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Original Paper

The impact of political connections on firm pollution: New evidence based on heterogeneous environmental regulation

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ABSTRACT

Increasing attention has been focused on the extent to which corporate political connections influence the growing pollution due to the rapid growth in the popularity of firm pollution in developing countries. We adopt a static threshold regression model to investigate the effects of heterogeneous environmental regulation on political connections and firm pollution based on the panel data from China's A-share listed companies from 2012 to 2019. The empirical results show a non-linear relationship between the degree of political connection of listed company executives and the level of firm pollution. And the relationship between the two roughly presents a U-shaped relationship under the action of the market-incentive environmental regulation threshold. However, it roughly presents an inverted N-shaped relationship under the action of the command-control environmental regulation threshold. Additionally, the group test results show that the existence of regional and ownership heterogeneity causes certain differences in the environmental behaviour of politically connected enterprises. These findings indicate that diverse environmental regulations are needed to promote sustainable green development and to further expand the theoretical and practical exploration of political connections on firm pollution.

1. Introduction

Carbon emission reduction and green development have increasingly become the focus of the global economy due to the climate crisis (Ren et al., 2022a, 2022b; Wang et al., 2022; Xiang et al., 2022). Governments around the world have strengthened various environmental regulatory policies to restrain environmental pollution. China has made remarkable achievements in economic growth as the world's second-largest economy in the past 40 years. However, the long-term extensive economic development model has caused serious energy waste and environmental pollution (Yan et al., 2022; Zhu et al., 2019), and firm pollution is an important factor leading to high consumption and high pollution (Deng et al., 2019; Meng et al., 2013). To further their economic interests, many enterprises have carried out a series of illegal operations, seriously threatening the quality of the ecological environment and the physical and mental health of residents. As a result, the Chinese government is currently focused on the protection and management of ecological resources and the environment, and has issued a series of environmental regulatory policies to intervene and monitor corporate activities. Following this move by the Chinese government, corporate managers have begun to establish contact with politicians to influence the process. It is, therefore, important to consider the issue of political influence when exploring corporate environmental disclosure in China.

The impact of political connections on organizational outcomes has long been an important issue around the world (Faccio, 2006). The empirical evidence in existing studies shows that political connections help promote firm performance and value (Amore and Bennedsen, 2013; Goldman et al., 2009, 2013). Political connections help businesses receive a variety of preferential treatment, such as tax relief, access to financial and political resources and deregulation, thereby reducing risk and gaining a competitive advantage (Faccio, 2006). There is a growing body of literature that has explored the benefits of political connections in competing for government contracts or subsidies (Goldman et al., 2013) and the advantages of accessing capital market financing or bank credit (Liu et al., 2013). However, studies also show that the political experience of business leaders is a double-edged sword for environmental issues, which is not like having a more direct impact on fiscal activity (Qian and Chen, 2020). For one thing, polluting companies can obtain some key resources, such as permits and

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project approvals, through their political connections, while also avoiding negative environmental impacts or non-disclosure (Muttakin et al., 2018). For another thing, this relationship can also have a positive impact on the environment as politically connected companies face more pressure on government regulation and compliance mechanisms, especially when politics and management have a significant impact on business activities. Thus, in return for government financial assistance, affiliates can use it to gain political legitimacy and promotion (Li et al., 2015). Nonetheless, there is still little research on how political connections influence corporate environmental behavior (Jiang et al., 2021; Zong et al., 2020). Therefore, it is necessary to examine the relationship between the political connections of business executives and corporate behaviour towards environmental issues.

In addition, the Chinese government is implementing various environmental regulatory policies to maintain the ecological environment as environmental pollution becomes more prominent in the process of economic development (Ren et al., 2022c). The role of political connections in environmental regulation may vary (Zhan and Tang, 2016). On the one hand, the government and companies colluded to undermine environmental laws because of political connections, thereby reducing the actual effect of environmental regulation (Villiers et al., 2011). Deng et al. (2020) also pointed out that political connections could weaken the implementation of environmental regulations, thereby increasing corporate pollution. This is the reason that pollution regulations have become more stringent and emissions reduction are still not as effective. However, politically connected companies take environmental responsibility as a government requirement to obtain favourable regulatory conditions (Agrawal et al., 2001). This may produce effective environmental regulation. Furthermore, the value-destroying effects of environmental regulations on polluting firms are more pronounced in firms with no political affiliation and in regions where judicial enforcement is more effective (Li et al., 2019b). However, the existing research on the relationship between political connections and firm pollution still focuses on the linear relationship, ignoring the mechanism analysis of the nonlinear relationship between the two. Thus, the question that arises is whether different levels of environmental regulation have different effects on the impact of political connections and firm pollution? This question remains to be tested.

This study poses the following questions based on the above discussion: Is there a non-linear relationship between the level of political connection of executives and the level of firm pollution? Can diversified environmental regulation affect the relationship between political connections and corporate pollution? How do government departments set standards for the regulation of heterogeneous environments? An exploration of these issues will provide an important reference value for relevant departments such as government and enterprises to establish an effective environmental supervision system.

Our research makes the following contributions: First, this study finely measures the extent of corporate political connections, further enriching the study of the influence of political connections and informal mechanisms on corporate environmental decisions. This is a deviation from most studies that focus on the impact of political connections on corporate economic decision-making rather than on environmental decision-making (Marquis and Qian, 2014). Second, this study utilizes threshold model to test the nonlinear relationship between *Pclevel* and firm pollution, taking full account of changes in development stages and expanding research methods on *Pclevel* and firm pollution. Third, this paper explores the external environmental mechanisms that influence the nonlinear relationship between *Pclevel* and firm pollution, namely *MER* and *CER*, filling the gap in relevant research. Finally, the heterogeneity analysis is carried out from the perspectives of regional and enterprise ownership to assist local governments in formulating suitable strategies.

The rest parts of this study is structured as follows: Section 2 briefly reviews the relevant literature and establishes our hypothesis. Section 3 captures the data and model used in this paper. Section 4 presents the results and findings based on empirical testing. Section 5 summarises and outlines some policy implications.

2. Theoretical analysis and research assumptions

2.1. Political connections and firm pollution

Political connections are special ties between a company's top executives and government officials. In China, when a senior business executive is a current or former government official, a representative of the National People's Congress, or a member of the National Committee of the Chinese People's Political Consultative Conference, the business is considered a politically connected (Bertrand et al., 2018; Cai and Sevilir, 2010; Faccio, 2010; Fan et al., 2008; Schweizer et al., 2017; Zheng et al., 2015). From the resource dependence theory perspective, many countries have enterprises that openly or covertly influence the formulation of the government's public policy to obtain resources and conditions that are conducive to the development of their business operations (Faccio, 2006). Therefore, political connection, as a valuable external social relationship, is an important informal channel for the government to intervene at the enterprise level (Zhang, 2017).

Current research on political connections mainly focuses on two aspects. On one hand, political connections have the role of a 'supporting hand'. Corporate executives are more conscious of their environmental responsibilities when they are politically connected (Chang et al., 2015), thereby improving corporate environmental performance and reducing firm pollution (Lin et al., 2015). Political connections of executives can enable companies to obtain green subsidies to promote corporate environmental protection and green innovation behaviours (Zhang, 2017; Zhou, 2013) and bring huge benefits to the development of enterprises. Consequently, politically connected companies have better environmental performance. On the other hand, research shows that political connections can distort corporate behaviour and act as a 'predatory hand' (Shleifer and Vishny, 1994; Villiers et al., 2011). For example (Fang and Guo, 2018), found that when a politically connected company commits an environmental violation, the local government would protect the company by mitigating or even exempting it from punishment, thereby reducing the cost of environmental violations. Politically connected firms are also vulnerable to short-term government economic goals, thereby increasing short-term, low-risk production projects and reducing long-term, high-risk innovation investments resulting from environmental disclosure (Chen et al., 2017). He and Cai (2019) stated that excessive political connections can increase rent-seeking costs and corporate pollution but inhibit corporate innovation and increase corporate pollution.

However, most studies measure political connection as a binary variable. That is, a firm is considered to have political connection to a firm if it has a clear affiliation with it (Marquis and Qian, 2014; Wu et al., 2016). This metric ignores multiple connections of a firm (Qian and Chen, 2020). Some studies have shown that it is not only the existence of the connections,but also the intensity of it in different management hierarchies (Liu et al., 2017). The purpose of this study is to explore the political connections among publicly traded companies. Given the double-edged nature of political connections, it is reasonable to assume that there may be some

kind of non-linear relationship between the degree of political connection and firm pollution. Summarising the above arguments, we propose the following hypotheses.

H1. There is a non-linear relationship between the level of political connection and firm pollution.

2.2. Theoretical mechanism of political connections affecting firm pollution

China's environmental problems are becoming urgent and serious, prompting the Chinese government to realize the importance of environmental protection. Therefore, in order to achieve the goal of carbon neutrality and carbon peak, industrial decarbonization is advocated to reduce greenhouse gas emissions (Li et al., 2022; Ma et al., 2022; Zhang et al., 2022a; Zhang et al., 2022b). Especially for industrial enterprises, a series of environmental protection measures have been introduced to deal with the pollution problem. Three Simultaneous system, sewage charging system, environmental administrative punishment and environmental protection target responsibility are the main measures (Zhu et al., 2021). Following this, this paper introduces the concept of environmental regulation and discusses the influence of political connections on corporate pollution under different environmental regulations.

MER is an economic stimulus-oriented business investment in the environment for sustainable development purposes. The research results show that a reasonable *MER* can directly affect the production and operation of enterprises, and can effectively reduce the control cost of social environmental pollution (Cheng et al., 2017). To maintain relations with government departments, companies with political connections are more likely to actively respond to national environmental protection policies, thereby reducing firm pollution. However, strict *MER* will prompt politically connected companies to play the role of political resources when choosing between environmental costs and corporate profits. They may likely seek government asylum and take economic actions to reduce environmental costs. This means that *MER* may strengthen the positive relationship between the government and polluting companies (Deng et al., 2020). Politically connected businesses may even communicate to policymakers on whether high environmental criterion are feasible and may persuade governments that it is pragmatic to relax standards (Zhang, 2017) or even accept lower environmental regulation standards by bribing local government officials (Maung et al., 2016; Yu et al., 2019) as a means of avoiding environmental regulations and penalties (Deng et al., 2020; Yu and Yu, 2011). Thus, it is detrimental to sustainable development for (Manderson and Kneller, 2012; Wang et al., 2019). The following hypothesis is proposed based on the above analysis.

H2. Different degrees of MER have different effects on the relationship between political connections and firm pollution.

CER is a mandatory environmental policy for companies engaged in production activities related to the environment in a specific period or region (Tang et al., 2020). The government formulates stricter emission reduction targets by promulgating environmental protection regulations and government regulations and establishes clear environmental standards to directly intervene in the behaviour of enterprises that damage the environment, thereby increasing the cost of pollution discharge and pollution control. Therefore, when government departments choose to reduce the *CER* intensity to compete for resources or pursue economic interests, enterprises with political resources are more inclined to reduce the cost of pollution discharge and produce environmentally unfriendly behaviours. In addition, lower *CER* allows the government and enterprises to collude. Politically connected enterprises tend to choose the government as the 'protective umbrella' to avoid environmental responsibility. However, a strict *CER* has national coercive and deterrent powers and will convey the government's commitment to its environmental development strategy. Therefore, under the pressure of high-intensity *CER*, enterprises, especially those with political connections, must take responsibility for environmental protection in response to the environmental protection policies of government departments. For example, eco-innovation is the key to improving the performance of companies in environmental management and meeting the requirements imposed by official environmental regulations (Wakeford et al., 2017; You et al., 2019). Based on the above analysis, the study proposes the following hypothesis.

H3. Different degrees of CER also have different effects on the relationship between political affiliation and corporate pollution.

3. Data and methodology

3.1. Data sources

This paper considers three main datasets: First, we used the database of the Institute of Public and Environmental Affairs (IPE) in the database as the primary source of corporate pollution indicators. Although environmental pollution is quite serious in China, there is a lack of authoritative databases at the enterprise level. As far as we know, the pollution inventory developed by the IPE is derived from real-time monitoring of pollution sources and is the most relevant and authoritative available database. The Center for Public Environmental Research is a non-governmental organisation dedicated to building an environmental database whose data is often used in recent studies (Deng et al., 2020; Marquis and Bird, 2018). Next, we obtained the accounting data of A-share listed companies and the resumes of corporate executives from the CSMAR database from 2012 to 2019. The political connection data was manually sorted according to the personal resumes of the executives. To clean up the data, we excluded the following observations: (a)companies without contamination information, (b) companies with invalid fixed assets and total assets information, (c) suspended or unlisted companies, (d) industry-specific companies such as *ST and those with financial classes each year and (e) Companies with financially unusual data such as incomplete data and missing variables. Our final sample includes 2092 companies with 9720 balanced panel data from 2012 to 2019.

3.2. Variable measurement

3.2.1. Dependent variable: Firm pollution

Firm pollution (*Pollution*) is the main variable of this study and can be measured by firms' environmental violations. The corporate environmental violation data was retrieved from the Institute of Public and Environmental Affairs (IPE). Among them are the firms that have been supervised many times and those that have repeatedly appeared, indicating that there are relatively serious environmental problems (Deng et al., 2020).

3.2.2. Independent variable: political connections

The degree of political connection (*Pclevel*) is a core explanatory variable in our analysis. A firm can generally be considered politically connected if its chairperson, chief executive officer, general manager, independent director, or any member of the board of directors is or was a government official (Marquis and Qian, 2014; Wu et al., 2016). Previous research has overlooked the full extent of a company's possible political connections, because both the

existence of political ties and the strength of such ties at different executive levels are important (Liu et al., 2017). Consistent with previous research, we measured the intensities of different political connections by whether the chairman or general manager of the company has served as officials in the government, party committee, the National People's Congress (NPC) Standing Committee, CPPCC Standing Committee, procuratorate, court, etc., or as party representatives, NPC deputies, or CPPCC members at different levels. We divided political connections into five levels (i.e., *Pclevel* = 0, 1, 2, 3 and 4), and the corresponding information of each level is shown in Table 1. If there is data for political connection in multiple level definitions, the maximum value is taken as the value of the political affiliation level of the enterprise. Their background information comes from the CSMAR database, which includes detailed personal characteristics and political stances of senior executives at each public company.

3.2.3. Threshold variables: MER and CER

MER: *MER* can adjust economic costs or benefits by changing the polluter-pays principle, i.e. using economic incentives to influence the behavioural decisions of polluters and indirectly achieving the improvement of environmental quality. Paying pollutant discharge fees is a market-oriented means to control the pollution discharge of enterprises and convert the external cost of environmental damage caused by emitters into internal costs of their production (Blackman et al., 2010; He et al., 2017; Xie et al., 2017). Previous studies have also shown that the sewage charging system can stimulate the environmental governance performance of enterprises (Wang et al., 2011; Yang et al., 2012). Therefore, following (Li et al., 2019a; Luo et al., 2021; Pan et al., 2019; Shen et al., 2019), we used the natural logarithm of sewage charges to measure *MER*.

CER: Administrative environmental legislation mainly refers to the command and control of environmental supervision tools such as the environmental impact assessment system, emission standards, and technical regulations, i.e. the use of administrative orders to control environmental pollution (Allen et al., 2018). The government has set clear boundaries for almost all polluting behaviour and there are prescribed punishments for those who do not comply (Xie et al., 2017). To meet the requirements, companies must take steps to reduce damage to the environment. Following (Liu et al., 2018), we used the natural logarithm of the number of regional environmental administrative penalty cases to measure *CER*.

3.2.4. Control variables

Following previous studies, several control variables that may influence corporate environmental behaviour are included in this study (Tang et al., 2020; Tsai et al., 2019; Wu et al., 2021). Specifically, the control variables we used in our analysis include firm age (*Firmage*), is measured as the number of years since a firm's founding date. Cash flow (*Cashflow*), measured by net cash flow from operating activities divided by total assets. The ratio of debt to assets (*Lev*), measured with total liabilities divided by total assets, reflected the financial risk and availability of financial resources of an enterprise. Tobin's Q (*TobinQ*), is calculated as the ratio of market value to total asset and can reflect good market expectations. Market-to-book ratio (*BM*) is measured as book value to market value of equity. In addition, because corporate profitability also affects corporate environmental performance, we controlled return on total asset (*ROA*), which is measured as the ratio of net profit to the total net asset. Individual effects were also controlled for in the regression analysis.

3.3. Model design

3.3.1. Benchmark regression model

This paper constructs a benchmark regression model, which mainly includes an OLS regression model and an OLS regression model with quadratic terms as shown in Equations (1) and (2), respectively. To figure out the influence of political connections on corporate pollution and whether there is a non-linear relationship between the two, the following equations were used

$$Pollution_{i,t} = \beta_0 + \beta_1 Pclevel_{i,t} + \gamma_i X_{i,t} + \nu_t + \varepsilon_{i,t} \tag{1}$$

$$Pollution_{i,t} = \theta_0 + \theta_1 Pclevel_{i,t} + \theta_2 pclevel_{i,t}\hat{2} + \vartheta_i X_{i,t} + \nu_t + \varepsilon_{i,t} \tag{2}$$

where i and t denote industry and year, respectively. Pollution represents the number of corporate violations, $Pclevel_{i,t}$ represents the degree of political connection, $Pclevel_{i,t}\hat{2}$ is the quadratic term of $Pclevel_{i,t}$, β_0 and θ_0 are constant terms. β_1, $\theta_1, \theta_2, \gamma_i$ and ϑ_i are the corresponding coefficients of the variables. $X_{i,t}$ is control variables, including firm age (*Firmage*), cash flow (*Cashflow*), profit rate of asset (*ROA*), asset-liability ratio (*Lev*), Tobin's Q (*TobinQ*) and price-to-book ratio (*BM*). ν_t stands for controlling the individual term, $\varepsilon_{i,t}$ represents the random error term. All variables were logarithmically processed to reduce the effect of heterogeneity.

3.3.2. Static threshold regression model

This study discusses the nonlinear relationship between the degree of political affiliation and corporate pollution caused by *MER* and *CER* using Hansen's (1999) panel threshold model to ensure that the sample interval delineation is reasonable and to reduce model estimation errors; see Equations (3) and (4). The following part of this paper takes *MER* and *CER* as the threshold variables to build the threshold effect model:

$$\begin{aligned} pollution_{i,t} = {} & \alpha_0 + \alpha_1 Firmage_{i,t} + \alpha_2 Cashflow_{i,t} + \alpha_3 ROA_{i,t} + \alpha_4 Lev_{i,t} \\ & + \alpha_5 TobinQ_{i,t} + \alpha_6 BM_{i,t} + \alpha_7 Pclevel_{i,t} + \alpha_8 Pclevel_{i,t} \\ & I(MER_{i,t} < \gamma_1) + \alpha_9 Pclevel_{i,t} I(\gamma_1 \le MER_{i,t} < \gamma_2) + \cdots + \\ & \alpha_{m+8} Pclevel_{i,t} I(MER_{i,t} \ge \gamma_m) + \nu_t + \varepsilon_{i,t} \end{aligned} \tag{3}$$

Table 1
Information corresponding to political connections.

The degree of political connection	Positions of different levels	Representatives of different levels
Pclevel = 4	Ministerial cadres	National level
Pclevel = 3	Department-level cadres	Provincial level
Pclevel = 2	Division-level cadres	City-level
Pclevel = 1	Section-level cadres	District level and below
Pclevel = 0	No political connection	No political connection

$$pollution_{i,t} = \delta_0 + \delta_1 Firmage_{i,t} + \delta_2 Cashflow_{i,t} + \delta_3 ROA_{i,t} + \delta_4 Lev_{i,t} + \delta_5 TobinQ_{i,t} + \delta_6 BM_{i,t} + \delta_7 Pclevel_{i,t} + \delta_8 Pclevel_{i,t} I(CER_{i,t} < q_1) + \delta_9 Pclevel_{i,t} I(q_1 \le CER_{i,t} < q_2) + \cdots + \delta_{n+8} Pclevel_{i,t} I(CER_{i,t} \ge q_n) + \nu_t + \varepsilon_{i,t} (4)$$

In the above model, the meaning of the variables remains the same, $MER_{i,t}$ and $CER_{i,t}$ are threshold variables, α_0 and δ_0 are constant terms. $\alpha_0, \alpha_1, \ldots, \alpha_{m+8}, \delta_0, \delta_1, \ldots$, and δ_{n+8} are the corresponding coefficients of the variables. m and n represent the number of thresholds of *MER* and *CER* respectively. $\gamma_1, \gamma_2 \cdots \gamma_m$ and $q_1, q_2 \cdots q_n$ are the threshold sizes of *MER* and *CER*. I(+) is an indicative function. The test results show that there may be multiple thresholds, so we extended the single-threshold model to a multi-threshold model.

4. Empirical results and analysis

4.1. Descriptive statistics

The descriptive statistics and correlation for the key variables are reported in Table 2. Panel A reports the variable statistics for this study without the natural logarithm treatment. From the results, the average number of environmental violations per company is 1.758, 473 is the maximum value, and 0 is the minimum value. There is a vast difference between the maximum and the minimum value, and its standard deviation is 9.848, which indicates that the pollution status of different enterprises is different. The median and mean of *Pclevel* are 0 and 1.141, respectively, indicating that no more than half of listed firms have political connections. In addition, the pollution situation and size of different firms are susceptible to extreme values from the perspective of standard deviation, followed by the age of the enterprise. To clearly capture the empirical results, the data are abbreviated in this paper.

Panel B reports Pearson correlations for key variables over the entire sample period. As shown in Table 2, there is a notable negative correlation between political connections and firm pollution. It means that the higher the level of political connection of executives, the lower the pollution level of the firm. Also, the correlation coefficients for master variables are relatively low, suggesting that this study is not concerned about multicollinearity. We also utilized variance inflation factors (VIFs) to recognize possible model estimation issues that might be incited by multicollinearity (See Appendix A1). The VIFs for the variables range from 1.08 to 2.85, as well below 10. It is a commonly used rule of thumb for assessing potential multicollinearity problems.

In addition, we describe the environmental performance of enterprises under different levels of political connection and their trends over time to further explore whether there is a nonlinear association between the *Pclevel* and firm pollution. The results are shown in Figs. 1 and 2. Fig. 1 shows that the nonlinear relationship between political connections and corporate pollution is tenable, which first inhibits and then increases. The enterprises without political connection have worse environmental performance, while the environmental performance is relatively better when the political connection is 2. Moreover, on the one hand, Fig. 2 demonstrates the nonlinear relationship between political connections and corporate pollution. And on the other hand, it can also show that the overall pollution level of enterprises shows an increasing trend over time. The reason for the aggravation of industrial enterprises' pollution may be that enterprises evade environmental protection responsibility in order to realize short-term benefits, or it may be caused by lax environmental law enforcement and "rent-seeking" activities.

Fig. 3 shows the environmental performance of enterprises under different industry pollution categories and marketization degrees. The environmental performance of enterprises in heavily polluting industries is poorer than that in lightly polluting industries from the figure on the left. Enterprises have more illegal discharges to save environmental costs because heavily polluting industries will generate more wastes that are harmful to the environment in the business course. In addition, the corporate environment performed less well when marketization was low. It facilitates the illegal operation of enterprises because the low market-oriented system weakens the public's awareness of environmental protection.

4.2. Main results of the baseline model

Table 3 presents the results of our regression analysis that are related to the effects of political connections on firm pollution. As reported in Model 1, the strength of the political connection of enterprises inhibits firm pollution without considering other

Table 2
Summary statistics of variables.

Panel A: Summary statistics of main variables

variables	N	mean	sd	p50	min	max
Pollution	9720	0.477	0.755	0	0	6.161
Pclevel	9720	1.132	1.608	0	0	4.000
Firmage	9720	2.864	0.351	2.944	1.386	3.970
Cashflow	9720	0.044	0.127	0.044	−10.216	0.652
ROA	9720	0.037	0.126	0.033	−1.558	7.249
Lev	9720	0.461	0.262	0.456	−0.195	10.082
TobinQ	9720	1.887	2.344	1.489	0.000	192.705
BM	9720	1.258	1.442	0.791	0.000	19.153

Panel B: Pearson correlation coefficient matrix

variables	*Pollution*	*Pclevel*	*Firmage*	*Cashflow*	*Roa*	*Lev*	*TobinQ*	*BM*
Pollution	1							
Pclevel	−0.036***	1						
Firmage	0.087***	−0.109***	1					
Cashflow	0.027***	0.017*	−0.004	1				
Roa	−0.0160	0.030***	−0.030***	−0.378***	1			
Lev	0.167***	−0.032***	0.160***	−0.091***	−0.297***	1		
TobinQ	−0.073***	−0.0110	−0.003	−0.643***	0.508***	−0.126***	1	
BM	0.307***	−0.028***	0.167***	−0.050***	−0.106***	0.430***	−0.221***	1

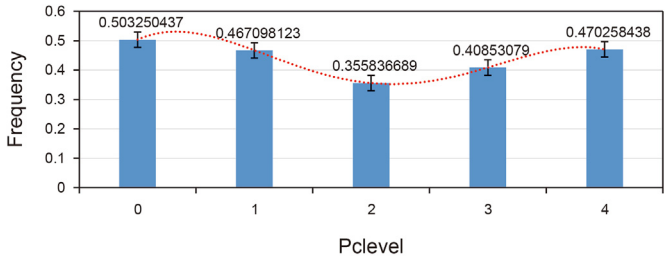

Fig. 1. The average number of environmental violations under different political connections.

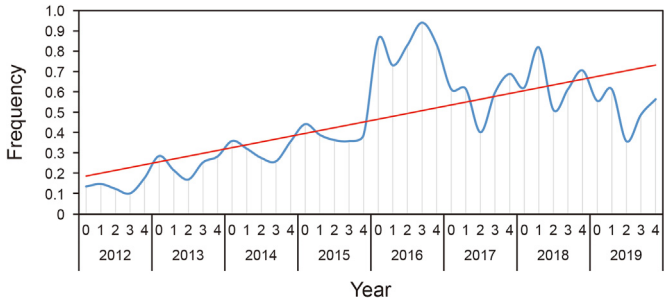

Fig. 2. The changing trend of environmental violations.

control variables, and the inhibitory effect is established at the 1% significance level ($\beta = -0.0297, \alpha < 0.01$). It may be because corporate executives who have worked or are working in high-level government departments have a higher corporate social responsibility and higher ethical standards. They can then better restrain themselves and actively respond to the national green environmental protection policy, thereby promoting the green development of a firm.

The result of Model 2 in Table 3 demonstrates that the political connection is negatively and significantly associated with firm pollution ($\beta = -0.0103, \alpha < 0.0051$) when other control variables are considered. It is similar to the interpretation of Model 1. According to the result of Model 3 in Table 3, the primary term of political connection is significantly negative and the quadratic term is significantly positive. This conclusion is basically consistent with Fig. 1. Thus there is a non-linear relationship between political connection and corporate pollution. It supports Hypothesis H1 and lays the groundwork for analysing the mechanism that affects the non-linear relationship between the two.

4.3. Threshold effect test and robustness estimation

Threshold model testing requires both a significance test and a plausibility test of the threshold effect. *MER* and *CER* were used as threshold variables to estimate the overall impact of political connections on firm pollution under different degrees of environmental regulation. The results show that the impact of political connections on firm pollution has single and double thresholds for *MER* and *CER*, respectively. The estimation results of the threshold model are shown in Table 4 and Table 5 respectively.

In Table 4, the results show that *MER* passed the single-threshold test at the 1% significance level, and the threshold value was 10.1792. The *CER* passed the double-threshold test at the 5% significance level, and the threshold values were 6.9594 and 7.4018.

Table 5 further analyses the threshold effects of different environmental regulations. The nexus between *Pclevel* and firm pollution will change as the thresholds change throughout the sample period. Model 4 in Table 5 shows the single-threshold regression results for *MER*. The results show that the regression coefficient is −0.0467 and is significant at the 1% level when the *MER* is lower than the threshold, i.e., the higher the degree of *Pclevel*, the less polluting is the behaviour of firms under the lower *MER*, and every increase of 1 unit of political connection strength can reduce 0.0467 unit of firm pollution. This shows that under the pressure of moderate *MER*, firms must pay sewage charges and increase investment in the environmental governance (Wang et al., 2021). However, when the *MER* is greater than the threshold, the regression coefficient is 0.0093 but not significant, indicating a slight positive correlation between *Pclevel* and firm pollution at this time. This may be because an overly stringent *MER* will cause politically connected companies to balance environmental costs and company benefits, and then hesitate or be counterproductive in the face of environmental protection. This appears to be a rather interesting phenomenon as most previous studies on the nexus between executives' *Pclevel* and firm pollution are mainly linear; in other words, for the same mechanism, they either promote the relationship between the two or inhibit the relationship between the two (Zhang, 2017). Our results demonstrate a non-linear relationship between political affiliation and corporate pollution as a function of the *MER* threshold, i.e. the relationship between the two significantly decreased with the increase of *MER*, and when the *MER* reached a certain level, the relationship between the two showed a slight positive correlation, which supports hypothesis H2. This provides a more accurate reference for government personnel to formulate environmental protection policies.

Model 5 in Table 5 shows the two-threshold regression results for *CER*. The results show that with the continuous increase of *CER*, the relationship between *Pclevel* and firm pollution approximates

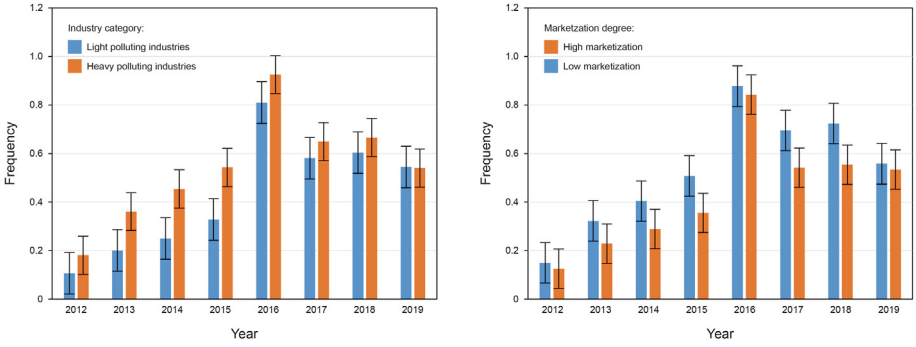

Fig. 3. The average number of environmental violations under different industry and marketzation.

Table 3
Results of baseline regression.

	Dependent variable: firm pollution		
	Model 1	Model 2	Model 3
Pclevel	−0.0297***	−0.0103**	−0.0554*
	(0.0052)	(0.0051)	(0.0236)
$Pclevel^{\wedge}2$			0.0117*
			(0.0064)
Firmage		0.5662***	0.5643***
		(0.0297)	(0.0297)
Cashflow		0.2140***	0.2122***
		(0.0743)	(0.0743)
ROA		0.0885	0.0877
		(0.0600)	(0.0600)
Lev		0.0623*	0.0618*
		(0.0326)	(0.0326)
TobinQ		0.0069**	0.0068
		(0.0041)	(0.0041)
BM		0.0736***	0.0763***
		(0.0065)	(0.0065)
Constant term	0.5105***	−1.2807***	−1.2718***
	(0.0168)	(0.0869)	(0.0869)
N	9720	9720	9720
R2-Adjusted	0.0043	0.0809	0.0809

Notes: The symbols ***, **, and* indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

an inverse 'N' type distribution. Specifically, the corresponding coefficient is negative but not significant when the *CER* is at a low level (*CER* < 6.9594). However, the corresponding coefficient is 0.0460 and significant at the 1% level when the *CER* is at a moderate level (6.9594 ≤*CER*< 7.4018), indicating that at a moderate level of *CER*, the strength of executives' political connections can significantly promote corporate violations. In addition, the corresponding coefficient is −0.0160 and is noteworthy at the 1% level when *CER* is at a high level (*CER*≥7.4018), indicating that under a high level of *CER*, *Pclevel* can significantly inhibit firm pollution, which supports hypothesis H3. A moderate level of environmental administrative regulation would prompt politically connected companies to use their political resources to seek government asylum. This will lead to more collusion between government and business, which is not conducive to the environmental protection development of enterprises. However, when the government adopts strict *CER*, the environmental regulation at this time has a strong deterrent and coercive force. It is difficult for firms to use political connections to evade environmental protection responsibilities. Conversely, politically connected enterprises should cater to the work of the government departments and take responsibility for corporate environmental protection, thereby significantly reducing firm pollution.

4.4. Heterogeneous analysis

With the acceleration of regional economic development, China's corporate political relations and corporate environmental performance have obvious regional characteristics (Chi et al., 2020;

Table 4
Test of threshold.

Firm pollution	Threshold variables	Threshold effects	F-statistics	P-values	Critical values			Threshold values	95% confidence interval
					1%	5%	10%		
Pollution	*MER*	Single threshold	52.80***	0.0033	38.7520	25.2580	19.7940	10.1792	(10.1332, 10.2179)
		Double threshold	13.11	0.3033	42.5243	29.6898	23.7193	11.4515	(11.4154, 11.4561)
		Triple threshold	11.29	0.1667	22.3559	16.4412	13.4515	12.1578	(12.1101, 12.1983)
	CER	Single threshold	45.90**	0.0200	49.1030	40.6731	36.0067	6.9594	(6.8650, 6.9632)
		Double threshold	24.26**	0.0300	28.7849	23.0279	20.5779	7.4018	(7.3815, 7.4091)
		Triple threshold	18.54	0.9600	114.0957	97.9384	84.2254	7.0942	(6.7627, 7.0976)

Table 5
Robust estimation of panel threshold regression under full sample.

All samples			
Model 4 (*MER*)		Model 5 (*CER*)	
MER<10.1792***	−0.0467***	*CER*<6.9594**	−0.0062
	(0.0085)		(0.0072)
MER≥10.1792***	0.0093	6.9594**≤*CER*<7.4018**	0.0460***
	(0.0059)		(0.0086)
		CER≥7.4018**	−0.0160***
			(0.0062)
Firmage	1.0611***	*Firmage*	1.0692***
	(0.0382)		(0.0393)
Cashflow	0.1171	*Cashflow*	0.1070
	(0.0759)		(0.0759)
ROA	0.0223	*ROA*	0.0227
	(0.0598)		(0.0598)
Lev	−0.0179	*Lev*	−0.0155
	(0.0342)		(0.0342)
TobinQ	0.0062	*TobinQ*	0.0054
	(0.0042)		(0.0042)
BM	0.0185**	*BM*	0.0198***
	(0.0072)		(0.0073)
Constant term	−2.5920***	Constant term	−2.5921***
	(0.1101)		(0.1132)
N	9720	N	9720
R-sq	0.112	R-sq	0.1071

Notes: The symbols ***, **, and* indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

Li and Jin, 2021; Lv et al., 2017; Ren et al., 2023; Yan et al., 2020). At the same time, state-owned enterprises (SOEs), which are firms that are controlled by government mechanisms, are also the backbone of China's national economy. Their strategic position and government ties make SOEs more accessible to policy incentives and support than non-state-owned enterprises (NSOEs) (Tang et al., 2020). Therefore, we will explore the threshold effects of heterogeneous environmental regulation on political connections and corporate pollution under different regions and ownership.

Combined with the characteristics of China's economic development, it is practically significant to explore the regional correlation between *Pclevel* and firm pollution under heterogeneous environmental regulation. To this end, we divide the regions where these companies are located into the eastern region and Midwestern regions for classification testing. The method used is consistent with Equations (3) and (4) and the results are shown in Table 6. Judging from the threshold regression results of different environmental regulations in different regions, the trend of the relationship between *Pclevel* and firm pollution in the eastern region with the change of *MER* is the same as that of the whole sample; thus, it is consistent with Model 4 in Table 5. In the central and western regions, *MER* also has a threshold effect and the threshold is less than that in the eastern region ($10.0560 < 10.4660$). This indicates that the Midwestern region is more sensitive to *MER* than the eastern region. In addition, it is found that the effect of implementing *MER* in the Midwestern regions is better than that in the eastern regions by comparing the coefficients. The possible reason is that the economic development level of the central and western regions is relatively low, and the collection of sewage charges makes enterprises pay more attention to the cost of environmental treatment. At this time, companies are more willing to implement environmentally friendly behaviors to reduce the economic penalties caused by environmental pollution. However, in the central and western regions, the relationship between *Pclevel* and corporate pollution is not affected by the threshold of imperative environmental regulation (the threshold test fails), i.e. there is no non-linear relationship between the two under the action of *CER*. Therefore, we considered whether there is some kind of linear relationship between the two under the influence of *CER*. In this regard, we tested the moderating effect of *CER* on the data of enterprises in the central and western regions (See Model 1 in Appendix A2). The results showed that the regulatory effect of *CER* was insignificant. Therefore, for politically connected enterprises, the implementation effect of *CER* in the eastern region is better than that in the Midwestern regions.

Regarding ownership, it is generally believed that NSOEs face stricter environmental regulations and more intense competition than SOEs. It is consistent with the corresponding results of *MER* in Table 7 because the *MER* threshold for SOEs is much lower than the *MER* threshold for NSOEs ($10.4689 < 12.2275$). It is also worth noting that the relationship between political connections and corporate pollution first decreased slightly and then increased significantly under the *MER* threshold in NSOEs, it is inconsistent with the trend of Model 4. This may be because, compared with SOEs, they will be more profit-oriented and ignore their corporate social responsibilities when NSOEs face fierce market competition, especially under strong supervision, political resources can prompt NSOEs to weaken the supervision pressure of *MER*, thereby increasing firm pollution. In addition, it can be seen from Table 7 that the threshold effect of *CER* on the political connections and environmental performance of NSOEs is consistent with Model 5. However, the threshold does not exist in SOEs. Therefore, under the influence of *CER*, there is no non-linear relationship between *Pclevel* and corporate pollution in SOEs. To verify whether *CER* affects the linear relationship between the two, we further tested the moderating effect of *CER* (see Model 2 in Appendix A2). The results present that the moderating effect of *CER* on *Pclevel* and corporate pollution is insignificant in SOEs, indicating that the implementation effect of *CER* in NSOEs is better than that in SOEs.

5. Conclusions and policy implications

This study focused on Chinese companies since China is one of the largest carbon-emitting regions in the world. It considered China's A-share listed companies from 2012 to 2019 as the samples, empirically tested the impact of *Pclevel* and firm pollution and tested the threshold effect of heterogeneous environmental regulation. We also examined the threshold effects of heterogeneous environmental regulation in different regions and under different ownership conditions. The study found that there is a nonlinear relationship between *Pclevel* and firm pollution, and this relationship will change with the changes of *MER* and *CER*. The study also found an approximate 'U'-shaped relationship between *Pclevel* and firm pollution under the *MER* threshold. That is to say, a moderate intensity of *MER* can significantly reduce the pollution level of enterprises with political connection, while a high intensity of *MER* makes enterprises pay more attention to profits, thereby stimulating the utilization of political resources and producing unfriendly behaviors to the environment. Furthermore, there is an approximate inverse 'N'-type relationship between *PClevel* and firm pollution under the threshold of *CER*. A medium-intensity *CER* will prompt enterprises to seek opportunities to collude with the government, while a high-intensity *CER* has a strong deterrent and coercive power, which will prompt enterprises to assume environmental responsibility to maintain political relations, thereby reducing pollution. From the perspective of regional characteristics, the sensitivity of the central and western regions to *MER* is higher than that of the eastern regions due to the differences in economic environment; Regarding enterprise ownership, the environmental impact of *CER* on NSOEs enterprises is better than that of SOEs. The value and innovation of this paper lie in the use of a representative sample to analyse the non-linear relationship between political connections and environmental violations under the threshold of heterogeneous environmental regulation intensity for enterprises in different Chinese regions and among different ownerships. In the end, more reliable and novel conclusions were drawn.

The following policy recommendations are suggested based on our research: It is necessary that the government establishes an environmental supervision system that adapts to local conditions, clarifies the standards for collecting sewage charges and environmental administrative penalties in various regions and gives full play to enterprises' political resources to promote environmentally friendly behaviours. Part of the government can promote the payment system of pollution discharge fees in the central and western regions, while imposing strict mandatory environmental regulations on non-state-owned enterprises. In addition, government departments should establish an environmental supervision system for the disclosure of external information, actively encourage complaints and reports of environmental pollution incidents, increase the channels for corporate environmental complaints and

Table 6
Threshold regression results based on regional heterogeneity.

The eastern region				Central and western regions			
MER		*CER*		*MER*		*CER*	
Firmage	1.0907***	*Firmage*	1.0832***	*Firmage*	0.9918***	*Firmage*	1.0141***
	(0.0459)		(0.0471)		(0.0707)		(0.0724)
Cashflow	0.1549*	Cashflow	0.1489	Cashflow	−0.0387	Cashflow	−0.0519
	(0.0928)		(0.0926)		(0.1658)		(0.1660)
ROA	0.1279	*ROA*	0.1404	*ROA*	−0.0007	*ROA*	−0.0050
	(0.1198)		(0.1194)		(0.0716)		(0.0717)
Lev	0.0036	*Lev*	0.0084	*Lev*	−0.0217	*Lev*	−0.0240
	(0.0603)		(0.0602)		(0.0417)		(0.0418)
TobinQ	0.0041	*TobinQ*	0.0031	*TobinQ*	0.0132	*TobinQ*	0.0119
	(0.0057)		(0.0057)		(0.0098)		(0.0099)
BM	0.0151	*BM*	0.0187**	*BM*	0.0252	*BM*	0.0238**
	(0.0092)		(0.0092)		(0.0118)		(0.0119)
MER<10.466***	−0.04***	*CER*<6.7685**	−0.0025	*MER*<10.0560*	−0.0919***	**The threshold for *CER* does not exist**	
	(0.0093)		(0.0089)		(0.0260)		
MER≥10.466***	0.0155***	6.7685**≤*CER*<7.4018**	0.0618***	*MER*≥10.0560*	−0.0034		
	(0.0073)		(0.0102)		(0.0100)		
		CER≥7.4018**	−0.0224***				
			(0.0076)				
Constant	−2.6774***	Constant	−0.0186**	Constant	−4.4358***	Constant	−4.4048***
	(0.1317)		(0.0076)			(0.4873)	(0.4871)
N	6600	N	6600	N	3168	N	3168
R-sq	0.1162	R-sq	0.1209	R-sq	0.0900	R-sq	0.0890

Notes: This table shows the regression results when *MER* and *CER* are used as threshold variables in different regions, respectively. The dependent variable is the firm pollution, and the independent variable is the levels of political connection (*Pclevel*). The t-statistics are reported in the parentheses. The symbols ***, **, and* indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

Table 7
Threshold regression results based on ownership heterogeneity.

SOEs				NSOEs			
MER		*CER*		*MER*		*CER*	
Firmage	1.4751***	*Firmage*	1.5815***	*Firmage*	0.8952***	*Firmage*	0.8650***
	(0.0789)		(0.0803)		(0.0448)		(0.0461)
Cashflow	−0.0519	*Cashflow*	−0.0396	*Cashflow*	0.1843**	*Cashflow*	0.1867**
	(0.1782)		(0.1783)		(0.0906)		(0.0906)
ROA	0.0618	*ROA*	0.0325	*ROA*	0.0844	*ROA*	0.0831
	(0.2786)		(0.2788)		(0.1079)		(0.1079)
Lev	0.1407	*Lev*	0.1458	*Lev*	−0.0025	*Lev*	−0.0019
	(0.1280)		(0.1282)		(0.0417)		(0.0417)
TobinQ	0.0228	*TobinQ*	0.0227	*TobinQ*	0.0075	*TobinQ*	0.0074
	(0.0147)		(0.0147)		(0.0054)		(0.0054)
BM	0.0105	*BM*	0.0150	*BM*	−0.0066	*BM*	−0.0062
	(0.0100)		(0.0100)		(0.0139)		(0.0139)
MER<10.1663**	−0.0515***	The threshold for *CER* does		*MER*<12.2059**	−0.0044	*CER*<7.4018*	0.0186**
	(0.0156)	not exist			(0.0069)		(0.0078)
MER≥10.1663**	0.0065			*MER*≥12.2059**	0.0640***	*CER*≥7.4018**	−0.0130*
	(0.0112)				(0.0156)		(0.0075)
Constant	−3.8743***	Constant	−4.1916***	Constant	−2.1433***	Constant	−2.0616***
	(0.2505)	(0.6181)	(0.2537)		(0.1251)	(0.3256)	(0.1287)
N	3680	N	3680	N	5544	N	5544
R-sq	0.128	R-sq	0.125	R-sq	0.105	R-sq	0.113

Notes: This table shows the regression results when *MER* and *CER* are used as threshold variables in different corporate ownership, respectively. The dependent variable is the firm pollution, and the independent variable is the levels of political connection (*Pclevel*). The t-statistics are reported in the parentheses. The symbols ***, **, and* indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

severely crackdown on corporate environmental pollution. For enterprises, it is necessary to balance the relationship between economic interests and green development, strictly review the senior management of enterprises with political resources and try to standardise the path of the political connections of enterprises to avoid 'political equilibrium'. There should also be an active response to the government's call to bear the responsibility of environmental protection, improve environmental performance, and achieve green and sustainable development.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Appendix A1
Test for multicollinearity

Variables	VIF	1/VIF
TobinQ	2.19	0.4561
Cashflow	1.89	0.5277
ROA	1.51	0.6616
Lev	1.41	0.7105
BM	1.35	0.7383
Firmage	1.05	0.9481
Pclevel	1.01	0.9864
Mean VIF	1.49	

Appendix A2
Regression results of the moderating variables

Results of regression tests		
	Dependent variable: Pollution	
	Model 1 (Central and western regions)	Model 2 (SOEs)
(1)Control variables		
Firmage	0.5830*** (0.0597)	0.6364*** (0.0698)
Cashflow	0.2372 (0.1617)	0.2589 (0.1792)
ROA	0.0024 (0.0715)	0.1782 (0.2744)
Lev	0.0003 (0.0408)	0.2836*** (0.1090)
TobinQ	0.0006 (0.0095)	0.0006 (0.0144)
BM	0.0529*** (0.0108)	0.0568*** (0.0096)
(2)Independent variable and moderating variables		
Pclevel	−0.0198 (0.0089)	−0.0252 (0.0100)
CER	−0.0091 (0.0088)	−0.0416 (0.0085)
(3)Moderating variables		
c_Pclevel_CER	−0.0028 (0.0053)	−0.0072 (0.0056)
Constant term	−1.1889*** (0.2033)	−1.1997*** (0.2490)
N	3120	3608
Adjusted R2	0.072	0.095

Note: *p<0.10; **p<0.05; ***p<0.01.
Among them, Model 1 in Appendix A2 examines whether command-and-control environmental regulation can moderate the relationship between political connections and firm pollution in the central and western regions.
Among them, Model 2 in Appendix A2 examines whether command-and-control environmental regulation can moderate the relationship between political connections and firm pollution in state-owned enterprises.
The results showed that the moderating effect of *CER* in model 1 and model 2 was not significant.

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