Incentives for China’s urban mayors to mitigate pollution externalities: The role of the central government and public environmentalism

Siqi Zheng a, Matthew E. Kahn b,* , Weizeng Sun a, Danglun Luo c

a Department of Construction Management and Hong Kong Center for Real Estate, Tsinghua University, China
b UCLA and NBER, United States
c Lingnan College, Sun Yat-Sen University, China

A B S T R A C T

China’s extremely high levels of urban air, water and greenhouse gas emission levels pose local and global environmental challenges. China’s urban leaders have substantial influence and discretion over the evolution of economic activity that generates such externalities. This paper examines the political economy of urban leaders’ incentives to tackle pollution issues. We present evidence consistent with the hypothesis that both the central government and the public are placing pressure on China’s urban leaders to mitigate externalities. Such “pro-green” incentives suggest that many of China’s cities could enjoy significant environmental progress in the near future.

1. Introduction

China’s pollution challenges are well documented. Many cities in China have extremely high air pollution levels. In early 2013, the terrible smog haze pollution in North China caught the world’s attention. 1 The PM2.5 concentration in those cities has been two, three, or even four times the emergency threshold of 250 μg/m³ (and up to 40 times levels the WHO considers healthy). 2 Based on an ambient particulate concentration criterion of PM10, twelve of the twenty most polluted cities in the world are located in China (World Bank, 2007). This pollution has mainly been caused by emissions from the heating and electricity sector (based on coal), and the industrial and transportation sectors.

As China surpassed Japan as the second largest economy in the world at the end of 2009, China’s energy consumption and electricity demand have also been soaring. The nation’s electricity consumption reached roughly 4.5 trillion kilowatt hours in 2011. 3 Given that 80% of China’s electricity is produced by coal fired power plants this has led to a huge increase in greenhouse gas emissions.

If China’s central and local governments stepped in and mandated credible regulations, then pollution externalities across China’s cities could be mitigated. Environmental economists have argued based on cross-national evidence that there is a “J” curve for regulation such that poor nations implement none and middle income nations start to implement such regulation which grows more intense as these nations develop from being middle income to being rich (Selden and Song, 1995). As China becomes one of the world’s leading economies, it is possible that a similar dynamic could play out there.

Such an optimistic, and deterministic, vision of regulatory adoption as a function of only national per-capita income abstracts away from institutions and incentives as important determinants of whether government officials are “up to the job” of combatting pollution. Yet, leading studies in growth economics have emphasized the fundamental role that institutions play in economic development (Acemoglu and Robinson, 2012).

Until recently, neither China’s national government officials nor local urban officials prioritized environmental protection. The Chinese central government creates a “tournament competition” among local mayors by promoting or demoting them on the basis of relative performance (Bo, 1996; Wu, 2010). The central government had been focusing on economic growth with an emphasis on GDP as the key evaluation criterion for local officials’ performance (Chen et al., 2005; Li and

See http://www.chinadaily.com.cn/china/2013-01/14/content_16115953.htm for more background information.

See http://www.chinadaily.com.cn/china/2013-01/14/content_16115953.htm for more background information.

* Corresponding author.
E-mail addresses: zhengsiqi@gmail.com (S. Zheng), mkahn@iies.ucla.edu (M.E. Kahn), sunweizeng@gmail.com (W. Sun), luodl@mail.sysu.edu.cn (D. Luo).

© 2013 Elsevier B.V. All rights reserved.

Please cite this article as: Zheng, S. et al., Incentives for China’s urban mayors to mitigate pollution externalities: The role of the central government and public environmentalism, Reg. Sci. Urban Econ. (2013), http://dx.doi.org/10.1016/j.regsciurbeco.2013.09.003
Stability is an important target when the State evaluates local officials. Since social pressure from the central government and the local public who are size relative to the past, urban mayors in China now face political challenges. In recent years the central government has been changing the performance evaluation criteria for local officials from purely output-based to including more “greenness” in the performance vector (Landry, 2008). Below we discuss why the central government changed its focus on GDP growth to an objective function that also includes environmental goals. The driving forces were both a desire to improve the people's quality of life and a desire to establish legitimacy in the public's mind to help retain political power (Wang, forthcoming).

Local residents provide a second source of pressure on urban mayors. In democracies, voters have the ability to hold elected officials accountable for their policy choices (Härsman and Quigley, 2010; List and Sturm, 2006). While China’s urbanites do not directly vote, they have alternative strategies for expressing their views. As the new urban cohorts become richer and more educated, they are likely to value safety and greenness. An educated public will seek out more information about environmental threats. Recent trends that reduce the cost of information acquisition, such as the rise of the Internet media, micro blogs (weibo, the Chinese version of Twitter), instant phone messages, and more liberated local newspapers have increased the public’s awareness of pollution challenges. The salience of this news allows them to overcome potential free rider issues and to unite to express their concerns and displeasure with current urban quality of life. Since social stability is an important target when the State evaluates local officials, local officials are keen to address their people's demand for a cleaner environment.

This paper uses unique city level panel data to test several predictions related to how a city’s environmental performance influences a mayor’s career prospects. We also study how quality of life conditions is associated with the public’s interest in environmental issues. Our study exploits cross-regional and within city variation in economic and environmental conditions to generate new facts about the causes and consequences of pollution on city leader's priorities. We hypothesize that relative to the past, urban mayors in China now face political pressure from the central government and the local public who are each demanding environmental progress. In a metaphorical sense, the mayors are “sandwiched” by these two different pressure groups and thus have less discretion than they had in the recent past.

We create several new data sets including information on the promotion propensities and demographics of prefecture-level city mayors, and their city’s industrial energy intensity and ambient particulate matter (PM10) levels of 86 Chinese cities during the years 2004 to 2009. We use these data to test whether there is an association between environmental performance and an urban leader’s probability of being promoted. We also test whether objective measures of urban residents’ environmentalism are associated with environmental progress. We present evidence consistent with the hypothesis that both the central government's regime shift and urban households' rising demand for greenness are contributing to local politicians’ accountability for their city's energy and environmental performance.

This paper contributes to a nascent empirical literature on the role that political leadership plays in determining government priorities over public good provision. Jones and Olken (2005) document the role that national leaders play in affecting macroeconomic growth. List and Sturm (2006) find that U.S. governors’ environmental policy priorities change when they are restricted by term limits from remaining in office. Ferreira and Gyorok (2009) document differentials in U.S. mayor policies over taxes, spending and public sector employment. Jia (2012) develops a model of politicians with career concerns making choices over the use of clean and dirty technologies. She exploits a unique data set identifying social networks between Chinese local governors and key central government officials, and concludes that politicians are motivated by strong promotion incentives which promote growth, regardless of its social costs.

The rest of the paper is organized in five sections. Section 2 describes the political economy of environmental regulation in China, especially the role of promotion criteria, and also the green nudge from the public. Section 3 discusses our empirical hypotheses and data creation as we construct several unique data sets, including the energy-environmental quality and mayor promotion data by city/year, and two indices reflecting Chinese urbanites’ concern intensity over pollution. Section 4 presents the empirical equations and results. Section 5 concludes.

2. Background on the central government’s promotion rules and the recent emphasis of environmental goals

2.1. The evolution of the promotion rules

China has a strong one-party central government, but hundreds of local governments act as competing enterprises. The State Council appoints the governors of provinces, municipalities, and some major cities (so-called “provincial-level” and “vice-provincial” cities) directly. Provincial governments appoint the governors of prefecture-level cities. How to select and reward subordinate officials is central to the effective governance of every large organization. The selection and promotion process is performed by the upper-level CCP (China’s Communist Party) Committee’s personnel department, which is a key sector in the upper-level government.5

In the past, local GDP growth was the main criterion used by upper-level governments in evaluating the performance of lower-level officials’ performance and deciding whether to promote them to higher positions. Recently, sustainability and social stability are included in the promotion criteria.

The Chinese State has established a number of notable targets for energy efficiency and pollution reduction. Specific energy efficiency and pollution reduction targets were clearly set and included in the tenth, eleventh and twelfth “Five-Year Plan” (2001–2005, 2006–2010, 2011–2015 FYP, respectively). In the tenth FYP, the target was set that major water and air pollutants should decrease by 10% over the five-year period. In the eleventh FYP, the target was that major pollutants such as COD (Chemical Oxygen Demand) and SO2 to decrease by 10% each year from the 2005 level; energy consumption per unit of GDP to decline by about 20% from the 2005 level. At the Copenhagen Climate Summit in 2009, China pledged to achieve a carbon intensity reduction of 40–45% by 2020 (Department of Climate Change, NDRC, 2010).

There are several motivations behind the Chinese central government’s ambitious shift to emphasize pollution reduction and climate change mitigation goals. First, domestic energy security concerns have risen on the central government’s agenda as a result of electricity shortages and rapidly rising energy consumption. Second, the central government believes that the rest of the world is embracing the low-carbon energy agenda which has created a market imperative for China to become a technological and economic leader in this nascent field (Boyd, 2012). Third, the central government may be concerned about the direct productivity loss and the disamenity effects caused by pollution exposure. Another possible explanation is that the central government seeks “legitimation” with the Chinese people and also in the international arena, and making a commitment to pursuing environmental goals

---

*This process is quite complicated, including performance evaluation with objective and quantitative targets, individual interview, and qualitative assessment of capacity and potential. Therefore, the promotion rule cannot be written out as a simple function.*
is one way to credibly signal to both domestic constituents and international actors that China is an international leader and that the Communist Party leadership cares about its own people (Wang, forthcoming). This suggests that environmental protection is part of a broader public relations campaign to boost popular domestic support and to reduce the risk of social instability.

Including greenness targets in the performance evaluation and promotion criteria of local government leaders is the State’s key approach to encourage local leaders to address sustainability challenges. Since the 11th FYP, the State has started to mobilize local government via the application of the target responsibility system (TRS) of energy conservation and pollution reduction, which is a top–down policy implementation mechanism based on China’s prevalent top–down pressure transfer political hierarchy (Qi, 2013). TRS involves four major steps: disaggregating targets, signing target responsibility contracts, accounting and monitoring energy consumption, and assessing target performance. For the first step, the central government disaggregated the total energy conservation and pollution reduction targets to provincial governments, and then provincial governments disaggregate their targets to municipal governments. The target responsibility contract is normally signed between the top officials of the upper and lower level governments.

Assessment and evaluation of target responsibility are a quantitative exercise. The energy conservation target, with the decline of energy intensity (EI, energy consumption per unit of GDP) as the major indicator, accounts for 40 points out of the total 100 points. The accounting system of this EI decline indicator was set up by the State Council. The other 60 points include many items, ranging from regularly reporting energy consumption numbers to upper level governments; investing in energy conservation and pollution reduction infrastructures, to effectively implementing environmental regulations. The assessment result is used in the performance evaluation of local leaders.

The main TRS targets are not closely linked to environmental outcomes that have significant impacts on the public’s health and quality of life. Instead, they are linked to the accounting indicators such as energy intensity and environmental infrastructure investment. These accounting indicators are more easily to be measured and collected. Credit for pollution reduction might be granted, for example, for the construction of a waste gas treatment plant or installation of pollution control technology in a power plant. Therefore local officials are incentivized to invest in environmental infrastructure and pollution control technology. With insufficient monitoring, there was much less focus on whether these investments are operated properly such that they actually reduce pollution. It was reported that factories adjusted pollution control equipment to report false data, treatment plants were left idle, local governments forced emergency shutdowns of electricity to local public services to meet energy efficiency targets, and so on (Wang, forthcoming). We will test this in Section 4 below by including different indicators in the promotion equation – objective quality of life indicators (such as PM10) and yearbook statistics (energy intensity and annual expenditure on waste gas treatment facilities) – and compare their effects.

### 2.2. Pressure applied by the urban public for environmental progress

While the central government has set performance standards based on criteria such as the number of pollution control facilities, the urban public has different priorities. They care about clean air and water. In the past, the public faced greater information costs concerning the environmental challenges they faced. The State and local governments monopolized the media – newspaper, radio and television. When a one party state controls information releases it may systematically choose to release information that helps it to achieve its political goals and may suppress negative information (Liu and Yang, 2009; Guan et al., 2012).

With the rise of the modern media and IT technologies such as blogs, microblogs, instant phone messages, China’s government has been losing its information disclosure monopoly. Local newspapers are also more liberalized. To attract readers, they report negative news such as pollution, corruption and land seize disputes. Improvement in remote sensing and cheaper pollution monitors has allowed others to measure and release China’s pollution levels (Zhang et al., 2007).

Recent research set in the US, India, Brazil, and Indonesia highlights the power of the media and information disclosure to mitigate classic principal–agent problems and to nudge government officials to supply public goods (Gentzkow et al., 2010; Besley and Burgess, 2002; Ferraz and Finan, 2008; Pargal and Wheeler, 1996). But those studies are all conducted in democracies. We are interested in whether the rising of information transparency in Chinese cities plays a similar role. The recent upsurge of environmental mass incidents (i.e., large-scale demonstration, protect or march triggered by environmental degradation or serious pollution events) provides some clues of this. In those mass incidents, the modern media helps to trigger a snowball effect, and this allows the public to make contributions to tackle pollution accidents. Examples include the Xiamen PX protest in 2007, Dalian PX protest in 2011, Shifang MoCu project protest in 2012, and Qidong protest on the paper mill’s pollution discharge into the sea in 2012. The number of mass incidents caused by pollution increased at an annual rate of 29% (Tong, 2013). Those events significantly threatened social stability, which is now another key target when evaluating officials’ performance. Therefore mayors are becoming more concerned about local people’s concern about environmental quality and local quality of life.

### 3. Empirical hypotheses and data

#### 3.1. Hypotheses

Based on the above discussion, we focus on testing four hypotheses related to the correlates of urban leaders pursuing policies that bring about environmental progress in China:

**H1.** Local officials are more likely to be promoted if their city experiences environmental progress.

**H2.** Public concern over urban pollution varies across space. Those regions (province/city) featuring stronger demand for environmental quality and with greater media openness have higher public concern intensity.

**H3.** City leaders facing recent public concern over environmental issues put more effort in pollution mitigation. There is a positive correlation between mayoral attributes such as his educational attainment and environmental progress.

**H4.** City leaders facing more pressure from the public will engage in greater energy conservation and environmental protection and this

---


8 In August 2011, messages were widely spread through micro blogs, blogs, Twitter and other internet forums that a PX (paraxylene) chemical factory (a joint venture between the city and a private company) built in Dalian city was at high risk to flood the town with the highly toxic chemical. Twelve thousand Dalian residents organized a peaceful public protest in Dalian’s People’s Square on August 14, demanding the factory to be immediately shut down and relocated, and that the details about the investigation into the factory should be made public. The Dalian government forbade the factory from opening. See http://www.nytimes.com/2012/07/29/world/asia/chinese-officials-cancel-plant-project-amid-protests.html?_r=0.


affects the shape of the pollution versus income relationship (i.e. the Environmental Kuznets Curve).

3.2. Data

3.2.1. Energy/environment indicators

We select three energy/environment indicators. One is the energy intensity measure, which is a key component of the TRS. Energy intensity \( (EI) \) of urban productivity is measured as “energy consumption per GDP dollar” (ton standard coal per 10,000 RMB) by city/year (Eq. (1)).

\[
EI_i = \frac{\text{Energy}_i}{\text{GDP}_i} = \frac{\sum_j \left( \text{GDP}_i \times EI_j \right)}{\text{GDP}_i}
\]

where subscript \( i \) represents city; \( t \) represents year; and \( j \) represents industry. This energy intensity variable reflects a city’s industrial composition in a given year. If a city’s industries are very energy intensive then its energy intensity will be high.

The energy consumption and GDP data are collected from the “China City Statistical Yearbook”. Fig. 1 shows the energy intensity values for the 86 cities in our sample for 2009. The energy intensity had decreased for many cities during 2004 and 2009. As we do not have city level energy intensity data, our \( EI \) variable is calculated using the national level energy intensity of each industry and creating the city’s index based on its industrial mix in a given year. Given this definition, a city’s energy intensity would decline if a mayor actively sought to replace dirty industries (i.e. steel) with clean industries such as services. But this index does not reflect within industry technique effects such as new clean factories opening and old dirty factories closing.

We have collected two indicators on air pollution. One is an “accounting” indicator – annual expenditure on waste gas treatment facilities per GDP dollar \( (\text{FACILITY}_\text{EXP}) \); and the other one is the “local quality of life” indicator – the ambient particulate concentration in the air \( (PM_{10}) \). The first variable measures local governments’ effort in providing air pollution mitigation facilities, which help them to gain some credit in the TRS. For the second measure, we first collect the API (air pollution index) of each city by week from the website of the Ministry of Environmental Protection, People’s Republic of China, and then calculate the average \( PM_{10} \) concentration (mg/m\(^3\)) by city by year \( (PM_{10}) \). Since people are more sensitive to severely polluted days, we also construct the variable of \( PM_{10,75} \) which stands for the 75 percentile value of \( PM_{10} \) concentration by city/year. Fig. 2 shows

---

11 Total suspended particles (TSP) measures the mass concentration of particulate matter in the air. Within TSP, \( PM_{10} \) stands for particles with a diameter of 10 \( \mu \text{m} \) or less. Particles that are ten micrometers or greater are filtered and generally do not enter the lungs. Particulates smaller than ten micrometers are likely to enter the lungs.

12 http://datacenter.mep.gov.cn/.

13 The quality of China’s API data has been debated. For instance, Wang et al. (2009) found that his self-measured PM level in Beijing during Olympic period is correlated with official API, but 30% higher. Andrews (2008) pointed out a likely systematic downward-bias around the “Blue Sky” standard (API less or equal to 100), and also highlighted a sampling downward bias for dropping monitoring stations in more pollution concentrated traffic areas in Beijing. These studies triggered some concerns on the measurement errors using Chinese official API data. Later studies suggest that Wang’s measurement gap between the self-measured data and official API data is mainly due to sampling and methodological differences (Tang et al., 2009; Yao et al., 2009; Simonich, 2009). A recent paper by Chen et al. (2011) uses both API and AOD data to analyze the changes before and after Beijing Olympic. Their study suggests that the two different data sources provide similar results. In our study, we convert API index back to \( PM_{10} \) concentration data using the SEPA API formula. Andrews (2008) shows that this approach is reliable, especially when the main purpose is to study the cross-city variation for a large number of cities.
the PM10 values for the 86 cities in 2009. Again, many cities enjoyed air quality improvement during 2004 and 2009.

3.2.2. City mayor and CCP secretary data set

A city has two leaders — the mayor and the CCP secretary. Our local official data set is by city/year and it contains the mayor's and the CCP secretary's name, information of age, gender, educational attainment, starting year and finishing year of his/her term on this position, the previous position and the next position. This data set is not publicly available and it is collected from internal sources in China's political system.

By law, the mayor is the executive officer of the municipal (city) government. At the same time, the law also says that the mayor is under the guidance of the city communist party committee of which the party secretary is the head. In practice, the division of labor is that the party secretary is in charge of the personnel and other political duties, while the mayor is in charge of the daily operation of the government for which economic growth is a top priority and now energy conservation and environmental protection are also addressed. Since the determinants of promotion may differ between party secretaries and mayors, we run the probit model for mayors and secretaries separately. Here we mainly discuss the regression results of the mayor's promotion equation, and place those of the city's CCP secretary in the Web Appendix (Table A3).

3.2.3. Public environmentalism measures

We construct two indices to reflect urban residents' environmentalism, or concern intensity, over environmental issues. The first is the Google Insight index based on the internet search intensity of the key word — "environmental pollution (huan jing wu ran)", as a measure of public concern intensity on Internet. Google Insights is a publically available online tool for tracking aggregate Google search intensity over time for specific geographic areas. Recent research (Kahn and Kotchen, 2011) shows that Google search terms are a powerful tool to predict public health epidemics and economic activity. Google Insights can report a search intensity index of a specific key word by geographic area (in the Chinese version of Google Insights, the geographic unit is province) during a time period specified. Here, we construct this public concern index (PCI_1) by province/year.

The time length and spatial coverage of the local official and air quality data sets constrain the sample of our empirical study to be 86 cities from 2004 to 2009. Among these 86 cities, there are 35 major cities (4 municipalities plus 31 provincial capital cities) and 51 medium and small-sized cities. We also collect the data of city attributes from China Statistics Yearbooks and China City Yearbooks, including GDP per capita ($GDPPC$), city population ($POP$), annual rainfall in year 1999 ($RAIN$, in mm), and temperature discomfort index in year 1999 (See Zheng et al. (2009,2010) for the construction of this index ($TEMP$). The variable definitions and descriptive statistics are listed in Table 1.
The above index relying on Google Insights cannot report the public intensity by city, therefore we construct the second index by city/year. This second index aims to measure the frequency of pollution-related articles reported in a city’s local newspapers. We search for the same key word “environmental pollution (huan jing wu ran)” in Google search and set the search criteria to be the articles published in a city’s major local newspapers in a year. We count the number of entries and divide this number by the total circulation of those local newspapers in each city/year to obtain a standardized index by city/year. Once published, newspapers in a city/year add the index to their websites and equal 0 if he or she remains on the current position, or moves to another position in the same or lower level, or retires.

**4. Results**

**4.1. Local official’s promotion propensities**

In this section we test hypotheses H1 and H2. First, we test whether energy conservation and pollution reduction indicators are reflected in city mayors’ promotion criteria. As economic growth is well known to be a prime determinant for promotion in China (Li and Zhou, 2005), we test if the upper level government has begun to include proxies for greenness into the promotion evaluation system.

![](image)

**Fig. 3.** Energy intensity gradient with respect to GDP per capita (2004–2009).

In Eq. (2) the unit of analysis is city/year. The dependent variable is a dummy indicating whether the mayor of city i gets promoted or not in year t, which equals 1 if the officer moves to a higher level (including a mayor promoted to be a CCP secretary in the same or another city), and equals 0 if he or she remains on the current position, or moves to another position in the same or lower level, or retires. “Abnormal” changes, e.g. death, arrest due to corruption, are excluded from the sample. We include year fixed effects. Standard errors are clustered by city. This equation is estimated using a probit model.

We include GDP growth which is measured as the difference between the average annual GDP growth during this mayor/secretary’s term (until that year) and that during his or her predecessor’s tenure (Wu et al., 2013). Our focus is on the green indicators (GREEN) — EI (the key indicator in the TRS), FACILITY_EXP (the “accounting” indicator of pollution mitigation effort), PM10 and PM10_{25} measures. EI, PM10 and PM10_{25} are all measured in annual percentage decreases.

\[
\text{Prom }_{i,t} = \beta_0 + \beta_1 \cdot \text{GDP GROWTH}_{i,t} + \beta_2 \cdot \text{GREEN}_i + \beta_3 \cdot Z_{i,t} + \delta_{i,t}
\]  

(2)
annual percentage decrease in EI is a commonly-used quantitative target when evaluating local officials’ performance. \textit{FACILITY	extunderscore EXP} is an annual flow variable so we use its lag term to mitigate inverse causality problem. Personal attributes (age, educational attainment and the term length till that year) of the officer are also included in the model.\footnote{In estimating Eq. (2), we are implicitly assuming that the central government does not follow a systematic rule assigning certain mayors based on quality dimensions unobserved by the economist to specific cities. For example, our estimates would be biased if the central government sent the best mayors (based on unobserved attributes) to the high pollution cities with the goal of cleaning them up. We only have a limited number of mayors’ attributes (age, years on position and educational attainment). Therefore omitted mayor attributes may also correlated with both the mayor’s promotion probability and its effort in reducing pollution (as well as boosting the economy). We acknowledge that we are unable to control for time-variant city attributes, and omitted mayor characteristics. For example politicians may pursue environmental progress due to self-interest. The current model specification neglects what presumably might be another important motivation: officials might care about pollution because of their own family’s health and safety. It would be interesting to test whether there is a difference in the policy outcomes for officials with children relative to those without children. We thank a reviewer for this point.}

Table 2 reports the results of mayors’ promotion equation regressions. Our results indicate that the relative GDP growth rate (comparing to the previous mayor) is the most important determinant of a mayor’s promotion. This variable (\textit{GDP	extunderscore GROWTH	extunderscore M}) is statistically significant at 1% level in all regressions. Column (1) is the baseline model. In column (2) we augment the regression by including the \textit{PM10} decline measure (\textit{PM10	extunderscore DECLINE}). It contributes to the promotion probability and the effect is marginally significant. In column (3) we replace this variable with the improvement in air quality in severely polluted days (\textit{PM10\textunderscore DECLINE}). This variable has a larger positive effect (sig. at 10% level) on the promotion probability, indicating that air quality improvement in the most polluted days helps the mayor in his/her performance evaluation. In column (4) we replace the air quality measure to the energy intensity (\textit{EI}) decline measure. It is positive and statistically significant at 10% level. In column (5) we change to the lagged waste gas treatment facility expenditure (\textit{FACILITY	extunderscore EXP}), which is significantly positive at 1% level. Further calculations based on columns (1) to (5) show that a 1% increase in \textit{PM10} declining rate and energy intensity declining rate, and 1% increase in waste gas treatment facility expenditure will increase the mayors’ promotion odds by 0.26%, 0.37% and 0.9%, respectively. In our sample, the annual declining rate of \textit{PM10} varies from \(-42\%\) to \(+41\%\) for all city/year observations. This means that, comparing to a city that experiences no air quality improvement in a given year, the mayors in the best-performing city and the worst-performing city (in terms of air quality improvement) will have a 10.9 percentage points higher or 10.7 percentage points lower promotion odds, respectively.

In column (6), we include the three green indicators (\textit{PM10}, \textit{EI} and \textit{FACILITY	extunderscore EXP}) together. The facility variable is positive and still statistically significant at the 1% level and the energy intensity variable is significant at 10% level. The joint F-test shows that the three variables are jointly significant at 1% level. In column (7) we replace \textit{PM10\textunderscore DECLINE} with \textit{PM10\textunderscore DECLINE}. The above results support the hypothesis that energy/environmental improvements are positively associated with mayor’s promotion odds.\footnote{We acknowledge the possibility that environmental progress is positively correlated with other unobserved improvements in a city’s quality of life. In this case, we would overstate the role that environmental progress has played in causing the mayor’s promotion when in reality the mayors’ promotion is improved by the quality of life and other unmeasured improvements. For instance, those who are savvy Internet users likely have more observable human capital than others. Also, cities/provinces with more Internet users are more likely to have better IT and other infrastructure condition. Therefore we regard the effect of this variable on \textit{PCI} as correlation rather than causality. We thank an reviewer for pointing out this.}

It is possible that the annual changes in air quality and energy intensity are fluctuating and contain lots of noise, and this year’s annual change does not have an “instant” impact on the mayor’s promotion. In Table A1 in the Web Appendix, we replace this year’s \textit{PM10} and \textit{EI} decline rates with the average annual declining rates in the last two years. The results are quite similar with those in Table 2, except that the \textit{EI} decline rate has the right sign but is not statistically significant.

To control for possible time invariant omitted variable at city level (such as natural endowments and city political status) in Eq. (2), we have also estimated linear probability model with city fixed effects. These are reported in the Web Appendix (see Table A2). The results are quite similar to the probit results reported in Table 2.

The highly significant facility expenditure variable but less statistically significant air quality measures supports the claim that the promotion criteria emphasize “accounting” measures over the more relevant public health variables such as \textit{PM10}. In fact, annual \textit{PM10} decline rate (\textit{PM10\textunderscore DECLINE}) and annual facility expenditure per GDP (\textit{FACILITY	extunderscore EXP}) have a very weak correlation of 0.02 during our study period, and the correlation between \textit{PM10\textunderscore DECLINE} and last year’s \textit{FACILITY	extunderscore EXP} is also weak with a correlation of 0.09.\footnote{One reviewer points out that public concern index (\textit{PCI}) may not bear a log-log relationship with \textit{PM10} concentration. It may be possible that people living in the cities where air quality is better than some threshold are far less likely to complain than those where air quality is worse. We have tried this but did not find significant threshold in our sample. Therefore we stick to the continuous measure of air quality.}

4.2. Measuring spatial variation in the public concern over environmental issues

We estimate Eq. (3) to explore the spatial and temporal variations in the two public concern indices. Our hypothesis is that the public concern intensity over pollution will be higher if urban households’ demand for environmental quality is stronger, the city (province) has a higher level media openness, and the city (province) has poorer environmental condition. We estimate:

\begin{equation}
\begin{aligned}
\log(PCI_{it}) &= \alpha_0 + \alpha_1 \log(DIS.\ HK) + \alpha_2 \log(HK) + \alpha_3 \log(PMI_{10it}) \\
&\quad+ \alpha_4 \log(GDPPC_{it}) + \alpha_5 \log(POP_{it}) + \alpha_6 \log(EDU_{it}) \\
&\quad+ \text{region fixed effects} + \text{year fixed effects} + \epsilon_{it}.
\end{aligned}
\end{equation}

Due to data availability, the unit of analysis is province/year for the first index (\textit{PCI\textunderscore 1}) and city/year for the second index (\textit{PCI\textunderscore 2}). In Eq. (2), \textit{DIS. HK} is city/province’s distance to Hong Kong. Those places close to Hong Kong are exposed to a relatively freer media environment. People there can watch Hong Kong TV, have a better access to Hong Kong newspapers and publications, and also have some contacts with Hong Kong people. Therefore they have a better understanding of civil society, how the media works and what they can do. This effect diminishes fast as the distance to Hong Kong increases so we measure the distance in logarithm term. \textit{INTERNET} is the number of internet users in city/province in year $t$. This measure should be positively correlated with media openness.\footnote{The coefficients here show the average effects of energy efficiency and environmental improvement on mayors’ promotion odds. In results that are available on request, we have re-estimated Eq. (2) for a subset of 35 major cities and estimated this equation for a later period (2006–2009). We sought to test for heterogeneity with respect to the correlation between urban environmental performance and promotion probabilities. We support the hypothesis that in larger cities that there is a stronger correlation between environmental performance and promotion. To our surprise, we reject the hypothesis that this association has grown larger in recent years (we compare the estimate of $\beta_3$ in 2004–2005 to an estimate of this coefficient between 2006 and 2009). We have interacted \textit{PCI} with \textit{EI} decline or \textit{PM10} decline to see if energy efficiency or environmental improvements have larger effects on promotion odds in the cities with higher public concern intensity, but no significant heterogeneity effect is found.}

Cities/provinces with higher GDPPC (per capita GDP) and \textit{EDU} (average years to schooling) are expected to face a stronger demand for environmental amenities. People in cities/provinces with bad air quality (\textit{PM10}) may complain more.\footnote{We control for a city/province’s population, city/province fixed effects and year fixed effects.} We control for a city/province’s population, city/province fixed effects and year fixed effects.
Table 2
Probit estimates of a mayor’s promotion probability. (Dependent variable: PROMOTION, whether the mayor was promoted in that year).

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP_GROWTH_M</td>
<td>1.716***</td>
<td>1.568***</td>
<td>1.661***</td>
<td>1.789***</td>
<td>1.636***</td>
<td>1.668***</td>
</tr>
<tr>
<td>(3.12)</td>
<td>(3.04)</td>
<td>(3.01)</td>
<td>(3.23)</td>
<td>(2.96)</td>
<td>(3.00)</td>
<td>(2.98)</td>
</tr>
<tr>
<td>PM10DECLINE</td>
<td>0.261(1.47)</td>
<td>0.272*</td>
<td>(1.72)</td>
<td>0.373*</td>
<td>(1.73)</td>
<td>0.380*</td>
</tr>
<tr>
<td>PM10g75DECLINE</td>
<td>0.00234(0.54)</td>
<td>0.0206</td>
<td>0.00210</td>
<td>0.00198</td>
<td>0.00220</td>
<td>0.00555</td>
</tr>
<tr>
<td>AGE_MAYOR</td>
<td>(0.48)</td>
<td>(0.49)</td>
<td>(0.45)</td>
<td>(0.49)</td>
<td>(0.35)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>MASTER_MAYOR</td>
<td>0.00701</td>
<td>0.00473</td>
<td>0.00389</td>
<td>0.00241</td>
<td>0.00510</td>
<td>-0.00151</td>
</tr>
<tr>
<td>TERT_MAYOR</td>
<td>0.236**</td>
<td>0.242***</td>
<td>0.245***</td>
<td>0.228***</td>
<td>0.248***</td>
<td>0.245***</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>461</td>
<td>461</td>
<td>461</td>
<td>461</td>
<td>461</td>
<td>461</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.097</td>
<td>0.102</td>
<td>0.103</td>
<td>0.102</td>
<td>0.106</td>
<td>0.117</td>
</tr>
<tr>
<td>chi²</td>
<td>47.67</td>
<td>48.76</td>
<td>50.50</td>
<td>48.68</td>
<td>55.85</td>
<td>57.53</td>
</tr>
<tr>
<td>Joint F test for PM10 DECLINE (PM10g75 DECLINE, EL DECLINE and FACILITY EXP(log1))</td>
<td>12.82***</td>
<td>13.37***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) Marginal effects are reported. (2) z-statistics are reported in parentheses. (3) ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level. (4) Standard errors are clustered by the city level. (5) See Table 1 for variable definitions.

Table 3
The cross-city determinants of public concern about environmental issues.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>log(PCI_1)</th>
<th>log(PCI_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>log(D_HK)</td>
<td>-1.417***</td>
<td>-0.900***</td>
</tr>
<tr>
<td>(3.46)</td>
<td>(-5.05)</td>
<td></td>
</tr>
<tr>
<td>log(INTERNET)</td>
<td>1.118*</td>
<td>0.214*</td>
</tr>
<tr>
<td>(1.90)</td>
<td>(1.84)</td>
<td></td>
</tr>
<tr>
<td>log(PM10)</td>
<td>1.622*</td>
<td>0.524**</td>
</tr>
<tr>
<td>(1.74)</td>
<td>(2.07)</td>
<td></td>
</tr>
<tr>
<td>log(GDPPC)</td>
<td>2.054***</td>
<td>0.0516</td>
</tr>
<tr>
<td>(2.491)</td>
<td>(0.35)</td>
<td></td>
</tr>
<tr>
<td>log(POP)</td>
<td>-2.804***</td>
<td>0.538***</td>
</tr>
<tr>
<td>(4.47)</td>
<td>(4.85)</td>
<td></td>
</tr>
<tr>
<td>EDU</td>
<td>0.981</td>
<td>0.263**</td>
</tr>
<tr>
<td>(1.33)</td>
<td>(3.13)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2.292</td>
<td>6.056***</td>
</tr>
<tr>
<td>(0.40)</td>
<td>(2.80)</td>
<td></td>
</tr>
<tr>
<td>East/west/central region dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Standard errors clustered</td>
<td>By province</td>
<td>By city</td>
</tr>
<tr>
<td>Observations</td>
<td>180</td>
<td>498</td>
</tr>
<tr>
<td>R²</td>
<td>0.505</td>
<td>0.492</td>
</tr>
</tbody>
</table>

Notes: (1) t-statistics are reported in parentheses. (2) ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level. (3) See Table 1 for variable definitions.

4.3. Local officials’ effort and environmental outcomes

In this section we investigate whether pressure from the public affects a city’s energy intensity and other environmental outcomes. In Table 4, we examine if there is an association between our public concern intensity index and the city’s performance on environmental criteria. The dependent variable in columns (1) and (2) is log(FACILITY_EXP). On the right-hand side, we include the one-year lagged public concern indices. Population and GDP per capita are controlled for. Province fixed effects (or city fixed effects) are also included. For those provinces with lagged higher PCI (or cities with lagged higher PCI), they experience significantly larger increase in waste gas treatment facility expenditure. In columns (3) and (4), the dependent variable is log(EI). The public concern indices have weaker effects on energy intensity though the signs are intuitive.

We examine the role of leadership in determining energy/environmental actions and outcomes. Here we focus on city leaders’ human capital level, measured by years to schooling (EDU_MAYOR). Highly-educated leaders may devote more efforts in protecting the environment, and thus their cities may benefit from their leadership and enjoy an aggressive environmental/energy progress.

We exploit leadership transitions across China’s cities. For each city i, if there is a leadership transition for the mayor position during our study period, we calculate the change of air pollution, energy intensity and waste gas treatment facility expenditure between the last year of the new mayor (mayor II) and the last year of the previous leader (mayor I), and see if this change is correlated with the human capital differential between the former and the new leader (Eq. (4)).

\[ \Delta_{\text{majority-major II}}\text{PM10} = \phi_1 \Delta_{\text{majority-major II}}\text{EDU} + \phi_2 \Delta_{\text{majority-major II}}\text{POP} + \phi_3 \text{Time-length}_{\text{majority-major II}} + \epsilon_i \] (4)

Table 5 reports the regression results for the mayor transitions. We include the time length between the two time points to control for the time trend in the dependent variable. City population change is

---

Notes: (1) Our approach builds on Jones and O’Keeffe (2005) who use the deaths of leaders while in office as a source of exogenous variation in leadership, and ask whether these plausibly exogenous leadership transitions are associated with shifts in country growth rates.

25 We acknowledge that the change of mayor in a city in our sample is not exogenous. It is possible that a capable mayor is assigned to a city under-performing on environmental criteria to help that city. Therefore the effect of mayor’s education on environmental progress is likely to be over-estimated in our model, and it can only be regarded as suggestive evidence.
also controlled for. In columns (1) and (2), we find that if a new mayor has a higher educational attainment than the former mayor, the city enjoys a significant air quality improvement. A one year increase in the mayor’s years to schooling is associated with a 2% decrease of the average value of the PM10 concentration.27 China’s unique political structure provides a plausible explanation for the correlations we have documented in Tables 4 and 5. A distinctive feature in Chinese cities is that local governments have a “visible” hand in influencing economic activities. That is why the TRS places local governments at the center of policy implementation. City leaders face trade-offs between economic growth and environmental quality. They can use cheap land and favorable tax deduction policies to attract the firms that can generate high GDP output, high tax revenues and more job opportunities, but those firms may be energy-intensive ones.28 If city leaders want to achieve pollution control requirement, they can also shut down heavily-polluted factories, and force those factories to leave (Witte et al., 2009). In this way the city will lose tax revenue and certain types of jobs. In addition, city leaders have a powerful control over the big SOE (State owned enterprise) energy-intensive firms within their jurisdictions. Those SOE firms are also included in the TRS. City leaders will sign target responsibility contracts with those firms’ managers, and the evaluation of the managers’ performance on the energy and environmental dimensions will affect those managers’ career (Qi, 2013).

4.4. Do public concern and the local leadership’s characteristics influence the relationship between pollution production and local economic development?

Building on the influential Grossman and Krueger (1995)’s study of the “Environmental Kuznets Curve” (EKC), an entire subfield of environmental economics has emerged that focuses on this “inverse-U” association between national per-capita income and pollution (Andreonio and Levinson, 2001; Stokey, 1998). In past research, we have estimated Environmental Kuznets Curve across China’s cities (see Zheng, Kahn and Liu 2010).

We estimate Eq. (5) below in order to examine how the shape of the EKC and in particular the GDP “turning point” varies as a function of city attributes and the city’s political leader’s attribute. Where, Y represents either EI or PM10. We let the data itself tell the best order of the polynomial expression of GDPPC and the form of this variable (in logarithm or not) to produce the highest R2.29 City population, temperature index, and rainfall are included as controls. Year fixed effects are also included.

\[
\log(Y_t) = \eta_0 + \sum_{j=0}^{J} \eta_{j1} \cdot GDPPC_t^j + \eta_{j2} \cdot X_t + \text{Year fixed effects} + \xi_t
\]

City leaders in urban China have greater influence than their counterparts in the US in influencing their cities’ industrial composition. They use cheap land and big tax reduction to attract those firms they favor, and also shut down or move those firms they dislike. City leaders’ “visible” hand will reinforce this inverse U relationship between energy intensity and per capita GDP. We expect that those cities with higher public concern intensity over pollution or higher human capital, or those cities with highly-educated mayor can reach the turning point at a relatively low income level.

Our data tells us that for EI-GDPPC relationship, including the level and quadratic terms of GDPPC as explanatory variables generates the best fit of the regression. The PM10 bears the best-fit function with GDPPC when including the level, quadratic and cubic terms of the latter (in log form). This indicates that the relationship is an “S” shape. A possible explanation is that, at the beginning of a city’s growth when population is small, environmental input has a relatively larger effect on reducing pollution. As the city becomes larger, this marginal effect diminishes, and technique and composition effects become dominant. Thus the inverse-U shape will emerge in the latter period. Harbaugh et al. (2002) also find such an “S” shape relationship for SO2 and GDP per capita in his cross-country study.

Table 5 reports the baseline regression results of estimating Eq. (5). Standard errors are clustered by city. Columns (1) and (3) are trend

---

26 In columns (3) and (4), it seems that a city with a new highly educated mayor does not necessarily achieve lower energy intensity and higher waste gas treatment expenditure records. Our guess is that highly-educated mayors may be more focused on real environmental outcomes.

27 The educational background of CCP secretaries does not show any significant effect on the city’s energy and environmental progress (Table A2 in the Appendix).

28 For example, in Zhejiang Province’s “new technology zones”, the government spent 100 thousand Yuan per mu (96 thousand US dollars per acre) on average to provide basic infrastructure to the industrial land, but the average sale price of such industrial land to firms was only 86 thousand Yuan per mu (83 thousand US dollars per acre), even less than the infrastructure cost. Half of the industrial land parcels were sold at the price less than 50% of the infrastructure construction cost. In some inland provinces that are kept to attract FDI and high-tax-revenue industries, some “new technology zones” sold their industrial land at zero price. See http://www.sznz.cn/article/2011/0318/article_22780.html

29 Harbaugh et al. (2002) suggest that the EKC is a fragile empirical result, and the pollution-income relationship is quite sensitive to functional forms (the order of the income polynomial function), the variable form, additional covariates, and the sample composition.
regressions for PM10 and EI. We only control for city population and examine the coefficients of year dummies. For the average city, air pollution (PM10) has been sharply declining since 2006 (the beginning of the 11th FYP), and energy intensity’s decline followed since 2007. In column (2), after controlling for city population, rainfall and temperature index, there is a clear inverted-U relationship between EI and GDPPC. The turning point is about 69.1 thousand Yuan (8324 US dollars, in 2003 constant price). When estimating the EKC for PM10, we use the median value of each public concern index to divide the city sample into two subsamples. Cities with higher public concern intensity over pollution (PCL_1 or PCL_2) have earlier turning points for both EI–GDPPC and PM10–GDPPC. If we employ a stricter classification method and define those cities with both index values exceeding the corresponding median index values, cities with this “hybrid pollution concern index” higher than its median value have much earlier turning points for both greenness indicators (columns (5) and (6)).

Cities with higher human capital have a stronger demand for environmental quality, and we do observe those cities to have an earlier turning point for both EI and PM10’s gradients with respect to GDP (columns (7) and (8)). Furthermore, cities with highly-educated mayors enjoy earlier environmental progress as they reach the income turning point at a lower level of income. Future research should test whether the rise of civil society in China will further lower the EKC income turning point.

5. Conclusions

The rise of “green cities” in China would directly improve quality of life for hundreds of millions of people as reductions in pollution would raise the standard of living. But, over the last 30 years China’s local leaders have had strong incentives to pursue local economic growth even if the environment was sacrificed. A recent qualitative political science literature has argued that a regime shift has taken place so that leaders have had strong incentives to pursue local economic growth. But, over the last 30 years China’s local leaders have had strong incentives to pursue local economic growth (Landry, 2008; Science). The rise of “green cities” in China would directly improve quality of life for hundreds of millions of people as reductions in pollution would raise the standard of living. But, over the last 30 years China’s local leaders have had strong incentives to pursue local economic growth even if the environment was sacrificed. A recent qualitative political science literature has argued that a regime shift has taken place so that leaders have had strong incentives to pursue local economic growth (Landry, 2008; Science).

To test if the nudge from the general public pushes the city to reach the turning point on the EKC curves at a lower GDP per capita level, we compare the turning points of the curves for different city sub-groups (Table 7). Those sub-groups are classified using the median values of the corresponding indicators. In columns (1)–(4), we use the median value of each public concern index to divide the city sample into two subsamples. Cities with higher public concern intensity over pollution (PCL_1 or PCL_2) have earlier turning points for both EI–GDPPC and PM10–GDPPC. If we employ a stricter classification method and define those cities with both index values exceeding the corresponding median index values, cities with this “hybrid pollution concern index” higher than its median value have much earlier turning points for both greenness indicators (columns (5) and (6)).

CITIES WITH HIGHER HUMAN CAPITAL HAVE A STRONGER DEMAND FOR ENVIRONMENTAL QUALITY, AND WE DO OBSERVE THOSE CITIES TO HAVE AN EARLIER TURNING POINT FOR BOTH EI AND PM10’S GRADIENTS WITH RESPECT TO GDP (COLUMNS (7) AND (8)). FURTHERMORE, CITIES WITH HIGHLY-EDUCATED MAYORS ENJOY EARLIER ENVIRONMENTAL PROGRESS AS THEY REACH THE INCOME TURNING POINT AT A LOWER LEVEL OF INCOME. FUTURE RESEARCH SHOULD TEST WHETHER THE RISE OF CIVIL SOCIETY IN CHINA WILL FURTHER LOWER THE EKC INCOME TURNING POINT.

Table 6
The energy intensity and PM10 gradients with respect to GDP per capita.

<table>
<thead>
<tr>
<th></th>
<th>Trend regression</th>
<th>Baseline EKC regression</th>
<th>Trend regression</th>
<th>Baseline EKC regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(POP)</td>
<td>0.135***</td>
<td>0.00126</td>
<td>log(POP)</td>
<td>−0.00106</td>
</tr>
<tr>
<td>(6.89)</td>
<td>(0.04)</td>
<td></td>
<td>(−0.07)</td>
<td></td>
</tr>
<tr>
<td>GDPPC</td>
<td>0.152***</td>
<td>0.011010**</td>
<td>log(GDPPC)</td>
<td>−0.0109**</td>
</tr>
<tr>
<td>(4.29)</td>
<td>(−2.44)</td>
<td></td>
<td>(−2.16)</td>
<td></td>
</tr>
<tr>
<td>GDPPC²</td>
<td>−0.011010**</td>
<td></td>
<td>log(GDPPC)²</td>
<td>0.383***</td>
</tr>
<tr>
<td></td>
<td>(−2.44)</td>
<td></td>
<td>(3.05)</td>
<td></td>
</tr>
<tr>
<td>log(RAIN)</td>
<td>−0.0381</td>
<td>−0.149</td>
<td>log(RAIN)</td>
<td>−0.126</td>
</tr>
<tr>
<td></td>
<td>(−0.17)</td>
<td>(−1.42)</td>
<td>(−1.84)</td>
<td></td>
</tr>
<tr>
<td>log(TEMP)</td>
<td>0.135***</td>
<td>0.149</td>
<td>log(TEMP)</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td>(6.89)</td>
<td>(1.13)</td>
<td>(1.61)</td>
<td></td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Year dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>−3.132***</td>
<td>0.633</td>
<td>Constant</td>
<td>0.199***</td>
</tr>
<tr>
<td></td>
<td>(−24.18)</td>
<td>(1.13)</td>
<td>(2.19)</td>
<td>(−3.68)</td>
</tr>
<tr>
<td>Observations</td>
<td>498</td>
<td>498</td>
<td>Observations</td>
<td>498</td>
</tr>
<tr>
<td>R²</td>
<td>0.112</td>
<td>0.558</td>
<td>R²</td>
<td>0.354</td>
</tr>
<tr>
<td>Peak turning point:</td>
<td></td>
<td></td>
<td>Peak turning point:</td>
<td></td>
</tr>
<tr>
<td>(2003 RMB 1000)</td>
<td>69.1</td>
<td></td>
<td>(2003 RMB 1000)</td>
<td>40.7</td>
</tr>
<tr>
<td>Joint F test for GDPPC</td>
<td>18.73***</td>
<td></td>
<td>Joint F test for log(GDPPC)</td>
<td>3.37**</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td>(0.0223)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) t-statistics are reported in parentheses. (2) ***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level. (3) See Table 1 for variable definitions.

Fig. 4. PM10 gradient with respect to GDP per capita (2004–2009).

30 ** = RMB88.3, in 2003.
31 All other independent variables are set at their mean values.

This paper has used several data sets to test this optimistic hypothesis by studying regional differences in the propensity for local officials to be...

Please cite this article as: Zheng, S., et al., Incentives for China’s urban mayors to mitigate pollution externalities: The role of the central government and public environmentalism, Reg. Sci. Urban Econ. (2013), http://dx.doi.org/10.1016/j.regsciurbeco.2013.09.003
promoted and for the public to reveal concern about environmental challenges. We have documented a number of associations that together suggest that a regime shift has taken place in China such that local officials are increasingly incentivized to consider the pollution consequences of their actions. Both the central government and many of the increasingly educated, informed and sophisticated urbanites demand environmental progress. Based on new estimates of the cross-city pollution versus income relationship, we find that cities with higher human capital and higher public concern about environmental issues have earlier EKC per-capita income turning points for energy intensity and particulate matter.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.regsciurbeco.2013.09.003.

References


World Bank, 2007. World Development Indicators. World Bank, Washington, DC.


