This Draft: June 26th 2013

(NBER wp 18754)

Incentives and Outcomes: China's Environmental Policy

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Abstract

China's record-breaking economic growth is evoking increasing concern about unaddressed environmental problems. We show that, while city government spending on environmental infrastructure has a demonstrably positive environmental impact, city spending is nonetheless strongly tilted towards transportation infrastructure. City governments' investment in transportation infrastructure is strongly positively correlated with real GDP growth, a measure of tangible economic growth that is found to raise city-level cadres' odds of being promoted, and with land prices, which elevate city governments' revenues from land lease sales and thus augment city-level cadres' budgets. In contrast, city governments' spending on environmental improvements is at best uncorrelated with cadres' promotion odds, and is also uncorrelated with local GDP growth and land prices. These findings suggest that, were environmental quality explicitly linked to cadres' chances of promotion, or were environmental quality to affect land prices substantially, city-level public investment in environmental improvement would rise.

Key Words: Urban Infrastructure; Environmental Protection; Local Government; China

JEL Code: H54, P26, Q58, R11

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We are grateful for helpful comments by Yang Yao, Colin Lixin Xu, Xiaobo Zhang, Karen Eggleston, and seminar participants in CCER Peking University, NUS Business School and the 2012 NBER working group meeting on the Chinese Economy. We gratefully acknowledge Jia He for excellent research assistance. Randall Morck thanks the SHRC and Bank of Canada for partial funding. Yongheng Deng and Jing Wu thank the Institute of Real Estate Studies at National University of Singapore for partial funding. Jing Wu also thanks the National Natural Science Foundation of China for financial support (No. 71003060). These views do not necessarily reflect those of the Bank of Canada

1. Introduction

China's phenomenal economic growth in recent decades is widely thought to be related to the Chinese Communist Party's (CCP) management of the economy. An important aspect of the Party's management system is arguably a merit-based promotion system for Party and government officials, whom we call *cadres* for brevity. In this system, merit can be demonstrated by having overseen tangible economic development (e.g., see Maskin, Qian and Xu (2000) for evidence at the central committee level, Li and Zhou (2005) and Chen, Li and Zhou (2005) for evidence at the provincial level, and Edin (2003) and Whiting (2004) for evidence in selected towns/villages).[1]

Accompanying this rapid tangible economic growth is a growing public outrage over environmental degradation. Lamenting visibly thick air pollution is almost an annual ritual in December/January, when still air over Beijing turns into a soup of floating pollutants. The US Embassy reported particulate air pollution (PM2.5) in Beijing exceeding the standard scale's maximum of 500 on Dec 5th, 2011 and about 1000 on some days in Jan 2013. Water quality is also a concern. For example, a *South China Morning Post* on Feb 22nd, 2013 headline ran "Pollution in China affects more than 50% of underground water**."** The state newspaper, *People's Daily* (online) on Feb 27th, 2013 stated that "More than 50 % of rivers and lakes in China are severely polluted."

While a degree of environmental degradation may be an unavoidable side-effect of rapid economic growth, the degree may reflect government policy choices. We examine the linkage between Chinese cities' investment in environment and transportation infrastructure through an

[1] The literature is divided on this point. Shih, Adolph and Liu (2012) find no significant correlation between CCP central committee members' promotions and economic growth performance; and find that other factors, such as factional ties with current and past top leaders assume greater importance at very senior levels in the Party hierarchy.

"organizational management" lens. That is, we investigate how organizational performance emerges from individuals' behavioural responses to their incentives, given their decision rights and budgetary resources (Jensen, 1998). Specifically, we relate city-governments' investment in transportation infrastructure versus environmental improvements to individual cadres' hierarchical assignments of duties, promotion incentives, and budgetary constraints.

Some institutional details about China's hierarchic management system provide context. CCP Politburo and Central Committee cadres occupy the apex of the system. Below them are top cadres of China's provinces and four "province-level" municipalities.[2] Beneath these are, in descending order, top cadres of cities, counties, and townships or villages. Cadres are rotated – reassigned to new positions, perhaps in new locations too – every three or more years. Conditional on a harmonious political attitude, a cadre's past performance, evidenced by having overseen high tangible economic development outcomes, is shown to augment their odds of promotion (Maskin, Qian and Xu, 2000; Edin, 2003; Whiting, 2004; Li and Zhou, 2005; Chen, Li and Zhou, 2005). This arguably merit-based promotion system is thought to induce competition between sub-national governments to produce tangible evidence of economic development throughout the hierarchy.

This competition must occur within a highly decentralized fiscal expenditure system. The World Bank's "China 2030" report (World Bank, 2012) states that "sub-national governments account for around 80 percent of total budgetary expenditures and bear responsibility for the provision of vital public services including basic health and education, pensions, unemployment insurance, and minimum income support." Sub-national governments,

[2] The four "province-level municipalities" (*zhi xia shi*) are Beijing, Shanghai, Tianjin and Chongqing. These are directly under the Central Government and with jurisdiction over a city and adjacent districts.

primarily city governments, also account for the lion's share of investment in urban infrastructure, which includes transportation systems and environmental improvements. However, city governments' revenues, based on a "tax revenue sharing mechanism and intergovernmental fiscal transfers, are not commensurate with city governments' expenditure responsibilities" (World Bank, 2012, p. 55). City governments must therefore find additional revenue sources to finance their expenditures.

Our focus is how this mismatch might affect top city-level cadres' investment and revenue raising decisions. Figure 1 illustrates how these considerations might play out in a local government's allocation of investment between transportation infrastructure and environmental improvements. Because cadres' careers depend on tangible evidence of having successfully fostered economic growth, the governments they direct might favour public expenditures with short-run contributions to tangible economic growth measures over those with long-run contributions to the environment, or economic growth. Transportation infrastructure readily contributes to tangible growth because construction activity elevates measures of economic activity immediately. Also, transportation infrastructure raises land prices; and local governments raise revenue by selling long-term land leases to real estate development enterprises. These considerations plausibly induce city cadres, angling for promotion and for larger discretionary budgets, to allocate more city funds to transportation infrastructure and less to environmental improvements.

Another possible reason for cadres favouring transportation infrastructure spending is the CCPs longstanding technocratic association of economic development with megaprojects –

dams, highways, and other monumental achievements. Massive transportation projects arguably fill this bill better than green spaces, sewage treatment facilities, or chimney scrubbers.

Our empirical tests lead us to five basic conclusions. First, city-level environmental investment is statistically and economically significantly correlated with better environmental outcomes. Success in improving the environment is both feasible and measurable. Second, city-level cadres boost city governments' transportation infrastructure investment in response to their province-level superiors' speeches emphasizing such investment, but do not act likewise when their superiors' speeches emphasize environmental concerns. Third, higher transportation infrastructure spending correlates with higher local land lease sale prices in the short term, while higher environmental spending does not. Higher land lease revenues, in turn, correlate with the city's spending more on transportation infrastructure subsequently. Fourth, spending on transportation infrastructure is correlated with the subsequent year's GDP growth, while spending on the environment is not. Finally, higher city-level GDP growth is statistically and economically significantly correlated with better odds of the city's top cadres being promoted. In contrast, higher city-level environmental investment is statistically and economically significantly negatively correlated with the odds of the city's top cadres being promoted.

Obviously, determining China's socially optimal public spending formula lies beyond the scope of this study. The Chinese people may indeed have a collective preference for rapid income growth and transportation infrastructure spending first, and other aspects of development, such as environmental improvements, later. Nonetheless, the findings offer suggestions as to how the CCP might promote intangible development goals, such as clean air and water, should it choose to prioritize such goals.

While these findings are correlations, endogeneity is of marginal importance in this context. A plausible chain of causality is that city-level cadres invest in transportation infrastructure because this boosts near-term tangible economic growth, which boosts their promotion odds. Alternatively, a lingering traditional central planning obsession with megaprojects, such as transportation infrastructure, might cause senior cadres to place their most promising junior cadres where large transportation infrastructure investment is about to soar. Regardless of the direction of causation, overseeing such investments correlates with career advancement, and breaking ranks to pour city money into green spaces is a résumé stain. Likewise, whether transportation infrastructure construction boosts land prices or rising land prices motivate transportation infrastructure, no such correlation between land prices and environmental quality means that breaking ranks to fund green investments cannot relax a city cadre's budget constraint either.

The remainder of the paper is organized as follows. The next section documents city-level transportation infrastructure and environmental improvement spending from 2000 to 2009; and also shows that public spending on environmental improvements correlates with better air quality. Section III presents empirical evidence consistent with urban infrastructure spending being constrained by revenues from land lease sales; and favouring transportation over environmental improvements, with two appearing to be substitutes. Section IV presents findings consistent with investment in transportation directly affecting economic growth and also exerting an indirect effect by raising land lease revenues and thus loosening local governments' budget constraints. This section also confirms that cadres' promotion odds rise with measures of tangible economic growth, but fall with measures of environmental investment. Section V concludes.

2. China's urban infrastructure investment and air quality

2.1 Decreasing environmental investment in the early 2000s

Upon Mr. Hu Jintao assuming the top positions in the CCP and government in 2002, the "Scientific Outlook on Development" (*ke xue fa zhan guan*) became a major principle of social and economic development. This translates loosely as "pursuing development in a balanced manner" and presumably includes not overlooking social and environmental development. The importance of environmental protection and social development has been repeatedly emphasized by the central government continuously.

However, during this era, city governments actually cut the share of resource allocate to environmental improvements, such as "drainage and sewage purification", "environmental sanitation and solid waste treatment", and "gardening and greening". Figure 2 shows that, at the national level, environmental improvement investment as a fraction of total urban infrastructure investment fell from 25.4% in 2000 to 19.1% in 2006, before recovering slightly to 21.3% in 2009. Environmental improvement investment over GDP similarly drops from 0.58% in 2003 to a low of 0.41% in 2007 before rising again somewhat.

This contrasts starkly with urban infrastructure investment in transportation, including "roads and bridges" and "public transportation", also plotted in Figures 2. Over the same period, transportation infrastructure rose from 60.2% of total urban infrastructure investment in 2000 to 72.7% in 2010. Transportation infrastructure over GDP likewise jumped from 0.90% in 2000 to 1.71% in 2003, and then fluctuated around 1.50% until the 2009 stimulus.[3]

[3] Besides the three components, grouped as environmental improvement investments, and the two components grouped as transportation infrastructure investments, five other components are reported in Ministry of Housing and

2.2 Pollution is an important problem

That pollution is a serious problem is visible to any visitor to any large Chinese city (World Bank, 2007, 2012). Bemoaning air pollution is almost an annual ritual. In early December 2011, air quality at "crisis" levels in Beijing attracted global media attention.[4] On Dec 5th, 2011, the US Embassy reported Beijing's particulate air pollution (PM2.5) exceeding the standard scale's maximum of 500, and described the situation as "crazily bad." In Jan 2013, Beijing PM2.5 levels allegedly neared 1,000.[5] The *Financial Times* (Mar 1st, 2013) reported "These days, it is healthier to live in an airport smoking lounge than in Beijing – and there are dozens of cities in China where air pollution levels are worse than in the capital. …. . Beijing's peak last month was 35 times the recommended healthy level."[6]

Air pollution is costly. The Global Burden of Diseases Studies (GBDS), a World health Organization initiative, linked high Chinese PM2.5 levels in 2010 to 1.23 million premature deaths, some 38.2% of all PM2.5-related deaths worldwide and 14.9% of all deaths in China

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Urban-Rural Development's urban infrastructure investment statistics. Below, we exclude "centralized heating" and "flood control" because these are significant only in certain cities; and the component "other" because its definition is opaque. The final two components, "water supply" and "gas supply", both correspond to basic necessaries, and thus arguably lie outside the emphasis of this study. Nevertheless, including total investment in water and gas supply (normalized by GDP) as a control variable generates qualitatively similar results, defined as identical patterns of signs and significance and comparable point estimates.

[4] "Victory for U.S. Embassy as Beijing Chokes on 'Heavy Fog'", *Wall Street Journal*, December 5, 2011; "Flights Grounded in China as Smog Worsens", *Financial Times*, December 5, 2011; "Outrage Grows over Air Pollution and China's Response", *New York Times*, December 6, 2011; "China's Pollution Data Shrouded in Official Fog", *Bloomberg BusinessWeek*, December 8, 2011; "Death-by-Air in Beijing Shows China's Heart Risk from Worsening Pollution", *Bloomberg News*, December 16, 2011; "Official Says Air Quality in Beijing is at 'Crisis' Level", *Wall Street Journal*, December 16, 2011.

[5] On Feb 28 2013 ABC News reports that **"**An hourly reading from the U.S. Embassy, which also monitors air quality from a device on its rooftop, went beyond index. Its PM2.5 reading was 510 micrograms per cubic meter, which corresponds to a U.S. Environmental Protection Agency Air Quality Index reading of 506. Anything above 301 is considered hazardous, and the scale stops at 500. The last major spike of pollution levels pushed the PM2.5 concentrations to a record 993 in January.

[6] Financial Times, Mar 1st, 2013, "*China pollution: Fears over poor air exacerbate healthcare concerns*"**.**

(Lim et al, 2012). The study ranked air pollution 4th highest risk factor to Chinese health, just behind dietary risks, high blood pressure, and smoking. Pan, Li, and Gao (2012) estimate PM2.5 at two to fourfold above WHO standards in Shanghai, Guangzhou, Xi'an and Beijing, and estimate that high PM2.5 pollution alone directly caused 7,770 deaths in those four cities in 2010, rising to 8,572 in 2012. Domestic media increasingly report hospitals receiving waves of patients suffering acute cardiac and respiratory ailments during weeks of high particulate pollution.

Air pollution is the most visible environmental problem to foreigners, but water quality is also compromised. The *South China Morning Post* (Feb 22nd 2013) headlined "Pollution in China affects more than 50% of underground water**."** The state newspaper, *People's Daily* (Feb 27th 2013, online) affirmed "With the rapid development of economy, water pollution has become a serious problem in China. Expanding construction of cities, over-used fertilizers and toxic chemicals and emissions from industries have aggravated water pollution. More than 50 % of rivers and lakes in China are severely polluted. Lots of Chinese still live on polluted water. The government has invested heavily in water pollution treatment and control." The state news agency Xinhua (Feb 22nd 2013) declared "China faces a grave situation in terms of chemical pollution control, citing inadequate pollution risk control by enterprises, a lack of systematic policies to restrain the making and use of highly toxic and dangerous chemicals and authorities' insufficient pollution monitoring and supervision capabilities"[7].

Our empirical tests focus on air pollution because of data availability. Since mid-2000, the Ministry of Environmental Protection has graded air quality in selected cities. Table 1 shows air quality problems through subsequent years. The annual mean and median fractions of days

[7] Telegraph, Feb 22nd, 2013, "*China admits pollution has caused 'cancer villages*".

with the highest grade, calculated across all cities, begins rising only in 2008, the year Beijing hosted the Olympic Games. The mean and median improvements are partially due to the ministry expanding coverage to more cities. Nonetheless, Panel B, using only the 37 cities covered throughout, also shows an improvement only after 2008.

2.3 Environmental investment and environmental outcomes

If investing in environmental improvements improves air quality both immediately and in future years, China's skimping on investment in environmental improvements through the past decade could accumulate into an explanation of its current air quality problem.

To investigate this, Table 2 examines data from 2001 to 2009 for the 82 cities whose air quality the Ministry of Environmental Protection graded each day.[8] Each city's *change in air quality* each year is the fraction of days on which it earned a top "Grade I" in air quality minus the same fraction the prior year.[9] Table 2 regresses this on "environmental development," defined as annual urban infrastructure investment in environmental improvements scaled by local GDP.[10] Investment in transportation infrastructures is also included for comparison. Also, the regressions control for lagged air quality and city fixed-effects; as well as real growth in per capita GDP and its cross term with the lagged real per capita GDP level to capture any Kuznets curve effect (Stern, Common and Barbier, 1996; Stern, 2004). Including year fixed-effects

[8] The four "province-level" mega cities: Beijing, Shanghai, Tianjin, and Chongqing are excluded for several reasons. First, because they are "province-level" administrative units, their top cadres have promotion possibilities far beyond those of top cadres in other cities. Second, they are much larger and more developed than most other cities. Third, they experience unique episodes, notably Beijing's 2008 Olympics and Shanghai's 2010 Expo.

[9] Regressions using the fraction of "Grade I" days, rather than its first difference, as the dependent variable generate qualitatively similar results.

[10] The tables normalize by local GDP the same year. Normalizing by population – that is, using per capita investment in environmental improvement, etc. – generates qualitatively similar results throughout. We relegate these to a footnote because China's official population figures account poorly for migrants, and thus may induce a bias associated with the net internal migration if used as a scaling factor.

generates qualitatively similar results – by which we mean an identical pattern of signs and significance levels and comparable point estimates. Because air quality in a city may be affected by pollution in surrounding cities and regions we also include a proxy for air quality changes in nearby cities of Zheng, Cao and Kahn (2011): the mean change in their ratios of days reaching "Grade I" air quality, weighted by the reciprocal of the exponential of the distance to each city. Finally, we control for lagged FDI, normalized by GDP, to capture effects of foreign investment on air quality as in Copeland and Taylor (2004). Significance tests in the tables cluster residuals by province. The definitions and sources of these variables are listed in the appendix.

Table 2 reveals a positive and significant correlation between investment in environmental improvement and air quality in both the concurrent year and two years in the future. The coefficient in regression (3) associates a one standard deviation increase in environmental investment with a 1.03 percent larger fraction of days reaching "Grade I" in the same year, and with a 1.19 percent increase two years later.[11] These effects are economically significant: on average, the fraction of days reaching "Grade I" rises by 0.86 percent per year, so this amounts to more than doubling the baseline trend. In contrast, investment in transportation infrastructure is uncorrelated with air quality improvement.

The control variables' coefficients are unsurprising. Per capita GDP growth is significantly negative, while its cross-term with lagged per capita GDP is significantly positive, tracing out the U-shaped relationship between air quality and local economic growth of an environmental Kuznets curve. Estimated using regression (1), minimal air quality corresponds to

[11] For the 86 cities with air quality information, the standard deviation of investment in environmental improvements (normalized by local GDP) is 0.417 during the sample period. Together with the coefficients in Table 2 (column 3), this implies a one standard deviation increase in environmental investment corresponds to $0.417 \times 0.0247 = 0.0103$ (1.03 percent) increase in the dependent variable during the same year, and to a $0.417 \times 0.0286 = 0.0119$ (1.19 percent) increase two years later.

a per capita GDP of about ¥127,300 (constant 2009 RMB) – about US$18,077. In the sample, a few of the most developed Chinese cities are approaching this. Nearby cities' air quality is positive, but not uniformly significant; consistent with local factors predominantly determining Chinese air quality (Zheng, Cao and Kahn (2011). The FDI variable is insignificant.

Table 1 shows the number of cities being graded for air quality expanding from 2001 to 2005, so the panel in regression (1) through (3) is unbalanced. If cities that entered the panel late have systematically different pollution issues, our results might be affected. To preclude this potential bias, regressions (4) to (6) use cities that have been in the data pool since 2001: a balanced panel covering the same cities each year. Qualitatively similar results ensue and the environmental investment variable becomes even more significant.

During the 2008 Summer Olympics, Beijing city cadres shut down the worst polluting state-owned enterprises so visitors could enjoy clear skies. Other city cadres could, if they wanted, do likewise, or force the relocation or green reengineering of the worst polluters. As a robustness check, we introduce the current or lagged change in share of the secondary industry (i.e., manufacturing) in total local output to control for changes in plausibly pollutant emitting industrial production. This coefficient is negative but statistically insignificant, and that of the environment investment variable is qualitatively unchanged.

Reverse causality seems implausible in these regressions. That city officials would wait until their air quality has improved, or is expected to improve, before investing in environmental improvements seems farfetched.

3. Infrastructure spending

3.1 Local government responsibility for urban infrastructure expenditures

The Ministry of Housing and Urban-Rural Development "China Urban Construction Statistics Yearbook" affirms that city governments are primarily responsible for urban infrastructure investment. Figure 4 shows governments financing 26.9% of all urban infrastructure investments in 2009 directly, and most of this is from local governments. The central government funded only 1.1% of total urban infrastructure investment that year, provincial government about less than 4%, and "others" 10%. Enterprise spending financed another 23.8%; but most infrastructure enterprises are city government-controlled SOEs. Another 39.7% of the total was financed by bond issues and bank loans by city governments and local SOEs. Summing these figures, somewhat less than 85% of total urban infrastructure investment is most likely directed by city governments, or more precisely, by their top cadres.[12]

3.2 City government investment and superiors' "emphasis"

Because local governments are preeminent in infrastructure development, their top cadres' budget constraints and incentives are potentially important. After a 1994 public finance reform, the central government collects a large proportion of all tax revenue and then allots funds to subsidiary levels of government. For most local governments, this allotment is designed to cover only basic operating expenses (*chi fan cai zheng*). As Figure 4 shows, this allotment is often

[12] The Ministry of Housing and Urban-Rural Development does not disaggregate funding by usage, so data for, e.g. transportation infrastructure investment versus environmental improvement investment, are not available.

inadequate, so city governments raise off-budget financing to fund urban infrastructure by either borrowing or selling land leases.

The CCP's management system entrusts public spending decisions at each level of government to that level's top cadres. China's merit-based management system is based on cadres' decisions being shaped by their incentives for career advancement. Because we study city-level data, we focus on the preferences of Party Secretaries of provincial CCP Committees (*sheng wei shu ji*), whose recommendations affect the careers of top city-level cadres (mayors and city Party Secretaries) in their provinces. Obviously, we cannot directly observe Provincial CCP Secretaries' preferences; however, we can make plausible inferences about them from their public records.

The 27 provinces we study were governed by a total of 82 provincial CCP Secretaries from 2000 to 2009. An annual index of their preference regarding infrastructure investment is constructed as follows. An internet search by the name and title of each provincial CCP Secretary yields a total number of hits. This is the denominator of the index. A second set of searches, each run within these hits, identifies webpages that also contain relevant keywords that might occur in these top cadres' speeches, articles and media reports: "infrastructure (*ji chu she shi*)" or "urban development (*cheng shi jian she*)" to flag urban infrastructure investments, "transportation (*jiao tong*)" to flag transportation related urban infrastructure investments, and "environmental protection (*huan bao* or *huan jing bao hu*)" to flag urban environmental infrastructure investments. (Note that, in Chinese, the terms for transportation and environmental protection are not implicitly subcategories of "infrastructure"). Dividing the number of hits each from these three joint searches by the denominator yields annual indexes for each provincial CCP secretary's connections with each of infrastructure investment in general,

transportation infrastructure investment, and environmental improvement investment. We interpret each index as reflecting the importance a provincial CCP Secretary assigns to investment in infrastructure in general, transportation infrastructure, and environmental improvements, respectively, that year.[13]

The panel averages of the three indices are 0.16 for infrastructure investment, 0.29 for "transportation infrastructure investment" and 0.22 for "environmental improvement investment." Thus, provincial CCP Secretaries on average emphasize transportation more than the environment, as covered by the online media.

China's hierarchical management system turns on city-level cadres, aspiring for promotion, pursuing investment policies in harmony with goals their provincial Party Secretaries emphasize. To explore this, we utilize data for 283 of China's 287 city-level (*di ji shi*) governments from 2000 through 2009, again excluding the four "province-level" cities. Table 3 presents regressions of city-level investment in transportation infrastructures and environmental improvements, both scaled by local GDP in the same year, on one-year lagged values of three proxies for local government budget constraints, budgetary allocation from the central government, revenues from land sales, and outstanding debt, all normalized by local GDP in the same year, and the lagged internet search-based index on provincial CCP Secretaries' priorities. The regressions also control for lagged values of real per capita GDP, FDI, investment other than urban infrastructure, and government expenditures, with the latter three normalized by local GDP. City fixed-effects are also included, and found to be jointly significant in Hausman tests.

[13] Zheng et al (2012) uses a similar methodology to construct an internet search-based index of developers' emphasis on the energy-efficiency of their housing developments in China.

Standard error estimates are clustered by province. More detailed descriptions of the variables are available in the appendix.

Table 3 reveals cities' budgetary allocations from the central government to be unrelated to investment in transportation or environmental improvements. This is consistent with those allocations being used for their official purpose – funding basic services. In contrast, revenue from land sales is significantly positive in explaining transportation infrastructure investment. The coefficient in column (1) implies that a one standard deviation increase in land sales revenue corresponds to a 0.14 percentage point increase in transportation investment as a fraction of local GDP the following year, which is equivalent of about 15.3% of mean transportation investment over GDP in the sample period.[14] However, land sales revenue is unrelated to environmental investment. Similarly, loan balances are positively and marginally significantly related to transportation infrastructure investment, but insignificant in environmental investment regressions.

These results are consistent with local governments using revenues from land auctions and, less clearly, from loans to finance transportation infrastructure, but not environmental improvements. A reverse causality scenario would have governments collected more revenues from land sales in the past because land leasers anticipated more investment in transportation infrastructure. This is plausible, for better transportation infrastructure might elevate land prices, thereby increasing local governments' land sales proceeds. However, independent of the causal

[14] For the sample cities the standard deviation of land sales revenue (normalized by local GDP) is 2.398 during the sample period. Together with the coefficients in Table 3 (column 1), this implies a one standard deviation increase in land sales revenue corresponds to $2.398 \times 0.0572 \approx 0.137$ percentage points increase in transportation infrastructure investment in the following year. Considering that the average GDP-scaled transportation investment is 0.895 percentage points, this accounts for 15.3% ($0.137 / 0.895 \approx 0.153$) of the average.

direction, in the short run government revenues from lands are related to transportation infrastructure investment but not to environmental investment.

The lagged proxies for provincial Party Secretaries' priorities, the internet search indexes, reveal their emphasizing infrastructure to be positive and marginally significant in explaining transportation infrastructure investment, but negative and insignificant in explaining environmental investment. Provincial-level cadres' emphasizing transportation infrastructure investment likewise correlates marginally significantly positively with spending on transportation infrastructure (column 2). In contrast, the index gauging provincial cadres' emphasis on the environment is negative and marginally significant in explaining spending on environmental investment (column 4). These findings are consistent with province-level cadres' calls for infrastructure investment motivating city-level cadres to spend more on transportation; but with city-level cadres essentially ignoring any emphasis their province-level superiors' assign to the environment. Reverse causation – province level cadres tailoring their utterances and internet coverage to reflect city-level cadres' decisions to invest in transportation infrastructure, rather than environmental improvement – seems implausible.

Intriguingly, cities that attracted more foreign direct investment in the past spend more on environmental improvements. Foreign investors might create pressure for environmental improvements. We cannot cleanly distinguish this from expectations of cleaner air attracting more foreign direct investment. Nonetheless, if top provincial cadres wish to implement policies conducive to FDI, either direction suggests that they prepare for higher environmental spending.

These results are robust. Qualitatively similar findings emerge scaling the two sorts of investment by their sum, instead of by GDP. Controlling for year fixed effects likewise yields

qualitatively similar results. So does dropping the global financial crisis years 2008 and 2009 to eliminate observations potentially affected by China's 2008 slowdown and aggressive 2009 macroeconomic stimuli.

4. Cadres' incentives regarding infrastructure

If city-level cadres are inclined towards spending available funds on transportation infrastructure because this augments their odds of being promoted, this would be evident in their career advancement paths. Having overseen rapid economic growth in one position is known to statistically and economically significantly raise provincial-level cadre's odds of promotion (Li and Zhou, 2005; Chen, Li and Zhou, 2005). All sorts of city government spending can increase aggregate demand, and thus stimulate a city's economic growth. However, spending on transportation infrastructure immediately creates economic activity, and thus might have a more immediate and tangible impact on economic growth than would spending on environmental improvements. A better environment might attract migrants and investment, including foreign investment, but its impact on recorded GDP growth is apt to be slower and spread out across the more distant future.

4.1 Infrastructure Investment and GDP growth

Previous studies indeed suggest that infrastructure investment induces an immediate boost to tangible measures of local economic growth. Based on Chinese province-level economic growth results, D´emurger (2001) argues that variation in provinces' infrastructure capital stocks,

especially those pertaining to transportation, is a key factor in explaining interprovincial variation in economic growth rates. Lin and Song (2002) come to a similar conclusion about infrastructure spending and economic growth using Chinese city-level data. Their cross-section results suggest that cities that pave their gravel roads more rapidly exhibit faster contemporaneous tangible economic growth. Fan and Zhang (2004) link infrastructure investment to tangible economic growth in the rural area of China.

Because our city-level data do not include capital stock measures, we follow the strategy adopted by Lin and Song (2002). Again using data for 283 cities from 2000 through 2009, Table 4 summarizes regressions of annual real per capita GDP growth, calculated as first differences in the log of real per capita GDP, on transportation infrastructure and environmental investments, both again normalized by local GDP, and controls. The controls include one-year lagged values of log real per capita GDP level as well as of FDI, total investment excluding urban infrastructure investment, and government expenditure, all as fractions of local GDP. To mitigate potential bias caused by omitted and unobservable variables – for example, population growth rates, natural resource endowments, stocks of human capital – we also include city fixed-effects. Standard error estimates are clustered by province.

Table 4 shows the coefficients of the various control variables to be generally consistent with prior work: for example, local GDP growth is significantly positively related to investment. Column (1) shows local GDP growth is also statistically significantly positively related to lagged transportation infrastructure investment as a fraction of local GDP. The point estimate implies that a one standard deviation increase in transportation investment corresponds to an additional

0.16 percentage points of local per capita GDP growth the next year.[15] This is in line with the effects found by D´emurger (2001) and Lin and Song (2002). In contrast, environmental investment is statistically insignificant. In column (2) and (3) additional lags of urban infrastructure investments are introduced, however neither measure is significant.

These results are robust. Qualitatively similar results ensue from introducing GDP growth rate as the dependent variable to avoid potential errors in imputed population data[16]. Introducing year fixed-effects and dropping the recession period of 2008 and stimulus period of 2009 both likewise generate qualitatively similar results to those in the table.

These findings are consistent with city governments' spending on transportation infrastructure boosting economic growth. A reversal causality scenario – expecting rapid growth, city government invest more in transportation infrastructure – cannot be excluded. However, both directions of causality are consistent with the premise that city-level cadres more intended on promoting tangible economic growth are also more inclined towards spending local government funds on transportation infrastructure, rather than on environmental improvements.

4.2 Transportation infrastructure investments and land sales revenue

Rosen (1979) and Roback (1982) show that equilibrium real estate prices are fully determined by the expected economic growth and quality-of-life (QOL) of a city. Because urban infrastructure

[15] For the sample cities during the sample period, the standard deviation of the change in GDP-scaled transportation infrastructure investment is 0.799 percentage points. Together with the coefficients in Table 4 (column 1), this implies a one standard deviation increase in transportation investment corresponds to $e^{0.799 \times 0.0020} \approx 0.0016$ percentage points higher local GDP the following year.

[16] China collects population statistics decadal national censuses, the two most recent in 2000 and 2010. Population levels in intervening years are imputed from census data assuming constant annual population growth rates. We therefore cannot include annual population growth rates in our regressions.

investment could enhance either a city's QOL or its economic growth, or both, such investment could raise real estate prices. Because revenue from land sales is an important off-budget funding source for China's local governments, higher land prices would loosen local government cadres' budget constraints. If investment in transportation infrastructure and investment in environmental improvements affected land prices differently, local top cadres might have different inclinations towards these sorts of investment.

Table 5 again uses panel of data for 283 cities from 2000 through 2009 to run regressions explaining city-level annual rates of increase in land prices, measured as first differences in logarithms of prices of land for all usages in constant 2009 yuan. The two key explanatory variables are lagged values of the two types of urban infrastructure investment over local GDP. The control variables include lagged values of the logarithm of the average real land price level; the growth rate (first difference in logarithms) of real per capita GDP; and FDI, total investment (excluding urban infrastructure investment), and government expenditure, each scaled by local GDP. Again, city fixed-effects are also included to control for potential omitted and unobservable time invariant city-level variables. Standard error estimates are clustered by province.

Table 5 summarizes these regressions, which show lagged transportation infrastructure investment are significantly positively related to land prices. This effect is economically significant: the coefficient implies that a one standard deviation increase in transportation infrastructure investment over GDP corresponds to a land prices growing 4.5 percentage points faster the following year. This amounts to a 21.5% increase over the average annual land price

growth rate for the 283 cities during the sample period.[17] In contrast, environmental investment is unrelated to land prices.[18]

These results are robust. Qualitatively similar results ensue if we include cities' land supply, which is controlled by the city government, each year as another control variable.[19] Qualitatively similar results also ensue from either introducing year fixed-effects or dropping 2008 and 2009 data.

The results in Table 5 are consistent with transportation infrastructure investment substantially raising land prices, and thus increasing city governments' revenues from land sales. Together with the results in Table 3, these findings are consistent with a positive feedback cycle, wherein city governments' transportation infrastructure investment boosts land prices and thus government income from land releases, which finances further transportation infrastructure investment by the city, and so on *ad infinitum*. The bidirectional causality in such a feedback loop affects the accuracy of the point estimates in Table 5, but regardless of the direction of causality, city-level cadres would be prone to invest in transportation infrastructure, as opposed to environmental improvements, if tangible economic growth elevated their odds of being promoted. Spillover from such a positive feedback loop might arise if higher land sales revenue also helped finance city governments' other investment projects, especially those that also boost local GDP growth. Environmental improvements would not seem to qualify here either.

[17] For the sample cities during the sample period, the standard deviation of transportation infrastructure investment (normalized by local GDP) is 1.025. Together with the coefficients in Table 5 (column 1), this implies a one standard deviation increase in transportation infrastructure investment corresponds to a $1.025 \times 0.044 \approx 0.0451$ percentage points higher land price growth rate the following year. As the average land price growth rate is 0.210 percentage points, this amounts to 21.5% ($0.0451 / 0.210 \approx 0.215$) over the average.

[18] Year-by-year cross sectional regressions without city fixed-effects (not shown) reveal a small and marginally significant positive coefficient in 2009 only, perhaps not inconsistent with the very tentative advent of a recent shift towards environmental factors mattering to land prices.

[19] In China, a city's government is the body that determines the volume of land supply in any given year and thus the monopolist in land supply. The additional control is the land supply taken to the land market by the government.

4.3 City-level Cadres' Promotion Odds

Existing empirical works using provincial-level data reveal overseeing rapid GDP growth to be the most important determinant of a cadre being promoted (Li and Zhou, 2005; Chen, Li and Zhou, 2005). If China's merit-based management system also encompasses city-level cadres, and if their promotion odds are higher for having overseen rapid local GDP growth, their evident preference for spending city government funds on transportation infrastructure, rather than environmental improvements, follows.

To explore this connection, we estimate probit regressions explaining an indicator variable set to one if a top city cadre, either its CCP Secretary or its mayor, is promoted within the year. We say a cadre is promoted, and set the indicator variable to one if the next job is a province-level or higher position; if a city-level mayor's next job is as a city-level CCP Secretary (either in the same or another city); if a cadre in other than a provincial capital is moved to the same position in a provincial capital; or if the cadre's new position is similar to the previous one but also entails selection as the member of the provincial CCP standing committee (*sheng wei chang wei*). In all other cases, including retirements, we say the cadre is not promoted and set the indicator to zero. Dropping the few observations involving retirements yields qualitatively similar results to those in the tables.

"Abnormal" career changes – deaths, arrests for corruption, etc. – are excluded. We also drop observations corresponding to cadres' first year in their positions. Also, because of data limitations in calculating some of our control variables, we only include data for cadres who assumed their current positions in or after 2000. This is in order to calculate some of our control

variables reliably. In a few cities, all cadres during the sample period either were or were not promoted; these observations are dropped because of the resulting collinearity with city fixed-effects, which are included throughout. We revisit these observations below as a robustness check.

We have two sets of focal explanatory variables. The first contains three measures of the GDP growth rate of a cadre's city: its mean GDP growth rate from the first to last year of the cadre's tenure; the difference between this and the mean GDP growth rate of all other cities in the same province during the same period; and the difference between the city's mean GDP growth rate during the cadre's tenure and its mean GDP growth rate during the cadre's predecessor's tenure.

The second set of focal explanatory variable gauge infrastructure spending. These include the two types of urban infrastructure investment; each scaled by GDP and averaged over the cadre's tenure from first to last year. Promotions may result from factors other than high GDP growth. For example, increased transportation infrastructure or better environmental outcomes might add to a cadre's odds of promotion, over and above their effect through economic growth.

Control variables include the following. Various personal attributes of cadres might affect their odds of promotion, so we control for them. For example, we control for a cadre's education, initiate age when assuming his/her current position, gender, ethnic origin, and whether he/she has previous government experience at the provincial level before assuming the current city level assignment. All these variables are plausibly factors of consideration for promotion. Table A2 of the appendix reports the full list of these variables and their detailed definition. City

fixed-effects are also included, and standard error estimates are clustered by cadre because any given cadre may appear in the panel multiple times – once for each year in each position. Because the determinants of promotion for Party Secretaries and mayors may differ, we run probit regressions separately for each class of city-level top cadre.

Table 6 and 7 display these regressions for Party Secretaries and mayors, respectively. In both tables, the difference between the city's GDP growth rate during the cadre's tenure less that during his predecessor's tenure is the only GDP growth measure to be significantly positive. This is consistent with cadres' promotions depending on outdoing their predecessors in encouraging rapid economic growth. Province-level cadres judging city-level cadres' performance primarily against this benchmark is plausible. Because China's cities exhibit substantial economic heterogeneity, a given city's growth under a prior civic administration is arguably a better bar than the growth rates of other cities. The finding that mayors' promotions are more significantly correlated with GDP growth than are Party Secretaries promotions is consistent with previous findings regarding provincial-level cadres' promotions suggesting that CCP secretaries are assigned more non-economic objectives (Li and Zhou, 2005).

The estimated coefficients from the probit regressions permit assessment of the economic significance of these factors in explaining a cadre's odds of promotion. A one standard deviation increase in the city's average GDP growth rate over that under a cadre's predecessor raises their probability of promotion by 4.83 percentage points for secretaries and 9.88 percentage points for mayors.[20]

[20] In the sample the standard deviation of average GDP growth rate compared with the predecessor is 3.351 percentage points for secretaries and 3.327 percentage points for mayors. Together with the odds ratio, this implies a one standard deviation increase in average GDP growth rate compared with the predecessor raises the probability of promotion by $3.351 \times 0.0144 \approx 0.0483$ for secretaries and $3.327 \times 0.0297 \approx 0.0988$ for mayors.

Remarkably, a city's investment in transportation infrastructure is completely insignificant in explaining its senior cadres' odds of promotion over and above the effect of GDP growth. This finding is consistent with spending on transportation infrastructure being motivated by its contribution to GDP growth.

Very interestingly a city government's spending on environmental improvements is actually significantly negatively related to the odds of its CCP secretary or mayor being promoted. A one standard deviation increase in average GDP-scaled environmental improvement investment corresponds to the probability of promotion being 8.2 percentage points lower for secretaries and 6.0 percentage points lower for mayors.[21] This suggests other factors at work. Perhaps city-level "environmentalists" offend province-level cadres, whose promotions previous work shows to be more clearly driven by economic growth.

One interpretation of our result is that cadres with less hope for promotion spend more on environmental improvement. This does not contradict cadres aiming for higher promotion odds spending less on environmental infrastructure. Still, such reverse causality could be a concern. To mitigate this concern, we focus on cadres with relatively higher promotion odds: those who are younger, have better education and training, have better previous government experience, etc. We first estimate a promotion probit model without any performance indicators, using only cadres' personal attributes and city fixed-effects. The resultant probit regression let us identify cadres with above median imputed promotion odds. We then re-run the specifications in Table 6 and Table 7 on this sub-sample. The coefficient on environmental investment remains negative

[21] In the sample the standard deviation of average environment Improvement investment is 0.346 percentage points for secretaries and 0.354 percentage points for mayors. Together with the odds ratio, this links a one standard deviation increase in average environment Improvement investment to a decrease the probability of promotion of $0.346 \times 0.237 \approx 0.082$ for secretaries and $0.354 \times 0.170 \approx 0.060$ for mayors.

and significant for mayors, and negative and marginally significant (p-value = 11%) for CCP secretaries.[22]

Nevertheless, city cadres might still feel minimal investment in environmental improvement prudent to their career advancement, and therefore not cut off environmental investment entirely. This is because "maintaining social stability" is also officially a make-or-break criterion (*yi piao fou jue*) for city cadres – all their other achievements are as nothing if embarrassing collective petitions or massive protests mar their term in office (Chen, 2012). Environment-related collective petitions and protests are becoming more frequent (Xie, 2009), so allowing unusually (for China) bad environmental conditions could be becoming a potential résumé blight. Indeed, the central government explicitly lists environmental protection as an evaluation indicator for city-level cadres in its latest "12th Five-year Plan (2010-2015) for Environment Protection" released in 2011. This may provide more direct incentives for city cadres to boost environmental investment. Unfortunately, a formal empirical investigation has to wait until comprehensive data are available.

The relationships of cadres' personal attributes to their promotion odds are less surprising. A cadre's age upon assuming their current position is most significant, especially for CCP Secretaries. Cadres who assumed their current position at an age nearer normal retirement age are less apt to be promoted again. The effect of gender is opposite in the two subgroups of

[22] A negative coefficient is consistent with news reports of cadres' "promotion based on tangible growth performance" despite overseeing environmental catastrophes. For example, on July 3rd 2010, the Zijing Mining Group's copper factory in Fujian Province released roughly 9,100 cubic meters of raw sewage into the Ting River. This killed millions of kilograms of fish being grown in fish farms using water from the befouled river, ultimately coating that industry over ¥30 million in direct economic losses. Zijin Mining Group's management concealed the incident for 9 days, and permitted a second sewage infiltration on July 16th. However, neither the secretary nor the mayor of the city was punished. Instead, the mayor was promoted one year later for overseeing high GDP growth. Another example, in Heilongjiang, played out similarly. Despite months, perhaps years, of increasingly vociferous complaints about Harbin General Pharmaceutical Company illegally dumping raw sewage, the local top cadre was promoted in mid-2012.

cadres: female CCP secretaries are more likely to be promoted; while female mayors are less apt to be promoted. A cadres' educational background is insignificantly related to their promotion odds. Prior work experience in other provinces helps mayors, but not CCP Secretaries, get promoted. Prior work in SOEs weighs against promotion, especially for CCP Secretaries.

These results are again robust. Including year fixed-effects to control for promotion decisions being clustered in certain years yields qualitatively similar results to those in the tables. Not dropping observations where all cadres in a given city were either promoted or not promoted also yields qualitatively similar results to those shown. Re-estimations of the probits using indicators set to one if a cadre is promoted within two, three, or four years, rather than within one year, also all generate qualitatively similar results. Longer windows mean each cadre enters the panel only once.[23] Cox proportional hazard regressions, rather than probits, likewise generate qualitatively similar results with the exception of environmental investment significantly negatively correlating with the promotion odds of *both* CCP Secretaries and mayors, while transportation infrastructure investment is insignificant. GDP growth compared with that under the cadre's predecessor is again positive and statistically significant for mayors, but less significant for CCP Secretaries.

5. Conclusions

Having lifted hundreds of millions of people out of severe poverty, the economic growth China's reform-minded leaders oversaw is difficult to criticize. Yet increasingly affluent Chinese are apt

[23] In our data, Party Secretaries serve an average of 3.36 years and mayors an average of 2.91 years before being promoted or otherwise reassigned.

to increasingly value the environment, as people in high income countries currently do. Indeed, people in higher income countries typically demand more public goods of various sorts – healthcare, public education, and social security as well as unpolluted air, water, and soil. This change in tastes appears to be a near universal side-effect of broad-based economic affluence.

Consistent with realizing that they rule an increasingly affluent country, China's top leaders specify "green" achievements, as well as enhanced public services of other sorts, as formal goals in the 12th Five Year Plan. Alternatively, the top leadership may be concurring with the World Bank's "China 2030" report, which flags these issues as critical to making China's growth sustainable over the long term. Regardless of the reasons, an adjustment to development priorities at the highest levels of the CCP appears possible.

Our findings that city-level cadres' promotion incentives, assigned responsibilities, and budget constraints induce a bias towards transportation infrastructure and away from environmental improvements suggest ways in which such a policy change might be effected. That city governments bear responsibility for most urban infrastructure and basic public provision, yet lack the tax-sharing revenues to fulfill these obligations, necessarily causes city-level cadres to choose to fund some investments and to leave other investments unfunded.

Our findings suggest that city cadres favor transportation infrastructure projects because these boost their "merit" as defined by China's merit-based system of promotions. If environmental investment is to be increased meaningfully, attention might be given to raising the importance of achieving high tangible environmental quality standards in assessing "merit". Rational city-level cadres enact policies that get them promoted and avoid policies that do not. Our results suggest that explicitly rewarding cadres with promotions for improving

environmental conditions in their cities and explicitly punishing cadres who oversee environmental catastrophes might lead to visible ameliorations of China's environmental problems within a timeframe corresponding to city-level cadres' promotion cycle – roughly three years in our data.

Our other results show that actual promotion decisions, not slogans, are needed if such a priority shift is to be meaningful. We find that senior cadres' public statements calling for transportation infrastructure bring boosted transportation infrastructure spending; but their public calls for environmental improvements bring no analogous boost to spending on environment – even amid rapidly worsening pollution. Clearly, the career-minded city-level cadre pays attention to what senior cadres do, not what they say. As long as transportation infrastructure investment leads to promotion and environmental investment does not, China's cities will see more transportation infrastructure investment and less environmental investment.

Our findings also suggest that city governments' revenues shortfalls, which arise because intergovernmental fiscal transfers from Beijing are insufficient to cover their mandated expenses, might provide a second channel through which environmental improvements might be effected. City-level cadres resolve this arithmetic impossibility by raising off-budget revenues through land-lease sales. These land-leases fetch higher prices where transportation infrastructure is more developed, but not where environmental conditions are better. This gives city cadres a second important incentive to invest what limited funds they have in transportation infrastructure, and may even fuel a feedback loop of more transportation infrastructure lifting land-lease prices, raising more revenue for the city, which can be spent on yet more transportation infrastructure, and so on. If land lease prices came to reflect local environmental standards too, a like effect might take hold and make environmental improvement similarly self-reinforcing. Perhaps

promotion-minded city-level cadres, who manage to implement rapid improvements in urban air quality, might set off such a cycle by advertising such an achievement as making their city a better place to live, work, or run a business. If China's increasingly affluent people truly value a clean environment, this should attract affluent immigrants, able to pay more for residential and business properties. The central government might kickstart such a feedback effect were, for example, the Organization Departments of the CCP, which oversees promotion decisions for the CEOs of major SOEs, to reward (promote) land developer SOE CEOs for constructing residential units in cities that bring pollution down and punish (demoted?) land developer SOE CEOs for undertaking developments where pollution is worsening. City-level cadres could then loosen their budget constraints by investing in environmental improvements to lift land lease prices, which would provide cities with more revenues for environmental improvement, which would further lift land lease prices, and so on.

Our empirical findings could also be partially driven by latent factors we have yet to explore. For example, cities with rapid GDP growth might have more resources, and therefore provide greater opportunities for cronyism. If so, cadres serving in these cities might be promoted faster because they are better-connected cronies. Or, investing in transportation infrastructure and allowing rapid rises in land prices and real estate might be an effective way for city cadres to channel private benefits to related parties. We plan to explore these issues elsewhere.

Obviously, because we cannot observe China's collective social welfare function, we cannot conclude that our findings indicate inefficient resource allocation. It remains plausible that city cadres' actions match the people's preferences: China's people might prefer to get acceptably rich first, and only afterwards grow concerned about the environment, or other public

goods such as education and health care. Recent growing public outrage over pollution in China suggests that this turning point in public expectations of their city governments may be nearing.

Regardless, our findings reveal the importance of government officials' incentives, assigned responsibilities, and budget constraint. Even the behavior of career Communist Party cadres reflects their economic incentives: cadres enthusiastically fulfill the parts of their assigned responsibilities that are rewarded and ignore those that are not. Career Communist Party cadres enthusiastically fulfill assigned responsibilities that expand their budgets and ignoring those that do not. Communist Party cadres, in short, appear to be card-carrying members of the species *hommo economicus*.

China's new five year plan emphasizes protecting the environment, raising health care standards, and enhancing the quality and universality of public education. These policy goals plausibly have localized idiosyncrasies that justify delegation to city cadres. To implement these policy goals, senior Party cadres may wish to consider carefully the ways in which city cadres' career incentives, policy responsibilities, and budget constraints interact. Specifically, the analysis above suggests that, should China's top leadership wish to improve the environment, steps might be taken to (1) include measurable evidence of progress towards this in formulae determining city cadres' promotions, and (2) link land prices to environmental quality by encouraging land development where such progress occurs and discouraging it where such progress is absent.

Appendix: Data Description

(1) City-Level Statistics

By the end of 2009 there are 287 cities which are classified at or above municipal level (*di ji shi*) in mainland China. Our empirical analyses cover 283 of them, excluding the four "province-level" municipalities (namely, Beijing, Shanghai, Tianjin, and Chongqing). All the city statistics variables in our sample are available by annual series between 2000 and 2009, and by cross-section over 283 cities, except for the air quality, which is available in 82 cities only.

The variables' definitions, sources and major statistics are listed in Table A-1. All the monetary variables are normalized by local GDP volume in the same year unless otherwise stated.

(2) Information on City Officers

During the sample period between 2000 and 2009, there are totally 976 CCP secretaries and 1075 mayors in the 283 cities. (According to our definition in this paper, if a turnover happens on or before June 30th, the corresponding city-year will be allocated to the newly-appointed officer, otherwise it will come to the predecessor.)

When a secretary or mayor is appointed, his/her official resume will be publicly reported in local medias, from which we collect the information on the officers' personal characteristics, previous working experience, and whether he/she gets promoted or not after current position. The variables' definitions, sources and major statistics are listed in Table A-2.

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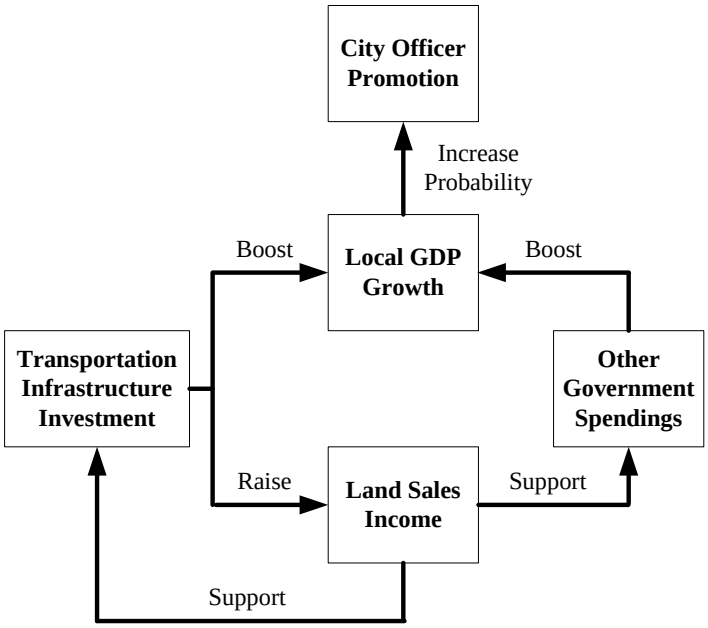
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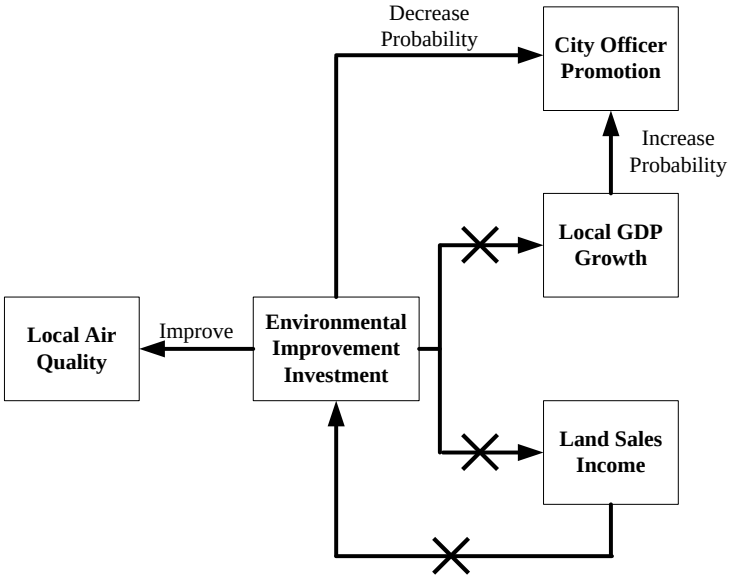
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(A) For transportation infrastructures:



(B) For environmental improvement:

Figure 1: Local Governments' Incentives and Urban Infrastructure Investments

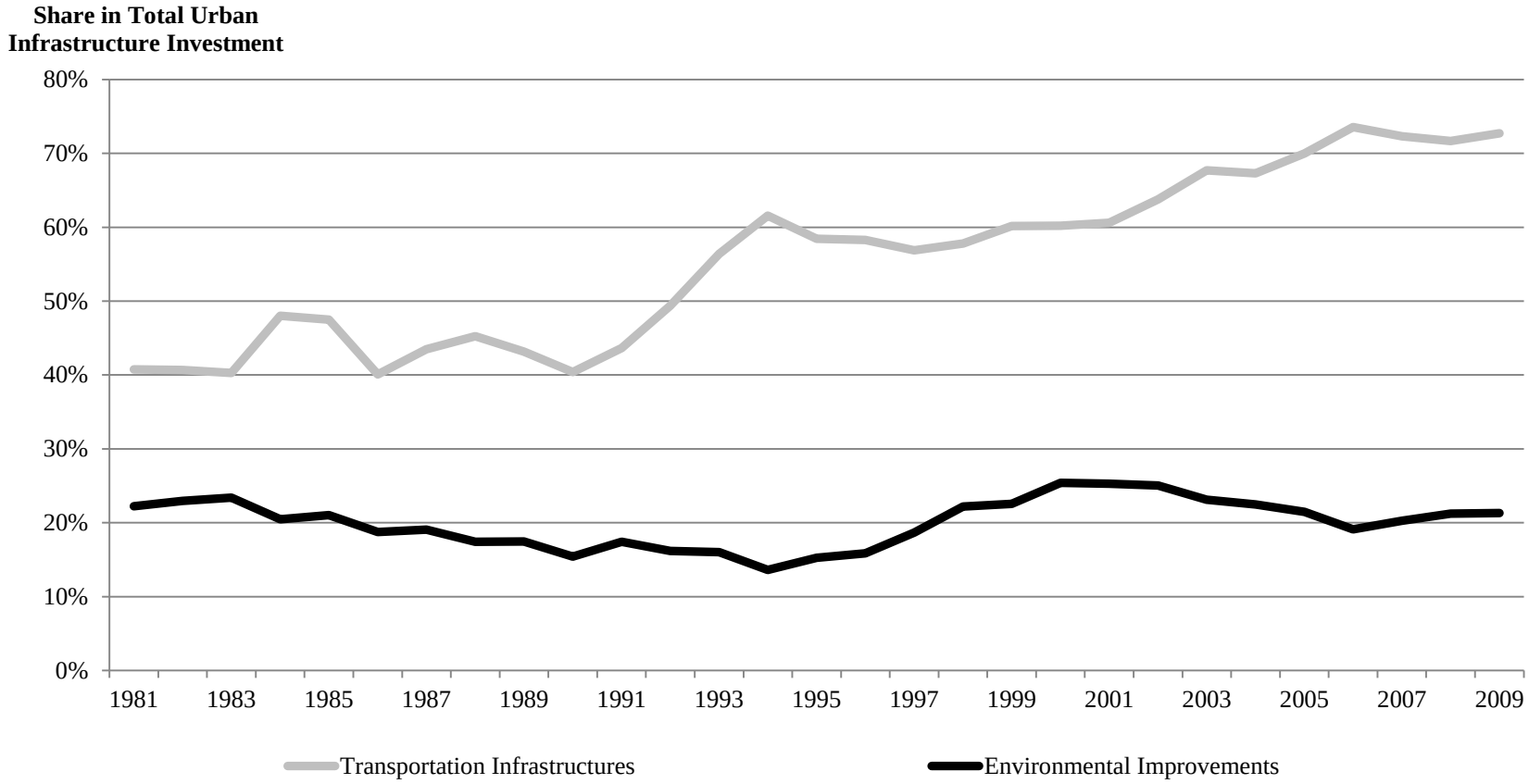


Figure 2: Structure of Urban Infrastructure Investments in the National Level

Source: Ministry of Housing and Urban-Rural Development of China, "China Urban Construction Statistics Yearbook".

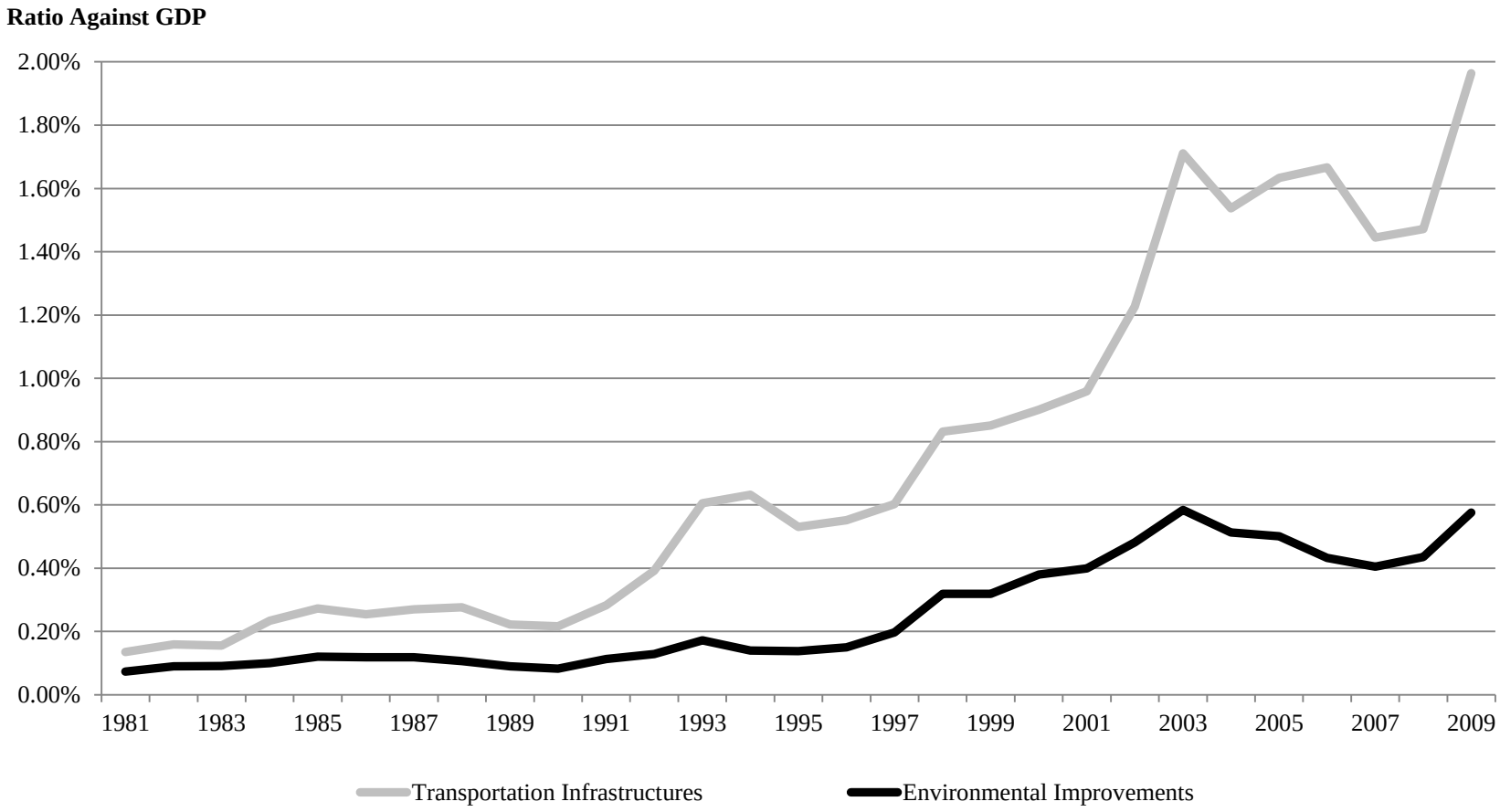


Figure 3: Ratio of Urban Infrastructure Investments against GDP

Source: Ministry of Housing and Urban-Rural Development of China, "China Urban Construction Statistics Yearbook".

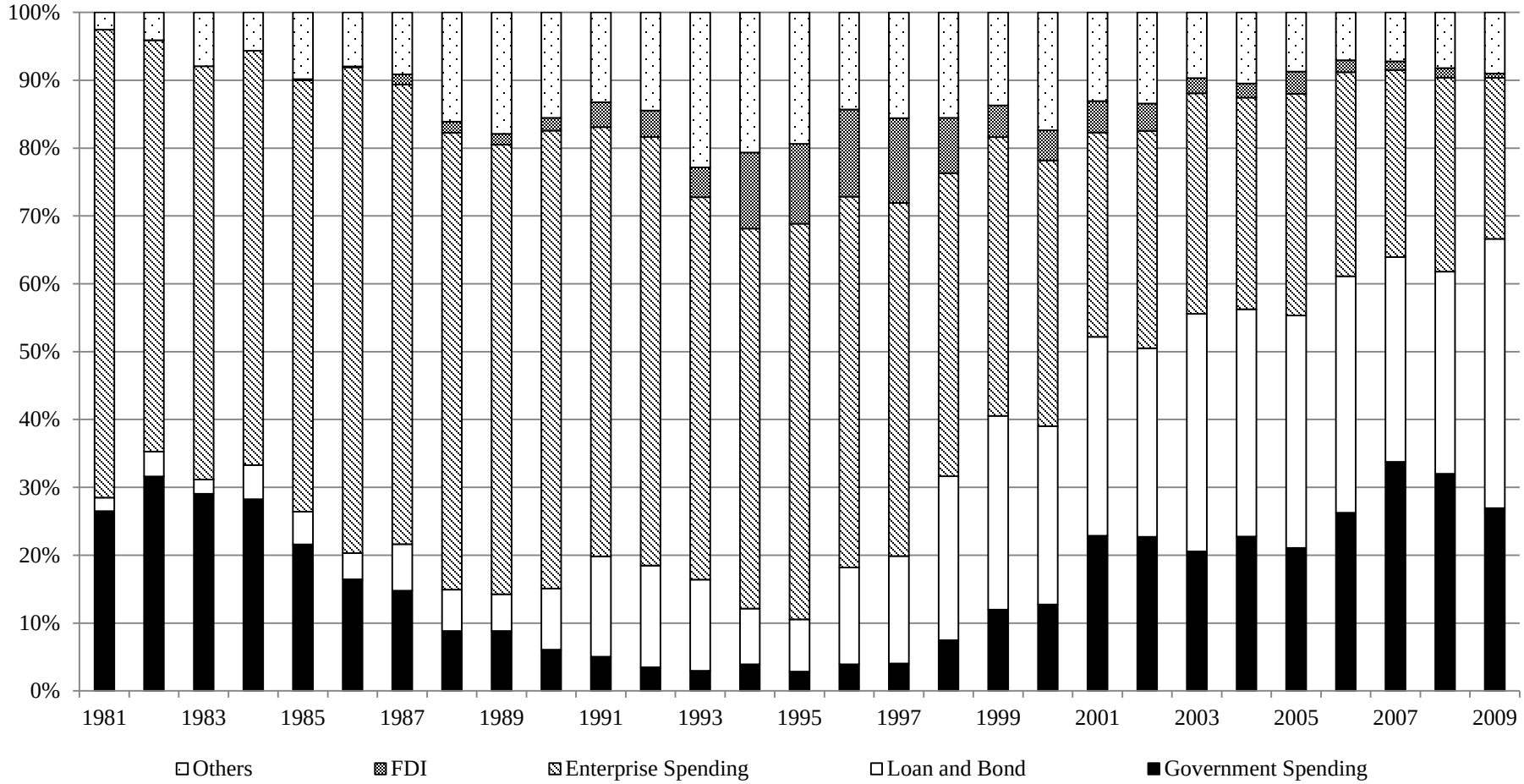


Figure 4: Fund Sources of Fixed Asset Investment on Urban Infrastructure

Source: Ministry of Housing and Urban-Rural Development of China, "China Urban Construction Statistics Yearbook".

Table 1: Average Ratio of Days Reaching "Grade I" in Air Quality

A. All the Cities Included

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Median	12.53%	13.97%	14.79%	13.39%	12.47%	13.29%	14.79%	15.17%	18.68%	18.14%
Average	18.29%	21.22%	21.13%	20.07%	19.15%	18.14%	18.97%	20.88%	23.54%	23.27%
Std. Dev.	20.81%	23.11%	21.46%	21.42%	19.28%	18.02%	17.46%	18.19%	18.98%	17.17%
Observations	37	47	47	47	84	86	86	86	86	86

B. The 37 Cities Appeared in All Years

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Median	12.53%	13.97%	14.79%	10.38%	14.79%	15.89%	14.79%	16.39%	18.68%	20.33%
Average	18.29%	20.18%	20.10%	19.04%	21.50%	21.63%	21.62%	23.98%	27.55%	28.30%
Std. Dev.	20.81%	21.49%	20.39%	20.48%	20.26%	19.60%	18.97%	20.57%	22.87%	21.09%
Observations	37	37	37	37	37	37	37	37	37	37

Note: A city is included in the analysis only if all the days in that year were monitored.

Source: Ministry of Environmental Protection of China.

Table 2: Environmental Improvement Investment and Local Air Quality

(Dependent Variable: Change in Ratio of Days Reaching "Grade I" in Air Quality)

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Environmental Improvement Investment	0.0201	0.0222	0.0247	0.0336	0.0336	0.0363
(normalized by GDP)	(1.87)*	(1.99)**	(2.22)**	(2.55)**	(2.52)**	(2.74)***
Transportation Infrastructure Investment	-0.0010	-0.0010	-0.0004	0.0001	0.0004	0.0013
(normalized by GDP)	(-0.36)	(-0.33)	(-0.14)	(0.03)	(0.11)	(0.35)
Lagged Environmental Improvement Investment		-0.0085	-0.0174		0.0028	-0.0062
(normalized by GDP)		(-0.71)	(-1.40)		(0.19)	(-0.42)
Lagged Transportation Infrastructure Investment		-0.0002	-0.0013		-0.0017	-0.0035
(normalized by GDP)		(-0.05)	(-0.34)		(-0.37)	(-0.74)
Two Year Lagged Environmental Improvement			0.0286			0.0328
Investment (normalized by GDP)			(2.35)**			(2.37)**
Two Year Lagged Transportation Infrastructure			0.0012			0.0038
Investment (normalized by GDP)			(0.32)			(0.87)
Lagged Air Quality Level	-0.7070	-0.7078	-0.7075	0.2607	0.2582	0.2690
	(-13.50)***	(-13.37)***	(-13.43)***	(4.04)***	(3.95)***	(4.15)***
Per Real Capita GDP Growth	-3.6434	-3.6257	-3.3039	-3.0852	-3.1389	-3.2256
	(-2.82)***	(-2.78)***	(-2.50)**	(-1.71)*	(-1.72)*	(-1.78)*
Per Real Capita GDP Growth * Lagged Real Per	0.3100	0.3094	0.2768	0.2515	0.2570	0.2640
Capita GDP Level	(2.42)**	(2.38)**	(2.10)**	(1.40)	(1.42)	(1.47)
Weighted Change of Air Quality in Other Cities	0.9833	0.9542	0.9681	1.2946	1.2876	1.2546
	(1.41)	(1.37)	(1.38)	(1.52)	(1.50)	(1.47)
Lagged Foreign Direct Investment	-0.0014	-0.0013	-0.0014	-0.0007	-0.0007	-0.0019
(normalized by GDP)	(-0.64)	(-0.57)	(-0.61)	(-0.19)	(-0.19)	(-0.50)
City Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.407	0.408	0.418	0.912	0.912	0.914
Number of observations	486	486	486	369	369	369

Note: (1) t statistics in parentheses

(2) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Determinants of City-Level Urban Infrastructure Investments

Dependent Variables	Transportation Infrastructure Investment (normalized by GDP)		Environmental Improvement Investment (normalized by GDP)	
Independent Variables	(1)	(2)	(3)	(4)
Lagged Local Budgetary allocation from the Central Government (normalized by GDP)	-0.0149 (-0.27)	-0.0158 (-0.29)	-0.0103 (-0.80)	-0.0110 (-0.84)
Lagged Local Land Sales Income (normalized by GDP)	0.0572 (2.61)**	0.0585 (2.64)**	0.0046 (0.71)	0.0043 (0.68)
Lagged Loan Balance (normalized by GDP)	0.0044 (1.37)	0.0046 (1.46)	0.0003 (0.19)	0.0001 (0.10)
Lagged Internet Search Index on Infrastructure Investment	0.6739 (1.14)		-0.1459 (-0.77)	
Lagged Internet Search Index on Transportation		0.5761 (1.31)		
Lagged Internet Search Index on Environmental Protection				-0.1868 (-1.16)
Lagged Real Per Capita GDP Level	0.1299 (0.58)	0.1650 (0.71)	-0.0072 (-0.07)	-0.0087 (-0.09)
Lagged Foreign Direct Investment (normalized by GDP)	0.0285 (1.04)	0.0289 (1.05)	0.0205 (2.36)**	0.0196 (2.23)**
Lagged Investment other than Urban Infrastructures (normalized by GDP)	0.0049 (1.26)	0.0050 (1.29)	0.0011 (0.90)	0.0011 (0.84)
Lagged Government Expenditure (normalized by GDP)	0.0109 (0.98)	0.0122 (1.08)	0.0050 (0.91)	0.0041 (0.78)
City Fixed Effect	Yes	Yes	Yes	Yes
R^2	0.534	0.535	0.437	0.437
Number of observations	2419	2419	2419	2419

Note: (1) the cities are clustered by province.

(2) t statistics in parentheses.

(3) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Urban Infrastructure Investment and Local GDP Growth

(Dependent Variable: Δlog(real Per Capita GDP))

Independent Variables	(1)	(2)	(3)
Lagged Change in Environmental Improvement Investment	-0.0013	-0.0012	-0.0013
(normalized by GDP)	(-0.53)	(-0.34)	(-0.31)
Lagged Change in Transportation Infrastructure Investment	0.0020	0.0018	0.0011
(normalized by GDP)	(2.27)**	(1.75)*	(1.04)
Two Year Change in Lagged Environmental Improvement Investment		-0.0024	-0.0010
(normalized by GDP)		(-0.99)	(-0.27)
Two Year Change in Lagged Transportation Infrastructure Investment		0.0003	0.0000
(normalized by GDP)		(0.33)	(0.03)
Three Year Change in Lagged Environmental Improvement Investment			0.0001
(normalized by GDP)			(0.02)
Three Year Change in Lagged Transportation Infrastructure Investment			0.0008
(normalized by GDP)			(0.81)
Lagged real Per Capita GDP Level	0.0126	-0.0012	-0.0204
	(1.94)*	(-0.15)	(-2.18)**
Lagged Foreign Direct Investment	0.0002	0.0002	0.0006
(normalized by GDP)	(0.44)	(0.37)	(1.30)
Lagged Investment other than Urban Infrastructures	0.0011	0.0009	0.0006
(normalized by GDP)	(5.30)***	(4.45)***	(3.36)***
Lagged Government Expenditure	-0.0000	0.0005	0.0015
(normalized by GDP)	(-0.03)	(0.82)	(2.50)**
City Fixed Effect	Yes	Yes	Yes
R^2	0.522	0.545	0.621
Number of observations	2198	1933	1659

Note: (1) the cities are clustered by province.

(2) t statistics in parentheses.

(3) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Urban Infrastructure Investment and Local Land Price

(Dependent Variable: Δlog(average land price))

Independent Variables	(1)	(2)	(3)
Lagged Environmental Improvement Investment	-0.0806	-0.0968	-0.1112
(normalized by GDP)	(-0.88)	(-1.07)	(-1.12)
Lagged Transportation Infrastructure Investment	0.0441	0.0420	0.0361
(normalized by GDP)	(2.37)**	(2.20)**	(1.64)
Two Year Lagged Environmental Improvement Investment		0.0547	0.0089
(normalized by GDP)		(0.70)	(0.13)
Two Year Lagged Transportation Infrastructure Investment		0.0055	-0.0177
(normalized by GDP)		(0.36)	(-1.01)
Three Year Lagged Environmental Improvement Investment			0.0017
(normalized by GDP)			(0.02)
Three Year Lagged Transportation Infrastructure Investment			0.0471
(normalized by GDP)			(1.39)
log (Lagged Average Land Price)	-0.7367	-0.7420	-0.8138
	(-19.15)***	(-19.78)***	(-15.60)***
Lagged Δlog (Real Per Capita GDP)	1.6369	1.6550	-0.0437
	(2.17)**	(2.18)**	(-0.07)
Lagged Foreign Direct Investment	-0.0380	-0.0383	-0.0479
(normalized by GDP)	(-2.21)**	(-2.26)**	(-3.04)***
Lagged Investment other than Urban Infrastructures	0.0105	0.0102	0.0113
(normalized by GDP)	(5.88)***	(5.62)***	(5.54)***
Lagged Government Expenditure	0.0227	0.0231	0.0252
(normalized by GDP)	(2.10)**	(1.92)*	(1.99)*
City Fixed Effect	Yes	Yes	Yes
R^2	0.480	0.483	0.492
Number of observations	2162	2153	1889

Note: (1) the cities are clustered by province.

(2) t statistics in parentheses.

(3) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Factors Affecting Prefectural CCP Secretaries' Promotion Odds

(Dependent Variable: whether the CCP secretary gets promotion within the year)

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Average GDP Growth Rate during the Tenure	-0.0142	-0.0139				
	(-1.83)*	(-1.75)*				
Relative GDP Growth Rate Compared with All Other Cities Within the Same Province			-0.0135	-0.0170		
			(-0.97)	(-1.20)		
Relative GDP Growth Rate Compared with Last Officer in the Same Position					0.0140	0.0144
					(2.39)**	(2.28)**
Average of Ratio between Environmental Improvement Investment and GDP during the Tenure		-0.2213		-0.2367		-0.2367
		(-2.79)***		(-2.96)***		(-2.91)***
Average of Ratio of Transportation Infrastructure Investment to GDP during Tenure		0.0067		0.0008		-0.0112
		(0.25)		(0.03)		(-0.38)
Whether the Officer is Female	0.2051	0.1935	0.2268	0.2189	0.2534	0.2458
	(1.65)*	(1.57)	(1.85)*	(1.80)*	(1.95)*	(1.88)*
Whether the Officer is Minority	-0.0485	-0.0516	-0.0569	-0.0615	-0.0871	-0.0957
	(-0.59)	(-0.62)	(-0.71)	(-0.77)	(-1.13)	(-1.26)
Whether the Officer is Local	0.0588	0.0749	0.0485	0.0681	0.0070	0.0028
	(0.70)	(0.86)	(0.58)	(0.78)	(-0.08)	(0.03)
The Age He/She Took Current Position	-0.0337	-0.0322	-0.0339	-0.0322	-0.0328	-0.0309
	(-5.28)***	(-4.99)***	(-5.25)***	(-4.94)***	(-4.71)***	(-4.38)***
Whether the Officer Has Master/PhD Degree	-0.0625	-0.0632	-0.0709	-0.0694	-0.0879	-0.0872
	(-1.13)	(-1.16)	(-1.27)	(-1.26)	(-1.43)	(-1.44)
Whether the Officer Has Worked in Central Government	-0.0332	-0.0158	-0.0388	-0.0153	0.0127	0.0531
	(-0.37)	(-0.17)	(-0.44)	(-0.17)	(0.13)	(0.54)
Whether the Officer Has Worked in Provincial Government	-0.0090	-0.0122	-0.0149	-0.0173	0.0041	0.0050
	(-0.21)	(-0.28)	(-0.34)	(-0.40)	(0.09)	(0.11)
Whether the Officer Has Worked in Universities	-0.0319	0.0133	-0.0573	-0.0112	0.0051	0.0655
	(-0.33)	(0.13)	(-0.62)	(-0.11)	(0.05)	(0.54)
Whether the Officer Has Worked as SOE Executives	-0.1903	-0.1934	-0.1926	-0.1951	-0.1907	-0.1919
	(-3.61)***	(-3.78)***	(-3.64)***	(-3.80)***	(-4.13)***	(-4.35)***
Whether the Officer Has Worked in China Communist Youth League	0.0411	0.0411	0.0460	0.0465	0.0890	0.0921
	(0.74)	(0.76)	(0.79)	(0.78)	(1.40)	(1.42)
Whether the Officer Has Worked in Other Provinces	0.2468	0.2215	0.2529	0.2239	0.2381	0.2062
	(3.34)***	(3.08)***	(3.37)***	(3.08)***	(3.07)***	(2.79)***
Whether the Officer Has Worked/Studied Abroad	-0.0074	0.0192	-0.0224	0.0069	-0.0094	0.0266
	(-0.11)	(0.27)	(-0.33)	(0.10)	(-0.14)	(0.38)
Whether the Officer Works As Top Officer in a City for the First Time	0.0397	0.0283	0.0461	0.0310	0.0235	0.0047
	(0.71)	(0.48)	(0.81)	(0.52)	(0.42)	(0.08)
City Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.113	0.122	0.110	0.121	0.123	0.132

Number of observations	789	776	789	776	774	761

Note: (1) the odds ratios are reported.

(2) the observations are clustered by secretaries.

(3) the perfect predictor city dummies are dropped.

(4) z statistics in parentheses.

(5) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Factors Affecting Prefectural Mayor' Promotion Odds

(Dependent Variable: whether the mayor gets promotion within the year)

Independent Variables	(1)	(2)	(3)	(1)	(2)	(3)
Average GDP Growth Rate during the Tenure	-0.0039	-0.0026				
	(-0.67)	(-0.43)				
Relative GDP Growth Rate Compared with All			-0.0052	-0.0059		
Other Cities Within the Same Province			(-0.55)	(-0.62)		
Relative GDP Growth Rate Compared with Last					0.0283	0.0297
Officer in the Same Position					(5.22)***	(5.29)***
Average of Ratio between Environmental		-0.1283		-0.1301		-0.1703
Improvement Investment and GDP during Tenure		(-1.76)*		(-1.81)*		(-2.11)**
Average of Ratio between Transportation		-0.0198		-0.0210		-0.0367
Infrastructure Investment and GDP during Tenure		(-0.84)		(-0.90)		(-1.42)
Whether the Officer is Female	-0.1165	-0.1176	-0.1184	-0.1188	-0.1273	-0.1249
	(-1.92)*	(-1.97)**	(-1.95)*	(-2.00)**	(-2.05)**	(-2.06)**
Whether the Officer is Minority	-0.0304	-0.0368	-0.0328	-0.0386	-0.0674	-0.0835
	(-0.38)	(-0.44)	(-0.41)	(-0.46)	(-0.81)	(-0.98)
Whether the Officer is Local	-0.0821	-0.0906	-0.0786	-0.0886	-0.1072	-0.1260
	(-1.27)	(-1.40)	(-1.21)	(-1.37)	(-1.67)*	(-2.00)**
The Age He/She Took Current Position	-0.0129	-0.0126	-0.0130	-0.0125	-0.0108	-0.0096
	(-2.27)**	(-2.21)**	(-2.30)**	(-2.20)**	(-1.82)*	(-1.60)
Whether the Officer Has Master/PhD Degree	-0.0180	-0.0130	-0.0196	-0.0136	0.0088	0.0214
	(-0.45)	(-0.33)	(-0.50)	(-0.34)	(0.21)	(0.52)
Whether the Officer Has Worked in Central	0.1495	0.1428	0.1465	0.1425	0.1445	0.1382
Government	(1.55)	(1.48)	(1.53)	(1.49)	(1.53)	(1.46)
Whether the Officer Has Worked in Provincial	0.0702	0.0802	0.0696	0.0805	0.0550	0.0648
Government	(2.11)**	(2.36)**	(2.10)**	(2.37)**	(1.60)	(1.83)*
Whether the Officer Has Worked in Universities	0.1091	0.1210	0.1047	0.1174	0.1528	0.1719
	(1.02)	(1.05)	(0.98)	(1.02)	(1.37)	(1.43)
Whether the Officer Has Worked as SOE	-0.0622	-0.0566	-0.0660	-0.0591	-0.0848	-0.0719
Executives	(-1.02)	(-0.91)	(-1.09)	(-0.96)	(-1.31)	(-1.07)
Whether the Officer Has Worked in CCYL	0.0210	0.0198	0.0220	0.0194	0.0025	0.0085
	(0.36)	(0.34)	(0.38)	(0.33)	(0.04)	(0.14)
Whether the Officer Has Worked in Other	-0.1623	-0.1600	-0.1631	-0.1600	-0.1725	-0.1700
Provinces	(-2.84)***	(-2.88)***	(-2.84)***	(-2.87)***	(-2.94)***	(-3.03)***
Whether the Officer Has Worked/Studied Abroad	-0.0204	-0.0132	-0.0205	-0.0125	-0.0036	-0.0101
	(-0.32)	(-0.21)	(-0.32)	(-0.20)	(-0.05)	(0.15)
Whether the Officer Works As Top Officer in a	-0.1566	-0.143	-0.1556	-0.1422	-0.1833	-0.1539
City for the First Time	(-2.20)**	(-2.06)**	(-2.17)**	(-2.02)**	(-2.43)**	(-2.12)**
City Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.091	0.094	0.091	0.094	0.110	0.116
Number of observations	1126	1117	1126	1117	1108	1099

Note: (1) the odds ratios are reported.
(2) the observations are clustered by mayors.
(3) the perfect predictor city dummies are dropped.
(4) z statistics in parentheses.
(5) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A-1: City-Level Variables

Variable	Definition	Source	Mean	Std. Dev
Environmental Improvement Investment	Annual investment on urban infrastructures in the categories of "Drainage Works (including sewage purification)", "Environmental Sanitation (including solid waste treatment)", and "Gardening and Greening"; normalized by local GDP in the same year.	Ministry of Housing and Urban-Rural Development (*China Urban Construction Statistical Yearbook*)	0.363	0.356
Transportation Infrastructure Investment	Annual investment on urban infrastructures in the categories of "Road and Bridges" and "Public Transportation"; normalized by local GDP in the same year.		0.895	1.025
Air Quality	Percentage of days in the year when the air quality reaches "Grade I" (the highest grade).	Ministry of Environmental Protection (the official website)	0.207	0.198
Per Capita GDP	Local annual per capita GDP (after adjusting according to two economic censuses); in thousand yuan RMB (in 2009 price).	National Bureau of Statistics (*China City Statistical Yearbook*; *China Statistical Yearbook for Regional Economy*; *Bulletins of Population Census* in 2000, 2010)	0.507	0.727
Budgetary allocation from the Central Government	Local governments' annual budgetary income (central government's allocation of tax revenues); normalized by local GDP in the same year.		5.005	1.770
Government Expenditure	Local governments' annual budgetary expenditure; normalized by local GDP in the same year.		11.347	6.326
Total Investment	Annual investment (excluding those on urban infrastructures); normalized by local GDP in the same year.		42.276	18.759
Loan Balance	Commercial banks' loan balance at the end of the year; normalized by local GDP in the same year.		74.810	38.102
FDI	Annual foreign direct investment; normalized by local GDP in the same year.		2.241	3.060
Land Sales Income	Annual land sales revenues; normalized by local GDP in the same year.	Ministry of Land Resource (*China Yearbook of Land Resources*)	2.144	2.398
Land Supply Volume	Annual land sales volume; in million sq.m of land area.		5.070	7.266
Land Price	Average price of land parcels sold during the year; in yuan (in 2009 price) per sq.m of land area.		276.992	326.584
Google Index on Infrastructure Investment	Index on the density that the corresponding provincial CCP secretary calls for infrastructure investment in the year; see the text for more details.	Authors' calculations based on Google searches.	0.161	0.063
Google Index on Environmental Protection	Index on the density that the corresponding provincial CCP secretary calls for environmental protection in the year; see the text for more details.		0.218	0.094
Google Index on Transportation Development	Index on the density that the corresponding provincial CCP secretary calls for transportation development in the year; see the text for more details.		0.289	0.092

Note: The air quality variable covers 86 cities, while all the other variables cover all the 283 cities.

Table A-2: City Officer Variables

Variable	Definition	CCP Secretary		Mayor	
		Mean	Std. Dev.	Mean	Std. Dev.
Promotion	Whether the officer in position at the beginning of the year gets promoted within the year (see the text for detailed definition of promotion); 1=yes, 0=o/w.	0.110	0.313	0.201	0.401
Gender	Gender of the officer in the city-year; 1=female, 0=male.	0.024	0.152	0.043	0.202
Ethnic Group	Whether the officer in the city-year is of a minority ethnic group; 1=yes, 0=o/w.	0.069	0.253	0.058	0.233
Home Town	Whether the officer in the city-year was born in this city; 1=yes, 0=o/w.	0.050	0.217	0.097	0.296
Age	Age of the officer in the city-year when he/she first occupied current position.	49.817	3.614	48.175	3.943
Education Level	Whether the officer in the city-year is with a master or higher degree; 1=yes, 0=o/w.	0.692	0.462	0.701	0.458
Working Experience in Central Government	Whether the officer in the city-year has worked as a senior officer in the central government; 1=yes, 0=o/w.	0.049	0.216	0.053	0.223
Working Experience in Provincial Government	Whether the officer in the city-year has worked as a senior officer in a provincial government; 1=yes, 0=o/w.	0.603	0.489	0.483	0.500
Working Experience in Universities	Whether the officer in the city-year has worked as a senior officer in a university or research institute; 1=yes, 0=o/w.	0.041	0.199	0.035	0.185
Working Experience in SOEs	Whether the officer in the city-year has worked as a senior officer in a state-owned enterprise; 1=yes, 0=o/w.	0.055	0.229	0.087	0.282
Working Experience in Chinese Communist Youth League	Whether the officer in the city-year has worked as a senior officer in the Chinese Communist Youth League; 1=yes, 0=o/w.	0.133	0.340	0.098	0.298
Working Experience in Other Government	Whether the officer in the city-year has worked in other provinces; 1=yes, 0=o/w.	0.101	0.302	0.068	0.251
Working/Study Experience Abroad	Whether the officer in the city-year has worked or studied outside mainland China; 1=yes, 0=o/w.	0.073	0.261	0.094	0.292
Working Experience as City Officer	Whether this is the first time for the officer in the city-year to be the top officer in a prefectural level city; 1=yes, 0=o/w.	0.276	0.447	0.894	0.308