Social Networks Among Officials and Enforcement of Environmental Regulations: Evidence from China

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Abstract

In 2014, the Chinese central government launched its "war on pollution" and successfully brought down the national pollution level. A key question to consider is: what factors drive the successful implementation of Chinese environmental policies? Understanding this is crucial for successful policy design in any developing country.

In this paper, we explore the role of personal relationships between city officials and provincial officials in enforcing environmental targets. The literature has pointed out that while personal affiliations might have a negative effect, they can benefit organizational efficiency through channels such as coordination and better information. We show that cities where top officials have personal connections with provincial leaders achieve better performance in enforcing environmental targets set by the provincial government, as measured by the attention in provincial government work reports. We then investigate whether better performance is driven by promotion incentives or relationship attributes such as trust and improved information. Finally, we examine the behaviors of city officials when facing pressures from both the provincial government and the public. We find that while both connected and unconnected officials respond to public attention, one channel through which connected cities respond to public attention is via provincial government's responses to public concern about the environment. In contrast, unconnected officials are responsive to public concerns about the environment, regardless of the level of provincial government attention. Our study reveals the ways in which personal connections improve organizational efficiency and provides policy lessons to strengthen institutional design, capturing these benefits while avoiding the costs of personal connections.

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1 Introduction

As the Chinese economy grows, so does the demand for better environmental protection. Taming rising environment cost has become one of the top objectives for the Chinese government. In responding to the increased level of demand for better environment, the central government declared 'war' on pollution (Greenstone et al., 2021), and launched various national environmental campaigns such as the two-control zone (Tang et al., 2020), clean winter heating plan (Ebenstein et al., 2017), and the emission trading system (ETS) (Cui et al., 2021).

The enforcement of environmental policy in developing countries typically faces challenges, often existing merely as formalities. Yet, China has demonstrated effective policy implementation. Therefore a natural question to ask is how Chinese government able to achieve this. Recent literature, including works by Jia et al. (2015) and Jiang (2018), highlights the role of inter-official connections as an important channel for enforcing governmental policies through the hierarchical structure. Several factors explain this phenomenon. Firstly, promotion is widely viewed as a pivotal incentive for Chinese officials (Li and Zhou, 2005). Owing to China's hierarchical political architecture, promotions are typically sanctioned by superiors situated just one level higher, known as the "one-level up" system. This unique structure allows higher-tier officials to harness the aspirations of their subordinates, compelling them to execute central government policies (Chen et al., 2018b; Fang and Lyon, 2022). This reciprocal dynamic, fueled by lower-level officials' desire for sustained relationship with their superiors, fosters an environment where local government officials are motivated to proficiently carry out directives from their higher-ups. Second, personal connections among officials may serve a conduit for policy coordination so as to avoid principle agent problem. In a hierarchical structures, the top-down relay of policy directives often leads to significant agency costs. Subordinates at lower levels might delay, misconstrue, or even deliberately undermine directives from above if these don't align with their interests. This dynamic can make

it challenging for higher-level officials to trust that the resources they allocate will be used effectively to further their policy objectives. Informal relationships offer a potential remedy to this trust deficit. Through a consistent exchange of favors and interconnected career paths, these ties can foster trust, ensuring that policy goals are pursued more faithfully. This concept is supported by studies like those by Rudolph and Rudolph (1979) and Scott (1972) .Finally, superiors might have more detailed knowledge about the abilities and preferences of individuals with whom they have personal relationships. This can enable them to choose the most qualified individuals for policy execution. Such patterns have been consistently observed in labor market outcomes, as highlighted by Montgomery (1991) and others.

Evidence regarding the impact of such connections on policy outcomes primarily centers on economic results. For instance, Jia et al. (2015) and Jiang (2018) demonstrate that lower-level officials with personal ties to superiors achieve higher economic growth rates. Jiang and Zhang (2020) reveals that cities personally connected with top provincial officials receive more fiscal transfers. Similarly, Lei (2023) indicates that cities linked with top provincial leaders are more likely to have public infrastructure projects approved and accrue higher debt levels during the fiscal stimulus phase of a financial crisis. As the economy grows, so do environmental challenges. China recognizes the imperative to enhance its environmental performance, not just due to domestic resource constraints but also in response to escalating pollution issues that jeopardize public health. Curtailing emissions aligns China with the global sustainability and low-carbon initiatives, positioning it as an international leader in the eyes of the world (Wang, 2013). Thus, it's reasonable to assume that shared experiences and connections would influence the implementation of different environmental policies.

To test the hypothesis whether personal connections indeed plays a role in environmental policies enforcement, we start by investigating if personal networks, established through shared academic or professional experiences, play a

role in the enforcement of environmental goals set by provincial governments in Chinese cities. We exploit heterogeneity across provinces and time by evaluating the emphasis on environmental protection as presented in provincial government work reports. These reports offer a straightforward means to gauge the priority of environmental objectives within a comprehensive evaluation framework. Zheng et al. (2014) has demonstrated that the environmental commitment of upper-level governments, as reflected by the ratio of environmental policies in their reports, influences the enforcement intensity of lower-tier governments. Our findings directly scrutinize whether such connections truly influence officials in achieving their goals. If so, a notable shift in the provincial government's focus should significantly sway city officials' actions. We demonstrate that these connections serve as a direct conduit for upper-tier governments to ensure adherence to their environmental objectives, with connected city governments exhibiting heightened enforcement rigor when provincial emphasis on environmental matters is pronounced. We then proceed to show what are the motivations behind better performance by testing whether connected officials are more likely to get promoted if they achieve better performance.

Second, if connected officials do respond to upper-level government incentive, then we should also observe that non-connected officials respond to more public demand more directly. This is for two reasons. First, while Chinese officials are rewarded for their performance, they also face severe punishments for non-performance. In particular stability is often ranked among the most important objective (Chen et al., 2016) and official often react actively to issues that may lead to public event. Second, while environmental target is gaining importance. Economic growth is still one of the most important objectives for the Chinese government. To test whether this is the case, we examine how public attention differs from provincial government attention between the connected and unconnected cities. We find that for unconnected cities, public attention has a larger effect on pollution compared to the provincial government's attention. On the other hand, the provincial government's attention has a more

significant effect on connected cities.

This paper contributes to two strands of literature. First, we contribute to the recent growing literature on connections between subordinate and superior officials (Chen et al., 2022; Jia, 2017; Jiang, 2018; Jiang and Mei, 2020) in China. This strand of literature challenges meritocracy's role in explaining China's fast economic growth with a bad institution. We contribute to this literature by showing whether connections matter for environmental policy enforcement. Our result does indirectly test the validity of their hypothesis and confirm that patron-client network is an important mechanism of top-down administration in China. We also complement this literature by examining the behaviour of unconnected officials.

Second, we contribute to the vast literature on China's environmental policy effectiveness by providing the perspective of political economy. In Western countries, politicians often trade the environment for more jobs in exchange for votes (Jia, 2017).Studies such as Chen et al. (2018b); Zheng et al. (2014) explain why environmental policies work/do not work with the unique Chinese political structure and contributes to the explanation of variation in terms of environmental policy enforcement. We complement this literature by outlining the importance of connection and the role of attention on the environment from both the public and upper-level government.

This paper proceeds as follows. In the next section, we provide brief literature on the background of Chinese environmental policies and political system. In the third section, we examine the role of connection in environmental police enforcement. In the fourth section, we introduce public attention to the environment and examine how it affects local officials' behaviour. The last section concludes.

2 Background and Related Literature

2.1 Environmental regulation in China

China's rapid economic development in recent decades has come at a cost to the environment and to the health of the Chinese population. The World Health Organization (WHO) finds that ambient air pollution led to more than one million deaths in China in 2016 while annual average $PM_{2.5}$ levels in the Beijing-Tianjin-Hebei region have been over ten times WHO recommended limits (Wong and Karplus, 2017). Similarly, Chen et al. (2013) show that air pollution reduced the life expectancy of people living in northern China by 5.5 years.

The Chinese government has made significant strides in combating environmental pollution over the past years. The Air Pollution Action Plan introduced in 2013 led to notable improvements in air quality, particularly in cities like Beijing where PM2.5 concentrations fell by more than 35% between 2013 and 2017 (Chen et al., 2013). This strand of literature have shown that one way of how these policies are enforced is to make targe explicitly for local officials involved so they have proper incentives. Chen et al. (2018a) tested the effect of target based performance evaluation system for SO_2 emission reductions under the Two Control Zone (TCZ) policy in China. They demonstrates that adjustments to the political evaluation system could be an effective channel through which local bureaucrats can be incentivised to pay more attention to environmental protection.Kahn et al. (2015) examine a similar regime shift but focus on water pollution indicators, and provides empirical evidence in support of the effectiveness of the political promotion inventive mechanism. Zheng et al. (2014) found that the declines in local air pollution levels and industrial energy intensities were statistically significant determinants of the probability of promotion.

2.2 Network and the Chinese institution

The tournament theory, advanced by Li and Zhou (2005), argues that one of the most important objectives Chinese government officials have is promotion. Promotion is considered as the main objective for two reasons. First, promotion can bring officials larger political power, and such political power can also be translated into a greater economic return through bribery or rent-seeking (Xu, 2011). Second, Chinese government officials have few options outside the internal political labor market. If a provincial leader is separated from the government hierarchy, there is virtually no avenue for her/him to find a job elsewhere (Li and Zhou, 2005).

The Chinese political system is characterized by multidimensional form (M-form) bureaucracy (Qian and Xu, 1993; Xu, 2011) which made performance differences between officials distinguishable and comparable, punishment and award based on performance are possible. This allows each level of government assess lower level governments in different measurable criteria and incentivise competition. In reality, connections between different level of officials or so-called patron-client relationship may well plays an important role in the interaction between upper and lower levels of governments. On the one hand, lower level officials who have connections with superiors has a significant higher chance of getting promotion, all other things equal (Jia et al., 2015). On the other hand, superiors appoint subordinates who have personal connections with them in order to build a stronger political position within a autocratic regime (Svolik, 2009), and to successfully implement any policies that serve the survival of the regime and superior themselves (Shih et al., 2012). To this end, connected subordinate will then faithfully execute the will of their superiors in exchange for future promotion.

3 Network, government attention and pollution

We start in this section by examining the role of connection in enforcing environment targets of the provincial government.

3.1 Data

We use data on 333 Chinese prefecture-level cities from 2007 to 2017, encompassing the second term of Hu Jintao administration and the first term of Xi Jiping administration. Our main data source on environmental indicators and city-level economic indicators comes from China City Statistical Yearbooks.

Our data on political connections and official personal characteristics comes from China Political and Business Elite Database (CPBED) from Ma and Guariglia (2022). Builds on the China Political Elite Database from Jiang (2018), CPBED contains detailed information on personal characteristics and experiences for all Chinese officials who are city-level (*dishiji*/*tingjuji*) or above.

To measure the focus on environment from provincial level leaders, we rely on provincial government work reports (*zhengfu gonguo baogao*) published by the government in each year. At the beginning of each year, each layer of local government in China presents their work report to the annually held National People's Congress and the Chinese People's Political Consultative Conference. The work report includes two parts. The first part summarise their jurisdictions' social and economic achievements in the past year such as GDP growth and environmental protection. The second part layouts the work plan and detailed targets for the coming year. It is considered one of the most important document government publishes in China as it is often widely reported in various news outlet. Failed to meet the target set in the work report not only means that officials are now less likely to get promoted but also facing higher pressure from the public.

We then conduct word frequency analysis to identify the words in all the

government work reports that are connected to environmental concerns. To facilitate the further matching work, we eliminate those words with frequencies less than 100 and select 30 environmental related words (See Appendix A for summaries). By matching the words extracted from the word frequency analysis with the content of the government work reports, it is possible to calculate the proportion of the number of sentences that contain environmental related words to the number of all sentences in each report. Accordingly, a higher proportion represents increasing government attention on the environment relative to other events.

3.2 Empirical Strategy

We estimated a model that is similar to the difference in difference (DD) strategy:

$$E_{cpt} = C_{cpt} + A_{pt} + C_{cpt} * A_{pt} + \boldsymbol{X}'_{cpt} + \lambda_t + a_i + \epsilon_{cpt} \tag{1}$$

where C is a dummy variable equals to 1 if the communist party sectary (CPS) or mayor of city c, in year t is connected to governor or party sectary of respective province p. A is the attention level of province p on environmental protection. We define that a CPS or mayor has connection if the CPS or mayor had worked or studied at the same place with the provincial party sectary or governor for 1 month at the minimum.

We include both city-level controls and official level controls. City-level controls are *GDP* which is the log of GDP, *Population* which is the log of city's population,*Fix Asset* which is the city's total fixed capital formation, *Real Estate* which is the total investments in real estate sector, and *Large Industry* which is the total output value of industrial firms with 50 million RMB revenue or more.

Official level controls include ages of CPS and mayor, education levels of CPS and mayor, gender of CPS and mayor and whether the CPS or mayor is

of ethnic minority.

E represents one of the dependent variables. We measure environment out using industrial dust/fumes (*dust*) and industrial Sulfur dioxide (SO2) emission.

Table 1 show the descriptive statistics of our main sample. Specifically, "Connected" denotes the C_{cpt} in equation (2) and "Attention(Gov)" represents the superior government attention.

[Tables 1 around here]

Table 2 shows the descriptive statistics of officials presented.

[Tables 2 around here]

3.3 Effects of network on pollution

Tables 3 and 4 show the primary results of estimating equation (2). Attention to the environment from superior government provides a significant incentive for local government to manage the environment, especially when subordinates are connected with their superiors, which is mainly verified by the interaction term of $Connected$ and $Attention(Gov)$. Specifically, in Table 3, columns (1) and (3) are results with different controls but without controls-specific year fixed effects, while columns (2) and (4) are results with controls-specific year fixed effects. According to column (4), superior government attention significantly reduces industrial sulphur dioxide emissions at 10% level when local governors are connected with their superiors. More specifically, 1% increase in the proportion of environmental related sentences in work reports would lead to 2.438% reduction in industrial SO2 emissions if governors are connected. Moreover, Table 4 shows the impact on industrial dust emissions and views a higher significance level. For example, in column (4), 1% increase in the proportion of environmental related sentences in work reports significantly reduces dust emissions 4.025% at 5% level. In addition, we also see some significance in government attention alone in Table 3 when controls-specific year dummies are included. In

this regard, it is possible to argue that superior attention to environment might provide incentives to unconnected subordinates as well. However, we cannot observe similar effects in estimations for dust emissions.

[Table 3 around here]

[Table 4 around here]

One of the most important concerns is that government attention can be dominated by precedent environment conditions, in which case the exogeneity of government attention is violated. Therefore, we append the average SO2/Dust emissions of last year across the province in estimations to mitigate possible endogenous effects. Tables 5 and 6 show results that eliminate possible endogeneity. For both tables, columns (1) and (3) are still results with different controls but without controls-specific year dummies, and columns (2) and (4) are results with controls-specific year fixed effects. Generally, significance remains constant compared with results in Table 3 and Table 4, which indicates that the impact of government attention is not altered by the concern of the possible endogenous factor. Additionally, the magnitudes of our interested terms (Connected * Attention) slightly decrease, implying that influences of precedent environment conditions has been captured successfully, concerning that the coefficients of last year's average provincial emissions are significantly positive at 5% level in estimations for SO2 and at 1% level in estimations for dust.

[Table 5 around here]

[Table 6 around here]

To further investigate the influences of government officials, we include extra controls to capture the officials' characteristics (Same with variables in Table 2. Tables 7 and 8 illustrate the results of estimations for SO2 and dust, respectively. In Table 7, columns (1) and (2) are results without eliminating possible endogeneity, where coefficients of government attention are not significant when connected with superiors. Alternatively, government attentions alone become

significant in columns (1) and (2), which indicates that, at least for impacts on SO2 emissions, local leaders' interests in managing the environment are not incited by the pressure of connected superiors but affected by officials' characteristics. This can be confirmed when columns (3) and (4) are considered where coefficients of government attention lose their significance completely when endogeneity is mitigated. However, there is a different story when telling about the dust emissions as shown in Table 8. Similarly, columns (1) and (2) are results without eliminating possible endogeneity, and columns (3) and (4) are results with eliminating possible endogeneity. We see some significance increases for interaction terms in columns (2) and (4), where controls-specific year fixed effects are considered. In specific, in column (4), which can be viewed as the most consolidated model, the interaction term is significantly negative at 5% level.

[Table 7 around here]

[Table 8 around here]

In summary, we find that higher provincial government's attention will incite city leaders to reduce industrial dust emissions if they are connected with their superiors, but such effects are not constant in SO2 emissions.

3.4 Motivations behind better performance

As frequently discussed in the literature, social networks can improve organisational efficiency through multiple channels, such as fostering long-term trust and transmitting more accurate information. However, in the Chinese context, another way social networks can strengthen incentives is through the increased likelihood of promotion for connected officials. Therefore, to determine the driving factor behind better performance in the Chinese context, we examine the following equation using a Probit model:

$$Promotion_{cpt+1} = E_{cpt} + C_{cpt} + E_{cpt} * C_{cpt} + \boldsymbol{X}'_{cpt} + \lambda_t + a_i + \epsilon_{cpt} \qquad (2)$$

Here we test whether connected officials will have better chance of getting promoted if they achieve better results in environmental performance.

4 The role of public attention

In this section, we examine the behaviour of connected and unconnected officials when facing pressures from both upper-level governments and public.

4.1 Data

To examine the role of public attention on environment,we collected Baidu Index for each city from 2011 to 2017 on a daily basis to construct the index for public attention. Baidu is China's largest search engine and Baidu Index reflects the daily search volume of different keywords in different cities [1]. We searched for all 30 keywords used in government work reports for better consistency.

Since the original Baidu Index data is on the daily level, we aggregate the index into the yearly level and calculate the percentage change from the mean value to show the variations. In this regard, we view the variation rate as the proxy of the change in public attention, as shown in Table 9.

[Table 9 around here]

4.2 Empirical Strategy

We estimated a model that is similar to the difference in difference in differences (DDD) strategy:

$$\begin{aligned} E_{cpt} =& C_{cpt} * A_{pt} * dA_{pt}^{Pub} + C_{cpt} * A_{pt} + C_{cpt} * dA_{pt}^{Pub} \\ &+ A_{pt} * dA_{pt}^{Pub} + \boldsymbol{X}'_{cpt} + \lambda_t + a_i + \epsilon_{cpt} \end{aligned} \tag{3}$$

dA_{pt}^{Pub} denotes the intensity of the public attention variation. Control vari-

[1] can be accessed at: https://index.baidu.com/v2/index.html

ables are the same as equation (1).

4.3 Results

Tables 10 and 11 show the robustness results of estimating equation (3). For both tables, columns (1) and (2) are results without mitigating endogenous factors, and columns (3) and (4) are results with eliminating endogenous factors (last year's average provincial emissions). "Economic Controls" represents control variables including ln(GDP), ln(Population), ln(Fix Asset), ln(Real Estate) and ln(Large Industry). "Growth Controls" represents "GDP growth" and "Population growth". Different reactions on SO2 emissions and dust emissions are observed. For example, in column (4) of Table 10, the "Connected * d_Attention(Pub) * Attention(Gov)" is significantly negative at 1% level when the interaction of connected relationship and public attention (Connected * d_Attention(Pub)) is significantly positive at 1% level. As a result, it is possible that public attention cannot push local leaders who connected with their superiors to concentrate more on the environment rather than economic development directly, but can make it by arousing superior attention to environmental issues. For unconnected officials, it seems that both public attention and government attention cannot provide enough incentives to focus more on the environment, at least for eliminating SO2 emissions. In addition, in column (4) of Table 11, public attention is significantly negative at 5% level, indicating that local governments do respond to the public concerns of reducing dust emission even when officials are not connected with their superiors. Given the condition that "Connected * Attention(Gov)" is still significant but at 10% level, a positive coefficient of "d_Attention(Pub) * Attention(Gov)" at 5% significance level implies that unconnected officials may not be likely to respond superior attention to the environment.

[Table 10 around here]

[Table 11 around here]

5 Conclusion

Many studies examined the mechanisms of how the national government enforces its environmental policy (Fang and Lyon, 2022) in China. We argue that another mechanism for how government officials enforce environmental protection policies is through connected local officials. Local officials with connections have stronger incentive to enforce upper level governments policies because of their personal relationship can bring trust, better information and also a stronger career incentive in executing the policies of upper-level officials more faithfully.

In this study, we first measure the connection between the city party sectary or mayor and the provincial party sectary or governor based on their common work or study experiences. We then explore the provincial heterogeneity by constructing the attention of the provincial government on environmental protection based on the province's government work reports using 30 environment-related keywords. By estimating the DD estimation using a sample from 2007 to 2017, we find that cities with connected mayor or CPS have lower SO2 emission or industrial fume emission compared to cities without connected CPS or mayors when the upper-level government attention on environmental protection is high.

We then examine the behaviour of local government officials when facing both superior attention and public attention. We measure public attention on the environment using Baidu Index with the same keywords as government work reports and use DDD estimation. We find that environmental outcomes are drastically different between connected and unconnected cities. For unconnected officials, the public attention on the environment puts much higher pressure on officials compared to connected officials. This result indicates that unconnected city-level officials are more concerned with environment-induced unrest or discontent when the public attention is high. On the other hand, when the public attention is low, unconnected officials adopt a more balanced

approach to different assessment criteria instead of faithfully executing the policies of their superiors.

Table 1: Descriptive Statistics for Main Variables

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Attention(Gov)	2,578	0.0646	0.0202	0.0166	0.154
Connected	2,578	0.107	0.309	0	1
ln(SO2)	2,574	10.44	1.108	0.693	13.43
ln(Dust)	2,525	9.731	1.093	3.526	15.00
ln(GDP)	2,578	7.027	0.926	4.441	10.02
ln(Population)	2,578	5.852	0.688	2.946	8.129
ln(Fix Asset)	2,578	15.84	0.962	12.79	18.98
ln(Real Estate)	2,578	13.77	1.270	9.268	17.50
ln(Large Industry)	2,578	16.49	1.210	12.21	19.59
Number of cityID	282	282	282	282	282

Table 2: Descriptive Statistics for Officials' Controls

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Minority(CPS)	2,578	0.0741	0.262	0	1
Gender(CPS)	2,578	0.0423	0.201	0	1
Minority(Mayor)	2,578	0.0652	0.247	0	1
Gender(Mayor)	2,578	0.0617	0.241	0	1
Age(CPS)	2,531	52.69	3.473	42	61
Age(Mayor)	2,504	50.18	3.772	29	61
Number of cityID	282	282	282	282	282

Table 3: Government Attention on SO2 Emissions

	(1) ln(SO2)	(2) ln(SO2)	(3) ln(SO2)	(4) ln(SO2)
Connected	0.103	0.0950	0.0744	0.0612
	(1.12)	(0.97)	(0.78)	(0.62)
Attention(Gov)	-1.206	-1.675*	-1.300	-1.828*
	(-1.29)	(-1.72)	(-1.40)	(-1.95)
Connected × Attention(Gov)	-2.777**	-2.870**	-2.338*	-2.364*
	(-2.06)	(-2.04)	(-1.72)	(-1.74)
ln(GDP)	0.0967	0.281	0.0190	0.230
	(0.60)	(1.15)	(0.10)	(0.85)
ln(Population)	-0.195***	-0.216*	-0.260***	-0.322**
	(-3.13)	(-1.91)	(-3.14)	(-2.54)
ln(Fix Asset)	-0.0850	-0.152	-0.0577	-0.0823
	(-1.12)	(-1.14)	(-0.71)	(-0.58)
ln(Real Estate)	0.108**	0.146**	0.0731	0.0741
	(2.54)	(1.98)	(1.64)	(0.93)
ln(Large Industry)	0.0672	0.000455	0.0854	0.0592
	(0.63)	(0.00)	(0.79)	(0.43)
Population growth			0.0600**	3.685
			(2.41)	(0.82)
GDP growth			0.0757**	0.207
			(2.08)	(0.36)
Control Year	No	Yes	No	Yes
Observations	2574	2574	2266	2266
R^2	0.345	0.369	0.362	0.395
Adjusted R^2	0.340	0.352	0.356	0.372
F	54.82	21.63	54.30	35.25

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Government Attention on Dust Emissions

	(1) ln(Dust)	(2) ln(Dust)	(3) ln(Dust)	(4) ln(Dust)
Connected	0.167	0.177	0.173	0.209
	(1.18)	(1.24)	(1.19)	(1.39)
Attention(Gov)	0.00433	-0.528	-0.182	-1.009
	(0.00)	(-0.43)	(-0.16)	(-0.83)
Connected × Attention(Gov)	-3.634**	-3.770**	-3.504**	-4.025**
	(-2.22)	(-2.25)	(-2.12)	(-2.30)
ln(GDP)	0.396*	0.801**	0.285	0.614
	(1.68)	(2.36)	(1.09)	(1.56)
ln(Population)	0.133	0.148	0.0992	0.211
	(1.57)	(1.14)	(0.99)	(1.50)
ln(Fix Asset)	-0.0626	-0.247	-0.0445	-0.307
	(-0.66)	(-1.43)	(-0.44)	(-1.46)
ln(Real Estate)	0.0725	-0.0129	0.0460	-0.0307
	(1.27)	(-0.14)	(0.79)	(-0.26)
ln(Large Industry)	-0.192*	-0.331*	-0.137	-0.127
	(-1.69)	(-1.77)	(-1.18)	(-0.62)
Population growth			-0.00758	3.151
			(-0.22)	(0.53)
GDP growth			0.0319	0.333
			(0.50)	(0.41)
Control Year	No	Yes	No	Yes
Observations	2525	2525	2218	2218
R^2	0.231	0.264	0.248	0.286
Adjusted R^2	0.225	0.244	0.241	0.259
F	36.97	14.83	33.05	22.78

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Government Attention on SO2 Emissions (Consolidated)

	(1) ln(SO2)	(2) ln(SO2)	(3) ln(SO2)	(4) ln(SO2)
L.SO2(Province)	0.149**	0.150**	0.146**	0.162**
	(2.41)	(2.45)	(2.34)	(2.59)
Connected	0.0916	0.0869	0.0795	0.0654
	(0.99)	(0.89)	(0.85)	(0.68)
Attention(Gov)	-0.838	-1.304	-0.767	-1.125
	(-0.93)	(-1.38)	(-0.86)	(-1.22)
Connected × Attention(Gov)	-2.554*	-2.715*	-2.394*	-2.438*
	(-1.90)	(-1.95)	(-1.76)	(-1.79)
ln(GDP)	0.0325	0.129	-0.0138	0.174
	(0.23)	(0.56)	(-0.08)	(0.67)
ln(Population)	-0.212***	-0.251**	-0.266***	-0.346***
	(-3.39)	(-2.47)	(-3.22)	(-2.71)
ln(Fix Asset)	-0.0721	-0.0846	-0.0726	-0.0709
	(-1.01)	(-0.63)	(-0.92)	(-0.52)
ln(Real Estate)	0.0746*	0.0786	0.0683	0.0759
	(1.80)	(1.03)	(1.57)	(0.95)
ln(Large Industry)	0.0881	0.0828	0.0999	0.0769
	(0.96)	(0.63)	(1.02)	(0.58)
Population growth			0.0562**	4.061
			(2.49)	(0.92)
GDP growth			0.0758**	0.198
			(2.17)	(0.36)
Control Year	No	Yes	No	Yes
Observations	2308	2308	2264	2264
R^2	0.358	0.384	0.367	0.401
Adjusted R^2	0.353	0.367	0.361	0.378
F	56.95	23.99	54.32	39.61

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Government Attention on Dust Emissions (Consolidated)

	(1) ln(Dust)	(2) ln(Dust)	(3) ln(Dust)	(4) ln(Dust)
L.Dust(Province)	0.337***	0.317***	0.343***	0.320***
	(5.82)	(5.75)	(5.89)	(5.67)
Connected	0.162	0.193	0.160	0.205
	(1.17)	(1.37)	(1.15)	(1.42)
Attention(Gov)	-0.00553	-0.329	-0.0365	-0.710
	(-0.00)	(-0.29)	(-0.03)	(-0.59)
Connected × Attention(Gov)	-3.321**	-3.699**	-3.290**	-3.896**
	(-2.07)	(-2.28)	(-2.05)	(-2.34)
ln(GDP)	0.221	0.521	0.201	0.535
	(1.10)	(1.61)	(0.83)	(1.42)
ln(Population)	-0.000663	0.0367	0.00586	0.113
	(-0.01)	(0.30)	(0.06)	(0.83)
ln(Fix Asset)	-0.0854	-0.281	-0.0917	-0.285
	(-0.97)	(-1.46)	(-0.95)	(-1.39)
ln(Real Estate)	0.0685	0.00609	0.0537	-0.0114
	(1.25)	(0.06)	(0.96)	(-0.10)
ln(Large Industry)	-0.0747	-0.0777	-0.0636	-0.0512
	(-0.71)	(-0.40)	(-0.57)	(-0.26)
Population growth			0.0168	2.791
			(0.59)	(0.48)
GDP growth			0.0577	0.294
			(0.91)	(0.37)
Control Year	No	Yes	No	Yes
Observations	2223	2223	2180	2180
R^2	0.265	0.294	0.263	0.297
Adjusted R^2	0.259	0.273	0.256	0.269
F	35.34	14.34	33.92	21.04

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Government Attention on SO2 Emissions (Officials' Controls)

	(1) ln(SO2)	(2) ln(SO2)	(3) ln(SO2)	(4) ln(SO2)
Connected	0.0642	0.0311	0.0654	0.0375
	(0.63)	(0.29)	(0.66)	(0.36)
Attention(Gov)	-1.568*	-1.613*	-1.033	-0.936
	(-1.68)	(-1.67)	(-1.16)	(-1.01)
Connected × Attention(Gov)	-2.136	-2.074	-2.142	-2.168
	(-1.52)	(-1.38)	(-1.52)	(-1.46)
ln(GDP)	0.0758	0.199	0.0446	0.151
	(0.41)	(0.69)	(0.27)	(0.55)
ln(Population)	-0.257***	-0.310**	-0.264***	-0.333**
	(-3.07)	(-2.19)	(-3.17)	(-2.36)
ln(Fix Asset)	-0.0609	-0.103	-0.0756	-0.0959
	(-0.70)	(-0.73)	(-0.91)	(-0.70)
ln(Real Estate)	0.0664	0.0691	0.0617	0.0695
	(1.50)	(0.98)	(1.44)	(0.99)
ln(Large Industry)	0.0715	0.115	0.0838	0.127
	(0.63)	(0.77)	(0.81)	(0.89)
Population growth	0.0570**	-2.981	0.0532**	-2.618
	(2.38)	(-0.52)	(2.48)	(-0.47)
GDP growth	0.0661*	0.406	0.0650*	0.410
	(1.81)	(0.71)	(1.87)	(0.74)
L.SO2(Province)			0.150**	0.149**
			(2.34)	(2.16)
Officials' Controls	Yes	Yes	Yes	Yes
Control Year	No	Yes	No	Yes
Observations	2168	2168	2166	2166
R^2	0.358	0.424	0.364	0.429
Adjusted R^2	0.349	0.365	0.355	0.371
F	35.77	.	35.94	.

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Government Attention on Dust Emissions (Officials' Controls)

	(1) ln(Dust)	(2) ln(Dust)	(3) ln(Dust)	(4) ln(Dust)
Connected	0.137	0.211	0.113	0.198
	(0.92)	(1.34)	(0.80)	(1.30)
Attention(Gov)	-0.253	-0.495	-0.169	-0.419
	(-0.22)	(-0.42)	(-0.15)	(-0.35)
Connected × Attention(Gov)	-3.075*	-4.270**	-2.739*	-3.944**
	(-1.83)	(-2.25)	(-1.68)	(-2.16)
ln(GDP)	0.340	0.597	0.261	0.520
	(1.37)	(1.50)	(1.16)	(1.37)
ln(Population)	0.131	0.289*	0.0396	0.199
	(1.26)	(1.94)	(0.42)	(1.36)
ln(Fix Asset)	-0.119	-0.426**	-0.153	-0.389*
	(-1.19)	(-2.13)	(-1.59)	(-1.97)
ln(Real Estate)	0.0621	0.0270	0.0694	0.0362
	(1.12)	(0.23)	(1.29)	(0.32)
ln(Large Industry)	-0.109	-0.102	-0.0426	-0.0303
	(-0.97)	(-0.49)	(-0.40)	(-0.15)
Population growth	-0.0139	-5.834	0.0103	-5.497
	(-0.39)	(-0.83)	(0.34)	(-0.80)
GDP growth	0.0206	0.689	0.0420	0.638
	(0.36)	(0.73)	(0.75)	(0.70)
L.Dust(Province)			0.321***	0.287***
			(5.24)	(4.71)
Officials' Controls	Yes	Yes	Yes	Yes
Control Year	No	Yes	No	Yes
Observations	2122	2122	2084	2084
R^2	0.258	0.354	0.268	0.357
Adjusted R^2	0.247	0.286	0.257	0.289
F	18.68	.	19.74	.

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Descriptive Statistics for Public Attention

	Obs.	Mean	SD	Min	Max
Public Index (Mobile)	2219	0	0.993	-1	6
Public Index (PC)	2226	0	0.706	-1	6
Public Index (All)	2226	0	0.610	-1	6
d_Attention(Pub)	1908	-6.080	274	-11888	509.088

Notes: Public Index - Percentage change from the mean.
Notes: d_Attention(Pub) denotes the variation rate of the Public Index (All).

Table 10: Public Attention on SO2 Emissions (Officials' Controls)

	(1) ln(SO2)	(2) ln(SO2)	(3) ln(SO2)	(4) ln(SO2)
Connected	0.0618	-0.116	0.0525	-0.141
	(0.47)	(-0.84)	(0.38)	(-1.00)
d_Attention(Pub)	-0.00387	-0.00284	-0.00396	-0.00281
	(-1.43)	(-1.22)	(-1.40)	(-1.20)
Connected × d_Attention(Pub)	0.00897	0.0368***	0.00724	0.0368***
	(0.98)	(2.60)	(0.79)	(2.71)
Attention(Gov)	-0.379	0.796	-1.917*	-0.934
	(-0.35)	(0.65)	(-1.76)	(-0.73)
Connected × Attention(Gov)	-2.141	0.00621	-2.014	0.488
	(-1.48)	(0.00)	(-1.40)	(0.31)
d_Attention(Pub) × Attention(Gov)	0.0517	0.0372	0.0526	0.0363
	(1.23)	(1.03)	(1.21)	(1.01)
Connected × d_Attention(Pub) × Attention(Gov)	-0.121	-0.487***	-0.0979	-0.486***
	(-0.99)	(-2.60)	(-0.80)	(-2.70)
L.SO2(Province)			-0.273***	-0.279***
			(-11.35)	(-10.03)
Economic Controls	Yes	Yes	Yes	Yes
Growth Controls	Yes	Yes	Yes	Yes
Officials' Controls	Yes	Yes	Yes	Yes
Control Year	No	Yes	No	Yes
Observations	1201	1201	1199	1199
R^2	0.428	0.494	0.449	0.512
Adjusted R^2	0.413	0.435	0.434	0.456
F	2585.0	.	.	.

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Public Attention on Dust Emissions (Officials' Controls)

	(1) ln(Dust)	(2) ln(Dust)	(3) ln(Dust)	(4) ln(Dust)
Connected	0.107	0.175	0.0585	0.136
	(0.69)	(0.98)	(0.36)	(0.74)
d_Attention(Pub)	-0.00507**	-0.00574**	-0.00491**	-0.00583**
	(-2.14)	(-2.41)	(-2.04)	(-2.35)
Connected × d_Attention(Pub)	-0.000841	-0.0101	0.00260	-0.0101
	(-0.18)	(-1.15)	(0.71)	(-1.14)
Attention(Gov)	0.271	-0.227	-0.0808	-0.766
	(0.21)	(-0.15)	(-0.06)	(-0.47)
Connected × Attention(Gov)	-2.639	-3.667*	-2.040	-3.434*
	(-1.64)	(-1.88)	(-1.23)	(-1.74)
d_Attention(Pub) × Attention(Gov)	0.0682*	0.0795**	0.0655*	0.0812**
	(1.87)	(2.16)	(1.77)	(2.12)
Connected × d_Attention(Pub) × Attention(Gov)	0.00836	0.128	-0.0365	0.127
	(0.13)	(1.09)	(-0.71)	(1.07)
L.Dust(Province)			0.0249	-0.0273
			(0.47)	(-0.48)
Economic Controls	Yes	Yes	Yes	Yes
Growth Controls	Yes	Yes	Yes	Yes
Officials' Controls	Yes	Yes	Yes	Yes
Control Year	No	Yes	No	Yes
Observations	1159	1159	1121	1121
R^2	0.352	0.439	0.342	0.432
Adjusted R^2	0.334	0.371	0.323	0.362
F	1479.1	.	.	.

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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Appendix A Environment related keywords

Table 12: Word Frequency for Words Related to Environment

Word	Frequency
Environment	10071
Ecology	9447
Energy	3142
Pollution	2933
Energy saving	2744
Environmental Protection	1726
Emission reduction	1518
Sewage	1383
Rubbish	1273
Energy consumption	898
Green	746
Emissions	709
Greening	618
Atmosphere	614
The air	526
Water source	501
Pollutants	485
Low Carbon	473
Water quality	459
Soil	418
Protected areas	415
Wetlands	391
Afforestation	351
Amount of emissions	344
Sulphur dioxide	301
PM2.5	168
Source of pollution	134
Environmental Governance	–
Nature Conservation	–
Sewage treatment rate	–

Data sources and notes

* Words are from government work reports.

** Words are translated from Chinese.

*** Last three words are combination words which can not be included in the word frequency.