lower-level officials and their likelihood of promotion. At the current stage, incorporating environmental objectives into the evaluation system of local officials can provide new incentives for local environmental governance and law enforcement [4]. This is also reflected in the frequency of environmental keywords in government work reports.

At present, Chinese government work reports and other official documents have gradually become a focus of academic research [5–8]. Some studies have shown that the content of government work reports is generally consistent with the government's actions and goals [9,10]. This suggests that the frequency of environmental keywords appearing in government reports can be used to predict government actions and efforts in environmental protection, providing a new method for quantitatively studying government investment and efforts in environmental protection. In contrast to ordinary environmental regulations, the frequency of environmental protection keywords in local government reports has a more systemic and measurable characteristic.

The primary motivation for this paper stems from further contemplation of the theme of “the reaction of foreign enterprises to green pressure from the Chinese government”. In a country such as China, which has a large economy and significant government power, does the green pressure from local governments influence the research and development activities of foreign-invested enterprises? Does this impact vary depending on the home country's green knowledge of the foreign-invested enterprises? Inspired by these motivations, the purposes of this paper focus on the impact of local governments' green attention on the innovation of foreign-invested enterprises at the level of Chinese prefecture-level cities. For this paper, we employed common empirical research methods in economics, used ordinary least squares (OLS) for the baseline regression, instrumental variables (IV) and two-stage least squares (2SLS) for treatment of endogeneity and simultaneously conducted a series of moderation effect and heterogeneity tests. The green attention of local governments can be described by the frequency of environmental keywords in government work reports. Previous studies have mainly focused on the relationship between a specific government strategy or policy and enterprise performance [11], with little attention paid to the impact of government macro-strategic policies on corporate innovation. In addition, although local government work reports make up the vast majority of the government work report system, most research to date has focused on the central government's reports, neglecting the analysis and research on local government work reports. In this paper, we use data from 288 prefecture-level cities in China between 2012 and 2017 as the main source of subsequent data analysis, attempting to analyze the impact of the green attention of local governments on foreign-invested enterprises' innovation from the perspective of government work papers.

In the current political system in China, official documents play an important role in communication between different levels of government and provide a way for the public to understand policy changes and dynamics. Among all official documents, a government work report is the most important one at all levels, which is mainly used to summarize the social issues and economic achievements of the jurisdiction in the past year and to formulate the work plan and goals for the upcoming year. A government work report often covers public affairs in areas such as politics, economy and culture and also includes environmental governance. Overall, a government work report provides an important source of information for people to understand the policies of the Party and the state [12].

This paper primarily contributes to three aspects: First, existing research on the impact of government actions on enterprise investment in research and development and innovative behavior is contentious. This paper, with China as the research context, provides evidence of the effectiveness of government's green pressure in promoting enterprise investment in research and development. Second, the conclusions of this study enrich the research on the factors determining enterprise investment in research and development by foreign companies in China. Existing research has already found that corporate governance, public subsidies, intellectual property law, etc., are factors affecting the investment

in research and development by enterprises, both domestic and foreign ones. However, through the study of government annual reports, we found that the green institutional pressure from the government also affects the investment in research and development by domestic and foreign enterprises, and that the green knowledge level of the home country has a universal moderating effect on this influence. Finally, the research presented in this paper also has significant policy implications. Especially in a country such as China that faces significant environmental challenges, the green development signals from local governments can effectively promote enterprise research and development input.

The remainder of this paper is structured as follows: Section 2 reviews the existing relevant literature, providing a research basis for this paper, and elaborates on the theories and the hypothesis. Section 3 explains the data sources, construction and processing methods of the core variables, as well as the model building. Section 4 describes the results of the empirical analyses and robustness tests of the main hypothesis. Section 5 mainly discusses further the results of the heterogeneity analysis and other aspects. Section 6 concludes the paper with a summary, and Section 7 reports the limitations of this study.

2. Literature Review and Research Gaps

Research indicates that research and technological capabilities are the key sources of competitive advantage for companies and industries, and that companies are the main drivers of innovation and technological development. Currently, the factors that influence an enterprise's investment in research and development are mainly divided into internal and external factors, with the controllability of internal factors far greater than that of external factors [13]. Internal factors are mainly divided into the following categories: an enterprise's financial condition, its profitability, size, capital structure, intangible assets, human resources, export activities, management and board of directors and shareholders.

In addition to the aforementioned internal factors, some scholars have also studied the impact of external factors on enterprises' research and innovation activities. Dobson and Safarian [14] analyzed the data of 11 high-tech enterprises in Chinese Zhejiang Province and found that as the flow of foreign direct investment and technology imports increased and the ability of domestic enterprises to absorb foreign technology gradually strengthened, more and more domestic enterprises in China were able to acquire international knowledge. This enhanced the research and development capability and labor productivity of domestic enterprises and encouraged them to pursue innovation. Gao and Jefferson [15] argued that once China's economic growth level aligns with the international economy, China's knowledge frontier will converge with that of developed countries and grow at the same rate as other developed economies. Zhu et al. [16] studied the effect of direct government subsidies on enterprise research and development and found that the effect of direct government subsidies is somewhat ambiguous. This ambiguity also reveals the risk aversion that may exist in the investment behavior of industrial sector. In other words, when both technological risk and market risk are high, government support may not be sufficient to stimulate investment in research and development in industrial sector.

On the other hand, there has been extensive research on how governments can influence enterprise investment in research and development. Studies show that the most direct policy tool for government to influence enterprise investment in research and development at present is to provide public incentives for research and development, which mainly focuses on fiscal and financial aspects. Fiscal incentive measures mainly include tax benefits for research and development expenses, which may take the form of accelerated depreciation, tax credits, tax exemptions or import duty exemptions. Financial incentives refer to the direct financial support that the government provides to research and development projects of enterprises through grants or subsidies, preferential loans (including interest subsidies) or equity [17]. Although research and development incentive schemes are easily influenced by factors such as coverage, enterprise size, different stages of research and development cycles, and government financial differences [18], innovation subsidies are still one of the best ways to enhance research and development incentives for enterprises [19].

This is because innovation subsidies can greatly stimulate enterprises to increase investment in research and development, thereby enhancing their own innovation capabilities, ultimately leading to an increase in overall productivity of enterprises [20]. Empirical research by Meuleman and Maeseneire [21] shows that enterprises with higher credit ratings are more likely to receive government subsidies. Small and medium-sized enterprises that receive government research and development subsidies have a better chance of obtaining long-term funding support due to government's recognition of their creditworthiness. With sufficient funds, small and medium-sized enterprises are more willing to increase investment in research and development to enhance their innovation capabilities, thereby helping to improve their financial competitiveness. Xu [22] conducted an empirical analysis using samples of high-tech enterprises in Chinese Dalian, and found that government's preferential policies have a constraining effect on the relationship between investment in research and development and enterprise performance. Xiong et al. [23] quantitatively analyzed the relationship between government subsidies and enterprise investment in research and development from the perspective of the life cycle and found that government subsidies only stimulate enterprise research and development activities during the decline phase. Other researchers [24] conducted an empirical analysis on the time series of high-tech enterprise and found that government subsidies can have a positive mediating effect on enterprise performance through investment in research and development, but there are certain differences in the effects of "process subsidies" and "pre-subsidies". Wu et al. [25] found that the moderating effect of government subsidies on the relationship between investment in research and development and enterprise value has a time limit.

Despite the existence of numerous studies on the impact of government actions on enterprise investment in research and development, there is some controversy regarding the effects of government behavior on enterprise investment in research and development and innovation behavior. Some studies suggest that the government's formulation of innovation policies and vigorous promotion of innovative activities can have a positive stimulating effect on enterprise investment in research and development. This is mainly because the government's active participation in and promotion of innovative endeavors can not only make up for the inherent deficiencies in the market's allocation of corporate innovation resources [26] but also provide an excellent external environment for enterprise research and development activities, thereby motivating enterprises to invest in research and development from both internal and external perspectives and enhancing regional innovation efficiency [27].

There are also studies that hold the opposite view, suggesting that the government's innovation policies and support for innovation activities have limited effects on corporate innovation and investment in research and development, and may even have negative impacts [12,28,29]. This is mainly because government policies and actions can disrupt normal market competition rules, leading to bureaucracy and excessive government intervention, thereby suppressing enterprise enthusiasm for and investment in innovation [12]. In addition, the limitations of the government itself (such as the lack of a supervision mechanism for government subsidies, the time lag of government subsidy policies, the cognitive limitations of government officials, corruption, etc.) can also restrain enterprise investment in research and development and innovation enthusiasm [28,30,31]. Some studies also suggest that the impact of government behavior on enterprise investment in research and development and innovation is subject to the joint effects of multiple conditions, rather than simple promotion or inhibition. Research has found that government subsidies for enterprise investment in research and development and innovation are influenced by various factors, such as the market and nature of the enterprise [32,33], subsidy amount [34], and the enterprise's own technological level [35], among others.

Finally, the current literature either does not distinguish between foreign-invested enterprises and other types of enterprises or primarily focuses on state-owned enterprises. For instance, researchers have found that positive pressure from the government, such as subsidies, has a more remarkable effect on corporate research and development in state-

owned enterprises, and this impact intensifies with the increase in government ownership [36,37]. Another study employs data from listed Chinese industrial firms to test the differential effects of environmental regulations on investment in research and developments between state-owned enterprises and other enterprises [38]. The findings suggest that government environmental audits can significantly enhance the quality of green innovation in state-owned enterprises [39], and the introduction of external directors through the “mixed-ownership reform policy” has a positive effect on the innovation motivation within state-owned enterprises [40]. In summary, the above literature review investigates the relationship between different forms of environmental regulation and enterprise research and development behavior in different industries and countries, but it still suffers from some shortcomings. Most of the previous literature examining the relationship between environmental regulation and enterprise behavior has focused on developed countries, such as the US, the UK, Japan and European countries [41–44], with less attention paid to emerging markets. Meanwhile, studies examining the impact of the local government’s pressure in the host country on the innovation of foreign-invested enterprises are scarce. This paper aims to explore the link between government’s green pressure and foreign-invested enterprise innovation in emerging market economies such as China.

3. Data and Methods

3.1. Research Hypothesis

Based on the above analysis, the impact of local governments’ green initiatives on investment in research and development by foreign-invested enterprises can be explained by the following factors. Firstly, the government work report, which reflects the policy planning and actions of the local government in the coming year, can serve as a guideline for future government work. Although China has a strong central government, regional policies can be independently formulated by local officials at the city level without violating the central government’s policy priorities, further enhancing the importance of the local government work report. When the frequency or proportion of environmental vocabulary in the government work report increases, it indicates that the focus and priorities of the local government in the coming year will shift towards environmental protection, which means that the government’s execution of environmental regulations will be stricter, and the punishment for polluting enterprises will be strengthened. To be exact, the increase in the frequency or proportion of environmental vocabulary enhances the degree of green pressure from local governments through four pathways. (1) Policy pressure: the frequent appearance of environmental themes in government work reports may guide the government to formulate stricter environmental regulations and policies, such as setting higher emission standards and stricter environmental inspections. (2) Financial pressure: An increase in environmental vocabulary may suggest that the government will enhance its fiscal input into the environmental sector, such as subsidizing green industries and levying environmental taxes on polluting enterprises. These measures will increase the demand of enterprises for environmental compliance, thereby forming pressure on enterprises. (3) Social pressure: The government’s emphasis on environmental protection may trigger broad public attention, thereby generating social pressure on enterprises. If enterprises cannot meet higher environmental requirements, they may face consumer boycotts and damage to their brand image. (4) Market pressure: The government may encourage the development of green industries, prompting a market shift towards environmental protection. In this situation, enterprises that cannot adapt to the green transformation may face declining market competitiveness. These pressures will force enterprises to reduce their pollution emissions, otherwise, they will face very high fines and serious subsequent chain reactions (such as the reduction in or cancellation of government subsidies), which will have a serious impact on their future development. In the context of sustainable and green development, enterprises can only survive by finding ways to reduce their own pollution emissions. Based on this, increasing investment in research and development, enhancing production efficiency, reducing production costs and reducing pollution emissions become the wisest solution

for foreign-invested enterprises to pursue profit maximization. In this case, strengthening investment in research and development has become the most sensible choice for enterprises to avoid policy and environmental risks. Based on this, the following hypothesis is proposed for this paper:

H1. *The increasing green pressure from local governments will lead to an increase in investment in research and development by foreign-invested enterprises.*

3.2. Data Sources and Model Setting

The primary data are based on the government work reports of 288 prefecture-level cities in China between 2012 and 2017. We identified environmental keywords from these reports. By merging these data with the directory of foreign-invested enterprises published by the Ministry of Commerce of China, as well as the nationwide tax survey database published by the State Administration of Taxation of China, we constructed the main database for this research. The directory of foreign-invested enterprises was compiled by the Ministry of Commerce according to the standards set forth in the “Measures for the Administration of Filing of Overseas Investment Enterprises (Institutions)” issued by the National Development and Reform Commission of China. It includes nearly 50,000 companies. The nationwide tax survey data were jointly organized and implemented by the Ministry of Finance and the State Administration of Taxation of China, with local tax authorities responsible for data reporting, collection and verification. Compared to the widely used financial databases of Chinese companies listed in research, the tax survey data cover a more comprehensive range of industries and enterprise sizes while also ensuring the representative nature of the samples through its scientific sampling method. Furthermore, in this study, we also merged the main database with the United States Patent and Trademark Office’s database to examine the moderating effect of the home country’s green level on the hypothesis. Finally, the fixed effects and heterogeneity analyses also utilized some data from the World Bank database.

Specifically, the dependent variable is the logarithm of research and development expenditure of an enterprise in that year. The definition of independent variable (environmental keyword frequency) is the number of occurrences of environmental keywords in the government work report of the prefecture-level city where the foreign-invested enterprise is located in that year. The variable of the environmental keyword frequency data refers to Chen et al.’s [45] method by manually collating government work reports from 288 prefecture-level cities in 31 provinces across China from 2012 to 2017, screening out environmentally related words appearing in government work reports, including the following: “环境保护 (environmental protection work)”, “环保 (environmental protection)”, “污染 (pollution)”, “能耗 (energy consumption)”, “减排 (emission reduction)”, “排污 (sewage discharge)”, “生态 (ecology)”, “绿色 (greenness)”, “低碳 (low carbonization)”, “空气 (air quality)”, “化学需氧量 (chemical oxygen demand)”, “二氧化硫 (sulfur dioxide)”, “二氧化碳 (carbon dioxide)”, and PM10 and PM2.5. The total sample size of environmental keyword frequency is 709,042, with a maximum value of 110 and a minimum value of 1. The mean of all samples is 35.61, and the standard deviation is 13.47. Through the above keywords, we can more comprehensively understand the government’s efforts in environmental governance and systematically reflect the government’s investment in environmental governance work. The specific descriptive statistics are shown in the table below (Table 1).

To study the effect of local governments’ environmental concern on investment in research and development by foreign-invested enterprises, we constructed the following model:

$$RDinvest_{ijt} = \beta_0 + \beta_1 NOG_{jt} + \beta_3 Controls_{it} + \gamma_i + \alpha_t + \delta_j + \varepsilon \quad (1)$$

“RDinvest” is the investment in research and development of a foreign-invested enterprise, while “ ε ” is the random disturbance. In the equation, i , j and t represent the

enterprise, industry and year, respectively. Values “ γ ”, “ α ” and “ δ ” represent firm fixed effects, time fixed effects and industry fixed effects, respectively. “Controls” represents a series of the control variables listed previously. “NOG” is the explanatory variable, indicating the frequency of appearance of environmental protection keywords in the government’s annual work report. In addition to the aforementioned variables, we selected a series of economic characteristics of enterprises as control variables including “Lnasset” (the logarithm of a firm’s total assets used to mitigate the influence of varying firm sizes on RDinvest), “Lnincome” (the logarithm of a firm’s annual sales revenue applied to control the effect of disparate profitability levels on RDinvest), “Lncost” (the logarithm of a firm’s annual cost employed to neutralize the impact of different product costs on RDinvest), “Lntax” (the logarithm of a firm’s annual tax payment utilized to counterbalance the effect of tax deductions on RDinvest) and “Lnexport” (the logarithm of a firm’s annual export volume used to offset the impact of firm exports on RDinvest).

Table 1. Descriptive statistics.

Value Names	Value Meaning	Size	Max	Min	Mean	Std. Dev.
id	Firm’s unique ID	709,042	260,393	3	122,565.3	50,994
RDinvest	Logarithm of the enterprise’s investment in research and development this year	709,042	25.43	0	1.52	4.55
NOG	Number of green keywords in government work report this year	709,042	110	1	35.61	13.47
Gpatents	Cumulative number of green patents for the nation	709,042	54,042	1	20,900.8	23,024
POG	Proportion of green keywords in the government work reports.	709,042	0.03	0.01	0.01	0.01
NOGd	Interaction between the number of green keywords and dummy variable of green country	709,042	110	0	31.44	17.2
POGd	Interaction between the proportion of green keywords and dummy variable of green country	709,042	0.02	0	0.01	0.01
lnasset	Logarithm of total business assets	708,804	28.21	0.01	16.72	2.33
lnincom	Logarithm of sales revenue	708,976	26.60	0	14.04	6.11
lncost	Logarithm of total cost of goods sold	590,411	27.27	0	13.5	6.39
lntax	Logarithm of total tax paid	708,971	25.89	0	11.4	5.07
lnexpor	Logarithm of enterprise’s exports	701,461	25.59	0	2.02	3.12

4. Results

4.1. Baseline Regression Results

Following the model specifications described earlier, the baseline regression of this study was conducted by progressively incorporating control variables and fixed effects, including those at the country and industry levels. From Table 2, we can see that the regression coefficient of environmental keyword frequency on investment in research and development by foreign-invested enterprises is positive and significant, indicating that an increase in the frequency of environmental keywords mentioned in the city government documents leads to an increase in investment in research and development by foreign-invested enterprises. When the frequency of environmental vocabulary in government work reports is higher, it indicates that the government is paying more attention to environmental pollution prevention and control, and local enterprises will face more stringent environmental pressure. In this overall policy background, foreign-invested enterprises

located in the city often choose to increase investment in research and development in order to maximize the avoidance of additional costs brought by the government's stringent environmental regulations. After further controlling for the firm, time and industry fixed effects in the regression model, the result remains positive, significant and robust, which further confirms the rationality of the model settings in this paper. Therefore, when the green keyword frequency in government reports is higher, it means that the government's attention will shift towards the environment, and the tolerance for enterprise pollution will decrease. Under this background, enterprises will choose to increase investment in research and development to cope with environmental regulatory pressure and avoid additional risks.

Table 2. Baseline regression results.

	RDinvest		
	(1)	(2)	(3)
NOG	0.003 *** (0.001)	0.003 *** (0.001)	0.004 *** (0.001)
lnexpor		0.091 *** (0.003)	0.080 *** (0.004)
lnasset		0.128 *** (0.004)	0.106 *** (0.005)
lnincom		0.010 *** (0.001)	0.013 *** (0.002)
lncost		0.017 *** (0.001)	0.014 *** (0.001)
lnntax		0.035 *** (0.001)	0.033 *** (0.002)
_cons	1.405 *** (0.011)	−1.706 *** (0.069)	−1.240 *** (0.082)
firm fixed effects	yes	yes	yes
year fixed effects	yes	yes	yes
nation fixed effects			yes
industry fixed effects			yes
sample size	708,993	590,147	454,100
R ²	0.735	0.739	0.791

Notes: (1) *** means 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

In order to better investigate the impact of national green knowledge levels on foreign-invested enterprises, we introduced the national green knowledge level as a moderating variable and conducted a baseline regression on the frequency of environmental keywords and investment in research and development by foreign-invested enterprises. Specifically, considering that countries with more than 10,000 green patents account for over half of the global green patents, we classified countries with more than 10,000 green patents as high-green-knowledge-level countries and the rest as low-green-knowledge-level countries. Variable NOGd reflects the interaction between the frequency of green keywords and the dummy variable for whether a country is a high-green-knowledge-level country. The regression results are shown in Table 3. After introducing the national-level green knowledge as a moderating variable, the coefficient of NOGd is significantly negative, and the values are −0.003, −0.004, −0.004 and −0.005. The results indicate that the promoting effect of the frequency of environmental keywords on investment in research and development by foreign-invested enterprises from countries with high green knowledge levels is weaker. This is primarily because if the green knowledge level of a foreign-invested enterprise's home country is relatively high, the enterprise can obtain substantial knowledge and technical assistance from it and therefore often possesses strong green innovation capabilities. Consequently, they are less constrained by local environmental regulations, resulting in a weaker impact of environmental policies on their green innovation.

Table 3. Basis regression after adding moderating variables.

	RDinvest		
	(1)	(2)	(3)
NOGd	−0.003 ** (0.001)	−0.004 *** (0.001)	−0.005 *** (0.002)
NOG	0.005 *** (0.001)	0.006 *** (0.001)	0.006 *** (0.002)
lnexpor		0.057 *** (0.006)	0.050 *** (0.007)
lnasset		0.108 *** (0.008)	0.078 *** (0.008)
lnincom		0.009 *** (0.003)	0.013 *** (0.003)
lncost		0.016 *** (0.002)	0.013 *** (0.003)
lntax		0.035 *** (0.003)	0.032 *** (0.004)
_cons	1.348 *** (0.025)	−1.366 *** (0.122)	−0.734 *** (0.138)
firm fixed effects	yes	yes	yes
year fixed effects	yes	yes	yes
industry fixed effects			yes
sample size	190,772	158,849	122,992
R ²	0.734	0.736	0.788

Notes: (1) ** and *** mean 5% and 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

4.2. Robustness Tests

In order to verify the validity of the baseline results in this chapter, we conducted the following robustness tests. First, we changed the model specification. In the baseline regression, we employed the ordinary least squares regression. However, due to a large number of zero values in the data on investment in research and development by foreign-invested enterprises, the baseline results may suffer from biases caused by model specification. Consequently, we used a Tobit model for estimation, and the results are shown in Table 4, Column 1. Second, we changed the measurement method for the core explanatory variable. The baseline regression employed the frequency of environmental keywords at the prefecture-level as the measurement indicator for local governments' green attention. We further used the proportion of environmental keyword frequency in government reports at the prefecture-level to characterize local governments' green attention and performed regression. The variable POG is the core variable after replacement, and the regression results are shown in Table 4, Column 2. Third, we considered the problem of omitted variables. Factors at the industry level, such as industry structure and pollution attributes, may affect whether local governments pay attention to environmental issues, thereby introducing biases in the baseline estimation. Therefore, we added industry-by-year fixed effects in the regression to address the omitted variable problem at the industry level. The results are displayed in Table 4, Column 3.

As shown in the table, after replacing the core variable, changing the model and controlling the model more strictly, the effect of local governments' green attention on investment in research and development by foreign-invested enterprises remains significantly positive.

In addition, we conducted a robustness analysis for the baseline regression that introduced the national-level green knowledge. Following a similar approach to the robustness analysis of the baseline regression, we performed the following tests: (1) using the Tobit model for regression to address the interference of model specification errors on the baseline results, with the regression results shown in Column 1 of Table 5; (2) changing the measurement of environmental pressure, from the frequency of environmental key-

words to the proportion of environmental keywords, and further adding POGd (POGd is the interaction between the frequency proportion and the national green knowledge level dummy variable), with the results shown in Column 2 of Table 5; (3) considering the issue of omitted variables, we included industry-by-year fixed effects to address potential industry-level omitted variable problems, with the results shown in Column 3 of Table 5. The results in the table indicate that the baseline findings remain robust, whether by increasing the model's control strength, changing the model or altering the measurement methods of the core explanatory variables.

Table 4. Robustness tests.

	RDinvest		
	(1)	(2)	(3)
	Tobit	Replacing Variable	Industry-by-Year Fixed Effect
NOG	0.103 *** (0.004)		0.002 *** (0.001)
POG		13.510 *** (3.671)	
control variables	yes	yes	yes
firm fixed effects		yes	yes
year fixed effects		yes	yes
industry fixed effects		yes	yes
industry-by-year			yes
sample size	590,198	454,100	453,889
R ²		0.790	0.794

Notes: (1) *** means 1% significance levels; (2) film-level robust standard errors are in brackets.

Table 5. Robustness tests after adding moderating variables.

	RDinvest		
	(1)	(2)	(3)
	Tobit	Replacing Variable	Industry-by-Year Fixed Effect
NOGd	−0.065 *** (0.015)		−0.005 *** (0.002)
NOG	0.111 *** (0.011)		0.004 *** (0.002)
POGd		−34.979 ** (14.654)	
POG		18.848 * (11.432)	
control variables	yes	yes	yes
firm fixed effects		yes	yes
year fixed effects		yes	yes
industry fixed effects		yes	yes
industry-by-year			yes
sample size	158,854	122,992	122,639
R ²		0.788	0.795

Notes: (1) *, ** and *** mean 10%, 5% and 1% significance levels, respectively; (2) film-level robust standard errors are in brackets.

4.3. Treatment of Endogeneity

Finally, to further eliminate any potential endogeneity that may confound the regression results, we employed a two-stage least squares regression (2SLS) with instrumental variables (IV) to test the robustness of the results. A valid and effective instrumental variable should satisfy two conditions: first, it must be exogenous; second, it should be cor-

related with the explanatory variable. In the study for this paper, we selected the age of the head of a local government in China, the municipal party secretary, as an instrumental variable for regression by combining tax survey data, data from the Chinese Ministry of Commerce and the customs database.

The reasons for choosing the age of government officials as an instrumental variable are as follows: Firstly, the particular system of governance officials in the Chinese government, compared to other countries, has given rise to the phenomenon of “promotion tournaments”: where relative GDP performance is stronger, the likelihood of an official’s promotion increases [46,47]. Theoretically, the appraisal of local government officials by the central government not only includes economic performance but also considers other factors such as environmental governance as important assessment indicators. However, driven by the competition for promotion, local government officials tend to overemphasize economic development due to political aspirations, thus neglecting other societal aspects [48–50]. As government officials grow older, the marginal benefits of promotion decrease, and their decision-making preferences change accordingly. For example, Wang and Xu [51] found that governors and provincial party secretaries alter their objective functions and decision-making styles as they age. Consequently, they found that ageing reduces their desire for promotion when they face age limits and are about to end their tenure. Some researchers analyzed data from the perspectives of promotion benefits and the cost of environmental governance. They found that as local officials age, the incentive for promotion weakens, and the marginal benefits of sacrificing the environment are smaller [52]. Therefore, older local officials, compared to their younger counterparts, tend to place a higher emphasis on environmental governance issues.

Older municipal party secretaries are less likely to be short-sighted and overambitious, and they tend not to favor “high pollution, big results” type of development, paying more attention to environmental pressure instead. Similar to the green keyword frequency in government work reports, the party secretary, as the main person in charge of the local government, can reflect the local government’s green pressure through their attitudes towards environmental protection and green development. Therefore, the age of the municipal party secretary is correlated with the green keyword frequency in local government work reports. On the other hand, the age of the municipal party secretary is evidently exogenous, so this variable meets the two basic conditions required for an instrumental variable. Specifically, for this paper, we used the current year minus the birth year of the local municipal party secretary as the instrumental variable, and the 2SLS regression results are shown in Table 6

Table 6. The 2SLS-IV estimates of basis regression.

	RDinvest			
	(1)	(2)	(3)	(4)
NOGd			−240.080 *	−313.756 **
			(131.672)	(137.233)
NOG	0.022 ***	0.028 ***	0.044 *	0.057 **
	(0.008)	(0.007)	(0.023)	(0.024)
control variables		yes		yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
sample size	598,418	497,542	146,448	121,799
first stage: Prob > F	0.001	0.001	0.001	0.001
Prob > chi ²	0.001	0.001	0.001	0.001

Notes: (1) *, ** and *** mean 10%, 5% and 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

Columns 1 and 2 of Table 6 display the 2SLS test results for the basic regression; and Columns 3 and 4 show the 2SLS test results for the baseline regression with the addition of moderating variables. Columns 2 and 4 include control variables, and the rest of the

settings are consistent with the main regression. The regression results are still robust, which corroborates the robustness of the core conclusions of this study.

5. Further Discussion

As mentioned earlier, areas with higher prefecture-level environmental keyword frequency tend to encourage enterprises to invest more in research and development. However, this result is highly likely to exhibit heterogeneity at the firm, industry and regional levels. To further ensure the robustness of the regression results and delve deeper into the impact of governments' environmental keyword frequency on enterprises across different dimensions, this section discusses heterogeneity. Firstly, we examined the heterogeneity of the promoting effect of prefecture-level environmental keyword frequency on enterprises' investment in research and development among different types of enterprises. Given that joint ventures tend to have more local social resources compared to wholly owned enterprises and may be less affected by policies, we conducted grouped regressions based on the nature of the enterprise (whether it is a wholly owned enterprise). The regression results are shown in Columns 1 and 3 of Table 7. When the control variables and fixed effects are included, the coefficients of NOG for both wholly owned enterprises and joint ventures are significant. The coefficient for wholly owned enterprises is slightly higher than that for joint ventures, with results being 0.005 and 0.003, respectively. This finding suggests that, compared to joint ventures, wholly owned enterprises may invest more in research and development when the local government's green attention increases.

Table 7. Heterogeneity test of business ownership attributes.

	RDinvest			
	Wholly Owned Enterprise		Joint Venture	
	(1)	(2)	(3)	(4)
NOGd		−0.008 *** (0.002)		0.001 (0.004)
NOG	0.005 *** (0.001)	0.008 *** (0.002)	0.003 *** (0.001)	0.001 (0.003)
control variables	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
sample size	410,648	87,509	141,020	34,293
R ²	0.750	0.763	0.815	0.820

Notes: (1) *** means 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

Further regression verification results of the moderating effect of national green knowledge level are shown in Columns 2 and 4 of Table 7. As can be seen, the regression results are more pronounced after adding the moderating effect. Compared to joint ventures, wholly owned enterprises are generally wholly owned by the host country and thus may be more influenced by the host country. The regression results show that the coefficient of NOGd for wholly owned enterprises is significantly negative at the 1% level, while it is not significant for non-wholly owned enterprises. This finding indicates that the higher the green knowledge level of the home country of wholly owned enterprises compared to non-wholly owned enterprises, the less investment in research and development they make.

In addition, industry characteristics play a crucial role in the implementation of environmental regulation. Due to differences in industry characteristics, the impact of environmental policies on enterprises in different industries varies according to their pollution levels. In this study, we categorized industries into service and nonservice industries because service industries are predominantly low-pollution industries. As a result, service enterprises should be less affected by environmental policy adjustments. Table 8 provides

the data of an empirical test of this result, with Columns 2 and 4 showing the outcomes after incorporating the national-level green knowledge as a moderating variable.

Table 8. Heterogeneity test of industry.

	RDinvest			
	Service Industry		Nonservice Businesses	
	(1)	(2)	(3)	(4)
NOGd		−0.001 (0.002)		−0.008 *** (0.002)
NOG	0.001 (0.001)	0.001 (0.002)	0.002 *** (0.001)	0.005 ** (0.002)
control variables	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
sample size	159,888	53,925	290,647	80,324
R ²	0.766	0.709	0.789	0.788

Notes: (1) ** and *** mean 5% and 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

Based on the regression results, the nonservice industry enterprise samples are significantly positive at the 1% significance level, while the service industry enterprise samples are not significant. Thus, it can be said that nonservice enterprises significantly increase their investment in research and development when local governments' green attention is enhanced. The coefficient for nonservice industry enterprise becomes significantly negative after introducing the moderating variable, while the regression result for service industry enterprises remains insignificant. This indicates that the high green knowledge level of the parent country has a negative moderating effect on the influence of local governments' green attention on investment in research and development by foreign nonservice industry enterprises. This is because foreign nonservice enterprise from countries with higher green knowledge levels have a stronger environmental awareness, and their environmental investment in research and development level is already relatively high. Therefore, the rise in local governments' green attention in China has a smaller positive effect on these enterprises.

China's major cities are largely distributed in the eastern coastal areas. To distinguish the effects of urban location heterogeneity, we divided the sample into two parts: eastern China and non-eastern China. On average, the corporate density and scale in the eastern region are larger, the technology is more advanced, and the environmental challenges are more serious. Enterprises may be more inclined to increase investment in research and development to cope with stringent environmental regulations when influenced by local governments' green attention. The empirical results are shown in Table 9, with Columns 2 and 4 representing the results after incorporating the national-level green knowledge as a moderating variable.

From the results in Columns 1 and 3, the regression coefficient for eastern enterprises is 0.004 and is significantly positive at the 1% significance level, while the result for non-eastern enterprises is not significant. Therefore, eastern enterprises are more willing to increase investment in research and development under the influence of enhanced local governments' green attention. The results in Columns 2 and 4 indicate that enterprises in the eastern region are negatively moderated by national-level green knowledge, with a regression coefficient of −0.006, significantly negative at the 1% significance level, while this coefficient for non-eastern enterprises is not significant. These results suggest that if eastern enterprises have parent countries with high green knowledge levels, they will suppress their investment in research and development when facing environmental policy shocks.

Table 9. Heterogeneity test of geographical area.

	RDinvest			
	Eastern Region's Enterprises		Non-Eastern Enterprises	
	(1)	(2)	(3)	(4)
NOGd		−0.006 *** (0.002)		−0.004 (0.006)
NOG	0.004 *** (0.001)	0.007 *** (0.002)	0.002 (0.002)	0.002 (0.004)
control variables	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
sample size	413,361	112,029	40,682	10,920
R ²	0.790	0.786	0.800	0.806

Notes: (1) *** means 1% significance levels, respectively; (2) film-level robust standard errors are in brackets.

The heterogeneity of the baseline regression results may also depend on whether foreign-invested enterprises have export-oriented products. If the products of foreign-invested enterprises need to be exported, they must not only meet the environmental and quality requirements of the host country but also meet the requirements of the importing country. Therefore, if external policies change, a chain reaction may easily occur in their future strategic planning. If the products of foreign-invested enterprises are not exported, i.e., they only supply the domestic market, they generally have stronger policy bargaining power and are less affected by external environmental policies. To verify this logic, we divided the enterprises into those with and without export products, and the results are presented in Table 10. Columns 2 and 4 show the results after incorporating the national-level green knowledge as a moderating variable.

Table 10. Heterogeneity test of export products.

	RDinvest			
	Enterprises with Export Products		No Export Product Enterprises	
	(1)	(2)	(3)	(4)
NOGd		−0.017 *** (0.003)		0.001 (0.002)
NOG	0.005 *** (0.001)	0.014 *** (0.003)	0.001 * (0.001)	−0.001 (0.002)
control variables	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
sample size	157,185	53,327	281,032	64,428
R ²	0.819	0.818	0.750	0.742

Notes: (1) * and *** mean 10% and 1% significance levels, respectively; (2) film-level robust standard errors are in brackets.

In the regression results without the moderating variable, the coefficient for enterprises with exports is significantly larger than that for enterprises without exports, and the former has stronger significance. Compared to enterprises without exports, the enhanced green attention of local governments has a stronger positive promotion effect on investment in research and development by export-oriented foreign-invested enterprises. The results after introducing the national-level green knowledge as a moderating variable also show a similar pattern. The regression results are consistent with the conjecture in this pa-

per: a higher green knowledge level of the parent country will have a negative moderating effect on the impact of local government's green attention.

Lastly, to study the impact of the parent country advantage of multinational enterprises on the conclusions of this paper, we divided the foreign-invested enterprises' parent countries into high-income and low-income countries based on their income levels (using the World Bank's classification of national income) and analyzed their heterogeneity (Table 11). Similarly, Columns 2 and 4 show the results after incorporating the national-level green knowledge as a moderating variable.

Table 11. Heterogeneity test of home country income level.

	RDinvest			
	High-Income Countries		Low-Income Countries	
	(1)	(2)	(3)	(4)
NOGd		−0.001 (0.002)		0.003 (0.005)
NOG	0.004 *** (0.001)	0.005 *** (0.002)	0.002 (0.001)	−0.001 (0.005)
control variables	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
sample size	412,134	412,134	41,914	41,914
R ²	0.793	0.793	0.702	0.702

Notes: (1) *** means 1% significance levels, respectively; (2) firm-level robust standard errors are in brackets.

When the parent country of a foreign-invested enterprise is a high-income country, the green attention of local governments has a positive promotion effect on the investment in research and development of multinational enterprises. This is because the higher the income of the parent country, the more resources the parent company of the multinational enterprise possesses, the stronger the parent country advantage, and the more financial and technological support it can provide for its subsidiaries. The results for low-income countries are not significant, indicating that, compared to enterprises from low-income countries, those from high-income countries are more inclined to pay attention to the green policy orientation of local governments and increase their investment in research and development accordingly.

6. Conclusions

Through an empirical analysis of data from China, this paper demonstrates that local governments' green institutional pressure promotes investment in research and development by foreign-invested enterprises. The greater the green knowledge is possessed by the home country of a foreign enterprise, the weaker this promotion becomes. These conclusions are reached through the empirical analysis of the data on environmental keyword frequency in the Chinese government annual work reports, the data on investment in research and development by foreign-invested enterprises and the data on the national green patents. The higher the frequency of environmental vocabulary in government work reports, the greater the local government's attention to the environment in that year, and the greater the external environmental pressure perceived by companies. On such a policy background, foreign-invested enterprises often choose to increase their investment in research and development to avoid risks; thus, the environmental keyword frequency has a positive promotion effect on investment in research and development by local foreign-invested enterprises. After controlling for export volume, total assets, sales revenue, sales cost, total taxes and fees as control variables and further controlling for individual, time, country and industry fixed effects, the results are still positively significant and robust.

Additionally, this paper introduces the national-level green knowledge as a moderating variable and studies the impact of environmental keyword frequency on investment in research and development by foreign-invested enterprises based on this. The results show that for foreign-invested enterprises with high green knowledge levels in their parent countries, the promotion effect of government's green attention on enterprise investment in research and development is weakened. This is because companies can obtain technical support from their parent countries, and thus they do not rapidly increase investment in research and development when facing external pressure. The heterogeneity analysis section describes the analysis we conducted with respect to five dimensions: the nature of corporate ownership, industry attributes, city location, export behavior and home country advantages, providing robust results.

To ensure the robustness of the baseline regression results, we conducted a series of robustness tests of the results. Because of potentially omitted variables, the model replaced the core explanatory variable, changing the environmental keyword frequency for a prefecture-level city to the proportion of environmental keyword frequency for a prefecture-level city. To solve the error caused by model specification, the model was changed. Due to the possibilities of potential zero values in the data on investment in research and development by foreign-invested enterprises, a Tobit model was employed for estimation. To address the error caused by reverse causality, the model added more control variables. Since there was a lack of industry-level control variables, we added fixed effects at the industry–year interaction level. To deal with endogeneity issues, we used the age of a prefecture-level city's party secretary as an instrumental variable and tested it. The core conclusion remains consistent, and the results are still significant even after introducing the national-level green knowledge as a moderating variable. Based on the insights drawn from our research findings, we propose the following policy recommendation: in addition to direct regulations and subsidies, avenues such as government work reports and other official information channels can be utilized to enhance firms' innovation motivation and investment. As a summary of past achievements and a prospect for future development, local government work reports have a guiding effect on enterprises when they formulate future development strategy.

7. Limitations and Future Research

This study has some limitations, mainly related to data constraints and conceptual measurement. The data used in this study are sourced from China. While China is an important emerging country, it is also a very unique nation with its distinctive political background and culture. The influence of Chinese local governments on enterprises could be shaped by the country's specific political system and cultural background, situations that might not be entirely replicated in other nations or regions. Secondly, the optimal measurement construct for the impact of a local government's "green" efforts on corporate research and development would be the firm's investment in research and development of green innovation. However, due to the limitations of the available data on Chinese foreign-invested enterprises, this study did not distinguish between the types of corporate innovation. Therefore, future research could further empirically investigate the impact of governments' environmental pressures on corporate research and development from more universal data sources (other emerging countries) or a more refined data structure (product or patent types).

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