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# Research on the environmental regulations for green technology innovation and the moderating role of political connection

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***Abstract:*** *Under the condition of severe environmental pollution and the great pressure of government regulation, the performance of Chinese enterprises in green technology innovation deserves attention. Previous studies pointed out that political connection could provide scarce resources for enterprises to enhance their competitiveness, so as to promoted their green technology innovation ability. Based on the data of 260 Chinese listed enterprises from 2016 to 2020, this study illuminates the relationship between environmental regulation and green technology innovation, and further investigates the moderating role of political connection. The results show that environmental regulation significantly promoted green technology innovation of Chinese enterprises. Besides, the positive effect was strengthened year by year. Political connection played a crucial role in stimulating green technology innovation and negatively moderated the positive effect of environmental regulation on green technology innovation. The research conclusions offer a fresh ideological line for using the relationship between Chinese government and enterprises to influence enterprises' green technology innovation under the concept of green economic development.*

***Keywords:*** *environmental regulation, green technology innovation, political connection*

## 1. Introduction

Since 2020, "double circulation" has been regarded as a major strategic deployment to accelerate the growth of Chinese open economy to a higher level. "Double circulation" pays more attention to the sustainability of economic development, aiming to improve the quality of economic development from both international and domestic aspects. Under the reform and opening-up policies, China has swiftly expanded into the 2nd largest economy in the last several decades. However, the excessive pursuit of economic benefits ignores ecological protection, it is urgent to explore a green development path that is compatible with the environment and the economy. The concept of green development takes the harmony between man and nature as the value orientation, the green low-carbon cycle is the key premise, and the establishment of ecological civilization as the basic starting point. Only by vigorously developing green economy can we effectively break through the bottleneck constraints of resources and gain more competitive advantage.

China is encountered with particularly serious environmental issues, and the government has been putting increasing efforts in environment protection. Environmental regulation regulates various behaviors that pollute the public environment for the purpose of protecting the environment and realizing the common development of environment and economy. Listed enterprises are characterized by its enormous assets and high technical requirements. The key to enterprise development lies in innovation. While enterprises face many institutional obstacles. Political connection, as an informal alternative system, has become an important strategic mean for enterprises to obtain innovation resources. Since political connections can help enterprises make up for their lacking resources to some extent, this may change the influence of government regulation on enterprises' innovation activities under the background of increasingly common political connection within enterprises.

On the basis of environmental legislation and guided by green economic development, the government has issued corresponding fiscal and tax policies to guide and support enterprise green technology innovation. Can political connections promote green technology innovation? The majority of the extant material focuses on proving Porter hypothesis, enterprise performance, government subsidies and so on. Whether the political connection will affect the relationship between environmental regulation

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and green technology innovation, and what's the impact path is not clear. Therefore, taking political relevance as a new research path, this paper establishes a regulatory effect test model for in-depth analysis.

## 2. Theoretical Background and Hypothesis

### *2.1. Environmental Regulation and Green Technology Innovation*

At present, three different views can be summarized in the academic on the relationship between environmental regulation and green technology innovation. The first category holds the view of promotion. Bie et al. (2021) proposed to increase the collection of environmental tax, cooperate with high-intensity supervision, or cooperate with special subsidies, and use the effect of "Pareto improvement" policy to promote enterprise green technology innovation [1]. Adam et al. (1997) and Qin (2019) found that environmental regulation would reduce pollution by improving production processes, form innovation compensation effect [2-3]. Frondel et al. (2007) believed that incentive-based environmental policy encouraged businesses to innovate. Environmental regulation effectively stimulated businesses' innovation vigor [4]. The second category holds the view of inhibition. Kneller and Manderson (2011) had shown that rigorous environmental regulation reduced the R&D investment and restricted the technological innovation of enterprises through empirical evidence [5]. Sun et al. (2021) found that in regions with middle-level of environmental-friendly technological innovation, market-driven environmental regulation tools had significant negative influences [6]. The third category holds the view of uncertain. Different conclusions will be drawn based on different research perspectives, which is no longer a single positive and negative relationship, but a U-shaped relationship of inhibition before promotion or inhibition before promotion [7-8]. Feng et al. (2021) also found that environmental regulation had no fixed influence on the level of innovation due to the interference of factors such as region, industry and the nature of property rights [9].

Externality theory shows that the environment has strong externality. No matter the enterprise protects the environment or pollutes it, it's impossible to achieve the optimal allocation of resources in the end, and it will definitely cause environment pollution. Therefore, as an effective means to solve this problem, environmental regulation turns the environmental externality problem into internality, and incorporates the environmental cost into the operating cost of the enterprise. With massive investments in pollution prevention, the increased spending of production activity cost can be offset by technological innovation and effectively improve production efficiency [10]. In the process of green innovation, products will obtain competitive product premiums, and the profits from innovation activities will make up for the increased cost consumption caused by environmental [11]. Therefore, green technology innovation has the potential to significantly boost business growth through the dual improvement of technical capacity and product production efficiency. This study proposes the hypothesis:

H1: Environmental regulation has a positive impact on enterprises' green technology innovation.

### *2.2. Political Connection and Green Technology Innovation*

Among now available research, there are three different types of research evidence on political connection and green technology innovation. The first evidence holds the view of promotion. According to Wang (2019), political connection played an important role in supporting high-tech firms' technical progress [12]. Yang et al. (2014) discovered that politically connected enterprises could effectively expand the amount of enterprise patent achievements [13]. Mai and Zhang (2019) believed that forming partnerships between private enterprises and government agencies to get scarce resources would help businesses perform better in terms of technological innovation [14]. The second evidence holds the view of inhibition. Zhu (2016) and Liu et al. (2020) found that the association between enterprises and the government would reduce innovation enthusiasm and inhibit technological innovation performance [15]. Thirdly, there is no definite influence relationship between the two variables. Research of Liang et al. (2011) showed that political connection had varying consequences on technical innovation in various intensive companies. Among them, high political connection was easier to increase investment and promote innovation activities in non-high-tech enterprises [16]. Liu et al. (2020) found that government officials serving as executives positively affected technological innovation, while representative committee members serving as executives would reduce firms' investment in technical innovation[17].

Technological innovation is based on scientific and technological knowledge and the resources it creates, which is inseparable from the support of various resources. Resource dependence theory shows that due to the scarcity of resources, enterprises will strive to seize resources that are beneficial to their

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survival and development. At present, in the new historical stage of economic transformation, the Chinese government possesses certain authority to direct the growth of businesses, and has the key resources that are crucial in the development of enterprises, which tremendously affects the production activities of enterprises. The Chinese government has put forward innovation policies to vigorously support innovation and entrepreneurship in all sectors of society. Political connection can help businesses undertake green technology innovation initiatives focused at environmental protection throughout the policy implementation phase[18]. First of all, through political connection, enterprises can more accurately understand national policies and regulations and effectively guide enterprises' green technology innovation within the specified scope. Under the background that enterprises generally pursue political connection, they will be more enthusiastic about the implementation of government policies[19]. Secondly, enterprises can more easily obtain financial resources through political connection, such as special funds and policies formulated by the government, and it can reduce imbalance information between enterprises and the government and obtain information resources that can enhance the power of technological innovation. Finally, solid political relations help to ensure that new projects can quickly obtain patent protection or even local protection, so as to mitigate some business risks related to technical innovation. This study proposes the following hypothesis:

H2: Political connection has a positive impact on enterprises' green technology innovation.

### *2.3. Environmental Regulation, Political Connection and Green Technology Innovation*

Through political connection to obtain government support and obtain key resources is an important way the growth of Chinese enterprises [20]. Under the government regulation, political connection can bring various advantages from resources and supervision to enterprises, such as cheap government resources, including land, credit loans and government subsidies, which will bring low-cost competitive advantages to enterprises. Furthermore, there is still a situation of sacrificing the environment for economic growth in the market. Environmental related laws and regulations have a direct impact on the business earnings and losses， and the political resource of enterprises is also an effective tool to avoid environmental responsibility [21]. In the face of the regulatory policies related to the environment, enterprises rely on strong political connection to buffer their relationship with local governments to reduce the implementation effect of environmental regulation policies. Furthermore, political connection even can be used to avoid environmental regulation [22]. Relying on the advantage of cheap government resources, enterprises choose development methods of high consumption to form crowding-out effect on the allocation of R&D resources. Enterprise executives evade environmental regulation by seeking political connection. The government will loosen the environmental supervision of enterprises if it has political connection, making enterprises with pollution behaviors more "confident"[23]. Political connection may have a "sheltering effect" on the punishment of environmental violations and become a protective umbrella for enterprises. In addition, the above-mentioned resources and regulatory advantages of political connection can also form the curse of political resources because of decreasing market competition and stimulating excessive expenditure, which aggravate the extensive development of enterprises by hinder innovation[24]. This study proposes the hypothesis:

H3: Political connection negatively moderates the effect of environmental regulation on enterprises' green technology innovation.

## 3. Research Design

### *3.1. Data Sources and Research Samples*

This study selects Chinese listed enterprises from 2016 to 2020 as the initial sample. The samples were screened according to the actual situation, and finally 9,100 data of 260 listed enterprises were obtained. The data sources of this article are CSMAR, cninfo, and enterprises' annual reports. Data is analyzed by STATA16 software.

### *3.2. Variable Measurement*

#### *3.2.1. The Dependent Variable*

Green technology innovation (RD). According to Zhou's (2021) practice, the ratio of green technology innovation investment represents RD [25].

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#### *3.2.2. Independent Variable*

Environmental regulation (EC). According to Ding's (2019) practice, environmental regulation measured by the "three simultaneous" environmental protection investment. "Three Simultaneities" means that simultaneous design, construction and operation of environmental protection facilities and main engineering projects [26].

#### *3.2.3. Moderator*

Political Connection (PC). According to Wang's (2014) practice, the political connection is defined according to the assignment method [27]. The enterprise is considered to have political connection, and the variable is 1. If not, it is 0.

#### *3.2.4. Control Variables*

After observing the data, this study adds four control variables: return on net assets (ROE), enterprise scale (SIZE), enterprise age (AGE), asset liability ratio (LEV), which makes the research results of this paper more accurate and reliable, as shown in Table 1.

*Table 1: Variable Descriptive Table.*

| Category | Variable Name | Variable symbol | Variable Measurement |
|---|---|---|---|
| Dependent variable | Green technology innovation | RD | Green technology innovation investment / Operating income |
| Independent variable | Environmental regulation | EC | Environmental protection investment |
| Moderator | Political connection | PC | "CEO or general manager of the enterprise is a current or former deputy to the National People's Congress or member of the CPPCC" = "1", if not, it's assigned to "0". |
| Control variable | Return on net assets | ROE | Current net profit / Total assets at the beginning of the period |
| | Asset liability ratio | LEV | Total liabilities/Total assets |
| | Enterprise age | AGE | Years of establishment |
| | Enterprise scale | SIZE | Total assets of the enterprise |

### *3.3. Model Design*

In order to analyze the relationship among environmental regulation, green technology innovation and political connection, models (1), (2), (3) are constructed in this study to test the theoretical hypothesis. The model forms are as follows:

$$RD_{it} = \beta_0 + \beta_1 EC_{it} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

$$RD_{it} = \beta_0 + \beta_1 EC_{it} + \beta_2 PC_{it} + \beta_3 X_{it} + \varepsilon_{it} \quad (2)$$

$$RD_{it} = \beta_0 + \beta_1 EC_{it} + \beta_2 PC_{it} + \beta_3 EC_{it} \times PC_{it} + \beta_4 X_{it} + \varepsilon_{it} \quad (3)$$

Among them, RD, EC, PC represent the dependent variable, the independent variable, and the moderator respectively, indicating the green technology innovation level, the extent to which external environmental regulations have an impact on enterprise and the political connection of listed enterprises i in year t; X represents all control variables; ECPC is the interaction term between environmental regulation and politics. (i=1, 2, 3, 4) is the regression coefficient; is the stochastic disturbance.

### *3.4. Descriptive Analysis*

Table 2 shows the descriptive statistics.According to the maximum, minimum and average value of RD, Chinese listed enterprises have a poor overall level of RD capability and there is a wide gap in strength. In terms of standard deviation, the impact of EC is uneven and fluctuates greatly, it shows that the execution strength of environmental protection policies and green production awareness of enterprises are different. The average value of political relations indicates that 21% of the enterprise chairmen or managers in the study sample have served as government officials. According to the size data, the enterprise asset scale is generally maintained at a high level, which shows that Chinese market economy has been in sound condition in recent years.

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*Table 2: Variable Descriptive Table.*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| RD | 1300 | 4.566 | 2.677 | 0.06 | 16.18 |
| EC | 1300 | 15.382 | 4.404 | 1 | 29 |
| PC | 1300 | 0.21 | 0.408 | 0 | 1 |
| ROE | 1300 | -0.002 | 0.398 | -4.782 | 7.446 |
| SIZE | 1300 | 21.732 | 0.998 | 19.576 | 24.956 |
| AGE | 1300 | 10.462 | 2.646 | 5 | 15 |
| LEV | 1300 | 0.394 | 0.274 | 0.023 | 5.07 |

## 4. Empirical Analysis

### *4.1. Correlation Analysis*

Table 3 shows that there is a significant positive effect between EC and RD ($r = 0.234$, $p < 0.01$), which preliminarily indicates that the correlation between variables can be proved by some evidence. This also preliminarily prove the hypothesis of this study.

*Table 3: Correlation Analysis.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| RD | 1 | | | | | | |
| EC | 0.234*** | 1 | | | | | |
| PC | 0.138*** | 0.092** | 1 | | | | |
| ROE | -0.048 | 0.030 | 0.022 | 1 | | | |
| SIZE | -0.094** | -0.071* | -0.125*** | -0.002 | 1 | | |
| AGE | -0.100** | 0.020 | -0.170*** | -0.053 | 0.282*** | 1 | |
| LEV | -0.092** | 0.035 | -0.046 | 0.476*** | 0.231*** | 0.140*** | 1 |

In addition, in order to avoid multicollinearity problems, this study uses the variance inflation factor analysis method to calculate the VIF value of variable regression. There is no correlation among variables in this study, as shown in Table 4

*Table 4: Moderating Effect Results.*

| Variables | EC | PC | ROE | SIZE | AGE | LEV |
|---|---|---|---|---|---|---|
| VIF | 1.02 | 1.05 | 1.33 | 1.16 | 1.13 | 1.41 |

### *4.2. B. Regression Analysis*

Table 5 shows the results of multiple linear regression.The results of model (1) show that EC significantly promotes RD (= 0.144, $p < 0.01$). It indicates that the implementation of environmental regulation policy has greatly stimulated green technology innovation of Chinese listed enterprises. H1 has been confirmed. This shows that green technology innovation essentially an economic activity, which can only be carried out under specific environmental regulations and cannot be separated from local policies. As a means of the Chinese government to manage the environment, environmental regulation has mandatory binding force, which can effectively stimulate the innovation vitality of enterprises, and urge enterprises to improve production processes through technological innovation, so as to improve productivity and enhance profitability to compensate for environmental regulation.

The results of model (2) show that EC significantly promotes RD (= 0.138, $p < 0.01$). It indicates that the presence of government officials in the senior management team of Chinese listed enterprises will significantly promote enterprises to augment proportion of funds for green technology innovation. Therefore, H2 is proven. Under the condition that Chinese current market mechanism is not yet perfect, the government, as a supplementary means, must intervene in the allocation of resources. On the one hand, political connection can help enterprises to obtain information about government policies, so they can know the purpose of government decisions as soon as possible. On the other hand, political connection can help enterprises reach preferential policies while promoting technology innovation, thus alleviate the problem of insufficient funds for technological innovation to a certain extent.

The results of model (3) shows that political connection plays a negative moderating role between environmental regulation and green technology innovation (= 0.1430, $p < 0.05$). In other words, enhancing the oversight of environmental rules and regulations would boost business excitement for innovation, but the presence of political linkages will dampen the excitement. H3 is affirmed. At the

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same time, combined with the regression results of model (2), after adding the interaction term of environmental regulation and political connection in model (3), the promotion effect of EC on RD of enterprises has dropped from 0.1383 to 0.1294, which also shows that political connection plays a negative moderating effect.

As for control variables, return on net assets, enterprise scale, enterprise age, and asset-liability ratio all negatively impact green technology innovation. As a for-profit organization, the enterprises' fundamental purpose is to reach maximize capital. The enterprise with strong capital base and high survival rate in the market, and the stronger the strength, they can easily engage in projects with high rate of return with its original advantages. Green technology innovation activities have high risks and low profits in the short term, and enterprises have insufficient motivation to independently develop and innovate green technology. Among them, the age of the enterprise inhibits the financial support in innovation, which means the length of enterprises' listing influences its amount of green technology innovation investment. This is because in long-term business activities, enterprises have formed the ability to predict risks and predict market trends. "Old" enterprises are better at grasping policy loopholes and effectively avoiding policy pressure caused by environmental regulation than "new" enterprises. Therefore, green technology innovation activities are more difficult to carry out.

*Table 5: Moderating Effect Results.*

| Variables | (1) | (2) | (3) |
|---|---|---|---|
| EC | 0.144***<br>(5.94) | 0.138***<br>(5.71) | 0.129***<br>(5.28) |
| PC | | 0.647**<br>(2.44) | 0.734***<br>(2.74) |
| EC*PC | | | -0.143**<br>(-2.11) |
| ROE | -0.193<br>(-0.63) | -0.207<br>(-0.67) | -0.204<br>(-0.67) |
| SIZE | -0.100<br>(-0.87) | -0.081<br>(-0.71) | -0.091<br>(-0.80) |
| AGE | -0.088**<br>(-2.07) | -0.073*<br>(-1.71) | -0.073*<br>(-1.73) |
| LEV | -0.649<br>(-1.41) | -0.627<br>(-1.37) | -0.661<br>(-1.45) |
| Constant | 5.695**<br>(2.34) | 5.068**<br>(2.08) | 5.439**<br>(2.24) |

Notes: ***, * *, * are significant at the level of 1%, 5% and 10% respectively; the number in parentheses is the value of T.

### *4.3. Further Analysis*

Besides, this paper makes a separate detailed study on the impact intensity of PC and RD from 2016 to 2020, as shown in Table 6. It can be found that, except for 2019, the coefficient increased continuously from 0.238 in 2016 to 0.247 in 2020, indicating that a need for green technology innovation is gradually increasing because as government's environmental supervision system strengthens and the populace's knowledge about green consumption advances, which determines the increase of investment in R&D activities and the degree of attention is deepening.

*Table 6: The Coefficient of Environmental Regulation.*

| year | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| coefficient | 0.238 | 0.256 | 0.260 | 0.172 | 0.247 |

### *4.4. Robustness Test*

The method of substituting independent variable environmental regulation (EC) is used to assess the robustness of the study's result in terms of making it more reliable. According to Xu and Wang (2022), environmental regulation (EC) mainly includes two major expenditures: capital and cost [28]. The former includes expenditures for the procurement and renewal of pollutant discharge and emission reduction equipment, and expenditures for the renewal and purchase of existing environmental protection production lines, which are mainly reflected in the details of "projects under construction" in the financial

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statements; The latter includes fees of sewage discharge, greenness, and environmental management system certification, which is reflected in the "administrative expenses" breakdown of the balance sheet. Table 7 shows that the correlation and significance levels in all models are consistent with Table 5, except for variable coefficients and a small amount of significance level changes, and the main conclusions have not changed. Therefore, the results have high reliability.

*Table 7: Robustness Test.*

| Variables | (1) | (2) | (3) |
|---|---|---|---|
| EC | 0.140***<br>(5.66) | 0.135***<br>5.46 | 0.129***<br>(5.28) |
| PC | | 0 .591**<br>(2.29) | 0 .656**<br>2.52 |
| EC*PC | | | -0.123**<br>(-1.89) |
| ROE | -0.229<br>(-0.74) | -0.225<br>(-0.73) | -0.203<br>(-0.66) |
| SIZE | -0.063<br>(-0.54) | -0 .082<br>(-0.72) | -0.098<br>(-0.86) |
| AGE | -0.091**<br>(-2.16) | -0 .078*<br>(-1.85) | -0.079*<br>(-1.86) |
| LEV | -0.601<br>(-1.30) | -0.695<br>(-1.51) | -0.678<br>(-1.48) |
| Constant | 3.645**<br>(1.32) | 5.221**<br>(2.14) | 5.675**<br>(2.32) |

Notes: ***, * *, * are significant at the level of 1%, 5% and 10% respectively; the number in parentheses is the value of T.

## 5. Conclusions and Recommendations

### *5.1. Research Conclusions and Policy Recommendations*

This study uses data from 260 Chinese listed enterprises from 2016 to 2020 as a sample to study the relationship between environmental regulation, political connection and green technology innovation. The conclusions are as follows: (1) Environmental regulation significantly promoted the green technology innovation. In further research, the role of environmental regulation in promoting green technology innovation investment continued to improve as the time goes by. (2) The political connection of enterprises significantly promoted green technology innovation. (3) Political connection weakened the positive impact of environmental regulation on green technology innovation, which played a negative moderating role. Focusing on the research conclusions, this study offers four suggestions from the viewpoints of government and enterprises, which are integrated with the current situation.

Firstly, the enterprise should reasonably balance the its political connection. Enterprises should try to allocate the proportion of executives with political backgrounds, so as to prevent deviations in making decisions and high potential of risk avoidance. These factors will affect enterprises to judge whether or not to engage in enterprise green technology innovation activities and how much funds to invest. Secondly, Enterprises should improve the internal governance mechanism to create an innovative atmosphere. In addition, enterprises should take technological innovation as the premise of strategic development and improve innovation efficiency by promoting green technology innovation activities. Thirdly, according to the growth requirements of different industries and the current situation of the overall market economy, government should establish diversified environmental regulating rules. This can provide good institutional support for green technology innovation by improving the adaptability between policies and enterprises. At last, the government can reinforce the foundation green technology innovation from education, making more efforts in establishing educational bases, continuously carrying out innovative academic exchange.

### *5.2. Research Limitations and Prospects*

This study has several limitations. Firstly, this study merely selects Chinese listed enterprises from 2016-2020 as sample and deletes some of them due to their incomplete or abnormal data, so the conclusions may be more or less subjective. If more comprehensive data can be acquired in the future, the time frame of the sample should be expanded to make the final research results more persuasive and

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credible.

Secondly, the two ways to analyze the political connection of listed enterprises are relatively rough. Several related factors are not be discussed, for example, there is no calculated data of proportion about executives with working experience in government. In future studies, researchers should quantify the measure of political connection, so that the moderating role of political connection can be better reflected.

Thirdly, the selection of control variables in this study is incomplete. In real life, there are many driving factors affecting green technology innovation of enterprises, such as education level, scientific and technological level, and government quality. In future study, these aspects should be considered and discussed.

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