

City's Soft Power: Political Networks and Financial Allocation in China

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This paper investigates how informal networks shape intergovernmental fiscal distribution in four Southeastern provinces of China. We use newly collected data that contain background information on allocation-relevant officials and focus on the Urban Maintenance and Construction Funds. We find that provincial top leaders allocate significantly more funds to cities governed by officials with the same birthplace or overlapping work histories. However, cities with top leaders from the same universities as any directors of allocation-relevant provincial departments receive less funding. We analyze heterogeneity across cities and connection types and discuss two mechanisms behind our results – trust and competition.

JEL Codes: D72, D73, H54, H72.

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I. Introduction

The influence of political consideration in the allocation of public resources has long been a central topic in political economy. Vast literature documents that electoral competition in democratic countries motivates politicians to allocate resources more favorably to their co-partisans ([Fourinaies and Mutlu-Eren, 2015](#)). In contrast, the impact of informal political networks in non-democratic countries remain less clearly understood ([Jiang and Zhang, 2020](#)).

Do informal networks influence the allocation of government funds? If they do, what are the underlying mechanisms? What are the consequences of a network-based resource allocation? To answer these questions, we investigate the role of social connections between city and provincial officials in provincial-level financial allocation in four provinces in China – Fujian, Zhejiang, Guangdong, and Anhui. We focus on three forms of connections – hometown, college, and work ties.

Several studies document the influence of informal networks on public fund allocation ([Wang et al., 2014](#)). While existing studies focus on the impact of top leaders (the governor and party secretary) on intergovernmental fiscal allocation, there has been relatively scant evidence on the discretionary power of other provincial officials, such as the directors of provincial functional departments (housing, transportation, water, and finance), which we analyze in detail.¹

An important consideration in our research design is that, for earmarked transfer payments, different types of funds are under the responsibility of different departments. That is, the decision-making power of the director of a department tends to be

¹The most closely related study is [Fan and Li \(2014\)](#). They perform a difference-in-differences analysis based on the replacement of ministers in 2003. They find that the political connection of a new minister increased the special transfer payments to his city of origin by approximately 200 million yuan (28 million US dollars). This amount remained relatively high even after the minister left office. Furthermore, if one oversaw a ministry with significant power (e.g., the National Development and Reform Commission and the Ministry of Finance), the amount increased to 940 million yuan.

restricted to one domain. Consequently, if we link connections with all functional department directors to the total amount of earmarked transfer payments a city receives, the role of informal networks may be inadequately measured. Therefore, we focus on the provincial Urban Maintenance and Construction Funds (UMC Funds) to exclude connections to officials with weaker discretion and minimize measurement errors.

Our baseline results show that hometown and work ties with any provincial top leaders are associated with an increase in the UMC Funds a city receives, whereas college connections with any directors of fund-related provincial departments is associated with a decrease in the fund that a city receives. Specifically, cities with top leaders that have hometown ties to the provincial governor or party secretary receive additional 16 yuan per capita, which is 0.49 standard deviation and 70 million yuan for an average-sized city. As for work ties, provincial top leaders allocate additional 13 yuan per capita, which is 0.4 standard deviation and 57 million yuan for an average-sized city, to cities under the authority of their former colleagues. In contrast, college connections with provincial department directors reduce the funds by 9 yuan per capita, which is 0.28 standard deviation and 39 million yuan for an averaged-sized city.

We then examine the heterogeneity of effects to understand the mechanisms behind our baseline results. We first focus on the heterogeneity across social atmospheres in population diversity. We find that population diversity mitigates the impact of hometown and college connections. It could be due to both selection and treatment effects. Specifically, areas with more population diversity tends to attract individuals who are more open to interactions with people outside their social networks. Such an environment also provides stronger incentives for cross-group interactions.

We also analyze the heterogeneity of the effects along the dimension of the scarcity and duration of the social connections to better understand the role of trust as a mechanism behind our findings. The results show that favoritism in resource allocation

is more prominent among government officials who are outlanders or former colleagues more than five years ago. These findings suggest that trust can at least partly explain the rewards from social connections with provincial top leaders.

We further investigate whether the disadvantage from social connections to the directors of provincial departments results from competition. There are plausible reasons to expect the importance of the competition mechanism. Since city top leaders rank at the same level as provincial department directors, they can easily become competitors for promotion. Thus, provincial department directors may be motivated to prevent city top leaders from gaining more funds.

Furthermore, the estimated effect of college connections is more strongly negative if the connected officials graduated from a local university. Considering that graduates of local universities constitute a large proportion of the government, competition for promotion is likely to be more fierce among graduates of a local university. However, when looking at the heterogeneity in the past colleague relationship (i.e. whether the city leader was once superior/subordinate to the provincial leader or they ranked at the same level), the insignificant estimates across all kinds of previous relationships suggest that the penalty from college connections is less likely to be persistent.

Finally, we analyze the impacts of network-based distribution on the promotion of officials and the efficiency of fund use. We find that having connections to provincial top leaders through hometown or workplace affiliations increases the chances of promotion, but only when the associated city receives funding. There are potential variations in the quality of these connections, and the acquisition of UMC Funds may solidify high-quality political connections. Second, by establishing an evaluation index for the level of urban public facilities, the results show that the investment of the provincial UMC Funds is positively correlated with the index, indicating its benefits on the development of urban public facilities. However, the marginal benefit decreases if the funds are

allocated to any connected city, suggesting a decline in the efficiency of fund utilization.

This research contributes to several strands of literature. First, it helps to understand the political economy of public resource allocation in developing countries. On the one hand, our findings are in line with many related articles. For instance, [Wan et al. \(2015\)](#) document that being a member of the Central Politburo helps the province party secretary to secure more conditional transfers. On the other hand, our paper further extends this line of research by considering other important provincial officials. To the best of our knowledge, it is the first to establish a more explicit and comprehensive political network and document potential penalties from connection in resource allocation in China. We also provide alternative interpretations of the motivations that drive biases in resource allocation. Specifically, we demonstrate that trust could serve as a channel to understand the positive impacts of informal political networks, and competition could at least partly explain the penalties from connections.

Second, it contributes to our understanding of the role of political connections in the selection of public officials. The existing literature has established two critical determinants of the selection of officials: connection and performance. Several studies emphasize the critical role of informal political connections in the promotion of officials ([Shih et al., 2012](#), [Fisman et al., 2020](#)). Other studies document the existence of the political promotion tournament in the Chinese bureaucracy, which motivates officials to accelerate economic growth to be promoted ([Yao and Zhang, 2015](#), [Landry et al., 2018](#)). [Jia et al. \(2015\)](#) further argue that connection and performance are complements. Specifically, politically connected provincial leaders are significantly more likely to be promoted, but only when they have strong economic performance.

Our baseline results, illustrating a positive relationship between informal connections and the amount of provincial funding received, suggest a possible mechanism for such complementarity. Provincial top leaders may allocate funds more preferentially

to certain clients on their target promotion list, aiming to improve their economic performance by providing financial support for government expenditures. Receiving provincial funding could reflect the strength of connections, which implies a higher likelihood of being promoted.² Our research contributes to the literature by providing novel evidence on the heterogeneity in the quality of connections.

Our work also links to the research on welfare losses caused by resource misallocation. A significant body of literature has pointed out the negative correlation between political connections and the efficiency of government investment in enterprises (Yu et al., 2010, Li et al., 2021, Ru and Zou, 2022, Barbosa and Ferreira, 2023). For example, using data on renewable energy firms in China, Li et al. (2019) find a direct negative impact of the informal political network on the performance in corporate innovation, especially for state-owned firms. In contrast, the effect of informal networks on the efficiency of urban infrastructure investment received relatively less attention.³ Consequently, our study fills in a gap in the literature by providing evidence that political ties may distort resource allocation and reduce the efficiency in resource allocation.

The paper also contributes to broader research on the political determinants of intergovernmental transfers, such as political representation (Porto and Sanguinetti, 2001),⁴ partisan alignment (Panda, 2016), and commonalities such as ethnicity and hometown (Dickens, 2018, Gonschorek, 2021).

The remainder of the paper is organized as follows. Section 2 describes the back-

²The positive correlation between government spending on urban construction and the probability of promotion has been documented by earlier studies. For example, Que et al. (2019) find a positive correlation between basic construction expenditure and the likelihood of promotion.

³One related study is Kahn et al. (2018). They estimate the marginal effects of a city’s growth potential, expected inequality reduction, and social connections (measured in four dimensions: workplace, birthplace, college, and political faction) on the probability that an industrial park is sited in a given city. By analyzing the site selection of industrial parks using a conditional Logit model, they argue that a provincial leader sacrifices 1.6 percentage points of the provincial annual GDP for helping a connected city mayor or party secretary.

⁴They claim that overrepresented states tend to obtain, on average, more resources from the national government compared to more populous and less represented states.

grounds and the data. Section 3 discusses the empirical strategy, baseline results, and robustness checks. Section 4 explores two mechanisms, trust and competition, based on the heterogeneous effects of informal networks. Section 5 discusses broader implications of network-based biases in resource allocation. Section 6 concludes the paper.

II. Background and Data

A. Background

Informal Network in China. *Guanxi*, literally meaning relationships, is the term mostly commonly used to refer to informal networks in China, emphasizing the importance of trust, obligation, and reciprocity. *Guanxi* can be divided into two kinds – kinship, based on family association, and other types of commonalities, such as shared birthplace, education, and work history. The latter does not require contemporaneous experiences. That is, two people do not have to be of similar age or go to school simultaneously to claim common social identity.

Informal networks (*guanxi*) have been deeply rooted in Chinese social, economic, and political systems, such as business activities (Wilson and Brennan, 2010), job searches (Weng and Xu, 2018), academic election (Fisman et al., 2018), and judicial decision-making (He and Ng, 2017). This paper explores the role of *guanxi* between the city and provincial officials based on three commonalities: shared birthplace, alma mater, and previous workplaces.

Administrative Division and the Hierarchy of Civil Service in China.

There are five levels of government in China – the central, provincial, prefecture, county, and township levels.⁵ As of 2015, China administers 34 provincial-level regions, 334

⁵Appendix Figure A1 illustrates the basic framework of administrative divisions. Each level below the central government can be divided to many types. The provincial level is composed of provinces,

prefecture-level divisions, and 2,850 county-level regions (China Statistical Yearbook, 2015).

The government at each level has two top political leaders: the head of the government, such as the governor or the mayor, and the party secretary, who is the head of the corresponding branch of the Chinese Communist Party (CCP). Top leaders at each level have significant discretion over policies, guided by top leaders in upper-level governments.

The provincial governments must abide by the central guidelines and implement policies adapted to local conditions, serving as an important bridge between the central and city governments. They are composed of several departments, whose directors play a significant role in formulating policies within their scopes, such as the Department of Transportation, the Department of Education, and the Department of Commerce.

We analyze prefecture-level city leaders' political connections to the top provincial leaders and the directors of fund-relevant provincial departments. Figure A2 in the Appendix presents the hierarchy of the civil service system. Top provincial leaders are ranked at the Provincial level. In contrast, the directors of provincial departments are ranked at the same level as city-level top leaders (the Department and Bureau level). The differences in the rank between officials may influence the nature of their interactions, which we will discuss in detail in Section 4.

Urban Maintenance and Construction Funds: We focus on the Urban Maintenance and Construction Funds (UMC Funds), which is earmarked funding for maintaining and constructing urban public infrastructures and utilities. It is aimed at funding urban economic development and improve the living environment of urban residents.

autonomous regions, (directly-administered) municipalities, and special administrative regions. The prefecture level is composed of prefecture-level cities, autonomous prefectures, and prefectures. The county level is composed of autonomous counties, county-level cities, counties, and urban districts.

Funding sources include central, provincial, and municipal budgetary funds (e.g., the urban maintenance and construction tax, extra charges for municipal utilities, urban infrastructure support fees, and wastewater treatment fees).

Our analysis focuses only on the provincial UMC Funds. To obtain funds from the provincial government, city governments need to submit project applications for a competitive process. Several provincial departments control the UMC Funds. The Department of Housing and Urban-Rural Development is the leading department, responsible for formulating development plans and policies for urban public utilities within the province and guiding their implementation. In certain cases, this department coordinates with the Department of Transportation and the Department of Water Resources to determine fund allocations for specific areas, such as road construction and water treatment. The Department of Finance processes and supervises provincial fiscal expenditures and financial allocations for government investment projects. Generally, the four departments jointly decide the allocation of UMC Funds.

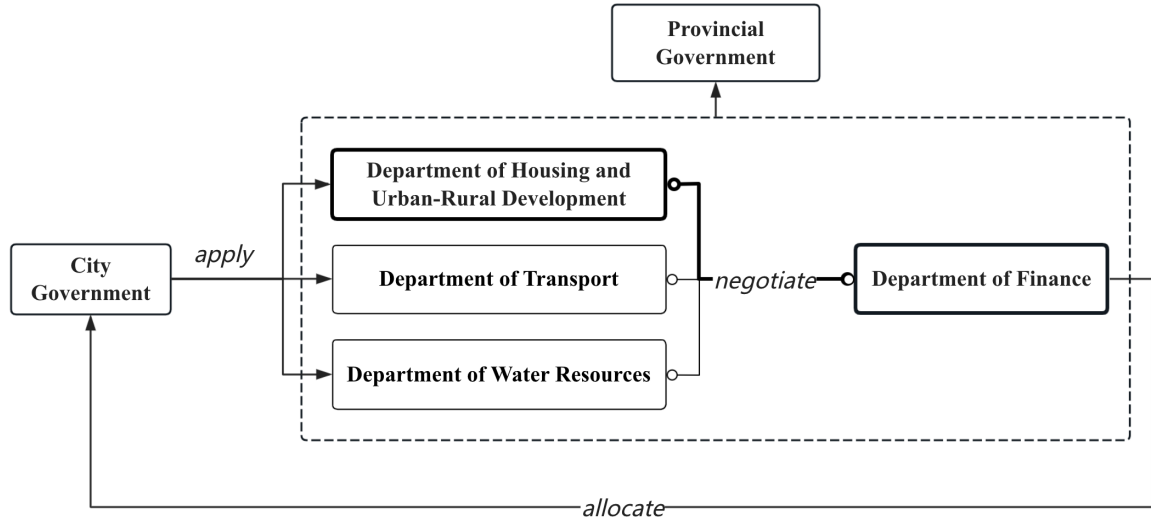


Figure 1. Procedures for the Approval of Provincial UMC Funds

Figure 1 illustrates the allocation process of the UMC Funds. Provincial depart-

ments first announce target investment directions. Then, city governments submit projects to the corresponding departments, with the Department of Housing and Urban-Rural Development and the Department of Finance being the two most crucial entities in the process (bold blocks). Afterwards, the provincial departments review all projects and determine the eligible ones. They subsequently send their decision to provincial top leaders for approval before they allocate funds. Therefore, although department directors have substantial discretionary power, the provincial governor and party secretary can still intervene in the approval of projects and affect the fiscal allocation. Accordingly, we divide the political network of city governments into two types – political connections with the provincial top leaders and those with the directors of the fund-related departments. We further analyze whether and through what mechanisms each type of political connection affects provincial resource allocations. As more funds mean better capacity to accelerate urbanization and improve the local economy, we assume that city governments have a strong incentive to compete and secure as many funds as possible.

B. Data

The empirical analysis requires background information on the complete set of top leaders – the governors of provinces, the mayors of cities, and party secretaries at provincial and city levels – as well as the directors of relevant provincial departments. We introduce a new dataset to ensure accuracy by manually collecting information from Baidu Baike (Chinese equivalent to Wikipedia) and other official websites, such as *Xinhua Net* (the official state news agency of China) and *People’s Daily Online* (the official news agency of the CCP). Notably, our dataset extends beyond existing studies by incorporating data on the directors of provincial departments.

We take four Southeastern provinces shown in Appendix Figure B1 – Fujian, Zhe-

jiang, Guangdong, and Anhui – as examples. We focus on the years between 2005 and 2015 due to data availability. In Appendix Table C1, we demonstrate the representativeness of our sample by comparing the mean and the standard deviation (in the parenthesis) of our data with those in other articles. Most summary statistics are broadly consistent with those of different sample sizes and covered years used in existing studies, suggesting the proper representativeness of our sample. However, these four provinces have distinct demographic and economic profiles compared to other regions in China. First, Zhejiang and Fujian have the highest levels of clan intensity, highlighting the importance of hometown connections in these areas. Second, Guangdong experiences the highest population inflow in China, while Anhui faces one of the highest outflows, providing a stark contrast in how these dynamics shape informal networks. Third, Guangdong and Anhui host the largest number of universities, whereas Fujian, with the fewest universities among the eastern provinces, may exhibit a relatively higher level of college connection intensity. These unique characteristics make it particularly interesting to investigate the role of connections in fiscal allocation within these provinces.

We use the *China Urban Construction Statistical Yearbook* as a source of the primary outcome measure – the amount of the provincial UMC Funds – as well as the measures of urban public facilities – road surface area per capita, daily water consumption per capita, public green space area per capita, and wastewater treatment rate. We use the *China City Statistical Yearbook* and *Provincial Statistical Yearbook* for other parts of the data, such as city-level population and GDP.

We construct three kinds of network measures – *HometownTie*, *CollegeTie*, and *WorkTie* – for shared backgrounds between cities’ top leaders (the mayor and the party secretary) and provincial officials. We use subscripts g and d to distinguish between city leaders’ social ties to provincial top leaders (governor and party secretary), denoted

by subscript g , and to directors of provincial departments, denoted by subscript d . Specifically, we define a dummy variable $HometownTie_g$ as equal to one if at least one of the two city leaders – a mayor or a party secretary – shares the same birthplace as the provincial governor or party secretary, and $HometownTie_d$ equal to one if at least one of the two city leaders shares the same birthplace as any directors of funds-relevant provincial departments. Similarly, we define $CollegeTie$ as a dummy variable that indicates whether at least one of the two city leaders graduated from the same university as any provincial top leader ($CollegeTie_g = 1$) or directors of provincial departments ($CollegeTie_d = 1$). Finally, we define $WorkTie$ as a dummy variable that indicates whether a city mayor or party secretary overlapped in the same government department with any provincial top leaders ($WorkTie_g = 1$) or directors of provincial departments ($WorkTie_d = 1$).

Table 1 provides summary statistics of the main variables. In Panel A, city leaders are hometown-connected with provincial top leaders less frequently than with directors of provincial departments. This pattern arises because most provincial top leaders are transferred from outside the province, while most department directors are promoted from within the province.⁶ Similarly, a larger proportion of city leaders are college-tied to the directors of provincial departments than with provincial top leaders, as most of them graduated from local universities. In contrast, a third of city leaders are work-connected with provincial top leaders since a majority of city leaders (57% in our sample) once worked in their provincial government.

Panel B shows that city leaders are mostly male and on average 51 years old with a substantial variation in age. About 96 percents have attained at least a college degree. In Panel C, the GDP per capita highlights a substantial variation in economic

⁶In terms of hometown, 72.8% of city leaders are local. 20.8% and 80.4% of provincial top leaders and department directors are local, respectively. In terms of undergraduate alma mater, 62.9% of city leaders graduated from local universities. The proportions of local university graduates among provincial top leaders and department directors are 14.2% and 41.8%, respectively.

Table 1. Summary Statistics

	Mean	SD	Min	Max	Obs.
Panel A: Connections with Provincial Top Leaders and Department Directors					
With Provincial Top Leaders:					
HometownTie	0.093	0.290	0	1	627
CollegeTie	0.165	0.372	0	1	606
WorkTie	0.333	0.472	0	1	624
With Directors of Provincial Departments:					
HometownTie	0.308	0.462	0	1	627
CollegeTie	0.442	0.497	0	1	575
WorkTie	0.234	0.424	0	1	599
Panel B: City Leaders' Characteristics					
Party Secretary:					
Female	0.053	0.223	0	1	627
Age	51.896	3.457	41	60	627
College	0.951	0.217	0	1	627
Tenure Length	2.839	1.697	1	11	627
Mayor:					
Female	0.069	0.253	0	1	627
Age	50.013	3.889	39	60	627
College	0.965	0.184	0	1	627
Tenure Length	2.565	1.651	1	9	625
Panel C: City-level Fiscal and Macroeconomic Variables (in Chinese Yuan)					
GDP per capita	37903	25650	3832	153821	627
Municipal Funds per capita	920	2317	6.8	29769	624
Provincial Funds per capita	7.4	32.7	0	390.0	624
Panel D: City-level Urban Public Facilities					
Road	15.4	6.8	0.4	54.6	625
Water	201.7	77.8	49.0	1058.5	627
Green	11.7	3.5	1.3	22.7	626
Sewage	77.4	19.3	0.1	100.0	611

Notes: *Female* is a female dummy variable. *College* is a dummy variable for completing a bachelor's degree. *Road* means road surface area per capita (m^2). *Water* means daily water consumption per capita (liter). *Green* means public green space per capita (m^2). *Sewage* denotes sewage treatment rate (%).

conditions across cities. The variability is also notable in the municipal UMC Funds. Cities with higher tax revenue tend to allocate more funds towards urban construction. Panel D presents four key measures of urban public facilities – road area per capita (m^2), daily water consumption per capita (liter), public green space per capita (m^2), and sewage treatment rate (%). Road areas and water consumption exhibit a significant variation across cities.

III. Analysis

A. Baseline Analysis

We begin by analyzing the impact of political networks on the allocation of provincial UMC Funds. The baseline regression is a fixed effects model with the following specification:

$$\begin{aligned} ProvincialFunds_{ip,t+1} = & \beta_1 Connection_{ipt}^{cg} + \beta_2 Connection_{ipt}^{cd} \\ & + \mathbf{X}_{ipt}\delta + \omega_c + \eta_p + \gamma_t + \epsilon_{ipt} \end{aligned} \quad (1)$$

where i, p , and t index city, province, and year, respectively. Since fiscal allocations are typically determined as a part of the annual budget produced in the preceding year, we use the amount of provincial UMC Funds per capita received by city i , province p in year $t + 1$ as the dependent variable. $Connection_{ipt}^{cg}$ is a dummy variable indicating that at least one of the city's top leaders is associated with the provincial governor or party secretary via connection type $c \in \{HometownTie_g, CollegeTie_g, WorkTie_g\}$. $Connection_{ipt}^{cd}$ is a dummy variable indicating that at least one of the city's top leaders is associated with at least one of the directors of relevant provincial departments via connection type $c \in \{HometownTie_d, CollegeTie_d, WorkTie_d\}$.

Considering that the influence of political connections may vary depending on their source (e.g., specific cities, universities, or government departments), we create fixed effects for the most prevalent sources of these connections within each province. For hometown ties, we set fixed effects based on key sources, such as Hefei for Anhui, and categorize other officials into an “Anhui - Others” group, which includes those within Anhui province who are either connected but not based in Hefei or those without connections. A similar method is applied for college and workplace ties within each province, where fixed effects capture connections originating from the most common sources (e.g., a particular university or department), while the “Others” category in each province includes officials with connections from less common sources or those without any connections. This approach allows us to isolate the political influence of significant connection sources while controlling for other, less prevalent ties.⁷ Provincial fixed effects, η_p , capture the influence of cross-sectional variation in province-specific policies. Year fixed effects, γ_t , capture the influence of nationwide shocks on UMC funds, such as business cycles or variations in the central government’s annual construction plan. ϵ_{ipt} is an error term.

X is a vector of control variables for city-level time-varying economic and urban development conditions as well as the backgrounds of the two city leaders. The economic controls are GDP per capita and the city-level UMC Funds per capita. For urban development conditions, we control for road surface area per capita (m^2), daily water consumption per capita (liter), public green space per capita (m^2), and sewage treatment rate (%). City leaders’ background variables are age, gender, education, and tenure length.

⁷The most prevalent sources of hometown connection among both the city mayors and party secretaries for Anhui, Fujian, Guangdong, and Zhejiang provinces are Hefei, Fuzhou, Meizhou, and Shaoxing, respectively. The most prevalent university among both the city mayors and party secretaries by province is Anhui University (Anhui), Xiamen University (Fujian), Sun Yat-sen University (Guangdong), and Zhejiang University (Zhejiang). The most prevalent sources of *WorkTie* among both the city mayors and party secretaries are the Provincial Party Committee of each province

Table 2. Baseline Results

	DV: Provincial UMC Funds Per Capita ($t+1$)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>HowntownTie_g</i>	18.48*** (4.689)			12.95*** (4.667)			10.19* (5.366)			15.97*** (5.893)
<i>HowntownTie_d</i>	3.798 (2.959)			4.862 (2.985)			-3.923 (3.914)			-2.143 (4.264)
<i>CollegeTie_g</i>		-1.182 (4.108)			2.578 (3.946)			2.513 (4.761)		0.990 (4.736)
<i>CollegeTie_d</i>		-6.365** (3.063)			-7.347** (2.946)			-8.662** (3.879)		-8.896*** (3.889)
<i>WorkTie_g</i>			5.724* (2.933)			6.193** (3.142)			15.25*** (4.617)	12.88** (5.077)
<i>WorkTie_d</i>			-6.184* (3.245)			-3.349 (3.271)			-5.259 (3.337)	-5.943* (3.582)
Province & Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls				✓	✓	✓	✓	✓	✓	✓
Hometown FE							✓			✓
College FE								✓		✓
Work FE									✓	✓
R^2	0.048	0.022	0.031	0.204	0.204	0.201	0.251	0.208	0.215	0.310
Observations	624	571	593	605	556	573	604	556	576	530

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. Control variables are macroeconomic and fiscal conditions (GDP per capita and the municipal UMC Funds per capita), measures of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate), and city leaders' characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 presents the main ordinary least squares (OLS) results. Columns (1)-(3) use a parsimonious specification with only the connection variables and the province and year fixed effects. In Columns (4)-(6), we further include city-level controls. Columns (7)-(9) use a richer model that includes fixed effects for sources of connection described above. The results show positive effects of *HometownTie_g* and *WorkTie_g* on fiscal allocation, which are quite robust across specifications. Cities with top leaders sharing the birthplace with the provincial governor or party secretary receive an additional 10.2 to 18.5 yuan per capita, which is 0.31 to 0.57 standard deviation or 45 to 81 million yuan for an average-sized city. Cities with top leaders that have career profiles overlapping with any provincial top leaders obtain an additional 5.7 to 15.3 yuan per capita, which is 0.18 to 0.47 standard deviation or 25 to 67 million yuan for an average-sized city. Notably, the coefficient of *WorkTie* more than doubles after including the fixed effect for the source of the work ties, which suggests that the power of work ties varies significantly across groups.

In contrast, the results demonstrate the negative effects of *CollegeTie_d* on inter-governmental fund distribution. Specifically, when a city’s mayor or party secretary graduated from the same university as at least one director of funds-relevant provincial departments, the city receives a reduced amount of provincial UMC Funds, with a per capita decrease ranging from 6.37 to 8.90 yuan, which is a 0.19 to 0.27 standard deviation or 28 to 39 million yuan for an average-sized city. One possible mechanism behind the negative coefficient is competition. Since the city’s top leaders rank at the same level of the bureaucratic hierarchy (the Bureau-Director Level) as the directors of provincial departments, they are more likely to compete in the promotion process.

Table 2 also implies a negative influence of *WorkTie_d*, although the coefficient is insignificant after including a complete set of controls and workplace fixed effects. Similar rankings between city leaders and the directors of provincial departments imply

comparable work capacity. They were more likely to have competed than cooperated in the previous workplaces. Therefore, being connected to the directors of provincial departments through previous workplaces may give disadvantage to city leaders in securing provincial funds. Column (10) includes a complete set of connection variables, and the estimates are similar to those in the separate regressions, both in the magnitude and precision of coefficient estimates.

A concern on causal identification regarding the above fixed effects model is the potential assignment of members within the political network to cities that tend to receive a relatively large amount of provincial resources. This situation may cause violation of the parallel trend assumption. Hence, we investigate this issue as follow, as in [Jiang and Zhang \(2020\)](#). We include a set of dummy variables for whether a city will be, currently is, or was connected to the incumbent provincial officials. If the parallel trend assumption holds, we expect the patterns of financial allocations to the connected cities to be similar to the others before forming a connection and after losing one. We estimate the following model.

$$ProvincialFunds_{ip,t+1} = \sum_{\tau=-1}^{+1} \beta_{\tau} Connection_{i,t+\tau}^c + \mathbf{X}_{ict}\delta + \omega_c + \eta_p + \gamma_t + \epsilon_{ipt}. \quad (2)$$

where i, p , and t index city, province, and year, respectively. $Connection_{i,t+\tau}$ is a set of indicators that any top leader in city i is in the political network of provincial officials at time $t + \tau$. Given the baseline results, we only investigate three specific types of connection – *HometownTie_g*, *CollegeTie_d* and *WorkTie_g*.

Figure 2 presents the coefficient estimates and their 95% confidence intervals for connection variables from equation (2). The coefficient is significantly different from zero solely in the year of the connection. It implies that favoritism in resource allocation takes effect exclusively when connected officials are in office and promptly ceases upon

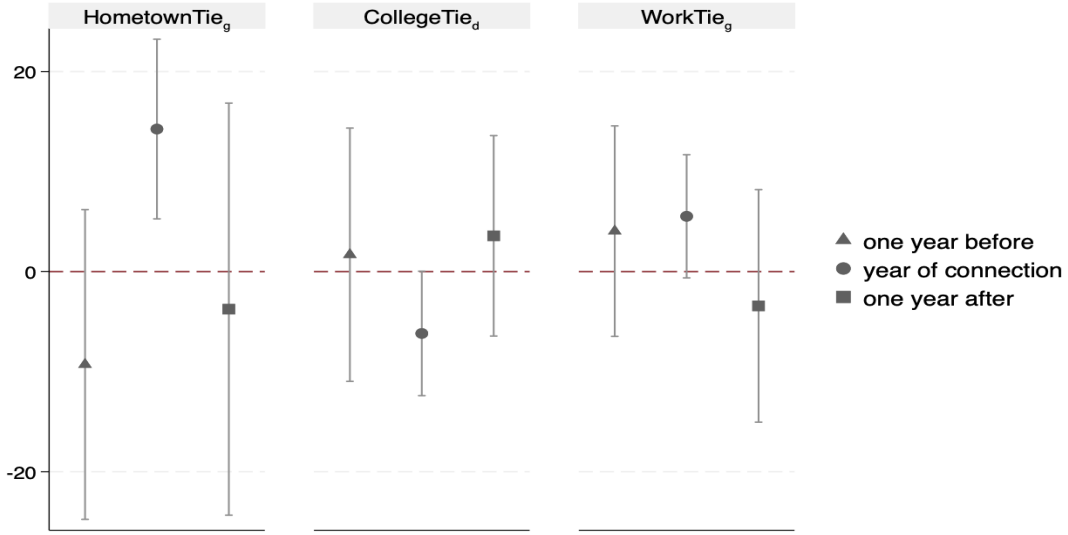


Figure 2. The Dynamic Effects of Political Networks on Fiscal Allocation

their departure. This result provides reassuring evidence that the connected cities do not significantly differ from the others in pre- and post-connection periods.

We take a further step to analyze differential effects from connections of different strength. We generate dummy variables for each type of connection that indicate whether the connections are based on two or more ties in a given year – *HometownTie2+*, *CollegeTie2+*, and *WorkTie2+* with subscripts g , for connections with provincial top leaders, and d for connections with the directors of provincial departments. Appendix Table C2 presents the results based on this alternative set of connection variables. The incremental influence of additional ties is not significant for hometown and work ties. Having college ties with more than one department director leads to a more serious disadvantage from connections, which is statistically significant at 10% level. The effect of having many members from the same college network among same-level officials will be discussed in detail in Section 4.

B. Robustness Check

In this section, we perform analyses to assess the robustness of our baseline results.

Table 3. Robustness Checks - Subsamples

	Birthplace			Provincial Capital			Poverty-stricken		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>HowntownTie_g</i>	22.55*** (7.479)			10.13* (5.675)			12.45* (7.027)		
<i>HowntownTie_d</i>	0.222 (5.085)			-3.996 (4.054)			-7.474 (5.033)		
<i>CollegeTie_g</i>		3.993 (5.993)			3.202 (5.208)			3.789 (6.033)	
<i>CollegeTie_d</i>		-10.54** (4.647)			-9.469** (4.120)			-10.73** (4.901)	
<i>WorkTie_g</i>			17.11*** (5.998)			16.66*** (4.876)			22.45*** (6.300)
<i>WorkTie_d</i>			-6.008 (4.053)			-4.039 (3.571)			-5.024 (4.653)
Province and Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hometown FE	✓			✓			✓		
College FE		✓			✓			✓	
Work FE			✓			✓			✓
R^2	0.318	0.242	0.253	0.254	0.214	0.225	0.275	0.236	0.248
Observations	476	440	456	571	525	544	459	428	438

Notes: Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Subsamples. We first examine whether a small number of cities that can independently secure more resources for other reasons might be driving the results. For example, provincial officials may preferentially allocate funds to their birthplaces.⁸ Columns (1)-(3) of Table 3 show the estimation results when we exclude birthplaces of

⁸Such favoritism for birthplaces has been previously documented in Wang et al. (2014), Carozzi and Repetto (2016), and ?.

the incumbent provincial leaders. The magnitude of estimated coefficients of political connections increases after excluding such cities.

In Columns (4)-(6) of Table 3, we exclude four provincial capitals – Guangzhou (Guangdong), Hefei (Anhui), Fuzhou (Fujian) and Hangzhou (Zhejiang). Provincial capitals may have greater bargaining power to secure provincial funds. In Columns (7)-(9) of Table 3, we exclude cities governing poverty-stricken counties, which are officially designated and prioritized for financial assistance. Overall, the estimated coefficients of political connections is roughly comparable in both the magnitude and precision. These patterns suggest that our findings are not driven by a specific groups of cities with distinctive characteristics.

Alternative Dependent Variables. We also investigate whether our main findings are sensitive to the choice of the dependent variable. Most urban facilities (e.g., green space and sewage treatment plants) occupy a large area and are proportional to the city size. In Columns (1)-(4) of Table 4, we replace the dependent variable with the amount of provincial funds divided by the area size of the district equipped with public facilities. In Columns (5)-(8), we use the logarithm of the amount of the provincial UMC funds.⁹ The main results remain robust with both alternative dependent variables, except that the estimate of $WorkTie_d$ becomes significantly negative when we use the logarithm of provincial funds.

Exogenous Turnover. Finally, we perform further analyses to alleviate concerns about the joint determination of funding allocations and the appointment of officials for leadership positions. For instance, officials may be more motivated to raise funds and invest in urban infrastructure when they first take office than when they are about

⁹The reduction in the sample size is due to cities that received no funding in the given year, which are dropped in the process of taking the logarithm.

Table 4. Robustness Checks - Alternative Dependent Variables

	Divided by Area of Built District				Log Term			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>HowntownTie_g</i>	45.62** (22.45)			61.09** (25.14)	1.035** (0.491)			1.642*** (0.514)
<i>HowntownTie_d</i>	-16.26 (16.44)			-14.56 (18.26)	0.070 (0.352)			-0.175 (0.358)
<i>CollegeTie_g</i>		12.96 (19.97)		10.24 (20.33)		-0.536 (0.413)		-0.696* (0.412)
<i>CollegeTie_d</i>		-36.26** (16.21)		-38.40** (16.59)		-0.930*** (0.339)		-1.062*** (0.362)
<i>WorkTie_g</i>			64.38*** (19.68)	51.62** (21.75)			1.065*** (0.397)	1.051** (0.406)
<i>WorkTie_d</i>			-16.40 (14.14)	-18.23 (15.31)			-0.799*** (0.282)	-0.986*** (0.293)
Province and Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Hometown FE	✓			✓	✓			✓
College FE		✓		✓		✓		✓
Work FE			✓	✓			✓	✓
R^2	0.215	0.173	0.178	0.266	0.242	0.247	0.248	0.390
Observations	604	556	576	530	294	273	279	260

Notes: Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

to leave. To investigate this possibility, we focus on the National Congress of the CCP. It is an event that is held every five years, where the turnover of officials is determined. Thus, we create a dummy variable NCC to indicate the year of the National Congress, which was 2007 and 2012 during our data period.

Table 5 presents the results. When we include the interaction terms between NCC and the connection variables, their coefficient estimates are statistically insignificant. As shown in Column (4), the results are still robust even when we include a complete set of connection variables, which suggests that changes in political posts have limited effects on funding allocations. Hence, the results are less likely to be driven by the

Table 5. Exogenous Turnover

	DV: Provincial Funds Per Capita			
	(1)	(2)	(3)	(4)
<i>HowntownTie_g</i>	11.45** (5.686)			17.07*** (6.293)
<i>HowntownTie_d</i>	-3.731 (4.098)			-1.832 (4.493)
<i>HowntownTie_g × NCC</i>	-10.01 (13.02)			-10.14 (13.72)
<i>HowntownTie_d × NCC</i>	-1.489 (7.219)			-2.275 (7.967)
<i>CollegeTie_g</i>		2.904 (4.933)		1.006 (4.934)
<i>CollegeTie_d</i>		-9.041** (4.214)		-8.938** (4.230)
<i>CollegeTie_g × NCC</i>		-3.212 (11.53)		-0.346 (11.29)
<i>CollegeTie_d × NCC</i>		0.792 (7.482)		1.582 (7.611)
<i>WorkTie_g</i>			16.20*** (4.713)	14.02*** (5.205)
<i>WorkTie_d</i>			-4.893 (3.712)	-5.765 (4.023)
<i>WorkTie_g × NCC</i>			-7.711 (7.412)	-10.56 (7.817)
<i>WorkTie_d × NCC</i>			-0.875 (7.850)	1.077 (8.080)
Province and Year FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Hometown FE	✓			✓
College FE		✓		✓
Work FE			✓	✓
<i>R</i> ²	0.252	0.208	0.216	0.313
Observations	604	556	576	530

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. *NCC* is an indicator variable denoting the year of the National Congress of the CCP. Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

exogenous turnover.

IV. Mechanisms and Heterogeneous Effects

In the previous section, we established a robust relationship between shared hometown, college, and work backgrounds and the allocation of provincial UMC funds. We now propose potential mechanisms behind the main results and discuss their evidence by conducting analyses of the heterogeneity in the effect of social connections.

A. Mechanisms

Trust. The social capital based on shared hometown or work histories may affect trust between individuals, encourage voluntary cooperation, and mitigate collective action problems. The role of such social capital, in turn, depends on the characteristics of the social environment. For instance, cities with high population diversity or mobility may give strong incentives for heterogeneous groups to interact with each other, which may, in turn, decrease the favoritism among officials with shared backgrounds. In sum, we postulate that population diversity and mobility reduce the favoritism based on shared backgrounds.

The value of the connection may also vary as a function of the context and the duration of the connection. Individuals who reside distantly from their hometown may appreciate their compatriots more due to their scarcity and a sense of social isolation, thereby strengthening intra-group trust. Hence, we compare the effects of hometown ties across local and outsider groups.

Also, longer-term relationships may provide more opportunities to strengthen mutual trust. Thus, we compare the impacts of work ties across three intervals of the duration of the relationship – more than ten years, five to ten years, and less than five

years.

Competition. As we briefly discussed above, competition among officials with similar ranks can be a plausible mechanism behind our baseline results on the negative estimated coefficients of *CollegeTie* with the directors of provincial departments. Officials from the same college network at a comparable level of seniority may compete for resources and status (Fisman et al., 2020). Therefore, they may impede resource allocation to one other. It is especially the case when the network size is large enough for the competition to be fierce.

Along with such intra-group competition, there may also be competition between groups. Specifically, government officials may wish to avoid any particular network within the government from obtaining too much power (Francois et al., 2023, Fisman et al., 2020). Accordingly, for college ties, competition may well be more intense among graduates from local universities, who form a large proportion of officials within the government. In 2015, for example, the proportions of city mayors and party secretaries who graduated from local universities were 61.4 and 57.9 percents, respectively. Hence, it is plausible to postulate that intra- and inter-group competition leads to a stronger disadvantage from college connections for graduates of local universities relative to those of non-local universities.

Furthermore, the disadvantage from connections may persist in the long run. If city and provincial leaders were on the same level of hierarchy in their shared work experience, they may have competed at the time. Such a history may, in turn, result in an unfriendly relationship in the long run and negatively influence resource allocations. To assess this possibility, we further explore the heterogeneity in the past work relationships, focusing on whether a city leader was once a superior to, a subordinate to, or at the same level as provincial leaders.

B. Heterogeneous Effects of Connections: Results

Trust. To explore the role of intra-group trust, we analyze the heterogeneity in the effect of social connection along the dimension of population diversity and mobility. We construct two indices, one for population diversity and the other for mobility, and then interact them with each connection variable as follows.

$$\begin{aligned} ProvincialFunds_{ip,t+1} = & \beta_1 Connection_{ipt}^{cg} + \beta_{11} Connection_{ipt}^{cg} \times Diversity_p \\ & + \beta_2 Connection_{ipt}^{cd} + \beta_{21} Connection_{ipt}^{cd} \times Diversity_p \\ & + \beta_3 Diversity_p + \mathbf{X}_{ipt}\delta + \gamma_t + \eta_p + \omega_c + \epsilon_{ipt} \end{aligned} \quad (3)$$

where $Diversity_p$ measures the population diversity (or mobility) in province p .

The measure of population diversity we construct is a Shannon index:

$$Diversity_p = - \sum_{i=1}^R s_i \ln s_i \quad (4)$$

where s_i is the share of the population that belongs to type i , calculated based on the sixth Census, conducted by the National Bureau of Statistics in 2010. R is the total number of types. If $R = 1$, i.e. there is only one type of population, $Diversity_p$ reaches its minimum value zero. If $R \geq 2$ and the population is evenly distributed, $Diversity_p$ reaches its maximum value $\ln R$. The larger the value of the index, the higher the degree of population diversity.

We define 32 population types ($R = 32$) based on the household registration of the current population residing in province p . This encompasses individuals from the local city, other cities within the province, and other mainland provinces.

We also construct a measure of population mobility using the share of floating population among the population captured by the census. We define $Mobility_p$ as

follows, based on the population of the provincial capital, where provincial policymakers live, work, and shape attitudes toward the members of their political networks.

$$Mobility_p = 1 - \frac{Registered\ Population}{Resident\ Population} \quad (5)$$

Registered population refers to the population registered in the the Household Registration (“*Hukou*”) system. *Resident population* is the total number of people who lived in a given area for more than half a year. Being enrolled in the Household Registration system enables access to local resources, such as education and medical treatment. Individuals who plan to settle down in the province have strong incentives to get registered. Therefore, we regard the share of the non-registered population as a measure of the floating population in the province.

Table 6 presents the regression results of the model above. Columns (1)-(3) and (4)-(6) employ *Diversity_p* and *Mobility_p*, respectively. Including interaction terms moderates the influence of *HometownTie* and *CollegeTie*. However, Columns (3) and (6) exhibit a positive coefficient for the interaction between *WorkTie* and the level of population diversity. This result may be due to the intrinsic difference between *WorkTie* and the other two connection types. *WorkTie* forms solely when individuals have been colleagues, meaning a more direct connection than hometown or college ties. Thus, if population mobility reduces biases against individuals with different origins, it fosters increased trust among those who have worked with each other before.

We now turn to investigating the heterogeneous effects of hometown ties in terms of the size and origin of the network. The impacts of *HometownTie* may be more sizable among outlanders due to the smallness of the network and closer interaction among members. In Table 7, we divide the city leaders into two subgroups depending on the locality of their birthplaces. In Column (2), we exclude city leaders who are

Table 6. Heterogeneous Effects - Population Diversity

	DV: Provincial Funds Per Capita					
	Shannon Index			Floating Population		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>HometownTie_g</i>	-0.838 (24.686)			-20.267** (10.176)		
<i>HometownTie_d</i>	21.299 (24.486)			3.545 (8.257)		
<i>HometownTie_g × Diversity_p</i>	5.353 (11.816)			146.714*** (42.609)		
<i>HometownTie_d × Diversity_p</i>	-12.117 (11.625)			-32.916 (30.999)		
<i>CollegeTie_g</i>		-20.068 (20.185)			-16.977* (10.197)	
<i>CollegeTie_d</i>		-8.354 (12.845)			-7.599 (6.900)	
<i>CollegeTie_g × Diversity_p</i>		11.236 (9.742)			86.363** (40.111)	
<i>CollegeTie_d × Diversity_p</i>		-0.360 (6.784)			-12.333 (28.748)	
<i>WorkTie_g</i>			-21.586 (20.580)			-3.095 (7.995)
<i>WorkTie_d</i>			-11.912 (11.570)			-7.889 (5.517)
<i>WorkTie_g × Diversity_p</i>			19.002* (10.207)			107.734*** (37.592)
<i>WorkTie_d × Diversity_p</i>			4.314 (6.164)			23.767 (27.275)
<i>Diversity_p</i>				-73.115 (70.493)	-36.859 (97.884)	-102.758 (71.861)
Province and Year FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Hometown FE	✓			✓		
College FE		✓			✓	
Work FE			✓			✓
<i>R</i> ²	0.253	0.211	0.223	0.270	0.216	0.230
Observations	604	556	576	604	556	576

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. *Diversity_p* measures the degree of population diversity in province p . Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Heterogeneity Effects - Locality of Hometown

	DV: Provincial Funds Per Capita		
	Baseline	Outlander	Local
<i>HometownTie_g</i>	10.19* (5.366)	30.42*** (7.542)	-8.485 (7.956)
<i>HometownTie_d</i>	-3.923 (3.914)	-9.416 (8.490)	-1.932 (5.407)
Province and Year FE	✓	✓	✓
Controls	✓	✓	✓
Hometown FE	✓	✓	✓
R^2	0.251	0.377	0.314
Observations	604	280	324

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

local. Compared with the baseline regression in Column (1), the estimated impact of *HometownTie* is three times as large in Column (2), which is consistent with the hypothesis above. In Column (3), we include only local officials. The coefficient estimate becomes insignificant, which is again consistent with our hypothesis above.

As discussed above, intra-group trust may also be correlated with the length of the relationship, making the effects of political networks vary over time. Since the data does not allow for determining when officials built connections via hometown or college ties, we only consider the heterogeneity of duration in *WorkTie* and estimate the following model.

$$\begin{aligned}
ProvincialFunds_{ip,t+1} = & \beta_1 \sum_j WorkTie_{g,ipt}^j + \beta_2 \sum_j WorkTie_{d,ipt}^j \\
& + \mathbf{X}_{ipt}\delta + \gamma_t + \eta_p + \omega_c + \epsilon_{ipt}
\end{aligned} \tag{6}$$

where $WorkTie_{g,ipt}^j$ is a set of dummy variables indicating that any top leader in city

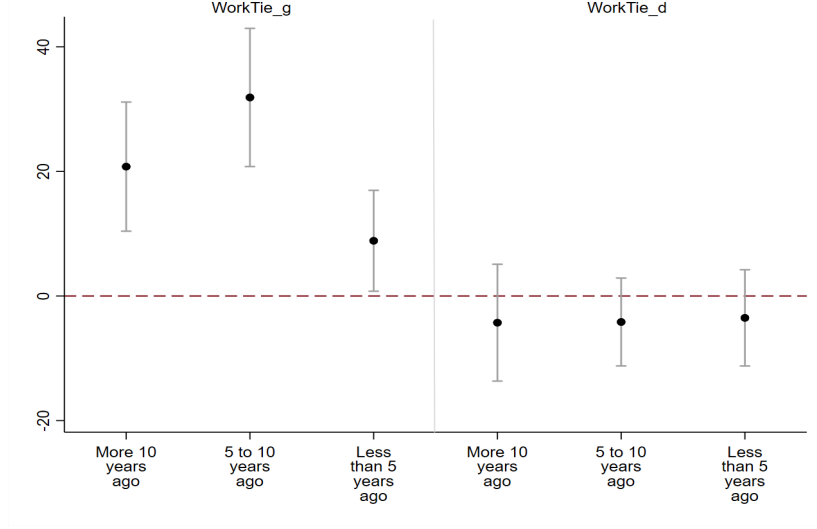


Figure 3. The time-variant impacts of WorkTie

i was the colleague of any provincial top leader j years ago in year t , where j is more than ten, five to ten, less than five years. $WorkTie_{d,ipt}^j$ is a set of indicators that any top leader in city i once worked with any director of provincial departments j years ago in year t .

Figure 3 shows that the estimated coefficients are more pronounced for longer-term relationships (more than five years). However, the estimated coefficients do not exhibit a monotone relation between the advantages from the work ties and the length of the relationship. One possible reason is that individuals who interacted long ago may have lost contacts in recent years, resulting in the weakening of the relationship.

Competition. We next turn to the analysis of competition as a mechanism for the disadvantage from connections, by focusing on the heterogeneity in college and work ties. We begin with heterogeneity in college ties – whether the shared undergraduate alma mater is located outside the province. We allow for the disadvantage from connections to vary as a function of the location of the alma mater. We interact college ties with $LocalU$, a dummy variable indicating whether the connected officials grad-

uated from a university inside the province. Table 8 reports the results. Column (2) shows that having college ties with the directors of provincial departments reduce the amount of provincial funds received, but only if the connected officials graduated from local universities.

Table 8. Heterogeneity in the Location of the Alma Mater

	DV: Provincial Funds Per Capita	
	Baseline	Local University
<i>CollegeTie_g</i>	2.513 (4.761)	-2.930 (8.381)
<i>CollegeTie_d</i>	-8.662** (3.879)	3.193 (6.431)
<i>CollegeTie_g × LocalU</i>		7.666 (9.507)
<i>CollegeTie_d × LocalU</i>		-18.235*** (6.734)
<i>LocalU</i>		13.583*** (4.031)
Province and Year FE	✓	✓
Controls	✓	✓
College FE	✓	✓
R^2	0.208	0.217
Observations	556	556

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. *LocalU* is an indicator variable indicating that the common alma mater locates within the province. Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

City top leaders and provincial department directors are both at the Bureau-Director level. Given their comparability in the rank, there can be an interesting variation in their past work relationships. That is, city leaders may have been superior to the provincial department directors, vice versa, or they may have been equals. In contrast, provincial top leaders, who are ranked higher than city leaders, were usually superior to city leaders in their past work relationship. Therefore, we focus on ana-

lyzing how the (dis)advantages from work ties varies with the type of the past work relationships.

We divide the officials into three subsamples based on whether any city leader was ever subordinate to, superior to, or ranked at the same level as any directors of relevant provincial departments. If competitive relationships are persistent, we expect a more negative coefficient estimate on *WorkTie_d* in the third subgroup.

Table 9. Heterogeneity in the Past Work Relationships

	DV: Provincial Funds Per Capita			
	Baseline	Subordinate	Superior	The same-level
<i>WorkTie_g</i>	15.25*** (4.617)	15.12*** (4.630)	14.68*** (4.641)	15.35*** (4.652)
<i>WorkTie_d</i>	-5.259 (3.337)	-4.771 (5.625)	-1.826 (5.310)	-4.164 (4.609)
Province and Year FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Work FE	✓	✓	✓	✓
<i>R</i> ²	0.215	0.212	0.211	0.212
Observations	576	576	576	576

Notes: The dependent variable is the amount of provincial UMC Funds per capita in year $t + 1$. Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9 presents the regression results for three subgroups. Column (2) excludes cities where the city top leaders' position was higher than or equal to that of any provincial directors in their past work relationships; Column (3) excludes cities with top leaders whose rank was lower than or equal to any provincial directors in their past work relationships; Column (4) excludes cities with top leaders who were previously ranked lower or higher than any provincial directors. Given the lack of precision in the coefficient estimates, we cannot reject the equality of the coefficient on *WorkTie_d* in any case at the 10 percent level, which does not enable us to draw strong conclusions

on the persistent negative impacts of competition.

V. Consequences of Network-based Fiscal Allocation

In this section, we analyze the possible consequences of network-based fiscal allocation, focusing on the promotion of officials and the efficiency in the utilization of funds.

A. Impacts on the Promotion of Officials

To examine how the network-based resource allocation affects the promotion of officials, we employ a Logit model. Given that provincial top leaders make the promotion decision for city top leaders, we only consider the connection between the them.¹⁰ Given our baseline results, we only include hometown and work ties in the model as follows:

$$\begin{aligned} Promoted_{ip,t+1} = & \beta_1 Connected_{g,ipt} + \beta_{11} Connected_{g,ipt} \times Funded_{ip,t+1} \\ & + \beta_2 Funded_{ip,t+1} + \mathbf{X}_{ipt} \delta + \gamma_t + \eta_p + \epsilon_{ipt} \end{aligned} \quad (7)$$

where i, p , and t denote city, province, and year, respectively. The dependent variable, $Promoted_{ip,t+1}$, is a binary variable, which equals 1 if any of city i 's top leaders is promoted¹¹ in year $t + 1$ and equals 0 if not. $Connected_{g,ipt}$ is a dummy variable

¹⁰Specifically, city top leaders are appointed through nominations by the standing committee of the higher-level party committee. This standing committee, composed of a select group of high-ranking officials, proposes candidates. These nominees are then reviewed and approved by the full committee, which includes broader representation from the provincial party. Final approval is secured through a secret ballot conducted by the full committee ([Central Committee of the Chinese Communist Party, 2019](#)). As top leaders are the highest-ranking members of the standing committee, they hold significant power in promotion decisions.

¹¹We follow [Li and Zhou \(2005\)](#) and [Yao and Zhang \(2015\)](#) to define promotion as follows: (i) a switch from a mayor to a party secretary in any city; (ii) a switch from an ordinary city to the mayor or the party secretary of a sub-provincial city (a city with greater administrative autonomy); (iii) a switch from any city to the central government or to a provincial government as a party secretary, a governor, a vice secretary, or a vice governor; or (iv) being appointed as a member of the Standing Committee of the CCP provincial branch. There is an important distinction between the existing and present studies in how the promotion is defined. Unlike existing studies, we do *not* categorize a

indicating that at least one of city i 's top leaders has hometown or work ties with any of provincial top leaders.¹² $Funded_{ip,t+1}$ is a dummy variable indicating that city i received provincial UMC funds in year $t + 1$. Accordingly, the interaction term $Connected_{g,ipt} \times Funded_{ip,t+1}$ generates four combinations: connected and funded, connected and not funded, not connected and funded, and not connected and not funded. X is a vector of control variables for economic growth (the growth rate of GDP) and officials' demographic characteristics (age, gender, education level, and tenure length).

We run the regression separately for each of the four cases. The first four subgraphs in Figure presents the coefficients from each of the four cases.

Table 10 reports the estimation result. Column 1 shows that among city leaders connected to provincial leaders, receiving provincial funding significantly increases the likelihood of promotion. In contrast, access to funding does not significantly influence the promotion rate of unconnected officials.

We further replace $Funded_{ip,t+1}$ with the specific amount of provincial funds. We do not find any significant impacts of the amounts of funds on the likelihood of promotion (the second column in Table 10). A possible reason is that the amount of funds is affected by other factors, such as the level of the development of urban public facilities and the amount of municipal UMC Funds, leading to a weak relationship between provincial funds and the evaluation of performance. Overall, the results provide some evidence that city officials who receive provincial funds tends to have better chance of promotion, if they are connected.

move from a city to the directorship of a provincial functional department as a promotion. Although a director takes charge of his department of the whole province, a mayor is in charge of the whole city. Hence, it is unobvious whether one has a higher authority than the other. Another distinction is that we categorize being selected as a member of the Standing Committee of the CCP Provincial Committee as a promotion.

¹²Given the negative estimate on college ties with the directors of provincial departments, we exclude cities with $CollegeTie_d = 1$.

Table 10. The Impacts of Network-based Fiscal Allocation on Promotion

	DV: Promoted in The Next Year	
$Connected_g$	-0.280 (0.207)	-0.018 0.149
$Connected_g \times Funded$	0.484* (0.275)	
$Funded$	0.095 (0.175)	
$Connected_g \times \#Funded$		0.003
$\#Funded$		-0.001
Province and Year FE	✓	✓
With controls	✓	✓
Observations	605	605

Notes: The dependent variable is a dummy indicating whether the city mayor or party secretary was promoted in the following year. The *Funded* dummy variable indicates whether city i received provincial UMC Funds in year $t+1$. $\#Funded$ represents the total amount of funding received. Control variables include GDP per capita, urban infrastructure (such as road area, water consumption, green space, and sewage treatment), and individual characteristics (such as age, gender, education, and tenure). Standard errors are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B. The Impacts on the Efficiency of Fund Utilization

Now we turn to investigating whether connection-based favoritism affects the efficiency of fund utilization. To this end, we construct a measure of urban public facilities at the city level, using the principal component analysis (PCA). We present the details of our analysis in Appendix Section D.

We use the score we construct of the urban public facilities as the dependent variable and estimate the following model.

$$\begin{aligned}
Score_{ip,t+1} = & \beta_1 ProvincialFunds_{ip,t+1} + \beta_{11} Connection_{ipt}^c \times ProvincialFunds_{ip,t+1} \\
& + \beta_2 Connection_{ipt}^c + \mathbf{X}_{ipt}\delta + \gamma_t + \eta_p + \omega_c + \epsilon_{ipt}
\end{aligned} \tag{8}$$

where i, p , and t denote city, province, and year, respectively. $Score_{ip,t+1}$ is the measure of the urban public facilities in city i in year $t+1$. $ProvincialFunds_{ip,t+1}$ is the amounts of the provincial UMC Funds per capita received by city i in year $t+1$. $Connection_{ipt}^c$ is an indicator variable denoting that city leaders are connected with provincial leaders via type $c \in \{HometownTie_g, CollegeTie_d, WorkTie_g\}$. X is a vector of control variables, including GDP per capita, municipal UMC Funds per capita, and individual characteristics (age, gender, education, and tenure length). γ_t is a year fixed effect, ω_c is a set of fixed effects for each type of connection, η_p is a province fixed effect, and ϵ_{ipt} is an error term.

Table 11 reports the regression results. As expected, the amounts of provincial funds is positively correlated with the measure of urban public facilities. However, the negative coefficients of the interaction terms with *CollegeTie* and *WorkTie* suggest that the positive effect of provincial funds on urban facilities is smaller for cities governed by leaders who have hometown or work ties to provincial top leaders. Overall, the evidence in this section indicates that provincial top leaders allocate funds more favorably to a subset of network members, whom they later promote. Such network-based favoritism in financial allocation may reduce the efficiency of fund use, thereby leading to a waste of resources.

Table 11. Impacts on the Efficiency of Fund Utilization

	DV: Score of Urban Public Facilities		
	(1)	(2)	(3)
$HowntownTie_g \times ProvincialFunds$	-0.344* (0.179)		
$CollegeTie_d \times ProvincialFunds$		0.227 (0.181)	
$WorkTie_g \times ProvincialFunds$			-0.354** (0.180)
$ProvincialFunds$	0.00371* (0.00124)	0.00168* (0.00097)	0.00322** (0.00134)
$HowntownTie_g$	22.114* (11.899)		
$CollegeTie_d$		-6.381 (8.381)	
$WorkTie_g$			16.337* (9.480)
Controls	✓	✓	✓
Province and Year FE	✓	✓	✓
Hometown FE	✓		
College FE		✓	
Work FE			✓
Observations	560	515	557
R^2	0.637	0.628	0.633

Notes: The dependent variable represents the score of urban public facilities obtained from the PCA, which has been scaled by a factor of 100 in this table. Control variables include GDP per capita, the municipal UMC Funds per capita and individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

VI. Conclusion

This article uses China as a case to explore how informal intra-governmental networks shape the distribution of fiscal funds. Focusing on the allocation of the Urban Maintenance and Construction Fund, we use a novel dataset to investigate how sharing backgrounds with provincial officials affects the funds received.

The results show that cities with top leaders sharing the birthplace or overlapping work history with the provincial governor or party secretary tend to receive more

UMC Funds. The positive correlation can be partially attributed to trust. In contrast, graduating from the same university as any director of the relevant functional departments may prevent city leaders from securing more funds. One potential explanation is that city's top leaders hold a similar rank to directors of provincial departments, thus positioning them as potential competitors in the promotion process. Examining the consequences of this network-based fiscal distribution, we further find that officials within the network exhibit a higher likelihood of promotion, particularly when they acquire provincial funds. However, such distributive favoritism appears to negatively impact the efficiency of fund utilization.

Taking a broader view, beyond reaffirming the crucial role of informal networks with provincial top leaders, we underscore the potential existence of connection penalties with other provincial officials. We also claim that the quality of connections may vary among network members. As a result, solely linking the membership with the likelihood of promotion without considering the nuanced differences in the relationship may lead to biased results. One limitation of this paper is that to identify the provincial officials who speak up, we only focus on one diversion of fiscal funding. Consequently, the conclusions may not be precisely suitable for the other diversions. Our study provides evidence that only considering the connections among government top leaders may be inadequate to explain the political economy of intergovernmental fiscal transfers in China.

References

- Barbosa, K. and F. Ferreira (2023). Occupy government: Democracy and the dynamics of personnel decisions and public finances. *Journal of Public Economics* 221, 104856.
- Carozzi, F. and L. Repetto (2016). Sending the Pork Home: Birth Town Bias in Transfers to Italian Municipalities. *Journal of Public Economics* 134, 42–52.
- Central Committee of the Chinese Communist Party (2019). Regulations on the selection and appointment of leading party and government cadres (in Chinese). https://www.gov.cn/zhengce/2019-03/17/content_5374532.htm. Accessed: 25 July 2024.
- Dickens, A. (2018). Ethnolinguistic Favoritism in African Politics. *American Economic Journal: Applied Economics* 10(3), 370–402.
- Fan, Z. and X. Li (2014). Political Connection of Ministers and the Allocation of Fiscal Transfer (in Chinese). *Economic Research Journal* 6, 129–141.
- Fisman, R., J. Shi, Y. Wang, and W. Wu (2020). Social Ties and the Selection of China’s Political Elite. *American Economic Review* 110(6), 1752–81.
- Fisman, R., J. Shi, Y. Wang, and R. Xu (2018). Social Ties and Favoritism in Chinese Science. *Journal of Political Economy* 126(3), 1134–1171.
- Fourinaies, A. and H. Mutlu-Eren (2015). English Bacon: Copartisan Bias in Inter-governmental Grant Allocation in England. *The Journal of Politics* 77(3), 805–817.
- Francois, P., F. Trebbi, and K. Xiao (2023). Factions in nondemocracies: Theory and evidence from the Chinese Communist Party. *Econometrica* 91(2), 565–603.
- Gonschorek, G. J. (2021). Subnational Favoritism in Development Grant Allocations: Empirical Evidence from Decentralized Indonesia. *World Development* 139, 105299.
- He, X. and K. H. Ng (2017). “it must be rock strong!” guanxi’s impact on judicial decision making in china. *The American Journal of Comparative Law* 65(4), 841–

871.

- Jia, R., M. Kudamatsu, and D. Seim (2015). Political Selection in China: The Complementary Roles of Connections and Performance. *Journal of the European Economic Association* 13(4), 631–668.
- Jiang, J. and M. Zhang (2020). Friends with Benefits: Patronage Networks and Distributive Politics in China. *Journal of Public Economics* 184, 104143.
- Kahn, M. E., W. Sun, J. Wu, and S. Zheng (2018). The Revealed Preference of the Chinese Communist Party Leadership: Investing in Local Economic Development versus Rewarding Social Connections. *National Bureau of Economic Research*.
- Landry, P. F., X. Liu, and H. Duan (2018). Does Performance Matter? Evaluating Political Selection Along the Chinese Administrative Ladder. *Comparative Political Studies* 51(8), 1074–1105.
- Li, H. and L.-A. Zhou (2005). Political Turnover and Economic Performance: The Incentive Role of Personnel Control in China. *Journal of Public Economics* 89(9–10), 1743–1762.
- Li, M., X. Sun, Y. Wang, and H. Song-Turner (2019). The Impact of Political Connections on the Efficiency of China’s Renewable Energy Firms. *Energy Economics* 83, 467–474.
- Li, X., J. Li, J. Wang, and D. Si (2021). Trade Policy Uncertainty, Political Connection, and Government Subsidy: Evidence from Chinese Energy Firms. *Energy Economics* 99, 105272.
- Meng, H., X. Huang, H. Yang, Z. Chen, J. Yang, Y. Zhou, and J. Li (2019). The Influence of Local Officials’ Promotion Incentives on Carbon Emission in Yangtze River Delta, China. *Journal of Cleaner Production* 213, 1337–1345.
- Panda, P. K. (2016). Economic and Political Determinants of Central Fiscal Transfers in India: A Dynamic Panel Analysis of State Level Data. *The Journal of Developing*

Areas, 329–347.

Porto, A. and P. Sanguinetti (2001). Political Determinants of Intergovernmental Grants: Evidence from Argentina. *Economics & Politics* 13(3), 237–256.

Que, W., Y. Zhang, and G. Schulze (2019). Is Public Spending Behavior Important for Chinese Official Promotion? Evidence from City-Level. *China Economic Review* 54, 403–417.

Ru, H. and K. Zou (2022). How do individual politicians affect privatization? evidence from china. *Review of Finance* 26(3), 637–672.

Shih, V., C. Adolph, and M. Liu (2012). Getting Ahead in the Communist Party: Explaining the Advancement of Central Committee Members in China. *American Political Science Review* 106(1), 166–187.

Wan, X., Y. Ma, and K. Zhang (2015). Political Determinants of Intergovernmental Transfers in a Regionally Decentralized Authoritarian Regime: Evidence from China. *Applied Economics* 47(27), 2803–2820.

Wang, J., Y. Zou, and Q. Wang (2014). Fiscal transfers from the central government to provinces in China: potential influence of the native-place connections of politburo members. *Journal of Chinese Economics* 2(3).

Wang, Z., Q. Zhang, and L.-A. Zhou (2020). Career incentives of city leaders and urban spatial expansion in china. *Review of Economics and Statistics* 102(5), 897–911.

Weng, Y. and H. Xu (2018). How Guanxi Affects Job Search Outcomes in China? Job Match and Job Turnover. *China Economic Review* 51, 70–82.

Wilson, J. and R. Brennan (2010). Doing Business in China: Is the Importance of Guanxi Diminishing? *European Business Review*.

Yao, Y. and M. Zhang (2015). Subnational Leaders and Economic Growth: Evidence from Chinese Cities. *Journal of Economic Growth* 20(4), 405–436.

Yu, M., Y. Hui, and H. Pan (2010). Political Connections, Rent Seeking, and the Fiscal

- Subsidy Efficiency of Local Governments. *Economic Research Journal* 3, 65–77.
- Zeng, J. and Q. Zhou (2024). Mayors' promotion incentives and subnational-level gdp manipulation. *Journal of Urban Economics* 143, 103679.

Appendix

This appendix provides supplementary material to the paper “City’s Soft Power: Political Networks and Financial Allocation in China.” Section A describes the administrative divisions and the Cadre Rank System of China. Section B displays the locations of the four provinces included in the sample. Section C presents additional tables comparing different samples with other literature and includes additional empirical analysis. Section D provides details of the process used to evaluate urban public facilities.

Appendix A. Administrative Divisions and the Cadre Rank System in China

Appendix Figure A1 illustrates the five-level administrative divisions of China based on data from 2015. This paper examines inter-government fiscal transfers between provincial-level and prefecture-level units. Appendix Figure A2 illustrates the cadre rank system of China. In this system, prefecture-level cities are categorized into sub-provincial cities and other types. Sub-provincial cities, although governed by provincial cadres, have officials whose rank is half a level above the prefectural rank and half a level below the provincial rank. For cities that are not sub-provincial, the party secretary and mayor hold the same rank, specifically “department and bureau level,” which is equivalent to the heads of provincial functional departments.

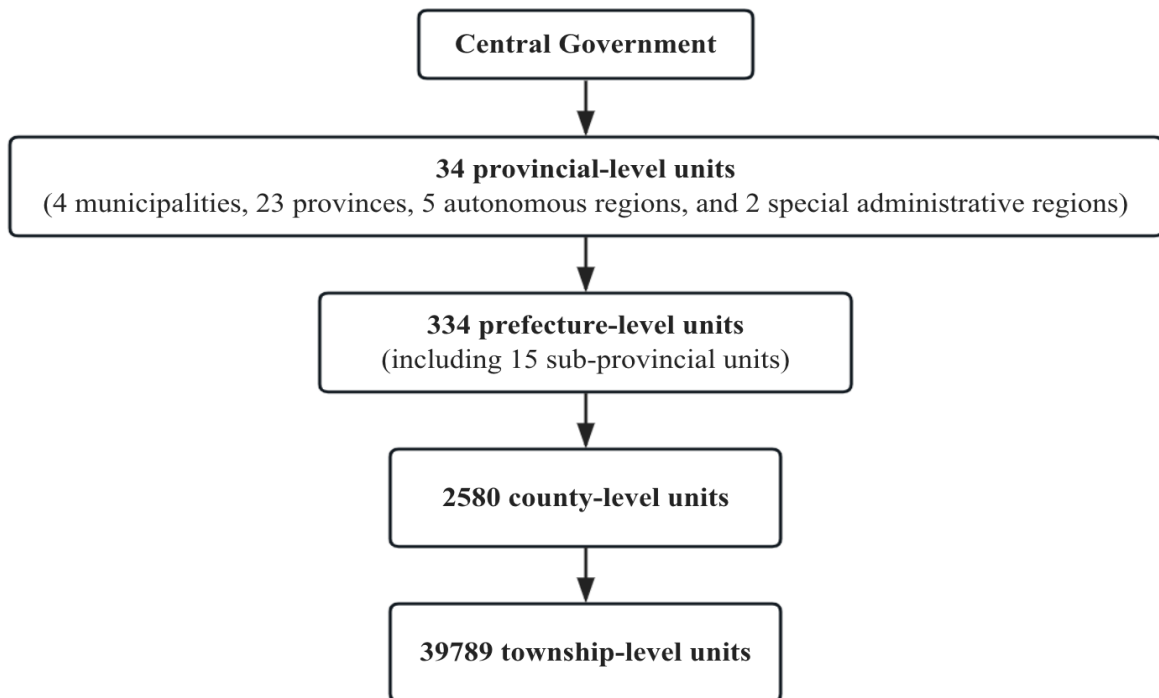


Figure A1. Administrative Divisions of China

Notes: This figure is based on data from 2015. While there have been minor changes to administrative divisions since then, the overall structure remains largely the same.

Source: [Social Service Development Statistical Bulletin of 2015](#).

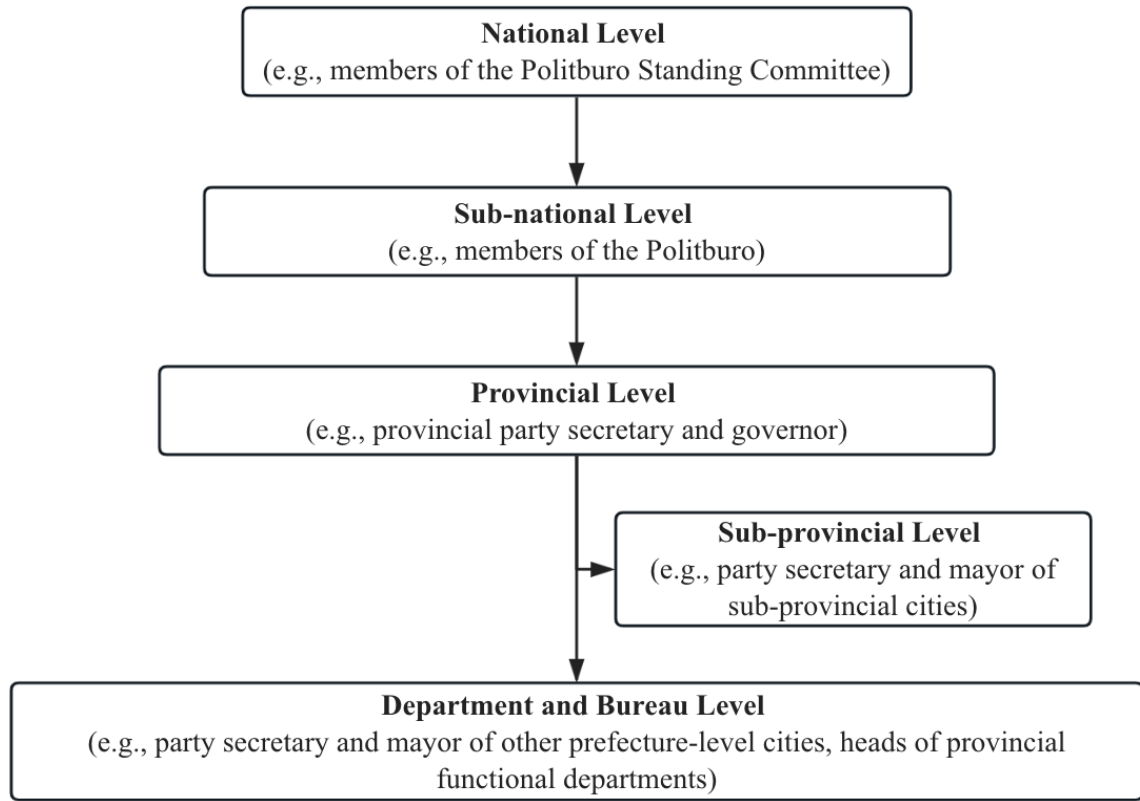


Figure A2. Cadre Rank System of China - Bureau-level and above

Appendix B. Sample

Appendix Figure B1 shows the locations of the four selected provinces. The white lines on the magnified map indicate the city borders within each province. The sample includes a total of 57 cities. Specifically, Anhui, Zhejiang, Fujian, and Guangdong have 16, 11, 9, and 21 prefecture-level cities, respectively.

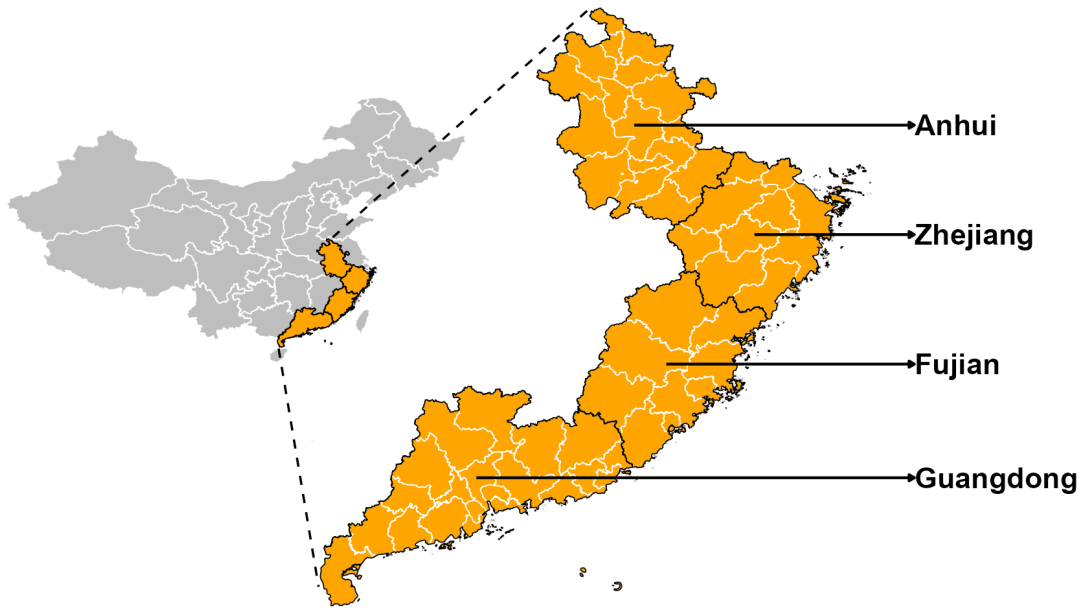


Figure B1. Provinces Included in the Sample

Appendix C. Additional Tables

Appendix Table [C1](#) presents the descriptive statistics from current literature for comparison. These studies were selected because they use similar data on city-level top leadership and cover overlapping time periods with our study, providing a relevant basis for comparison. Appendix Table [C2](#) displays additional analysis on the differential effects from connections of different strength.

Table C1. Comparison with Previous Studies of Different Samples

	This paper	Jia et al. (2015)	Meng et al. (2019)	Wang et al. (2020)	Zeng and Zhou (2024)
Governor: age	50.013 (3.889)		49.58 (4.65)		50.6 (3.76)
Secretary: age	51.896 (3.457)		51.85 (4.5)	49.898 (3.946)	
Governor: age>57	0.032 (0.176)	0.034 (0.18)			
Secretary: age>57	0.082 (0.276)	0.077 (0.27)			
Governor: tenure	2.565 (1.651)	1.55 (1.57)	2.82 (1.81)		3.91 (1.38)
Secretary: tenure	2.839 (1.697)	1.83 (1.71)	3.16 (1.93)	3.729 (1.889)	
Governor: female	0.069 (0.253)	0.05 (0.21)			0.067 (0.251)
Secretary: female	0.053 (0.224)	0.02 (0.15)			
Num. of cities	57	279	25	200	277
Year	2005-2015	2001-2009	2000-2010	2000-2011	2003-2013

Notes: The studies listed in this table were selected due to their use of data on city-level top leadership and their overlapping time periods with our study, which provides a relevant basis for comparison.

Table C2. Differential Effects of Multiple Connections

	DV: Provincial Funds Per Capita		
	(1)	(2)	(3)
<i>HowntownTie_g</i>	10.45* (5.419)		
<i>HowntownTie2+_g</i>	-10.71 (31.35)		
<i>HowntownTie_d</i>	-3.903 (3.921)		
<i>HowntownTie2+_d</i>	-0.325 (21.95)		
<i>CollegeTie_g</i>		2.144 (4.869)	
<i>CollegeTie2+_g</i>		1.489 (11.26)	
<i>CollegeTie_d</i>		-7.535* (3.913)	
<i>CollegeTie2+_d</i>		-11.84* (6.411)	
<i>WorkTie_g</i>			13.84*** (4.900)
<i>WorkTie2+_g</i>			6.254 (6.668)
<i>WorkTie_d</i>			-5.088 (3.528)
<i>WorkTie2+_d</i>			0.619 (8.699)
Province and Year FE	✓	✓	✓
Controls	✓	✓	✓
Hometown FE	✓		
College FE		✓	
Work FE			✓
R^2	0.251	0.214	0.216
Observations	604	556	576

Notes: The dependent variable is the amount of provincial Urban Maintenance and Construction Funds per capita in year $t + 1$. *Tie2+* are indicator variables for each type with two or more ties in a given term. Control variables include fiscal and macroeconomic indices (GDP per capita and the municipal UMC Funds per capita), levels of urban facilities (road area per capita, daily water consumption per capita, public green space per capita, and sewage treatment rate) as well as individual characteristics (age, gender, education, and tenure length). Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D. Evaluating urban public facilities

This section details the methodology used to evaluate urban public facilities.

Based on the dimensions of the UMC Funds utilization and data availability, we have selected four dimensions of public infrastructure: basic services (water coverage rate (x_1), gas coverage rate (x_2), and capacity of urban public water supply (x_3)), transportation (road surface area per capita (x_4) and length of urban roads and bridges (x_5)), environmental sustainability (density of drainage pipelines in built-up areas (x_6), wastewater treatment rate (x_7), domestic garbage harmless treatment rate (x_8), and domestic waste treatment rate (x_9)), and green spaces (public green space per capita (x_{10}) and area of urban green space in built-up areas (x_{11})). All data are from the China Urban and Rural Construction Statistical Yearbook (2006-2016).

We start from standardizing the variables and use the Kaiser-Meyer-Olkin (KMO) test to examine the applicability of PCA. The calculated KMO value is 0.735, which means that conducting PCA for the data is acceptable. In the second step, we calculate the correlation coefficient matrix.

We then calculate the eigenvalues. The scree shot (Figure D1) shows that four of the eleven components have an eigenvalue larger than 1, with a cumulative variance of 78.61%. Accordingly, we apply the Varimax rotation, which maximizes the sum of the variances of the squared loadings and provides a clearer pattern structure. Table D1 and D2 summarize the variance matrix and corresponding eigenvectors for the rotated components. Based on Table D1, we calculate the weight of each component by using its corresponding proportion divided by the cumulative proportion. For example, the weight of *Comp1*, $W_{Comp1} = 0.271/0.786 = 0.344$.

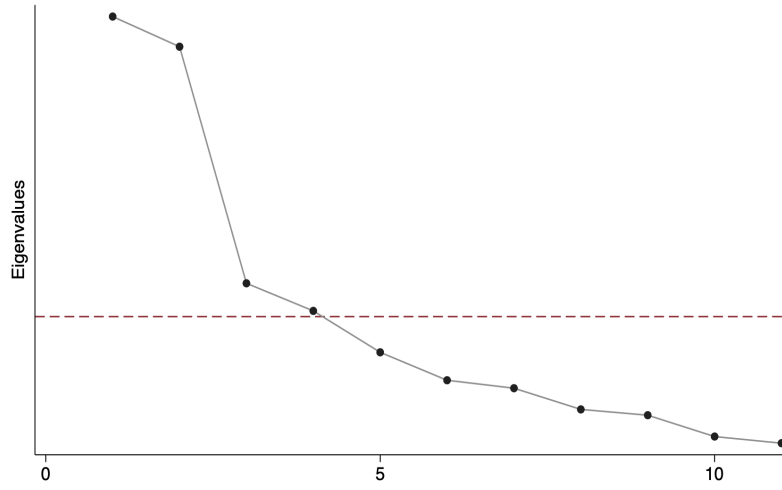


Figure D1. Scree plot of eigenvalues after PCA

Table D1. Variance matrix of the selected principal components after rotation

Component	Variance	Difference	Proportion	Cumulative
Comp1	2.976	.676	0.271	0.271
Comp2	2.300	.480	0.209	0.480
Comp3	1.820	.269	0.165	0.645
Comp4	1.551	-	0.141	0.786

Table D2. Eigenvectors of the selected principal components after rotation

	Comp1	Comp2	Comp3	Comp4
x_1	-0.053	0.596	-0.008	-0.060
x_2	-0.044	0.594	-0.007	-0.027
x_3	0.561	-0.030	-0.025	-0.036
x_4	-0.067	0.084	-0.068	0.679
x_5	0.562	-0.031	0.008	0.041
x_6	0.047	-0.096	0.058	0.715
x_7	0.109	0.286	0.281	0.059
x_8	-0.055	-0.069	0.677	0.031
x_9	0.036	0.038	0.668	-0.037
x_{10}	0.137	0.430	-0.092	0.117
x_{11}	0.568	0.013	-0.006	-0.026

The scores of the selected principal components are then equal to the product of the eigenvectors of the correlation coefficient matrix and the standardized matrix of original variables. For instance, for the first Component, we have:

$$\begin{aligned}
Y_{Comp1} = & -0.053 \times x_1 - 0.044 \times x_2 + 0.561 \times x_3 + (-0.067) \times x_4 \\
& + 0.562 \times x_5 + 0.047 \times x_6 + 0.109 \times x_7 - 0.055 \times x_8 \\
& + 0.036 \times x_9 + 0.137 \times x_{10} + 0.568 \times x_{11}
\end{aligned} \tag{9}$$

Given the weight and score of each selected principal component, we obtain the total score for the level of public facilities based on:

$$Score = \sum_{i=1}^4 Y_{Comp_i} \times W_{Comp_i}$$