Economic development and natural amenity: An econometric analysis of urban green spaces in China

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Abstract

Rapid urbanization and spontaneous economic development has brought about profound changes in urban landscapes throughout the world. The task of managing transforming urban landscapes, particularly urban green spaces, so as to provide sufficient natural amenity for increasing urban populations, is one of the critical challenges facing policy makers. However, little empirical evidence exists about the evolving path of urban green spaces along with economic development and urbanization. This study attempts to fill in this knowledge gap through an econometric analysis of panel data across 285 Chinese cities during a period of rapid urbanization and economic growth (2001–2010). The results point to the existence of an N-shaped environmental Kuznets curve (EKC) for an important aspect of environmental quality: urban green spaces. Urban green space coverage increases at the initial stage of economic development, and then it starts to decrease as GDP per capita exceeds RMB50,855 and then increases again at a high GDP per capita level (RMB107,558). Large elasticity (>1) is expected as GDP per capita grows to a higher level (beyond RMB128,095). By the end of 2010, 30% of Chinese cities are still located on the downward-sloping path and only four cities have attained elasticities greater than one. The findings present a challenging and pressing call for policy makers to effectively manage the tradeoffs between continuous economic development and better natural amenities.

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Introduction

Urbanization and spontaneous economic development have brought profound changes to urban landscapes around the world (Grimm et al., 2008; Deng et al., 2009). Original vegetated land has been replaced by built surfaces and structures to accommodate increasing population (Sharpe et al., 1986; Harrison and Pearce, 2001; Zhu and Zhang, 2006). Meanwhile, urban green spaces have been widely designated in city environs (Miller, 1997; Nowak et al., 2001). As the most prominent and pertinent natural components of cities, urban green spaces generate notable natural amenity (a bundle of esthetic and psychological benefits) that play a decisive role in defining the livability and sustainability of modern cities, and the well-being of urban dwellers (Bolund and Hunhammar, 1999; Nowak et al., 2001, 2006; Chiesura, 2004; Crane and Kinzig, 2005; Sandström et al., 2006; James et al., 2009). The worldwide growing urbanization and consequent pressure on natural amenity fuel a need to understand how urban green space evolves along with economic development and urbanization.

How economic growth affects the environment has been an important intellectual challenge since the 1990s (Barbier, 1997; Dinda, 2004; Stern, 2004; Luzzati and Orzini, 2009; Kijima et al., 2010). The well-known environmental Kuznets curve (EKC) hypothesis postulates an inverted U-shaped relationship, implying environment quality will initially deteriorate, but the environmental degradation declines as a higher level of income is reached at which people demand and afford a better environment. Some researchers found an N-shaped relationship, suggesting the environmental degradation starts increasing again after a decrease to a certain level (Kijima et al., 2010). A myriad of environmental aspects have been investigated to test the EKC hypothesis, such as air quality, water quality, municipal solid waste, urban sanitation, access to safe drinking water and energy use (Dinda, 2004; Kijima et al., 2010). However, in contrast to the vast empirical studies on the EKC, there are limited studies about how urban green spaces evolve with economic development, although it has been widely acknowledged that urban green spaces play an important role in improving the quality of urban environmental (Yang et al., 2005; Nowak and Dwyer, 2007).

From an economic perspective, the natural amenity of urban green spaces is tantamount to economic goods (Power, 2006; Zhu and Zhang, 2006). Thus, the constantly evolving urban green space is determined by socioeconomic decisions which reflect how
individuals, as well as societies, allocate resources (land and revenue) to satisfy an important need: natural amenity. Rapid urbanization and simultaneous economic development pose both challenges and opportunities for the provision of the natural amenity of urban green spaces (Jim, 2004; Tzoulas et al., 2007). Economic development implies potential funds for caring for natural amenities, such as vegetation planting and maintenance (Zhu and Zhang, 2008; Pauleit and Breuste, 2011). Meanwhile, increasing urban population places pressure on urban land, as adequate infrastructure is needed (Zhu and Zhang, 2006). Empirical evidence indicates mixed impacts of economic development on urban green spaces. A U-shaped EKC has been found in 149 southeastern U.S. cities that urban green coverage initially decreases with economic development due to the pressure on land associated with the increasing population density. The relationship between income and urban green coverage then shifts to positive once the household income exceeds US$39,000 (Zhu and Zhang, 2006). However, the existing literature is scant regarding the role of economic development as one of the driving forces of urban natural amenity in developing countries, where urban green spaces are becoming increasingly important (Thaiutsa et al., 2008; Gangopadhyay and Balooni, 2012; Muthulingam and Thangavel, 2012).

China’s urban landscapes are undergoing an unprecedented transformation due to rapid economic development and extensive urbanization; the speed at which this is happening has never before been experienced in urban history (Friedman, 2005; Liu et al., 2005; Campanella, 2009; Li et al., 2010; Chen et al., 2013). It is predicted that by 2050, about 70% of the Chinese population will live in cities (Shen et al., 2005). Managing these swiftly changing urban landscapes to provide sufficient natural amenity for the increasing urban population is one of the critical challenges currently facing policy makers (Kong and Nakagoshi, 2005). While several existing studies have explored the changing pattern of urban green spaces during the process of China’s urbanization (e.g., Li et al., 2005; Kong and Nakagoshi, 2005), few studies have analyzed the evolution of urban green spaces (an integral part of urban natural amenity) along with economic development.

The objective of this study is to fill the above mentioned knowledge gap by examining the evolving pattern of urban green spaces across Chinese cities during a period of rapid urbanization and economic growth. Using panel data ranging from 2001 to 2010 for 285 cities at the prefecture level and above, the existence of an EKC for an important aspect of environmental quality, urban green space, is investigated. Potential linear and nonlinear (quadratic and cubic) relationships between the provision of natural amenity (proxied by the coverage of urban green spaces) and economic development are tested econometrically. The results would provide both a theoretical and practical guide for an appropriate strategy for maintaining a balance between natural amenities and continuing economic development in rapidly urbanizing cities.

**Methodology**

**Econometric models**

The percentage of urban green space coverage (UGS) of a city (area of urban green spaces/total area of the built-up land × 100), an important indicator representing the provision of natural amenity in a city, is adopted as the dependent variable. This index of urban green spaces has been precisely inventoried by municipal greening/landscape departments annually. Theoretically, the amount of urban green spaces in a city is jointly determined by natural environment (such as temperature and precipitation) and socioeconomic factors (such as economic status, population density, land availability, and greening planning and policies) (Nowak et al., 1996, 2001; Nowak, 2012; Heynen and Lindsey, 2003; Choumert and Salanié, 2008; Fuller and Gaston, 2009; James et al., 2009; Zipperer et al., 2011; Kendal et al., 2012). Based on an empirical study of the demand of urban forests in U.S. cities (Zhu and Zhang, 2008), a reduced econometric equation of urban green spaces as the function of economic growth and other control variables is employed in the present study. The fundamental explanatory variable is gross domestic product (GDP) per capita. According to the statistical criteria adopted by the National Bureau of Statistics of China, GDP refers to the final products at market process produced by all economic units in a city in a given year. In this study, GDP per capita is calculated by dividing the total GDP by the total population of a city. The Chinese currency RMB (Renminbi) is used in this paper, with exchange rate at about US$1.00 = RMB6.77 in 2010.

In the present study, four control variables are incorporated: ecozone, population density, built-up land area, and policy factor. Ecozone is defined as the natural environment of a city at the macro level (Nowak et al., 1996, 2001; Heynen and Lindsey, 2003). Population density and built-up land area reflect the progress of demographic and social factors that are strongly related to the presence of urban green spaces (Nowak et al., 1996, 2001; Zhu and Zhang, 2006; Fuller and Gaston, 2009). Greening policies could also exert a strong influence on the provision of urban green spaces (Miller, 1997; Heynen and Lindsey, 2003). Despite the fact that various greening policies are formulated at the national level (such as the Regulations for the Indices of Planning and Development of Urban Forestry and Greening issued by the China Forestry Ministry in 1995, which recommends greening standards for all cities), their implementation has been strongly dependent on city-level efforts. In addition, some cities may have augmented greening programs and cognate policies to make their landscapes physically viable and beautiful (Yu and Padua, 2007), amongst which the competition for the National Garden City is most relevant to the development of urban green spaces in a city. A dummy variable is therefore defined as whether a city has been conferred the accolade of National Garden City to infer the impact of policy in the econometric models.

To explore the pattern of the relationship between urban green spaces and economic development, three basic econometric models are tested: linear, quadratic, and cubic. A general empirical model can be written as:

\[ UGS_{it} = \phi_0 + \phi_1 GDP_{it} + \phi_2 (GDP_{it})^2 + \phi_3 (GDP_{it})^3 + \phi_4 POD_{it} + \phi_5 ECOZONE_{it} + \phi_6 LAND_{it} + \phi_7 POLICY_{it} + \phi_8 F_{it} + e_{it} \]  \hspace{1cm} (1)

When \( \phi_1 > 0 \) and \( \phi_2 = \phi_3 = 0 \), the relationship between GDP per capita and urban green coverage is linear. In the quadratic case, if \( \phi_2 > 0 \) and \( \phi_3 < 0 \), and \( \phi_3 = 0 \), the coverage of urban green space exhibit an inverted-U relationship to GDP per capita. The cubic model (\( \phi_1 > 0 \), \( \phi_2 < 0 \), and \( \phi_3 > 0 \)) results in an N-shaped relationship, suggesting urban green coverage increases with economic development, then shifts to a decreasing path, and finally increases again when GDP per capita attains a higher level.

In this model, \( UGS_{it} \) denotes the percentage of urban green space coverage of a city (area of urban green spaces/total area of the built-up land) for city \( i \) at year \( t \), \( GDP_{it} \) is per capita GDP, \( POD_{it} \) is the population density, \( ECOZONE_{it} \) is the locational characteristics of city \( i \), \( LAND_{it} \) is the built-up land area, and \( POLICY_{it} \) is the dummy variable for National Garden City status. \( F_{it} \) is the fixed effect for city and year specific factors, \( \phi_0 \) is the constant, and \( e_{it} \) is a stochastic error. Based on the result of the Hausman test (Hausman and Taylor, 1981), Eq. (1) is estimated by fixed-effects method, which allows for accommodating intra-city heterogeneity and time-invariant variables (such as \( ECOZONE \)) in the relationship between urban green spaces and economic development (Koop and Tole, 1999).
Diagnostic tests

A series of diagnostic tests are performed to mitigate potential bias. Firstly, a Wald test is performed to determine if time fixed effects were needed in the fixed-effect model. The result rejected the null prediction that all year coefficients would jointly equal zero. Therefore, the two-way fixed effects model is used to control for both year- and city-specific effects. Secondly, the potential serial correlation in the residuals is checked using the test developed by Wooldridge (2002) for panel data models. And the potential heteroskedasticity is also checked using a standard likelihood ratio test. Both tests rejected the null hypothesis, suggesting first-order autocorrelation and heteroskedasticity in our data. To account for these problems, we scaled the standard errors (heteroskedasticity and autocorrelation consistent standard errors, or Newey-West standard errors) to allow for correlated errors within the cluster at the city level. According to Wooldridge (2002), this clustering approach, based on the robust variance matrix, offers an effective way to correct such problems and obtain reliable results. Thirdly, we checked the variance inflation factors (VIFs) for all variables. In all the equations, the VIFs are below the cut-off value of 10, indicating that multicollinearity among independent variables was not a serious problem. Fourth, to rule out the potential threat of a unit root in the panel dataset, we conducted Fisher-type Augmented Dickey–Fuller (ADF) test. The result is highly significant ($t = -19.16$, $p < 0.001$), suggesting stationarity in the panels.

Finally, we consider the potential problem of endogeneity in our estimation which arises when there is a correlation between the parameter or variable and the error term. The problem can be the result of measurement error, auto regression with auto correlated errors, simultaneity, omitted variables, and sample selection errors. Theoretically, a loop of causality between the independent and dependent variables of a model leads to endogeneity. In our study, cities with more green space may be influenced by its National Garden City status. To test if the policy variable is endogenous, we employ the treatment rate of solid waste, and the treatment rate of sewage as instruments to run two-stage least squares regression and perform Durbin–Wu–Hausman endogeneity tests. The rational of choosing the two variables as instruments is that they only affect the urban green spaces through the policy variable (i.e. whether a city is conferred National Garden City), yet are less likely to be influenced by the urban green space ratio (Greene, 2008). The Durbin–Wu–Hausman (DWH) endogeneity tests examine whether or not there is a correlation between the dependent variable, and the part of the suspect variables’ variation that is not explained by genuinely exogenous factors. We obtain insignificant results from the DWH test ($F = 2.67$, $p > 0.1$), suggesting that endogeneity is not likely a problem for the policy variable in our estimation (Anselin et al., 2000). The computation is performed by STATA (Stata Corporation, 2011).

Data

Panel data consist of observations from 285 Chinese cities at the prefecture level and above for the period of 2001–2010 (excluding Lhasa, Hong Kong, and Macau due to data shortage). The bulk of city-level panel data comes from the Urban Statistical Yearbooks of China (the National Bureau of Statistics of China, 2001–2010), and the China Urban Construction Statistical Yearbooks (the Ministry of Housing and Urban–rural Development of the People’s Republic of China, 2001–2010). For missing data, the database was complemented by the Municipal Statistical Yearbooks and China Statistical Yearbooks (various years).

ECOZONE is a variable reflecting locational ecological-geographical characteristics, which defines the natural endowment of a city at the macro level. According to the hydrothermal conditions characterized by the annual aridity index (the modified Selinianov) and annual precipitation (Zheng, 2008), four major ecological-geographical regions are defined in China, including the humid-forest region (aridity index: −0.99; annual precipitation: >800 mm); the semihumid-meadow region (aridity index: 1.00–1.49; annual precipitation: 800–400 mm); the semiarid-steppe region (aridity index: 1.50–4.00; annual precipitation: 400–200 mm); and the arid-desert region (aridity index: ≥4.00; annual precipitation: <200 mm). The specification of National Garden City status (POLICY) is based on the report of the National Land Greening Office (2011). The definition and description of variables are summarized in Table 1.

Results and discussion

Synoptic spatial/temporal pattern of urban green spaces

In 2001, the 285 cities at the prefecture level and above accounted for 177.5 million nonagricultural inhabitants (about 13.9% of the total population in China), which increased to 388.7 million by the end of 2010 (about 29% of the total population). The total built-up land area expanded from 17,605 km² to 31,766 km². The same period also witnessed an overall increase of urban green spaces and green area per capita. The percentage of urban green space coverage (in the built-up area of cities) increased from 25.7% to 41.3%. The amount of urban green space per capita was 24.2 m² in 2001, grew to 44 m² in 2010, with an average growth rate of 6.86% per annum. The increase of green space coverage was slower than that of per capita green space (Fig. 1). It suggested that the installation of urban green spaces is slower than the rate of urban expansion, but faster than the rate of urbanization, as indicated by the increase of urban population.

By the end of 2010, the coverage of urban green spaces in Chinese cities varied markedly (Fig. 2). The average coverage was 41.3%, ranging from only 0.6% (Pingliang, Gansu province, western China) to 70.7% (Erdoes, Inner Mongolia, northern China). Per capita green space provision showed a significant divergence, from only 0.4 m² per person in Longnan (Gansu province, western China) to more than 300 m² in Shenzhen and Heyuan (Guangdong province, southern China). Some 201 cities’ green space coverage is lower than the average level, indicating a significant shortage of natural amenity for residents inhabiting these cities.

Economic growth and urban green space coverage

The panel regression results for the coverage of urban green spaces in Chinese cities are presented in Table 2. The quadratic model is rejected as the second-order effect of economic development (GDP) is not significant ($p > 0.1$). The cubic model is well
Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable</strong></td>
<td>Percentage of urban green space coverage (area of urban green space cover/built-up area)</td>
<td>33.09</td>
<td>10.04</td>
<td>0.20</td>
<td>91.00</td>
</tr>
<tr>
<td><strong>Independent variable</strong></td>
<td><strong>GDP</strong> Gross domestic product per capita ($\times 10^4$ RMB/person)</td>
<td>2.65</td>
<td>2.14</td>
<td>0.12</td>
<td>24.90</td>
</tr>
<tr>
<td><strong>Control variable</strong></td>
<td><strong>POD</strong> Population density ($10^4 \times$ persons/km$^2$)</td>
<td>0.10</td>
<td>0.09</td>
<td>0.01</td>
<td>1.14</td>
</tr>
<tr>
<td><strong>ECOZONE</strong> Ecological-geographical region where a city is located:</td>
<td>humid-forest = 4, semihumid-meadow = 3, semiarid-steppe = 2, and arid-desert = 1</td>
<td>3.47</td>
<td>0.80</td>
<td>1.00</td>
<td>4.00</td>
</tr>
<tr>
<td><strong>LAND</strong> Area of built-up land (km$^2$)</td>
<td></td>
<td>89.00</td>
<td>125.04</td>
<td>5.00</td>
<td>1350.00</td>
</tr>
<tr>
<td><strong>POLICY</strong> Dummy variable, =1 if the city is designated the National Garden City in a specific year, =0 if otherwise</td>
<td></td>
<td>0.24</td>
<td>0.43</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The initial stage of economic development and urbanization is characterized by an expansion of urbanizing area in the form of new urban districts, development zones, government office areas, and university towns. This expansion has encroached into originally natural or agricultural land at urban fringes, but usually resulted in new, very-low density, urbanized areas. At this point, human population densities in the new urban sites are relatively low and put little pressure on the land. Thus, there is an increase of the overall coverage of urban green spaces as some pieces of natural land have been left and classified as urban green spaces.

Then, there is a transitory stage (the middle part of the N curve) which is characterized by accelerating economic growth and urbanization and decreasing urban green space coverage. During this period, many municipal governments pay close attention to the...
The turning points in the N-shaped EKC define the level of GDP per capita corresponding to the turning points in the N-shaped curve could be calculated as RMB50,855 (the first) and RMB107,558 (the second). In 2001, the GDP per capita of 280 cities is lower than the first threshold and only one city (Shenzhen, Guangdong province, Southern China) exceeds the second threshold. By the end of 2010, the GDP per capita of 192 cities is below the first turning point, and a total of 8 cities have GDP per capita surpassing the second turning point. These results suggest that a certain number of Chinese cities and a large part of the population residing in them are still on the downward-sloping path characterized by continuous economic development, but worsening natural amenity with regard to urban green spaces.

The elasticity of urban green spaces with respect to the changes in GDP per capita could be calculated by employing Eq. (3) based on the coefficient estimates in the cubic model reported in Table 2:

$$
\varepsilon = \phi_1 + 2\phi_2(GDP) + 3\phi_3(GDP)^2
$$

(3)

This elasticity implies how sensitive the quantity of natural amenity supplied (urban green space coverage in the present study) is to economic growth (proxied by changes in GDP per capita). Results are presented in Fig. 3. When a city is in the early stage of development (GDP per capita < RMB30,317), economic development and urbanization could increase the coverage significantly; the rise in green coverage is more than proportionate to the rise in GDP per capita with other factors held constant. However, as per capita GDP grows to between RMB30,317 and RMB128,095, urban green space coverage becomes inelastic ($\varepsilon < 1$). In 2010, more than 65.3% of Chinese cities fell within this range. This implies that a change in affluence leads to a relatively small change in urban green coverage, increasing slowly (albeit at a declining rate) until per capita GDP passes RMB50,855 (the first turning point), then decreasing as economic development continues. Once the second turning point (RMB107,558) is reached, the coverage of urban green spaces starts to increase again, but at a slow rate. Large elasticity is expected as GDP per capita grows to a certain high level (beyond RMB128,095): a 1% growth of GDP per capita implies that a change in affluence leads to a relatively small change in urban green coverage, increasing slowly (albeit at a declining rate) until per capita GDP passes RMB50,855 (the first turning point), then decreasing as economic development continues. Once the second turning point (RMB107,558) is reached, the coverage of urban green spaces starts to increase again, but at a slow rate.

The turning points in the N-shaped EKC define the level of GDP per capita after which the relationship between GDP per capita and the coverage of urban green spaces switches from positive to negative, and then from negative to positive. According to Plassmann and Khanna (2007), the standard estimators of the two turning points are defined as:

$$
\theta_{1,2} = -\frac{1}{3\phi_3}(\phi_2 \pm \sqrt{\phi_2^2 - 3\phi_1\phi_3})
$$

(2)

Using the parameter estimates of the cubic model (Table 2), the value of GDP per capita corresponding to the turning points in the N-shaped curve could be calculated as RMB50,855 (the first) and RMB107,558 (the second). In 2001, the GDP per capita of 280 cities is lower than the first threshold and only one city (Shenzhen, Guangdong province, Southern China) exceeds the second threshold. By the end of 2010, the GDP per capita of 192 cities is below the first turning point, and a total of 8 cities have GDP per capita surpassing the second turning point. These results suggest that a certain number of Chinese cities and a large part of the population residing in them are still on the downward-sloping path characterized by continuous economic development, but worsening natural amenity with regard to urban green spaces.

Fig. 3. Elasticity of urban green space coverage with respect to economic development in Chinese cities.
demand for natural amenity from wealthier urban dwellers (Deller et al., 2001). In 2010, only four cities had reached this level.

**Control variables**

All control variables entered into the models are statistically significant at the 1% level (Table 2). The positive coefficients of ECOCODE suggest that the percentage of urban green space coverage is high in the humid-forest region, decreasing gradually in cities located in the semihumid-meadow region, the semiarid-steppe region, and the arid-desert region. This result is consistent with empirical findings in American cities that the macro natural condition characterized by precipitation and temperature is a main determinant of the variation in the percentage of urban green space coverage at the city level (Nowak et al., 1996, 2001; Zhu and Zhang, 2008). As asserted by Heynen and Lindsey (2003), such a finding is not surprising; it is of particular importance, however, because it indicates that human intervention has not superseded the influence of natural factors. It emphasizes that understanding the natural, biophysical, and ecological processes operating in cities is essential to activities pertinent to urban green spaces (such as planning, design, maintenance, etc.) that aim to attain desirable natural amenity in an urbanizing world (Sanders, 1984; Nowak, 1993; Flores et al., 1997; Shochat et al., 2006).

The coefficients of built-up land area (LAND) are negative, which implies that the increase of urban green spaces is not proportionate to the rapid urban expansion (the increment of urbanized land area outpaces the increase of urban green spaces) that has been taking place in Chinese cities. As urban areas expand into the fringe rural landscape, most land is transformed for industrial, residential and commercial use (Yeh and Wu, 2009) to increase the economic growth rate and local fiscal revenue. Even so, creating a living environment (through limited provision of urban green spaces) is one of the focuses of local governments (Shen, 2007). As a result, increased urbanized land area tends to decrease the overall percentage of urban green space coverage in Chinese cities. This negative relationship between urban land area and the percentage of urban green space coverage is inconsistent with findings in American cities (Nowak et al., 1996) and European cities (Fuller and Gaston, 2009). This disparity might be attributable to the existence of the large amount of vacant land which is usually transformed into urban green spaces by human intervention or natural regeneration.

It is worth noting that the population density variable (POD) is positively correlated to the percentage of urban green coverage, which is at variance with the results of Nowak et al. (1996, 2001) that show that the percentage of urban tree coverage in American cities tends to decrease as population density increases. However, it is consistent with the analysis of urban open spaces in North Carolina (Wang et al., 2012). One possible explanation for this is that the high efficiency of land use in urbanized areas might save some land for the development of urban green spaces (Zhu and Zhang, 2006), particularly in compact cities, a preferred form of urban landscape.

The econometric analysis in the present study examines the evolving path of an important natural amenity, urban green spaces, in the process of rapid urbanization in China. Specifically, it highlights how economic development affects the coverage of urban green space through testing the EKC hypothesis for the case of urban green space development in a fast-growing developing country. Largely exploratory in nature, this investigation provides a dynamic intra-city analysis of urban green space coverage in 285 cities at the prefecture level and above over the period of 2001–2010, when China witnessed high rates of economic development and urbanization, accompanied by dramatic changes in its urban landscape.

A very clear nonlinear relationship between economic development and urban green space coverage is uncovered, which follows an N-shaped EKC. The percentage of urban green space coverage increases in the early stage of economic development and urbanization. This positive relationship is mainly attributable to the low density of urban expansion into natural vegetated areas that are then classified as urban green spaces. Then, there is a transitory stage (the middle part of the N curve) characterized by accelerating economic growth and decreasing urban green space coverage due to the rapid filling in of areas of low-density development and inadequate greening policies. The coverage of urban green spaces then returns to a rising path again, as GDP per capita grows further, as a response to increasing municipal affordability and demand for better natural amenity from a wealthier urban populace. The turning points are estimated to lie at RMB50,855 (switch from increasing to decreasing path) and RMB107,558 (shift to increasing path again). By the end of 2010, a total of 85 Chinese cities (about 30%) are still located on the downward-sloping path characterized by continuous economic development but worsening natural amenity with regard to urban green spaces. The GDP per capita level in only 8 cities surpasses the second turning point, where the provision of urban green spaces increases as economic development continues. However, the estimated elasticity shows the growth of urban green coverage is not proportionate until the GDP per capita exceeds RMB128,095, a number that only four cities have surpassed.

Urban policy in developing countries, such as China, tends to be weak due to a lack of support for scientific input in the decision making process (Li et al., 2010), which is crucial for improving the quality of China’s future urbanization (Chen et al., 2013). This study could inform policy makers to theoretically understand how urban green spaces evolve along with economic development and urbanization. The results provide a challenging and pressing call for policy makers to achieve an optimal balance between economic development and a better natural amenity. If appropriate policy intervention (such as scientific planning and management of urban green spaces) could be contemplated, it is possible to shorten the transitory period or even merge two turning points into one inflexion point. In this way, the urban populace could enjoy sustainable natural amenity in the process of economic development and urbanization.
As far as the estimate of elasticity is concerned, whether the large elasticity of the four cities attaining highest level of economic development is associated with special municipal policy or unique urbanization pattern merits further investigation. Moreover, this study captured the specific dynamic of a particular developing country. Cross country studies (e.g., together with other developing countries) may be more informative for investigating the evolving path of urban green spaces with urbanization and economic growth using more heterogeneous datasets and studying the relative effectiveness of different urban greening and planning policies.

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