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On the determinants of public infrastructure spending in Chinese cities: A spatial econometric perspective

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ABSTRACT

In the context of fiscal decentralization, we use cross-sectional data of 242 Chinese cities in 2005 to explore the major factors contributing to the decline of public investment. The main finding is that a city government appears to reduce its own infrastructure spending as a response to the rise of infrastructure spending of its neighboring cities, revealing evidence of positive spillover effects of public infrastructure expenditure. This paper contributes to the existing literature by providing a new perspective for understanding the decline in public investment. In addition, this paper sheds some light on the ongoing debate on the nature of government competition in China and has important implications for policy makers in making fiscal arrangements among government tiers in a decentralized economy.

1. Introduction

Infrastructure investment, served to achieve certain economic, social and environmental goals, has been long recognized as the engine of economic development at both the national and the regional level (Agenor & Moreno-Dodson, 2006; Aschauer, 1989a,b, 1993; Bassanini, Scarpetta, & Hemmings, 2001; Easterly & Rebelo, 1993; Eberts, 1990; Fedderkea & Bogetic, 2009; Guo, Lv, & Zhang, 2003; Kessides, 1993; Lall, 2007; Munnell, 1990).[1] Specifically, Aschauer (1989a,b, 1993) shows that public investment in infrastructure such as railways, roads and airports increases the productivities of private capital, which makes private investment more profitable and promotes the national (regional) economy. International institutions like the World Bank and International Monetary Fund (IMF) and policymakers from several countries also support such point of view. As infrastructure investment plays such an important role in economic development, we would expect that public investment should have been increasing over years. Evidence shows, however, that public investment has been declining in most industrial countries as well as less-developed countries since the 1970s (IMF, 2004; Mehrotra & Valila, 2006).

The ensuing question to be asked is: Why has public investment declined in so many countries during the last few decades? The reasons for this downward trend in public investment, however, are not well understood. The decline in public investment has been attributed to the following factors: policies of fiscal restraint (Roubini & Sachs, 1989), budgetary consolidations (Vuchelen & Caekelbergh, 2010), political-economic factors such as fiscal stringency and frequent changes of government (De Haan, Sturm, & Sikken, 1996; Sturm, 1998), cyclical behavior of public investment (Gali & Perotti, 2003; Mehrotra & Valila, 2006), general economic and fiscal variables such as GDP, output gap, long-term interest rates, public debt (Bruce, Carroll, Deskins, & Rork, 2007; Mehrotra & Valila, 2006; Painter & Bae, 2001; Turrini, 2004).

These studies provided explanations of the decline in public investment. An important feature of public

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[1] For a detailed overview of the impact of infrastructure investment on economic development, see Gramlich (1994) and Sturm (1998).

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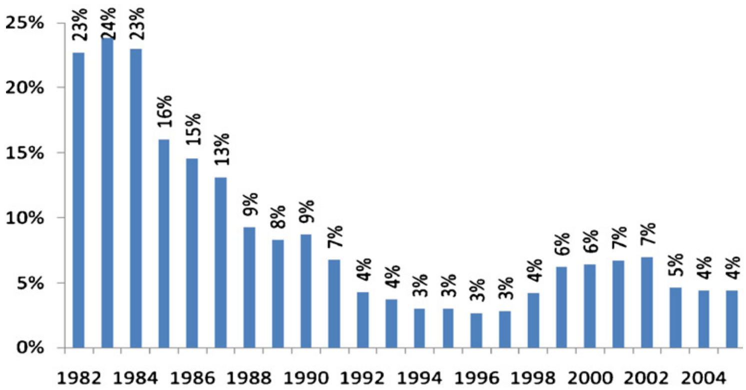

Fig. 1. Public infrastructure spending as a share *f* total investment in China (1982–2005).
Source: China Statistical Yearbook 2006.

investment, however, is ignored in the existing literature. The public investment exhibits the characteristic of spatial interactions among local jurisdictions due to spillover effects, resource-flow effect or yardstick competition (Case, Hines, & Rosen, 1993; Costa-Font & Pons-Novell, 2007; Moscone & Knapp, 2005. For excellent surveys, see Brueckner, 2003; Revelli, 2005). In a multilevel government system, if the decision is made by the central government, an optimal amount of spending can be reached as the externalities (e.g., positive spillovers) are internalized into the decision-making process. If public investment spending is decentralized to local governments, inefficient provision of public infrastructure would occur since the local governments would play a Nash game. Along with these arguments, a link is believed to exist between the decline of public investment and fiscal decentralization.

China serves as a good example to examine the impact of fiscal decentralization on public investment for two reasons. First, public infrastructure spending in China, like many other countries, has been declining since early 1980s. Second, important expenditure responsibilities (e.g., infrastructure expenditure) have been assigned to local governments since China's fiscal reform was implemented in 1994.

Using cross-sectional data of 242 Chinese cities in 2005, this study applies spatial econometric methods to examine the factors that determine public infrastructure spending in a decentralized economy. The empirical results reveal that: (1) a positive spillover effect exists among city governments' infrastructure provision as a consequence of China's fiscal decentralization; (2) a city government's spending on infrastructure is positively associated with its own fiscal capacity and with education expenditure share; (3) infrastructure investment by lower-level governments has a positive effect on the city government's infrastructure spending, whereas infrastructure investment by the upper-level government (i.e., provincial government) has no effect.

The paper is organized as follows. Section 2 presents a brief overview of China's public infrastructure development and fiscal arrangements between the central and the local governments. Section 3 introduces a simple theoretical model, from which fiscal strategical interactions are derived. Section 4 specifies the empirical spatial regression model. Section 5 describes the data used in the regression. Section 6 reports the estimation results. The last section concludes with some policy implications.

2. Overview of public investment in a decentralized economy

Two important features have been observed in the Chinese public sector during the last thirty years. The first feature is that, being one important component of investment, public investment has been considered to be the important driving force of economic growth. However, its ratio to total investment has been declining over the years indicated. The second one is that a lot of public expenditure responsibilities had been assigned to local governments owing to fiscal decentralization form implemented in early 1980s.

2.1. Declining role of public sector in financing investment in China

As far as public infrastructure spending is concerned, a well-documented fact around the world is that its ratio to total investment has been declining. For instance, in the group of large European countries such as United Kingdom, France, Germany and Italy, public investment fell on average from 4% of GDP in the early 1970s to 2.2% at present, while in the group of smaller countries such as Austria, Belgium, Denmark, Netherlands and Sweden, the average public investment decreased more than half from about 5% of GDP during the early 1970s (Mehrotra & Valila, 2006). Likewise, a general decreasing trend of public investment is found in Latin American countries since early 1980s. On average the public investment as a percentage of GDP fell from the highest level of 7.5% in 1982 to the lowest level of 4% in 2002 (Martner & Tromben, 2005). China exhibited a similar downward pattern in public investment. As Fig. 1 shows, the public contribution to total investment has been declining in China since 1980s. The ratio of public infrastructure spending to total investment decreased from 23% in early 1980s to 4% in 2005.

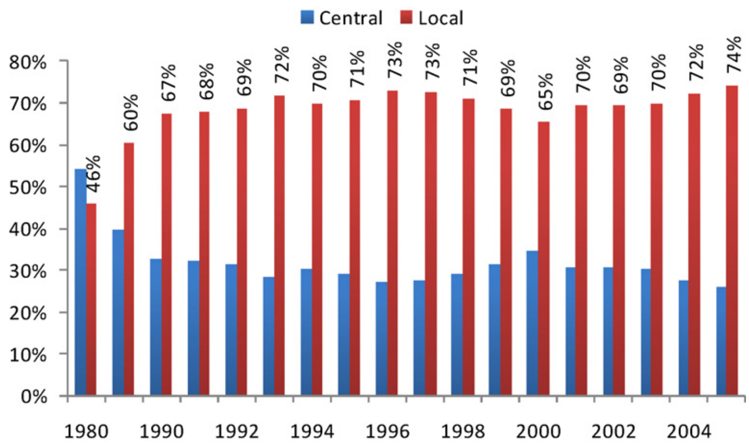

Fig. 2. Expenditure share by the central versus local government in China (1980–2005).
Source: China Statistical Yearbook 2006.

2.2. Fiscal decentralization in China

Over the past 30 years, China has been experiencing a significant fiscal decentralization. As a consequence, a lot of expenditure responsibilities had been assigned to local governments. As illustrated in Fig. 2, total expenditure share by local governments increased from less than 50% in 1980 to about 75% in 2005.

Similar to other categories of government spending, infrastructure spending has also been shared by different levels of governments with local governments taking more responsibilities. For example, total public investment in China was 404.1 billion Yuan in year 2005, among which, 267.5 billion Yuan was spent by local governments with a share higher than 66%. Among local governments, provincial and city level governments play relatively bigger roles in financing infrastructure in China (see Table 1).

3. A simple model of fiscal interactions in a decentralized economy

As mentioned above, given the fact that infrastructure has spillover effect, "free rider problem" is hard to avoid. In other words, local governments may incorporate their neighbors' infrastructure spending decisions in their own decision making process. Thus, to capture the potential interactions among city decision-makers, we follow Hoel (1991) by introducing a simple model with spatial spillovers concerning a public infrastructure spending game. Specifically, there are two cities, $i = 1, 2$, in this noncooperative game. Each city's public infrastructure spending is X_i ($i = 1, 2$). The payoff function to each city is specified as,

$$\pi_i = B_i(X_1 + X_2) - C_1(X_i) \tag{1}$$

where B_i is the benefit function which depends on total infrastructure spending, and C_i is the cost function which depends on the infrastructure spending of city *i*. Assuming that $B_i' > 0, B_i'' < 0, C_i' > 0,$ and $C_i'' > 0$, we total differentiate Eq. (1) with respect to X_1 and get the following first order conditions to maximize the payoff,

$$\frac{d\pi_1}{dX_1} = B_1'(X_1 + X_2) - C_1'(X_1) = 0, \quad \text{or} \quad B_1'(X_1 + X_2) = C_1'(X_1) \tag{2}$$

This defines X_1 as a function of X_2, which is called the response function of city 1, and denoted by $R_1(X_2)$. From Eq. (2) we have,

$$R_1'(X_2) = \frac{B_1''}{B_1'' - C_1''} < 0 \tag{3}$$

Similarly, city 2's optimal response to city 1's choice of X_1 is given by,

$$B_2'(X_1 + X_2) = C_2'(X_2) \tag{4}$$

which yields city 2's response function as,

$$R_2'(X_1) = \frac{B_2''}{B_2'' - C_2''} < 0 \tag{5}$$

Fig. 3 illustrates these two response functions. Their intersection at point *E* is the Nash equilibrium where the set of strategies $(X_1^*,\ X_2^*)$ satisfies Eqs. (2) and (4), i.e., $X_1^* = R_1(X_2^*)$ and $X_2^* = R_2(X_1^*)$. Following Eqs. (3) and (5) we can conclude that the decision-makings of these two cities are strategic substitutes. In other words, if one city increases its public infrastructure investment, the neighboring city may cut its own spending as a response. This suggests that positive spillovers can take place in cities' public infrastructure investment.

Thus, a hypothesis that can be derived directly from the theoretical model is that cities are engaged in strate-

Table 1
Public infrastructure spending by different government tiers, 2005.

Government	Amount (in Billion Yuan)	Share
Central	136.6	33.80%
Province	104.5	25.90%
City	99.3	24.60%
County (Township included)	63.7	15.80%
National Total	404.1	100.00%

Source: China Statistical Yearbook 2006 and China Fiscal Yearbook 2006.

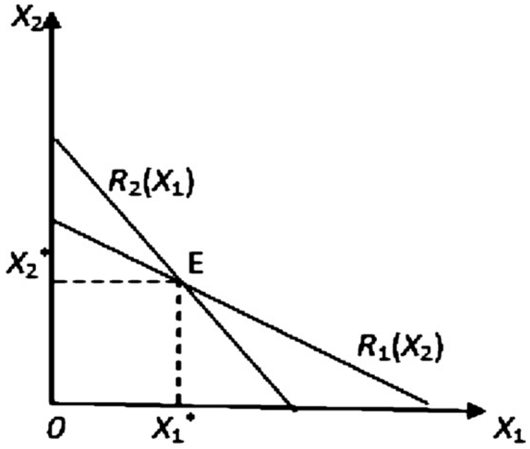

Fig. 3. Nash Equilibrium of public infrastructure investment.

gic interactions in determining how much to spend on infrastructure. In the following sections, we provide procedures to test the hypothesis empirically by examining whether a city would cut its own infrastructure spending as a response to a rise in the spending of its neighboring city.

4. Estimation strategies

To test the above hypothesis, we use a spatial econometric framework to examine the horizontal spatial interaction among cities. Given that the responsibility to finance public infrastructure is shared by all levels of local governments, we also incorporate two additional fiscal variables to capture the vertical fiscal effects.

4.1. Horizontal interactions among cities

Using a cross-sectional data set on 242 Chinese cities, the empirical model of public infrastructure expenditure can be specified in a classical OLS model as,

$$y = \alpha\iota_n + X\beta + \epsilon, \epsilon \sim N(0, \sigma^2 I_n), \quad n = 1, 2, \ldots, 242 \qquad (6)$$

where ι_n is an $n \times 1$ vector of ones associated with the constant term parameter α. y is $n \times 1$ vector of the dependent variable denoting per capita government spending on infrastructure in city n, X is a set of explanatory variables which are identified to influence city government's investment in infrastructure. ε is the error terms across observations, β is the parameter to be estimated. The OLS approach may be properly applied to describe relationship among Chinese cities in their public infrastructure in the event of no spatial effect. Otherwise, the OLS estimation does not yield consistent estimates (Anselin, 1988).

Following the spatial econometric approach developed by Anselin (1988), in the event of spatial dependence, Eq. (6) should be extended to account for spatial dependence in public infrastructure spending across cities. The spatial dependence can take two forms. One is the spatial lag model specifying the spatial correlation in the dependent variable, which more or less resembles the autoregressive (AR) model in time-series econometrics. The other is the spatial error model which allows for spatial autocorrelation in the error term, and which is more or less like the moving average (MA) model in time-series econometrics.[2] These two types of spatial correlation are commonly observed in the spatial econometric literature.

To account for spatial correlation in the dependent variable, that is, to specify a spatial lag model (SLM), the classical linear regression model in Eq. (6) is adapted as,

$$y = \alpha\iota_n + \lambda W y + X\beta + \epsilon, \epsilon \sim N(0, \sigma^2 I_n), \quad n = 1, 2, \ldots, 242 \qquad (7)$$

where W is the nonstochastic $n \times n$ spatial weights matrix in which the element m_{ij} is equal to $1/d_{ij}$ with d_{ij} being the distance between two cities i and j ($i \neq j$) (Biles, 2003; Dubin, 1988; Garrett, Wagner, & Wheelock, 2007; Hernandez, 2003).[3] In making such specification, we assume that as the distance between cities i and j increases (decreases), W_{ij} decreases (increases), which poses less (more) spatial weight to the city pair (i, j). We see that the weight matrix is defined as a priori by the economist and does not include parameters to be estimated. The data for spatial distance matrix W used in this analysis is constructed from Yu (2009). Wy is the weighted average of neighboring observations of y. In this model, the parameters to be estimated are the usual regression parameters β, σ^2, and the additional parameter λ, which we call spatial lag parameter. This parameter is the most important coefficient to be estimated in that it allows us to test the spatial interaction hypothesis mentioned above. It can be seen that if there is no spatial dependence in the vector of cross-sectional observations y, λ takes a value of zero and this model reduces to the classical least-squares regression equation (Eq. (6)). In the case of spatially lagged dependence, traditional OLS does not yield unbiased and consistent estimates as the autoregressive component of the model is correlated with residuals. Hence, we apply the maximum likelihood estimation (MLE) method to estimate the model with a spatially lagged dependent variable (Anselin, 1988).

To incorporate a spatial dependence in the disturbances, the classical OLS model is adapted to a spatial error model (SEM) specification as follows,

$$y = \alpha\iota_n + X\beta + \mu, \mu = \rho W\mu + \epsilon, \epsilon \sim N(0, \sigma^2 I_n) \qquad (8)$$

Despite OLS estimation yields unbiased coefficient estimator in the presence of spatial correlation among model disturbances, estimates of standard errors is inconsistent.

[2] Unlike the AR model in time-series econometrics, OLS estimation on a spatial lag model will be inconsistent, because of the endogeneity problem. Also, the OLS estimation on a spatial error model will be inefficient due to its violation of the assumption of independence among the error terms. Consequently, both models will be estimated using the maximum likelihood estimation.

[3] Another commonly used weight matrix specifications is the contiguity-based binary matrix in which each element m_{ij} of the matrix W is set to one if city i and j ($i \neq j$) share a common border, and zero otherwise (Anselin, 1988; Case, 1992; Cliff & Ord, 1981). The drawback of such specification is that all neighboring cities are assumed to have equal influence and any spatial correlations between two non-neighboring cities are ignored.

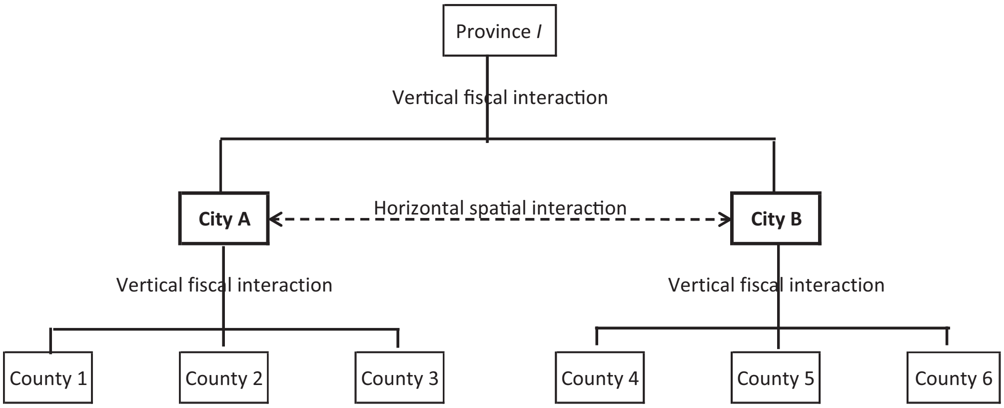

Fig. 4. Horizontal and vertical interactions among government tiers.

This implies that the derived *t*-statistics and *F*-statistics will be incorrect, and statistical inferences based on these statistics will be misleading. Also, the MLE method can be used to estimate the model with spatially correlated disturbances.

In the empirical implementation, we will conduct several tests to choose a proper model specification with better statistical properties.

4.2. Vertical interaction effects

The estimate of spatial correlations among cities' infrastructure expenditure based on the two spatial models mentioned above could be biased if vertical fiscal variable is omitted from the spatial model (Revelli, 2003). Two types of vertical interaction effects exist in the context of China. The first type is the vertical fiscal interactions among the city government and its upper-tier government (provincial government). For example, if a city government increases its infrastructure spending, its neighboring city within the same province is observed to increase the infrastructure spending as well. As a result, a misleading conclusion could be reached that a spatial correlation exists between these two cities at first glance. However, as a matter a fact, the rise in infrastructure spending in both cities can be the result that the provincial government mandates them to do so. The second one is the vertical fiscal interactions among the city government and its lower-tier government (county governments). A similar rationale can be applied to such type of vertical interactions. Consequently, a reverse causality problem can arise in infrastructure expenditures by a city government and by its upper-tier government (or by its lower-tier governments). To deal with this issue, following Revelli (2003), we incorporate two vertical fiscal variables (public infrastructure spending from lower-level governments and upper-level governments, respectively) into the spatial models to identify the true spatial effects across cities' public infrastructure spending.

We illustrate the analytical framework in this section in Fig. 4. The main objective of this study is to examine horizontal spatial interactions among cities (City *A* and City *B* in Fig. 4), which are both under the supervision of Province *I* and at the same time each administers several counties. Apparently, the two types of vertical fiscal interactions—interaction between City *A* (City *B*) and its upper government, Province *I*, and interaction between City *A* (City *B*) and its counties—have to be controlled in order to explore the true horizontal spatial effects between City *A* and City *B*.

5. Data source

The dataset for this study consists of a cross-section data set covering 242 Chinese cities in 2005. Table 2 lists the variables used in the empirical models. All variables, unless otherwise noted, are obtained from *Statistical Materials of City and County Public Finances 2006* (*2006 Quanguo dishixian caizheng tongji ziliao*, in Chinese, Ministry of Finance, 2006). The dependent variable (INFRASTRUCTURE) is measured as per capita spending on infrastructure by the city government. Public infrastructure categories, according to the decree released by the Ministry of Finance, include mainly agriculture, water conservancy, forestry, railway, transport, communications, power, national defense, education, science, culture, health. The explanatory variables are identified as follows.

5.1. Fiscal variables

The first fiscal variable is **REVENUE**, measured by the city government's own revenue per capita, is used to reflect a city's fiscal capacity. This variable is expected to have a positive effect on public infrastructure expenditure.

The next two sets of fiscal variables are public infrastructure spending by lower-level governments and by upper-level governments, respectively (**VERTICAL_LOW**, **VERTICAL_UP**). As mentioned earlier, accounting for these two vertical fiscal variables is necessary in identifying the true horizontal spatial effects of public infrastructure spending across cities. In terms of the variable **VERTICAL_LOW**, theoretically the effect of the variable on public infrastructure spending is ambiguous. On one hand, if two county governments within the same city increase their own spending on infrastructure (i.e., building a new road), the city government may also have incentives to increase its own infrastructure spending for the purpose of connecting these two roads, or connecting them with the main

Table 2
Summary statistics of variables (242 Chinese cities in year 2005).

	Mean	S.D.	Minimum	Maximum
INFRASTRUCTURE	156.746	498.419	0.041	7,048.089
INFRA95	3.778	5.312	0.000	72.000
REVENUE	1,034.801	1,907.379	70.692	24,972.970
EDUCATION	0.182	0.050	0.020	0.365
URBANIZATION	0.337	0.244	0.039	1.000
POPDENSITY	425.368	285.859	4.770	2,362.020
POPULATION	408.313	233.795	16.760	1,094.37
VERTICAL_LOW	59.081	126.331	−24.004	1,475.759
VERTICAL_UP	276.263	894.180	76.919	12,965.400
NORTHEAST	0.124	0.330	0.000	1.000
CENTRAL	0.264	0.442	0.000	1.000
WESTERN	0.219	0.414	0.000	1.000

Notes: INFRASTRUCTURE: public infrastructure spending per capita (10,000 RMB Yuan); INFRA95: area of paved roads per capita in 1995 (square kilometers); REVENUE: city government's own revenue per capita (10,000 RMB Yuan); EDUCATION: ratio of public education spending to total city public spending (%); URBANIZATION: percentage of total population living in the urban area (%); POPDENSITY: total population divided by total land area (persons per square kilometer); POP: total city population (10,000 persons); VERTICAL_LOW: infrastructure spending per capita by lower-level governments (10,000 RMB Yuan); VERTICAL_UP: infrastructure spending per capita by upper-level governments (10,000 RMB Yuan).

road within the city.[4] On the other hand, if a county government invests a project in which the city government also wants to, the city government may reduce its own efforts as a response. Therefore, the sign of this variable can be positive or negative. The variable **VERTICAL_UP**, which is defined as provincial government's spending on infrastructure in 2005, is obtained from *China Statistics Yearbook 2006*, and it has variations across provinces but has no variations within a province. The expected sign for this vertical fiscal variable can also be positive or negative. Infrastructure spending by the provincial government increases the marginal productivity of the city's investment, the city government may have incentives to increase its own infrastructure spending. Alternatively, the city government may tend to reduce its infrastructure spending if provincial government finances the project that the city would otherwise invest.

Public spending on infrastructure and education are two priorities for the city government in making its budgetary decisions. The variable **EDUCATION**, measured as the percentage of a city's total public expenditure allocated to education, is expected to affect the city's public infrastructure spending. Under constant budget constraints, a larger education share would pose more pressures on a city government's decision on infrastructure spending. Hence the education variable is expected to have a negative coefficient sign.

5.2. Economic/demographic characteristics

The variable **INFRA95** is defined as area of paved roads in squared kilometers in 1995 in per capita term. This variable is used to proxy for the initial stock of infrastructure, and is obtained from *China City Statistical Yearbook 1996*. We expect this variable to affect current infrastructure spending negatively in that a city with a high level of initial infrastructure tends to spend less on current infrastructure, possibly due to diminishing benefits derived from additional infrastructure spending.

Three demographic variables are used in this study: population density, city population size, and urbanization rate. Population density (**POPDENSITY**) is defined as the number of persons per square kilometer. Population density can be negatively related to infrastructure spending per capita. For example, if a city is sparsely populated, the length of TV cable lines required to connect two households will be larger. However, the demand for certain kinds of infrastructure (such as sewage systems) will be low when population density is low, and will increase as the city becomes more densely populated, which calls for more public expenditure. Therefore, the effect of population density on public infrastructure can be positive. Overall, the expected sign of **POPDENSITY** is ambiguous. The second demographic variable is city population size (**POPULATION**). A city may have either a large (or small) population size and population density, or it may have a large (small) population size and a small (large) population density. As the size of population in a city increases, public spending on infrastructure may grow faster or slower than population growth. Consequently, per capita public infrastructure spending may rise or fall as population size increases. Overall, we do not have predicted sign for the variable **POPULATION**.

Urbanization rate (**URBANIZATION**) is defined as the percentage of total city population living in urban area. Two opposing forces may dominate the overall impact of urbanization rate on infrastructure spending. If economies of scale in infrastructure provision dominate, then *ceteris paribus*, cities with a higher urbanization rate are expected to spend less on infrastructure per capita. However, if agglomeration economies increase the return to infrastructure expenditures in urban areas, then a higher urbanization rate may demand more infrastructure service provision (Randolph, Bogetic, & Hefley, 1996). Hence, the expected sign of **URBANIZATION** is indeterminate.

[4] Recognizing that cities are supervising counties, the positive relationship between city infrastructure spending and county infrastructure spending may simply reflect the fact that cities have consistent investment policies across their jurisdictions. If this were the case, the positive effect of the variable VERTICAL_LOW could be attenuated. We appreciate one of the anonymous reviewers for pointing out this issue for us.

5.3. Region-specific attributes

In our model, region-specific characteristics not captured by the aforementioned explanatory variables may affect city's public infrastructure spending behavior in that region. Without accounting for these characteristics could lead to potential omitted variable bias. To deal with this issue, regional dummy variables are included in the spatial model.[5] There are four economic regions in mainland China as suggested by the central government. They are coastal, northeastern, central, and western regions.[6] As a result, we include three regional dummies (**NORTHEAST**, **CENTRAL**, and **WESTERN**) in the empirical model (**COAST** is the omitted group).

6. Empirical results

As mentioned earlier, the results based on OLS (Eq. (6)) are inconsistent if spatial effects exist in the model. To test the existence of spatial dependence, we apply Moran, 1950 *I* test on the residuals from the OLS model.[7] The test statistic of 7.531 ($p = .000$) indicates that there is significant spatial dependence in the data, suggesting a spatial econometric model, a spatial lag model (Eq. (7)) or a spatial error model (Eq. (8)), should be used.

To test for spatially lagged dependence, the Lagrange multiplier (LM-Lag) test is applied. Likewise, the LM-Error test is applied to test for spatial error dependence (Anselin, 1988). Both tests reveal evidence of spatially lagged dependence and spatially correlated error dependence at 1% level of significance, respectively.[8] However, these two tests are unable to separate one form of spatial dependence from another. To distinguish between these two forms of spatial dependence, two robust versions of these two LM tests ($\text{LM-Lag}_{\text{robust}}$ and $\text{LM-Error}_{\text{robust}}$) are proposed (Anselin, 1988). It is shown that either test statistic is found to be greater than its corresponding critical values (as $p = .000$ for both tests), however, the $\text{LM-Error}_{\text{robust}}$ test statistic (39.267) is found to be larger than the $\text{LM-LAG}_{\text{robust}}$ test statistic (20.832), implying that spatial error model (Eq. (8)) appears to be the proper specification.

6.1. Main results

Based on Eq. (8), we find that the spatial error parameter (λ) is 0.896, and is statistically significant at 1% (Table 3).[9] With respect to the explanatory variables, city government's own revenue (**REVENUE**) appears to have a statistically significant and positive impact on its infrastructure spending. To be specific, *ceteris paribus*, one Yuan increase in city government's own revenue per capita increase the city government's per capita spending on infrastructure by about 0.272 Yuan. Lower-level government's infrastructure spending (**VERTICAL_LOW**) is found to be statistically significant at 1% level with a positive coefficient of 0.501. We fail to find evidence of infrastructure spending effect for upper-level government (**VERTICAL_UP**).

A one major component of public expenditure, education expenditure share (**EDUCATION**) is positively associated with public infrastructure spending. This result is beyond our expectation. A tentative explanation could be that, under a constant budget constraint, the city government is likely to increase both expenditures while cutting back other types of public expenditures.

The initial stock of infrastructure (**INFRA95**) is found to affect current infrastructure spending negatively, indicating a diminishing return for public infrastructure spending. Higher urbanization rate (**URBANIZATION**), i.e., a higher proportion of the population living in the urban area, is found to have a negative impact on public infrastructure expenditure per capita. As stated above, this result could imply evidence of economies of scale in infrastructure provision. Larger population size (**POPULATION**) is associated with lower per capita public infrastructure expenditure, indicating that growth of public spending on infrastructure is relatively slower than population growth.

One interesting finding is that, other things being equal, cities in noncoastal provinces tend to have a higher level of public infrastructure spending per capita. Along with the negative coefficient estimate of the initial stocks of infrastructure, the result reveals a catch-up effect in public infrastructure spending between coastal and noncoastal cities.

6.2. Robustness check

One issue that needs to be addressed in estimating the aforementioned spatial model is that some explanatory fiscal variables can be endogenous. To check whether the results obtained from the SEM regression are robust to the specification with two types of spatial dependence and possible endogeneity bias problem, Kelejian and Prucha (1998) suggest a three-step procedure known as a generalized spatial two-stage least squares (GS2SLS) procedure to estimate a model with spatially lagged dependent variables and spatially autoregressive disturbances based on a set of instruments H. The procedure proceeds as follows. In the first step the regression model in Eq. (7) is estimated by two-stage least squares (2SLS) using a set of instrument variables H (X, WX, W^2X). That is, regressing WY on X, WX, W^2X and using the fitted values $\widehat{WY}$ as instruments for WY. In the second step, estimating the autoregressive parame-

[5] We appreciate one anonymous referee for pointing out the issue of potential missing variable bias in our estimation.

[6] The east coast (**COAST**) covers 9 provinces, including 3 municipalities (Beijing, Fujian, Guangdong, Hebei, Jiangsu, Shandong, Shanghai, Tianjin, and Zhejiang). The Northeastern area (**NORTHEAST**), also known as the old industrial base in China, includes 3 provinces (Heilongjiang, Jilin, and Liaoning). Central regions (**CENTRAL**) cover 6 provinces (Anhui, Henan, Hubei, Hunan, Jiangxi, and Shanxi). The less developed western regions (**WESTERN**) cover 9 provinces including 5 autonomous regions (Gansu, Guangxi, Guizhou, Qinghai, Inner Mongolia, Ningxia, Shaanxi, Sichuan, Xinjiang, Tibet, and Yunnan).

[7] We report the OLS results in Table A.1.

[8] These two test statistics are reported at the bottom of Table A.1.

[9] Results of spatial lag model are available upon request.

Table 3
Spatial results of public infrastructure spending of Chinese cities, 2005.

	Spatial Error Model (SEM)	Generalized Spatial Two-Stage Least Squares (GS2SLS)
Fiscal variables		
REVENUE	0.272***	0.272***
	(41.96)	(42.10)
VERTICAL_LOW	0.501***	0.509***
	(6.19)	(6.34)
VERTICAL_UP	−0.002	−0.003
	(0.14)	(0.29)
EDUCATION	680.342***	689.766***
	(2.70)	(2.76)
Economic/demographic characteristics		
INFRA95	−3.187*	−3.301*
	(1.65)	(1.73)
URBANIZATION	−332.838***	−313.955***
	(5.81)	(5.47)
POPDENSITY	0.002	0.015
	(0.05)	(0.30)
POPULATION	−0.122**	−0.130**
	(2.26)	(2.45)
Region-specific attributes		
NORTHEAST	142.128***	89.397**
	(2.94)	(2.25)
CENTRAL	113.931***	100.139**
	(3.79)	(3.10)
WESTERN	131.799***	108.746**
	(3.56)	(2.15)
λ (LAG)	NA	−1.709**
		(1.99)
ρ (ERROR)	0.896***	3.453***
	(8.88)	(30.15)
CONSTANT	−149.233	2.746
	(1.20)	(0.18)
Adj. R^2	NA	NA
Obs.	242	242

Notes: *t*-values are shown in parentheses.
NA stands for not applicable.
* Statistical significance at $\alpha = .10$.
** Statistical significance at $\alpha = .05$.
*** Statistical significance at $\alpha = .01$.

ter ρ by GMM using the residuals obtained in the first step. In the last step, using the estimates of ρ to perform a spatial Cochrane–Orcutt transformation of the data and obtain efficient estimates of β and λ.[10]

The GS2SLS regression results are reported in Column 2 of Table 3. We find that the spatial lag and error parameters are statistically significant, indicating both types of spatial dependence coexist in the model. In particular, we find that the spatial lag parameter is negative (−1.709). This result suggests that a city tends to cut its own infrastructure spending as a response to the rising expenditures of its neighboring cities. This empirical finding supports our hypothesis that cities engage in strategic interaction in deciding their spending on infrastructure. Specifically, a positive spillover effect emerges from infrastructure provision across cities.

Turning to other explanatory variables, in general we find that the empirical results from the SEM regression are robust to the GS2SLS specification, though we find larger effects (in absolute values) for some major explanatory variables and smaller effects for region-specific variables in the latter specification. The comparable results from these two models indicate that endogeneity bias is not a serious problem in this study.

7. Conclusions

In the context of fiscal decentralization, we use a cross-sectional data covering 242 Chinese cities in 2005 to explore the major factors contributing to the decline of public investment. Our main finding is that a city government appears to reduce its own infrastructure spending as a response to the rise in infrastructure expenditure of its neighboring cities. This result suggests positive spillover effects exist among city governments' infrastructure expenditures.

This paper provides a new perspective for understanding the decline of public investment, which is traditionally attributed to factors such as policies of fiscal restraint, budgetary consolidations, politico-economic factors, etc. Our main finding has important implications for policy makers in making fiscal arrangements among different government tiers. The positive spillovers under a decentralized

[10] If no spatially lagged dependent variable is present in a model with only spatially correlated errors, the model in the first and third steps can be estimated by OLS; in this case the estimator computed in the third step would be the feasible generalized least squares (FGLS) estimator.

decision making process imply that the externalities have to be internalized in order to reduce efficiency loss. In other words, the responsibility to provide infrastructure services should be assigned to an upper-level government.

The finding in this study is important to policy makers in China. China has been undergoing significant government reorganizations since 2004. One of the major policies implemented is the so-called "Province Manages County (*sheng guan xian*)" policy through which most government responsibilities including infrastructure spending have been bypassed the cities and reassigned to county governments. Based on the findings in this study, we would expect the infrastructure services to be underprovided.

Our findings also shed some light on the ongoing debates on the nature of government competition in China. For instance, studies by scholars like Chen, Li, & Zhou (2005), Tao, Lu, Su, & Wang (2009), and Xu (2010) argue that local governments engaging in fiscal competition for economic development and growth take investing in Infrastructure as the prior tool to reach their goals, which results in a "race to the top" of government expenditures. The empirical finding of this study fails to support their argument and contributes to the existing literature by providing additional evidence for skeptics of the traditionally believed "race to the top" story on local fiscal competition.

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Appendix A.

See Table A.1.

Table A.1
OLS results of per capita infrastructure spending of Chinese cities, 2005.

	OLS Model
Fiscal variables	
REVENUE	0.267***
	(38.89)
VERTICAL_LOW	0.466***
	(5.32)
VERTICAL_UP	−0.005
	(0.39)
EDUCATION	610.423**
	(2.28)
Economic/demographic characteristics	
INFRA95	−2.817
	(1.35)
URBANIZATION	−340.172***
	(5.57)
POPDENSITY	−0.008
	(0.17)
POPULATION	−0.130**
	(2.28)
Region-specific attributes	
NORTHEAST	134.041***
	(3.36)
CENTRAL	125.451***
	(4.41)
WESTERN	171.600***
	(5.33)
Constant	−162.692**
	(2.19)
Adj. R^2	0.89
Obs.	242
Diagnostics Test	
Spatial error:	
Moran's 1	7.531 [.000]
Lagrange multiplier	22.552 [.000]
Robust Lagrange multiplier	39.267 [.000]
Spatial lag:	
Lagrange multiplier	4.117 [.042]
Robust Lagrange multiplier	20.832 [.000]

Notes: *t*-values are shown in parentheses; *p*-values are shown in brackets. NA stands for not applicable.
*Statistical significance at $\alpha = .10$.
** Statistical significance at $\alpha = .05$.
*** Statistical significance at $\alpha = .01$.

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