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ABSTRACT

In generating fast economic growth, China is also generating growing concern about its environmental record. Using 2000-2009 data, we find that, while spending on environmental infrastructure has visible positive environmental impact, city spending is strongly tilted towards transportation infrastructure. Investment in transportation infrastructure correlates strongly with both real GDP growth, a measure of tangible economic growth relevant to city-level Party and government cadres' promotion odds, and with land prices, which affect city governments' revenues from land lease sales. In contrast, city governments' spending on environmental improvements is at best uncorrelated with cadres' promotion odds, and is uncorrelated with local GDP growth and land prices. These findings suggest that, were environmental quality explicitly linked to a cadre's chance of promotion, or were environmental quality to affect land prices substantially, city-level public investment in environmental improvement would rise.

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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 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 on the central committee level, Li and Zhou (2005) and Chen, Li and Zhou (2005) for evidence on the provincial level, and Edin (2003) and Whiting (2004) for evidence on selected towns/villages).[1]

The alleged critical role of this system in China's economic success motivates our adoption of an "organizational management" focus: namely, that organizational performance emerges from individuals' behavioural responses to their incentives, given their decision rights and budgetary resources (Jensen, 1998). Applying this logic, we relate city-governments' investment in transportation infrastructure versus environmental improvements to cadres' hierarchical assignment of duties, promotion incentives, and budgetary constraints.

This exercise focuses on institutional details about China's hierarchic management system. The apex of this system is the CCP politburo and central committee. Below them are the top cadres of China's provinces and its four "province-level" municipalities.[2] Beneath these are, in descending order, the top cadres of cities, counties, and townships or villages. Cadres are

[1] The literature is not unanimous on this point. For example, Shih, Adolph and Liu (2012) find no significant correlation between CCP central committee members' promotions and economic growth performance; consistent other factors, such as factional ties with current and past top leaders assuming greater importance at very senior levels in the Party hierarchy.

[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.

rotated – reassigned to a new position every three or more years, and perhaps to new locations as well. Conditional on a harmonious political attitude, a cadre's past performance, evidenced by having overseen high tangible economic development outcomes, is shown to affect his 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 a competition between sub-national governments to produce tangible evidence of economic development at all levels of the management hierarchy.

This competition is thought to take place within China's highly decentralized fiscal expenditure system. The World Bank's (2012) China 2030 report 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, primarily city governments, also account for the lion's share of investment in urban infrastructure, such as transportation systems and environmental improvements. However, city government revenues, based on a "tax revenue sharing mechanism and intergovernmental fiscal transfers, are not commensurate with local government expenditure responsibilities" (World Bank 2012, p. 55). City governments must therefore find additional revenue sources to finance their expenditures.

This mismatch could affect top city-level cadres' investment and revenue raising decisions. To the extent that their careers depend on tangible evidence of having successfully fostered economic growth, the governments they direct are apt to allocate public expenditures according to their short-run contributions to tangible economic growth, rather than their long-run

tangible and intangible contributions to total growth. Figure 1 illustrates how these considerations might play out in a local government's allocation of investment between transportation infrastructure and environmental improvements. 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 incline local government and Party cadres, seeking to expand their discretionary spending budgets, to allocate more city funds to transportation infrastructure and less to environmental improvements. Like considerations might similarly direct local public spending away from other relatively intangible investments, such as education and healthcare.

Another possible reason for an emphasis on transportation infrastructure spending might be the CCPs longstanding technocratic interpretation of economic development as requiring megaprojects – dams, highways, and other monumental achievements. Huge 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. Second, city-level cadres increase city government transportation infrastructure investment in response to their province-level superiors emphasizing such investment, but do not act likewise if their superiors emphasize environmental concerns. Third, higher transportation infrastructure spending is, while higher environmental spending is not, correlated with higher

land prices in the short term; higher land lease revenues in turn raise future spending on transportation infrastructure. Fourth, current spending on transportation infrastructure is correlated with next year's GDP growth while spending on environment is not. Finally, higher city-level GDP growth is statistically and economically significantly positively related to greater odds of the city's top cadres being promoted. On the contrary, higher city-level environmental investment is statistically and economically significantly negatively related to better odds of the city's top cadres being promoted.

Obviously, determining China's socially optimal public spending formula lies far 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.

Equally obviously, our findings reveal correlations, not causes. We lack any credible means of explicitly confirming what causes what. However, these issues are unlikely to alter our basic argument: city-level cadres prefer to invest in transportation infrastructure which has a stronger positive correlation with near-term tangible growth, which in turn is related to higher promotion odds. Or, this emphasis might reflect a lingering traditional central planning obsession with megaprojects, such as transportation infrastructure. In addition, investing in transportation infrastructure boosts land prices, which boost cities' revenues from land sales, which increases top city-level cadres' discretionary spending powers. These are prima facia plausible

explanations of the correlations we find; however, we welcome alternative interpretations of our empirical findings.

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 public spending on environmental improvements to correlate positively with air quality. This is consistent with spending on environmental improvements alleviating air pollution. 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 replicates prior results consistent with cadres' promotion odds rising with measures of tangible economic growth. 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 position in the CCP and China in 2002, the "Scientific Outlook on Development (*ke xue fa zhan guan*)" became a major principle of social and economic development. The importance of environmental protection was repeatedly emphasized by the central government, just like it currently is in the 12th Five Year Plan.

However, during this era, local governments actually allocated less resources to urban 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 gradually dropped from a peak of 25.4% in 2000 to the nadir of 19.1% in 2006, before recovering slightly to 21.3% in 2009. Figure 2 shows environmental improvement investment over GDP similarly dropping from a peak of 0.58% in 2003 to a low of 0.41% in 2007, and then rising again somewhat.

This contrasts starkly with infrastructure investment in urban transportation, including "roads and bridges" and "public transportation", also plotted in Figures 2. Over the same decade, transportation infrastructures as a share of total urban infrastructure investment rose from 60.2% 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]

2.2 Pollution is an important problem

Pollution, especially air pollution, is a serious problem – obvious to any visitor to any large Chinese city (World Bank, 2007, 2012). For example, in early December 2011, air quality

[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 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.

reached a "crisis" level in Beijing, attracting global media attention.[4] On Dec 5th, the US Embassy reported particulate air pollution in Beijing exceeding the standard scale's maximum of 500, and described the situation as "crazily bad". The media also reported that the pollution brought a rush of patients to hospitals during those weeks, most suffering from heart attacks or respiratory problems. These dramatic visible air pollution problems resurfaced again in Jan 2013.

Air quality problems persisted through most of the past decade. Since mid-2000, the Ministry of Environmental Protection has graded air quality in selected cities. Table 1 shows the annual mean and median fractions of days with the highest grade, calculated across all cities, beginning to rise only in 2008, the year Beijing hosted the Olympic Games. This improvement is only partially due to the ministry expanding its coverage to include more cities. Panel B, using only the 37 cities covered throughout the sample period, also shows an improvement only after 2008.

2.3 Environmental investment and environmental outcomes

Investing in environmental improvements plausibly improves air quality both immediately and in future years. If so, China's skimping on investment in environmental improvements through the past decade could accumulate into its current poor 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. (The four "province-level"

[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.

mega cities: Beijing, Shanghai, Tianjin, and Chongqing are excluded.)[5] Each city's change in air quality each year is the fraction of days in which it earned a top "Grade I" in air quality less the same fraction the prior year.[6] Table 2 regresses this on "environmental development," defined as annual urban infrastructure investment in environmental improvements scaled by local GDP.[7] Investment in transportation infrastructures is also included for comparison. In addition, the regressions control for lagged air quality level and city fixed-effects. The regressions also include 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 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 follow Zheng, Cao and Kahn (2011) in constructing a proxy for air quality changes in nearby cities: the weighted average of the changes in the ratios of days reaching "Grade I" air quality in all other cities that year, weighted by the reciprocal of the exponential function of the distance to that city. Finally, lagged FDI, normalized by GDP, is also introduced to control for any effect of foreign investment on air quality of the sort found by 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.

[5] We exclude these data for several reasons. First, because these cities are "province-level" administrative units, their top government and Party officials are considered to be top provincial government and Party cadres, and thus to have promotion possibilities not comparable to those of top cadres in other cities. Second, the four cities are much larger and more developed than most other cities during the sample period. Finally, unique occasions – most notably, the 2008 Summer Olympics in Beijing and the 2010 Expo in Shanghai – affect data for those cities.

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

[7] The tables normalize by local GDP in the same year. Normalizing by population – that is, using per capita investment on 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.

Table 2 reveals a positive and significant correlation between environmental investment and better air quality in both the concurrent year and two years in the future. Using the coefficient in column 3, a one standard deviation increase in environmental investment correlates 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.[8] These marginal effects are economically significant: on average, the fraction of days reaching "Grade I" increases by only 0.86 percent per year, so a one standard deviation increase in environmental investment correlates with a better than doubling of the baseline improvement trajectory. In contrast, investment in transportation infrastructure is uncorrelated with air quality improvement.

The coefficients on the control variables 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. Calculated using column (1), the turning point corresponds to a per capita GDP of about ¥127.3 thousand (in constant 2009 RMB). In the sample data, a few of the most developed Chinese cities approach this point. Nearby cities' air quality attracts a positive coefficient, but is not uniformly significant; consistent with the finding of Zheng, Cao and Kahn (2011) that local factors are predominant determinants of air quality in China. The FDI variable is insignificant.

As Table 1 shows, the number of cities graded for air quality increased between 2001 and 2005, so the panel in column (1) through (3) is unbalanced. If cities that entered the data late

[8] 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.

have systematically different pollution problems, our results might be affected. Columns (4) to (6) therefore use only data from 2005 on: a balanced panel containing the same cities each year. Qualitatively similar results ensue; indeed environmental development variable becomes more significant.

Reverse causality seems implausible in these regressions. That city officials would wait until their air quality has improved to invest in environmental improvements seems *prima facie* implausible. That some unknown latent factor causes both investment in environmental improvement and improves air quality through some other channel, such as closing pollution intensive SOEs, is possible.

3. Infrastructure spending

3.1 Local government responsibility for urban infrastructure expenditures

The Ministry of Housing and Urban-Rural Development's "China Urban Construction Statistics Yearbook" declares local (city) governments to be primarily responsible for urban infrastructure investment. Figure 4 shows that government spending accounting for 26.9% of all urban infrastructure investments in 2009, and most of this to be by local governments. In contrast, the central government only contributed about 1.1% of total urban infrastructure investments. Enterprise spending accounts for another 23.8%; and most infrastructure enterprises are SOEs controlled by local governments. Local governments can also use debt financing, either on their own balance sheets or on those of SOEs they control, to magnify their budgets. In 2009, bank loans and bonds to local governments provided funds for 39.7% of urban infrastructure

investments. Thus, the lion's share of urban infrastructure investment is directed by local governments, or more precisely, by their top cadres.[9]

3.2 City government investment and superiors' "emphasis"

Because local governments are preeminent in infrastructure development, their top cadres' budget constraints and incentives are important. After a 1994 public finance reform, the central government collects a large proportion of 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*). Local governments therefore must access off-budget financing to fund urban infrastructure. Most of this is either borrowing – that is, bank loans or bond issues – or revenue from the sale of long-term land leases to property development enterprises.

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 their 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 observe Provincial CCP Secretaries' preferences; however, we can make plausible inferences about them from their public records.

[9] 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.

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 and articles: "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.[10]

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, at least in their on-line coverage.

[10] 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.

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, all normalized by local GDP. City fixed-effects are also included, and found to be jointly significant in Hausman tests. 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 ($2.398 \times 0.057 \approx 0.137$) 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. 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.

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 have attracted foreign direct investment in the past spend more in environmental amenities. Foreign investors might create pressure for environmental improvements. We cannot cleanly distinguish this from 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 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 in 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, the strategy of Lin and Song (2002) is tractable while that of D´emurger (2001) is not. Again using data for 283 cities from 2000 through 2009, Table 4 regresses 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. Other factors may well enter – population growth rates, natural resource endowments, stocks of human capital, and so on – but these are not available annually at the city-level. To mitigate

these deficiencies, we also include city fixed-effects, which Hausman tests again reveal to be jointly significant. 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 positive and statistically significantly 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 point of local per capita GDP growth the next year ($\exp(0.799 \times 0.0020) \approx 0.0016$). 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 in order to avoid potential errors in the imputed population indicator[11]. Introducing year fixed-effects as control variables and dropping the recession period of 2008 and stimulus period of 2009 both likewise generate qualitatively similar results.

These findings are consistent with city governments spending on transportation infrastructure boosting economic growth. However, a reversal causality scenario – expecting rapid growth, city government invest more in transportation infrastructure – cannot be excluded. Both directions of causality are consistent with the premise that city-level cadres more intent on

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

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 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, and 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, with the last three scaled by local GDP. Again, city fixed-effects are also included and are jointly significant in Hausman tests. Standard error estimates are clustered by province.

Table 5 displays these regressions, which show lagged transportation infrastructure investment 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 price growth rate higher by 4.5 percentage points the following year ($1.025 \times 0.044 \approx 0.0451$). This amounts to a 21.5% increase in the average annual land price growth rate for the 283 cities during the sample period. In contrast, environmental investment is unrelated to land prices.[12]

These results are robust. Qualitatively similar results ensue if we include cities' land supply each year, which is controlled by the city government, as another control variable. (We do not include this control in the table because it is obviously endogenous.) Qualitatively similar results also ensue from introducing the year fixed-effects and from 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 the existence of a positive feedback cycle wherein local governments' transportation infrastructure investment boosts land sales income, which finances further transportation infrastructure investment by the city, and so on *ad infinitum*. The bidirectional causality in such a feedback loop affects the reliability 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 can also help finance city governments'

[12] 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 shift towards environmental factors mattering to land prices.

other investment projects, especially those that also boost local GDP growth. Environmental improvements would not seem to qualify here either.

4.3 City-level Cadres' Promotion Odds

Existing empirical work using provincial level data reveals 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 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, only 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 city; 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 these few observations instead yields similar results to those in the tables.

"Abnormal" changes – death, arrest for corruption, etc. – are excluded from the sample. 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 the year 2000 in order to calculate some of our control variables reliably. In a few cities, all the 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 also affect their odds of promotion. Therefore, we control for them. Detailed definitions of these variables are provided in the appendix. 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 (Li and Zhou, 2005).

The regression coefficients permit assessment of the economic significance of these factors in explaining a cadre's odds of promotion. One standard deviation increase in average GDP growth rate compared with the predecessor raises the probability of promotion by 4.76 percentage points for secretaries and 10.0 percentage points for mayors. This is consistent with the fact that typically the tasks for CCP secretaries are more diversified than just the high GDP growth rate.

Remarkably, a city's investment in transportation infrastructure is completely insignificant in explaining its senior cadres' odds of promotion. This finding is perhaps

consistent with spending on transportation infrastructure being motivated by its contribution to GDP growth.

Most remarkably of all, a city government's spending on environmental improvements is actually significantly negatively related to the odds of its CCP secretary and mayor being promoted. One standard deviation increase in average GDP scaled environmental improvement investment lowers the probability of promotion by 8.5 percentage points for secretaries and 6.3 percentage points for mayors. This finding suggests that other factors are at work. Perhaps city-level "environmentalists" offend province-level cadres whose promotions previous work shows to be more clearly driven by economic growth. Or perhaps city-level cadres with less hope for promotion or less career-minded are more apt to invest in environmental improvements. This interpretation is consistent with the narrative story that "promotion based on tangible growth performance" induces government leaders competing for promotion invest in transportation infrastructure, rather than in environmental amenities, because the former contributes more readily to tangible growth.

Nevertheless, it is still necessary for local officers to maintain a minimum level of investment on environmental amenities to secure his/her political career, instead of just cutting down all the environmental investments. In China "keeping social stability" is always a key criterion with decisive and veto power (*yi piao fou jue*) for local officers; in other words, all other achievements are equal to nothing if collective petitions or massive protests occur in his/her jurisdiction (Chen, 2012). Therefore, with the emerging environment-related petitions and protests in China (Xie, 2009), failing to maintain a basic standard of environmental amenities would be very risky for local officers. Most recently, the central government also explicitly listed environmental protection as an evaluation indicator for local officers in its latest

"12th Five-year Plan (2010-2015) for Environment Protection" released in 2011, which may provide more direct incentives for local officers to expand environmental investments.

The relationships of cadres' personal attributes to their promotion odds are less surprising. A cadre's age upon assuming the current position is most significant, especially for the CCP Secretaries. Cadres who assumed their current position at an age too near the typical retirement age are potentially less likely to be further promoted. The effect of gender is opposite in the two groups of cadres: female CCP secretaries are more likely to be promoted; female mayors are less likely. Cadres' educational background is insignificantly related to their promotion odds. Their previous work experience reveals past positions in other provinces to be helpful for the mayors, but not for Party Secretaries and past positions in SOEs to weigh against promotion, especially for Party 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. We also tried including observations where all cadres in a given city were either promoted or not promoted, and this also yields qualitatively similar results to those shown. Rerunning 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.[13] Running Cox proportional hazard regressions, rather than probits, also generates qualitatively similar results: environmental investment significantly negatively affects the promotion odds of both CCP Secretaries and mayors, while transportation infrastructure investment is insignificant. GDP growth compared with that under the cadre's

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

predecessor is also positive and statistically significant for mayors, but less significant for CCP Secretaries.

5. Conclusions

China, while generating miraculously fast economic growth, is also well known for severe air pollution and a range of other environmental problems. Likewise, its problems in providing of key public goods, including basic healthcare, universal public education, and social security, continue to draw both national and international criticism. The China's 12th five year plan sets 'green' achievements and the enhanced provision of public services as important targets. The World Bank's "China 2030" report also flags these issues as critical to making China's growth sustainable.

These outcomes appear to be due to the promotion incentives, assigned responsibilities, and budget constraints with which China's public governance surrounds city-level Party cadres. Local governments are assigned the lion's share of responsibility for providing urban infrastructure and basic public services. However, local governments' revenues based on tax revenue sharing and intergovernmental fiscal transfers are insufficient to cover these expenses. Party cadres assigned to local governments must resolve this arithmetic impossibility, knowing that their careers are governed by promotion criteria, applied every three or so years, emphasizes the delivery of tangible economic growth. Given these duties, these budget constraints, and this system of career advancement incentives, local government cadres quite rationally invest scare public funds in investments that produce tangible evidence of growth within a few years.

The results above, exploring spending on urban infrastructure, illustrate this logic. From 2000 through 2009, city-level governments spending on urban infrastructure stressed transportation over environmental amenities. Senior cadres' public statements calling for transportation infrastructure heralded transportation infrastructure spending; but, like calls for spending on improving the environment did not similarly stimulate spending on environment – even as environmental conditions in major Chinese cities worsened palpably, senior central government cadres' speeches increasingly drew attention to environmental issues, and data accumulated shows that spending on environmental amenities significantly improves air quality.

The empirical results above reveal that spending on transportation infrastructure raises both GDP growth, a key promotion determinant, and land prices. Because land lease sales are city-level governments' sole major source of additional revenues, policies that elevate land prices held city-level cadres cope with the mismatch of their heavy spending responsibilities and inadequate fiscal transfers from Beijing. This gives city-level cadres an added incentive to favor transportation infrastructure spending – it loosens their budget constraints. Investing in environmental improvements has no such salubrious consequences.

Indeed, our empirical results indicate that spending on environmental amenities negatively affects city-level cadres' odds of promotion. This is plausibly because funds spent on the environment do not translate as surely into added local GDP growth; though we cannot reject the possibility that cadres less keen on rapid promotion might also favor environmental improvements. Regardless, either interpretation reinforces the point that cadres' promotion concerns very likely affect local governments' spending priorities.

Our empirical findings could also be partially driven by other latent issues that we have yet to explore. For example, cities with rapid GDP growth might have more resources and opportunities for cronyism, and top cadres in these cities might be promoted faster. Or, investing in transportation infrastructure and allowing rapid rises in land prices and real estate might be an effective way to channel benefits to connected parties.

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 the governments' action matches people's preference: people might want to get rich first, and only afterwards grow concerned improving the environment, or public education or health care.

Regardless, our findings reveal the importance of government officials' incentives, assigned responsibilities, and budget constraint. Clearly, even the behavior of career members of the Chinese Communist Party is shaped by the incentives set before them: cadres appear to enthusiastically fulfill the parts of their assigned responsibilities that are rewarded and to ignore those that are not incorporated in the incentive system. Moreover, all this occurs is shaped by a budgetary process: Chinese Communist Party cadres enthusiastically fulfill assigned responsibilities that expand their budgets, while ignoring assigned responsibilities 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 their delegation to local cadres. To

implement these policy goals, senior Party cadres may wish to consider carefully the ways in which lower-level cadres' career incentives, policy responsibilities, and budget constraints are likely to interact. Specifically, the analysis above suggests that, should China's senior leadership wish to improve air quality, or achieve any other such environmental goal, steps might be taken to include measurable and tangible evidence of progress towards this in formulae determining lower level cadres' promotions and budgets.

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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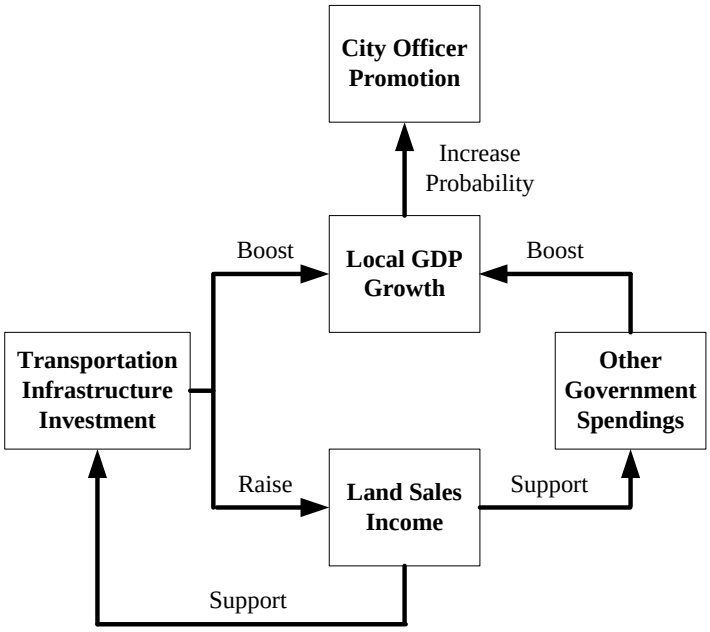
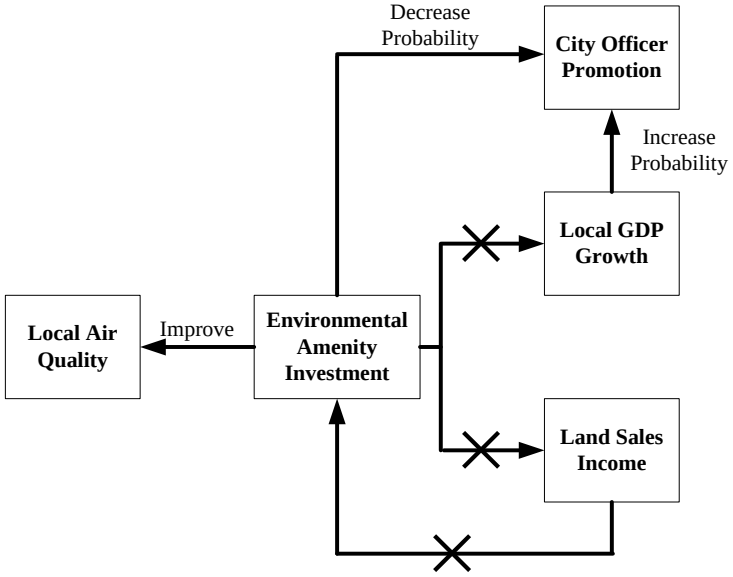


(A) For the transportation infrastructures:



(B) For the environmental amenities:

Figure 1: Local Governments' Incentives and Urban Infrastructure Investments

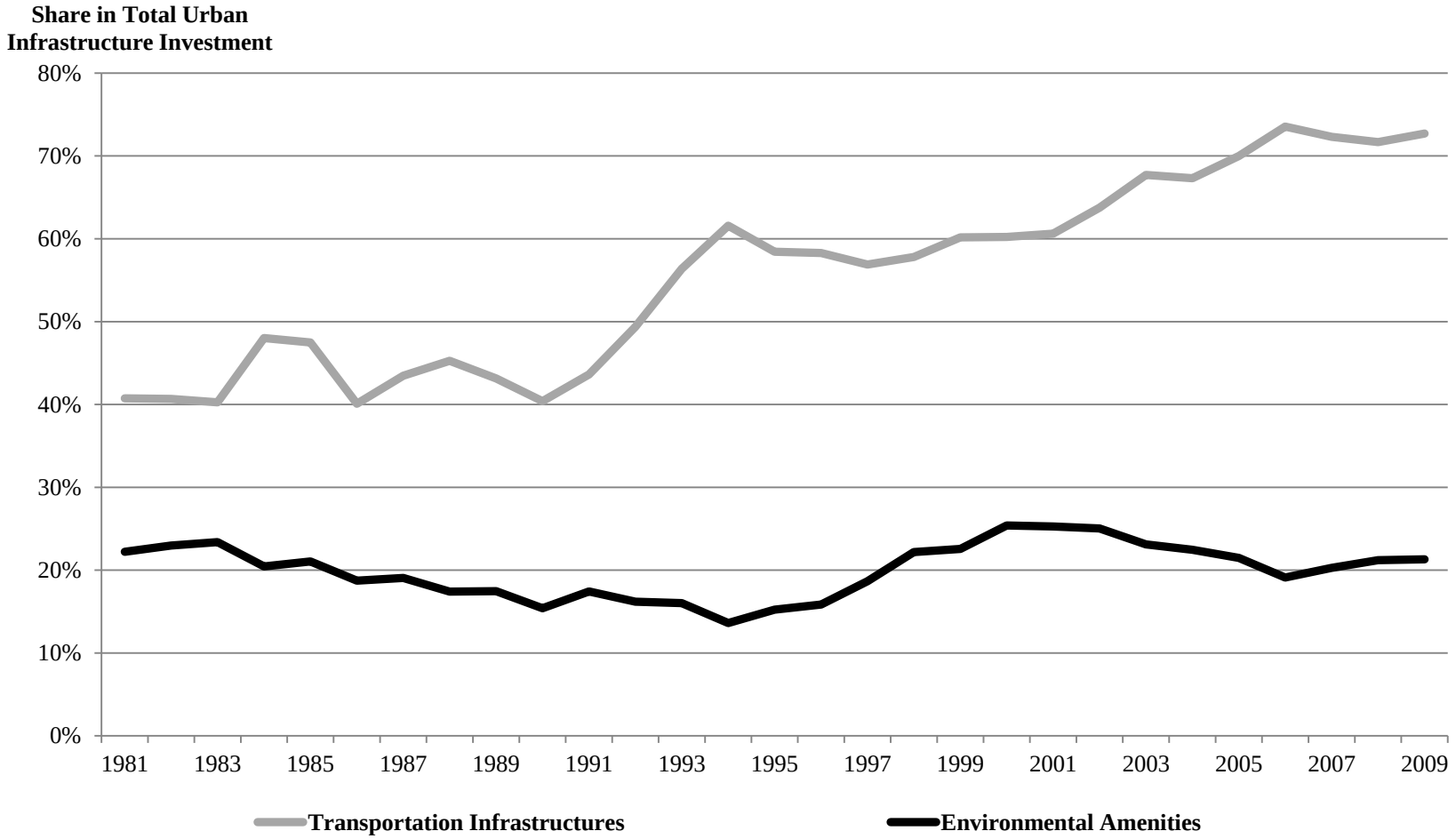


Figure 2: Structure of Urban Infrastructure Investments in the National Level

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

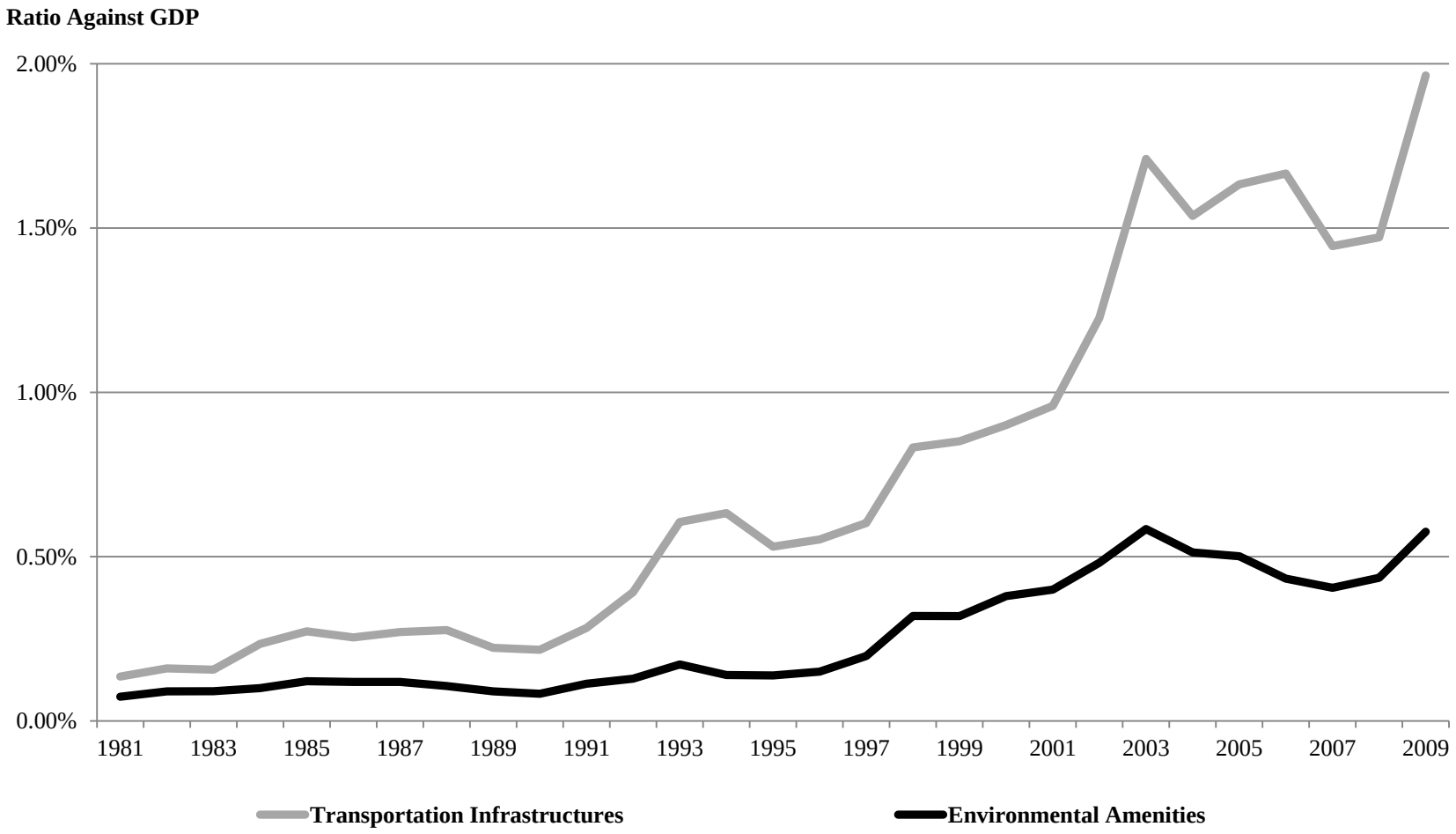


Figure 3: Ratio of Urban Infrastructure Investments against GDP

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

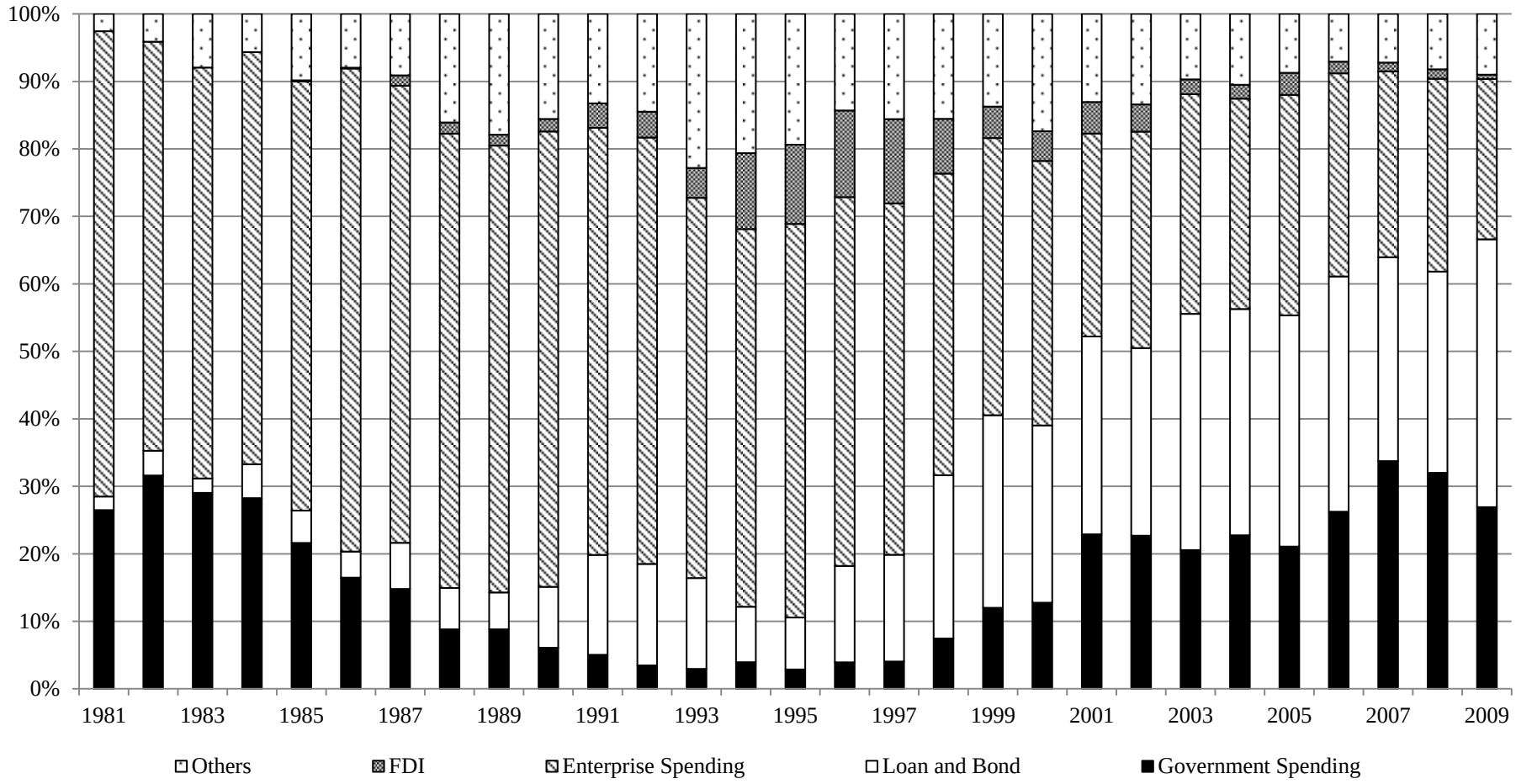


Figure 4: Fund Sources of Fixed Asset Investment on Urban Infrastructure

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 Amenity 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 Amenity 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 Amenity 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 Amenity			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 Amenity 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 Amenity 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 Amenity 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 Amenity 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 Amenity 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 Amenity 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 Amenity 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	-0.0538	-0.0529				
	(-1.83)*	(-1.75)*				
Relative GDP Growth Rate Compared with All			-0.0510	-0.0650		
Other Cities Within the Same Province			(-0.97)	(-1.20)		
Relative GDP Growth Rate Compared with Last					0.0543	0.0563
Officer in the Same Position					(2.39)**	(2.28)**
Average of Ratio between Environmental Amenity		-0.8448		-0.9021		-0.9259
Investment and GDP during the Tenure		(-2.79)***		(-2.96)***		(-2.91)***
Average of Ratio of Transportation Infrastructure		0.0256		0.0030		-0.0436
Investment to GDP during Tenure		(0.25)		(0.03)		(-0.38)
Whether the Officer is Female	0.6283	0.6001	0.6845	0.6672	0.7631	0.7475
	(1.65)*	(1.57)	(1.85)*	(1.80)*	(1.95)*	(1.88)*
Whether the Officer is Minority	-0.1993	-0.2153	-0.2369	-0.2616	-0.4022	-0.4589
	(-0.59)	(-0.62)	(-0.71)	(-0.77)	(-1.13)	(-1.26)
Whether the Officer is Local	0.2057	0.2589	0.1714	0.2369	-0.0272	0.0109
	(0.70)	(0.86)	(0.58)	(0.78)	(-0.08)	(0.03)
The Age He/She Took Current Position	-0.1278	-0.1231	-0.1280	-0.1226	-0.1270	-0.1207
	(-5.28)***	(-4.99)***	(-5.25)***	(-4.94)***	(-4.71)***	(-4.38)***
Whether the Officer Has Master/PhD Degree	-0.2258	-0.2298	-0.2540	-0.2507	-0.3178	-0.3184
	(-1.13)	(-1.16)	(-1.27)	(-1.26)	(-1.43)	(-1.44)
Whether the Officer Has Worked in Central	-0.1330	-0.0620	-0.1566	-0.0596	0.0482	0.1923
Government	(-0.37)	(-0.17)	(-0.44)	(-0.17)	(0.13)	(0.54)
Whether the Officer Has Worked in Provincial	-0.0339	-0.0465	-0.0558	-0.0653	0.0160	0.0195
Government	(-0.21)	(-0.28)	(-0.34)	(-0.40)	(0.09)	(0.11)
Whether the Officer Has Worked in Universities	-0.1278	0.0498	-0.2404	-0.0434	0.0197	0.2333
	(-0.33)	(0.13)	(-0.62)	(-0.11)	(0.05)	(0.54)
Whether the Officer Has Worked as SOE	-1.4128	-1.5279	-1.4469	-1.5621	-1.5615	-1.6650
Executives	(-3.61)***	(-3.78)***	(-3.64)***	(-3.80)***	(-4.13)***	(-4.35)***
Whether the Officer Has Worked in China	0.1491	0.1605	0.1656	0.1689	0.3143	0.3272
Communist Youth League	(0.74)	(0.76)	(0.79)	(0.78)	(1.40)	(1.42)
Whether the Officer Has Worked in Other	0.7487	0.6845	0.7634	0.6904	0.7349	0.6529
Provinces	(3.34)***	(3.08)***	(3.37)***	(3.08)***	(3.07)***	(2.79)***
Whether the Officer Has Worked/Studied Abroad	-0.0284	0.0714	-0.0876	0.0261	-0.0370	0.1000
	(-0.11)	(0.27)	(-0.33)	(0.10)	(-0.14)	(0.38)
Whether the Officer Works As Top Officer in a	0.1452	0.1051	0.1674	0.1150	0.0892	0.0181
City for the First Time	(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 observations are clustered by secretaries.
(2) the perfect predictor city dummies are dropped.
(3) z statistics in parentheses.
(4) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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	-0.0122	-0.0080				
	(-0.67)	(-0.43)				
Relative GDP Growth Rate Compared with All			-0.0163	-0.0185		
Other Cities Within the Same Province			(-0.55)	(-0.62)		
Relative GDP Growth Rate Compared with Last					0.0892	0.0942
Officer in the Same Position					(5.22)***	(5.29)***
Average of Ratio between Environmental Amenity		-0.4012		-0.4069		-0.5400
Investment and GDP during Tenure		(-1.76)*		(-1.81)*		(-2.11)**
Average of Ratio between Transportation		-0.0618		-0.0658		-0.1162
Infrastructure Investment and GDP during Tenure		(-0.84)		(-0.90)		(-1.42)
Whether the Officer is Female	-0.4199	-0.4275	-0.4278	-0.4328	-0.4763	-0.4699
	(-1.92)*	(-1.97)**	(-1.95)*	(-2.00)**	(-2.05)**	(-2.06)**
Whether the Officer is Minority	-0.0977	-0.1197	-0.1056	-0.1255	-0.2292	-0.2929
	(-0.38)	(-0.44)	(-0.41)	(-0.46)	(-0.81)	(-0.98)
Whether the Officer is Local	-0.2777	-0.3114	-0.2646	-0.3038	-0.3808	-0.4649
	(-1.27)	(-1.40)	(-1.21)	(-1.37)	(-1.67)*	(-2.00)**
The Age He/She Took Current Position	-0.0401	-0.0393	-0.0405	-0.0391	-0.0341	-0.0304
	(-2.27)**	(-2.21)**	(-2.30)**	(-2.20)**	(-1.82)*	(-1.60)
Whether the Officer Has Master/PhD Degree	-0.0555	-0.0404	-0.0604	-0.0422	0.0278	0.0684
	(-0.45)	(-0.33)	(-0.50)	(-0.34)	(0.21)	(0.52)
Whether the Officer Has Worked in Central	0.4201	0.4039	0.4125	0.4033	0.4102	0.3954
Government	(1.55)	(1.48)	(1.53)	(1.49)	(1.53)	(1.46)
Whether the Officer Has Worked in Provincial	0.2185	0.2510	0.2168	0.2519	0.1734	0.2054
Government	(2.11)**	(2.36)**	(2.10)**	(2.37)**	(1.60)	(1.83)*
Whether the Officer Has Worked in Universities	0.3128	0.3456	0.3010	0.3362	0.4313	0.4827
	(1.02)	(1.05)	(0.98)	(1.02)	(1.37)	(1.43)
Whether the Officer Has Worked as SOE	-0.2055	-0.1867	-0.2189	-0.1957	-0.2915	-0.2455
Executives	(-1.02)	(-0.91)	(-1.09)	(-0.96)	(-1.31)	(-1.07)
Whether the Officer Has Worked in CCYL	0.0644	0.0608	0.0675	0.0601	0.0078	0.0266
	(0.36)	(0.34)	(0.38)	(0.33)	(0.04)	(0.14)
Whether the Officer Has Worked in Other	-0.6255	-0.6188	-0.6299	-0.6188	-0.6950	-0.6894
Provinces	(-2.84)***	(-2.88)***	(-2.84)***	(-2.87)***	(-2.94)***	(-3.03)***
Whether the Officer Has Worked/Studied Abroad	-0.0648	-0.0416	-0.0651	-0.0396	-0.0114	0.0319
	(-0.32)	(-0.21)	(-0.32)	(-0.20)	(-0.05)	(0.15)
Whether the Officer Works As Top Officer in a	-0.4418	-0.4106	-0.4393	-0.4052	-0.5148	-0.4397
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 observations are clustered by mayors.
(2) the perfect predictor city dummies are dropped.
(3) z statistics in parentheses.
(4) * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A-1: City-Level Variables

Variable	Definition	Source	Mean	Std. Dev
Environmental Amenity 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).		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.	National Bureau of Statistics (*China City Statistical Yearbook*; *China Statistical Yearbook for Regional Economy*; *Bulletins of Population Census* in 2000, 2010)	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