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European Journal of Political Economy xxx (xxxx) xxx

Contents lists available at ScienceDirect

European Journal of Political Economy

journal homepage: www.elsevier.com/locate/ejpe

Pro-growth inefficiency: Rents and moral hazard in infrastructure contests in China

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ARTICLE INFO

JEL classification:
D73
O18
H54
P26

Keywords:
Infrastructure investment
Rent seeking
Moral hazard
Bureaucratic politicized promotion
Corruption
China

ABSTRACT

We study contests for promotion of local government leaders orchestrated by the central government in China. The contests rewarded regional economic success. The probability of promotion increased with regional infrastructure investment but we find negative returns from infrastructure. We find feedback between corruption and investment in infrastructure. There was moral hazard – successful local government leaders who were promoted to higher level positions in the government and Party hierarchical structure left behind regional local governments mired in debt or bankruptcy because of debt financing of infrastructure investment that was used to win the center-orchestrated contests. Our study makes a contribution to contest theory by providing an empirical study for rent-seeking contests.

1. Introduction

We study center-orchestrated regional economic-success contests in China. The winners of the contests among local and regional governments were promoted to higher level positions within the governmental hierarchy. We focus on infrastructure investment as a major instrument for economic growth for winning the contests for promotion. The probability of officials being promoted increased with infrastructure investment in their locality but we find negative returns to regional infrastructure investment, indicating inefficiency through overinvestment. We also find a feedback relation between infrastructure investment and corruption, with increased infrastructure investment providing more opportunities for benefit for officials through returns from corruption and corruption increasing infrastructure investment.

The contests for promotion were therefore counterproductive. Pro-growth public policy with counterproductive incentives resulted in wasteful investment. Corruption, which has been endemic within the government bureaucracies in China (Kahana and Liu, 2010; Chen and Liu, 2015; Aidt et al., 2020) was encouraged. Importantly, there was moral hazard. Regional and local officials borrowed on behalf of regional and local governments to increase infrastructure investment, resulting in unsustainable debt, and, in many cases that we document, there was regional or local government bankruptcy. The officials who won the contests moved on to different locations and to greater personal benefits from higher levels of the governmental hierarchy.

Most basically, rent-seeking incentives contests were created. Tullock (1967) observed that there was a social cost of contestability of rents. The theory of contests has described how rents are contested (Congleton et al., 2008a; Konrad, 2009; Corchón and Serena,

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https://doi.org/10.1016/j.ejpoleco.2023.102397
Received 4 October 2022; Received in revised form 17 March 2023; Accepted 10 April 2023
Available online 15 April 2023
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Please cite this article as: Qijun Liu, Xin Huang, *European Journal of Political Economy*, https://doi.org/10.1016/j.ejpoleco.2023.102397

2018; Hillman and Long, 2019). There have been applications of the theory (Congleton et al., 2008b). The literature has, however, lacked study of actual contests. Hillman (2023) proposed that, with the contests described in contest theory unobservable, the existence of contests can be inferred from observed rents and successful rent seekers that are “footprints in the sand” for the unobserved contests that have taken place. The “footprints” are quite explicit in our study, which shows the means by which rents were contested (infrastructure investment), the rents (promotion in the governmental or Party hierarchy), and we observe the successful rent seekers who won promotion in the contests. We do not observe social loss in the actual contests through the time and effort of rent seekers as described in the contest models. We do observe social loss of contestability of rents through excessive infrastructure investment and through local debt and bankruptcies that have been the consequences of moral hazard.

Contest theory includes models of contest design whereby a contest designer orchestrates a contest to maximize “effort” of contest participants (on orchestration of contests, see Gradstein and Konrad, 1999). We show that the contests orchestrated by the central government in China departed from the model of contest design in that the contest designers created counterproductive incentives. Excessive “effort” resulted in negative-yielding overinvestment and through moral hazard resulted in financial difficulties for local and regional governments whose borrowing financed infrastructure for the benefit of officials’ promotion prospects.

2. Background

The central government of China initiated economic reforms in the late 1970s to stave off collapse of the centrally-controlled non-market economy (Liu, 2007). Economic federalism was implanted within an authoritarian system (Qian and Weingast, 1996; Chen et al., 2002; Xu, 2011). Control of tax revenue was centralized (Chen et al., 2002) but local leaders were responsible for development of the local economy.

To encourage local government and Party leaders to prioritize economic success, the center introduced linkage between economic performance and promotion in the administrative and political hierarchy (Li and Zhou, 2005; Sahoo et al., 2010; Zhang, 2020). The tournaments have the character of multi-winner rent-seeking contests. Those local leaders who achieved economic targets were rewarded with promotion and those who failed were demoted. Local leaders were thus judged by the center and placed in situations of yardstick competition (Besley and Case, 1995).[1]

To win the promotion contest, local leaders have to achieve high growth rates by all means. Growth is obtainable by increasing consumption, exports, or investment. Consumption and exports were dismissed by local leaders as relatively uncontrollable. Investment in education and health care is slow to achieve high returns before the term ends. Investment in infrastructure, which is a form of public input in the production function (Hillman, 1978) and can increase growth by attracting industry including foreign investment to a region (Zhang et al., 2007), became however the preferred means for local government leaders to seek to win the contests for political promotion.

The contest-based rent-seeking incentives however led to overinvestment. Expansion of infrastructure continued when the returns had become negative. The negative contribution of infrastructure investment to economic growth could occur because the return to infrastructure was not computed. As occurred in other transition economies (Gelb et al., 1998), politically incentivized rent seeking and rent extraction created inefficiency.

Alongside rent seeking, incentives were also created for corruption (on corruption and rent seeking, see Aidt, 2016). Wang and Zheng (2020) show that returns from corruption are an important influence on success in political tournaments in China, while the increase in salary across the bureaucratic spectrum is not sufficient to evoke effort to win the contests. Aidt et al. (2020) show that in China personal benefits from rents obtained through corruption increase with higher levels in the political and Party hierarchy. The higher rents are a motivation for local government officials to win promotion. We find feedback and simultaneity in rents extracted through corruption from infrastructure investment.

There was moral hazard. Fiscal revenues of Chinese provinces for the period 2003–2020 covered only 60% of the costs of infrastructure projects. Local governments were consequently mired in debt or bankrupt (Clarke and Lu, 2017). Local leaders who won the economic-success contests however achieved their personal objectives and could move up the governmental and political hierarchy, leaving behind the local government in financial distress or bankruptcy.

Based upon a dataset for the period 2003–2020, we show that local leaders personally benefited from infrastructure expansion. When infrastructure investment increased by one percent, the probability of promotion of the provincial chief leader (the Party secretary) increased by 5.6 percentage points. For evidence of feedback from corruption to further investment, we use a panel dataset for the period 2006–2015. An increase in infrastructure investment by one percent increased economic rents captured by officials through corruption by 0.57 percentage points on average. At the same time, an increase in corruption by one percent increased infrastructure investment by 0.06 percentage points. For efficiency losses, we show the presence of negative returns from infrastructure. For moral hazard, we provide evidence on the finances of local governments.

[1] See for example Chen et al. (2022) on the same circumstances in dealing with COVID-19.

3. Infrastructure investment

3.1. Comparative Chinese investment

China's infrastructure investment stands out when compared with other major economies around the world. By statistics from the OECD, China exceeded for example the UK, the US, Germany and India for the period 1995–2019 in terms of both absolute values and the ratio of infrastructure investment relative to Gross Domestic Product (see Fig. 2).[2] For the period 1978–2020, the average growth rate of infrastructure investment was 14.27 percent per year, 71.10 percentage points higher than the average growth rate of GDP per capita (8.34 percent) for the same period (see Fig. 1).[3]

3.2. Financing of infrastructure

How was infrastructure in China financed? Official statistics show that sources were local governments, the central government, and the private sector. Fig. 3 shows the financing structure for the period 2004–2020. Investments from the central government declined steadily from 20.84% of the total in 2004 to 9.94% in 2020. Private investment grew gradually from 0.98% in 2004 up to 14.25% in 2020. The majority of funding came from local governments, which contributed each year around 70% of total investments.

3.3. Local government finance and moral hazard

For the period 2003–2020, 90.74% of local government spending was on infrastructure construction (see Table 1). To raise funds for infrastructure investment, local governments turned to all possible financing sources, including borrowing from banks, selling land, and issuing local government bonds (Zhao et al., 2019; Cheng et al., 2022). Over 90% of provinces (28/31 = 90.03%) were made bankrupt by infrastructure development.[4] Most were deeply entrapped in default risk with the debt-to-GDP ratio over 60% by the mid-2010s, which was well above the EU's fiscal warning line (Clarke and Lu, 2017; Gao et al., 2021).

Why did the local leaders continue to finance infrastructure construction even when there was a fiscal deficit? The answer is because of the term limit. The nominal term for a local leader is five years. But in fact it is shorter. Statistics show that the average tenure of all provincial government leaders (both provincial governors and Party secretaries) is 3.73 years. Of the 233 provincial leaders in our sample, 87.6% (=204/233) has a term in office of less than five years. They had to achieve the target growth before their term ended. After that, they were either promoted to a higher level or moved to a new location. The debts were not personal but there were personal benefits from use of debt to finance infrastructure investment. The bankruptcies and default risks of local governments were social costs of the rent-seeking incentives for increasing infrastructure investment, as we have indicated, occurred in consequence of moral hazard.

3.4. The returns to infrastructure investment

To establish whether the expansion of infrastructure investment was driven not by anything else but pursuit of economic growth *per se*, we conducted a study using a panel dataset for the period 2003–2020 for estimation. An inverse U-formed relationship is identified between infrastructure investment and economic growth across China (see table A2 in the appendix).[5] According to our estimation, near half of the sample observations (261/527 = 49.53%) fall on the right side of the curve. This result suggests that infrastructure investment continued to increase well beyond the turning point even after returns to investments became negative.[6]

4. Political benefit from infrastructure investment

With economic returns through growth negative, we now look at personal benefit for local leaders from infrastructure investment. We use individual-level data to examine empirically whether expansion of infrastructure investment improved the probability of

[2] For example, in 2019, China invested 1309.982 billion dollars in transport, 44.78 times that of the UK (US$ 29.25 billion), 11.09 times that of the US (US$ 118.17 billion dollars), and 38.91 times that of Germany (US$ 33.67 billion). Values are in current prices. Data for India in 2019 is not available.

[3] In 1978, total investment in infrastructure was 83.04 billion *yuan* (approximately US$ 12.27 billion) and spiraled to 15,892.28 billion *yuan* (US$ 2348.25 billion) in 2020, 191.38 times that in 1978. For the period 1978–2020, China spent totally 165,454.89 billion *yuan* (US$ 24,447.63 billion) on infrastructure projects. All values are in 2010 constant prices in this paper except in Fig. 2.

[4] During the period 2003–2020, infrastructure investment cost 149,037.26 billion *yuan* (US$ 22,021.76 billion) while fiscal revenues of all 31 provinces in mainland China totaled 89,090.58 billion *yuan* (US$ 13,164.03 billion), 59.78 percent of total infrastructure investments. Only three provinces in China, Shanghai, Beijing and Guangdong, had fiscal revenues higher than infrastructure costs (see Table 1).

[5] A similar result is reported by Liao et al. (2018).

[6] For most provinces, the turning point occurred around 2010 (according to Liao et al. (2018), in 2012). Most provinces continued the expansion of infrastructure investment beyond the turning point. By the end of 2020, only four provinces (Hainan, Ningxia, Qinghai and Tibet) had not passed the threshold value of the inflection.

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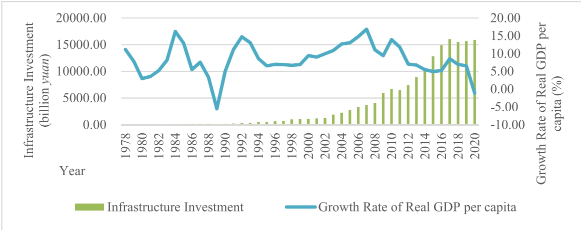

Fig. 1. Infrastructure investment and growth rate of real GDP per capita in China, 1978–2020.

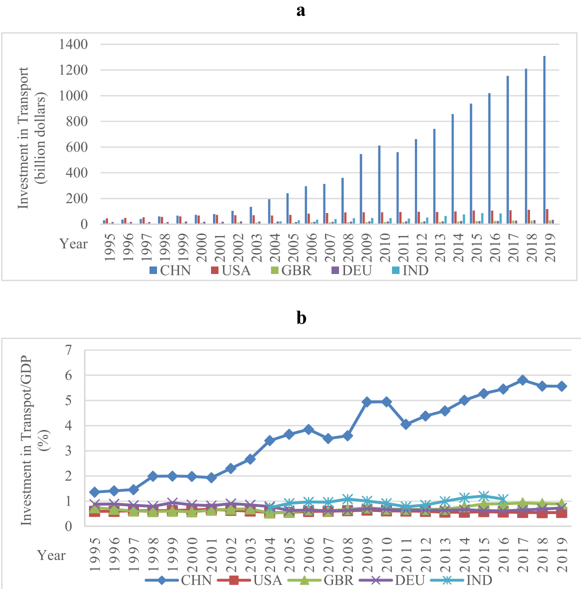

Fig. 2. a. Magnitude of investment in transport by country, 1995–2019.
b. Ratio of investment in transport to GDP by country, 1995–2019.
Data source: OECD.

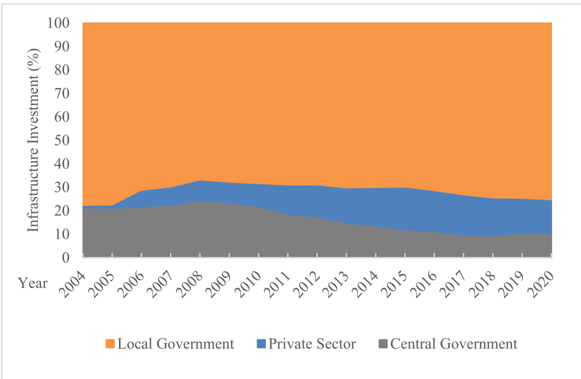

Fig. 3. Financing structure of infrastructure investment in China, 2004-2020
Data source: National Bureau of Statistics of China.

Table 1
Infrastructure investments, fiscal revenues and local government expenditures in 31 provinces in China, averaged over 2003–2020 (in billion *yuan*).

Province	Infrastructure investments	Fiscal revenues	Percentage of Infra. Inv. (%)	Government expenditures	Percentage of Infra. Inv. (%)
Anhui	268.30	146.00	183.77	322.32	83.24
Beijing	137.37	281.44	48.81	337.73	40.67
Chongqing	261.26	116.65	223.97	222.29	117.53
Fujian	366.67	149.73	244.90	230.85	158.84
Gansu	121.74	43.40	280.49	177.26	68.68
Guangdong	506.14	572.01	88.49	725.13	69.80
Guangxi	269.78	89.54	301.28	249.06	108.32
Guizhou	258.09	81.71	315.86	235.38	109.65
Hainan	50.12	33.87	147.99	74.77	67.03
Hebei	404.21	170.14	237.58	355.65	113.65
Heilongjiang	160.52	79.75	201.27	253.66	63.28
Henan	429.99	181.90	236.40	431.65	99.62
Hubei	360.22	152.54	236.15	339.60	106.07
Hunan	360.91	145.01	248.88	353.69	102.04
Inner Mongolia	298.97	110.06	271.64	256.50	116.56
Jiangsu	489.12	459.30	106.49	584.11	83.74
Jiangxi	205.97	112.43	183.20	260.48	79.07
Jilin	164.16	70.10	234.17	200.59	81.84
Liaoning	214.92	180.61	119.00	322.66	66.61
Ningxia	55.46	20.75	267.22	67.78	81.82
Qinghai	70.91	13.94	508.51	83.06	85.38
Shaanxi	336.83	115.32	292.09	264.33	127.42
Shandong	458.95	334.25	137.31	503.28	91.19
Shanghai	141.98	348.06	40.79	393.70	36.06
Shanxi	185.76	114.86	161.72	222.69	83.42
Sichuan	539.67	194.92	276.87	471.44	114.47
Tianjin	151.69	129.31	117.31	173.00	87.68
Tibet	45.91	7.85	584.87	82.22	55.83
Xinjiang	188.81	72.79	259.39	226.60	83.32
Yunnan	326.26	106.18	307.26	296.64	109.98
Zhejiang	449.15	315.05	142.56	406.22	110.57
Total	**8279.85**	**4949.48**	**167.29**	**9124.37**	**90.74**

Data source: National Bureau of Statistics of China.

political promotion of local leaders.[7]

4.1. Model and data

To examine whether infrastructure investment is conducive to personal promotion in the hierarchy of government and the Party, we estimate the following model:

$$Promotion_{ijt} = \alpha_0 + \alpha_1 Infrastructure_{ijt} + \alpha_2 X_{ijt} + \delta_j + \gamma_t + \varepsilon_{ijt} \tag{1}$$

where $Promotion_{ijt}$ is a dummy variable that equals one if a local leader i in region j in period t is promoted and zero otherwise[8]; $Infrastructure_{ijt}$ is the logarithm of infrastructure investments averaged over the tenure of a local government leader; X is a vector of control variables including personal traits of the local leader; δ_j stands for the region fixed effect that accounts for heterogeneity in time-invariant characteristics across regions; γ_t is the period fixed effect that absorbs time-variant common shocks to all regions[9]; and ε_{ijt} is the idiosyncratic error.

To test whether economic growth is a potential channel through which infrastructure investment increases political promotion, we estimate the augmented model below:

$$Promotion_{ijt} = \alpha_0 + \alpha_1 Infrastructure_{ijt} + \alpha_2 Growth_{ijt} + \alpha_3 Growth_{ijt}^2 + \alpha_4 Infrastructure_{ijt} * Growth_{ijt} + \alpha_5 X_{ijt} + \delta_j + \gamma_t + \varepsilon_{ijt} \tag{2}$$

[7] In a preliminary analysis, we found a U-formed relation between promotion of provincial chief leaders and growth of the local economy (see appendix B).

[8] Promotion is defined as appointment to a higher position in the state-party hierarchy. For the province governor, promotion opportunities include provincial Party secretary, vice-chairman of the Standing Committee of the National People's Congress or the National Committee of the Chinese People's Political Consultative Conference, membership of the State Council, the vice-premiership, the premiership and membership of the Politburo or the Politburo Standing Committee. For the provincial Party secretary, include membership of the Secretariat of the Central Committee, membership of the State Council, the vice-premiership, the premiership and membership of the Politburo or the Politburo Standing Committee.

[9] China has seven geographical regions: East, North, Central, South, Southwest, Northwest, and Northeast. As most appointments of provincial leaders occur around the year when the National Congress of the CPC opens, in accordance, we have only four time windows for the sample period. We therefore control for the region rather than province fixed effects due to the small sample size.

where $Growth_{ijt}$ is the growth rate of real GDP per capita averaged over the local leader's tenure. The other terms are the same as in equation (1).

We use an individual-level dataset for estimation. Personal information of the provincial leaders, 273 Party secretaries and governors who served in 31 provinces for the period 2003–2020, was manually collected from the websites People. com.cn and Baidu Encyclopedia. Net of the 40 leaders appointed before 2003 and with a tenure of less than one year (see also Li et al., 2022), the dataset consists of 233 provincial leaders. The final sample contains 107 provincial Party secretaries and 126 governors. The promotion rate for the Party secretaries is near a quarter whereas the rate for governors is near 60% (see table B1 in the appendix).

Data on infrastructure investment is from the Statistical Yearbooks of China. According to the National Bureau of Statistics of China, infrastructure investment covers investments in four categories: (i) production and supply of electricity, heat, gas and water; (ii) transport, storage and post; (iii) information transmission, software and information technology; and (iv) water conservancy, environment protection and public facilities.[10]

Infrastructure investment is measured by the logged value of infrastructure investments averaged over the tenure of a local leader. We define a leader's tenure as follows: when he/she takes office in the first half of the year (i.e., before June 30), the current year is recorded as the first year of his/her tenure; when a leader takes office in the second half of the year (i.e., after June 30), the following year is taken as the first year. Similarly, if a provincial leader leaves office before June 30, the prior year is recorded as the final year of his/her tenure. The rationale is that it takes time for a newly appointed leader to become accustomed to the job and the policies under his/her leadership take time to be effective.

Promotion is also related to the leader's personal traits (see Li and Zhou, 2005; Chen et al., 2005). We control for age, education, and tenure length of the provincial leaders. Panel A of table A1 in the appendix presents the variable definition and data summary.

4.2. Results

Regression results show that only the chief leaders, the provincial Party secretaries, benefited from expansion of infrastructure investment. Table 2 reports the effect of infrastructure investment on local chief leaders' promotion probability.[11] We start with a parsimonious model and then include personal traits of the provincial leaders (columns (1) and (2) of Table 2). Both models suggest that increasing infrastructure investment enhances the promotion probability for the provincial Party secretary. By the estimates in column (2), the marginal effect is 0.077 – that is, infrastructure investment increasing by one percent during the tenure, the probability of promotion of the provincial Party secretary increased by 7.7 percentage points.

Regarding the control variables, age has a negative effect on promotion probability. This is consistent with the central preference to younger cadres in political selection. No significant effect of education background is observed. A college degree is a priority in political selection in China. The insignificance of the estimate for the education variable is due to the fact that 98.13 percent of the provincial leaders have met this criterion.[12] An inverse U-formed relation is found between tenure length and promotion. The turning point occurs at 5.65 years, which means that hope of promotion decreases when a leader stays in office longer than 5 years.

As infrastructure investment is correlated with growth (see table A2), it is very likely that infrastructure investment also affects the promotion probability of the chief leader *indirectly* through growth. To test if this occurred, we add the interaction of infrastructure investment and growth to the model. We find that infrastructure investment increased promotion by increasing growth, as the estimate for the interaction term has a positive and highly significant value (see column (3)). The same result is obtained when the control variables are added (column 4). By the estimates in column (4), our preferred model, when infrastructure investment increases by one percent, the probability of promotion of the provincial Party secretary increased by 5.6 percentage points.

4.3. Robustness

We check the robustness of the above estimates in three ways. First, we drop from our sample those provincial Party secretaries who held office for one year or less. These leaders may have little impact on local economic development as it takes longer time for public policies to take effect. Similar results are obtained from the smaller sample (column (5)). Next, we change the dependent variable from a dichotomous variable into an ordered variable (promotion = 3, lateral transfer = 2, and otherwise = 1). The estimates for the key explanatory variables retain their signs and significance levels (column (6)). Finally, we estimate equation (2) again using an

[10] This categorization differs from that of the World Bank (1994). The World Bank takes infrastructure as an umbrella term including public utilities (power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas), public works (roads and major dam and canal works for irrigation and drainage), and other transport sectors (city and intercity railways, urban transportation, ports and waterways, and airports).

[11] For the results for all local leaders and provincial governors alone, see tables A3 and A4 in the appendix.

[12] Of the 107 Party secretaries in the sample, 98.13% (105/107) have a college degree (25.23% (27/107) with a bachelor's degree, 55.14% (59/107) with a master's degree, and 17.76% (19/107) with a PhD degree). Only two Party secretaries received no higher education.

Table 2
Infrastructure investment and promotion of provincial Party secretaries.

Method:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Probit	Probit	Probit	Probit	Probit	Ordered Probit	Probit
Infrastructure	0.655**	0.685**	0.691*	0.838**	0.839**	0.457**	0.922**
	(0.304)	(0.296)	(0.383)	(0.414)	(0.426)	(0.195)	(0.425)
Growt			−0.222***	−0.476**	−0.541***	−0.177***	−0.469***
			(0.078)	(0.197)	(0.210)	(0.065)	(0.176)
Growth-squared			0.016***	0.026***	0.029***	0.009**	0.025***
			(0.004)	(0.010)	(0.011)	(0.004)	(0.009)
Infra*Growth			0.188***	0.247**	0.252**	0.145***	0.280***
			(0.066)	(0.109)	(0.106)	(0.036)	(0.094)
Ag		−0.172***		−0.210***	−0.210***	−0.227***	−0.204***
		(0.056)		(0.063)	(0.064)	(0.046)	(0.064)
Education		−0.031		0.002	0.005	0.018	0.065
		(0.264)		(0.276)	(0.284)	(0.199)	(0.278)
Tenure		1.061***		1.120***	0.973**	0.165	1.006***
		(0.367)		(0.381)	(0.458)	(0.256)	(0.369)
Tenure-squared		−0.094**		−0.088**	−0.073	−0.003	−0.084**
		(0.038)		(0.038)	(0.045)	(0.028)	(0.038)
/cut1						−10.232***	
						(3.688)	
/cut2						−8.775**	
						(3.654)	
Constant	−11.667***	−3.937	−12.097***	−3.550	−3.648		−4.942
	(2.519)	(4.675)	(2.952)	(5.555)	(5.642)		(5.634)
Region FE	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES
Observations	107	107	107	107	101	107	107
Pseudo R-squared	0.214	0.388	0.308	0.494	0.485	0.287	0.495

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

alternative indicator of infrastructure investment, infrastructure investment in the final year of tenure.[13] Similar results are obtained (column (7)). These results confirm the positive association of infrastructure investment with political selection.[14] No significant relation however is observed for the provincial governors (see table A3 and table A4 in the appendix). To sum up, our analysis shows that only provincial Party secretaries in China benefited politically from expansion of infrastructure investment. This is understandable because the Party secretary is the chief leader at all levels in the Chinese government hierarchy.

5. Infrastructure investment and corruption

We now examine the relationship between infrastructure investment and corruption. Due to data availability, the sample is limited to a shorter time span for the period 2006–2015.

5.1. Model and data

To test the impact of infrastructure investment on corruption, we estimate the following model:

$$Corruption_{jt} = \beta_0 + \beta_1 Infrastructure_{jt} + \beta_2 X_{jt} + \delta_j + \gamma_t + \varepsilon_{jt} \quad (3)$$

where $Corruption_{jt}$ is the logarithm of corruption magnitude in province j in year t; $Infrastructure_{jt}$ is the logarithm of infrastructure investments; X is a vector of control variables; δ_j stands for a province fixed effect; γ_t is the year fixed effect; and ε_{jt} is the idiosyncratic error.

We use a province-level panel dataset for the period 2006–2015 to estimate the relationship between infrastructure investment and corruption. Data on infrastructure investment is from the Statistical Yearbooks of China. For the period 2006–2015, totally 66,154.60 billion *yuan* (US$ 9775.05 billion) was invested for infrastructure development in the 31 provinces in China, over US$ 977.51 billion

[13] Infrastructure projects usually have time delays in construction. Tenure-averaged infrastructure investment may capture effects from the predecessor when there are time lags. To mitigate this effect, we recalculated tenure-averaged infrastructure investments with two new methods: (i) attributed the investment in the final year of one' tenure to the successor; (ii) dropped the investment in the final year of tenure for all observations. The findings remain intact when using the two new variables. We thank an anonymous reviewer for pointing this out. Regression results are available upon request.

[14] The main finding remains intact when we introduce work experiences in the central government into the model or use tenure-averaged infrastructure investment per capita as a proxy for infrastructure investment, or expand our sample size to include all provincial Party secretaries who experienced turnover during 2003–2020. These regression results are available upon request.

per year on average.[15] Despite constant increases for the sample period, infrastructure investment has a wide variation across the country (SD = 555714.32), from 11.71 billion *yuan* in Tibet in 2006 to 816.61 billion *yuan* in Jiangsu province in 2015.

Data on corruption is drawn from China Corruption Conviction Databank (CCCD). By the Criminal Law of China, corruption-related crimes include bribe-taking, bribe extortion, embezzlement, misappropriation of public funds or state assets, and possession of property with unidentified sources. Data on corruption is objective as it is drawn from corruption cases that have been detected and convicted in China.[16] Our sample consists of 70,653 corruption cases that occurred in 31 provinces across China for the period 2006–2015. The monetary values captured by government officials amount to 9,943, 153, 574.05 *yuan* (US$ 1,468, 816, 540.96), 140,732.22 *yuan* (US$ 20,789.16) per case on average.[17] In the present study, we measure corruption magnitude by the average monetary value of all corrupt activities that occurred in a province in a year.[18] The corruption index therefore reflects the aggregate level of corruption of a province. Finally, we have a panel of 310 province-year observations. Our corruption data merits for its objectiveness as it is based on corrupt activities in reality. Another advantage is its precision in reflection of the actual corruption magnitude by monetary values.

Many factors may affect corruption, from institutional quality to socioeconomic conditions of a country (Gutmann et al., 2020). China has a highly centralized polity. Institutional difference across provinces, if any, would be trivial and much smaller than across countries. We therefore control for no political factors in our estimation. Nonetheless, homogeneity in political institutions does not necessarily mean equality in law enforcement in all corners of the country. We therefore include anticorruption as a control variable in the baseline model. Corruption detection signals local governments' determination of corruption deterrence. We use the number of corruption cases that have been detected in a province in a year to measure local anticorruption efforts. We also include the provincial income level to control for heterogeneity in economic development levels across provinces. China is the most populous country with a wide variation across regions, which may affect corruption. We therefore include local population size as a control variable. We include provincial secondary education level to account for the potential effect of education on corruption.

The above covariates appear in most corruption studies (see, for example, Chen and Liu, 2018; Aidt et al., 2020; Gutmann et al., 2020). But there are also other relevant factors such as trade openness (De Jong and Bogmans, 2011; Thede and Gustafson, 2012), natural resources (Zhan, 2017), government size (Gründler and Potrafke, 2019), bureaucrat wage (Chen and Liu, 2018), external control of corruption (Dong and Torgler, 2013), and urbanization (Aidt et al., 2020). We include these variables to check the robustness of the baseline model results. Panel B of table A1 in the appendix presents variable definition and data summary.

5.2. Baseline model results

Our estimation starts with a parsimonious model and moves on with additional control variables. Table 3 presents the results. The coefficient for infrastructure investment is positive and statistically significant in all models, suggesting a positive correlation of infrastructure investment to corruption. By the estimates in column (5), the baseline model, when infrastructure investment increases by one percent, corruption magnitude increases by 0.57 percentage points. This effect is large given the size of infrastructure investment per year (6615.46 billion *yuan*) and average yearly monetary values stolen in corrupt activities (994.32 million *yuan*) during the sample period.

With regard to the control variables, the coefficient for anticorruption has the right sign but is not statistically significant, suggesting that corruption control efforts in China are not effective during the sample period. Corruption has an inverse U-formed relation with economic development levels: corruption increases as income increases at first and then decreases as the economy further develops. The turning point occurs when income reaches 21,136.40 *yuan* (US$ 3122.30). All provinces have passed the threshold at the end of 2015, which means that corruption will decrease as the Chinese economy grows onwards. The coefficient for population size has a positive and significant value, suggesting that corruption is more rampant in more populous provinces. This result is consistent with the findings by Escresa and Picci (2020). We find no significant effect of education on corruption.[19]

5.3. Robustness

The baseline model results may suffer from omitted variable bias as corruption has many potential determinants (Gutmann et al., 2020). Now we include more province-level variables to test for the sensitivity of the baseline model results. Table 4 presents the results. The positive correlation between infrastructure investment and corruption is observed with inclusion of more variables that are likely to affect corruption. The estimate value for infrastructure investment changes little, ranging between 0.50 and 0.59. The

[15] The values of infrastructure investment are in 2010 constant prices deflated by the Fixed Asset Investment Price Index.

[16] For the detailed description of the Databank, see appendix A in Aidt et al. (2020).

[17] The corruption cases used in this study are from the website (http://wenshu.court.gov.cn) open to the public. The convictions document the current value of a bribe in cash. For in-kind bribes such as gifts, real estate and other properties, the values are calculated at current prices and then recorded as cash values in court files. All values have been deflated by the Consumers' Price Index into 2010 constant prices in this study.

[18] One would argue that a better measure of corruption is the average value lost in corruption cases that occurred in infrastructure construction projects. We believe that it is unnecessary to confine corruption cases to the infrastructure industry, because the purpose of this study is to identify the correlation of the general level of corruption in a society to infrastructure investment rather than to calculate the leakage of investments to corruption in a specific industry.

[19] Dong and Torgler (2013) and Dincer and Gunalp (2020) found that education reduces corruption. Aidt et al. (2020) found the opposite.

Table 3
Baseline model results.

Method:	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Infrastructure	0.630**	0.627**	0.600**	0.563*	0.574*
	(0.284)	(0.287)	(0.283)	(0.291)	(0.292)
Anticorruption		−0.056	−0.079	−0.040	−0.049
		(0.130)	(0.130)	(0.134)	(0.134)
Income			7.052*	11.747***	10.884**
			(3.607)	(4.237)	(4.372)
Income-squared			−0.386**	−0.582***	−0.537**
			(0.189)	(0.215)	(0.222)
Population				4.038**	3.885**
				(1.696)	(1.707)
Education					0.106
					(0.106)
Constant	5.860***	6.067***	−25.961	−87.751***	−82.782**
	(1.928)	(2.056)	(17.699)	(31.838)	(32.501)
Province FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Observations	310	310	310	310	310
R-squared	0.555	0.555	0.562	0.572	0.573

Notes: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 4
Sensitivity tests.

Method:	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS
Infrastructure	0.579**	0.569*	0.584**	0.554**	0.594*	0.516*	0.498*
	(0.293)	(0.293)	(0.291)	(0.276)	(0.304)	(0.294)	(0.287)
Anticorruption	−0.047	−0.051	−0.053	−0.009	−0.044	−0.042	−0.010
	(0.132)	(0.134)	(0.135)	(0.139)	(0.136)	(0.135)	(0.137)
Income	11.453**	10.944**	10.321**	12.279***	9.874**	11.992***	13.238***
	(4.542)	(4.409)	(4.499)	(4.180)	(4.930)	(4.402)	(4.871)
Income-squared	−0.564**	−0.539**	−0.505**	−0.571***	−0.488*	−0.591***	−0.601**
	(0.231)	(0.224)	(0.230)	(0.213)	(0.250)	(0.223)	(0.249)
Population	3.724**	3.925**	3.641**	3.993**	3.834**	4.520***	4.264**
	(1.726)	(1.738)	(1.714)	(1.623)	(1.742)	(1.740)	(1.703)
Education	0.111	0.106	0.121	0.022	0.104	0.099	0.037
	(0.108)	(0.107)	(0.108)	(0.112)	(0.107)	(0.106)	(0.113)
Openness	−0.002						−0.003
	(0.005)						(0.005)
Resource		0.006					0.024
		(0.032)					(0.033)
Government			0.018				0.030
			(0.017)				(0.018)
Wage				−2.040***			−2.219***
				(0.623)			(0.620)
Internet					−0.009		−0.004
					(0.022)		(0.020)
Urbanization						0.019	0.022*
						(0.013)	(0.012)
Constant	−84.372**	−83.475**	−78.567**	−73.034**	−77.254**	−94.346***	−80.805**
	(32.702)	(33.049)	(33.177)	(30.580)	(35.489)	(33.199)	(34.516)
Province FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Observations	310	310	310	310	310	310	310
R-squared	0.573	0.573	0.574	0.594	0.574	0.577	0.603

Notes: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

estimates for anticorruption, income, population and education retain their signs and significance levels as in the baseline model.

Regarding the additional control variables, higher wages for government workers deter corruption. This result is consistent with the finding by Chen and Liu (2018). The estimate for urbanization has a positive and significant value, suggesting increases of corruption magnitude in the process of urbanization in China. This is understandable because demand of infrastructure increases as cities expand.

The other factors, trade openness of the local economy, natural resource endowments, local government size, and external corruption control, have no significant impact on corruption. Similar results are obtained when we use infrastructure investment per capita, ratio of infrastructure investment to local GDP, and investment in public facilities, respectively, as the indicator of infrastructure investment (see table A5 in appendix). These results suggest the robustness of the baseline model results.

5.4. Endogeneity

A potential concern with our baseline model estimation is endogeneity possibly due to (i) reverse causality from corruption to infrastructure investment (see Table 6 below) and (ii) simultaneity among the explanatory variables (see table 4). We use three estimators to test for endogeneity, the instrumental variable method, the Lewbel method, and System GMM. We first instrument the key variable, infrastructure investment, by the emissions of sulfur dioxide (SO_2) from daily life activities in a province in a year.[20] The simple correlation between infrastructure investment and SO_2 emission is 0.47 ($p = 0.000$) and that between SO_2 emission and corruption is -0.04 ($p = 0.466$). We expect the SO_2 emissions in daily life is positively related to infrastructure investment, as demand of environment protection rises when pollution grows more serious and hence more infrastructure investment. There is however no evidence that the SO_2 emission in daily life has a direct impact on corruption.

Column (1) of Table 5 presents the estimates from the two-stage-least-square (2 S LS) regression.[21] The instrument proves strong (see table A6 in the appendix). The estimation is not under-identified as suggested by the Kleibergen-Paap rk statistic. The parameter estimate of infrastructure investment remains positive and highly significant.

Similar results are obtained when more aggregate variables are included in the model (not shown here). One may argue that infrastructure investment can feed back on SO_2 emissions. For instance, as transport infrastructure improves, travels by car, train and airplane increase which leads to more SO_2 emissions.[22] To test the effect from this potential, we perform another 2SLS regression with an alternative index of infrastructure investment net of investment in transport. Column (2) of Table 5 presents the results. Similar results are produced. The estimate for infrastructure investment remains positive and significant. These results verify the validity and strength of the instrument and the finding in the baseline model that expansion of infrastructure investment increased corruption.

The results from the Lewbel method lead to the same conclusion (Column (3) of Table 5). The Lewbel estimator provides internal instruments by exploiting model heteroscedasticity for linear models containing endogenous variables (Lewbel, 2012; Baum and Lewbel, 2019). The effect of infrastructure investment on corruption is positive and statistically significant at the 0.05 level.

Another potential concern is autocorrelation with our panel data. Column (4) reports the estimates from a two-step system GMM regression. The system GMM estimator uses a collapsed instrument matrix that includes all available lags to expunge the endogenous components in the panel data. The effect of infrastructure investment on corruption remains positive and statistically significant at the 0.10 level.

The above exercises confirm our finding that infrastructure investment increased corruption during the sample period in China.

5.5. Simultaneity

We have shown that infrastructure investment increases corruption. It is very likely that corruption also stimulates more investment in infrastructure.[23] Using our panel dataset, we calculate the effect of corruption on infrastructure investment, using the following model for the estimation:

$$Infrastructure_{jt} = \theta_0 + \theta_1 Corruption_{jt} + \theta_2 X_{jt} + \delta_j + \gamma_t + \varepsilon_{jt} \quad (4)$$

where the main variable definitions are the same as those in equation (3) but a new set of control variables are used (see Castells and Solé-Ollé, 2005; Albalate et al., 2012).

Table 6 reports the results. Column (1) shows a positive correlation between corruption and infrastructure investment as the estimate for corruption is positive and significant at the 0.01 level. The estimate retains its sign and significance after introduction of the province-level control variables (column (2)).

The estimates from a simple OLS regression here however are inconsistent due to feedback from infrastructure investment to corruption (see Tables 3–5). We therefore turn to the instrumental variable method, using the number of employees in public institutions per 10,000 citizens in a province as the instrument for corruption (column (3)). In China, employees in public institutions include workers in the Party and government agencies, state-owned enterprises, hospitals, universities and organizations supported by fiscal income. It is very likely that more workers in public institutions lead to greater corruption. The first-stage F-statistic (=23.50) suggests that public employment is a strong instrument (see table A7 in the appendix). The estimate for the corruption variable remains positive and highly significant as before. To confirm the results from the 2SLS estimation, we conduct two more regressions using the

[20] Official statistics of SO_2 emissions include (i) from industrial production, and (ii) from daily life activities. We use the latter as the indicator. The data are from the Statistical Yearbooks of China.

[21] The first-stage regression results are reported in table A6 in the appendix.

[22] We thank one of the reviewers for this suggestion.

[23] Chen and Liu (2015) provided supportive anecdotal evidence for high economic rents from public projects. Finocchiaro Castro et al., 2014 investigated the association between the efficiency of infrastructure provision and the level of corruption in Italy and reported greater corruption in the regions with lower efficiency in public contracts execution, suggesting leakage of part of investment in public projects to rent seeking activities.

Table 5
Endogeneity.

Method:	(1) 2SLS	(2) 2SLS	(3) Lewbel	(4) System GMM
Infrastructure	1.874***	1.311***	1.776**	0.952*
	(0.727)	(0.497)	(0.877)	(0.563)
Anticorruption	−0.035	0.002	−0.036	−0.762
	(0.135)	(0.133)	(0.134)	(0.649)
Income	5.640	7.299	6.035	7.767
	(5.465)	(4.902)	(5.569)	(5.101)
Income-squared	−0.343	−0.386	−0.358	−0.585*
	(0.255)	(0.237)	(0.256)	(0.336)
Population	3.290*	2.953*	3.335*	−1.554
	(1.763)	(1.731)	(1.724)	(2.301)
Educatio	0.136	0.124	0.134	0.175
	(0.104)	(0.100)	(0.101)	(0.354)
Constant	−54.432	−59.151*	−56.568	0.000
	(37.546)	(35.246)	(37.181)	(0.000)
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
First-stage F-statistic	26.11***	45.95***	12.28***	
Kleibergen-Paap rk statistic	21.47***	32.03***	14.86***	
AR (1) [p-value]				[0.001]
AR (2) [p-value]				[0.650]
Hansen test [p-value]			[0.806]	[0.996]
Observations	310	310	310	310
R-squared	0.528	0.559	0.535	

Notes: All models include province and year fixed effects. Column (1) reports 2SLS regression with infrastructure investment instrumented by the log of emissions of SO_2 from daily life activities in a province in a year. Column (2) presents the results from an alternative infrastructure investment index without investments in transport instrumented by SO_2 emissions from daily life. Column (3) presents the results from the Lewbel estimator. Column (4) presents a two-step system GMM regression using a collapsed instrument matrix of all available lags. Robust standard errors are in parentheses and p-value in brackets. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The first-stage results are reported in table A6 in the appendix.

Table 6
The effect of corruption on infrastructure investment.

Method:	(1) OLS	(2) OLS	(3) 2SLS	(4) Lewbel	(5) System GMM
Corruption	0.075***	0.059***	0.380***	0.120**	0.253**
	(0.028)	(0.018)	(0.081)	(0.052)	(0.122)
Income		0.813***	0.780***	0.807***	0.380***
		(0.180)	(0.256)	(0.166)	(0.138)
Openness		0.003**	0.002	0.003**	0.004
		(0.001)	(0.002)	(0.001)	(0.003)
Urbanization		0.008***	0.004	0.008***	0.003
		(0.002)	(0.005)	(0.002)	(0.007)
Population growth		0.049**	0.030	0.046**	0.059
		(0.022)	(0.027)	(0.021)	(0.052)
Constant	6.196***	−1.726	−4.490*	−2.246	0.000
	(0.276)	(1.726)	(2.580)	(1.607)	(0.000)
Province FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
First-stage F-statisti			23.50***	10.75***	
Kleibergen-Paap rk statistic			14.57***	6.402**	
AR (1) [p-value]					[0.060]
AR (2) [p-value]					[0.499]
Hansen test [p-value]				[0.346]	[0.915]
Observations	310	310	310	310	310
R-squared	0.952	0.966	0.913	0.964	

Notes: All models include province and year fixed effects. Columns (1)–(2) report the estimates from OLS regressions. Column (3) presents a 2SLS regression with corruption instrumented by the number of public employees per 10,000 citizens in a province. Column (4) presents the results from the Lewbel estimator. Column (5) presents a two-step system GMM regression using a collapsed instrument matrix of all available lags. Robust standard errors are in parentheses and p-value in brackets. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The first-stage results from the 2SLS and Lewbel methods are reported in table A7 in the appendix.

Lewbel and system GMM methods. The estimates for corruption remain positive and highly significant as ever (columns (4)–(5)). These results show that corruption also increased infrastructure investment during the sample period in China and hence a vicious cycle between expansion of infrastructure investment and corruption.

6. Conclusions

We have studied officials' promotion within the government and Party hierarchy in China, focusing on infrastructure investment. The promotion system has the character of contests designed to evoke effort. We find however, in the context of the contest design model, excessive effort through infrastructure investment, revealed in negative returns from infrastructure investment. Although there was inefficiency through negative returns, we have found that the chief leaders of local governments benefitted from infrastructure investment through increased probability of promotion. We have found feedback between increased infrastructure investment and corruption. Moral hazard is revealed through officials placing local governments in financial distress or bankruptcy to finance the infrastructure investment from which they personally benefit through increased prospects for promotion, with promotion then placing them elsewhere.

We have contributed to the literature on contests by providing evidence for a "footprints in the sand" approach to inferring the existence of rent-seeking contests. While not observing actual time and effort allocation by the participants in contests, we observe the means of contesting rents (infrastructure investment), the rents (being promoted in the government and Party hierarchy), and the successful rent seekers (the officials who are promoted).

To summarize our baseline empirical findings, when tenure-averaged infrastructure investment increased by one percent, the probability of promotion of the provincial Party secretary increased by 5.6 percentage points. An increase in infrastructure investment by one percent also increased corruption rents captured by local government officials by 0.57 percentage points, and an increase in corruption of one percent increased infrastructure investment by 0.06 percentage points, showing feedback and simultaneity between infrastructure investment and corruption.

Our study complements a number of studies that have looked at the relationship between promotion of local leaders and growth of the local economy in China.[24] These studies have not addressed inefficient overinvestment, corruption feedbacks, moral hazard, or the rent-seeking context. In studies that related to western democracies, infrastructure investment is not a means for political promotion to higher levels of leadership from local to broader regional and higher-level government. Promotion is not determined by central governments in the manner of orchestrated rent seeking contests. Infrastructure investment rather involves quests for votes, growth, and the tax base.[25] The Chinese experience is special because local government leaders have had absolute authority to decide on investment in infrastructure projects and on how to finance the projects. The contests for participation by individual local-government leaders could therefore be implemented, with the adverse rent-seeking consequences that we have described.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

I have shared the link to my data/code at the Attach Files step.

Acknowledgements

We thank the participants at the 3rd Ariel Conference on the political economy of public policy, the editor, and one of the anonymous reviewers for helpful comments and suggestions.

[24] See, for example, Chen et al. (2005), Li and Zhou (2005), Tao et al. (2009), Jiang et al. (2015), Wiebe (2020), Huang et al. (2022), and Wang et al. (2022).

[25] On the U.S., see Aschauer (1989). Henisz (2002) provides an extensive international comparison over two centuries of infrastructure investment. Aidt et al. (2008) studied the relation between the level of economic development and the efficiency costs of corruption. Kemmerling and Stephan (2002) found that regions in Germany were rewarded with transfers for local infrastructure development in return for political support in a general election. Cadot et al. (2006) found that central transfers for transport infrastructure in France were for political support rather than for relief of local traffic congestion.

Appendix A

Table A1
Variable definition and data summary

Panel A Dataset for estimation of the effect of infrastructure investment on political promotion				
Variables	Definition [data source]	N	Mean	Std. Dev.
Promotion	Promotion = 1 and 0 otherwise [A]	107	0.243	0.431
Turnover	Promotion = 3, lateral transfer = 2, and 1 otherwise [A]	107	1.841	0.791
Infrastructure	Logarithm of infrastructure investment averaged over the tenure	107	7.565	0.953
Infrastructure-final	Logarithm of infrastructure investment in the final year	107	7.725	0.939
Growth	Growth rate of real GDP per capita averaged over the tenure	107	9.081	4.966
Age	Age in the final year of the tenure [A]	107	61.61	4.378
Education	Doctor = 4, master = 3, undergraduate = 2, and 1 otherwise [A]	107	2.888	0.705
Tenure	Number of years in office [A]	107	3.748	1.637
Panel B Dataset for estimation of the relation between infrastructure investment and corruption				
Variables	Definition [data source]	N	Mean	Std. Dev.
Corruption rent	Average monetary value of rent captured in corruption in a province per year [B]	310	207,101	555,714
Corruption	Logarithm of corruption rents [B]	310	11.68	0.908
Infrastructure	Logarithm of infrastructure investment	310	7.374	0.849
Infrastructure-pc	Logarithm of infrastructure investment per capita	310	8.493	0.575
Infrastructure/GDP	Share of infrastructure investment in local GDP (%)	310	18.22	9.440
Public facility	Logarithm of investment in fixed assets of public facilities	310	6.226	1.136
Anticorruption	Logarithm of detected corruption-related crimes per 10,000 public employees [C]	310	3.087	0.500
Income	Logarithm of real GDP per capita	310	10.32	0.531
Population	Logarithm of local population	310	8.092	0.854
Education	Ratio of secondary school enrollment to population (%)	310	3.820	0.968
Openness	Ratio of imports and exports to GDP (%)	310	31.85	38.90
Resource	Ratio of natural resource tax to tax revenues (%)	310	2.437	2.540
Government	Ratio of government consumption to GDP (%)	310	15.39	6.219
Wage	Logged value of yearly salary of public employees	310	10.57	0.350
Internet	Ratio of Internet users to population (%)	310	34.11	16.87
Urbanization	Share of population in cities (%)	310	50.73	15.03
Population growth	Population growth rate	310	0.858	1.220
SO_2	Logarithm of sulfur dioxide emissions in daily life	310	10.89	1.287
Without transport	Logarithm of infrastructure investment without investments in transport	310	6.922	0.894
Public employees	Public employees per 10,000 citizens	310	122.38	50.75

Data source: [A] from People.com.cn and Baidu Encyclopedia; [B] from China Corruption Conviction Databank; [C] from Statistical Yearbooks of the People's Supreme Procuratorate of China; the rest from Statistical Yearbooks of China.

Table A2
The growth effect of infrastructure investment

	(1)	(2)
Method:	OLS	OLS
Infrastructure	5.563**	5.324**
	(2.266)	(2.254)
Infrastructure-square	−0.345**	−0.356**
	(0.168)	(0.173)
Nationalization		−6.522
		(4.933)
FDI		1.213**
		(0.552)
Education		0.730*
		(0.407)
Population		7.053
		(6.870)
Constant	−3.268	−69.156
	(8.623)	(59.985)
Province FE	YES	YES
Year FE	YES	YES
Observations	527	527
R-squared	0.574	0.587

Notes: The dependent variable is economic growth, the growth rate of real GDP per capita. Infrastructure investment is the logarithm of the amount of infrastructure investment lagged by one year. Control variables include nationalization, FDI per capita, education, and population. Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A3
The effect of infrastructure investment on promotion of provincial leaders (Party secretaries and governors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Method:	Probit	Probit	Probit	Probit	Probit	Ordered Probit	Probit
Infrastructure	0.316**	0.305**	0.320**	0.318**	0.463***	0.304**	0.263*
	(0.134)	(0.132)	(0.137)	(0.136)	(0.152)	(0.125)	(0.137)
Growth			−0.065	−0.046	−0.061	−0.048	−0.041
			(0.044)	(0.047)	(0.051)	(0.043)	(0.045)
Growth-squared			0.003	0.001	0.001	0.001	0.001
			(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Infra*Growth			0.021	0.032	0.071**	0.045**	0.035
			(0.026)	(0.026)	(0.031)	(0.022)	(0.025)
Age		1.616***		1.616***	1.988***	1.601***	1.596***
		(0.511)		(0.518)	(0.546)	(0.543)	(0.517)
Age-squared		−0.015***		−0.015***	−0.018***	−0.015***	−0.015***
		(0.004)		(0.004)	(0.005)	(0.005)	(0.004)
Education		−0.035		−0.004	0.150	0.066	0.003
		(0.149)		(0.150)	(0.161)	(0.127)	(0.149)
Tenure		0.061		0.073	0.159	−0.089	0.033
		(0.173)		(0.176)	(0.238)	(0.176)	(0.176)
Tenure-squared		−0.013		−0.014	−0.023	0.007	−0.011
		(0.019)		(0.019)	(0.023)	(0.021)	(0.019)
/cut1						43.932***	
						(15.828)	
/cut2						44.971***	
						(15.842)	
Constant	−2.999***	−46.614***	−2.802***	−46.509***	−59.674***		−45.492***
	(1.076)	(14.986)	(1.088)	(15.255)	(16.160)		(15.207)
Region FE	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES
Observations	233	233	233	233	210	233	233
Pseudo R-squared	0.035	0.155	0.0417	0.161	0.206	0.178	0.156

Notes: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A4
The effect of infrastructure investment on promotion of provincial governors alone

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Method:	Probit	Probit	Probit	Probit	Probit	Ordered Probit	Probit
Infrastructure	0.241	0.228	0.270	0.254	0.457**	0.310	0.171
	(0.178)	(0.181)	(0.181)	(0.186)	(0.210)	(0.195)	(0.186)
Growth			−0.011	0.011	−0.010	0.017	0.009
			(0.055)	(0.060)	(0.066)	(0.056)	(0.058)
Growth-square			−0.002	−0.003	−0.003	−0.002	−0.003
			(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Infra*Growth			−0.009	0.002	0.031	0.010	0.001
			(0.034)	(0.034)	(0.043)	(0.030)	(0.033)
Age		−0.000		−0.001	−0.005	−0.054	0.001
		(0.040)		(0.040)	(0.046)	(0.036)	(0.040)
Education		0.053		0.075	0.300	0.085	0.087
		(0.211)		(0.219)	(0.246)	(0.199)	(0.218)
Tenure		−0.240***		−0.240***	−0.300***	−0.237***	−0.248***
		(0.080)		(0.081)	(0.094)	(0.072)	(0.082)
/cut1						−2.510	
						(2.448)	
/cut2						−1.573	
						(2.472)	
Constant	−1.716	−1.072	−1.841	−1.228	−3.206		−0.757
	(1.439)	(2.713)	(1.458)	(2.729)	(3.289)		(2.718)
Region FE	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES
Observations	126	126	126	126	109	126	126
Pseudo R-squared	0.038	0.119	0.0471	0.128	0.178	0.143	0.122

Notes: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

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Table A5
Estimation with alternative indicators of infrastructure investment

	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Infrastructure investment per capita	0.574*		
	(0.292)		
Ratio of infrastructure investment to GDP		0.023**	
		(0.010)	
Investment in public facilities			0.391**
			(0.173)
Anticorruption	−0.049	−0.054	−0.025
	(0.134)	(0.130)	(0.139)
Income	10.887**	9.174**	9.738**
	(4.372)	(4.625)	(4.511)
Income-squared	−0.537**	−0.428*	−0.469**
	(0.222)	(0.236)	(0.230)
Population	4.459***	3.520**	4.020**
	(1.636)	(1.762)	(1.693)
Education	0.106	0.095	0.122
	(0.106)	(0.107)	(0.107)
Constant	−88.082***	−69.467**	−77.695**
	(31.935)	(34.457)	(32.919)
Province FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	310	310	310
R-squared	0.573	0.572	0.572

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table A6
First-stage results of 2SLS and Lewbel models for the effect of infrastructure investment on corruption

	(1)	(2)	(3)
Method:	2SLS	2SLS	Lewbel
SO_2	0.152***	0.218***	
	(0.030)	(0.032)	
Generated A			−0.164***
			(0.033)
Generated B			0.013*
			(0.007)
Anticorruption	−0.025	−0.065*	−0.022
	(0.032)	(0.035)	(0.031)
Income	3.637***	3.936***	4.395***
	(0.996)	(1.216)	(1.481)
Income-squared	−0.124**	−0.146**	−0.184**
	(0.052)	(0.063)	(0.076)
Population	0.727	1.296***	−0.298
	(0.455)	(0.498)	(0.475)
Education	−0.013	−0.010	−0.032
	(0.029)	(0.031)	(0.030)
Constant	−24.275***	−31.115***	−15.544
	(7.607)	(9.125)	(9.963)
Province FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	310	310	310

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table A7
First-stage results of 2SLS and Lewbel models for the effect of corruption on infrastructure investment

	(1)	(2)
Method:	2SLS	Lewbel
Public employees	0.010***	
	(0.002)	
Generated A		0.009***
		(0.002)
Generated B		−0.015**
		(0.008)
Income	−0.066	−0.193
	(0.693)	(0.626)
Openness	−0.003	0.001
	(0.005)	(0.004)
Urbanization	0.020*	0.013
	(0.012)	(0.009)
Population growth	0.049	0.057
	(0.049)	(0.044)
Constant	9.395	11.434*
	(6.612)	(5.941)
Province FE	YES	YES
Year FE	YES	YES
Observations	310	310

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Appendix B

We use the following equation to estimate the relationship between economic growth and promotion (see also Tao et al., 2009; Jiang et al., 2015; Wiebe, 2020):

$$Promotion_{ijt} = \alpha_0 + \alpha_1 Growth_{ijt} + \alpha_2 Growth_{ijt}^2 + \alpha_3 X_{ijt} + \delta_j + \gamma_t + \varepsilon_{ijt} \quad \text{(b1)}$$

where the terms are the same as those in equation (2) in the text.

We use a sample of 233 provincial leaders (107 provincial Party secretaries and 126 provincial governors) who served in 31 provinces for the period 2003–2020 for estimation. Table B1 provides the data summary. Table B2 reports the results.

Previous studies reported a linear relation between economic growth and promotion of local government leaders (e.g., Chen et al., 2005; Li and Zhou, 2005). Our estimation identifies a U-formed relation between economic growth and promotion of local government leaders. This relation exists for provincial Party secretaries only (see models 5–8 of table B2). The turning point occurs at the growth rate of 8.25%.

Table B1
Variable definition and data summary

		All provincial leaders			Provincial Party secretaries			Provincial governors		
Variables	Definition [data source]	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Promotion	Promotion = 1 and 0 otherwise [A]	233	0.429	0.496	107	0.243	0.431	126	0.587	0.494
Growth	Real GDP per capita growth rate averaged over the tenure	233	9.006	5.330	107	9.081	4.966	126	8.942	5.639
Age	Age when leave office [A]	233	60.46	4.079	107	61.61	4.378	126	59.48	3.541
Education	Doctor = 4, master = 3, undergraduate = 2, and 1 otherwise [A]	233	2.948	0.711	107	2.888	0.705	126	3.000	0.716
Tenure	Number of years in office [A]	233	3.730	1.779	107	3.748	1.637	126	3.714	1.897

Data source: [A] from People.com.cn and Baidu Encyclopedia; and growth calculated according to Statistical Yearbooks of China.

Table B2
The effect of economic growth on promotion

	All provincial leaders				Provincial Party secretaries				Provincial governors			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Method:	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Growth	−0.010	−0.051	−0.026	−0.024	0.028	−0.141*	−0.255**	−0.307*	−0.034	−0.015	0.013	0.007
	(0.026)	(0.041)	(0.045)	(0.051)	(0.058)	(0.074)	(0.110)	(0.173)	(0.033)	(0.050)	(0.056)	(0.063)
Growth-squared		0.003	0.001	−0.000		0.012***	0.015***	0.017**		−0.001	−0.002	−0.003
		(0.002)	(0.002)	(0.003)		(0.004)	(0.006)	(0.009)		(0.003)	(0.003)	(0.003)
Age			1.614***	1.747***			−0.202***	−0.204***			0.006	0.005
			(0.511)	(0.531)			(0.063)	(0.064)			(0.038)	(0.043)
Age-squared			−0.015***	−0.016***								
			(0.004)	(0.005)								
Education			0.005	0.102			−0.121	−0.123			0.102	0.300
			(0.149)	(0.159)			(0.289)	(0.295)			(0.215)	(0.239)
Tenure			0.059	0.054			0.996***	0.825*			−0.245***	−0.290***
			(0.172)	(0.231)			(0.365)	(0.439)			(0.079)	(0.091)
Tenure-squared			−0.013	−0.013			−0.085**	−0.067				
			(0.018)	(0.023)			(0.037)	(0.043)				
Constant	−0.530*	−0.474	−44.334***	−48.961***	−6.608***	−6.670***	2.418	2.602	0.272	0.246	0.179	−0.450
	(0.305)	(0.306)	(14.896)	(15.515)	(0.578)	(0.629)	(4.371)	(4.373)	(0.410)	(0.408)	(2.477)	(2.830)
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	233	233	233	210	107	107	107	101	126	126	126	109
Pseudo R-squared	0.017	0.021	0.141	0.159	0.150	0.196	0.387	0.376	0.033	0.034	0.117	0.143

Notes: Columns (1)–(4), (5)–(8), and (9)–(12) present results for provincial leaders – both the provincial Party secretaries and governors, provincial Party secretaries, and provincial governors, respectively. Columns (1)–(2), (5)–(6), and (9)–(10) include economic growth terms only; columns (3), (7), and (11) include all control variables. Columns (4), (8), and (12) present results from a smaller sample net of officials who held office for only one year. We did not include the age-squared term in the models for provincial Party secretaries because the estimates are statistically insignificant. For the same reason, the age-squared term and tenure-squared term are excluded from models for provincial governors. Including these squared terms do not change the results. Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejpoleco.2023.102397.

References

Aidt, T.S., 2016. Rent seeking and the economics of corruption. Consititut. Polit. Econ. 142–157.
Aidt, T.S., Dutta, J., Sena, V., 2008. Governance regimes, corruption and growth: theory and evidence. J. Comp. Econ. 195–220.
Aidt, T.S., Hillman, A.L., Liu, Q., 2020. Who takes bribes and how much? Evidence from the China Corruption Conviction Databank. World Dev. 133, 104985.
Albalate, D., Bel, G., Fageda, X., 2012. Beyond the efficiency-equity dilemma: centralization as a determinant of government investment in infrastructure. Pap. Reg. Sci. 599–615.
Aschauer, D.A., 1989. Is public expenditure productive? J. Monetary Econ. 23, 177–200.
Baum, C.F., Lewbel, A., 2019. Advice on using heteroskedasticity-based identification. STATA J. 19, 757–767.
Besley, T., Case, A., 1995. Incumbent behavior: vote seeking, tax setting and yardstick competition. Am. Econ. Rev. 85, 25–45.
Cadot, O., Röller, L., Stephan, A., 2006. Contribution to productivity or pork barrel? The two faces of infrastructure investment. J. Publ. Econ. 90, 1133–1153.
Castells, A., Solé-Ollé, A., 2005. The regional allocation of infrastructure investment: the role of equity, efficiency and political factors. Eur. Econ. Rev. 49, 1165–1205.
Chen, K., Liu, Q., 2015. Economic development and corruption in China in the shadow of rent seeking. In: Congleton, R.D., Hillman, A.L. (Eds.), Companion to the Political Economy of Rent Seeking. Edward Elgar, Cheltenham UK and Northampton MA, pp. 395–409.
Chen, Y., Liu, Q., 2018. Public-sector wages and corruption: an empirical study. Eur. J. Polit. Econ. 54, 189–197.
Chen, K., Hillman, A.L., Gu, Q., 2002. Fiscal re-centralization and behavioral change of local governments: from the helping hand to the grabbing hand. China Economic Quarterly 2, 111–130.
Chen, Y., Li, H., Zhou, L., 2005. Relative performance evaluation and the turnover of provincial leaders in China. Econ. Lett. 88, 421–425.
Chen, Q., Huang, Q., Liu, C., Wang, P., 2022. Career incentives of local leaders and crisis response: a case study of COVID-19 lockdowns in China. Eur. J. Polit. Econ. 75, 102180.
Cheng, Y., Jia, S., Meng, H., 2022. Fiscal policy choices of local governments in China: land finance or local government debt. Int. Rev. Econ. Finance 80, 294–308.
Clarke, D., Lu, F., 2017. The law of China's local government debt: local government financing vehicles and their bonds. Am. J. Comp. Law 65, 751–798.
40 Years of research on rent seeking. In: Congleton, R.D., Hillman, A.L., Konrad, K.A. (Eds.), 2008a. Theory of Rent Seeking, ume 1. Springer, Heidelberg.
Congleton, R.D., Hillman, A.L., Konrad, K.A. (Eds.), 2008b. 40 Years of Research on Rent Seeking. Applications: Rent Seeking in Practice, ume 2. Springer, Heidelberg.
Corchón, L.C., Serena, M., 2018. Contest theory. In: Corchón, L.C., Marini, M.A. (Eds.), Handbook of Game Theory and Industrial Organization. Edward Elgar, Cheltenham UK, pp. 125–146.
De Jong, E., Bogmans, C., 2011. Does corruption discourage international trade? Eur. J. Polit. Econ. 385–398.
Dincer, O., Gunalp, B., 2020. The effects of federal regulations on corruption in U.S. states. Eur. J. Polit. Econ. 65, 101924.
Dong, B., Torgler, B., 2013. Causes of corruption: evidence from China. China Econ. Rev. 26, 152–169.
Escresa, L., Picci, L., 2020. The determinants of cross-border corruption. Publ. Choice 184, 351–378.

Finocchiaro Castro, M., Guccio, C., Rizzo, I., 2014. An assessment of the waste effects of corruption on infrastructure provision. Int. Tax Publ. Finance 21, 813–843.
Gao, H., Ru, H., Tang, D.Y., 2021. Subnational debt of China: the politics-finance nexus. J. Financ. Econ. 141, 881–895.
Gelb, A., Hillman, A.L., Ursprung, H.W., 1998. Rents as distractions: why the exit from transition is prolonged. In: Baltas, N.C., Demopoulos, G., Hassid, J. (Eds.), Economic Interdependence and Cooperation in Europe. Springer, Heidelberg, pp. 21–38.
Gründler, K., Potrafke, N., 2019. Corruption and economic growth: new empirical evidence. Eur. J. Polit. Econ. 60, 101810.
Gutmann, J., Padovano, F., Voigt, S., 2020. Perception vs. experience: explaining differences in corruption measures using microdata. Eur. J. Polit. Econ. 65, 101925.
Henisz, W.J., 2002. The institutional environment for infrastructure investment. Ind. Corp. Change 11, 355–389.
Hillman, A.L., 1978. Symmetries and asymmetries between public input and public good equilibria. Publ. Finance/Finances Publiques 33, 269–279.
Hillman, A.L., 2023. Empirics and rent seeking: footprints in the sand and public policy. Discussion Paper. European Public Choice Society Conference. Hanover, Germany.
Hillman, A.L., Long, N.V., 2019. Rent seeking: the social cost of contestable benefits. In: Congleton, R.D., Grofman, B.N., Voigt, S. (Eds.), Oxford Handbook of Public Choice, vol. 1. Oxford University Press, Oxford UK, pp. 489–518 (chapter 25).
Huang, L., Lin, S., Wang, X., Yang, C., 2022. How does target-leading affect infrastructure? A quantitative and qualitative analysis. Ind. Econ. Res. 1, 129–142.
Jiang, D., Jiang, G., Chen, D., 2015. Local leaders' promotion and economic efficiency: an empirical study from the performance evaluation and heterogeneity perspectives. China Ind. Econ. 10, 21–36.
Kahana, N., Liu, Q., 2010. Endemic corruption. Eur. J. Polit. Econ. 26, 82–88.
Kemmerling, A., Stephan, A., 2002. The contribution of local public infrastructure to private productivity and its political economy: evidence from a panel of large German cities. Publ. Choice 113, 403–424.
Konrad, K.A., 2009. Strategy and Dynamics in Contests. Oxford University Press, Oxford U.K.
Lewbel, A., 2012. Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models. J. Bus. Econ. Stat. 30, 67–80.
Li, H., Zhou, L., 2005. Political turnover and economic performance: the incentive role of personnel control in China. J. Publ. Econ. 89, 1743–1762.
Li, Y., Shao, X., Tao, Z., Yuan, H., 2022. How local leaders matter: inter-provincial leadership transfers and land transactions in China. J. Comp. Econ. 50, 196–220.
Liao, M., Xu, Z., Hu, C., Yu, C., 2018. Will infrastructure investment still promote economic growth? Empirical research based on provincial panel data from 1994 to 2015. Manag. World 34, 63–73.
Liu, Q., 2007. How to improve government performance. Eur. J. Polit. Econ. 23, 1198–1206.
Qian, Y., Weingast, B.R., 1996. China's transition to markets: market-preserving federalism, Chinese style. J. Pol. Reform 1, 149–185.
Sahoo, P., Dash, R.K., Nataraj, G., 2010. Infrastructure Development and Economic Growth in China. Discussion Paper No, 261. Institute of Developing Economies: Japanese External Trade Organization, Chiba, Japan.
Tao, R., Lu, X., Su, F., Wang, H., 2009. China's transition and development model under evolving regional competition patterns. Econ. Res. J. 44, 21–33.
Thede, S., Gustafson, N., 2012. The multifaceted impact of corruption on international trade. World Econ. 35, 651–666.
Tullock, G., 1967. The welfare costs of tariffs, monopolies, and theft. West. Econ. J. 5, 224–232.
Wang, B., Zheng, Y., 2020. A model of tournament incentives with corruption. J. Comp. Econ. 48, 182–197.
Wang, Z., Yao, Y., Zhang, J., 2022. The competence-loyalty tradeoff in China's political selection. J. Comp. Econ. 50, 369–393.
Wiebe, M., 2020. Replicating the literature on meritocratic promotion in China. Available at. https://michaelwiebe.com/research/. (Accessed 2 October 2022). accessed.
World Bank, 1994. World Development Report 1994: Infrastructure for Development. Oxford University Press, Oxford U.K.
Xu, C., 2011. The fundamental institutions of China's reforms and development. J. Econ. Lit. 49, 1076–1151.
Zhan, J.V., 2017. Do natural resources breed corruption? Evidence from China. Environ. Resour. Econ. 66, 237–259.
Zhang, W., 2020. Political incentives and local government spending multiplier: evidence for Chinese provinces (1978–2016). Econ. Model. 87, 59–71.
Zhang, J., Gao, Y., Fu, Y., Zhang, H., 2007. Why does China enjoy so much better physical infrastructure? Econ. Res. J. 3, 4–19.
Zhao, J.Z., Su, G., Li, D., 2019. Financing China's unprecedented infrastructure boom: the evolution of capital structure from 1978 to 2015. Publ. Money Manag. 39, 581–589.
Gradstein, M., Konrad, K.A.,1999. Orchestrating rent seeking contests. Economic Journal 109(458), 536-545. Reprinted in: Congleton, R.D., Hillman, A.L., Konrad, K. A. (Eds.), 2008. Forty Years of Research on Rent Seeking 1 - the Theory of Rent Seeking, Springer, Heidelberg, pp.571-580.