Article

Urban Affairs Review
1–25

DOI: 10.1177/10780874261468958
journals.sagepub.com/home/uar

Municipal Fragmentation and Metropolitan Open Space Patterns

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Abstract

Municipal fragmentation is a defining feature of U.S. metropolitan governance, yet its implications for open space provision remain theoretically contested. Drawing on public choice theory and regional governance perspectives, this study examines how fragmented governance shapes the amount, size, and accessibility of metropolitan open space. Using the Trust for Public Land's ParkServe dataset and measures of local government fragmentation across U.S. metropolitan statistical areas, we estimate ordinary least squares and instrumental variable two-stage least squares models. The results show that greater municipal fragmentation is associated with increased provision of small and medium-sized parks and higher accessibility, measured as the share of residents living within a 10-minute walk of open space. However, fragmentation is negatively associated with the provision of larger parks, with a threshold of approximately 10 acres marking the transition. These findings reconcile competing theories by demonstrating that public choice dynamics promote localized neighborhood amenities while limiting the coordinated preservation of regionally significant open spaces, with important implications for metropolitan planning and environmental equity.

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Keywords
metropolitan governance, municipal fragmentation, open space provision

Introduction

Open space planning at the regional, landscape, or metropolitan scale has a long-standing tradition in the field of city and regional planning. Historical examples of metropolitan-scale interventions include Olmsted's plan for Buffalo and efforts by the Regional Planning Association. As metropolitan areas have suburbanized, the role and function of open space have expanded and diversified. Advocacy for open space often draws on universal themes such as environmental health and quality of life. Its preservation is frequently framed and marketed as a public good that serves a range of ecological, social, spiritual, health, and even fiscal purposes. Given the wide array of personal and community benefits, access to open space is a matter of considerable public interest (Boulton, Dedekorkut-Howes and Byrne 2018).

However, open space provision is rarely coordinated at the regional or metropolitan scale. Instead, it tends to emerge from localized land use decisions and broader urban development patterns. Consequently, the spatial distribution of open space reflects the uncoordinated actions of multiple levels of government: city, county, state, and federal, often operating independently over time. This makes the maintenance of open space highly contingent on local governments' capacity. One key dimension of that capacity is government fragmentation, which we define as the extent to which authority over land-use and public service provision is dispersed across multiple local jurisdictions within a metropolitan area.

This raises a central institutional question: to what extent do metropolitan governance structures, particularly the degree of municipal fragmentation, shape the amount, configuration, and equity of open-space provision? Although fragmentation is a defining characteristic of U.S. metropolitan governance, theory provides conflicting predictions about its consequences for environmental amenity provision. Public choice theory suggests that fragmentation enhances responsiveness and encourages jurisdictions to compete by supplying visible, neighborhood-scale amenities such as small parks. In contrast, regional governance perspectives argue that fragmented systems struggle to provide public goods whose benefits spill across boundaries, including large parks, ecological corridors, and regionally significant open-space systems. Moreover, this concern is not merely academic. Unequal access to parks, particularly high-quality and large open spaces, exacerbates spatial inequities across metropolitan regions.

Using polygon data from the ParkServe dataset, we examine the relationship between local open space and municipal fragmentation. We also examine whether greater political fragmentation produces increased accessibility.

By combining Ordinary Least Squares (OLS) and instrumental-variable two-stage least squares (2SLS) models, this study provides national-scale causal evidence on the institutional determinants of metropolitan open-space patterns. In doing so, it clarifies how fragmented governance simultaneously encourages the creation of small neighborhood parks while inhibiting the preservation of large regional spaces, thus illuminating the institutional mechanisms underlying both spatial configuration and distributive equity in open-space systems.

The rest of the paper is structured as follows. We begin with a review of the literature on municipal fragmentation and the provision of open space, situating our work within debates on public choice theory. We then describe our data and methods, including the ParkServe dataset, measures of municipal fragmentation, and descriptive statistics to illustrate the distribution of open spaces by size throughout U.S. metropolitan areas. We specify several models to explain both the total and normalized amounts of metropolitan open space, as well as the accessibility of open space, measured as the share of the population living within a 10-min walk of open space as a function of municipal fragmentation, while controlling for confounding variables. Finally, we discuss the implications of these findings for metropolitan planning and governance and conclude by identifying key contributions for public choice theory and directions for future research.

Literature Review

Competing Theoretical Frameworks

What is the relationship between the institutional landscape of our metropolitan areas and the amount, distribution, and configuration of open space? Similarly, what effect does municipal fragmentation within metropolitan areas have on patterns of metropolitan open space? Although open space is often considered an amenity, it differs fundamentally from other consumer-oriented amenities in several key ways. First, the location and distribution of open space is not easily replaceable or particularly transferable. This is in part because its location is shaped by the geography of natural features and the presence of unique landscapes, such as greenways and waterfronts. Second, open space serves a wide range of diverse societal and ecological needs, offering a range of benefits, and is often justified through universalizing themes with reference to social, economic, and ecological values which accrue to individuals and societies. However, a growing body of research demonstrates that access to open space, particularly higher quality open space, is unevenly distributed across a number of socioeconomic variables (Sister, Wolch and Wilson 2010; Boone et al. 2009; Rigolon 2016). This

pattern aligns with environmental justice scholarship showing spatial inequities in environmental amenities.

Finally, while retail and leisure amenities largely arise from private-sector investment and property rights, open space is a public good and its provision tends to be a public sector responsibility. This distinction aligns with Tiebout's (1956) influential argument that competition among local governments enables households to "vote with their feet" across a metropolitan region, choosing jurisdictions that offer their preferred bundle of services and amenities. Multiple local governments give residents and firms more choices in tax and service packages, the theory goes, increasing the likelihood of meeting diverse preferences. Competition among jurisdictions drives efficiency, responsiveness, and service quality, while different services can be provided at the scale that suits them best. By contrast, regional governments create service monopolies that lack competitive pressures.

Building on this, Fischel's "homevoter" hypothesis (2001) posits that homeowners, because their largest investment is tied to the immobile value of their property, are motivated to maintain or enhance neighborhood quality, which in turn shapes their political behavior. This logic closely aligns with the median voter model of local public finance: in many suburban jurisdictions, where homeowners dominate local politics, elected officials have incentives to provide the bundle of local public goods preferred by the median homeowner-voter. Given the increasingly fragmented (and unequal) nature of metropolitan regions (Savitch and Adhikari 2016), municipalities are incentivized to support and maintain open spaces to enhance quality of life, protecting property values and attracting residents. This median voter model tends to be most relevant within smaller (generally suburban) municipalities, where residents have greater influence over land use decisions. Several studies have empirically demonstrated that the demand for local open space (that which is preserved by local actors) is highly elastic with regard to income (Bates and Santerre 2001; Schmidt and Paulsen 2009)

The counter argument is that larger, more centralized multiple-service governments have economies of scale to provide more efficient and effective means to deliver a whole range of public services. Centralized governance reduces duplication, confusion, and transaction costs, while internalizing growth-related externalities and achieving economies of scale. Consolidating governance into a single general-purpose authority is believed to improve coordination, achieve efficient service delivery, and thereby promote higher economic performance (Goodman 2021). In contrast, competition among small jurisdictions leads to inefficient and inequitable development, overzoning, and hindered metropolitan-wide planning.

Empirical findings to better understand the relationship between governance fragmentation and outcomes have been mixed. While Stansel (2005)

finds a positive relationship between the number of municipalities per 100,000 residents and economic growth, Nelson and Foster (1999) find support for the more centralized school of thought. Hammond and Tosun (2011) find that government organization matters for local economic growth, but that the impacts vary by government unit and by economic indicator.

Relationship to Open Space Distribution

Applying this theoretical framework to the provision of open space, a more fragmented metropolitan governance structure could conceivably strengthen local incentives to provide amenities that attract residents and tax base, including parks and other forms of open space. Homeowners may also pressure local governments to supply visible amenities that can enhance neighborhood desirability and property values (Fischel 2001). Under this competitive logic, greater municipal fragmentation could be associated with a spatial pattern characterized by many small open spaces as a result, the proportion of local open spaces may increase, and their accessibility may improve. The outcome for total open space area is less clear ex ante, because competition may primarily generate small open spaces rather than large ones.

However, these positive hypotheses are conditional. Competition mechanisms are most likely to produce improvement when the relevant public goods are highly visible within jurisdictions, relatively excludable, and, most importantly, when benefits can be internalized by the residents and taxpayers who bear the costs (Feiock 2009). Open space often fails to meet these conditions, because many of its benefits (ecological services, regional climate mitigation, recreation for residents/nonresidents) spill across municipal boundaries and accrue over long time horizons (Bengston, Fletcher, and Nelson 2004). Moreover, providing and sustaining open space typically requires long-term investments in land acquisition, planning, and maintenance. These activities depend heavily on administrative capacity, stable funding, and cross-jurisdictional coordination.

From a metropolitan governance perspective, the provision of open space systems often requires coordinated planning across jurisdictions, creating an institutional collective action problem (Feiock 2013). Fragmentation can increase transaction costs, intensify free-riding, and weaken the ability to implement regionally coherent open space strategies. Fragmentation may also erode local fiscal and administrative capacity by dispersing responsibilities across smaller governments. Under such constraints, the types of open space that are most vulnerable are often small and dispersed local parks that require labor-intensive maintenance by local

governments, which can be the first to be scaled back when budgets are tight or when governance capacity is limited. Consequently, municipal fragmentation is expected to be associated with an overall contraction of open spaces as large, coordinated projects are difficult to realize and preserve. Taken together, these competing theoretical expectations imply that the net spatial signature of government fragmentation is not predetermined.

This study argues that metropolitan governance structure fundamentally shapes the spatial patterns of open space systems. Specifically, municipal fragmentation influences not only the total amount of open space, but also its size distribution, configuration, and accessibility. While fragmented governance may stimulate the localized provision of small, visible parks through interjurisdictional competition and homeowner preferences, it may simultaneously undermine the coordinated acquisition and preservation of large, regionally significant open spaces. The net effect of fragmentation is therefore theoretically indeterminate and reflects the tension between competitive localism and metropolitan collective action. Moreover, this has important equity implications for access to open space. Municipal fragmentation can produce uneven access to open space because provision becomes tied to wealth, homeowner preferences, and administrative capacity rather than metropolitan-wide needs. In the next section, we discuss our dataset, how we operationalized municipal fragmentation, the development of our control variables, and introduce some descriptive statistics to illustrate the distribution of open spaces by size throughout U.S. metropolitan areas.

Data and Methods

For this study, we utilize open space polygons from the Trust for Public Lands ParkServe dataset, which contains over 150,000 records in all urban areas of the U.S. and is available for download in multiple file formats. The dataset is compiled from multiple sources, including municipal governments, regional open data portals, and manual delineation via satellite imageries in areas where spatial data are not available.

The dataset is quite extensive, and includes all open spaces that are located outdoors, are a named destination, encourage informal public use and at least one "park-like" activity such as socializing, enjoying nature, or play/exercise. Excluded from the dataset are non-public parks in gated communities, water, private golf courses, publicly managed stadiums or zoos, and private cemeteries.

In addition to open spaces, the dataset calculates a 10-min walking service area for each open space using ESRI's network analyst tools, and spatially

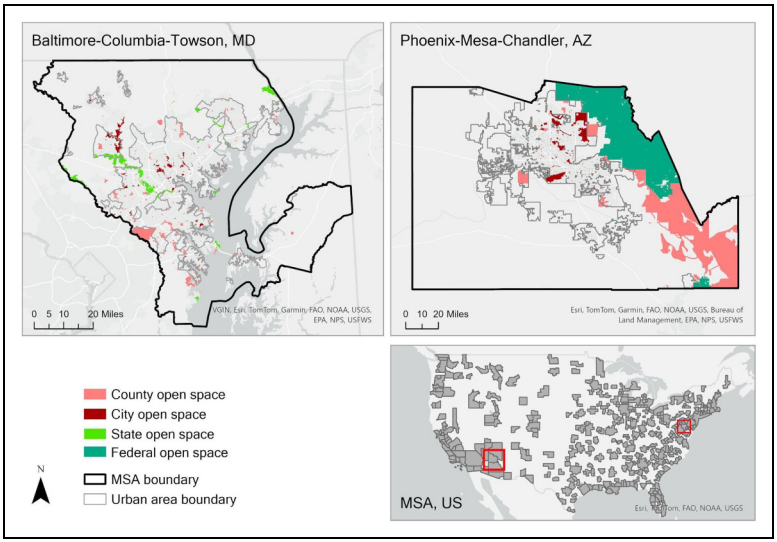

Figure 1. Examples of MSAs with different open space governance structures. The Baltimore–Columbia–Towson MSA (left) displays a dense distribution of city and county open spaces; the Phoenix–Mesa–Chandler MSA (right) includes extensive areas of both local (city and county) and federally managed open spaces.

joins block group-level demographic information to these service areas, making it possible to measure open space accessibility and identify underserved areas. Among all open space records, more than 117,000 are located within metropolitan statistical areas (MSAs); geographical regions with a relatively high population density in its core and closely interlinked economic connections across the entire area. To facilitate analysis, the open spaces are categorized based on their managing authority and administrative level, dividing them into four categories: city, county, state, and federal. An illustrative map of different levels of open spaces within a single MSA is shown in Figure 1, where we select one MSA, Baltimore-Columbia-Towson, MD, characterized by a dense network of local open spaces and another one, Phoenix-Mesa-Chandler, AZ, representing extensive federal and county park coverage.

Measuring Metropolitan Political Structure

We adopt widely used measures of government fragmentation to investigate their influence on open spaces. Government fragmentation is commonly measured as the number of specific types of governments, or in its normalized

form, government's per capita (Hendrick, Jimenez and Lal 2011; Schneider 1986; Grossman, Pierskalla and Dean 2017; Hammond and Tosun 2011; Stansel 2005). Although this measure has been criticized for ignoring differences in government scale and the primacy of county in service provision (Foster 1993; Goodman 2021), it remains the most common indicator that captures the overall dispersion of political authority and can be easily adapted to distinguish between different types of government (e.g., general- or special-purpose governments) for use in different contexts. Since the ParkServe dataset includes only open spaces located within the urban areas and places[1] of each MSA, we constrain the spatial domain of our fragmentation measure to include only government units within those areas. We operationalize municipal fragmentation across the metropolitan regions as the total number of local governments per 10,000 residents for each MSA, a relatively common measure (Stansel 2005; Hammond and Tosun 2011), using three slightly different definitions of local government. The first (Local Govt 1) only includes municipal and county government units, both of which are directly responsible for providing local open spaces. The second measure (Local Govt 2) builds on the first by additionally counting towns, or minor civil divisions (MCDs), in six New England states, as well as PA, NJ, and NY, as local governments. Although not classified as municipal governments by the Census of Governments, they are in fact local units of governance providing public services. The third measure incorporates all general-purpose governments (general-purpose govt), including counties, municipalities, and townships. Because the provision of local open spaces depends more on general-purpose government, we exclude other types, such as school or special districts (Campbell 2004).

Modeling the Amount and Accessibility of Open Space

The central question we ask is whether more fragmented local governance structures, which may affect fiscal capacity and coordination costs, are associated with open space supply and accessibility. To quantity this relationship, we begin with the following OLS specification at the MSA level:

$$ln(open\ spaces_i) = \beta\ ln(govt\_frag_i) + X_i\gamma + \delta_{region(i)} + \varepsilon_i$$

Where the dependent variable $open\ spaces_i$ is measured in three ways: (1) total open spaces area per MSA i, (2) open spaces per 10,000 residents, and (3) population share of local open spaces with 10-min walking distance as a measure of open spaces accessibility. Our key explanatory variable, $Govt\_Frag_i$ captures government fragmentation, measured in three ways as described in the previous section. X_i is a vector of MSA-level control

variables. Following Schmidt and Paulsen (2009), control variables include the median property tax base (as a proxy of fiscal health), median family income, population to control for size, median building year to control for age, the amount of non-local green space, which we define as being sourced from either the state or federal government (which may act as a substitute for local open space, and may have an inverse relationship with demand for local open space), the percent of the population that are homeowners (to test for the impact of homeowners on local politics), and median family income. In studying the distribution of environmental amenities and open space, Bates and Santerre (2001) determined that demand for open space is income elastic. Since our data is cross-sectional, we account for regional heterogeneity, $\delta_{region(i)}$, by introducing regional level fixed effect dummies representing a four-region classification based on the U.S. Census Bureau. These dummy variables help control for regional unobserved variations that are not captured by control variables but may influence the dependent variables, for example, differences in economic growth. The inclusion of the regional level fixed effects follows the work of Foster (1993), Nelson and Foster (1999), and Grassmueck and Shields (2010).

Our initial models were estimated using the OLS estimator. However, OLS estimates are very likely to be biased due to endogeneity issues in the model. Instead of arguing that government fragmentation stimulates the provision of open spaces, reverse causality may exist. For instance, higher amenities can attract residents who favor local autonomy and more restrictive land use policies, which may in turn sustain or increase governmental fragmentation, thus leading to reverse causality. Furthermore, endogeneity may arise from omitted variable bias, as there exist unobserved local political and neighborhood characters/preferences (e.g., NIMBYism) that lead to an increase in both open spaces provision and the support for independent jurisdictions.

To address these endogeneity concerns and tease out the true causal effect, we utilized the 2SLS estimator with instrumental variables (IV) to obtain more consistent estimates, in addition to OLS models. An ideal IV should be highly correlated with current government fragmentation (to satisfy *relevance*) while being unrelated to today's open spaces outcomes except through its effect on current fragmentation (to satisfy the *exclusion restriction*). We constructed two historical IVs: municipal fragmentation index in 1950 and railroad density in 1893. The 1950 municipal government fragmentation index is measured as the number of municipalities per 10,000 people for each MSA in 1950. The dataset comes from Goodman (2023), who compiled municipality level incorporation (and experimental disincorporation) dates for U.S. active municipalities from 1789 onward, along with geographic crosswalks for spatial matching and aggregation. We consider this IV valid

Table 1. Size Distribution and Statistics of Open Spaces.

Size Range (acres)	Total # Open Spaces	Total % Count	Total Area (acres)	Total % Area	Mean # Per MSA
< 0.5	13,093	12.50%	3,127.4	0.05%	33.9
0.5–1	8,571	8.18%	6,318.1	0.10%	22.2
1–2	11,337	10.82%	16,523.0	0.27%	29.4
2–5	19,996	19.08%	67,156.5	1.10%	51.8
5–10	16,351	15.61%	118,015.1	1.94%	42.4
10–20	13,316	12.71%	189,175.0	3.11%	34.5
20–50	11,382	10.86%	357,716.9	5.88%	29.5
50–100	4,956	4.73%	347,121.6	5.71%	12.8
100–500	4,760	4.54%	961,472.4	15.81%	12.3
> 500	1,012	0.97%	4,016,114.2	66.02%	2.6

because 1950 proceeds the postwar suburbanization era when fragmentation became widespread, and theories linking fragmentation to public service provision (e.g., Tiebout sorting mechanisms) became well recognized. Under this logic, current open spaces outcomes should not be directly related to fragmentation in 1950, except through its impacts on contemporary fragmentation, as government fragmentation was less of a salient determinant of local public service provision. The second IV is railroad density in 1893, measured as miles of railroad per 1000 km^2. The dataset was collected from Atack (2016). We chose 1893 because railroad coverage is more complete than in earlier years (e.g., 1861), and because this cutoff year predates the City Beautiful movement, and many cities had not yet developed park systems. So early transportation infrastructure is less likely to be correlated with open space outcomes through channels other than its influence on subsequent institutional development and fragmentation.

Data Sources and Descriptive Statistics

Open spaces-related variables, including total area, their spatial distribution, and the population share of local open spaces, are collected from the ParkServe dataset. In addition, the data on units of government used to measure local government fragmentation are collected from the Census of Governments (CoG) of the U.S. Census Bureau. We further utilize the corresponding gazetteer file, which contains spatial information (e.g., longitude and latitude), to accurately match individual governments with the urban area boundaries for each MSA, where ParkServe maintains the green space dataset. In this way, we construct local government fragmentation indicators specifically for urban portions of MSAs. To ensure that our control variables

accurately reflect the socioeconomic characteristics of the urbanized areas within each MSA, we first collect median property taxes, building years, and family incomes from sub-MSA census units located within the urbanized areas from the American Community Survey (5-year estimates). These data are then aggregated to the MSA level using a population-weighted method. In this case, we are operationalizing "local open space" as that preserved and managed by either the municipality (city) or county. This comports not only with public choice theory and previous studies of open space (Schmidt and Paulsen 2009), but also reflects the reality that in some parts of the U.S., counties serve as the general service local government. Finally, we should note some limitations of our analysis. For example, in their comprehensive review of the literature, Boulton, Dedekorkut-Howes and Byrne (2018) identify seven factors that influence the provision of urban green space: resources, governance tools, political leadership, land availability, governance structure, economies and markets, and organizational culture, many of which we are not able to control for. To provide an overview of our data, we display the descriptive statistics of variables, as shown in Table A1 in the appendix.

Table 1 below reports the distribution of open spaces by size. Because there is no universally accepted cutoff for classifying open spaces by size, we group them based on our expertise. Though a bit arbitrary, they are sufficient to reveal the underlying patterns. As shown in the table, 79 percent of open spaces are smaller than 20 acres (roughly the area of 15 American football fields), yet these open spaces account for only 6.58 percent of total open spaces acreages. By contrast, open spaces larger than 500 acres comprise approximately 1 percent of sites, but they account for two-thirds of the total area of open spaces. This extremely unbalanced size-area distribution highlights the necessity of classifying open spaces by size. Aggregating all parks into a single "total open spaces" measure can mask substantively different mechanisms. In particular, because a small number of large parks dominate total acreage, unclassified totals can mechanically track the presence of a few large parks and obscure the impacts of neighborhood small open spaces, which constitute the majority and are most important for everyday access and equity considerations.

Results

Modeling Total and Normalized Open Space Area

We specify several models to explain both the total and normalized amounts of metropolitan open space, as well as the accessibility of open space, measured as the share of the population living within a 10-min walk of open space as a function of fragmentation. Before turning to the regression results, it is

Table 2. 2SLS to Show the Relationship Between Total Open Space Area (ln) and Government Fragmentation (ln) (Local Govt 1). Open Spaces are Categorized by Size. Small Open Spaces (<2.20 Acres), medium Open Spaces (2.20–10.15 Acres), and Large Open Spaces (>10.15 Acres).

Dependent Variable: Total open space area (ln)	(1) All Open spaces	(2) Small open spaces	(3) Medium open spaces	(4) Large open spaces
Local govt 1 (ln)	−.14	.226**	.131*	−.176
	(.124)	(.11)	(.074)	(.135)
Median property tax (ln)	.265*	.412***	.235***	.271*
	(.146)	(.124)	(.086)	(.157)
Median building year (ln)	.677***	.291	.261*	.742***
	(.247)	(.21)	(.148)	(.271)
Population density (ln)	−.212	−.079	.311***	−.299
	(.236)	(.165)	(.117)	(.271)
Median family income (ln)	1.38***	.451	.458**	1.526***
	(.312)	(.277)	(.196)	(.352)
Population (ln)	.832***	.807***	.726***	.845***
	(.063)	(.062)	(.043)	(.068)
Non-local park area (ln)	−.018	−.003	.003	−.022*
	(.012)	(.009)	(.007)	(.013)
Homeownership rate (ln)	.011	.141	.512**	−.049
	(.406)	(.327)	(.227)	(.438)
MSA land area (ln)	.177**	.223***	.217***	.177**
	(.077)	(.064)	(.045)	(.084)
Constant	−22.796***	−17.428***	−17.596***	−24.184***
	(4.14)	(3.45)	(2.408)	(4.599)
Observations	288	284	288	288
R-squared	.78	.791	.877	.756
IV tests:				
Kleibergen-Paap F-statistics	66.210	64.881	65.414	66.210
Sargan-Hansen statistics	0.004	0.067	0.236	0.001
Endogeneity test	0.556	1.687	0.478	0.454

Robust standard errors are in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.
Note: (1) All models include regional dummy variables (Northeast, South, Midwest, and West). (2) "Naples-Marco Island" is dropped from this regression table (and all subsequent regression tables) due to the unusually high value of open spaces area per capita.

important to note that all models in this section are estimated using 2SLS estimators (Table 2–5), with historical municipality fragmentation in 1950 and railroad density in 1893 as IVs. The corresponding OLS estimates are reported in the appendix (Table A2–A4) for comparison, and are broadly consistent with the 2SLS results. The 2SLS results are considered more trustable

Table 3. 2SLS Regressions to Show the Relationship Between Open Space Area per 10k People (ln) and Government Fragmentation (ln) (Local Govt 1). Open Spaces are Categorized by Size. Small Open Spaces (<2.20 Acres), medium Open Spaces (2.20–10.15 Acres), and Large Open Spaces (>10.15 Acres).

Dependent Variable: Local open space area per 10,000 people (ln)	(1) All Open space	(2) Small	(3) Medium	(4) Large
Local govt 1 (ln)	−.152	.232**	.163**	−.213
	(.125)	(.103)	(.07)	(.134)
Median property tax (ln)	.266*	.407***	.25***	.315**
	(.146)	(.123)	(.087)	(.16)
Median building year (ln)	.676***	.298	.26*	.752***
	(.25)	(.21)	(.15)	(.273)
Population density (ln)	−.372**	−.265*	0.01	−.399*
	(.189)	(.157)	(.113)	(.21)
Median family income (ln)	1.373***	.47*	.424**	1.441***
	(.328)	(.275)	(.197)	(.361)
Urbanized area share (ln)	−.172***	−.207***	−.246***	−.18**
	(.066)	(.055)	(.04)	(.071)
Non-local park area (ln)	−.019*	−.003	.005	−.021*
	(.011)	(.009)	(.007)	(.012)
Homeownership rate (ln)	.007	.158	.486**	.691
	(.382)	(.324)	(.229)	(.552)
Constant	−13.496***	−8.369**	−8.023***	−17.787***
	(4.061)	(3.429)	(2.429)	(4.671)
Observations	288	284	288	289
R-squared	.221	.293	.388	.218
IV tests:				
Kleibergen-Paap F-statistics	84.531	83.239	84.531	85.621
Sargan-Hansen statistics	0.005	0.067	0.493	0.001
Endogeneity test	0.516	1.508	1.606	0.148

Robust standard errors are in parentheses.
*** $p<.01$, ** $p<.05$, * $p<.1$.
Note: (1) All models include regional dummy variables (Northeast, South, Midwest, and West).

estimates because the IV strategy mitigates potential endogeneity in government fragmentation and thus identifies the causal effect of government fragmentation on open spaces provision. For each 2SLS model, we report standard diagnostic tests to evaluate instrument validity and strength, including the Kleibergen-Paap F-statistics for weak instruments identification, Sargan–Hansen overidentification test for instrument exogeneity, and the Endogeneity test to evaluate the necessity of IV estimation. Overall, the diagnostics reported across the 2SLS models (Table 2–5) confirm that the IVs are sufficiently strong and valid.

Table 4. Robustness Check Using Local Govt 2 (ln) and General Purpose Govt (ln) as Measures of Government Fragmentation. Models are Estimated Using 2SLS Regressions.

	(1) All Open spaces	(2) Small	(3) Medium	(4) Large
Panel A: relationship—total open space area (ln) and Local govt 2 (ln)				
Local govt 2 (ln)	−.165	.26**	.151*	−.208
	(.144)	(.127)	(.088)	(.157)
Panel B: relationship—total open space area (ln) and General purpose govt (ln)				
General purpose govt (ln)	−.166	.261**	.152*	−.208
	(.144)	(.128)	(.088)	(.157)
Panel C: relationship—open space area per 10k pop (ln) and Local govt 2 (ln)				
Local govt 2	−.174	.249**	.187**	−.244
	(.141)	(.119)	(.08)	(.151)
Panel D: relationship: open space area per 10k pop (ln) and General purpose govt (ln)				
General purpose govt (ln)	−.174	.249**	.187**	−.243
	(.141)	(.119)	(.08)	(.151)
Observations	288	284	288	288

Robust standard errors are in parentheses.
*** p < .01, ** p < .05, * p < .1.
Note: (1) All models in this table include control variables and regional dummy variables (Northeast, South, Midwest, and West).

The tables below are the results of the 2SLS regressions on the relationship between total open space area (Table 2), normalized open space areas (per capita) (Table 3), and government fragmentation. For each table, we specify four models. Model 1 examines the influence of government fragmentation on open spaces provision of all sizes, and models 2–4 report the corresponding estimates for small, medium, and large open spaces, respectively. We classify open spaces into three equal count size groups, and obtain the following grouping cutoffs: Small open spaces (<2.20 acres), medium open spaces (2.20–10.15 acres), and large open spaces (>10.15 acres). Because these cutoffs appear to be arbitrary, we conduct additional robustness checks by reclassifying open spaces into quintiles and deciles to assess the sensitivity to alternative grouping cutoffs and robustness of the overall pattern observed (see Figure 2).

The regression results in Tables 2 and 3 indicate that the degree of municipal fragmentation is significant and *positive* on the both the normalized and total area in regards to both small and medium sized open spaces, suggesting that increased municipal fragmentation is associated with the provision of greater amounts of smaller and mid-sized open spaces and this effect is statistically significant, even when controlling for other aspects such as income,

Table 5. 2SLS Regressions to Show Relationship Between Open Spaces Accessibility (ln) and Government Fragmentation (ln).

Dependent Variable: open spaces accessibility (ln).	(1) Model 1	(2) Model 2	(3) Model 3
Local Govt 1 (ln)	.082**		
	(.038)		
Local Govt 2 (ln)		.094**	
		(.043)	
General Purpose Govt (ln)			.095**
			(.044)
Median property tax (ln)	.154***	.152***	.154***
	(.052)	(.052)	(.052)
Median building year (ln)	.388***	.379***	.378***
	(.089)	(.09)	(.09)
Population density (ln)	.639***	.657***	.658***
	(.071)	(.073)	(.074)
Median family income (ln)	.208*	.195*	.199*
	(.119)	(.118)	(.119)
Population (ln)	−.023	−.02	−.021
	(.022)	(.023)	(.023)
Non-local park area (ln)	−.003	−.003	−.003
	(.004)	(.004)	(.004)
Homeownership rate (ln)	.414***	.409***	.407***
	(.136)	(.136)	(.137)
Constant	−12.108***	−12.154***	−12.195***
	(1.439)	(1.441)	(1.451)
Observations	288	288	288
R-squared	.684	.685	.682
IV tests:			
Kleibergen-Paap F-statistics	71.764	69.643	64.598
Sargan-Hansen statistics	0.006	0.010	0.001
Endogeneity test	2.248	1.843	2.932

Standard errors are in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.
Note: (1) All models include regional dummy variables (Northeast, South, Midwest, and West).

relative wealth, and other sources of open space. In addition, the homeownership rate is positive and significant as well, but only for mid-sized open spaces. This comports with our theory, namely that higher homeownership rates and greater municipal fragmentation produce more smaller open spaces.

By contrast, fragmented metropolitan governance, with multiple entities operating at different scales, can produce disjointed administration landscapes and functional overlaps due to limited coordination, which may impede the acquisition and preservation of larger open spaces. A less fragmented

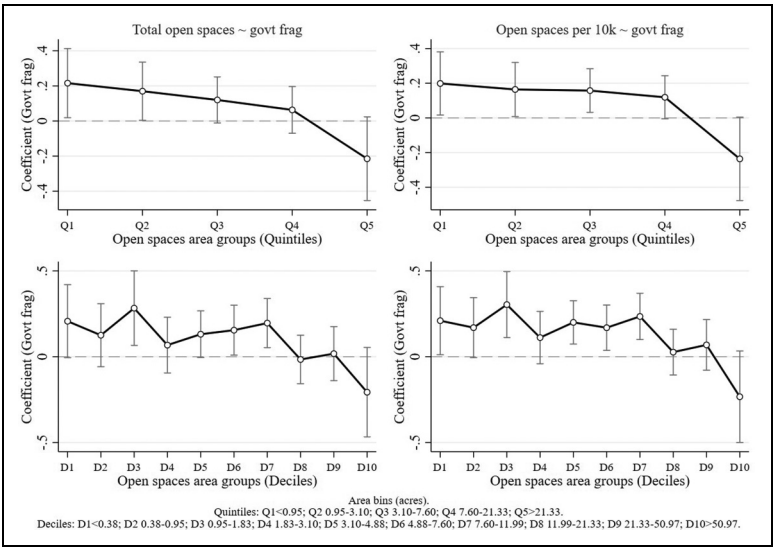

Figure 2. Robustness check for the estimated fragmentation effects by classifying open spaces into quintiles and deciles instead of small, medium, and large. Notes: The left panels plot the estimated coefficient of government fragmentation (Local Govt 1) on total open spaces area, and the right panels plot the corresponding coefficient on open spaces area per 10,000 residents. The upper row uses quintile size bins and the lower row uses decile size bins. Models are estimated using two-stage least square regressions (2SLS).

metropolitan governance structure is more effective and efficient at providing larger open spaces. This is further validated when we observe the negative and significant coefficient for the amount of non-local open space, suggesting a substitution effect occurring for larger open spaces. As the amount of non-local open space (i.e., state or federal), which tends to be larger in size, increases, demand for larger local open space declines. In all models, median property tax and median family incomes were positive and significant across all models, regardless of size. This supports the assertion that the demand for open space is income elastic, possibly due to greater demand, political capacity, or environmental preferences. This raises concerns about the equity of open space access, something we will explore later.

Robustness Checks

Given that the three equal-count size groups are somewhat arbitrary, we conduct additional robustness checks by further classifying open spaces into

quintiles and deciles based on open space size. Figure 2 visualizes the estimated fragmentation coefficients for each size bin, separately for total open spaces area (left panels) and open spaces per 10k residents (right panels). Each cutoff corresponds to specific size ranges, for example, Q2 in quintile grouping corresponds to open spaces between 25th and 50th percentiles in size (0.95–3.10 acres).

Regardless of the quintiles or deciles classifications, the main patterns remain unchanged: government fragmentation is positively associated with the provision of smaller open spaces, and the relationship becomes weaker and eventually negative for larger open spaces. The quintiles figures show positive coefficients through Q3, but the coefficient becomes statistically insignificant by Q4, and turns negative for Q5, which suggests that the turning point lies between the Q3 and Q4 cutoffs (approximately 7.60–21.33 acres). The finer decile classification further pinpoints this threshold: coefficients are positive through D7 (open spaces up to about 11.99 acres), become approximately zero at D8, and turn negative for larger open spaces. Taken together, these robustness checks, alongside the three equal-count size grouping discussed above, suggest a threshold of approximately 10 acres. Open spaces greater than this are negatively correlated with municipal fragmentation, while open spaces smaller than 10 acres are positively associated with greater fragmentation. This suggests that greater municipal fragmentation will produce more open spaces 10 acres or smaller.

Table 4 below presents a robustness check using the other two measures of government fragmentation (Local govt 2 and General purpose govt) for both total open spaces area (Panels A and B) and open spaces area per 10,000 residents (Panels C and D). All models are estimated using 2SLS with robust standard errors (in parentheses) and include the full set of control variables. Across all panels, the results are consistent with our baseline results (in Tables 2 and 3). Greater government fragmentation is associated with more neighborhood scale (small and medium) open spaces, but not with the provision of larger open spaces, as shown by the negative and statistically insignificant coefficients. This conclusion is robust to alternative definitions of government fragmentation.

Modeling Accessibility

Finally, we examine the relationship between open space and accessibility, measured as the share of the population living within a 10-min walk of open space, using 2SLS regression models. As shown in Table 5, municipal fragmentation is positively associated with greater open space accessibility across three separate measures of municipal fragmentation (Local Govt 1 includes municipal and county government units, Local Govt 2 includes

towns, or minor civil divisions (MCDs), in six New England states, as well as PA, NJ, and NY, as local governments, the third incorporates all general-purpose governments (General-purpose govt), including counties, municipalities, and townships). Consistent with our earlier models, median property tax levels, median family income, and homeownership rates are also positive and statistically significant. These findings suggest that while fragmentation may be associated with higher accessibility, this relationship is likely conditioned by socioeconomic factors. The results are broadly consistent with public choice theory: as metropolitan governance becomes more fragmented, households sort into jurisdictions that function as "clubs" for public goods provision, and wealthier, homeowning residents may demand more proximate open space amenities. The corresponding OLS regression models are reported in Appendix Table A4, and are consistent with the 2SLS findings.

However, this interpretation should be treated cautiously. Our dataset does not account for variation in the quantity or quality of open space, nor does it capture disparities in investment, maintenance, or programming, as emphasized by Sister, Wolch and Wilson (2010), Boone et al. (2009), and Rigolon (2016). Accordingly, higher measured accessibility does not necessarily imply equitable or substantively comparable open space provision across communities.

Discussion

This study offers new empirical evidence on how metropolitan governance structure shapes the amount, configuration, and accessibility of open space. Our findings reveal a nuanced pattern. Greater municipal fragmentation is positively associated with the provision of small and medium-sized local open spaces and with higher measured accessibility (population within a 10-min walk), yet it is negatively associated with large local open spaces; with 10 acres serving as the general threshold. These results suggest that fragmentation may stimulate the localized provision of visible, neighborhood-scale amenities, while simultaneously inhibiting the coordinated acquisition and preservation of larger, regionally significant landscapes. This has both theoretical and practical implications.

The findings both support key tenets of public choice theory. The positive association between fragmentation and smaller parks or accessibility aligns with Tiebout's (1956) model and Fischel's (2001) homevoter hypothesis. In fragmented metropolitan regions, homeowners may indeed "vote with their feet," sorting into jurisdictions that provide desirable amenity bundles, including proximate open space. Local officials, responding to median voter preferences and property value incentives, may supply highly visible, neighborhood-scale open spaces that enhance residential desirability. The positive relationship between homeownership and mid-sized open spaces

reinforces this interpretation. In this sense, the evidence lends support to metropolitan governance and regionalist critiques of public choice theory. Fragmented systems may be effective at supplying club-like, localized amenities but less capable of delivering metropolitan-scale environmental goods.

For planners and policymakers, these findings imply that relying solely on municipal competition to produce equitable open space systems may be insufficient. Instead, institutional mechanisms that encourage regional coordination, such as metropolitan park districts, interlocal agreements, dedicated regional funding streams, or state-level conservation mandates, may be necessary to overcome collective action problems. Moreover, accessibility gains associated with fragmentation appear conditioned by income, property tax base, and homeownership rates. This raises equity concerns: without redistributive mechanisms or regional standards, fragmented systems may reproduce amenity advantages in wealthier jurisdictions while leaving lower-income areas underserved. It is worth noting that other countries have adopted more institutionalized and vertically integrated frameworks for open-space preservation and planning, in which regional authorities exercise oversight and local land-use decisions are required to align with regional planning objectives (Schmidt and Buehler 2007). Such arrangements offer potentially instructive models for improving the coordination and long-term stewardship of open-space systems.

Moreover, the accessibility findings should not be interpreted as evidence of distributive equity. Because our measure captures proximity rather than quality, it cannot assess whether fragmented systems produce comparable experiences or environmental benefits across socioeconomic groups. The consistent positive relationship between income-related variables and open space provision suggests that fiscal capacity remains a powerful determinant of amenity distribution. Without metropolitan intervention, fragmentation risks reinforcing existing spatial inequalities.

These findings underscore the importance of institutional design and suggest that metropolitan open space systems are deeply shaped by institutional arrangements. Future research should extend this analysis in several directions. First, incorporating measures of open space quality, programming, and maintenance would provide a more complete picture of equity. Second, longitudinal analysis could clarify dynamic relationships between fragmentation and park provision over time. Third, examining metropolitan areas with formal regional park authorities or consolidated governments could illuminate how alternative governance structures influence spatial outcomes.

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Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Notes

1. The ParkServe open spaces product covers census-defined urban areas, and incorporate places, census-designed places, and minor civil divisions that intersect with the census-defined urban areas.
2. 12 MSAs with missing values because they had no railroads in 1893 are filled in using railroad density (miles per 1,000 km^2) from 1912.

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Appendices

Table A1. Descriptive Statistics of Variables. the Number of Observations N = 293. The Area of Open Spaces is Measured in Acres.

Variables	Mean	SD	Median	Min	Max
Open spaces variables:					
total open spaces area	13320.96	52740.98	2806.83	90.89	834477.81
small open spaces area	88.88	190.99	33.85	1.1	2067.13
medium open spaces area	537.07	1014.41	215.55	11.33	8343.58
large open spaces area	12758.5	52246	2435.57	52.83	831870.88
open spaces area per 10k residents	163.61	194.74	115.12	11.38	1800.06
small open spaces area per 10k residents	1.52	1.09	1.19	.09	7.17
medium open spaces area per 10k residents	9.42	5.22	8.15	1.15	30.79
large open spaces area per 10k residents	153.12	193.25	105.29	5.98	1794.44
pop share within 10 min open spaces	.49	.19	0.48	.05	.94
Variables of interest: government fragmentation					
Local govt 1	.48	.37	0.40	.03	2.44
Local govt 2	.58	.49	0.45	.03	3.93
General purpose govt	.59	.5	0.46	.03	3.93
Control variables					
median property tax	2942.76	1639.23	2616.21	591	9887.8
median building age	47.56	11.45	46.17	26.35	78.25
pop density	2156.1	926.69	1925.86	765.63	6815.95
	.11	.1	0.08	0.02	.63

(continued)

Table A1. Continued.

Variables	Mean	SD	Median	Min	Max
percent urbanized area					
median family income	91036.71	18460.09	87614.0	58241.28	182340.04
urban population	739806.3	1764820.4	233963.0	21175	19648592
homeownership rate	56.08	6.43	56.80	29.26	72.17

Table A2. OLS Regression Models to Show the Relationship Between Total Open Space Area (ln) and Government Fragmentation (ln) (Local Govt 1).

Dependent Variable: Total open space area (ln)	(1) All	(2) Small	(3) Medium	(4) Large
Local govt 1 (ln)	−.1833**	.1393**	.1005**	−.2186**
	(.0931)	(.067)	(.0481)	(.1007)
Control variables	Y	Y	Y	Y
Observations	292	288	292	292
R-squared	.7769	.7820	.8753	.7535

Robust standard errors are in parentheses.
*** p < .01, ** p < .05, * p < .1.

Table A3. OLS Regression Models to Show the Relationship Between Open Space Area per 10k People (ln) and Government Fragmentation (ln) (Local Govt 1).

Dependent Variable: Local open space area per 10,000 people (ln)	(1) All parks	(2) Small parks	(3) Medium parks	(4) Large parks
Local govt 1 (ln)	−.1745*	.1542**	.1197**	−.1883*
	(.0933)	(.0706)	(.0479)	(.0976)
Control variables	Y	Y	Y	Y
Observations	292	288	292	292
R-squared	.2243	.2646	.3731	.223

Robust standard errors are in parentheses.
*** p < .01, ** p < .05, * p < .1.

Table A4. OLS Regression Models to Show Relationship Between Open Spaces Accessibility (Measured as Population Share Within 10 min Walking of Open Spaces).

Dependent Variable: open spaces accessibility (ln).	(1) Local Govt 1	(2) Local Govt 2	(3) General Purpose Govt
Local Govt 1 (ln)	.0416*		
	(.0251)		
Local Govt 2 (ln)		.0534*	
		(.0291)	
General Purpose Govt (ln)			.062**
			(.027)
Control variables	Y	Y	Y
Observations	291	291	262
R-squared	.6813	.682	.699

Robust standard errors are in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.