Pollution for Promotion

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Abstract

This paper demonstrates that China's high environmental pollution levels can partly be explained by the incentives embedded in the country's political institutions. Guided by a simple career concerns model with the choice of dirty and clean technologies, I examine empirically how promotion incentives of provincial governors affect pollution. To find exogenous variation in promotion incentives, I explore *within-governor* variation in connections with key officials due to reshuffling at the center and document the fact that connections are complementary to economic performance for governors' promotion. The data confirms the model prediction that connections increase pollution. Auxiliary predictions of the model are also confirmed by the data. First, a higher relative price of clean technologies increases the use of dirty technologies, and this substitution effect is strengthened by connections. Second, the impact of connections on pollution is more than proportional to their impact on GDP. The evidence from different sources of data is consistent with the interpretation that connections affect the efforts and policy choices of politicians.

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1 Introduction

China has experienced phenomenal growth rates over the last three decades, driven by an economic transition since 1978. This growth miracle, however, has been fueled by fossil energy sources with adverse impacts on the environment, both within China and across the globe.[1] Air pollution, as measured by the ambient concentrations of particulate matter (PM) and sulfur dioxide (SO_2), is among the worst in the world. Across China, only 1% of urban dwellers breathe air that would be considered safe by the European Union (The New York Times 2007). The pollution problem is by no means limited to the air, however, and water pollution is another pressing challenge.[2] In recent years, less visible issues such as heavy-metal pollution have also become salient. Part of the explaination for the pollution problem is structural change. In this respect, the pollution problem in China shares some common features with industrialized societies when they were less developed. But relative to its developmental stage, China has relied on an unusually high amount of polluting industries (Vennemo et al. 2009). In this paper, I demonstrate that China's high pollution levels can partly be explained by the incentives embedded in the country's political institutions.

It is generally suspected that pollution in China may have important political roots: abundant anecdotal evidence suggests that purposeful choices by political leaders are key to understanding the popularity of polluting technologies.[3] The logic is that politicians welcome polluting technologies in their regions when they have strong incentives to enhance growth, as economic growth is relevant for their promotion outcomes. Complaints regarding local politicians' laxity on pollution for the sake of their own careers occur on a daily basis. In recent years, many members of the National People's Congress and the National Committee of the People's Political Consultative Conference have argued that environmental quality ought to be considered in the promotions of politicians (*Legal Daily*, 2010). But the impact of these requests seems very weak at a stage when growth is the primary target for all levels of government, and hence for the success of political leaders. This is also an important reason why the targets of the Central government to reduce pollution have rarely been realized. For example, in 2001, the Central government pledged to cut SO_2 by 10% between 2002 and 2005. Instead, emissions increased by 27% (Economy 2007).

In this paper, I examine the impact of the promotion incentives on pollution empirically, guided by a simple career concerns model with choices of clean and dirty technologies as well as efforts. I use political connections between local governors and key officials at the political center as a source of variation in the career concerns emphasized in the model.

[1] For example, China overtook the United States in 2006 as the world's biggest emitter of carbon dioxide. Another example is that sulfur dioxides and nitrogen oxides spewed by China's coal-fired power plants fall as acid rain on Seoul, South Korea (The New York Times 2007).

[2] See *The River Runs Black* (Economy 2004) for a vivid discription of water pollution in China.

[3] For example, the following report says that the aim for higher GDP is the root of Yangtze River pollution: http://finance.ifeng.com/news/special/djlcngs/20110411/3847717.shtml; Another report argues that many polluting projects are constructed without permission of environmental bureaus due to the support of local governments: http://finance.ifeng.com/roll/20121108/7270597.shtml.

I document that connections and economic growth are complements for promotion in the data. Based on this empirical finding, I assume complementarity between connections and performance in the model: connections increase the marginal value of economic performance. This complementarity also implies that connections increase the marginal values of dirty technologies and efforts. As a result, the model predicts that connections increase pollution for a given level of effort. Meanwhile, more effort allows the politician a larger budget to afford more dirty inputs. The simple model also delivers two auxiliary predictions. First, a higher relative price of clean technologies increases the use of dirty technologies due to a substitution effect. Moreover, connections further strengthen the substitution effect because of their complementary role in promotion. Second, under the standard assumption that the production technology has decreasing returns to scale in the two types of technologies, the model predicts that the impact of connections on pollution is more than proportional to their impact on production.

I test the three predictions with provincial-level data between 1993 and 2010.[4] Two main empirical challenges are identification and data quality. The identification challenge is to find exogenous variation in political connections. A governor is defined as connected if at least one of his past colleagues entered the Politburo Standing Committee (who decide on the promotion of provincial leaders) due to the reshuffling at the center. But connections are not necessarily exogenous. For example, connected politicians might be appointed to regions where they can develop the economy without relying on dirty industries. To find exogenous variation in connections, I focus on *within-governor* variation: I examine how governors respond to gaining or losing connections due to the reshuffling of the Politburo Standing Committee, given that they have already been appointed.[5] This way, I can address the endogenous appointment concern that has been discussed yet often unsolved. For example, as Huang (1999) pointed out, "instead of monitoring the specific tasks that local officials perform, the central government carefully monitors political and professional credentials when they make personnel selections".

The second challenge, which is general for studies on the political economics of contemporary China, is that the data might be subject to gaming of politicians. To address this challenge, I employ data from various sources, including biographies of politicians open to the public, provincial-level outcomes from official yearbooks, river-quality data from national monitoring stations, weather shocks from the US National Oceanic and Atmospheric Administration (NOAA), as well as the complaints of citizens. This way, I can examine the impacts of career concerns with different lenses and check for the consistency of the findings based on different data sources.

To test the first model prediction, on the link between connections and pollution, I

[4]I start from 1993 because this is the year to which the detailed biographical data of politicians and pollutants can be traced back. Meanwhile, it is the division year of fiscal decentralization, which provides a stronger incentive for local politicians to generate growth.

[5]This strategy has a similar flavor to that in Blanes i Vadal et al. (2011) who explore within-lobbyist variation to evaluate the impact of connections on revenues of lobbying firms.

investigate province-level information on pollutants. I focus on Chemical Oxygen Demand (COD) in industrial waste water and industrial SO_2, a major pollutant in the air. I find that COD increases by about 25% and SO_2 by about 10% after a governor becomes connected to key officials in the Centeral Government. Moreover, industrial GDP increases by about 15% while non-industrial growth is unaffected, suggesting that sectors more responsive to government policies are affected more. I also use weekly data on river quality from various stations monitored by the Chinese Environmental Monitoring Bureau as a complement. The results are consistent with those using provincial-level COD data, showing that these findings are robust to measurement concerns.

To test the second model prediction, related to the interaction of connections and the relative price of inputs, I focus on the electricity generation sector. In China, two main technologies produce electricity: coal-fired thermal power is dirty and hydro power is clean. When droughts limit the use of water, hydro power becomes relatively more expensive. This creates a testing ground for my model. I find that droughts indeed increase coal-fired power use by about 4% and that connections further strengthen the impact of droughts to about 10%.

To check the third model prediction, that the effect of connections on pollution goes beyond a scale effect − i.e., pollution is proportional to GDP − I examine a scenario where a scale effect alone accounts for the impact of connections on pollution. I estimate the impact of connections on GDP and the correlation between GDP and pollutants in the data. The product of the two estimates can be thought of as the scale effect. In this scenario, connections increase COD by about 9% and SO_2 by about 5%. Hence, consistent with the model, the impact of career concerns on pollution goes beyond a simple scale effect.

In this paper, I interpret connections as a proxy for career concerns. Specifically, connections work as an accelerator that increases the marginal return of efforts or inputs. But I also examine alternative interpretations. Connections might work as protection for pollution so that connected governors can pollute more without worrying about being punished. In the data, neither pollutant growth nor the interaction of pollutant growth and connections affects promotion, suggesting that year-on-year change of pollution does not directly affect governors' career. Thus, protection for pollution is less relevant. I also examine the impact of connections on favors from the center by examining different types of transfers. I find that connections increase effort-related transfers rather than more discretionary transfers. In addition, I conduct various robustness checks on the main findings.

My findings suggest that connections have pros and cons. The welfare implication for an average citizen depends on how she trades off higher industrial output against more pollution. As an indirect measure of welfare, I use the number of complaints regarding environmental issues and do not find that the number of complaints increases along with connections. But this finding is limited by the fact that politicians with a promising career might repress complaints more.

My paper contributes to several literatures. First, it is an application of the theory of incentives in firms to the organization of governments. Since the seminal paper by Holmström (Holmström 1982, 1999), the theory of career concerns has been widely applied to the behavior of government agencies in both theoretical models (Dewatripont et al. 1999; Alesina and Tabellini 2007) and empirical analysis (Besley and Case 1995). Empirically, it is not easy to find exogenous variation in career concerns. Existing studies focus on the lame-duck effect due to term limits or age.[6] This paper provides another approach to the study of career concerns. To the best of my knowledge, mine is the first paper to examine the effect of career concerns using within-individual variation.

Second, in the context of China, an emerging literature in economics argues that career concerns play an important role in promoting growth, as provincial leaders are incentivized by promotion positively associated with economic performance. Due to the political structure that each province not only enjoys a certain degree of autonomy but also is self-contained in its functions, it is also feasible for provincial leaders to enhance growth once they are incentivized. This line of empirical literature finds that higher economic growth increases the probability of promotion (Li and Zhou 2005). Xu (2011) summarizes related studies. The finding is not uncontroversial, as social connections are thought to be a critical factor for promotion stressed by the political science literature.[7] Thus, the question is whether growth still matters for promotion once social connections are accounted for (Opper and Brehm 2007; Shih et al. 2012). In a related paper, my coauthors and I provide systematic evidence on the complementarity between connections and growth for promotion (Jia et al. 2012). This study focuses on one important consequence of promotional incentives: the environment.

In this respect, the paper contributes to a third literature on the political economy of the environment (e.g., List and Sturm (2006) on how election incentives affect environmental policies in the US and Burgess et al. (2012) on how private incentives of local politicians increase the deforestation in Indonesia).[8] In terms of external validity, the feature that politicians are strongly motived by promotion might be specific to China. However, the implication on how political incentives affect the environment is general. For instance, politicians who care about votes in democracies may face a tradeoff between job opportunities and the environment.[9]

A fourth related literature studies the value of political connections (Fisman 2001; Shih 2004; Khwaja and Mian 2005). It is not surprising that politicians or firms benefit from

[6] I do not focus on the effect of age in this paper. On the one hand, the central government set the mandatory retirement age at 65 for ministers in 1982, provincial party secretaries and governors. On the other hand, a leader is no longer subject to this requirement once he or she gets promoted. Given this institutional background, the effect of age is ambiguous.

[7] There is also a literature on factionalism in Chinese politics contributed by political scientists such as Nathan (1973), Dittmer (1995), Shih (2004), Bo (2007), and Shih et al. (2012). More closely related to this paper, Cai and Traisman (2006) speculate that growth-enhancing policies emerged from competition between pro-market and conservative factions in the Central government.

[8] A recent study (Wu et al. 2012) shows that the investment in environmental protection does not increase the promotion chance of city leaders, which provides an indirect way to understand why leaders have no incentive to invest in environmental protection.

[9] The Ilva steelworks scandal in south Italy is an example.

connections. But these private benefits might have social costs. Pollution is one of the examples of the potential social costs. Meanwhile, different from the favor-related channel stressed in this line of literature, I show that connections also affect the efforts and policy choices of politicians. If connections of politicians in China only worked through a favor channel, the outcomes would be very inefficient. In contrast, if connections of politicians also lead to more efforts and more pro-growth policies (despite the multi-tasking distortions of different dimensions of efforts), there are positive effects on economic growth.[10] This might be one reason why a society like China where connections play a critical role in business and politics can still grow fast.

Finally, existing studies on the political economy of contemporary China have also examined the impact of other characteristics of politicians, particularly the impact of inside versus outside politicians on local capture (Persson and Zhuravskaya 2011; Jia and Nie 2011). This characteristic does not vary within individuals. This paper studies the impact of political characteristics that may vary over time.

The paper is organized as follows. Section 2 lays out a theoretical framework of career concerns and pollution, which guides the empirical specifications. Section 3 describes the institutional background and the data. Section 4 presents the main empirical strategy and the baseline results and Section 5 includes robustness checks and discussions on the mechanisms. Section 6 discusses the welfare implications for an average citizen. Section 7 concludes the paper.

2 Theoretical Framework

The logic behind the anecdotal evidence on China's pollution is that politicians welcome polluting technologies in their regions when they have strong career concerns to promote growth, since polluting technologies are usually cheaper and generate growth faster than do clean technologies. To help formalize this logic, I need a model with three key elements.

First, there is a positive link between career concerns and output. This feature is shared by the standard career-concerns model (Holmström 1982). Second, there are at least two inputs, one clean and one dirty, with the clean one being more expensive. This feature is shared by the literature on trade and the environment that treats emissions as an input (Copeland and Taylor 2004). Third, variations in career concerns are allowed. I model this feature as different social connections to the key officials in the Center. This feature is specific to this paper and has empirical underpinnings. An empirical testing of this assumption is discussed in Section 2.3.

With these three features, in the model, a Local Governor (G_L) is motivated by career concerns to satisfy the Central Government (G_C). Different from the standard career-concerns model, I examine how G_L responds to career concerns by making two choices: one is on the

[10]This feature has a similar flavor as the multitasking model in Holmström and Milgrom (1991).

level of effort positively associated with his budget and the other is how to allocate his budget between a clean input and a dirty input. Local Governors differ in their social connections.

2.1 Model Assumptions

Technology The Local Governor G_L can produce output Y by using a dirty input (E), a clean input (K) and a third factor such as land or labor (L). The production function is as follows:

$$Y = E^{\alpha} K^{\beta} L^{1-\alpha-\beta}, \tag{1}$$

where $\alpha + \beta < 1$.[11] The dirty input (E) generates pollution. This is a shortcut to think about the policy instruments of G_L. In the real world, G_L can choose policies such as environmental regulations that affect the technology choices of firms. For simplicity, I assume L to be fixed and equal to 1. Thus, the production function can be rewritten in logs:

$$y \equiv \ln Y = \alpha \ln E + \beta \ln K. \tag{2}$$

The choice of G_L is subject to his budget:

$$pE + K = e, \tag{3}$$

where the price of K is normalized to 1 and the relative price of E is p.

G_L can increase his budget (e) by putting in more effort. Efforts are costly, with an increasing cost function Ae, where A is a positive constant.[12] If a higher output increases the promotion probability, G_L would like to use more dirty input E for a given a level of e. However, pollution has an additional cost of BE, where B is a positive constant. The cost can reflect that G_L dislikes pollution like any citizen or because pollution leads to some punishment.

The final observed log output also depends on G_L's competence θ:

$$\widetilde{y} = \theta + \alpha \ln E + \beta \ln K, \tag{4}$$

where θ has a normal distribution with mean $\overline{\theta}$ and variance σ_θ^2. Here, I use log transformations for calculation simplicity and θ can be considered as a productivity shock to y. (For example, the observed output can be written as $\widetilde{Y} = \widetilde{\theta} E^{\alpha} K^{\beta}$.)

Note that—as in the Holmström (1999) career concerns world—G_L also does not observe θ when he takes the decisions. As discussed in Persson and Tabellini (2000), this avoids

[11] I use the Cobb-Douglas production function following a literature in environmental economics (Copeland and Taylor 2004). By assumption, there is a complementarity between E and K. All results below hold if I assume that E and K are perfect substitutes. Using the Cobb-Douglas production function also simplifies my calculations.

[12] The linear cost function is assumed for simplicity. The results are robust to using a convex cost function but the expressions will be less transparent.

issues of signaling but leads to similar conclusions as in the case where G_L observes θ. The assumption that G_L does not know his ability can be considered as him not certain about his ability to run a place so that he also needs output information to update his own belief.

Promotion Rule The promotion rule is determined by the Central Government (G_C). The payoff that G_C can get from G_L is complementary in $G_L's$ competence (θ) and connectedness (C). I assume that what G_C can get is given by the expected value $\mathbb{E}(q(C)\theta)$, where $q'(C) > 0$. I set $q(C) = C$ so that I do not need to carry $q'(C)$ around in the calculation. One interpretation can be that G_L can hide a certain part of the production (positively associated with G_L's competence) from G_C but connected one hides less. Empirical support for the complementarity assumption is presented in Section 2.3. Of course, one can imagine that C and θ are substitutes. If C and θ were substitutes, the implications would be opposite to the solution presented below.

G_L gets promoted if the expected utility from promoting him for G_C exceeds the expected utility from promoting an average governor. Denote the expected utility $\underline{U}$.[13]

The promotion can be written as:

$$\mathbb{E}(C\theta) \geq \underline{U}. \tag{5}$$

where connectedness (C) can be observed by G_C. By contrast, G_C cannot observe $G_L's$ competence θ. Instead she infers θ from the noisy signal $\ln y$. Thus, the promotion rule can be rewritten as:

$$C\mathbb{E}(\theta|\widetilde{y}) \geq \underline{U}. \tag{6}$$

Since $\mathbb{E}(\theta|\widetilde{y}) = \overline{\theta}+\widetilde{y}-\mathbb{E}\widetilde{y}$, the promotion probability is defined by the following condition:

$$P = \Pr\left(\theta \geq -y + \mathbb{E}y + \frac{\underline{U}}{C}\right) = 1 - \Phi\left(-y + \mathbb{E}y + \frac{\underline{U}}{C}\right). \tag{7}$$

Promotion Incentives and Connectedness In equilibrium, $\mathbb{E}y = y$, and the promotion probability will be:

$$P = 1 - \Phi\left(\frac{\underline{U}}{C}\right). \tag{8}$$

This condition implies that connected G_L is more likely to be promoted. Further,

$$\frac{\partial P}{\partial y} = \phi\left(\frac{\underline{U}}{C}\right). \tag{9}$$

[13] In this setup, I focus on whether G_C decides to promote one governor compared with the expected utility from promoting an average ($\underline{U}$). Yardstick competition is not considered here. Allowing for yardstick competition generates a similar conclusion on the incentives but has different implications on the equilibrium chance of promotion.

$\phi(\cdot)$ is the p.d.f of the normal distribution with mean $\overline{\theta}$ and variance σ_θ^2. For $P < \frac{1}{2}$,[14] this condition implies that the marginal effect of GDP on promotion is higher for connected G_L.

In this paper, I focus on the *upward* (promotion) incentives for politicians, as provincial governors have a promising career where the returns from promotion are high. In the real world, some governors may also care about private rents that breed corruption in the environmental regulation. Such *downward* (corruption) incentives are relatively more important for politicians that have little hope to move upward such as those in charge of a specific sector.[15]

Timing Before coming to the solution, I clarify the timing of events here. First, G_L chooses E and K, knowing his own connections C but not his ability θ. Second, nature picks θ. Output is realized and observed (augmented by θ) by G_C. Last, observing the output, G_C decides whether not to promote G_L. If G_L is promoted, G_C gets $C\theta$ from him. If an average candidate is promoted, G_C gets $\underline{U}$.

2.2 Solution

The problem of G_L is to maximize the expected benefits from promotion minus the cost of pollution (with the benefit from promotion being normalized to 1):

$$P \cdot 1 - Ae - BE, \tag{10}$$

s.t.

$$E + pK = e. \tag{11}$$

where $P = 1 - \Phi\left(-y + \mathbb{E}y + \frac{\underline{U}}{C}\right)$.

Note that G_C can dislike pollution more than G_L. However, given that E is not verifiable for G_C, whether E is in G_C's utility function or not does not change the solution to G_L's problem. Besides, the costs of E in G_L's utility imply that pollution does not directly affect the promotion probability P. I provide empirical support for this implicit assumption in Section 2.3.

Substituting the budget constraint into the maximization equation, the first-order conditions can be written as follows:

$$MR_E \equiv \phi(\frac{\alpha}{E} - \frac{\beta p}{e - pE}) = MC_E \equiv B, \tag{12}$$

$$MR_e \equiv \phi\frac{\beta}{e - pE} = MC_e \equiv A, \tag{13}$$

[14] This assumption is reasonable given that the mean promotion rate is 0.13 in the data.

[15] For example, Jia and Nie (2011) focus on local politicians in charge of safety and investigate how they collude with firms for the safety regulation of coal mines.

where $\phi \equiv \phi(\frac{U}{C})$ indicates the density of competence, while $(\frac{\alpha}{E} - \frac{\beta p}{e-pE})$ and $\frac{\beta}{e-pE}$ indicate the marginal returns from E and e in terms of increasing output.

The two first-order conditions give the equilibrium level of E and K:

$$E^* = \frac{\alpha\phi}{pA+B} \equiv \alpha\phi\widetilde{p}, \tag{14}$$

$$K^* = e - pE = \frac{\beta\phi}{A}, \tag{15}$$

where $\widetilde{p} \equiv \frac{1}{pA+B}$ can be thought of as (a transformation of) the price of K relative to E (rather than the other way around).

Comparative Statics Since $\phi_C > 0$ (given that $P < \frac{1}{2}$), comparative statics in the equilibrium condition for E in equation (14) give the following two predictions:

Prediction 1 *Connectedness (C) has a positive impact on emissions (E): $\frac{\partial E}{\partial C} > 0$.*

Prediction 2 *Not only does the relative price of the clean input ($\widetilde{p}$) raise E: $\frac{\partial E}{\partial \widetilde{p}} > 0$, but the interaction of C and $\widetilde{p}$ also has a positive impact on E: $\frac{\partial^2 E}{\partial \widetilde{p} \partial C} > 0$.*

The proof is straightforward. Here, I intuitively discuss the mechanisms at work. Given that the promotion probability is less than $\frac{1}{2}$, it can be seen that $\phi_C > 0$, i.e., a higher level of C increases the value of a given unit of marginal output, and consequently increases the effort e and the use of dirty input E. Different from C, a higher price of the clean input ($\widetilde{p}$) increases the marginal returns from the dirty input and hence makes the dirty input more attractive. This substitution channel itself is quite mechanical. More interestingly, the substitution effect is further strengthened by G_L's career concerns (affected by C), which drives the interaction effect of $\widetilde{p}$ and C.

It is worthwhile to mention that the impact of connections on E is positive but smaller for a fixed level of effort e. Now suppose that e is fixed. Taking the derivative with respect to C in equation (12) gives:

$$\frac{\partial E}{\partial C} = \frac{\alpha\phi_C - \frac{\beta p E}{e-pE}\phi_C}{\beta\phi p\frac{e}{(e-pE)^2} + B}. \tag{16}$$

In the case where e is endogenous, equation (12) and equation (13) give the following condition:

$$\frac{\partial E}{\partial C} = \frac{\alpha\phi_C}{\beta\phi p\frac{1}{e-pE} + B}. \tag{17}$$

Clearly, the right-hand side of equation (16) is smaller (with a smaller nominator and a larger dominator) but it is also positive (the sign can be seen from the first-order condition). This comparison shows that there is an additional effect of connections on pollution by putting in more efforts.

Further, given the production technology, the impact of connections on E is more than proportional to the impact on the production scale Y. This can be seen by the following calculations.

Rewrite the production function in terms of E^* and K^*:

$$Y = (E^*)^\alpha (K^*)^\beta = (\phi\alpha\widetilde{p})^\alpha (\frac{\phi\beta}{A})^\beta, \tag{18}$$

and divide E by Y ($E = \phi\alpha\widetilde{p}$) to get:

$$\frac{E(C)}{Y(C)} = \phi(C)^{1-\alpha-\beta}(\alpha\widetilde{p})^{1-\alpha}(\frac{\beta}{A})^{-\beta}. \tag{19}$$

Equation (19) gives the following prediction:

Prediction 3 *The impact of connectedness (C) on emissions (E) is more than proportional to the impact on the production scale.*

This prediction follows because $\alpha + \beta < 1$ (together with $\phi_C > 0$). $\alpha + \beta < 1$ follows a standard assumption of the production function in the literature. This assumption is also reasonable in this context, as the inputs are often subject to certain capacities. For example, the increasing demand for coal makes coal mining deeper and deeper. Again, one can imagine other assumptions of the production function that deliver different and opposite predictions.

2.3 Discussion of the Assumptions

The two key assumptions for Prediction 1 and Prediction 2 are that connections and performance are complementary for promotion and that pollution outcomes do not directly affect the promotion probability. The assumptions revolve around the promotion outcome, which is the focus in Jia et al. (2012) rather than in this paper. I here present some statistical support for the assumptions. Specifically, I examine how promotion is affected by GDP and pollutant growth, connections as well as the interaction of the two factors. I discuss these empirical findings here in close connection with the model, even though I have not yet introduced the underlying data. These data will be carefully discussed in the next section, however.

The research on promotion of Chinese politicians has been controversial because the definitions of promotion vary across studies (Tao et al. 2010). I change the promotion indicator by adding potential positions one by one. Promotion for governors is defined as becoming a Party Secretary or a Minister (definition I), assuming vice-chairmanship of the National People's Congress (definition II) as well as becoming vice-chairmen of the the National Committee of the People's Political Consultative Conference (definition III). In line with the underlying literature, GDP and pollutant growth are measured by the average annual growth rate since assuming office. In Jia et al. (2012), we find that networks between former work colleagues matter the most for promotion. Thus, I use this definition of connections.

Table 1 presents the main results for definition I of promotion (these results are robust to using definitions II and III). Column 1 shows that connections increase the promotion probability by around 8.8 percentage points − a large effect, given that the mean promotion rate is around 13 percentage points. This finding is consistent with the argument on connections in the political-science literature such as Shih et al. (2012). It is also the implication of equation (8) above. Column 2 shows that GDP growth also increases the promotion rate − a 10 percentage point increase in GDP growth increases the promotion probability by about 6.8 percentage points. This finding is consistent with the argument in the related economics literature such as Li and Zhou (2005). Column 3 presents the result on the interaction effect (also controlling for the interactions between GDP growth and other characteristics of governors) − and shows that only the interaction effect is significantly positive in this horse race. This confirms the implication in equation (9) above. These findings shed some light on the debate of whether performance matters for promotion. They suggest that performance and connections are complementary and provide an empirical underpinning for the complementarity assumption made in the above model.

Columns 4-7 present the results on how the growth of two pollutants (COD and SO_2) affects promotion. Neither pollutant growth or nor its interaction with connection has a significant impact on promotion. This is not surprising given that pollution may affect promotion only when it leads to extreme accidents. These results provide support for the assumption that (year-to-year) pollution has no direct impact on promotion.

[Table 1 about here]

2.4 Welfare Implications

My simple model focuses on the (positive) question of how political incentives affect production and pollution and abstracts from many other interesting (normative) questions. For example, how does China's promotion regime compare with other regimes, such as a social planner's problem or a democracy? How do career concerns affect the welfare of citizens? Here I discuss these two questions.

How does the promotion regime compare with a social planner's problem? Consider a centralized problem for a social planner, who chooses a level of emission and effort that maximizes the output minus the costs of pollution: $\max \alpha \ln E + \beta \ln(e - pE) - Ae - BE$. The solution is defined by the following condition:

$$\frac{\alpha}{E} - \frac{\beta p}{e - pE} = B, \tag{20}$$

$$\frac{1}{e - pE} = A. \tag{21}$$

For a given level of e, the difference between the equilibrium levels of E in the social planner's regime and the career concerns regime depends on a wedge of $\phi(-\frac{U}{C})$. If the wedge $\phi(-\frac{U}{C}) > 1$, the equilibrium level of E is larger in the career concerns regime. Besides, career concerns have a further positive impact due to their positive impact on e. The strengthening effect (on the opposite direction) is similar if $\phi(-\frac{U}{C}) < 1$. Ideally one would also like to think about an optimal constitution design allowing for different incentives such as direct accountability towards citizens. This aspect is beyond the scope of this paper and is left for future work.

How do career concerns affect the welfare of citizens? The analysis of the model abstracts from citizens' utility. Similar to Copeland and Taylor (2004), it seems natural to assume that a citizen likes higher income and dislikes emissions, i.e., the indirect utility function of a citizen is $V = u(\frac{GDP}{N}) - BE$, where N is population size. Career concerns increase both u and E. Hence, the impact on V depends on the parameters of the utility function.

3 Institutional Background and Data

To test Prediction 1 empirically, I combine information on provincial governors and data on provincial-level pollutants. Connectedness C is defined from politicians' careers. This gives a general picture on connections and pollution. To test Prediction 2, I focus on the electricity-generation sector and examine the interaction effect of connections and droughts, as droughts affect the relative price of coal-fired power and hydro power. Since the use of my data hinges on institutions, I now combine a discussion of institutional background with a description of data. In Section 5.3, I discuss the measurement concerns and conduct robustness checks regarding them.

3.1 Province-level Outcomes

Corresponding to E in the model, I look at two major pollutants in each province i and year t. These are the logs of Chemical Oxygen Demand (COD) in industrial waste water ($\ln \text{COD}_{it}$) and industrial Sulfur Dioxide (SO_2) emissions ($\ln \text{SO}_{it}$), which are known from the literature on the impacts of pollution to be detrimental to health and land productivity. The source for these data is *China Environment Yearbooks,* available between 1993 and 2010.[16] I exclude Tibet from my analysis as data is often missing.[17] A second source of data I use is the weekly reports on the water quality at different monitoring points along the main river segments and their tributaries, published by the China National Environmental Monitoring Center. Since this data is published weekly about various rivers and not easily manipulated,

[16]The year information refers to the data rather than the yearbook. The information in year t is reported in yearbook $t + 1$. This is true for the all the yearbooks used in this paper.

[17]The results presented later also hold if I exclude four Autonomous Regions where governors have to be ethnic minorities.

it provides more precise information on pollution. Unfortunately, it is only available since 2002.

COD and SO_2 COD in industrial waste water is known to be positively correlated with liver cancer and digestive cancers such as gastric cancer (Zhao et al. 2012). Besides the direct health impact, a large share of China's irrigation water is waste water, where a higher level of COD has a negative impact on land productivity as well as a negative indirect health impact via crops (The New York Times 2007).

Industrial SO_2 is significantly correlated with chronic obstructive pulmonary diseases in some parts of China (Xu et al. 2000). In addition to its adverse impact on health, SO_2 is also the main cause of the acid-rain problem, a serious threat to agricultural productivity (Xing 2002).

The COD and SO_2 data presented in the yearbooks is the numbers of total amount (in tons) discharged into surface water or air. As explained in the yearbooks, the numbers are obtained in two distinct ways. COD is measured at certain monitoring points and its quantity is obtained by multiplying the average COD density at the monitoring point and the volume of waste water. On the other hand, SO_2 is imputed by multiplying reported uses of energy and SO_2 emission coefficients for different types of energy. Because the COD data really measures the quantity of pollutants, it may contain more precise information about pollution than SO_2. Summary statistics for them are presented in Panel A of Table 2.

[Table 2 about here]

River Quality The China National Environmental Monitoring Center publishes weekly reports on the water quality at different monitoring points along the main river segments and their tributaries. Between 2002 and 2010, the number of monitoring stations went up from 68 to 100. These stations are distributed across 26 provinces. The locations of the monitoring points as well as the water quality in the first week of 2010 are presented in Figure A1.

This data has information on the densities of COD, Ammonia Nitrogen (NH) and Dissolved Oxygen (DO), the level of pH and a crude grade of water quality. Ebenstein (2012) uses similar information for 2004 and finds a positive link between the order of the grade and the digestive cancer death rate. I focus on the densities of COD to check for consistency with the COD information from the yearbooks. The yearly average of this variable is my alternative dependent variable. Summary statistics are presented in Panel A of Table 2.

Industrial GDP and Non-industrial GDP To evaluate the trade-off between environment and GDP, I examine the impacts on the logs of industrial GDP and non-industrial GDP. The data is obtained from *Comprehensive Statistical Data for 60 Years of New China* for the years between 1993 and 2008 and from *China Statistical Yearbook* for the years 2009 and 2010. Summary statistics are also presented in Panel A of Table 1.[18]

3.2 Connections of Provincial Governors

Corresponding to C in the model, I look at the provincial governors' connections to the Politburo Standing Committee members.

I focus on provincial governors because they are the officials in charge of economic activities. Existing studies suggest that governors are more likely to be rewarded for economic performance, compared with Party Secretaries (Sheng 2009). I include the characteristics of Party Secretaries in my controls.[19]

The promotion of Provincial Governors is controlled by the Politburo, a group of about twenty people who oversee the Communist Party of China. Unlike politburos of other Communist parties, power within the Politburo is centralized in the Politburo Standing Committee (PSC).[20] Hence, I mainly exploit the connections with the PSC members.[21] Memberships in the PSC as well as the Politburo at large are renewed every five years. In the period of interest, the number of the PSC members increases from seven to nine.

Anecdotal evidence suggests that connections significantly affect promotion, as the members in the PSC tend to promote people connected with themselves. The "Shanghai Clique" and the "League Faction" are two popular phases coined for this phenomenon. The "Shanghai Clique" refers to the politicians who previously worked with the former CPC General secretary, President Jiang Zemin, in his Shanghai administration. Many of these people were promoted when Jiang became President and head of the PSC. The "League Faction" refers to the group of politicians who share work experience with the CPC General secretary, President Hu Jintao, who held various Youth League positions in his political career.

To formally capture such anecdotal evidence, I use a network dataset based on the biographical data of Provincial Governors, Party Secretaries and Politburo members between 1993 and 2010. It contains biographical data on Chinese leaders, including detailed information about their education history and job history. Connections can be defined in different ways: having been work colleagues, having studied at the same university, or sharing the

[18]The results on industrial versus non-industrial GDP hold if I use secondary-sector versus non-secondary GDP. Besides industrial GDP, secondary-sector GDP also includes the sector of construction. On average, industrial GDP accounts for 86% of secondary-sector GDP during the studied period.

[19]I do not find that the connections of Party Secretaries have positive impacts on pollution. This may be because their major responsibilities include the implementation of the Central government's policies and social stability whereas governors' key duty is to promote growth. See Tan (2006) for qualitative discussions on the roles of Party Secretaries and Governors. For example, when the Central government decided to crack down on Falun Gong organizations, "while provincial governors were more concerned about the possible fallout on the economy, Party Secretaries were more preoccupied with taking the correct political line and implementing the central decision" (Tan 2006).

[20]See Lawrance and Martin (2012) for the organization of the Politburo as well as a general picture of China's political system.

[21]Connections with non-standing members do not have a significant impact on promotion.

province of origin. With respect to each type of connection, the connection dummy C_{ijt} indicates whether governor j of province i has at least one connection with a PSC member at year t, i.e., $C_{ijt} = \mathcal{I}(C_{ij} * PSC_{jt} > 0)$ where C_{ij} indicates that i and j were colleagues in history and PSC_{jt} indicates that j is a member of PSC in year t. In the period between 1993 and 2010, the PSC is reshuffled in three congress years (1997, 2002 and 2007), which creates variations for PSC_{jt} and hence for C_{ijt}.[22]

Figure A2 in the appendix gives an example of the colleague connection between Governor Huang and PSC member Wu. Huang and Wu were working in Jiangxi Province together in the late 1980s and 1990s. In 1997, Wu left Jiangxi whereas Huang stayed. In May 2001, Huang became the Governor of Jiangxi. In November 2002, Wu became a PSC member. According to my definition, Governor Huang was not connected in 2001 and 2002 but was connected between 2003 and 2006.[23] Among my 489 governor-year observations, 365 are never connected, 77 are always connected for a given governor and 47 have variations within a given governor (i.e. switchers). Summary statistics of this dummy and other characteristics of politicians are presented in panel B of Table 2. Table A1 presents summary statistics of observable characteristics for the three groups of governors. It shows that governors who are always connected have shorter tenure and are less likely to govern their home province, suggesting that their appointment may be endogenous. By contrast, the switchers and those never connected are not very different in these observables.

The definition of connections provides a detailed characterization of connections among Chinese top politicians. Particularly, the connection dummy is not only time-variant within provinces but also time-variant within a group of politicians. This variation provides further information beyond the connection definitions in related studies (Shih 2004; Opper and Brehm 2007; Shih et al. 2012). It allows me to control for politician fixed effects, which is critical to address the concern of endogenous appointments.

3.3 The Case of Electricity Generation

Prediction 2 of the model involves the relative price (p) of clean and dirty inputs. To bring this prediction to data, one needs to consider a certain product. The electricity generation sector provides a natural testing ground for two reasons.

First, the electricity market in China is not integrated (See Yang (2006) for a detailed description of the evolution and Lin and Purra (2012) for the challenges of the electricity sector). Because electricity is critical for growth and often becomes a constraint for provinces to grow as many industries are in dire need of power, inter-provincial electricity trade is limited by regional protectionism (Lin and Purra 2012).

[22] Since the congress took place in October or November in year t, the actual reshuffle years are 1998, 2003 and 2008.

[23] Following the literature on the career of Chinese politicians (e.g. Li and Zhou 2005), the stay of politicians is defined by month. If a politician starts or ends his position before June in year t, the time counted as the year of $t-1$. If he starts his position after June in year t, the time counted as the year of t. I exclude those in office less than one year as their influence on policies should be weak.

Second, there are mainly two technologies for producing electricity in China: one is dirty (coal-fired thermal power) and the other is clean (hydro power). 28 out of 30 provinces use both technologies (the two exceptions are Tianjin and Shanghai where hydro power is not available). In 2010, coal-fired power accounts for 80.3% of the total electricity power whereas the hydro power accounts for about 18.4%. Nuclear, wind and other sources together only have a share of 1.3%. Coal-fired thermal power is a major source of pollution, which accounts for more than 50% of industrial SO_2 emissions. In recent years, the Central government encourages limiting the use of coal-fired power through policies such as the Two-Control Zones policy.[24] It is often reported that the incentive for promoting growth makes the aim of limiting the use of coal-fired power impossible to realize, especially when droughts occur (*Life News* 2010). Droughts make the relative price of hydro power higher and hence make coal-fired power more attractive.

Droughts Droughts (D_{it}) are defined from rainfall data. Provincial-level rainfall data is aggregated from monthly grid-level information with ArcGIS, provided by the Climate Prediction Center Merged Analysis of Precipitation (CMAP) at NOAA, available for 28 provinces between 1993 and 2010. Grid-level information in this database does not cover Beijing and Tianjin. I first sum the twelve months of rainfall to get the yearly data for each grid. Then, I use the median of the grid-level data as my measure of provincial-level precipitation. The result is similar if I use the mean of the grid-level data. Drought is set at 1 when $\ln(\text{Rainfall})$ in a given year is less than the provincial mean between 1993 and 2010 minus one standard deviation and 0 otherwise.[25]

Coal-fired Power I investigate the impact of D_{it} as well as the interaction between D_{it} and C_{it} on the log of coal-fired power ($\ln \text{CoalPower}_{it}$), measured in 10^4 kilowatt hours. The data source is *China Electricity Yearbooks*. The summary statistics for all these provincial-level data are presented in panel C of Table 2.

4 Empirical Strategy and Baseline Results

4.1 Empirical Strategy

The connection dummy (C_{ijt}) is defined based on job history (i.e., C_{ij} is based on historical information) and its variation comes from the reshuffling in the center (i.e., from PSC_{jt}). This way of defining connections allows me to address different sources of endogeneity.

[24] The "Two Control Zone" policy refers to the policy entitled "Acid Rain and Sulfur Dioxide Emission Zones". It was launched by the Central government in 1996, in order to control SO_2 emissions. Since this policy applies to 175 cities/districts in 27 provinces, it is unlikely to contaminate my results. But the impact of this policy is worthwhile studying with city-level or county-level data.

[25] The rainfall data is available since 1979. Droughts can also be defined according to the mean and standard deviation of data between 1979 and 2010. Using this definition generates similar results to those presented below.

The first endogeneity challenge is that i would like to build a connection for his career. This may happen in the real world but is not the focus of this paper. My definition avoids the concern as the connection is based on historical information.

A second challenge is that connected governors may be appointed to certain regions, e.g. provinces that can develop relying on cleaner technologies. As I focus on *within-governor* variation, i is already a governor. Thus, this concern is relieved.

A remaining challenge is that j's entry to the PSC is affected by i's performance. This concern is very unlikely in this context because politicians are rotated often in China. In the subsample with within-governor variation, none of j entered PSC immediately after i took the governorship. In other words, after i and j shared a workplace, j either took a position in another province or in the Central government. Later I also allow for a dynamic specification to check for this concern.

The main estimation strategy is similar to a differences-in-differences (DD) strategy, where I compare the impact of connections before and after getting connected, within the same governor. The baseline estimates always control for province and year fixed effects. These fixed effects control for all time-invariant differences between provinces and time-variant changes that affect all provinces similarly. Moreover, I control for governor fixed effects and exploit within-governor variation.

Meanwhile, I control for regional-specific (nonparametric) trends by including region × year fixed effects, where regions refer to the East, the West and the Central. One reason for doing this is that macro policies are usually implemented according to this categorization such as the program to "Open Up the West" and the plan of "the Rise of Central China". Controlling for region × year fixed effects is a flexible way of taking into account the impact of macro policies during the time horizon of this study.

The main specification is as follows:

$$\ln \mathrm{E}_{ijt} = \mu_j + \beta_C \mathrm{C}_{ijt} + \mathrm{X}'_{ijt}\gamma + \mathrm{R}\lambda_t + \alpha_i + \lambda_t + \varepsilon_{ijt}, \qquad (22)$$

where $\ln \mathrm{E}_{ijt}$ is the log of pollution outcomes under the administration of governor j in province i and year t. α_i and λ_t indicate province fixed effects and year fixed effects. $\mathrm{R}\lambda_t$ indicates regional trends. μ_j indicates governor fixed effects. C_{ijt} is set at 1 when governor j in province i is connected to a PSC member in year t. X_{ijt} is a vector of controls including whether the provincial Secretary is connected, the the governor has been in office longer than average (3 years), his age, his education (college or not), whether he is from the province he governs and whether he has work experience in the Central government, as well as the corresponding variables of the provincial Secretary. Naturally, time-invariant governor characteristics are redundant after including governor fixed effects. All standard errors are clustered at the province level. This corrects for potentially autocorrelated errors. The results are also robust to using two-way clustering at both the province and the year level as suggested in Cameron et al. (2008).

4.2 Impacts of Connections on Pollution and GDP

In specification (22), β_C is the parameter of interest. Prediction 1 says that connections increase pollution, i.e., $\beta_C > 0$. Now I show the results for different measures of E_{ijt}.

Impacts on COD and SO_2 Table 3A presents the results using $\ln \mathrm{COD}_{ijt}$ as the dependent variable. Columns 1-2 show the results from within-province estimations. Column 1 presents the results conditional on province and year fixed effects. Column 2 shows the results after including controls. Columns 3-4 are the corresponding results from within-governor estimations. Columns 5-6 show the within-governor results after excluding the governors who are always connected, leaving the sample to the governors that have within-individual switches and those that never get connected, while column 6 also includes nonparametric regional trends.

After clustering the standard errors at the province level, the within-province coefficients are not very precisely estimated but the magnitude of the parameter of interest is positive (0.14). The within-governor estimates are more precise and larger in magnitude, around 0.25. This finding implies that getting connected increases industrial COD by about 25%. The mean of the province-year COD is around 0.21 million tons. Thus, a 25% increase in COD implies an amount of 1.5 ($0.21 \times 30 \times 25\%$) million tons of COD.

Similarly, Table 3B presents the results using $\ln \mathrm{SO}_{ijt}$ as the dependent variable. Once more, the within-governor estimates are more precise and larger in magnitude, around 0.10. This implies that getting connected increases industrial SO_2 by about 10%. The mean of the province-year SO_2 is around 0.55 million tons. Thus, a 10% increase in SO_2 implies an amount of 1.65 ($0.55 \times 30 \times 10\%$) million tons of SO_2.

[Tables 3A and 3B about here]

Impacts on River Quality Table 3C presents the results using the log density of COD as the dependent variable. The results are presented in Table 3C. Once again, the within-governor estimates are larger than the within-province estimates. The finding using the river data is consistent with the findings using the yearbook data. Without controlling for regional trends, connections increase COD density by about 28% and this effect becomes even larger after controlling for regional trends (around 43%).

[Table 3C about here]

Impacts on Industrial GDP and Non-industrial GDP To investigate the impact on GDP, I replace $\ln \mathrm{E}_{ijt}$ with the logs of GDP. I also divide GDP into industrial GDP and non-industrial GDP. The results are presented in Table 4. Here, I do not find a strong positive impact on any category of GDP from within-province estimations. However, I find a significant impact from within governor estimations for industrial GDP but not for non-industrial GDP. The finding shows that connections increase industrial GDP by about

15%. The average impact of total GDP is around 5%. I interpret this result as evidence that connections make governors increase the efforts to promote growth in industrial sectors which are more responsive to government policies.

[Table 4 about here]

4.3 Droughts, Connections and Coal-fired Power

I focus on the electricity generation sector to test prediction 2 of the model. I do not have data on regional electricity prices or prices of coal-fire power and hydro power. Instead, I explore exogenous droughts shocks to the relative price between hydro power and coal-fire power due to droughts. Droughts naturally make coal-fired power more attractive. Moreover, the model predicts that connections strengthen the impact of droughts.

To test this prediction, I run a within-governor estimation as follows:

$$\ln \mathrm{CoalPower}_{ijt} = \mu_j + \beta \mathrm{C}_{ijt} \times \mathrm{D}_{it} + \beta_C \mathrm{C}_{ijt} + \beta_D \mathrm{D}_{it} + \mathrm{X}'_{ijt}\gamma + \mathrm{D}_{it} \times \mathrm{X}'_{ijt}\nu + \mathrm{R}\lambda_t + \alpha_i + \lambda_t + \varepsilon_{ijt}. \tag{23}$$

The specification is similar to the baseline specification (22). As in models studying interactions, I also include the interaction of droughts and controls ($\mathrm{D}_{it} \times \mathrm{X}_{ijt}$). This is to address the concern that the impact of droughts might be heterogeneous contingent on different controls. The results are presented in Table 6.

Columns 1 and 2 present results of (the log of) rainfall and droughts on coal power use. Rainfall decreases coal power use whereas droughts increase coal power use by about 4%. This confirms that my definition of droughts is reasonable.

Column 3 presents the result after including connections. As expected, connections have a significant positive impact on coal power use. Columns 4 and 5 present the interaction effect with and without controls. The interaction of connections and droughts increases the coal power use by about 7%. Column 6 shows the result after controlling for $\mathrm{D}_{it} \times \mathrm{X}_{ijt}$. The magnitudes of the estimates are very close to the previous results. Because the specification allows for heterogeneous effects contingent on control variables, the coefficient of droughts from this specification is now different.

These results suggest that connections increase the response of coal-fire power to droughts from about 4% to about 10%. The mean of province-year coal-fired power use is around 55 Twh. Thus, a 10% increase implies an amount of 165 ($55 \times 30 \times 10\%$) Twh, which is somewhat more than the annual power produced in Sweden.

[Table 6 about here]

4.4 Beyond the Scale Effect

The model predicts that the impact of connections on pollution may go beyond a scale effect. I use two ways to check whether this is the case. First, I present some estimates on the magnitude of the scale effect. Second, I include production scale as a control variable to see whether the impact on pollution still remains.

The reduced-form results show that connections increase COD by about 25% and SO_2 by about 10% whereas they increase industrial GDP by about 15%. Suppose that pollution is one-to-one to production, then the impact on industrial GDP cannot explain the finding on COD.

I can provide estimates on the scale effect by estimating the relationship between production and pollution. Suppose that connections affect pollution only through a scale effect. Then, the impact on E can be calculated from the following two equations (where fixed effects are included):

$$\ln \mathrm{Y} = \gamma \mathrm{C} + \epsilon, \tag{24}$$

$$\ln \mathrm{E} = \alpha \ln \mathrm{Y} + \varepsilon. \tag{25}$$

Thus, $\ln \mathrm{E} = \alpha\gamma \mathrm{C} + \epsilon'$, where $\alpha\gamma$ measures the scale effect and $\epsilon' = \alpha\epsilon + \varepsilon$. If $\alpha\gamma$ is close to β_C in equation (22), the scale effect might fully account for the positive impact of connections on pollution above. I have estimated γ in the previous section. Measures of α, correlations between the levels of pollutants and production (the logs of industrial GDP and non-industrial GDP), are presented in Table 5A. Not surprisingly, conditional on the fixed effects, both industrial COD and SO_2 are significantly correlated with industrial GDP. In contrast, the link between industrial COD and SO_2 and non-industrial GDP is not significant after controlling for fixed effects.

[Table 5A about here]

The results suggest that a scale effect alone cannot explain the findings in Section 4.2. For instance, for the full sample, the impact on COD from a scale effect is $\alpha\gamma = 0.042 \times 1.513 = 0.06$ and $\alpha\gamma = 0.142 \times 0.637 = 0.09$ in terms of industrial GDP whereas the estimated β_C is around 0.238. After isolating the scale impact, the magnitude of the remaining impact is around 15%-18%. After isolating the scale impact on SO_2, the magnitude of the remaining effect is around 5%. The finding is potentially biased as production is endogenous. However, to attribute the impact of connections to the scale effect alone, one would need that a 10% increase in production generates more than a 30% increase in pollution.

A second way to isolate the scale effect is to add (the log of) production as a control variable. This certainly is not perfect because these control variables are endogenous. I still present the results in Table 5B as a comparison. They show that the impact of connections on COD is still significantly positive after controlling for production scale. The impacts on SO_2 are not very precisely estimated after including the production scales.

[Table 5B about here]

5 Robustness Checks and Interpretations

In this section, I conduct robustness checks and provide evidence to pin down the main mechanism of connections. First, I allow for a more flexible specification to investigate how the impact evolves over time as well as the concern of pre-trends in differences-in-differences studies. Second, I conduct a test using neighboring provinces as a placebo. The purpose is to ensure that the pollution outcomes are really affected by politicians rather than some regional shocks. Third, I discuss concerns about the measurement of pollution, GDP as well as connections. Given these robustness checks, I discuss my interpretation of connections in comparison with alternative interpretations. Finally, I show some suggestive evidence on potential policy tools of governors.

5.1 Dynamic Impacts of Gaining Connections

Equation (22) captures the average effect over time of being connected. A more flexible way of examining the effects is to study how the pollutants evolve in the years before and after the change in C_{ijt}. Among the observations that have switches within a given governor, the majority of them (33) gain a connection.[26] Hence, I look at the dynamic effects of gaining links by estimating the following regression:

$$\ln \mathrm{E}_{ijt} = \mu_j + \sum_{\tau=-n}^{\tau=+m} \beta_\tau \mathrm{C}_{ij(t_0+\tau)} + \mathrm{X}'_{ijt}\gamma + \mathrm{R}\lambda_t + \alpha_i + \lambda_t + \varepsilon_{ijt}, \tag{26}$$

where t_0 presents the transition year and τ flags the years before and after t_0.

Limited by the data, I cannot estimate a long-horizon dynamics. I use the period more than two years before transition as the default period and compare it with one year before getting connected, the first year of getting connected as well as more than (or equal to) two years after getting connected. This flexible specification also allows me to check for pre-trends. If β_{-1} is not significantly different from 0, there is no significant difference between the connected and control governors before getting connected.

The results on COD and SO_2 are presented in columns 1-4 of Table 7. The results from columns 1 and 3 are visualized in Figures 1A and 1B. An impact of connections is only seen after getting connected. The pre-connection coefficient β_{-1} is very close to 0, suggesting that there is no significant trend difference between those who get connected in office and those who never get connected. In other words, whether these governors get connected is not correlated with their past performance. This gives further evidence for the validity of my identification strategy.

[26] There are two reasons why the number of losing connections is smaller than that of gaining connections. First, the number of the Politburo Standing Committee Members increased from seven to nine. Second, the number of connections increase over time as the political system becomes more stable − the younger cohorts are more likely to have experience in various levels of local governments before becoming governors.

It is worthwhile to clarify the timing of the effect. The national congress that leads to switches in connections of governors takes place in October or November in year t. The results show that the impact takes place already in $t+1$ or $t+2$. The short time lag suggests that governors would like to grab the opportunity quickly, since the average length in office is only slightly above three years. Considering that China as a whole builds the equivalent of two, 500 megawatt, coal-fired power plants per week and a capacity comparable to the entire UK power grid each year (MIT Coal Study 2007), it is not surprising that politicians can change the dirty technologies quickly.

[Table 7 about here]
[Figure 1A and Figure 1B about here]

Similarly, I check the dynamic results for the logs of industrial GDP and non-industrial GDP as the dependent variable. The results are presented in columns 5-8 of Table 7. Once again, a positive impact is found only for industrial GDP.

5.2 The Border Effect and Using Neighbors as a Placebo

The previous check for pre-trends can be thought of as a placebo test: moving the connection back in time should not produce a significant estimate. Another placebo test I conduct is to assign the pollution outcomes in a province to its neighbor. If the impact I have found were not driven by politicians but by some regional shocks, I would find a similar positive impact from this placebo test. This strategy will not work if the spillover effect of pollution outcomes due to connections is very large.

Since I have information on specific rivers, I can also examine whether a large spillover effect exists. Anecdotally, rivers close to the border of two provinces are more polluted because this leaves the regulation responsibility unclear. Table 8A presents an estimate for the border effect. The border dummy indicates a river at the boundary of at least two provinces. The positive and large estimates are consistent with the border phenomenon. However, as column 6 shows, the interaction of connections and the border has no impact. This finding implies that the border effect is independent of connections, even though the border rivers are of worse quality. Given this finding, I can use outcomes of neighboring provinces as a placebo test.

[Table 8A about here]

There are various ways of defining a neighbor, such as weighting by distance. I employ a very simple way: the nearest neighbor of a province is defined as the closest province in terms of the distance between the two provincial capitals. The results are presented in Table 8B. Columns 1-3 show the results on COD whereas columns 4-6 show the corresponding estimates for SO_2. I do not find any positive impact of a governor's connection on the pollution of its neighbor.

[Table 8B about here]

5.3 Measurement Concerns

Measurement of Pollutants and GDP One may wonder about the reliability of the data on pollutants as well as GDP, especially as these variables may affect the chance of promotion. I have three remarks on this issue.

First, the data on COD and SO_2 reflect two different ways of measurement. By using both measures, I get a sense of how robust the results are. Indeed, I find a stronger and more precisely estimated effect in terms of COD.

Second, I find that governors with stronger career concerns pollute more. If they would have manipulated the data, it is unlikely that they would overreport pollution. As for the GDP data, I find that career concerns increase industrial GDP but have no positive impact on non-industrial GDP. This also suggests that GDP data does contain an accurate signal about the provincial economy.

Third, I use an alternative source for pollution, namely river quality and find that the results with different data sources are consistent.

All these findings suggest that the official data does have useful information. There is an emerging literature evaluating the quality of official data. For example, Chen et al. (2012) examine city-level air pollution index data between 2000 and 2009.[27] They find that the air-pollution index contains useful information about air pollution but that there is bunching on the count of blue-sky days. This is because the number of blue-sky days is related to the award of "environmental protection model cities". My results are consistent with their finding. As shown above, pollution growth itself is not directly related to promotion.

Measurement of Connections Although the connection information in the current database is very detailed, I cannot observe those dimensions that do not appear in a politician's curriculum vitae. For example, marriage is said to be a way of boosting one's political career, which cannot be captured by these data. Besides, sharing the same job history does not necessarily imply friendship and might even hurt one's career in some cases. These quantifications imply that my positive estimates of the impact of connections on promotion constitute a lower bound.

Another measurement concern is sample size. For clean identification, I rely on within-governor variation. As expected, the number of governors with within-individual connection switches is not large. Among the 30 provinces between 1993 and 2010, only 8 have within-governor switches.[28] Among my 489 governor-year observations, 365 are never connected, 77 are always connected for a given governor and 47 have variations within a given governor. Despite the restriction in the data, I obtain precise estimates in most cases.

I also symmetrically trim the 5% tails of the logs of COD and SO_2 to check whether the

[27] I do not use this data in the paper as the cities that have information dating back to 2000 are mainly capital cities.

[28] The 8 provinces are Jilin, Shanghai, Zhejiang, Fujian, Jiangxi, Hunan, Chongqing and Yunnan. Their development stages and locations are quite diverse.

estimates are influenced by extereme values. The results are presented in Table 9. As they show, the estimates are close to the baseline results.

[Table 9 about here]

One can potentially explore heterogeneity in connections such as age differences or the number of years working together as a way of providing more information on the strength of connections. But I do not focus on these heterogeneities as the sample size is limited.

5.4 Interpretations of Connections

Connections as an Accelerator The main findings suggest that connections matter for the outcomes of pollution because they affect the likelihood of promotion and hence politicians' behavior. However, in the real world, connections might also capture other dimensions. I interpret connections as an accelerator. A different interpretation related to the mechanism of career concerns is that connections work as protection. For example, the promotion probability of connected politicians may be less likely to decrease even if they pollute more. In the theoretical framework, this implies that connections decrease the costs of pollution rather than increase the returns from output. In the real world, pollution might lead to political costs when it leads to extreme accidents. However, when it comes to yearly emissions, the impact on promotion is unclear. As already shown in Table 1, the interaction of connection and pollutant growth does not affect promotion. By contrast, the interaction of GDP growth and connections has a significantly positive impact on promotion. These results suggest that the protection mechanism is less important than the accelerator mechanism.

How about Connections as Favor? A different interpretation of connections is the favor-related channel. For example, connected governors might get more resources from the Center. Thus, the provinces under their governance grow faster and pollute more. This interpretation implies that the pollution and GDP growth difference stems from redistribution and there may be no real growth in total. This has different implications than my interpretation of career concerns. Given the finding in Section 4.4 that the impact of connections is beyond the scale effect, the concern about more help from the Center is not that critical. Even if connected politicians get more transfers from the Center that increase the scale of the economy, this cannot totally explain the previous findings.

However, it might be interesting in itself to check for the link between connections and favors and examine whether connections still matter once help from the Center is controlled for. This is feasible given detailed information on the fiscal budget of provincial governments. I know the amount of fiscal transfers from the Central government to each province. This data is from *China Finance Yearbooks* and is available between 1994 and 2010.

Besides, another source of data provides information on the composition of the fiscal transfers, namely *the Compendium of Local Fiscal Statistics*. This data is currently available till 2007. The transfers are of three types: tax refunds, financial assistance and special transfers. The difference among these transfers has been documented by a public finance literature such as Lin (2011). Generally speaking, tax refunds are highly correlated with tax revenues generated by the local government and are thus more effort-related. In contrast, financial assistance and special transfers are more discretionary and can be seen as help from the Center. I examine the impact of connections on different types of fiscal transfers. The specification is analogous to equation (22). The results are presented in Table 10A.

Columns 1-2 show that connections increase fiscal revenues by about 4%, which is a natural outcome of a larger economy. Columns 3-4 show the result on total transfers whereas columns 5-8 show the results for tax refunds and discretionary transfers separately. As expected, the impact on tax refunds is close to that of the tax revenues. The impact on discretionary transfers is close to zero once controls are included. These results suggest that the effort-related channel of connections is more relevant than the favor-related channel.

[Table 10A about here]

As another robustness check, I control for the logs of fiscal revenues and transfers. As shown in Table 10B, the baseline results still hold.

[Table 10B about here]

Naturally, it can still be argued that there might be favors that are difficult to observe and measure. For example, it might be easier for a connected governor to construct heavy polluting factories when permissions from the central government are needed. Even in this case, pollution is induced by the demand for factories. In many cases, governors have the decision power on what factories to construct. Moreover, it is also difficult for the hypothesis of favors to explain the finding on the impact of droughts as well as the interaction of droughts and connections.

5.5 Suggestive Evidence on Policy Instruments

In the model, I assume that governors make choices of clean or dirty technologies. In the real world, governors can influence environmental regulations that affect the technology choices of firms. For example, governors can influence the decision on whether to build a power plant. They can also affect whether and how much a factory is punished for pollution.

Ideally, besides pollution outcomes, one would like to have information on environmental regulations. Unfortunately, no systematic information on regulations is available. Here, I provide some suggestive evidence using fees on pollution discharges as an indirect measure of environmental regulations. Only the total amount of fees on different types of pollution discharges is available. The data comes from *China Environment Statistical Yearbooks*. I use two ways to get a measure of the de facto discharge fee rate. First, I divide the fees by the amount of COD discharges as well the amount of SO_2 emissions to get two rates.

Second, the elasticity of pollution fees and COD (or SO_2) is 0.15 (or 0.31) in the data (after controlling for province and year fixed effects). I use the two elasticities to weight the two rates obtained in the previous step and get an average rate, i.e., the weighted average rate $= 0.15\times(\text{Fees/COD}) + 0.31\times(\text{Fees}/SO_2)$.

Table 11 presents the results for the log of the fee rate obtained in different ways. Columns 1-3 show that the facto fee rate (measured by COD) is decreased by around 17% for connected governors. Columns 4-6 show that the facto fee rate (measured by SO_2) is not significantly decreased. The two estimates provide some bounds for the de facto fee rate, suggesting that the de facto rate may be decreased for connected governors. As shown in columns 7-9, the average rate is decreased by about 12% for connected governors. This evidence provides an example for potential policy instruments that can be affected by governors.

[Table 11 about here]

6 The Welfare of Citizens

In sum, my findings suggest that connections have pros and cons. On the one hand, connections increase industrial GDP by about 15% but have no impact on non-industrial growth. The average impact on total GDP is not significant. On the other hand, connections increase industrial COD by about 25% and SO_2 by about 10%. What do these numbers tell us about citizens' welfare? Obviously, the answer depends on who the citizen is as well as his preferences. For instance, an agricultural worker who lives at a river downstream from factories might not benefit so much from industrialization as an industrial worker. However, he might suffer more from the polluted water from the upstream factories. As for the preference of citizens, the adverse impact of pollution is often related to health in the long run whereas the positive impact of income materializes in the short run. The trade-off between the two is related to many factors such as individual discount rates.

One indirect way of evaluating welfare is to investigate the discontent of citizens over environmental issues. In theory, this information can be obtained by the number of environment-related complaints via personal visits paid to the government or environment-related letters sent to the government. If the income effect overweights the health concerns, the number of complaints will not increase along with connected governors. In practice, such information is certainly imperfect. Complaints, known as *Xin-Fang* (letter-or-visit), are very much suppressed, especially personal visits. Given this, I look at the impacts on letters and visits separately, using data from *China Environment Yearbooks*. The idea is that letters might be a better proxy for the will of citizens than visits. The information on the number of letters is available for the whole period whereas the number of visits is available since 1996.

The results using the logs of the two variables as the dependent variable are presented in Table 12. Columns 1-3 show the results for the number of letters and there is no significant impact from either within-province or within-governor specifications. Columns 4-6 show the results for the number of visits. Both within-province and within-governor results show that connections decrease the number of visits by over 60%. This does not necessarily mean that citizens are happier, since politicians with a promising career are likely to suppress visits more. But judging by either outcome, I do not find a larger number of complaints in the wake of higher GDP and more pollution.

[Table 12 about here]

7 Conclusions

China's pollution is well recognized by academics and the media. Despite abundant anecdotes on the political roots of this problem, little research exists on the political economics of China's pollution. In this paper, I formalize the political logic with a simple model that highlights the link between politicians' career concerns and pollution outcomes. The simple model has predictions about economic output as well as pollution.

Two main challenges for this study are identification and data quality. For the challenge of identification, I exploit within-individual variation in political connections. Different from the favor-related channel of political connections stressed in many existing studies, the results in this paper is consistent with the interpretation that connections affect efforts and policy choices of politicians. This interpretation may provide a rationale of the current growth phenomena of China, a fast-growing society where connections are known to be relevant in politics and business.

For the challenge of data quality, which is general to any study on contemporary China, I test the predictions of the model using various sources of data: biographies of politicians, provincial-level outcomes from yearbooks, river quality from physical measurements, weather shocks, and complaints by citizens.

Different sources of data deliver a similar message: the incentive scheme of politicians in China is a double-edged sword. Politicians motived by strong promotion incentives would like to promote growth, regardless of its social costs such as pollution. The findings suggest that party officials may be "over-incentivized" by career concerns. However, under the current political system, flattening the incentives may not reduce the problems if this makes politicians turn to rent-seeking in the form of corruption and collusion with firms. The key to avoid choking on growth may therefore be a broader political reform to make politicians accountable to citizens.

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Figure 1A: The Dynamic Impacts of Connections on COD

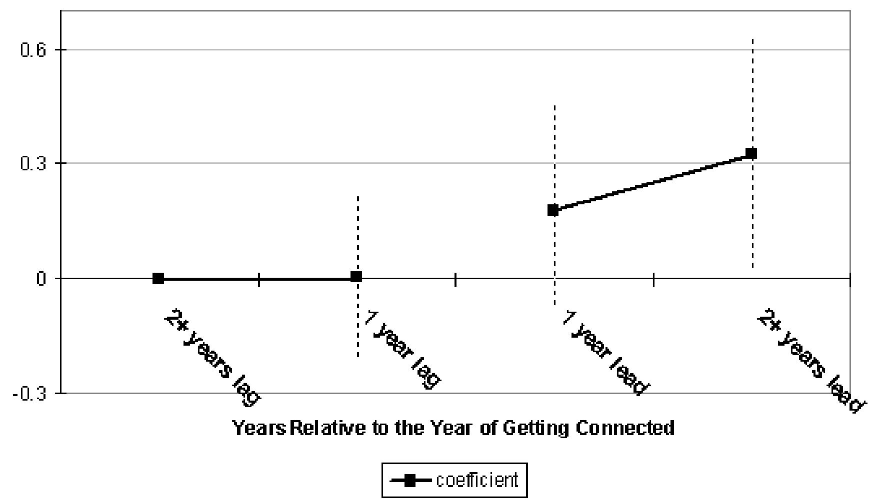
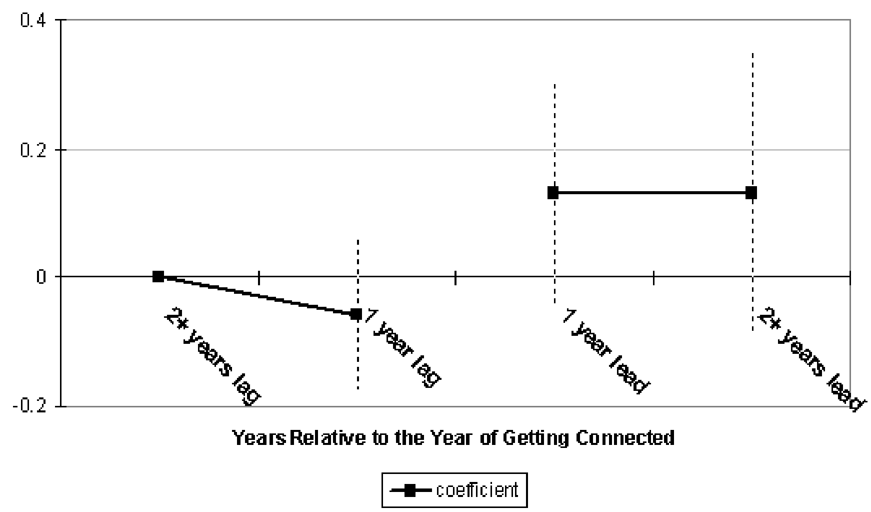


Figure 1B: The Dynamic Impacts of Connections on SO_2



Notes: The figures visualize the results in columns 1 and 3 of Table 7. They show that the impacts are discontinuous before and after gaining a connection. The dotted line indicates the 95% confidence interval, with standard errors clustered at the province level. Every estimated effect is relative to the period two years or more before getting connected, which is displayed as an "effect" of 0 to aid visual analysis.

Table 1: Empirical Support for the Model Assumptions

	(1) Promote	(2) Promote	(3) Promote	(4) Promote	(5) Promote	(6) Promote	(7) Promote
Connection*GDP Growth			0.998**				
			(0.396)				
GDP Growth		0.685**	-1.207				
		(0.304)	(7.369)				
Connection*COD Growth					-0.021		
					(0.063)		
COD Growth				-0.000	0.194		
				(0.002)	(0.377)		
Connection*SO2 Growth							-0.867
							(0.543)
SO2 Growth						0.030	2.242
						(0.119)	(2.349)
Connection to SC	0.088*		0.075		0.072		0.054
	(0.047)		(0.052)		(0.103)		(0.060)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y
Region*Year FE	Y	Y	Y	Y	Y	Y	Y
Controls			Y	Y	Y	Y	Y
Controls*Growth			Y	Y	Y	Y	Y
# clusters	30	30	30	30	30	30	30
# observations	489	457	437	457	437	457	437

Notes: Promotion is a dummy indicating that a governor becomes a secretary or a minister. The results are robust to using more general definitions of promotion. Growth measures the average of annual growth since assuming office. Controls include whether the governor has been in office longer than average, his age, his education, whether he is from the province he governs and whether he has work experience in the Central government, as well as the corresponding variables of the provincial Secretary. Region*Year FE is to control for the effect of macro policies (as in the tables presented below).
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 2: Summary Statistics

	Mean	S.D.	Min	Max	Obs.
Panel A: Provincial-level Outcomes					
Log (COD)[a]	11.77	1.20	4	14.97	489
Log (SO2)[a]	12.92	0.99	10	14.38	489
Log (Ind. GDP)[b,i]	7.09	1.29	3.57	9.97	489
Log (Non-ind. GDP)[b,i]	7.59	1.08	4.21	10.11	489
Log (River COD Density)[c]	1.43	0.81	-1.61	5.43	784
Border River[c]	0.33	0.47	0	1	784
Panel B: Leader Characteristics					
Connections to the Standing Committee[d]	0.20	0.40	0	1	489
Connections to the Non-standing[d]	0.24	0.43	0	1	489
Years in Office[d]	3.13	2.01	1	12	489
Age[d]	57.65	4.08	43	66	489
Governing Home Prov.[d]	0.37	0.48	0	1	489
Worked in the Center[d]	0.35	0.48	0	1	489
Finished College[d]	0.83	0.37	0	1	489
Secretary: Connections to SC[d]	0.26	0.44	0	1	460
Secretary: Years in Office[d]	3.32	2.26	1	12	480
Secretary: Age[d]	59.38	4.09	47	68	460
Secretary: Governing Home Prov.[d]	0.12	0.33	0	1	460
Secretary: Worked in the Center[d]	0.43	0.50	0	1	460
Secretary: Finished College[d]	0.81	0.39	0	1	460
Panel C: Coal-fired Power					
Log (Coal Power)[e]	5.88	1.03	2.72	8.06	489
Log (Hydro Power)[e]	3.50	2.01	-4.61	7.15	461
Drought[f]	0.16	0.36	0.00	1.00	496
Panel D: Other Variables in Robustness Checks					
Log (Fiscal Revenue)[g]	5.44	1.22	1.95	8.42	487
Log (Total Transfers)[g]	14.64	1.02	11.80	17.07	465
Log (Transfer: Tax Refund)[h]	13.37	0.96	10.93	15.37	379
Log (Transfer: Discretion)[h]	13.56	1.17	10.69	16.02	379
Log (Discharge Fee / COD)[j,a]	-1.99	1.06	-5.42	2.93	489
Log (Discharge Fee / SO2)[j,a]	-3.14	0.74	-5.49	-1.36	489
Log (# of Letters)[a]	8.56	1.49	3.85	11.66	489
Log (# of Visits)[a]	7.08	1.28	0.69	9.20	414

Data Sources:

a. China Environment Yearbooks.

b. Comprehensive Statistical Data for 60 Years of New China.

c. China National Environment Monitoring Center: http://58.68.130.147/.

d. Public Curriculum Vitae.

e. China Electricity Yearbooks.

f. NOAA: http://www.cpc.ncep.noaa.gov/products/globalprecip/html/wpage.cmap.html.

g. China Finance Yearbooks.

h. The Compendium of Local Fiscal Statistics.

i. China Statistical Yearbooks.

j. China Environment Statistical Yearbooks.

Table 3A: The Impact of Connections on COD

	(1) COD	(2) COD	(3) COD	(4) COD	(5) COD	(6) COD
Connection	0.152	0.139	0.238**	0.230***	0.266***	0.253**
	(0.150)	(0.155)	(0.090)	(0.075)	(0.082)	(0.100)
Province and Year FE	Y	Y	Y	Y	Y	Y
Controls		Y		Y	Y	Y
Governor FE			Y	Y	Y	Y
Region*Year FE						Y
# clusters	30	30	30	30	30	30
# observations	489	460	489	460	383	383

Notes: The dependent variable is the log of COD. Columns 1-2 are the results from within-province estimations. Column 1 reports the results conditional on province and year fixed effects. Column 2 shows the results after including controls. Controls include whether the governor has been in office longer than average, his age, his education, whether he is from the province he governs and whether he has work experience in the Central government, as well as the corresponding variables of the provincial Secretary. Columns 3-6 report the results from within-governor estimations. Column 5 shows the results excluding the governors always connected. Column 6 shows the results after including regional trends.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 3B: The Impact of Connections on Industrial SO_2

	(1) SO2	(2) SO2	(3) SO2	(4) SO2	(5) SO2	(6) SO2
Connection	0.075	0.069	0.084	0.107*	0.123**	0.097*
	(0.066)	(0.067)	(0.056)	(0.059)	(0.055)	(0.057)
Province and Year FE	Y	Y	Y	Y	Y	Y
Controls		Y		Y	Y	Y
Governor FE			Y	Y	Y	Y
Region*Year FE						Y
# clusters	30	30	30	30	30	30
# observations	489	460	489	460	383	383

Notes: The dependent variable is the log of SO_2. Columns 1-2 are the results from within-province estimations. Column 1 reports the results conditional on province and year fixed effects. Column 2 shows the results after including controls. Controls include whether the governor has been in office longer than average, his age, his education, whether he is from the province he governs and whether he has work experience in the Central government, as well as the corresponding variables of the provincial Secretary. Columns 3-6 report the results from within-governor estimations. Column 5 shows the results excluding the governors always connected. Column 6 shows the results after including regional trends.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 3C: The Impact of Connections on River Quality

	(1) COD	(2) COD	(3) COD	(4) COD	(5) COD	(6) COD
Connection	0.182***	0.123**	0.238**	0.270**	0.285**	0.434***
	(0.035)	(0.046)	(0.087)	(0.107)	(0.119)	(0.141)
Province and Year FE	Y	Y	Y	Y	Y	Y
Controls		Y		Y	Y	Y
Governor FE			Y	Y	Y	Y
Region*Year FE						Y
# clusters	26	26	26	26	25	25
# observations	784	780	784	780	563	563

Notes: The river data is available between 2002 and 2010. The dependent variable is the log of COD density. Column 1 reports the results conditional on province and year fixed effects. Column 2 shows the results after including controls. The controls include whether the governor has been in office longer than average, his age, his education, whether he is from the province he governs and whether he has work experience in the Central government, as well as the corresponding variables of the provincial Secretary. Columns 3-6 report the results from within-governor estimations. Column 5 shows the results excluding the governors always connected. Column 6 shows the results after including regional trends.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 4: The Impact of Connections on GDP

	(1) GDP	(2) GDP	(3) GDP	(4) Ind. GDP	(5) Ind. GDP	(6) Ind. GDP	(7) Non-Ind.	(8) Non-Ind.	(9) Non-Ind.
Connection	0.042	0.046	0.048**	0.142**	0.156**	0.150***	-0.018	-0.019	-0.013
	(0.033)	(0.030)	(0.018)	(0.069)	(0.064)	(0.030)	(0.013)	(0.014)	(0.014)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y		Y	Y
Region*Year FE			Y			Y			Y
# clusters	30	30	30	30	30	30	30	30	30
# observations	489	460	383	489	460	383	489	460	383

Notes: GDP is divided into industrial GDP and non-industrial GDP. The dependent variables are in logs. The controls are the same as those in Tables 3A-3C. Columns 3, 6 and 9 show the results excluding the governors always connected while controlling for regional trends.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 5A: Correlations between Pollutants and Production

	(1) COD	(2) COD	(3) COD	(4) SO2	(5) SO2	(6) SO2
Log (GDP)	1.513*			0.632**		
	(0.743)			(0.243)		
Log (Ind. GDP)		0.637*			0.456***	
		(0.331)			(0.144)	
Log (Non-Ind. GDP)			0.812			0.086
			(0.850)			(0.395)
Province and Year FE	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y
# clusters	30	30	30	30	30	30
# observations	489	489	489	489	489	489

Notes: The dependent variables are in logs.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 5B: Control for the Production Scale

	(1) COD	(2) COD	(3) COD	(4) COD	(5) SO2	(6) SO2	(7) SO2	(8) SO2
Connection	0.168*	0.190*	0.275**	0.290**	0.022	0.051	0.082	0.059
	(0.095)	(0.103)	(0.110)	(0.120)	(0.057)	(0.060)	(0.061)	(0.054)
Log (Ind. GDP)	0.494	0.258	-0.049	-0.251	0.437***	0.362**	0.235	0.255*
	(0.340)	(0.443)	(0.471)	(0.471)	(0.153)	(0.168)	(0.140)	(0.131)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y	Y	Y		Y	Y	Y
Region*Year FE				Y				Y
# clusters	30	30	30	30	30	30	30	30
# observations	489	460	383	383	489	460	383	383

Notes: The results show the impacts of connections after controlling for the log of industrial GDP. The controls are the same as those in Tables 3A-3C. Columns 3-4 and 7-8 show the results excluding the governors always connected.

Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 6: Coal-fired Power: Droughts Meet Career Concerns

	(1) CoPower	(2) CoPower	(3) CoPower	(4) CoPower	(5) CoPower	(6) CoPower
Drought*Connection				0.063**	0.073**	0.064*
				(0.025)	(0.031)	(0.036)
Connection			0.113*	0.103	0.100*	0.095*
			(0.065)	(0.065)	(0.055)	(0.050)
Drought		0.041**	0.042**	0.031	0.032*	0.267
		(0.018)	(0.018)	(0.019)	(0.017)	(0.294)
Log (Rainfall)	-0.130***					
	(0.045)					
Province and Year FE	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y
Controls					Y	Y
Region*Year FE					Y	Y
Droughts*Controls						Y
# clusters	28	28	28	28	28	28
# observations	455	455	455	455	426	426

Notes: The dependent variables are in logs. The grid-level information on Beijing and Tianjin is not available. The controls are the same as those in Tables 3A-3C. Columns 5-6 show the results excluding the governors always connected while controlling for regional trends.

Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 7: Dynamic Impacts of Connections

	(1) COD	(2) COD	(3) SO2	(4) SO2	(5) Ind. GDP	(6) Ind. GDP	(7) Non-ind.	(8) Non-ind.
1 Year Before Connection	0.003	0.042	-0.058	-0.050	0.019	0.006	-0.010	-0.011
	(0.104)	(0.112)	(0.057)	(0.055)	(0.043)	(0.058)	(0.025)	(0.029)
The First Year of Connection	0.184	0.181	0.130	0.096	0.181	0.150***	-0.046*	-0.043
	(0.130)	(0.187)	(0.083)	(0.070)	(0.111)	(0.047)	(0.025)	(0.026)
2 Years or More after Connection	0.326**	0.329*	0.130	0.096	0.190*	0.198***	-0.040	-0.031
	(0.147)	(0.179)	(0.107)	(0.095)	(0.111)	(0.050)	(0.026)	(0.026)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Region*Year FE		Y		Y		Y		Y
# clusters	30	30	30	30	30	30	30	30
# observations	383	383	383	383	383	383	383	383

Notes: The sample excludes those governors who are always connected. The dependent variables are in logs. The controls are the same as those in Tables 3A-3C. The results from columns 1 and 3 are visualized in Figures 1A and 1B.

Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 8A: The Border Effect

	(1) COD	(2) COD	(3) COD	(4) COD	(5) COD	(6) COD
Connection*Border			-0.032	-0.035	-0.157	-0.188
			(0.185)	(0.192)	(0.207)	(0.224)
Border	0.474**	0.474**	0.488**	0.488**	2.911*	3.287*
	(0.196)	(0.196)	(0.228)	(0.229)	(1.652)	(1.743)
Connection		0.239**	0.258*	0.289**	0.440***	0.624***
		(0.088)	(0.137)	(0.135)	(0.142)	(0.197)
Province and Year FE	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y
Border*Controls					Y	Y
Region*Year FE						Y
# clusters	26	26	26	26	26	26
# observations	784	784	784	780	780	780

Notes: The dependent variable is the log of COD density. Border refers to rivers close to the boundary of at least two provinces. The table shows that rivers at the border are indeed dirtier. However, the border effect is independent of connections. The controls are the same as those in Tables 3A-3C.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 8B: Using Neighbors as a Placebo

	(1) Nb COD	(2) Nb COD	(3) Nb COD	(4) Nb SO2	(5) Nb SO2	(6) Nb SO2
Connection	-0.185**	-0.189*	-0.208	-0.021	-0.011	0.022
	(0.083)	(0.110)	(0.154)	(0.065)	(0.072)	(0.106)
Province and Year FE	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y
Region*Year FE			Y			Y
# clusters	30	30	30	30	30	30
# observations	486	457	457	486	457	457

Notes: The dependent variables are the logs of pollution outcomes in the neighboring province, which is defined as the nearest one in terms of distance between two provincial capitals. The controls are the same as those in Tables 3A-3C.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 9: Results after Trimming the 5% Tails

	(1) COD	(2) COD	(3) COD	(4) COD	(5) SO2	(6) SO2	(7) SO2	(8) SO2
Connection	0.261***	0.279***	0.285***	0.244**	0.101*	0.118*	0.122*	0.078
	(0.074)	(0.063)	(0.062)	(0.091)	(0.059)	(0.063)	(0.067)	(0.061)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y	Y	Y		Y	Y	Y
Region*Year FE				Y				Y
# observations	397	377	323	323	397	377	323	323

Notes: The table presents the results after trimming the 5% tails of the dependent variables. The controls are the same as those in Tables 3A-3C. Reported in parentheses are standard errors clustered at the province. Significant at * 10%, ** 5%, *** 1%.

Table 10A: Connections and Transfers

	(1) Fis Rev	(2) Fis Rev	(3) Transfers	(4) Transfers	(5) Tax Refund	(6) Tax Refund	(7) Discretion	(8) Discretion
Connection	0.049**	0.049	0.071	0.010	0.047	0.047	0.081	-0.050
	(0.023)	(0.038)	(0.047)	(0.046)	(0.040)	(0.046)	(0.101)	(0.065)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y
Region*Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y		Y		Y		Y
# clusters	30	30	30	30	30	30	30	30
# observations	379	355	379	355	379	355	379	355

Notes: The dependent variables are in logs. As the data on different types of transfers is currently available till 2007, the results employ the data between 1993 and 2007. Transfers are the sum of tax refunds and more discretionary transfers. The controls are the same as those in Tables 3A-3C.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 10B: Controlling for Transfers

	(1) COD	(2) COD	(3) COD	(4) COD	(5) SO2	(6) SO2	(7) SO2	(8) SO2
Connection	0.207**	0.205**	0.250***	0.251**	0.068	0.086	0.107*	0.091
	(0.087)	(0.081)	(0.074)	(0.100)	(0.051)	(0.052)	(0.054)	(0.057)
Log (Total Transfers)	0.219	0.172	0.108	0.041	0.111	0.142	0.103	0.059
	(0.194)	(0.188)	(0.181)	(0.186)	(0.112)	(0.095)	(0.093)	(0.096)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y	Y	Y		Y	Y	Y
Region*Year FE				Y				Y
# clusters	30	30	30	30	30	30	30	30
# observations	465	441	367	367	465	441	367	367

Notes: This table presents the results after including the log of total transfers. The dependent variables are in logs. The controls are the same as those in Tables 3A-3C. Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 11: The Impact on Pollution Discharge Fee Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	CODRate	CODRate	CODRate	SORate	SORate	SORate	WeightedRate	WeightedRate	WeightedRate
Connection	-0.150***	-0.172**	-0.176**	0.004	-0.049	-0.053	-0.092*	-0.125*	-0.127
	(0.053)	(0.070)	(0.084)	(0.092)	(0.091)	(0.102)	(0.052)	(0.067)	(0.077)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y		Y	Y
Region*Year FE			Y			Y			Y
# clusters	30	30	30	30	30	30	30	30	30
# observations	489	460	460	489	460	460	489	460	460

Notes: The dependent variables are the log of pollution fee rate (fees/COD, fees/SO_2 or 0.15×fees/COD+0.31×fees/SO_2). The fees information is only available for the total amount of pollution charges. The controls are the same as those in Tables 3A-3C.
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table 12: Impacts on Letter-or-Visit Complaints

	(1) Letter	(2) Letter	(3) Letter	(4) Visit	(5) Visit	(6) Visit
Connection	0.062	0.004	-0.046	-0.565	-0.673*	-0.646*
	(0.223)	(0.254)	(0.262)	(0.376)	(0.386)	(0.335)
Province and Year FE	Y	Y	Y	Y	Y	Y
Governor FE	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y
Region*Year FE			Y			Y
# clusters	30	30	30	30	30	30
# observations	489	460	460	414	400	400

Notes: The dependent variables are the log of letters and visits regarding environmental issues. Controls are the same as those in Tables 3A-3C.

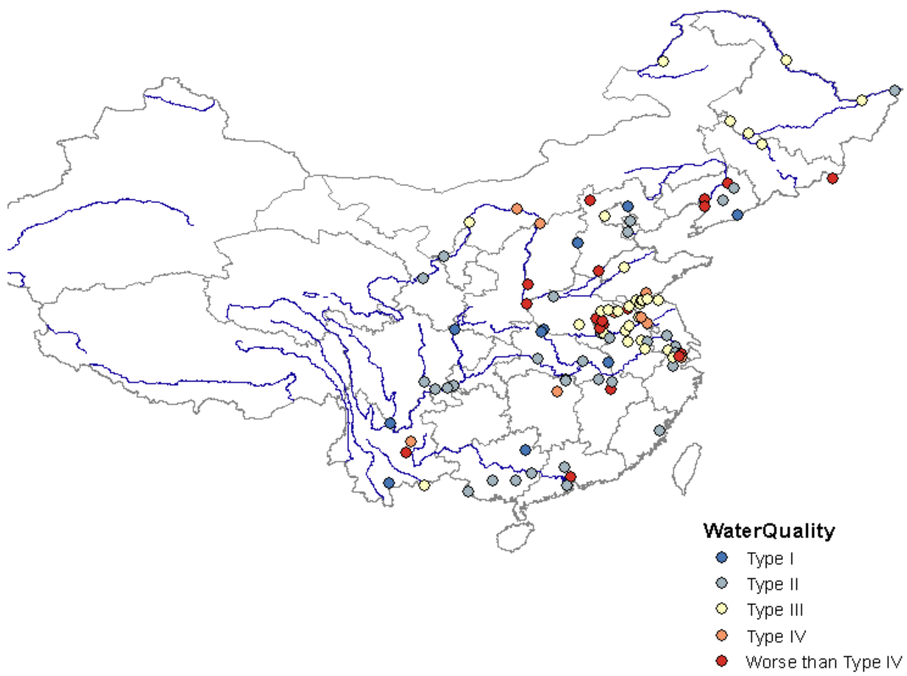
Reported in parentheses are standard errors clustered at the province level. * Significant at 10%, ** 5%, *** 1%.

Table A1: Differences in Observables

	Never Connected	Always Connected	Switchers
Years in Office	3.137	2.740	3.723
	(2.072)	(1.551)	(2.072)
Age	57.863	56.195	58.383
	(3.819)	(4.484)	(4.857)
Governing Home Prov.	0.397	0.169	0.447
	(0.490)	(0.377)	(0.503)
Worked in the Center	0.318	0.468	0.404
	(0.466)	(0.502)	(0.496)
Finished College	0.836	0.792	0.872
	(0.371)	(0.408)	(0.337)
Observations	365	77	47

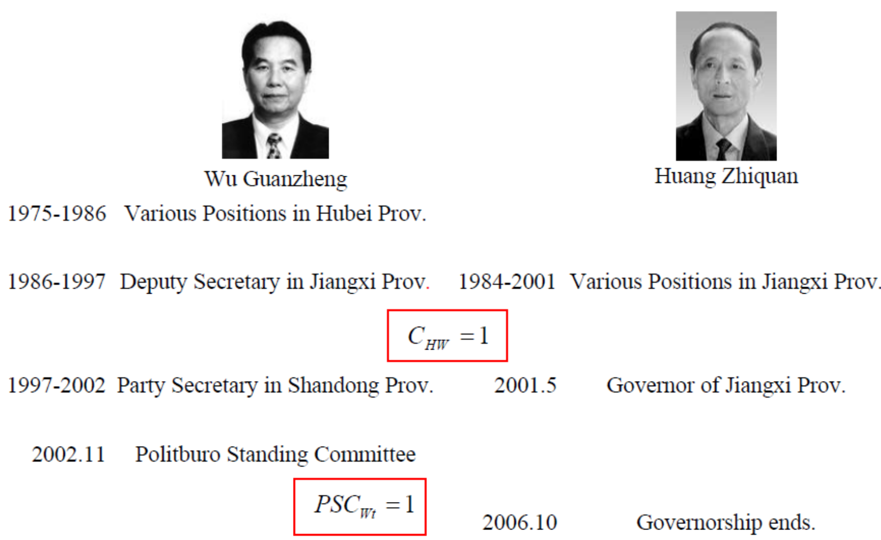
Notes: The table presents differences in characteristics between three groups of governors: those never connected, always connected and the switchers. They show that those always connected have shorter tenure and are less likely to govern home province, suggesting that their appointment might be endogenous.

Figure A1: Water Quality from the River Monitoring Stations in 2010



Notes: This map shows the locations of the 100 monitoring stations as well as the quality data in the first week of 2010. The categorization of the water quality is as follows: drinkable water (Type I or II), undrinkable but suitable for human contact (Type III), appropriate for general industrial water supply and recreational waters in which there is no direct human contact with the water (Type IV), appropriate only for agricultural water supply and general landscape requirements (Type V) and essentially useless (Type VI). Ebenstein (2012) uses similar information in 2004 and finds that a positive link between the order of water quality and the digestive cancer death rate.

Figure A2: Connections between Governor Huang and PSC Member Wu



Notes: This is an example to illustrate how connections are defined. Huang and Wu were working in Jiangxi Province together in the late 1980s and 1990s. Thus, $C_{HW} = 1$. In 1997, Wu left Jiangxi whereas Huang stayed. In May 2001, Huang became the Governor of Jinagxi. In November 2002, Wu entered the Politburo Standing Committee and hence $PSC_{Wt} = 1$. According to my definition, governor Huang was not connected in 2001 and 2002 but got connected since 2003 (when $C_{HWt} = C_{HW} \times PSC_{Wt} = 1$).