Strategic Interaction in Urban Infrastructure Finance: A Spatial Panel Econometric Analysis of Chinese Prefecture-Level Cities

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Abstract

This research represents one of the first attempts to empirically examine strategic interaction in urban infrastructure expenditures on capital construction and maintenance in China. Drawing upon the theories of strategic interaction, this study further disentangles the sources of strategic interaction in urban infrastructure finance based on a spatial panel data consisting of 277 prefecture-level cities from the years of 2001 to 2012. The empirical findings confirm that city infrastructure expenditures are significantly and positively affected by the action of neighboring cities. By decomposing urban infrastructure expenditures, we reveal that the positive effect of strategic interaction is stronger in the spending category of infrastructure capital investment than that of infrastructure maintenance expenditure. In addition, cities in the eastern regions react more strongly to their neighboring cities' infrastructure capital investment than those in the middle region. Strategic interaction in the spending category of urban infrastructure maintenance only occurs cities in the middle regions. Finally, Chinese cities react more strongly to the total infrastructure investment of their neighboring cities either one year prior to and during the Provincial Communist Party Congress (PCRC) or the year after a city's party secretary takes office. These findings are largely consistent with the yardstick competition literature, which states that upper-level policymakers or local citizens place extra weight on policies and outcomes in the neighboring jurisdictions when evaluating a jurisdiction's performances.

Keywords: strategic interaction, urban infrastructure, capital investment, maintenance, China

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Introduction

How do governments respond to other governments when providing public goods and services? The subject of strategic interaction among governments has been the focus of substantial research interests by public economists and regional scientists (e.g., Case et al. 1993; Besley and Case 1995; Brueckner 2003; Revelli 2003, 2005, 2006; Baicker 2005; Revelli and Tovmo 2006; Bruce et al. 2007; Isen 2014; Terra and Mattos 2017). To date, most strategic interaction research has focused on tax setting and program adoption. However, there has been some work finding competition on the expenditure side, mostly in the specific categories of state spending on health and public welfare. Few studies analyze the strategic interaction of infrastructure investment (Bruce et al. 2007). In addition, the majority of empirical studies of spatial interaction are done in developed countries. A comprehensive quantitative study on spatial interdependence in developing countries is lacking and urgently needed. To fill this gap, the purpose of this research is to examine whether Chinese city governments strategically influence each other with respect to infrastructure spending on capital construction and maintenance activities.[1]

China serves as a unique venue for examining strategic interaction across local governments, particularly for the provision of local public infrastructure services. In China, in general, the local tax rate cannot be altered by local governments.[2] In other words, local governments cannot engage in tax competition. Hence, competition is focused on expenditure behavior. Because of this, we are able to examine the expenditure competition behavior of Chinese local governments in isolation. Further, since the implementation of Chinese fiscal reform in 1994, important infrastructure expenditure responsibilities have been gradually assigned to local governments. In China, promotion of local officials is decided by their upper-level governments which evaluate their performance largely based on local economic growth. Within the growth-based promotion path, local public officials have strong incentives to attract private investment by providing more infrastructure services. Finally, with the rapid growth in urbanization, China has made substantial investments in urban infrastructure. It is estimated that the total amount of urban infrastructure construction during the 12th Five-Year Plan from 2011–2015 exceeded 7 trillion

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[1] There is a growing number of studies examining the funding structures and financing patterns of urban infrastructure investment in China (e.g., Wu 1999; Su and Zhao 2006; Cao and Zhao 2011; Wang et al. 2011; Zhao and Cao 2013; Lin 2016; Zhan, De Jong, and Bruijn 2017). However, the potential characteristics of strategic interaction in urban infrastructure finance is neglected in the extant Chinese infrastructure development literature. For example, the most recent article by Tong et al. (2018) explores the factors that drive capital investment in urban infrastructure across Chinese cities. However, there are two limits in their research. First, they do not incorporate spatial effects into their models. Failing to account for such spatial interdependence risks an incomplete understanding of the fiscal choices made by local actors. Second, they ignore maintenance expenditures in urban infrastructure, which is also a key component of urban infrastructure spending.

[2] It should be noted that local governments in the minority regions can adjust some tax rates. For example, corporate income tax (the part which belongs to the local governments), with the approval of the higher-level government.

yuan, the equivalent of US $1,013 billion (Zhan et al. 2017). Despite tremendous efforts, urban infrastructure investment still lags behind the rate appropriate to the country's growth in urbanization and industrialization (Lin, 2016).

The central research questions of this study are:

- Do Chinese city governments behave strategically in making both infrastructure capital and maintenance spending decisions?
- What are the potential sources of strategic interaction of urban infrastructure investment (e.g., political competition or spatial spillovers)?

This research is one of the first attempts to examine strategic interaction in Chinese urban infrastructure development within a spatial econometric framework. It makes two key contributions to the existing literature. First, this study explicitly incorporates strategic interaction into the study of urban infrastructure finance in China and tests the notion that cities respond strategically to the policy decisions of other cities. Strategic interaction, in essence, is a spatial phenomenon and leads to cross-jurisdictional effects, that is, one city may have to make decisions in infrastructure investment in response to decisions and behaviors of neighboring cities. Adding the spatial interaction perspective into the existing literature on urban infrastructure finance not only provides a more complete understanding of the determinants that drive Chinese local infrastructure development but also provides practical policy suggestions for Chinese local policymakers to make efficient and sustainable infrastructure investment.

Second, this study proceeds to further disentangle the possible sources of strategic interaction in Chinese urban infrastructure spending. In theory, there are at least three channels through which local governments strategically respond to the infrastructure spending behaviors of their neighboring governments (which we review in the next section of the paper). In this research, we analyze various potential spatial interaction mechanisms among Chinese prefecture-level cities and identify their effects on urban infrastructure investment. Our findings advance the understanding of strategic interactions among Chinese local governments.

Literature Review

Chinese Urban Infrastructure Finance

Infrastructure is the foundation of modern economies and society. Public infrastructure refers to the physical capital investment and maintenance—for example, highways, bridges, airports, public transit, drinking water, and wastewater treatment systems—traditionally provided by the public sector to private business and households (Fox and Smith 1990). In general, urban infrastructure is defined as "the essential public works and public utilities required for the functional operation of a city" (Wang et al. 2011, 2976). In the Chinese context, urban infrastructure includes public utilities (water supply and drainage, residential gas and heating supply, and public transport), municipal works (roads, bridges, tunnels, docks, and sewerage), parks, sanitation and waste management, and flood control in urbanized areas (Wu 1999; Zhao and Cao 2011).

Previous studies on urban infrastructure finance in China can be divided into four categories: (1) the historical evolution of Chinese institutions and policies on urban infrastructure finance (e.g., Chan 1998; Wu 1999; Zhao and Cao 2011; Wang et al. 2011; Zhan, de Jong, and de Bruijn 2017); (2) the level and development of urban infrastructure provision (e.g., Chan 1998; Wu 1999; Lin 2016); (3) the models and revenue composition of urban infrastructure finance (e.g., Zhao and Cao 2011; Wang et al. 2011; Su and Zhao 2007); and (4) the determinants of urban infrastructure investment (e.g., Yu et al. 2011; Tong et al. 2018; Qiu, Xu, and Li 2018).

Historical Evolution of Chinese Institutions and Policies on Urban Infrastructure Finance

There are a growing number of studies describing and analyzing the institutional changes in urban infrastructure finance in China. Drawing on fieldwork in five cities in 1994 as well as national statistics, Chan (1998) analyzes the institutional environment for urban infrastructure provision in a planned economy (1948–1977) and in a reform period (1978–1994). According to Chan (1998), during the planned economy, the major funding sources for urban construction were central budgetary allocations and a number of fees or levies on infrastructure use determined by the central government (such as the public utility surcharge established in 1963). However, since the commencement of the 1978 economic reforms, the provision of urban infrastructure services and financing has increasingly relied on a variety of market-oriented infrastructure financing mechanisms.

Wu (1999) identifies three key institutional factors that improve China’s performance in providing urban infrastructure since 1979. These factors include (1) providing local governments greater freedom for fiscal management through decentralized fiscal systems and changes in the central-local fiscal relationship; (2) incorporating a variety of alternative infrastructure financing mechanisms into urban infrastructure finance systems and increasingly relying on extra-budgetary revenue to fund urban infrastructure; and (3) streamlining municipal organizational structure for infrastructure policy-making and coordination and expanding the degree of managerial and financial autonomy for urban construction authorities (Wu 1999, 2267–2268). Zhao and Cao (2011) trace the history of China’s urban infrastructure investment since 1949. The first historical period is the shortage period (1949–1978), in which there existed a deficit of both political and financial support for urban infrastructure provision. The second historical period is the central-government-promotion period (1978 to 1994). During the second period, the central government began to recognize and promote urban infrastructure development through laws and regulations. The third historical period is after the introduction of fiscal decentralization in 1994 (1994 to present). This period is characterized by the centralization of fiscal revenue whereas expenditure responsibilities remain decentralized. Facing a fiscal gap caused by increasing expenditure shares in total expenditure and decreasing revenue shares in total revenue, local governments are increasingly turning to a wide variety of market-based infrastructure financing mechanisms (loans, bonds, foreign capital, and land sales).

Wang et al. (2011) contend that the entrepreneurial tendency of the city and the reformulation of central-local fiscal relations that impacted taxation and investment are the two broader institutional contexts necessary to understand the evolution of urban infrastructure finance in China. They divide up the history of urban infrastructure development in three time periods: the 1949–1978 centrally planned period, the 1978–1994 transitional and trial period, and the period from 1994 onward, a period of market-based development. Building upon the work of Wang et al. (2011), Zhan, de Jong, and de Bruijn (2017) described the evolution of the financial arrangements in China for urban infrastructure development over time as a path-dependent process. According to Zhan et al. (2017), the evolution of urban development financing has gone through three phases (planned economy, reform and pilot, and socialist market economy). Path-dependent evolution will steer urban infrastructure finance in a new direction once infrastructure actors perceive the drawbacks of existing institutional arrangements as unsustainable and in need of further development.

The Level and Development of Urban Infrastructure Provision

Chan (1998) presents the latest available figures about urban infrastructure provision in five selected cities. He asserts that on a per capita basis, the level of urban infrastructure services in Chinese cities approaches that in lower-middle-income countries. In addition, there exist differences between large and small cities in the level of urban infrastructure provision, especially in the less developed provinces such as Guizhou. Wu (1999) points out that despite China's record of progress in urban infrastructure provision, urban infrastructure provision faced three challenges: unmet demand, deficiencies in cost recovery, and inadequate maintenance. Lin (2001) indicates that local infrastructure development in many Chinese regions has lagged economic growth. He further identified three main reasons for the slower infrastructure growth: low government spending on infrastructure, decreased investment incentives of state enterprises, and the diminished ability of local government in mobilizing rural resources. Lin (2016) points out that although there has been great progress in developing Chinese urban infrastructure, the current level of urban infrastructure is still insufficient to support a rapidly growing urban economy and population. He further suggests that infrastructure development is quite uneven across regions. Cities in the western regions have lagged behind cities in the eastern regions. In a similar vein, Wu (2013) shows that there are noticeable differences in nearly all available aggregate indicators of urban infrastructure services across the three regions (eastern, central, and western). Cities in the eastern regions have high levels of urban infrastructure services. By contrast, urban infrastructure in many inland provinces is in poor condition.

Funding and Financing Patterns of Urban Infrastructure Development

Chan (1998) offered an initial analysis of the revenue composition of urban construction and maintenance in 1991, 1993, and 1995. The 1995 data imply that across the nation, miscellaneous sources of revenue (land sales, land use fees, and infrastructure connection fees) were the largest source (44.8 percent), followed by local taxes (24 percent) obtained from two urban construction-related taxes (urban construction and maintenance tax and public utility surcharge). The next three most important urban infrastructure funding sources included local grants, user charges, and domestic loans (Chan 1998, 519–520). Zhao and Cao (2011) provide a comprehensive analysis of financial resources for urban infrastructure finance. They categorize Chinese urban infrastructure finance into two types. The first is pay-as-go-fiscal revenues, which include central and local budgetary allocations, fees and user charges (water resource fees, infrastructure connection fees, and user charges), and land transfer fees. Market financing is the second type. It consists of debt financing (domestic bank loans and nationally issued bonds) and equity financing (self-raised funds, foreign capital and stock financing). Based on data mainly from the China Urban Construction Yearbook (2000–2008), Zhao and Cao (2011) examine the trends and patterns of urban infrastructure funding sources.

Wang et al. (2011) summarize three models of urban infrastructure finance based on the main source of investment and the key actor managing urban infrastructure projects. These models include government-led financing, state-owned enterprise-led financing, and PPP-led financing (Wang et al. 2011, 2981–2987). Government-led financing involves the predominant use of budgetary public money (taxes, grants, and administrative charges/fees). State-owned enterprise-led financing indicates reliance on quasi-public entities—Urban Investment and Trust Corporations (UITCs). The UITCs are created by city governments and authorized to raise funds through market-based financial instruments (loans, land-use right conveyance fees, and enterprise self-raised funds). PPP-led financing refers to the use of private enterprise to finance projects (Wang et al. 2011, 2981–2987).

There are also several studies exploring the funding and financing patterns of urban infrastructure provision in specific geographic areas or specific urban funding and financing mechanisms. Mikesell et al. (2011) investigate urban infrastructure finance in Guangdong Province and documents the decision-making process and financing mechanisms for urban infrastructure development there. Fu (2007) offers a detailed case analysis of urban infrastructure investment and financing in the city of Shanghai. He argues that the substantial development in urban infrastructure in Shanghai is attributed to the use of diversified financial resources and the termination of the free use of land resources and the cheap use of infrastructure facilities.

Zhao and Cao (2013) systematically describe the trends and patterns of land transfer fees and its usage for urban infrastructure. Using the data from the China Urban Development Statistical Yearbook (2000–2008), they find that the share of GDP from the agriculture industry, urban population density, local fiscal revenues, and the geographic location of the province are important factors for explaining the use of land transfer fees in urban infrastructure provision. Zhang (2014) explores how city characteristics, spatial pressures, and other institutional forces drive the use of public-private partnerships among Chinese prefecture-level cities from 1992 to 2008. Based on the theory of policy diffusion, his empirical results reveal that local market and political characteristics, as well as policy changes in neighboring cities and peer cities, exert a significant influence on private participation in urban infrastructure development.

Determinants of Chinese Urban Infrastructure Investment

Yu et al. (2011) utilize a cross-sectional sample of 242 Chinese cities in 2005 to examine the main factors contributing to the decline of urban infrastructure spending. Based on a spatial econometric analysis, the authors find results suggesting that (1) there is a positive spillover effect in the provision of urban infrastructure among Chinese cities, (2) the stronger a city's fiscal capacity, the more urban infrastructure investment, and (3) city infrastructure investment is affected by the infrastructure spending decisions of other governments (counties). Tong et al. (2018) investigate the patterns and drivers of capital investment in urban infrastructure (CIUI) among 282 prefecture-level cities and four municipalities from the period of 2000 to 2008. Their analysis reveals that despite the overall increase in CIUI, there is a huge regional disparity in CIUI among cities. Furthermore, they examine the impact of public demand, government supply, and intergovernmental fiscal institutions on CIUI through the theoretical lens of the Political-Market Framework (PMF). They find that population agglomeration in high density areas reduces CIUI. By contrast, cities with higher fiscal capacity and more tertiary economy made higher levels of investment. In addition, the impact of city fiscal revenue capacity on CIUI is conditioned by the city's physical distance to Beijing, implying an important interaction effect between government supply and political institutions.

Focusing on the transportation sector, Qiu, Xu, and Li (2018) use a panel data of 160 Chinese cities over the time span of 2000–2015 to probe the relationships between annual investment in the public transport sector and the scale of bus network facilities, annual passenger volume, and land area used for urban roads. They point out that the annual investment in the public transport sector has a positive correlation with the length of operated bus transit routes. Meanwhile, both the land areas for urban roads and urban road network density are found to exert a negative impact on city annual investment in the public transport sector.

Strategic Interaction in Public Finance and Fiscal Policy

Strategic interaction models depart from traditional models of decision making in that they incorporate variables other than those facing the decision maker that are determined by the decisions of other competitors or collaborators. The traditional economic model of decision-making models behavior by an individual or organization as a function of individual or collective preferences and exogenous variables that the decision maker must react to. These variables are broadly determined by the external environment, not by any specific economic actor. For example, a representative resident of a jurisdiction i determining whether to vote affirmatively for a project to public goods would face a utility maximization problem where their utility is a function of their consumption of private goods c_i, their per capita expenditure on a public good e_i and a vector of characteristics X_i that affects preferences (such as age or the number of school age children):

$$(1)\ \max U\ (c_i, e_i; X_i)$$

If per capita personal income is denoted by y_i (fixed), we can write the individual's budget constraint as $c_i = y_i - e_i$. Substituting this into (1) yields:

$$(2)\ \max U\ (y_i - e_i, e_i; X_i) \equiv \max V\ (e_i; X_i)$$

Strategic interaction means that the decision maker takes into account not only terms that enter into (2), but also similar variables chosen by decision makers in other jurisdictions. If we denote the choices on the expenditure for the public good as e_{-i}, the right-hand side of equation (2) becomes

$$(3)\ \max V\ (e_i, e_{-i}; X_i)3)$$

Solving (3) for the optimal level of e_i involves setting equal to zero the first partial derivative of V with respect to e_i, as in $\partial V/\partial e_i \equiv V_{e_i} = 0$. Because the derivative is a function of e_{-i} along with X_i, the solution depends on the choices made in other jurisdictions. The solution is a type of “reaction function” where the optimal level of e_i is a function of the decisions in other jurisdictions and characteristics of the individual or jurisdiction:

$$(4)\ e_i^* = R(e_{-i}; X_i)$$

Spillover Models

The literature on strategic interaction can be broadly divided into two types, following Brueckner (2003). The first type models strategic interaction as a function of “spillovers” of decisions from other jurisdictions, along the lines of the classic interaction model in equations (3) and (4). The first such model which was estimated by Case, Rosen, and Hines (1993), quantifies how a state reacts in regard to the per capita expenditures of other states. They find evidence that states consider the decisions of their neighbors related to total public expenditures and several functional categories of spending. They further find that the coefficients on variables that traditionally measure the demand for public spending change considerably when considering spatial dependencies. There have been innumerable papers that analyze the spillover effect. Important papers in this vein include Figlio, Koplin, and Reid (1999) who find that neighboring states set welfare benefits to compete with neighboring states, and Baicker (2005) who models spending in expenditure categories using a weight matrix that includes a measure of “neighborliness” of states instead of simple geographic proximity (this measure captures among other things migration rates between states).

More recently, there have been numerous papers estimating the spillover effect within Chinese subnational governments. China represents a good opportunity for this research as the data to support these types of studies is fairly accessible, and there are a large number of subnational units of government with varying policy choices. Examples of papers analyzing spillover effects in Chinese subnational policy setting are Yu et al. (2013), who find evidence of strategic interaction in public health expenditures from a panel of 31 provinces, and Chen, et.al. (2019) who find evidence of benefit spillover effects in Chinese environmental public expenditure in data from 30 provinces. The paper most directly related to our current research is the aforementioned study by Yu et al. (2011), who find evidence of spillover effects in infrastructure decisions in a cross section of 242 Chinese cities. Though not directly related to policy decisions, Zhang and Yi (forthcoming) find strong evidence for positive spatial economic spillovers in Chinese infrastructure investment.

A second type of model that fits under the spillover category are “yardstick competition” models. In these models, voters in a jurisdiction look at public service and tax levels in other jurisdictions to help judge whether their government is using its resources efficiently. In the yardstick competition model, the e_i in equation (3) are replaced by T_i, these being relative efficiency measures (the quantity of public good provision relative to taxes). Thus, the reaction function will be a measure of how a voter adjusts their preferred tax and spending levels in response to a perceived lower or higher efficiency of their jurisdiction compared to others. The seminal paper in this literature is from Besley and Case (1995) who measure voter support for sitting governors as a function of variables from their jurisdictions but also from neighboring ones. They find strong evidence that voters in statewide elections consider how their state measures up to other states in terms of taxes when deciding whether to vote to keep an incumbent in office. As with fiscal spillover models, the literature on yardstick competition has been abundant since the 1990s. Within the public finance sphere, it has been used as a framework to study property tax choices in Italy (Bordignon, Cerniglia, and Revelli 2003) and the Netherlands (Allers and Elhorst 2005), choice of tax instrument in Ohio (Hall and Ross 2010), and public infrastructure investments in Flemish municipalities (Goeminne and Smolders 2014).

As with the fiscal spillover literature, there has been a recent focus on employing these models in the Chinese context. Caldiera (2012) provided the opening paper, examining strategic interactions among Chinese first-level local state administrative organizations (provinces, autonomous regions and municipalities). He found evidence of strategic interactions among these jurisdictions even in the absence of local control by elections. He surmised that the yardstick competition was happening "from the top." This is because the Chinese central government uses relative performance as a yardstick to help evaluate local government officials' performance and to decide whom to promote. Since this line was developed, yardstick competition has been detected in Chinese prefecture-level city industrial land leasing price (Huang and Du 2017), provision of urban public green spaces (Chen et al. 2017), and spending decisions regarding environmental protection (Deng et al. 2012), along with the setting of tax rates on foreign investment by Chinese provincial governments (Liu and Martinez-Vazquez 2014).

Resource Flow Models

The second category of model in the spatial competition literature is the "resource flow" model. In this category, jurisdictions are not directly affected by the decisions of other jurisdictions but must compete for a resource s_i that is distributed over all jurisdictions and affected by the decisions of all.[3] As Brueckner (2003) shows, despite the difference in objective functions, in the end the reduced-form utility function is the same as in (3) — with obvious differences in choice variables according to the decision being modeled. The best example of this type of model is the "tax competition" model owing to Beck (1983), Wilson (1986), Zodrow and Mieszkowski (1986) and others. In these models, jurisdictions compete for mobile capital using tax rates to increase the after-tax rate of return on their capital versus competing jurisdictions (this is the "strategic" form of the model, in the "competitive" form, where jurisdictions are small relative to the economy, tax rates cannot alter the rate of return substantially and therefore rates are set independently of other jurisdictions).

Early empirical evidence of tax competition was provided by Ladd (1992) and Case (1993). Using data from 94 counties in metropolitan areas where a closely neighboring county could be identified, Ladd (1992) finds a significant positive effect of a neighboring county's total tax

[3] The spillover model views that the fiscal expenditure decisions of one local government can directly affect the expenditure decisions of its surrounding local governments. The reason is that most public expenditures have strong externalities and public goods in one region can also be used by residents in adjacent areas (Case et al. 1993). In contrast to the spillover model, the resource flow model argues that fiscal policy in one local government does not directly affect fiscal expenditure decisions of other adjacent local governments but would indirectly affect them by affecting the movable resources in their jurisdictions.

burden and property tax burden on those burdens in a given county. Case (1993) uses data on changes in state income tax burdens for tax filers in three income categories. She analyzes the data using a two-stage least squares instrumental variables estimator to control for endogeneity of tax rate changes among states. She finds that changes in neighboring state tax burdens have a strong effect on a given state's change in tax burden. She also finds that having a governor stand for reelection mitigates this effect entirely. Similar to the models above, these early works gave birth to numerous studies, notably Brueckner and Saavedra's (2001) analysis of property tax competition in Boston area municipalities, Buettner's (2001) analysis of German local business tax rates, and Lyytikäinen's (2012) examination of a property tax reform intervention in Finland. Unlike the spillover models, there have been few papers that have examined the role of tax competition in the Chinese setting. This is likely due to the tax structure and level of revenue autonomy of Chinese subnational governments. One notable exception to this is Choi (2009), who examines the mechanisms through which Chinese local governments may engage in informal tax competition. She identifies the following "inventive" ways that Chinese local officials can reduce taxes for businesses:

1. Tax refunds – direct rebates of taxes paid;
2. Drawing taxes – local governments induce companies to register with the tax bureau in their region, and then provide preferential tax treatment for those companies;
3. Exploiting formal preferential policies – designating companies as high-tech firms, establishing local development zones, and levying taxes in ways not specified in law; and
4. Lax tax enforcement for businesses.

Another area where resource flow interaction can be seen is in the area of welfare competition. In this form of competition, jurisdictions set social benefit levels in order to induce migration of recipients to move to other jurisdictions. The result is a "race to the bottom" that lowers benefits for all recipients. Examples of these studies are Saavedra (2000), who found evidence of competition among states in setting AFDC benefit levels and a migration-based weight matrix for determining neighboring states' policies, and Volden (2002), who examined evidence on AFDC benefit changes using a model of changes in policy versus benefit levels and a geographic-based indicator of policy change in neighboring states.

Summary of Literature Review

There are a large and growing number of studies examining the institutional structure and funding patterns of urban infrastructure development in China. Most of them have focused on the role of institutional factors, different periods in the growth path of policies, and other macroeconomic and social variables in explaining funding patterns and outputs. The literature on strategic interaction in policy decisions is a voluminous literature. Further, the Chinese context is increasingly being used to explore the existence of strategic policy interaction. Despite the depth of the literature in both areas, the role of strategic interaction in urban infrastructure finance decisions have been relatively neglected in the extant Chinese infrastructure finance literature. This oversight is a significant gap in the literature. Failing to account for such spatial interdependence risks an incomplete understanding of the fiscal choices made by local actors. Our study will address this shortcoming through a robust analysis of the spatial factors affecting infrastructure decisions in China.

Theories and Hypotheses Development

Strategic interaction among governments is a major focus of theoretical work in public finance (e.g., Case et al. 1993; Besley and Case 1995; Brueckner 2003; Revelli 2003, 2005, 2006; Baicker 2005; Revelli and Tovmo 2006; Isen 2014; Terra and Mattos 2017). There are at least three channels through which local governments are expected to affect the spending behaviors of their neighboring governments. First, expenditure competition might occur if local government officials compete with their neighbors to attract households or firms (e.g., Case et al. 1993; Revelli 2003). Second, yardstick competition might occur if local governments' spending on infrastructure promotes local economic development and growth, which is the major indicator used by higher-level governments to evaluate and promote (or reappoint) local government officials (e.g., Caldeira 2012; Terra and Mattos 2017). Third, expenditure externalities might occur if public spending (on education, infrastructure, environmental protection, or others) by one local government can create benefits for or have detrimental effects on its neighboring jurisdictions (e.g., Case et al. 1993; Baicker 2005; Bruce et al. 2007).

Why would strategic interaction exist in Chinese local infrastructure expenditures? Based on the theoretical models of strategic interaction among governments, we argue that the Chinese cities have three incentives to interact strategically in the case of infrastructure development.
The first incentive is related to inter-city competition for mobile resources. From the perspective of the resource flow model, Chinese local governments are competing very hard to attract domestic and foreign capital through a variety of instruments such as local tax competition (lowering effective tax rates), lower land price, and infrastructure investment. Although Chinese local governments do not have legislative power to change the tax rates, local governments are able to create development zones as a conduit to offer tax incentives (e.g., tax exemptions, tax breaks) to domestic and foreign investors (Liu and Martinez-Vazquez 2014). Beyond tax competition (race to the bottom), Chinese local governments use land price as a tool to implement regional competition. Local governments lease out industrial land at a lower price when facing competition for attracting investments. Last, quality transportation infrastructure and utilities reduce business costs and enhance job accessibility. Chinese local governments build new infrastructure to compete for mobile businesses. During our fieldwork interviews in three cities, all interviewees highlight the role of building high-quality infrastructure to attract foreign investments and the relocation of domestic industrial firms.

Second, there exist inter-city spillovers associated with the benefits from building and maintaining urban infrastructure projects such as highways, bridges, railroads. If positive spillovers exist, a city may reduce its own infrastructure spending as a response to the rise of infrastructure spending of its neighboring cities.

Third, according to the yardstick competition model (Besley and Case 1995), voters use information about policies implemented in neighboring jurisdiction as a yardstick to help evaluate the relative performance of public officials. Although the yardstick competition was developed in the context of Western countries, it is applicable in the Chinese context (e.g., Xu 2011; Caldeira 2012; Su et al. 2012; Kung and Chen 2014; Yu et al. 2016, 2017; Huang and Du 2017; Pan et al. 2017; Tian et al. 2020). In China, promotion of local officials is decided by their upper-level governments. The Chinese central government implements a comprehensive five-year plan, which define targets for infrastructure development and economic growth. Local government officials' career development is based on fulfilling a range of top-down mandates and satisfying their superiors. The Chinese central and provincial governments consider relative performance as a yardstick to help assess local government officials' performance and to decide whom to promote. This is similar to the scenario involving voters in Western countries. Infrastructure projects such as roads are highly visible and important components of the performance evaluation of local government leaders. One of the interviewees explicitly states that infrastructure investment is a key development indicator for performance evaluations of local government officials. The central and provincial governments evaluate a local government's effort in infrastructure investment by comparison with other cities, which may pressure the local government into mimicking the infrastructure policy of a neighboring city. Our fieldwork research reveals that economic development performance remains the most important political motivation for local government officials to develop urban infrastructure. In sum, as people, resources, and information flow across different jurisdictions, city governments in China do not make their infrastructure investment decisions in isolation. Instead, they strategically consider the impacts of infrastructure spending decisions made by peers or competitors. This leads to a situation where city policy decisions on infrastructure development are affected not only by the various characteristics of one's own city, but also by policy decisions on infrastructure investment made by other cities. Considering the above theoretical consideration, the proposed research will specifically test the following hypotheses:

- Hypothesis 1: *A Chinese city's total investment in urban infrastructure is affected by the total infrastructure investment amounts of "neighboring" or "peer" cities*.

- Hypothesis 2: *A Chinese city's capital investment in urban infrastructure is affected by the capital investment amounts of "neighboring" or "peer" cities*.

- Hypothesis 3: *A Chinese city's maintenance spending on urban infrastructure is affected by the maintenance expenditures amounts of "neighboring" or "peer" cities.*

- Hypothesis 4: *A Chinese city's infrastructure spending is affected through competition for expenditures with "neighboring" or "peer" cities.*

- Hypothesis 5: *A Chinese city's infrastructure spending is affected through yardstick competition with "neighboring" or "peer" cities.*

- Hypothesis 6: *A Chinese city's infrastructure spending is affected through spillover effects from infrastructure spending of "neighboring" cities.*

Data and Empirical Methodology

Estimation Methods

Model Specification

In terms of empirical modelling, there is no difference between the two models of spillover and resource flow. Both models result in an identical empirical specification. For our case, I_i denotes the level of infrastructure expenditure by city *i*. I_{-i} indicates infrastructure spending by other cities, which characterizes strategic interaction among cities. X_i is a vector of control variables that represent city *i's* characteristics. The reduced urban infrastructure spending function for city *i* is as follows:

$$(5)\ I_i = R\ (\ I_{-i}, X_i)$$

Hence, the reaction functions *R(•)* generated by the spillover and resource flow models show that each local jurisdiction's decision on urban infrastructure expenditures is related to its own characteristics and the decisions of other jurisdictions. The strategic interaction theories, as we discussed before, do not predict the sign of the slope of reaction functions. A positive slope means that urban infrastructure finance decisions of interacting jurisdictions are strategic complements, while a negative slope infers that that decision variables are strategic substitutes. A zero slope suggests that there are no strategic interaction effects (Brueckner 2003).

To test the existence of strategic interaction in urban infrastructure finance among Chinese local governments, we employ a spatial econometric model. The basic estimating model is specified as follows:

$$(6)\ Y_{it} = \rho \textstyle\sum_{j=1}^{N} w_{ij}\, Y_{jt} + X_{it}\beta + \omega_i + \lambda_t + \varepsilon_{it}$$

$$\varepsilon_{it} = \gamma \sum_{j=1}^{N} W_{ij}\, \nu_{it} + u_{it}$$

where, *i* and *j* index cross-sectional units. The total number of cross-sectional individual units in the economy is N+1. and *t* is the time unit. Y_{it} is the dependent variable, for example, total annual capital or maintenance spending in urban infrastructure in city *i* in year *t*. w_{ij} is the spatial weighting matrix which captures the interaction between city *i* and city *j*. ρ is the slope of the reaction function, which is the main interest of our empirical research. X_{it-1} contains a set of control variables containing the characteristic variables of the cities. We lagged all control variables for one year to mitigate the concern of endogeneity. The public demand control variables include *Ln Pop Density* (Log of total city population divided by city total land area), *Urbanization (*The share of people living in urban area*)*, *Ln Urban Household Income* (Log of urban household income real per capita), *Urban-Rural Income Disparity* (the ratio of urban household income divided by rural household income). The government supply control variables contain *Economic Development* (Log of Real GDP per capita), *% of Own-Source Revenue* (Ratio of city own revenue sources in total city revenue), *and Fiscal Deficit* (General fiscal expenditure minus general fiscal revenues, and then divided by total population). The political control variables include *Party Secretary's Tenure* (Prefectural party secretary's accumulated year in office by the end of that year) and *Party Secretary's Time to Retirement* (60 minus a prefectural party secretary's age). The term ω_i is the spatial fixed effect controlling for unobserved heterogeneity across Chinese cities. λ_t represent the time trend. ε_{it} is a composite error term made up of two distinct components: a spatially autocorrelated error ($W\nu$) and a true idiosyncratic error (u_{it}). The latest version of a commonly used statistical software (Stata 16) is utilized to estimate and test our spatial econometric models.

<u>Specification of Weighting Matrix</u>

The identification of neighbors, that is, the weighting matrix (*W*), is key to spatial analysis. However, there is no clear guidance about what criteria should be used. The most two common weighting schemes are identified in the extant spatial econometric literature. One is a simple contiguity weighting matrix, which defines neighbors as the ones sharing a common border. Another one considers the distance-based weighting matrix, where city *i' s* infrastructure spending is affected by infrastructure expenditures of all the other cities in the sample, but in inverse proportion of their distance to city *i*. In our study, we use the distance-based weighting matrix as our preferred weighting scheme. In this weighting matrix, all diagonal elements of *W* are zeros. Off-diagonal elements w_{ij} are defined as $w_{ij} = \frac{1}{d_{ij}}$, where d_{ij} is the point distance between centroid of two cities when $i \neq j$. Each row of the distance-based weighting matrix (W) is normalized to be 1. As a robustness check, we also employ a contiguity weighting matrix.

Data Sources and Variable Definitions

The units of analysis are all 277 Chinese prefecture-level cities between the years of 2001 and 2012. This period is chosen for two reasons: (1) this period had common definitions of sectors of infrastructure investment; and (2) data availability.

For each of the cities, three dependent variables are used, respectively. They are the annual amount of total infrastructure expenditure (real per capita), the annual amount of infrastructure fixed assets capital investment (real per capita), and annual amount of infrastructure maintenance (real per capita). The information on city-level infrastructure investment was extracted from various editions of *China's Urban Construction Statistical Yearbook.* This official statistical yearbook is based on data reported by construction authorities of provinces, autonomous regions, and municipalities. This data source has been used in numerous prior published articles on this topic (see, for example Yu et al. 2011; Zhao and Cao, 2011; Qiu et al. 2018; Tong et al. 2018;). It should be noted that according to *China's Urban Construction Statistical Yearbook*, urban infrastructure spending includes a variety of revenue sources: central, provincial and city governmental fiscal allocation, local earmarked taxes, fees and user charges, land transfer fees, borrowing (domestic loans and bonds), and equity financing (foreign capital and stock financing).

Drawing from existing literature (Yu et al. 2011; Qiu et al. 2018; Tong et al. 2018), we identified several control variables affecting city infrastructure investment (infrastructure demand, government infrastructure supply, and political factors). They are real GDP per capita, real urban resident income per capita, fiscal stress, own fiscal revenue capacity, urbanization, population density, urban and rural income inequality, and two political control variables—city party secretary tenure in office and time to retirement (measured in years). Variables related to monetary values, including infrastructure investment data, GDP, household income, fiscal revenues and expenditures are deflated to base year 2010. Table 1 provides details on data sources and summary statistics. A few things stand out from the descriptive statistics. First, all of the infrastructure spending variables and many of the independent variables have a high coefficient of variation, with evidence of outliers. We tested the results of the statistical analysis for leverage and found no significant effects of outliers on the results. Second, our analysis covers not only wealthy urban prefectures with a substantial amount of income, economic output, and revenue autonomy (indicated by a high percentage of own-source revenue), but also smaller rural prefectures with far less of each. This variation increases the generalizability of our results. Last, the characterization of party secretary's tenure and age can only be described as short-tenure (just under 2 years on average) and relatively senior (51.5 years or only 8.5 years from mandatory retirement). This suggests a long period of maturation through the party apparatus before having a relatively brief chance to develop their reputation.

Table 1: Variable Definition and Data Sources

Variables	Description	Mean	SD	Min	Max	Data Sources
Dependent Variables						
Total Urban Infrastructure Spending	Total annual fixed assets investment in urban infrastructure (real per capita) Chinese Yuan	331	743	0.66	19463	China's Urban Construction Statistical Yearbook
Infrastructure Capital Spending	Total annual fixed assets investment in urban infrastructure (real per capita) Chinese Yuan	199	529	0.5	19380	China's Urban Construction Statistical Yearbook
Infrastructure Maintenance Spending	Total annual maintenance expenditure in urban infrastructure (real per capita) Chinese Yuan	83	242	0.2	6155	China's Urban Construction Statistical Yearbook
Independent Variables						
Public Demand						
Population Density	Total city population divided by total land area (persons per square kilometer)	412	364	4	11564	China City Statistical Yearbook
Urbanization	The share of people living in urban area	0.11	0.03	0.09	0.43	China City Statistical Yearbook
Urban Household Income	Urban household income (real per capita) Chinese Yuan	12577	6675	1881	164741	China City Statistical Yearbook
Urban-Rural Income Disparity	Ratio of urban household income divided by rural household income	2.71	0.84	0.33	28.66	China City Statistical Yearbook
Government Supply						
Economic Development	Real GDP per capita (Chinese Yuan)	22069	19894	1394	183505	China City Statistical Yearbook
% Own-Source Revenue	Ratio of city own revenue sources in total city revenue	0.49	0.22	0.037	0.94	China City Statistical Yearbook
Fiscal Deficit	(General fiscal expenditure minus general fiscal revenues) divided by total population	-0.12	0.16	-4.8	0.15	China City Statistical Yearbook
Political Factors						
Party Secretary's Tenure	Prefectural party secretary's accumulated year in office by the end of that year	1.8	1.7	0.5	9	The Chinese Political Elite Database
Party Secretary's Distance to Retirement	60 minus a prefectural party secretary's age	8.5	3.79	0	21	The Chinese Political Elite Database

Empirical Findings

Descriptive Exploration of Spatial Autocorrelation in Urban Infrastructure Spending

The Global Moran's I Statistics

To justify the use of multivariate spatial econometric model, we first offer some preliminary, descriptive evidence of spatial autocorrelation in Chinese city infrastructure spending. For this purpose, we drew on data from the years of 2001 to 2012 (using the average) and present two pieces of evidence: thematic maps and Global Moran's I statistics. The thematic maps provide visual plots of the distribution of urban infrastructure expenditures in Chinese geographic spaces. The Global Moran's *I* statistics is a cross-sectional correlation coefficient that measures the overall spatial autocorrelation of a variable in a particular jurisdiction and its neighbors. It is specified as follows:

$$I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2} \quad (7)$$

Where *i* and *j* index individual observations (here, individual cities), and *W* is the row-standardized spatial connectivity matrix linking observations (the distance-based weighting matrix). Table 2 presents the results of the Global Moran's I statistics for our three urban infrastructure spending categories. The null hypothesis for this test is that there is no spatial autocorrelation in the data. The testing results reject the null hypothesis and suggest that there exists a statistically significant spatial autocorrelation in all three spending categories.

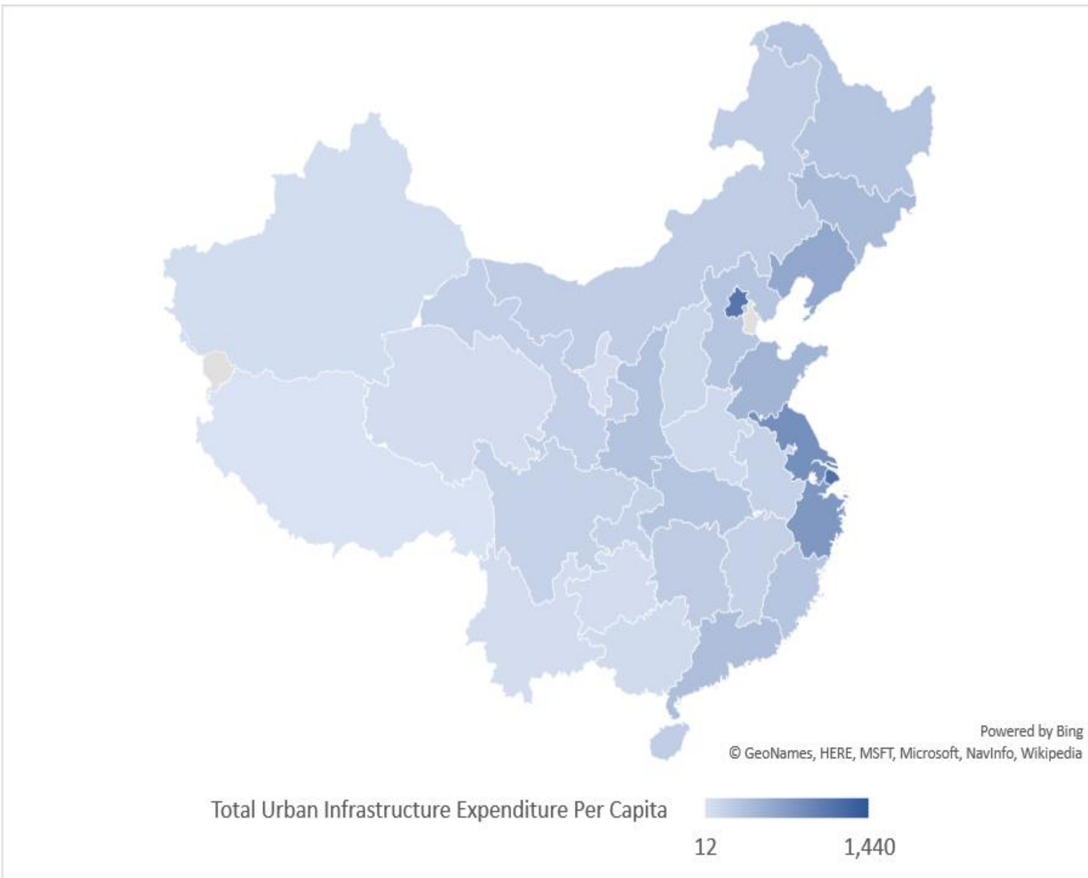
Table 2. Global Moran's I Statistics
(Average Spending in Category, 2001–2012)

	χ^2 **test**	**p-Value for Model Test**
Total Infrastructure Expenditure Per Capita	chi2(1) =48.11	Prob > chi2 =0.0000
Infrastructure Capital Expenditure Per Capita	chi2(1) =37.44	Prob > chi2 = 0.0000
Infrastructure Maintenance Expenditure Per Capita	chi2(1) =31.15	Prob > chi2 = 0.0000

Thematic Maps

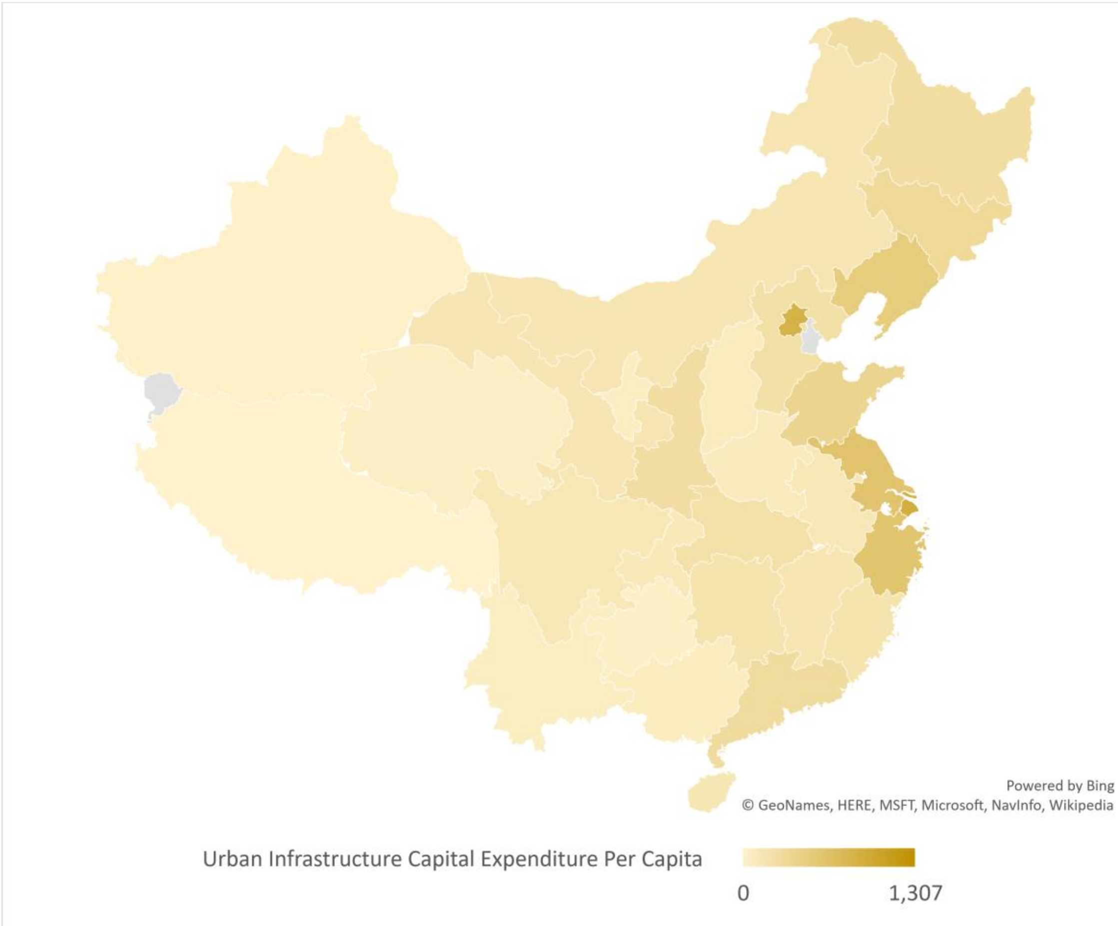
Figures 1, 2 and 3 present the thematic maps for each spending variable (total infrastructure, capital, and maintenance). The thematic map displays a significant degree of heterogeneity in urban infrastructure finance across the three spending categories and across the individual cities. The differences are particularly pronounced regarding city total infrastructure expenditure and capital spending. Furthermore, there appear to be clear patterns of geographic clustering of similar spending levels. In sum, both visual and statistical tests support the spatial autocorrelation in Chinese urban infrastructure investment and provide a strong motivation for using the multivariate spatial econometric for modelling urban infrastructure finance among Chinese cities.

Figure 1: Average City Infrastructure Expenditure Per Capita During 2001–2012



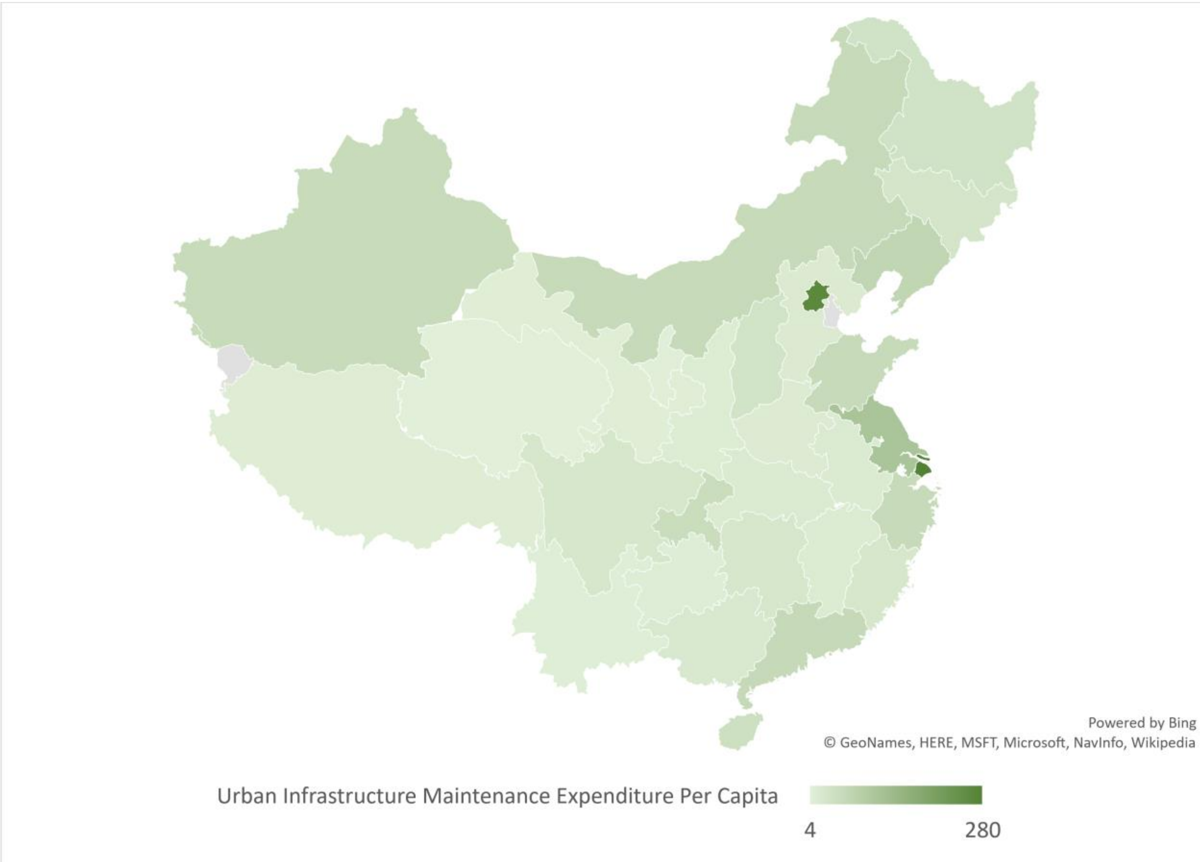
Source: Ministry of Housing and Urban-Rural Development of China (2002–2013), *China's Urban Construction Statistical Yearbook.*

Figure 2: Average City Infrastructure Capital Expenditure Per Capita During 2001–2012



Source: Ministry of Housing and Urban-Rural Development of China (2002–2013), *China's Urban Construction Statistical Yearbook.*

Figure 3: Average City Infrastructure Maintenance Expenditure Per Capita During 2001–2012



Source: Ministry of Housing and Urban-Rural Development of China (2002–2013), *China's Urban Construction Statistical Yearbook*

Baseline Spatial Panel Regression Results

Table 3 reports the basic spatial panel regression results.[4] The most important results are the estimation of the spatially lagged dependent variables ($W \times Y$), and the spatial interaction or reaction function slope parameter. The spatial interaction coefficients are positive and statistically significant for all three infrastructure spending categories. These results indicate that strategic interactions exist among Chinese prefecture-level cities in urban infrastructure investment. The positive sloping reaction function suggests that city *i*'s response to an increase of its neighbors' infrastructure investment is to increase its own infrastructure spending accordingly. These findings indicate that urban infrastructure spending between neighboring cities are strategic complements.

[4] Economic and fiscal control variables are highly endogenous even though we used one-year lag. In order to address concerns, we re-estimated the models without control variables and with only exogenous control variables. The spatial interaction of urban infrastructure investment remains positive and statistically significant. In the Appendix, we document these alternative results.

Across three models, the coefficient of the spatially lagged dependent variables ranges from 0.285 to 0.766. It has the largest value in the model of city infrastructure capital expenditure (0.766), followed by 0.535 in the model of city total infrastructure expenditure, and then 0.285 in the model of city infrastructure maintenance expenditure. A one percent increase of neighboring cities' total infrastructure spending would induce one city to increase its own total infrastructure expenditure by 0.535 percent. Similarly, a one percent increase of neighboring cities' infrastructure capital spending would induce one city to increase its own infrastructure capital expenditure by 0.76 percent. Lastly, a one percent increase of neighboring cities' infrastructure maintenance spending would induce one city to increase its own infrastructure capital expenditure by 0.285 percent.

Concerning the economic and fiscal control variables of the cities' characteristics, as expected, we find that the variable of real GDP per capita is statistically significant across all three models. This indicates that economically developed cities make more investment toward infrastructure capital and maintenance expenditure. Fiscal deficit has a statistically significant and negative effect among all models. This infers that cities experiencing more fiscal pressure spend less on infrastructure because less fiscal resources are available for infrastructure investment. The variable of urban resident income has a positive sign in all three models, but it is only statistically significant in Model 3 ($p<0.05$). Now turning to the demographic variables, the coefficient of Pop Density is negative and statistically significant in two of the three models (Models 1 and 2). This indicates that highly dense cities are associated with less amounts of spending on total infrastructure and infrastructure fixed capital assets. This may be because there are economies of density in the provision of urban infrastructure services. High-density compact cities can reduce infrastructure capital requirements. Both variables of urbanization and social inequality (urban to rural income inequality) are found to significantly reduce the amount of city spending on infrastructure maintenance. Examining political variables, the variable of Party Secretary's tenure is only statistically significant in Model 3. Its positive sign implies that the longer the city party secretary stays in the position, the more likely it is that the city government will spend more on infrastructure maintenance.

Table 3: Baseline Spatial Panel Regression Results

Variables	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Ln Real GDP Per Capita	0.287***	0.549***	0.217*
	(0.088)	(0.119)	(0.117)
Ln Urban Household Income	0.310	0.340	0.639**
	(0.189)	(0.253)	(0.249)
Ln Pop Density	-0.321***	-0.438***	-0.206
	(0.123)	(0.166)	(0.162)
Urbanization	-1.841	1.971	-6.497***
	(1.354)	(1.823)	(1.777)
Urban and Rural Income Inequality	-0.042	-0.051	-0.092**
	(0.034)	(0.045)	(0.044)
Fiscal Deficit	-0.989***	-1.456***	-0.767***
	(0.124)	(0.168)	(0.165)

% of Own-Source Revenue	0.046	0.042	0.024
	(0.08)	(0.110)	(0.110)
Party Secretary's Tenure	0.004	0.001	0.020*
	(0.008)	(0.01)	(0.012)
Party Secretary's Time to Retirement	-0.002	-0.005	0.003
	(0.005)	(0.006)	(0.006)
Time Trend	-0.056**	-0.142***	-0.039
	(0.025)	(0.032)	(0.034)
W × Total Infra Exp Per Capita	0.535***		
	(0.190)		
Error_Total Infra Exp Per Capita	0.592***		
	(0.181)		
W × Ln Capital Exp Per Capita		0.766***	
		(0.113)	
Error_Capital Exp Per Capita		0.581***	
		(0.178)	
W × Ln Maintenance Exp Per Capita			0.285*
			(0.159)
Error_Ln Maintenance Exp Per Capita			0.852***
			(0.055)
Constant	0.756***	1.017***	0.994***
	(0.009)	(0.013)	(0.013)
R-Squared	0.2715	0.3668	0.3752
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Alternative Model Specifications

<u>Heterogeneity Across Chinese Regions</u>

We start by exploring strategic integrations in urban infrastructure finance across different regions of China. Table 4 presents the spatial panel estimation results in the eastern, middle, and western regions of China. Interestingly, the coefficients for the spatially lagged dependent variables are statistically significant and positive in the eastern and middle regions of China, but insignificant in the western regions of China. This indicates that strategic integration in total urban infrastructure spending occurs in the eastern and middle areas of China, but not in the western area. The positive reaction slope coefficient for city total infrastructure spending is larger in the eastern region (0.807) than in the middle region (0.502). Turning to the largest component of urban infrastructure expenditure, the coefficient for the spatially lagged capital expenditure dependent variables are statistically significant and positive in the eastern (0.886) and middle regions (0.724) of China. In contrast, it has a significant and negative sign (-0.419) in the western region. In the case of urban infrastructure maintenance, the coefficient for the spatially lagged infrastructure maintenance expenditure dependent variables is only statistically significant and positive in the middle region (0.578). The eastern region is the most developed area in China. Cities in this region are often thought to compete fiercely for economic development. It is easy to see why city government officials in the eastern costal area rely more on building new infrastructure (less on infrastructure maintenance) to attract foreign investment and stimulate local economic growth. The middle area of China has a location disadvantage compared with the eastern region. To attract foreign investment, local governments must compete heavily for both building new infrastructure and maintaining infrastructure in good condition. The economic investment environment and location condition is worse in the western region than even that of the middle region. For cities in this region, it may not be easy to attract outside business investment via infrastructure improvement.

Table 4: Spatial Panel Regression Results for Different Regions of China

Variables	The Eastern Region			The Middle Region			The Western Region		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**	**Total Infra Exp PC**	**Capital Exp PC**	**Maintenance Exp PC**	**Total Infra Exp PC**	**Capital Exp PC**	**Maintenance Exp PC**
Ln Real GDP Per Capita	0.440***	0.703***	0.261	0.594***	0.569*	0.911***	-0.205	-0.122	-0.077
	(0.146)	(0.207)	(0.213)	(0.231)	(0.310)	(0.296)	(0.144)	(0.189)	(0.198)
Ln Urban Household Income	-0.738***	-1.007***	0.121	-0.195	0.0004	0.066	1.998***	2.480***	1.844***
	(0.261)	(0.363)	(0.420)	(0.367)	(0.495)	(0.473)	(0.428)	(0.564)	(0.594)
Ln Pop Density	-0.320**	-0.557***	-0.117	-0.300	-0.199	-0.239	-0.653**	-0.544	-0.599
	(0.132)	(0.188)	(0.182)	(0.450)	(0.601)	(0.575)	(0.316)	(0.414)	(0.435)
Urbanization	-0.222	4.507**	-6.097***	-13.88**	-9.582	-23.30***	-5.796	-11.43	-1.009
	(1.330)	(1.892)	(1.773)	(7.008)	(9.371)	(8.963)	(6.168)	(8.057)	(8.491)
Urban_Rural Income Inequality	0.253**	0.152	0.054	0.079	-0.011	-0.014	-0.184***	-0.229***	-0.189***
	(0.110)	(0.153)	(0.181)	(0.096)	(0.129)	(0.124)	(0.050)	(0.066)	(0.070)
Fiscal Deficit	-1.287***	-1.812***	-1.374**	-1.440***	-2.872***	0.655	-0.679***	-1.056***	-0.518**
	(0.419)	(0.591)	(0.643)	(0.520)	(0.705)	(0.681)	(0.156)	(0.205)	(0.215)
% Own-Source Revenue	0.401**	0.476*	0.586*	0.191	0.413*	-0.620***	-0.228*	-0.500***	0.083
	(0.189)	(0.264)	(0.320)	(0.162)	(0.219)	(0.209)	(0.136)	(0.179)	(0.187)
Secretary's Tenure	0.017	0.017	0.046**	-0.0001	0.002	-0.021	0.001	5.40e-05	0.032
	(0.013)	(0.019)	(0.018)	(0.015)	(0.020)	(0.019)	(0.018)	(0.023)	(0.024)
Secretary's Time to Retirement	-0.009	-0.016	-0.001	0.0003	-0.006	-0.004	0.0004	0.005	0.016
	(0.007)	(0.010)	(0.009)	(0.008)	(0.010)	(0.010)	(0.010)	(0.014)	(0.014)
Time Trend	0.012	-0.019	0.036	-0.017	-0.115	-0.035	-0.098*	-0.173**	-0.068
	(0.029)	(0.039)	(0.057)	(0.057)	(0.077)	(0.074)	(0.054)	(0.073)	(0.075)
W × Total Infra Exp	0.807***			0.502***			-0.363		
	(0.052)			(0.124)			(0.243)		
Error_Total Infra Exp	-0.296*			0.564***			0.743***		
	(0.179)			(0.118)			(0.079)		
W × Ln Capital Exp		0.886***			0.724***			-0.419**	
		(0.030)			(0.078)			(0.210)	
Error_Capital Exp		-0.396**			0.684***			0.881***	
					(0.090)			(0.033)	
W × Ln Maintenance Exp			-0.187			0.578***			-0.190
			(0.167)			(0.114)			(0.246)
Error_Ln Maintenance Exp			0.870***			0.686***			0.754***
			(0.038)			(0.096)			(0.081)
Constant	0.688***	0.979***	0.936***	0.740***	0.990***	0.947***	0.824***	1.079***	1.134***
	(0.015)	(0.022)	(0.021)	(0.016)	(0.021)	(0.020)	(0.020)	(0.026)	(0.028)
R-Squares	0.0923	0.2047	0.207	0.0449	0.0997	0.1375	0.1735	0.2166	0.1527
Observations	1,164	1,164	1,164	1,200	1,200	1,200	960	960	960
Number of groups	97	97	97	100	100	100	80	80	80

Note: *** p<0.01, ** p<0.05, * p<0.1

Use of Alternative Dependent Variables

In our baseline estimation, the dependent variables are constructed based on the per capita basis. As a robustness check, we employ three alterative dependent variables—real infrastructure, capital, and maintenance spending per km^2 of land area. Table 5 presents the new results. The coefficients of spatially lagged dependent variables remain positive and statistically significant from Model 1to Model 3, although their magnitudes are smaller than those of using the per person based dependent variables.

Table 5: Basic Spatial Panel Regression Results (Alternative Dependent Variables)

Variables	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp Per km^2	**Capital Exp Per km^2**	**Maintenance Exp Per km^2**
Ln Real GDP Per Capita	0.323***	0.585***	0.250*
	(0.089)	(0.119)	(0.117)
Ln Urban Household Income	0.322*	0.374	0.664***
	(0.189)	(0.254)	(0.249)
Ln Pop Density	0.709***	0.556***	0.785***
	(0.124)	(0.166)	(0.162)
Urbanization	-1.900	1.968	-6.430***
	(1.365)	(1.825)	(1.776)
Urban and Rural Income Inequality	-0.046	-0.057	-0.097**
	(0.034)	(0.045)	(0.044)
Fiscal Deficit	-0.606***	-1.069***	-0.376**
	(0.126)	(0.169)	(0.165)
% of Own-Source Revenue	0.055	0.030	0.009
	(0.083)	(0.111)	(0.110)
Party Secretary’s Tenure	0.005	0.001	0.020*
	(0.009)	(0.01)	(0.012)
Party Secretary’s Time to Retirement	-0.002	-0.005	0.003
	(0.005)	(0.006)	(0.006)
Time Trend	-0.051**	-0.142***	-0.036
	(0.025)	(0.032)	(0.034)
W × Total Infra Exp Per Capita	0.483***		
	(0.172)		
Error_Total Infra Exp Per Capita	0.635***		
	(0.142)		
W × Ln Capital Exp Per Capita		0.737***	
		(0.144)	
Error_Capital Exp Per Capita		0.631***	
		(0.188)	
W × Ln Maintenance Exp Per Capita			0.295*
			(0.159)
Error_Ln Maintenance Exp Per Capita			0.844***
			(0.058)
Constant	0.762***	1.019***	0.994***
	(0.010)	(0.013)	(0.013)
R-Squared	0.1561	0.459	0.2058
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Use of Spatial Panel Durbin Model

A final robustness check is employing the alternative estimation method of Spatial Panel Durbin Model (SPDM). Besides containing the spatial lags of dependent variables and error terms in SPDM, it also incorporates the spatial lag values of the explanatory variables into the estimation model. Table 6 summarizes the results of SPDM. The findings suggest that the results are robust to the different model specification. The coefficients for all spatially lagged dependent variables are positive and statistically significant for three urban infrastructure spending variables. Compared with the baseline regression estimation, the spatial interaction effects are much stronger under the SPDM, especially for urban infrastructure maintenance spending.

Table 6: Spatial Panel Durbin Regression Results

Variables	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Ln Real GDP Per Capita	0.306***	0.571***	0.249**
	(0.089)	(0.120)	(0.117)
Ln Urban Household Income	0.396**	0.389	0.739***
	(0.185)	(0.251)	(0.243)
Ln Pop Density	-0.342***	-0.473***	-0.197
	(0.123)	(0.166)	(0.162)
Urbanization	-1.284	2.904	-6.781***
	(1.364)	(1.836)	(1.790)
Urban_Rural Income Inequality	-0.050	-0.048	-0.104**
	(0.033)	(0.045)	(0.044)
Fiscal Deficit	-1.001***	-1.412***	-0.836***
	(0.126)	(0.169)	(0.166)
% of Own-Source Revenue	0.040	0.010	-0.032
	(0.088)	(0.119)	(0.116)
Party Secretary’s Tenure	0.003	0.0003	0.019
	(0.009)	(0.012)	(0.012)
Party Secretary's Time to Retirement	-0.002	-0.006	0.002
	(0.005)	(0.006)	(0.006)
W × Ln Real GDP Per Capita	0.212	-0.086	0.021
	(0.680)	(0.935)	(0.838)
W × Ln Urban Household Income	-1.267	-1.611	0.304
	(0.901)	(1.244)	(1.132)
W × Ln Pop Density	-0.720	0.845	0.147
	(1.677)	(2.359)	(2.106)
W × Urbanization	53.88***	73.94***	10.11
	(16.71)	(23.20)	(21.20)
W × Urban_Rural Income Inequality	0.587**	0.250	0.658*
	(0.285)	(0.394)	(0.364)
W × Fiscal Deficit	-2.178**	-4.841***	4.195***
	(1.020)	(1.521)	(1.329)
W × % Own-Source Revenue	-0.087	0.032	0.500
	(0.383)	(0.587)	(0.487)
W × Party Secretary’s Tenure	0.008	-0.031	-0.014

	(0.062)	(0.089)	(0.077)
W × Party Secretary's Time to Retirement	-0.070*	-0.128**	-0.047
	(0.039)	(0.052)	(0.048)
W ×Total Infra Exp Per Capita	0.720***		
	(0.010)		
Error_Total Infra Exp Per Capita	0.244		
	(0.202)		
W × Ln Capital Exp Per Capita		0.803***	
		(0.062)	
Error_Capital Exp Per Capita		0.361**	
		(0.159)	
W × Ln Maintenance Exp Per Capita			0.791***
			(0.060)
Error_Ln Maintenance Exp Per Capita			0.178
			(0.158)
Constant	0.753***	1.014***	0.992***
	(0.010)	(0.013)	(0.013)
R-Squared	0.2715	0.3668	0.3752
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Accounting for the Dynamic Effects of Infrastructure Investment

In our baseline estimation, we do not account for the time persistent characteristic of urban infrastructure finance. Instead, we employ a dynamic spatial panel model using lagged variables as instruments and use the Generalized Method of Moments (GMM) to account for the time dynamic effect of urban infrastructure investment (Arellano and Bover 1995; Blundell and Bond 1998). Table 7 summarizes the results of dynamic spatial panel estimation. The lagged dependent variables are positive and statistically significant across all three models. The suggests the robustness of the dynamic spatial panel model approach in modelling the determinants of urban infrastructure investment. Consistent with the previous results from the baseline spatial panel estimations in Table 3, the spatial interaction effect is positive and statistically significant in all three models. This further confirms that strategic interaction exists in urban infrastructure finance among Chinese cities. It is interesting to note that the magnitude of the effect of spatial interaction is much larger than that of the time dynamic effect.

Table 7: Dynamic Spatial Panel Regression Results

	Model 1	Model 2	Model 3
Variables	**Total Infra Exp PC**	**Capital Exp PC**	**Maintenance Exp PC**
Ln Total Infra Exp Per Capita (One-Year Lag)	0.151*** (0.016)		
Ln Capital Exp Per Capita (One-Year Lag)		0.185*** (0.017)	
Ln Maintenance Exp Per Capita (One-Year Lag)			0.136*** (0.017)
Ln Real GDP Per Capita	0.260*** (0.087)	0.496*** (0.117)	0.192* (0.115)
Ln Urban Household Income	0.236 (0.186)	0.245 (0.248)	0.482* (0.247)
Ln Pop Density	-0.328*** (0.122)	-0.358** (0.163)	-0.213 (0.161)
Urbanization	-1.801 (1.331)	1.365 (1.785)	-6.339*** (1.759)
Urban_Rural Income Inequality	-0.025 (0.033)	-0.029 (0.044)	-0.066 (0.044)
Fiscal Deficit	-0.864*** (0.124)	-1.217*** (0.166)	-0.684*** (0.164)
% Own-Source Revenue	-0.010 (0.082)	-0.036 (0.110)	-0.032 (0.109)
Party Secretary's Tenure	0.003 (0.008)	-0.0006 (0.012)	0.017 (0.012)
Party Secretary's Time to Retirement	-0.001 (0.005)	-0.003 (0.006)	0.003 (0.006)
Time Trend	-0.031 (0.025)	-0.104*** (0.033)	-0.020 (0.034)
W × Total Infra Exp Per Capita	0.290** (0.145)		
Error_Total Infra Exp Per Capita	0.791*** (0.064)		
W × Ln Capital Exp Per Capita		0.603*** (0.144)	
Error_Capital Exp Per Capita		0.737*** (0.112)	
W × Ln Maintenance Exp Per Capita			0.272* (0.155)
Error_Ln Maintenance Exp Per Capita			0.848*** (0.054)
Constant	0.744*** (0.009)	0.997*** (0.013)	0.984*** (0.013)
R-Squared	0.2968	0.3922	0.3907
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Disentangling the Sources of Strategic Interaction in Chinese Urban Infrastructure Finance

We perform additional tests to identify the potential sources of strategic interaction in urban infrastructure finance among Chinese prefecture-level cities.

Test the Sources of Strategic Interaction from the Theory of Yardstick Competition

In China, promotion of local government officials is decided by their upper-level governments which evaluate their performance largely based on local economic growth. In this scenario, local government officials have strong incentives to attract private investment by providing more infrastructure services (e.g., Caldeira 2012; Terra and Mattos 2017). According to the theory of yardstick competition, city governments react more strongly to the neighboring cities' decisions on infrastructure investment during political cycle. This is because provincial leaders compare city government leaders' economic performance during the political periods. To test this theoretical prediction, we developed two sets of political cycle dummy variables. First, a series of time dummy variable are created for the Provincial Communist Party Congress (PCRC). They are one year before the PCRC (Pre_PCRC), the year of PCRC (Current_PCRC), and the first year after the PCPC (Post_PCRC). Second, taking the changes in local political leadership into consideration, two kinds of time dummy variables are utilized. They are the first year of tenure in office (Tenure_First Year), and the second year of tenure in office (Tenure_Second Year). Our two sets of political cycle dummy variables are then interacted with the weighted neighboring cities' infrastructure spending (WY).

Tables 8 and 9 provide the estimation results using the political interaction terms, respectively. The results in Table 8 show that Chinese cities react more to their neighboring cities' total infrastructure and capital expenditures during and one-year before the PCRC. Overall, cities cut their spending during these periods but they cut them less compared to neighboring cities. Table 9 indicates that cities react more to their neighboring cities for total infrastructure spending during their first year of city party secretary's tenure. Again, cities cut their spending overall but relatively less compared to neighboring cities. Both results imply that during or one-year before the Provincial Communist Party Congress (PCRC) or after taking office, city government officials compete with neighboring cities to signal their own competence and performance by maintaining infrastructure investment levels relative to their neighbors. Our empirical findings are consistent with our field interview about the political motivation of urban infrastructure investment. One interviewee points out that new infrastructure investment is "a handy way for local government officials to enhance their political capacities." Another interviewee asserts that infrastructure investment is visible and "helps local leaders to impress their superiors with economic and political achievement."

Table 8: Spatial Panel Estimation Results for the Yardstick Competition Model
(The Political Cycle of the Provincial Communist Party Congress)

Variable	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Pre-One-year Provincial Communist Party Congress	-0.499***	-0.486***	-0.185
	(0.132)	(0.182)	(0.195)
Pre-One-year Provincial Communist Party Congress × Wy	0.091***	0.083*	0.030
	(0.031)	(0.044)	(0.049)
Current year Provincial Communist Party Congress	-0.452***	-0.641***	0.006
	(0.125)	(0.173)	(0.190)
Current year Provincial Communist Party Congress × Wy	0.080***	0.123***	-0.012
	(0.030)	(0.043)	(0.050)
Post One-Year Provincial Communist Party Congress	-0.275**	-0.520***	0.347*
	(0.133)	(0.185)	(0.200)
Post One-year Provincial Communist Party Congress × Wy	0.050	0.089**	-0.077
	(0.031)	(0.044)	(0.051)
Ln Real GDP Per Capita	0.330***	0.595***	0.299***
	(0.083)	(0.113)	(0.113)
Ln Pop Density	-0.290**	-0.403**	-0.180
	(0.123)	(0.165)	(0.162)
Urban and Rural Income Inequality	-0.004	-0.015	-0.019
	(0.026)	(0.035)	(0.034)
Fiscal Deficit	-1.038***	-1.529***	-0.789***
	(0.121)	(0.165)	(0.165)
Urbanization	-1.640	2.180	-6.333***
	(1.353)	(1.818)	(1.776)
Party Secretary's Tenure	0.005	0.001	0.0210*
	(0.009)	(0.012)	(0.012)
Party Sectary's Time to Retirement	-0.003	-0.006	0.003
	(0.005)	(0.006)	(0.006)
% Own-Source Revenue	0.111	0.120	0.060
	(0.078)	(0.108)	(0.111)
Time Trend	-0.044***	-0.120***	0.025
	(0.015)	(0.019)	(0.024)
W × Total Infra Exp Per Capita	0.719***		
	(0.065)		
Error_Total Infra Exp Per Capita	0.124		
	(0.162)		
W × Ln Capital Exp Per Capita		0.842***	
		(0.046)	
Error_Capital Exp Per Capita		0.308**	
		(0.148)	
W × Ln Maintenance Exp Per Capita			0.304*
			(0.171)
Error_Ln Maintenance Exp Per Capita			0.841***
			(0.063)
Constant	0.754***	1.014***	0.994***
	(0.010)	(0.013)	(0.013)
R-Squared	0.2714	0.3674	0.3739
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 9: Spatial Panel Estimation Results for the Yardstick Competition Model
(The Political Cycle of City Party Secretary's Tenure in Office)

Variables	Model 1 Total Infra Exp PC	Model 2 Capital Exp PC	Model 3 Maintenance Exp PC
Party Secretary's Tenure First Year	-0.267** (0.133)	-0.0851 (0.173)	-0.158 (0.164)
Party Secretary's Tenure First Year × Wy	0.0519* (0.0279)	0.0212 (0.0356)	0.0252 (0.0332)
Party Secretary's Tenure Second Year	0.100 (0.147)	0.182 (0.195)	-0.0151 (0.186)
Party Secretary's Tenure Second Year × Wy	-0.0233 (0.0342)	-0.0364 (0.0447)	-0.00243 (0.0421)
Ln Real GDP Per Capita	0.326*** (0.0845)	0.593*** (0.115)	0.297*** (0.113)
Ln Pop Density	-0.310** (0.123)	-0.424** (0.166)	-0.190 (0.162)
Urban and Rural Income Inequality	-0.00443 (0.0261)	-0.0120 (0.0352)	-0.0183 (0.0345)
Fiscal Deficit	-1.726 (1.353)	2.085 (1.820)	-6.304*** (1.777)
Urbanization	-1.006*** (0.123)	-1.474*** (0.167)	-0.789*** (0.165)
Party Secretary's Tenure	-0.0101 (0.0190)	0.000650 (0.0256)	0.00745 (0.0251)
Party Sectary's Time to Retirement	-0.00248 (0.00471)	-0.00545 (0.00634)	0.00307 (0.00617)
% Own-Source Revenue	0.0533 (0.0798)	0.0550 (0.109)	0.0406 (0.110)
Time Trend	-0.0356** (0.0179)	-0.110*** (0.0207)	0.0230 (0.0242)
W × Total Infra Exp Per Capita	0.653*** (0.140)		
Error_Total Infra Exp Per Capita	0.424** (0.216)		
W × Ln Capital Exp Per Capita		0.792*** (0.0927)	
Error_Capital Exp Per Capita		0.532*** (0.175)	
W × Ln Maintenance Exp Per Capita			0.307* (0.164)
Error_Ln Maintenance Exp Per Capita			0.843*** (0.0599)
Constant	0.755*** (0.00970)	1.016*** (0.0131)	0.995*** (0.0128)
R-Squared	0.2733	0.3676	0.3735
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Test the Sources of Strategic Interaction from the Resource Flow Model

As we discussed previously in the spatial competition literature, the "resource flow" model assumes that jurisdictions are not directly affected by the decisions of other jurisdictions but instead must compete with each other for a particular mobile resource (e.g., Brueckner 2003)

From this theoretical perspective, it is expected that cities located in foreign investment or industrial output dependent areas should react more strongly to their neighboring cities' infrastructure investment. This is because they tend to be more concerned about retaining and attracting mobile resources (foreign investment or manufacturing firms) to sustain local economic development. In order to test the potential source of strategic interaction from the viewpoints of the "resource flow" model, we developed two kinds of dummy variables for mobile-resource dependent areas. The first one is a dummy variable for the foreign direct investment (FDI)-dependent city (FDI_AboveMedian=1 if the ratio of FDI to GDP in one city is above the median among all prefecture-level cities). The second one is a dummy variable for the industrial output-dependent area (IndustrialOutput_AboveMedian=1 if the ratio of the value of industrial output to GDP in one city is above the median among all prefecture-level cities). Then, the two sets of dummy variables for mobile-resource dependent areas are interacted with the weighted neighboring cities' infrastructure spending (*WY*).

Tables 10 and 11 show these new estimations. The results in Table 10 indicate that Chinese cities in the FDI-dependent areas do react more strongly to their neighboring cities' total infrastructure and maintenance expenditures. However, in Table 10, the interaction term of the industrial output-dependent area and spatially lagged dependent variables is not statistically significant, suggesting that there is no evidence that cities with a high reliance on industrial outputs respond more strongly to their neighbors. In sum, there is some weak evidence to support the source of strategic interaction from the competition for the mobile resource of foreign investment. This empirical finding is supported by our case study interviews. Public officials in all three selected cities contend that attracting foreign investment is one of the most important economic rationales for urban infrastructure development.

Table 10: Spatial Panel Estimation Results for the Resource Flow Model
(Compete for the Mobile Resource—Foreign Direct Investment)

Variables	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
FDI Above Median × Wy	0.032**	0.025	0.049**
	(0.016)	(0.022)	(0.022)
Ln Real GDP Per Capita	0.312***	0.584***	0.277**
	(0.085)	(0.115)	(0.113)
Ln Pop Density	-0.312**	-0.428***	-0.189
	(0.123)	(0.166)	(0.162)
Urban_Rural Income Inequality	-0.007	-0.013	-0.019
	(0.026)	(0.035)	(0.034)
Fiscal Deficit	-1.838	1.986	-6.435***
	(1.354)	(1.822)	(1.778)
Urbanization	-1.025***	-1.485***	-0.807***
	(0.124)	(0.168)	(0.165)
Party Secretary's Tenure	0.004	0.0013	0.020*
	(0.009)	(0.012)	(0.012)
Party Secretary's Time to Retirement	-0.002	-0.005	0.003
	(0.005)	(0.006)	(0.006)
% Own-Source Revenue	0.055	0.053	0.040
	(0.081)	(0.110)	(0.110)
Time Trend	-0.031*	-0.109***	0.024
	(0.018)	(0.021)	(0.024)
W × Total Infra Exp Per Capita	0.608***		
	(0.168)		
Error_Total Infra Exp Per Capita	0.499**		
	(0.207)		
W× Ln Capital Exp Per Capita		0.774***	
		(0.111)	
Error_Capital Exp Per Capita		0.572***	
		(0.181)	
W × Ln Maintenance Exp Per Capita			0.332*
			(0.184)
Error_Ln Maintenance Exp Per Capita			0.825***
			(0.076)
Constant	0.756***	1.017***	0.995***
	(0.010)	(0.013)	(0.013)
R-Squared	0.2726	0.3674	0.376
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 11: Spatial Panel Estimation Results for the Resource Flow Model
(Compete for the Mobile Resource—Industrial Firms)

Variables	Model 1	Model 2	Model 3
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Industry Outputs Above Median × Wy	-0.006	-0.003	0.020
	(0.013)	(0.018)	(0.017)
Ln Real GDP Per Capita	0.330***	0.594***	0.283**
	(0.086)	(0.116)	(0.113)
Ln Pop Density	-0.313**	-0.428***	-0.187
	(0.123)	(0.166)	(0.162)
Urban_Rural Income Inequality	-0.007	-0.012	-0.020
	(0.026)	(0.035)	(0.034)
Fiscal Deficit	-1.763	2.069	-6.231***
	(1.354)	(1.822)	(1.777)
Urbanization	-1.008***	-1.475***	-0.783***
	(0.124)	(0.167)	(0.165)
Party Secretary’s Tenure	0.004	0.001	0.021*
	(0.009)	(0.012)	(0.012)
Party Secretary’s Time to Retirement	-0.002	-0.005	0.003
	(0.005)	(0.006)	(0.006)
% Own-Source Revenue	0.055	0.054	0.043
	(0.081)	(0.109)	(0.110)
Time Trend	-0.029	-0.109***	0.0261
	(0.0183)	(0.021)	(0.024)
W × Total Infra Exp Per Capita	0.574***		
	(0.181)		
Error_Total Infra Exp Per Capita	0.551***		
	(0.195)		
W × Ln Capital Exp Per Capita		0.782***	
		(0.102)	
Error_Capital Exp Per Capita		0.554***	
		(0.178)	
W × Ln Maintenance Exp Per Capita			0.299*
			(0.158)
Error_Ln Maintenance Exp Per Capita			0.849***
			(0.056)
Constant	0.756***	1.017***	0.995***
	(0.010)	(0.013)	(0.013)
R-Squared	0.2711	0.3667	0.3733
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Multiple Case Studies

To understand why and how spatial interaction happens in the real context of Chinese urban infrastructure finance, we supplement our spatial econometric analysis with qualitative case studies of three cities in China. We selected three cities: Suzhou, Wuhu, and Lanzhou. This selection was partially due to convenience, but since the cities are quite different in terms of geographic location, population size, and economic development, similarities across these three cities may be more generalizable than only looking at cities which have more in common.

Our primary data collection method was an in-depth interview, but we also reviewed written documents such as city official records, policy documents, and statistical yearbooks. One of the core members of the research team visited China during 2019 and conducted field interviews in three cities from the period of mid-June to mid-July. A total of nine interviews were completed, three for each city. Interviewees include a combination of public officials from Municipal Commission of Development and Reform, Municipal Housing and Urban-Rural Development Bureau, Research Office of Municipal People's Government, and Municipal Department of Transportation. In order to obtain candid responses to our questions, interviewees were guaranteed anonymity. We employed content analysis to identify themes and other insights provided by interviewees. We asked a series of questions of the interviewees. The questions related to the motivations of municipal provision of urban infrastructure development, the perceived role models of urban infrastructure development, and the perceived competitors of urban infrastructure development. There are limitations to our case studies. With a small sample size, we may have missed a perspective that is different from the individuals we interviewed. In addition, our research reflects only experiences in the three chosen cities and may not be generalizable to other Chinese cities. However, we found commonalities with responses from interviewees across cities despite the wide variety of sizes and circumstances. Overall, we believe that our results can be useful to both scholars and practitioners and help us better understand the factors and mechanisms driving strategic interaction in Chinese urban infrastructure finance.

Socioeconomic Background of the Three Cities

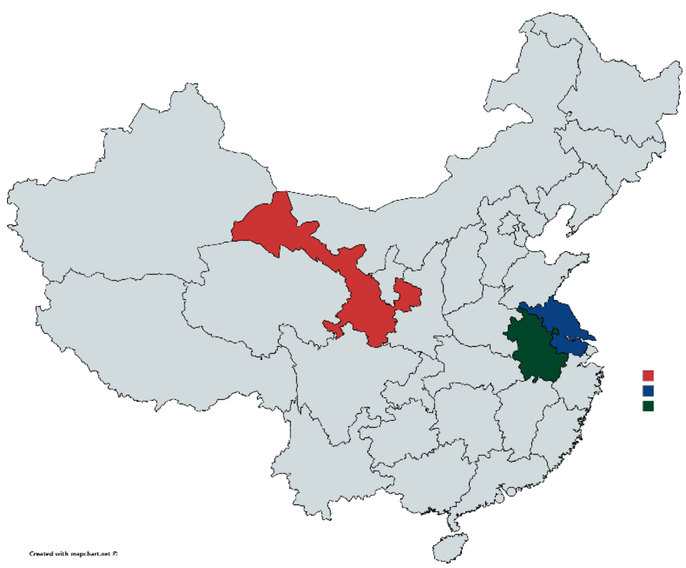
The social-economic profiles of the three selected Chinese cities vary substantially (see Table 12). Suzhou is in the Jiangsu province, which is one of the most developed provinces in the eastern region of China. It has the largest population size (7.06 million), highest GDP per capita (CNY 148,427), and the strongest government financial capacity. In addition, Suzhou is one of the most popular investment destinations for foreign companies and attracts the highest number of foreign companies (more than 17,000 foreign-funded enterprises). Wuhu is the second largest economy in Anhui province, which is a relatively less developed province in the middle region of China. It is a midsize city in terms of population (3.70 million). Wuhu has relatively higher GDP per capita (CNY114,672) and stronger government financial capacity. This city has attracted a relatively larger number of foreign investors. Lanzhou is the capital and largest city of Gansu province, which is one of the poorest provinces in the western region of China. Compared with Suzhou and Wuhu, Lanzhou has smaller population and less developed economy. Due to its heavy reliance on primarily on the agricultural industry, this city appears to have a low number of foreign companies. Figure 4 shows the geographic location of each city's province. Blue represents Jiangsu province, green Anhui province, and red Gansu province.

Table 12: Socioeconomic Characteristics of Three Chosen Chinese Cities (2018)

Name of Cities	Suzhou	Wuhu	Lanzhou
Region	Eastern	Middle	Western
Total City Registered Population (Million)	7.06	3.70	3.08
Urbanization Rate (%)	76	70	68
GDP Per Capita (Chinese Yuan)	148,427	114,672	73,042
Primary Industry as Percent of GDP (%)	1.00	1.44	52
Secondary Industry as Percent of GDP (%)	47.30	55.94	41
Tertiary Industry as Percent of GDP (%)	51.70	42.62	7
Population Density	1,259	606	279
Local General Public Budget Revenue (10,000 yuan)	19,081,002	3,112,297	2,533,169
Local General Public Budget Expenditure (10,000 yuan)	17,714,698	4,632,994	4,656,417
Foreign Capital Actually Utilized ($10,000)	450,392	268,730	17,958
Foreign Funded Enterprises	17,000	748	112

Source*: Chinese City Urban Construction Statistical Yearbook* and *Chinese City Statistical Yearbook*

Figure 4: Map of Provinces for the Three Chosen Chinese Cities



Source: Authors

Interview Analysis

Our interviews resulted in three primary areas of focus: motivations for urban infrastructure development, role models of urban infrastructure development, and competitors of urban infrastructure development. We will discuss each of these in turn. Throughout the analysis, we will review similarities and differences across cities**.**

Main Motivation of Urban Infrastructure Development

The interviewees believed that urban infrastructure in Chinese cities has experienced major growth and expansion in recent years. "*Infrastructure development is exploding everywhere in China. Many Chinese cities are increasingly turning to expanding and upgrading key infrastructure* …" We categorize and summarize the main motivations for urban infrastructure development in Table 13.

In Suzhou, the most important economic motivation for urban infrastructure development is to attract foreign direct investment. Three interviewees from Suzhou said "*The municipal government of Suzhou, with the strong support from the central and provincial governments, built first-class physical infrastructure such as power, water, roads, bridges, and telecommunication to attract foreign enterprises because these infrastructure investments make our city stand out from the crowd* …" "*We made substantial infrastructure improvements … We knew that our infrastructure investment would benefit the city by boosting connections with foreign investors* …" "*The good infrastructure, high-tech talents … in Suzhou appeals to foreign investors*." Another major economic motivation is the attraction of high-end manufacturing businesses and high-tech industrial firms. For example, one interviewee mentioned that "*Industrial parks play a significant role in our city. They were built to facilitate industrial development and better adapt to industrial transformation in the new era. We built extensive high-quality roads, rapid public transit systems, high-speed railroads, and utility facilities to support the functions of industrial parks and attract large manufacturing and high-tech industries to locate in our industrial zones* …" One interviewee from Suzhou also emphasized the need for building high-quality infrastructure to maintain the global competitiveness of doing business. "*We are striving to build a group of industries that can compete in the world and become showcases of Suzhou's advanced manufacturing industry … We did everything to maintain and enhance the infrastructure for utilities and transportation required by our manufacturing industry* …"

Now turning to political motivations, it seems that the major political motivation in Suzhou is local government officials' concern for economic development performance. Interviewees from Suzhou said "*sustaining high economic growth is probably one of the most important political tasks for our city government. Our key political leaders need to ensure that there are sufficient infrastructure investments toward promoting economic growth* …" "*Suzhou has long been recognized as a national model of high growth of economic development. Many prior municipal officials got promoted to a higher-level government position due to their superior economic performnace in Suzhou*" "*Investment in infrastructure is a key development indictor for performance evaluation of local government officials* …" In addition, meeting the infrastructure demands of urban residents is another key political motivation. "*The rapid urbanization in Suzhou causes massive expansion of population living in urban areas. In order to keep up with the growing demands for urban infrastructure, we accordingly develop and upgrade extensive infrastructure such as public transport, power, water, telecommunication networks, and parks* …" Concerning social-environmental motivations, two interviewees from Suzhou pointed out that "*It is well-known that Suzhou is a historical city. Tourism is expanding here. In recent years, we invested a lot in recreational facilities (e.g., parks, conventional centers, museums) and green infrastructure to integrate elements of the traditional with new urban recreational* *spaces*." Another interviewee indicated that "*Suzhou is a desirable travel destination for foreign visitors. We built modern infrastructure to maintain the international reputation of our city brand as the 'Venice of the Orient.'*"

In Wuhu, local government officials view attracting foreign investors as the most important economic rationale for urban infrastructure development. Interviewees from Wuhu said "*the city of Wuhu was overlooked by foreign investors who usually flocked to the eastern coastal cities. However, as the city improves its local infrastructure system, many foreign companies found Wuhu an important link in developing the domestic distribution system and expanded their companies here* …" "*With a significant amount of infrastructure investment in the forms of expressway system and high-speed railroads, we have been very successful in attracting foreign investment.*" "*Growing infrastructure and a steady supply of highly skilled labor has made our city an attractive destination for foreign investors* ..." Besides attracting foreign investment, another major economic motivation relates to supporting the relocation of industrial firms from the eastern region to Wuhu. "*Manufacturers in coastal regions are moving production lines to less-developed inland regions because of lower labor costs*. *The Wuhu municipal government has been focusing on building competitive infrastructure to attract more supporting manufactures to here* …" "*China has seen a surge in industry transfer from the coastal area to the middle and western regions due to rising labor costs and environmental pressures. The move will bring business opportunities for the inland region. We upgraded infrastructure, public services, and support facilities to accommodate this kind of large-scale industrial transfer* …" One interviewee from Wuhu highlighted the role of integrated infrastructure development in regional economic development. "*We are part of the Yangtze River Delta Economic Region. Physical infrastructure plays a vital role in integrating cities in this region. Our city is building in infrastructure to strengthen the interconnection of transportation, utilities, and telecommunication infrastructure* …"

Consistent with the case of Suzhou, local government officials' concern for economic development is the key political motivation. Interviewees from Wuhu asserted "*Building new infrastructure is a handy way for local government officials to enhance their political capacity by boosting their local GDP* …"*Local Government officials are basically told to go out and increase GDP to comply with the primary goal of national economic development* … *Infrastructure investment is vital in achieving the high rate of GDP growth mandated by the government* …" "*Infrastructure development is a key component of the local government political agenda* … *It is a necessary precondition for economic development* …" Another key political motivation is to satisfy the growing infrastructure needs of urban residents. For example, one interview said "*As more people move to the city, the demand for urban infrastructure is soaring in recent years* … *It is very important for city officials to satisfy the needs of the urban residents* …" Regarding social-environmental motivations, two interviewees from Wuhu highlighted the need to improve the livability of urban communities. "*Our city initiated many urban renewal projects to renovate old communities and build new community facilities* … *These projects are aimed at improving the living condition and environment for our urban residents.*" The city of Wuhu is subject to a higher level of flood risks. One interviewee indicated that "*To reduce potential flood hazards, the city invested large-scale projects on flood mitigation infrastructure projects* …"

Unlike the two cities in the eastern and central regions, Lanzhou has experienced slower economic growth in the past decade. All interviewees from Lanzhou pointed out that filling the infrastructure gap and promoting local economic development is the most critical economic rationale for urban infrastructure development. "*Lanzhou has embraced slower economic growth … It is our hope that the city's recent infrastructure initiatives can create a boost to Lanzhou's economic development …*" "*In recent years, the government has used substantial infrastructure investment to hedge against flagging economic growth …*" "*Bridges rail, and road building are seen as vital to the economic development of our province—such a poor province in the western China.*"

Two interviewees referred to another major economic rationale for urban infrastructure development—attracting foreign direct investment. For example, one interviewee responded "*We had little trade with the outside world … We hope to improve our infrastructure and build better business environment to attract foreign investment …*" "*In order to attract more foreign investors to Lanzhou, our local government tried very hard to develop a favorable and competitive infrastructure system …*" Like the city of Wuhu, one interviewee mentioned that supporting the relocation of industrial firms from the eastern region to Lanzhou is one important economic motivation. "*Our economy is basically driven by metals and other raw minerals. Infrastructure improvement could help the city embrace manufacturing businesses from coastal regions …*"

Consistent with the cities of Suzhou and Wuhu, local government officials' top concern for economic development remains the most important political rationale. Interviewees from Lanzhou said "*Infrastructure investment is highly visible and helps local leaders to impress their superiors with economic and political achievement …*" "*Infrastructure development is a top political priority for our government because of the slower economic growth here … The promotion chance of city political leaders increases with the economic performance …*" Two interviewees mentioned that another political motivation relates to complying with the central government's two national policies on developing the western Chinese region. One national policy, issued in 2000, is the "Go West" policy to narrow the income gap between the booming eastern seaboard and the remote west. Another national policy is the Belt and Road Initiative (BRI) which was proposed by President Xi in 2013. The BRI aims at improving economic connectivity and cooperation among countries in the Asia, Africa and Europe. "*Following the national policies of 'Go West' and 'the Belt and Road Initiative (BRI)', we have been actively building infrastructure to facilitate the trade between China and Central Asia.*" Taking social-environmental motivations into consideration, two interviewees from Lanzhou pointed out that the improvement of the livability of urban community is a key motivation. For example, one government official contended that "*The government focuses on projects ranging from underground sewage and household waste treatment to gas pipe and heating systems as well as public transport and power grid upgrades to improve the living environment of urban residents*." Another official said "*Lanzhou is one of the most polluted cities in northern China. We built lots of environmental and ecological infrastructure to help combat air pollution and create a better urban life here …*"

Table 13: Main Motivations for Urban Infrastructure Development

City	Economic	Political	Social-Environmental
Suzhou	Attract Foreign Direct Investment (3) Attract High-End Manufacturing Firms and High-Tech Industrial Firms (2) Maintain Global Competitiveness of Doing Business (1)	Political Leaders' Top Concern of Economic Development (3) Meet Citizens' Demand for Urban Infrastructure (2)	Improve City Parks and Recreational Facilities (2) Enhance City International Reputation (2)
Wuhu	Attract Foreign Direct Investment (3) Attract Relocation of Industrial Firms (2) Support Regional Economic Cooperation (1)	Political Leaders' Top Concern of Economic Development (3) Meet Citizens' Demand for Urban Infrastructure (2)	Improve Living Standards and Conditions of Urban Residents (2) Improve Flood Infrastructure Resiliency (1)
Lanzhou	Fill the big gap in infrastructure development and stimulate economic growth (3) Attract Foreign Direct Investment (2) Attract Relocation of Industrial Firms (1)	Political Leaders' Top Concern of Economic Development (3) Central Government Policies (Western Development Policy) and One Belt One Road (2)	Improve Living Standards and Conditions of Urban Residents (2) Environmental and Ecological Protection (2)

Source: Author Interviews

Role Models of Urban Infrastructure Development

Public officials from the city of Suzhou are actively learning from the experience of other cities. All interviewees from Suzhou perceive Shanghai as their role model in developing urban infrastructure. The main reason is because Suzhou is geographically close to Shanghai. "*As Shanghai's closest neighbor, Suzhou has benefited from Shanghai's development and its catalytic role in stimulating growth in surrounding cities*." "*Shanghai is the most developed Chinese city and a gateway city for international investors … It is probably our best role model. We have captured key opportunities in Shanghai, such as the development of New Pudong District, for our own rapid development …*"

Shanghai has developed the extensive metropolitan rail transit network. Three interviewees from Suzhou pointed out that the sound development of a metropolitan public transportation system in Shanghai is the main focus of their learning. Interviewees stated "*The Shanghai Metro is one of the best subway systems in China. Its metro system is integrated with other modes of public transport. The Suzhou municipal government learnt a lot from the Shanghai's Metro, especially* *about the planning and operation of urban rail transit …*" "*The scale and speed of expansion of the Shanghai's metro system is unprecedented. It expanded from less than 10 lines to 17 lines in just a few years and the Shanghai Municipality invested about 30 billion Chinese yuan each year …*" "*Intermodal interchanges for public transportation are a key element in any urban transportation system … The Shanghai Metro is connected to two airports and the Beijing-Shanghai high-speed rail line. It provides an excellent example of intermodal connectivity.*" From the interviewees' responses, it seems that the quick development and expansion of urban subway systems in Shanghai has motivated Suzhou to develop its own urban rail systems. One interviewee explicitly said that "*Inspired by the Shanghai Metro, since 2010, the Suzhou municipality embarked on a highly ambitious investment program for various means of public transportation, reinforced by intermodal coordination. Nowadays, all urban districts in Suzhou are now served by metro and by buses …*" Another interviewee mentioned that "*The current Suzhou Metro system only has three lines and is not extensive. Following our neighbor—Shanghai, Suzhou is now seeking to expand its subway system ...*"

It should be noted that the integrated development of the Yangtze River Delta region has become a national regional development strategy. This region, which encompasses Shanghai and the provinces of Jiangsu, Zhejiang, and Anhui, represents one quarter of the country's GDP. The cities of Suzhou and Wuhu are in this delta region. Not surprisingly, three public officials from Wuhu also perceive Shanghai as a role model in urban infrastructure development. One interviewee stated "*You may know that Wuhu is one of the 41 cities in the Yangtze River Delta economic zone. The city of Shanghai plays a key role in this delta region and serves as a role model for our city …*" Another interviewee asserted that "*Shanghai is China's most important industrial and commercial city. The city has one of the most developed urban infrastructure systems in China. For sure, it is our role model …*" Public officials from Wuhu agreed that that the development of urban rails and airports are the key things that they have learnt from Shanghai. "*We learned that one of the major reasons for Shanghai's success is building modern high-quality infrastructure. The city recently built many mega projects such as the construction of the Yangshan seaport, the renovation of the Hongqiao International Airport and the expansion of the metro network …*" Shanghai is China's urban showcase. Emulating its role model Shanghai, the city of Wuhu initiated a significant number of new urban infrastructure projects. One interviewee recounted "*Several years ago, our city government representatives visited Shanghai and were very impressed by Shanghai's Metro system. We set a clear focus on building rapid transit systems and constructing an airport. In 2016, our city begun to build our own rapid transit project—the Wuhu Metro. The Wuhu-Xuancheng airport is currently under construction …*"

The city of Shenzhen is viewed as a role model in the eyes of public officials in Lanzhou. Interviewees said "*Shenzhen offers lessons for our city … infrastructure and reforms enable a city to replace an island as an investment hub …*" "*The journey of Shenzhen's transformation from a small fishing village into a global economic powerhouse in just over 40 years offers a great example for Lanzhou's economic development.*" "*It (Shenzhen) is one of the most dynamic cities in China because of its new focus on high technology and its improved transport links to other cities in the area …*" Lanzhou's public officials recognize that the lack of adequate public infrastructure poses a real challenge to Lanzhou's future economic growth and they are interested in learning how to better plan and finance local physical infrastructure construction from the city of Shenzhen. Interviewees stated that "*Shenzhen remains a role model in the adoption of innovative financial models for city infrastructure development*." "*Shenzhen is truly a remarkable success story … urban planning played a central role in sustaining and driving the city's economic growth and the transformation of urban landscape …*" To accelerate the development of urban infrastructure, public officials from Lanzhou have applied the lessons from Shenzhen. For instance, one interviewee mentioned that "*We are going beyond the traditional funding streams to venture into innovative strategies, such as land value capture and public private partnerships to fund urban infrastructure investment …*" Another interviewee from Lanzhou pointed out that problems exist in local government's decision-making process including planning for urban land use and infrastructure construction. To solve these problems, the city of Lanzhou follows Shenzhen and "*uses socioeconomic and spatial planning in a new way, specifically facilitating and promoting economic growth and market development …*"

Table 14: Role Models of Urban Infrastructure Development

City	Who	Why	What to Learn	How to Influence
Suzhou	Shanghai	International Metropolis Neighbor	Metropolitan rail transit network	Intermodal coordination Expansion of the Suzhou Metro
Wuhu	Shanghai	International Metropolis The same economic zone	Development of urban rails and airport	Building the Wuhu Metro System and the Wuhu-Xuancheng Airport
Lanzhou	Shenzhen	Infrastructure and reforms help city replace island as an investment hub	Infrastructure Finance Urban Planning	Adoption of Innovative Infrastructure Finance Use socioeconomic and spatial planning

Source: Author Interviews

Competitors of Urban Infrastructure Development

It should be noted that Suzhou-Wuxi-Changzhou region is the core area of the Yangtze River Delta region. It consists of three prefecture-level cities including Suzhou, Wuxi, and Changzhou. Public officials from Suzhou indicated that inter-city competition is very intense, and the main competitors come from its two nearby cities—Wuxi and Changzhou. One interviewee from Suzhou said "*The two neighboring cities of Wuxi and Changzhou are our main economic competitors because of geographical closeness and economic similarity. We are increasingly competing against each other for foreign direct investment.*" Another interviewee indicated that "*The industrial structure is very similar in the three cities [Suzhou, Wuxi, and Changzhou]. In order to pursue economic development, local governments mobilized their resources to support their predominant industries … Urban competition has intensified …*"

The city of Suzhou adopted several strategies to strengthen their comparative advantages. One interviewee mentioned that "*Compared with Wuxi and Changzhou, Suzhou is the closet city to Shanghai. This is our locational advantage*." To strengthen Suzhou's advantage, this interviewee said that "*We are in the stage of expanding our subway system to link Shanghai and Suzhou. This will provide more convenience to residents, visitors, and foreign investors* …" Another interviewee pointed out the use of new technologies in developing Suzhou's urban infrastructure "*Suzhou's application of new technologies in urban infrastructure and operation is more advanced than its neighboring competitive cities [Wuxi and Changzhou].*" The last interviewee discussed the significant investment of information infrastructure in Suzhou. He said that "*Suzhou is striving to build a leading place for the development of digital industrialization, the local government has come up with policies and measures to improve urban information infrastructure* …"

For the city of Wuhu, it seems that its competitors mainly come from its neighboring major cities in Anhui province such as Hefei and Ma'an'shan. One interviewee mentioned that "*Since local governments are responsible for their own economic development, infrastructure is viewed as a vehicle for accelerating economic development … I see increasing infrastructure competition for foreign investment from our nearby cities such as Hefei, Ma'an'shan* …" Another interviewee asserted that "*Our city is in the Hefei Metropolitan area. All seven cities in this area can be considered as a competitor to Wuhu … each city in this area has increasingly engaged in extensive infrastructure building and improved the competitiveness of its urban infrastructure* …" To deal with intercity competition, the city of Wuhu adopted a development strategy to boost investment in the urban environment. "*Transportation has become the strategic infrastructure that these cities have attempted to invest in. Our competitor—Hefei's transportation infrastructure has been a recent popular target for investment with city's first rapid transit system, the Hefei subway, and the Hefei Xinqiao International airport … Now, Hefei is easily accessible by air, rail and metro … To strengthen our competitive position in the Hefei Metropolitan area, our city launched an ambitious plan for urban infrastructure investment—including the building of a regional airport, the Wuhu rapid transit system, and river-crossing tunnels and bridges* …" Another interviewee contended that "*Besides building extensive transportation infrastructure, our government sees culture as an important driver of economic growth: hence the development of the creative industries and cultural clusters are a priority. Cultural infrastructure—from local libraries to museums—is rapidly being built* …"

Lanzhou's economic development has lagged major cities on the coast and other cities in the inland region. For the city of Lanzhou, its competitors are the big cities from the western region such as Xi'an and Chengdu. Interviewees from Lanzhou stated that "*Xi'an and Chengdu are the capital cities for two provinces within the western region of China. They are a highly competitive economically. Both cities invest heavily in building up metropolitan infrastructure* …" "*Our city is in fierce competition with Xi'an … The key reason is that Xi'an and Lanzhou have positioned themselves as an economic and transportation hub in the northwestern region of China and have stepped up infrastructure efforts to lure both domestic and foreign investors* …" Like most other cities in China, there is an enormous need to expand and create new areas for development in Lanzhou. In this city, government infrastructure support is primarily targeted to attract FDI to stimulate the growth of exports and foreign investors. Interviewees from Lanzhou stated "*Lanzhou is seeking to become a key transport link and manufacturing hub for China's transnational* '*One Belt, One Road*' *economic initiative. The government has invested heavily in infrastructure to support industries*." "*Our economic* competitors *in the western region—the cities of Xi'an and Chengdu have undertaken extensive infrastructure developments to transform* *themselves into an international hub with a convergence of air routes, roads and railways. To face its challenges, Lanzhou has engaged in a number of planning and infrastructure development initiatives to enhance the competitive strength for the future …*"

Table 15: Competitors of Urban Infrastructure Development

City	Who	Why	How to Influence
Suzhou	Wuxi	Close Neighbors	Expand Subway to Connect Shanghai and Suzhou
	Changzhou	Competition for Foreign Investment	More investment in information infrastructure
		Competition for High-End Manufacturing Firms	More investment infrastructure for smart city
Wuhu	Hefei	Close Neighbors	Building a New Rapid Transit System and a New Airport, Transit
	Ma'anshan	Competition for Foreign Investment	More Investment to Improve livable condition environment
		Competition for Relocation of Industrial Firms from the Eastern Region	
Lanzhou	Xi'an	Provincial Capital City in the Same Region	Building a Transportation Hub
	Chengdu	Competition for FDI	
		Competition for Relocation of Industrial Firms from the Eastern Region	More Investment in Urban Infrastructure

Source: Author Interviews

Case Studies Summary

The interviewees in these three city governments vary in their opinions regarding their motivation, perceived role models and competitors of urban infrastructure development. Economically, Suzhou and Wuhu are in a better shape than Lanzhou. In the cities of Suzhou and Wuhu, attracting foreign investors is the most important economic motivation. In contrast, as a provincial city in one of the poorest provinces in the western China, filling the big gap in infrastructure development and stimulating economic growth is the most critical economic motivation for Lanzhou. Interestingly, the top concern of local political leaders—economic development performance—was cited as the most important political motivation across all cities for urban infrastructure development. This is because development of the local economy is the top political priority of local public officials. The social-environmental motivations differ among the three cities.

Both role models and competitors are present in each city in terms of urban infrastructure development. Due to the geographic factor, Shanghai is the role model for Suzhou and Wuxi. Shenzhen is the role model of Lanzhou. All three cities are following the example of their role models and are seeking to develop their own urban infrastructure systems. It is interesting to note that competitors are generally viewed as neighboring cities or peers in the same region. This implies that geographic closeness results in more intense competition for urban infrastructure development. Thus, yardstick competition appears to be at work in Chinese prefectures. Factors driving inter-city competition mainly come from competing for the mobile resources—foreign direct investors and manufacturing firms. It should be noted that all three cities engage in fierce inter-city competition for building new infrastructure rather than maintaining infrastructure. This is because a new capital infrastructure project is highly visible and can stimulate economic growth in a short period.

Conclusion

Although there is a growing literature on strategic interaction in public finance and fiscal policy, few empirical studies examine spatial interaction in the policy area of infrastructure investment. Furthermore, most of the existing studies that analyzed infrastructure interaction were conducted in developed countries (Case et al. 1993; Bruce et al. 2007). There is a lack of comprehensive quantitative studies on spatial interdependence in developing countries. To fill this niche, our research utilizes spatial econometric modelling to estimate to extent to which city infrastructure spending in three categories (total infrastructure spending, infrastructure capital investment, and infrastructure maintenance expenditures) is affected by the spending decisions of neighboring localities. Drawing upon the theories of strategic interaction, we further disentangle the sources of strategic interaction in urban infrastructure finance based on spatial panel data consisting of 277 prefecture-level cities from the years of 2001 to 2012. Further, we conducted three case studies of prefectures in different regions of China, using a qualitative interview design. The interviewer asked respondents from prefecture governments questions about the focus of infrastructure investment, and perceived role models and competitors for infrastructure services.

The empirical findings confirm that city infrastructure expenditures are significantly and positively affected by the action of neighboring cities. By decomposing urban infrastructure expenditures, we find that the positive effect of strategic interaction is stronger in the spending category of infrastructure capital investment than that of infrastructure maintenance expenditure.

This is because compared with infrastructure maintenance expenditures, infrastructure capital projects usually receive high levels of public visibility and attention (Walden and Eryuruk 2012; Chen 2016;). There is no ribbon-cutting ceremony for pothole repairs. In addition, we find that cities in the eastern regions react more strongly to their neighboring cities' infrastructure capital investment that those in the middle region. Strategic interaction in the spending category of urban infrastructure maintenance only occurs cities in the middle regions. Due to location disadvantage, there is no strong evidence to show that cities in the western region engage in strategic interaction in infrastructure investment. Finally, we present strong evidence that Chinese cities react more strongly to their neighboring cities' total infrastructure investment one year prior to and during the PCRC or the first year after the city party secretary takes office. These findings are largely consistent with the yardstick competition literature, which states that upper-level policymakers or local citizens place extra weight on policies and outcomes in neighboring jurisdictions when evaluating their jurisdiction's performance (Besley and Case 1995; Goeminne and Smolders 2014).

Interview findings from multiple case studies support the results of the quantitative analysis by confirming that economic and political motivations play a major role in urban infrastructure development. Each city has role models and competitors. It seems that intercity competition for urban infrastructure development stems from competition for mobile resources (foreign investments and high-technology and manufacturing firms) and the political priority of developing local economy. Consistent with our quantitative analysis, cities compete to build new infrastructure rather than to maintain existing infrastructure.

Overall, this study represents one of the first attempts to empirically examine strategic interaction in urban infrastructure finance among Chinese local governments. It makes three key contributions to the existing literature of infrastructure finance. First, it explicitly incorporates strategic interaction into the study of urban infrastructure finance in China and tests the notion that cities respond strategically to the policy decisions of other cities. Second, this study further identifies potential sources of strategic interaction in urban infrastructure spending. It also provides a better understanding of the underlying forces that drive infrastructure interaction in a developing country context. Last, it presents qualitative case studies which bolster the credibility of the quantitative findings.

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Appendix Table 1

Spatial Panel Regression Results (Without Control Variables)

Variables	Model 1	Model 2	Model 3
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Spatial Lag DV	0.447***	0.633***	0.312**
	(0.162)	(0.156)	(0.164)
Control Variables	N	N	N
City Fixed Effects	Y	Y	Y
Time Effects	Y	Y	Y
R-Squared	0.1378	0.2373	0.1698
Observation	3,324	3,324	3,324
# of Cities	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 2

Spatial Panel Regression Results (Only Exogeneous Control Variables)

Variables	Model 1	Model 2	Model 3
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Ln Pop Density	-0.325***	-0.447***	-0.194
	(0.124)	(0.168)	(0.163)
Urbanization	-1.838	1.874	-6.263***
	(1.369)	(1.847)	(1.787)
Party Secretary's Time to Retirement	-0.0007	-0.002	0.0007
	(0.004)	(0.006)	(0.006)
Time Trend	0.058***	0.035***	0.096***
	(0.012)	(0.015)	(0.017)
W × Total Infra Exp Per Capita	0.448***		
	(0.160)		
Error_Total Infra Exp Per Capita	0.659***		
	(0.122)		
W × Ln Capital Exp Per Capita		0.627***	
		(0.153)	
Error_Capital Exp Per Capita		0.753***	
		(0.115)	
W × Ln Maintenance Exp Per Capita			0.322**
			(0.167)
Error_Ln Maintenance Exp Per Capita			0.829***

			(0.066)
R-Squared	0.1209	0.2333	0.1166
Observations	3,324	3,324	3,324
Number of groups	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 3: Alternative Weighting Matrix (Industrial Structure Similarity)
Spatial Panel Estimation Results for the Resource Flow Model
(Competition for the Mobile Resources—Industrial Firms)

Variables	**Model 1**	**Model 2**	**Model 3**
	Total Infra Exp PC	**Capital Exp PC**	**Maintenance Exp PC**
Spatial Lag DV	0.702***	0.901***	0.501
	(0.277)	(0.256)	(0.416)
Exogeneous Control Variables	Y	Y	Y
City Fixed Effects	Y	Y	Y
Time Effects	Y	Y	Y
R-Squared	0.1983	0.523	0.3452
Observation	3,324	3,324	3,324
# of Cities	277	277	277

Note: *** p<0.01, ** p<0.05, * p<0.1