Does "Smart Growth" Matter to Public Finance?

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U.S. Department of Housing and Urban Development Working Paper # REP 06-02; submitted in final form to *Urban Studies*, June 2007

Previous versions of this paper and related research were presented at the 2005 meetings of the North American Regional Science Council in Las Vegas, Nevada; a session of the Fall, 2006 Urban Studies and Planning Seminar Series at the University of Maryland; and the 2007 meetings of the Western Regional Science Association, in Newport Beach, California. Special thanks to Marlon Boarnet, Randy Crane, Bernard Fingleton, Regina Gray, Derek Hyra, Gerrit Knaap, Gordon Mulligan, Darla Munroe, Chris Nelson, Rolf Pendall, Tom Sanchez, Alberto Solé-Ollé, and three anonymous referees for their helpful comments and suggestions and to Justin Fazzari and Farris Shuggi for their invaluable research assistance.

Abstract. This paper addresses four fundamental questions about the relationship between "smart growth," a fiscally motivated anti-sprawl policy movement, and public finance: Do low-density, spatially extensive land use patterns cost more to support? If so, how large of an influence does sprawl actually have? How does the influence differ among types of spending? And, how does it compare to the influence of other relevant factors? The analysis, which is based on the entire continental United States and uses a series of spatial econometric models to evaluate one aggregate (total direct) and nine disaggregate (education, fire protection, housing and community development, libraries, parks and recreation, police protection, roadways, sewerage, and solid waste disposal) measures of spending, provides the most detailed evidence to date of how sprawl affects the vast sum of revenue that local governments spend every year.

1. Introduction

During the 2002 fiscal year, the 87,576 local governments in the United States—counting all counties, boroughs, municipalities, townships, school districts, and special districts—channeled over $1.14 trillion toward the provision of public services. Of this amount, 38.72% ($441.43 billion) was spent on education services, 11.15% ($127.07 billion) was spent on social services and income maintenance, 9.22% ($105.15 billion) was spent on environmental services and housing, 9.05% ($103.21 billion) was spent on public safety, 5.64% ($64.32 billion) was spent on transportation services, 4.66% ($53.11 billion) was spent on administrative services, and 3.85% ($43.88 billion) was spent paying interest on debt; the remaining 17.71% ($201.92 billion) was spent on utilities, insurance trusts, and other miscellaneous activities and operating costs (Census of Governments 2005). As shown in Table 1, which lists 2002 population, gross state product, and expenditure patterns by state, across all categories, local governments spent a combined national average of $3,959 per capita, a value that, in total, represents 10.95% of the gross domestic product.

Although many factors influence the allocation, distribution, and volume of this spending, there is a growing conviction among urban and regional policymakers that the character of the built environment is one of them. Specifically, the kind of low-density, spatially extensive pattern of growth commonly characterized as "sprawl" (Bruegmann 2005) is thought to raise the cost of public services because it fails to capitalize on economies of scale and/or optimize on facility location. On the other hand, more compact modes of development are believed to reduce costs by concentrating residents together and creating locational efficiencies in access and delivery. The thinking is that, because public finance ultimately plays out across geographic space, the dimensions of the development it supports matter in substantive ways.

Based on this reasoning, advocates of "smart growth," a movement that seeks a holistic rethinking of the contemporary approach to land use planning, have advanced policy frameworks that, among other things, specifically emphasize the importance of fiscal health (DeGrove 2005). For example, the State of Maryland's (1998) *Smart Growth and Neighborhood Conservation Act* establishes "priority funding areas," or specific districts where development is supported via public investment in capital facilities and other needs. Similarly, more established state land use planning mandates in Florida, Oregon, Washington, and elsewhere promote contiguity of growth and concurrency, which requires capacity in necessary infrastructure and services to be in place before development can proceed (see Knaap et al. 2001). What makes the present push for smart growth so striking is that it and its fiscally motivated anti-sprawl policies have been enjoined by states as diverse as Arizona, Maine, Michigan, and Tennessee (Gray 2005). The movement has also gathered broad-based support at the local level, and, perhaps for that reason, it has produced remarkably consistent land use patterns in communities across the country (Song 2005). In short, on the promise of limiting sprawl and its financial discontents, smart growth has rapidly swept the United States and brought about far-reaching changes in the way that state and local governments plan for development.

But, beyond this political and on-the-ground progress loom difficult questions about the veracity of connections between the built environment and the cost of public services. In particular, there is little empirical evidence that sprawl is more expensive to support and, in fact, research on the issue has produced conflicting results. Moreover, there is no reason to believe that the relationship, if any, applies to all types of expenditures in the same way—it may be, for example, that the influence of the built environment cuts in both directions, raising some costs and lowering others depending on the nature of the service in question. Do low-density, spatially extensive land use patterns cost more to support? If so, how large of an influence does sprawl actually have? How does the influence differ among types of spending? And, finally, how does it compare to the influence of other relevant factors? The answers to these questions are key to understanding how well the anti-sprawl policies of smart growth line up with its objective of promoting fiscal health.[1]

2. Background Discussion

2.1 Measuring and Explaining Sprawl

Sprawl is defined here as the kind of low-density, spatially extensive pattern of development that has become prevalent throughout the United States over the course of the last 50 years (Fulton et al. 2001; Glaeser and Kahn 2004; Bruegmann 2005; Úlfarsson and Carruthers 2006). The best way—and, at present, virtually the only way—to measure the reach and pace of sprawl nationally is via the USDA's (2001) National Resources Inventory (NRI), which provides estimates of the amount of land in major land use categories at the county level for the years 1982, 1987, 1992, and 1997. A limitation of the NRI is that, at high resolution, it is known to have a wide enough margin of error that reported values for, say, the amount of developed land in a given county, may

[1] Note here that public finance is only one of several core concerns of smart growth, which, in fact, has a very broad quality-of-life orientation. For example, the *Smart Growth Network* describes the movement as being motivated by "…a growing concern that current development patterns—dominated by what some call "sprawl"—are no longer in the long-term interest of our cities, existing suburbs, small towns, rural communities, or wilderness areas. Though supportive of growth, communities are questioning the economic costs of abandoning infrastructure in the city, only to rebuild it further out. Spurring the smart growth movement are demographic shifts, a strong environmental ethic, increased fiscal concerns, and more nuanced views of growth." See: *www.smartgrowth.org/about/default.asp?res=1280*.

be imprecise. As a result, the data is not reliable enough to know with certainty that there are "exactly *x* number of acres of developed land in county *i*," so some of its documentation cautions against using it at that level. Because this limitation is sometimes viewed as an issue (Burchfield et al. 2006), it is important to be clear that the warning is there mainly to comply with data reporting requirements set forth by the Office of Management and Budget, which is responsible for the quality of information collected and disseminated by the federal government.[2] All of that said, the NRI does an excellent job of capturing how development patterns vary cross-sectionally and longitudinally or, in other words, how land use in county *i* differs from land use in county *j* and how land use in county *i* has changed between two or more points in time, *t*. Used in this way, the data measures land use representatively, even if individual data points are imprecise in some cases.

To demonstrate the validity of using the NRI for cross-sectional analysis, Figures 1 and 2 compare its (1997) measure of developed land area to the Census Bureau's (2000) measure of urbanized land area[3] in all counties located in the continental United States. Specifically, Figure 1 is a scatter plot that registers acres of developed land on the *x*-axis and acres of urbanized land on the *y*-axis and Figure 2 is a histogram of the absolute value of the difference between the two as a percentage of total county land area.[4] Both charts reveal a high degree of correspondence between the two estimates of land use: The trend line fit to the scatter plot has an R^2 of 0.91 and the histogram indicates that, in 80% of the sample, the difference is a value that ranges between just one and five percent of total county land area. Together, Figures 1 and 2 indicate that the NRI data provides a good overall representation of how development patterns vary across the country, at least with respect to another commonly used measure of land use.

Since this comparison is admittedly rather coarse, it is reassuring that other researchers have come to similar conclusions about the ability of the NRI to representatively measure land use. For example, a recent comparison by Irwin and Bockstael (2006) finds that the NRI lines up exceptionally well with land cover data derived from multispectral satellite imagery. The analysis

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[2] The authors have discussed this directly with NRI staff and the reason for the cautionary statement is that the data has statistical properties that require a level of analytical expertise above-and-beyond that of the public at large in order to use and interpret it properly. A statement by OMB on federal data reporting requirements is available online, in the *Federal Register*: *http://www.whitehouse.gov/omb/fedreg/2006/092206_stat_surveys.pdf.*

[3] The Census Bureau categorizes every census block in the country that has an average population density of 1,000 people per square mile, or about 1.5 people per acre, as urban, so summing the area of these blocks by county yields an estimate of the spatial extent of the built-up area within each county. Note that this measure is based on average population density, not actual land use, and some counties register no urbanized land area at all—in these instances, the NRI's measure of developed land area is correspondingly very small.

[4] The histogram is of the values resulting from this calculation: |developed land area – urbanized land area| / total county land area. Note that there are nine counties that do not appear on the histogram because these outliers stretch the figure out too far to be easily readable; in these cases, the differences are 21%, 23%, 25% (× 2), 29% (× 2), 36%, 38%, and 93%.

involves data for just the State of Maryland and uses somewhat larger (multi-county) areas than are of interest here, but the two measures are nearly identical and their close relationship apparently holds across the size-of-place hierarchy, because there is little difference among urban, suburban, exurban, and rural groupings of counties. So, although imperfect, the NRI is consistent with alternative data sources and it remains virtually the only one presently available for comparing land use patterns across the country as a whole.

Returning now to the matter at hand, Figures 3 and 4 illustrate the reach and pace of sprawl in the United States during recent years. Figure 3, which maps changes in aggregate density, measured as the number of people plus jobs per acre of developed land, shows that only about a fifth of all counties (691 out of 3,075) grew more dense between 1982 and 1997. Meanwhile, Figure 4, which maps the proportion of land absorption that took place during the last five years of the whole 15-year timeframe,[5] shows that the trend toward sprawl appears to have accelerated: In nearly half of all counties (1,285 out of 3,075) more than 50% of the overall change in developed land occurred between 1992 and 1997. If the trend were more-or-less constant, the pattern shown on the map would not emerge because the 5-year rate of land absorption would instead be closer to 33%.

The nation's land use has evolved in this way mostly because of population growth combined with rising incomes and falling commuting costs—an early cross-sectional analysis of sprawl found that these basic factors explain nearly 80% of variation in the spatial extent of regions' urbanized land area (Brueckner and Fansler 1983)—but other, more nuanced factors also play a role. In particular, three market failures, the failure of development to internalize (1) the benefits of open space, (2) the social costs of traffic congestion, and (3) the cost of the services that it requires, contribute to a sub-optimal pattern of land use (Brueckner 2000). While each of these is important to understanding sprawl, the third is central to the present analysis because, as a corollary, it suggests that growth would be more dense if it had to pay the full cost of the services needed to support it. In fact, both theoretical (Brueckner 1997; McFarlane 1999) and empirical (Pendall 1999) analyses show that impact fees, which attempt to correct for this problem, promote compact development. So, even though sprawl is largely explained by basic human ecology, it is also fueled by more complicated market failures, at least one of which is linked to public finance. Either way, if the connections between the built environment and the cost of public services are as substantial as many policymakers judge them to be, the trend documented in Figures 3 and 4 suggests that the consequences of sprawl may indeed be quite large.

[5] This figure is calculated as the ratio of the change in developed land area during the last five years and the change in developed land area during the entire time period, or $\Delta_{1992-1997} / \Delta_{1982-1997}$.

2.1 Smart Growth as a Policy Response

Acting on public finance oriented (among other) concerns, a number of states have adopted legislation aimed at limiting sprawl (Carruthers 2002). This began with what is often described as the "first wave" of state land use legislation that evolved out of the environmental movement of the 1960s and 1970s. At the time, the main objective was to create mechanisms for overseeing local decision-making processes, particularly with respect to the conversion of farmland and "developments of regional impact," such as major capital facilities and shopping centers. During the 1980s, the "second wave" of state land use legislation popularized the concept of "growth management," an approach to land use planning that emphasizes the need to accommodate, rather than limit, development through a coordinated effort among local governments. It was during this period that the nationwide conversation first began to shift toward identifying the policy-relevant problems of sprawl and developing specific mechanisms, like concurrency, for addressing them in ways other than restricting growth outright. Finally, the "third wave" of state land use legislation, which emerged in the 1990s, brought "smart growth," with its holistic orientation toward quality of life, to the forefront of urban and regional policy. These frameworks often cast local, rather than state, governments as the agents of land use reform and almost unilaterally cite environmental and/or fiscal motivations for confronting sprawl. The practical appeal of smart growth combined with its on-the-ground success has given it considerable political traction: As of 2005, legislation had been adopted by 20 states[6] and many other initiatives have been implemented independently at the local level (see DeGrove 1984, 1992, 2005 for a complete accounting of the history summarized here).

As opposed to sprawl, the benefits of smart growth for public finance are believed to be at least twofold (Knaap and Nelson 1992). First, advocates often argue that, for many public services, the cost per unit—that is, per person or household—of output is higher for low-density development because it fails to capitalize on economies of scale, which are achieved by concentrating users together. Second, spatially extensive development, whatever the density, is accused of making it difficult to optimize on facility location, especially if it happens in a noncontiguous way. Simply put, the reasoning is that sprawl is inefficient because, other things being equal, the cost of public services is negatively influenced by density and positively influenced by the spatial extent of developed land.

[6] Arizona, Colorado, Connecticut, Delaware, Florida, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, Oregon, Pennsylvania, Rhode Island, Tennessee, Utah, Washington, and Wisconsin (Gray 2005).

The rejoinder for years has been that the “harshness” of high-density, compact built environments acts as a countervailing force that, after a point, overrides any financial efficiency they may achieve (Ladd 1998). Central cities, for example, often require large amounts of public investment for things like police protection and roadway maintenance due to their social complexity and economic primacy, which affect how intensively services are used. The reasoning here is that, like other commodities, public services are subject to both economies and diseconomies of scale, with the latter being a consequence of the kind of congestion, disorder, social pathologies, and other problems found in many densely populated areas. However, it is too rarely pointed out that the connection to the built environment in-and-of-itself may not be as strong as it has been made out to be—a paper by Gordon and Richardson (1997) is a good example—because the perspective seems, at times, to conflate the influence of land use with problems that have more to do with the deterioration and strife experienced by many aged, built-up areas of the country. From this line of reasoning, it follows that high-density, compact development patterns may well be less expensive to support and that the “harshness” of these environments is a different issue that must be dealt with separately.

The few empirical analyses of the relationship between the built environment and the cost of public services have, over time, produced results that are consistent with both of the perspectives just described. Research on the first dimension of sprawl, the density of developed land, essentially began with the Real Estate Research Corporation’s (RERC 1974) much-maligned *Costs of Sprawl*. The study finds that low-density development is as much as twice as expensive to support as high-density development, but it has been extensively criticized for, among other things, its failure to control for other relevant factors (Altshuler and Goméz-Ibáñez 1993). Since then, refinements on the approach have mainly continued to find that low-density land use patterns are more expensive to support, but, unfortunately, most produce few generalizable conclusions due to their site-specific focus (see Frank 1989 and Burchell 1998 for reviews and Spier and Stephenson 2002 for an example). Meanwhile, public finance oriented work by Ladd and Yinger (1991) and Ladd (1992, 1994) finds a u-shaped relationship between the number of people per square mile of county land area and per capita spending and, so, concludes that high-density areas are ultimately more, not less, expensive to support. Last, a study of land use patterns by Carruthers and Úlfarsson (2003) finds evidence that density does lower the cost of many services; the analysis measures density via developed land area, not county land area, but it is primarily a hypothesis testing exercise, so it stops short of attempting to measure the magnitude of the relationship between sprawl and public finance in a detailed way.

Research on the second dimension of sprawl, the spatial extent of developed land, emanates from Lösch-style (1954) locational analysis, where the problem is to optimize on the placement of centralized facilities (see Thisse and Zoller 1983). This has traditionally been done on the basis of accessibility and coverage but other criteria, such as equity—which is accepted by many planners as a normative benchmark of urban form (Lynch 1981)—can also be used (Mulligan 1991, 2000; Farhan and Murray 2006). In the present context, the spatial extent of developed land matters in terms of the number and size of facilities needed to serve a given population, plus in terms of the span of the infrastructure needed to support day-to-day activities and deliver services effectively. But, even though capital improvements planning is central to land use planning (Kaiser et al. 1995), very little work has been done to identify how the spatial extent of developed land affects public finance; instead, this dimension of sprawl is usually just treated as implicit in density. A notable exception is a study by Hopkins et al. (2004), which finds that carefully planned development can save revenue by relying on fewer and larger facilities. The analysis by Carruthers and Úlfarsson (2003) also finds evidence that the spatial extent of developed land increases the cost of many public services but, as with density, no attempt is made to measure the size of the influence. In sum, even though locational analysis has long been used for facilities planning, relatively little is known about how the horizontal dimension of sprawl affects public finance.

3. Empirical Analysis

3.1 Modeling Framework

The point of departure for the empirical analysis is a so-called "spillover model" that results from strategic interaction among local governments (Brueckner 1998, 2003):

$$e_i = R(e_j, X_i), \qquad (1)$$

where per capita expenditure on public services in jurisdiction i, e_i, depends on per capita expenditure on public services in surrounding jurisdictions j, e_j, plus a vector of local characteristics, X_i. R is described as a "reaction function," (Brueckner 2003, page 177) because it results from jurisdiction i's calculated response to the spending of proximate jurisdictions. Although spillovers can take different forms—for example, due to competition, emulation, and/or other kinds of government behavior—they are treated as a composite here because the focus is squarely on sprawl as a cost factor.

The relationship in equation (1) can be estimated with a spatial lag model (Anselin 1988, 2002), expressed as:

$$e_i = \beta \sum_{j \neq i} \omega_{ij} e_j + X_i \Gamma + \upsilon_i \,. \quad (2)$$

In this equation, ω_{ij}, $\forall\, j \neq i$, represents a set of spatial weights that aggregate public spending by jurisdictions near to i into a single composite variable; β represents an estimable parameter that describes how per capita expenditure in jurisdiction i is influenced by per capita expenditure in nearby jurisdictions; Γ represents a vector of estimable parameters; and υ_i represents an unobserved, stochastic error term. This modeling framework was originally applied by Case et al. (1993) in a behavioral analysis of state-level spending and is often used in public finance oriented research (see Revelli 2005 for a recent review). Overall, the results of this work show that, because it plays out across geographic space, public finance is subject to systematic spatial dependence.

The present analysis applies the modeling framework just described to examine per capita expenditure on public services, e, by local governments (including state and federal government transfers) at the regional level by using counties as the spatial units, i and j. This adaptation, which is similar to work done by Kelejian and Robinson (1992, 1993), means that each observation generally contains multiple jurisdictions—including the county itself, plus municipalities, school districts, special districts, and, potentially, others—so the spillovers that the analysis captures are really the net of interaction among many entities at multiple tiers of government. It is for this reason that the effect is simply labeled a "composite spillover" and no attempt is made to understand the specific nature of the mechanism/s involved.[7] Even so, the strategic interaction framework is adopted for both theoretical and empirical reasons: First, to recognize the presence of an underlying behavioral model of public finance and second, to avoid an econometric misspecification that does not account for the spatial dependence introduced by various forms of strategic interaction.

Moving on, in addition to the spatially lagged dependent variable, equations (1) and (2) contain a vector, X_i, representing relevant explanatory variables. The specification of the empirical model originates from early work done by Bergstrom and Goodman (1973) and Borcherding and Deacon (1972) and the choice of specific variables is based directly on more recent work done by Ladd and Yinger (1991), Ladd (1992, 1994), Carruthers and Úlfarsson (2003), Solé-Ollé (2005), and Solé-Ollé and Bosch (2005). Although the specification does not match any of these identically—due to data availability, the different purposes of the analyses, and so on—care was taken to ensure it corresponds to the extent possible. In particular, five

[7] Identifying different types of spillovers and their behavioral mechanisms is a complicated venture in-and-of-itself: See, for example, Esteller-Moré and Solé-Ollé (2001), Revelli (2001, 2002, 2003), Bordignon et al. (2003), Lundberg (2006), and Solé-Ollé (2006).

categories of factors, pertaining to the cost of and demand for public services, are hypothesized to influence per capita spending: *Built Environment, Political Structure, Growth and Demographics, Sources of Revenue*, and *Size and Primacy*. The first category is measured via the density of developed land, the percentage of county land area that is developed, the median housing value, and the percentage of housing built before 1940; the second category is measured via the per capita number of municipalities and the per capita number of special districts; the third category is measured via the rate of population change, per capita income, the percentage of the population that is white, the percentage of the population that is less than five years old, and the average household size; the fourth category is measured via the percentage of tax revenue that comes from property taxes, per capita federal revenue, per capita state revenue, and per capita long-term debt; and, last, the fifth category is measured via county land area, the ratio of employment to population, and the average government wage, plus dummy variables for metropolitan and micropolitan counties.

Like the specifications used in other research, this specification is oriented around variables measuring the cost of and demand for local government spending. The key cost factors in the model are: The average government wage, a measure of input costs, and the ratio of employment to population, which measures competition in the job market and, also, how intensively services are used by people who may be nonresidents. Other variables measuring costs include what Ladd (1992, page 278) calls "environmental cost factors," such as the density of developed land and the percentage of county land area that is developed, which describe sprawl, the object of this analysis. (Note here that total county land area is held constant, so the percentage of county land area that is developed measures the spatial extent of development or, in other words, the horizontal dimension of sprawl.) The key demand factors in the model are: Per capita income, a fundamental measure of demand, the median housing value, a measure of the median voter's stake in the outcome of public spending (Fischel 2001), and the percentage of tax revenue that comes from property taxes, which measures the tax price for residents, albeit somewhat roughly because other taxes are also paid. Additional variables measuring demand include factors that relate to the preferences of the population, such as the relative number of young children, and the availability of resources, such as intergovernmental revenue and public indebtedness. Across the board, factors that raise costs and demand, like high government wages and high per capita incomes, are expected to positively influence spending while factors that lower them, like weak employment markets and high tax prices, are expected to negatively influence spending.

Given the principles of smart growth, it is expected that sprawl raises the cost of public services because it fails to capitalize on economies of scale and/or optimize on facility location. If this is the case, other things being equal, per capita spending will be negatively influenced by density and positively influenced by the percentage of county land area that is developed. The two fragmentation variables, per capita municipalities and per capita special districts, are included to control for the political geography of local government finance; generally speaking, if the Tiebout hypothesis (1956) is correct, greater fragmentation will lower per capita spending by way of intergovernmental competition. Finally, there is every reason to suspect upfront, as many residents do, that the rate of population growth negatively influences per capita spending because the existing population almost always finances new development (Ladd 1994). This fear, justified or not, is precisely what led to the widespread adoption of local growth controls during the 1970s and 1980s (Glickfield and Levine 1992).

3.2 Data and Econometric Specification

The empirical model is used to analyze per capita expenditure by local governments in all 3,075 counties[8] of the continental United States during the 2002 fiscal year (Census of Governments 2005). The geographic scope of the analysis is shown in Figure 5, a map of per capita total direct spending by county. Inspection of the figure quickly reveals two major patterns: Expenditures are clustered by both state and region, including, in the latter case, in a way that spills across state lines. The first pattern suggests that fixed effects should be added to an empirical specification of equation (2) in order to account for unobserved factors common to all counties located within the same state; it also suggests that the model should be estimated in a manner that deals with heteroskedasticity introduced by variation in unobservable characteristics relevant to that level. Even more important, the second pattern reinforces the choice of modeling frameworks because spatial relationships that are not confined by state boundaries are clearly visible, even to the naked eye. As already mentioned, failing to account for this pattern of spatial dependence would produce a misspecified model and, ultimately, biased and inefficient estimates of Γ (Anselin 1992).

The modeling framework described in the preceding section is applied identically (for the sake of comparability) to one aggregate and nine disaggregate measures of public spending: Total direct expenditure, education, fire protection, housing and community development, libraries,

[8] The actual number of county equivalents is slightly greater, due to a number of independent cities such as Baltimore, Maryland St. Louis, Missouri, and cities throughout Virginia. These were integrated with appropriate counties when the data was compiled because some data—from the BEA's Regional Economic Information System, for example—is not available at that level, but the entire surface of the continental United States is still represented in the data set.

parks and recreation, police protection, roadways, sewerage, and solid waste management. A description of each measure of spending, taken from the survey form that the Census of Governments uses to collect the data, is provided in Table 2. Table 3 lists the source, units of measurement, and descriptive statistics for all of the continuous variables involved in the analysis; zero values were excluded from the calculations for certain measures of spending because counties where none occurred end up getting dropped in the estimation process. Note that all explanatory variables except for the spatially lagged dependent variable are lagged in time to 1997; this was done in part because the NRI data, which is used for the two measures of sprawl, is available only up until that year. The time lag also makes good practical sense given how the public planning process works, because there is usually a long delay between when expenditure decisions are made and when they are carried out. In order to be consistent, 1997 values of variables collected from decennial census data were estimated by using a time-weighted average of 1990 and 2000 values.

Applying this dataset to equation (2) results in the following structural model of per capita local government expenditure, written in matrix form:

$$e_s^* = \beta_s We_s^* + \Phi_s + X\Gamma_s + \upsilon_s. \tag{3}$$

Here, all notation is the same as above, except that e^* indicates that per capita public expenditure is in natural log form (Carruthers and Úlfarsson 2003) and so is its spatial lag, We^*; s denotes each of the ten measures of public spending; Φ represents a vector of state fixed effects, including one for Washington, DC; and W is a 3,075 × 3,075 ($n \times n$) row-standardized weights matrix that describes the spatial connectivity of the data set. The weights matrix was created using the center of each county's population—that is, a point, calculated using census tract-level data, identifying where people are concentrated rather than the geographic center—to identify neighbors. In the scheme, each county i is related to all counties j having population centers located within 50 miles of its own population center or, in the 65 cases where the distance is greater than 50 miles, to a single nearest neighbor. The connectivity of the resulting spatial weights matrix is illustrated in Figure 6.

Last, the behavioral underpinning of the model says that proximate counties are influenced by each other, so We is endogenous to e, and equation (3) cannot be properly estimated using ordinary least squares (OLS). That is, because per capita spending in county i depends on per capita spending in counties j and the other way around, there is a "chicken-or-egg" problem that must be resolved by choosing an appropriate estimator. The approach used here is a spatial two-stage least squares (S2SLS) strategy developed by Kelejian and Prucha

(1998), which involves first regressing We_s on X and WX, the spatial lag of X, to produce predicted values of the endogenous variable and then using the predicted values, $\hat{W}e_s$, in place of the actual values in equation (3). The only shortcoming of this strategy is that the exogenous variables, X and WX, are not always good predictors of We_s, so, as a precautionary step, an additional instrument derived from the "three group method"—wherein the instrument is assigned a negative one, zero, or one depending on whether the value of the original variable, We_s, is in the bottom, middle, or top third of its ordinal ranking (Kennedy 2003)—is included in the first stage regression (see, for example, Fingleton and López-Bazo 2003; Fingleton 2005; Fingleton et al. 2005). Like the alternative, maximum likelihood (ML) estimation, this strategy yields efficient, unbiased parameter estimates, even in the presence of spatial error dependence (Das et al. 2003). Recent examples of other work in the area of public finance that use this estimator as opposed to, or along with, an ML estimator include Esteller-Moré and Solé-Ollé (2001), Revelli (2002, 2003), Baicker (2005), and Solé-Ollé (2006).[9]

3.3 Estimation Results

The S2SLS estimation results for the various structural models are shown in Tables 4 – 7; to better illuminate the spatial component of the analysis, the first of these, the table for total direct spending, also includes results for a model estimated via OLS without the spatial lag. Nearly all of the parameter estimates are statistically significant and the adjusted R^2 values, which range from a low of 0.25 (for the housing and community development equation) to a high of 0.68 (for the roadways equation), show that the models do a good job of explaining how per capita spending varies across the United States, especially given that they were not specifically tailored to the individual types of services. As already noted, the number of observations differs from model-to-model because counties where no spending took place during the 2002 fiscal year were dropped in the estimation process. In addition to the parameter estimates and the values of their corresponding *t*-statistics, the tables list elasticities, η_k, which were calculated for each of the continuous explanatory variables at the mean values of the regressors using the appropriate set of counties—that is, the calculations were made after accounting for dropped observations, so they reflect only those that were actually included in the individual models. The elasticities are considered in detail in the next section, which applies the findings of the empirical analysis to address each of the four policy questions that were posed in the introduction. For now, working

[9] In practice, all of the spatial variables, We_s and WX were calculated in *GeoDa*, a program designed for spatial analysis and computation (Anselin 2003; Anselin et al. 2006), then imported into *EViews*, an econometrics program, with the rest of the data, e_s and X, where the two-stage least squares (2SLS) regressions were run using panel settings to identify the states as cross-sections for fixed effects and as clusters for White-adjusted standard errors.

down though the list of explanatory variables, the following paragraphs summarize the estimation results in a general way.

To begin with, the spatially lagged dependent variables, We_s, register positive and highly significant spillover effects in all of the equations. The mediating influence of the strategic interaction is illustrated in Table 4, which includes OLS estimates alongside the S2SLS estimates. Adding the spatial lag to the model and re-estimating it with the appropriate technique lowers the value of most of the parameter estimates, sometimes by a wide margin. For example, compared to the OLS estimates, the S2SLS estimates of the parameters on the two variables measuring sprawl, the density of developed land and the percentage of county land area that is developed, are 15.97% and 5.15% smaller, respectively; on average, the absolute value of the difference in the parameters from the first regression to the second is 10.17%. Because the dependent variables and their spatial lags are both in log form, the parameters on the spatial lags are interpreted as elasticities, so a 1% change, whether positive or negative, in per capita total direct spending in the surrounding region produces a localized ~0.20% change in total direct spending. Of course, the size of this effect varies substantially among the nine disaggregate measures of spending: The elasticity on the spatial lag of per capita spending on police protection (0.3767) is by far the largest and the elasticity on the spatial lag of per capita spending on education (0.1119) is the smallest. Taken as a group, these estimates show that local governments engage in exactly the kind of strategic interaction that motivates the modeling framework, and, just as importantly, that the resulting pattern of spatial dependence in public finance persists even after accounting for the kind of state-level correlation absorbed by the fixed effects.

Next, in the *Built Environment* category, the parameter on the density of developed land, the first measure of sprawl, carries a negative sign and is statistically significant in the total direct, education, parks and recreation, police protection, and roadways models; it is negative and insignificant in all other cases, except for housing and community development where it is positive and highly significant. The parameter on the second measure of sprawl, the percentage of county land area that is developed (holding county land area constant), is positive and statistically significant in all cases except for housing and community development and solid waste management. Median housing value, a demand factor, and the percentage of housing built before 1940, an additional cost factor, also have a positive influence in most of the equations. The only equation where median housing value negatively influences spending is for housing and community development, a service that is mainly channeled to blighted areas in need of redevelopment and/or where people receive rental subsidies, such as assistance under the Section 8 voucher program (Pendall 2000). Meanwhile, aged development requires higher levels of spending for rehabilitation and maintenance of physical infrastructure like roadways and sewerage. As explained further below, the results from the two measures of sprawl yield clear evidence that smart growth, with its anti-sprawl policies, matters to public finance: The estimates consistently indicate that high-density, compact development costs less to support than low-density, spatially extensive development. More broadly, these findings represent a large step forward in urban and regional policy evaluation, because they are the most detailed measurements to date of the relationship between the built environment and public finance.

The remaining categories of control variables also reveal important relationships. First, in the *Political Structure* category, the two fragmentation variables, per capita municipalities and per capita special districts, supply little evidence that intergovernmental competition lowers the cost of public services. In fact, municipal fragmentation apparently increases per capita spending on education and roadways, possibly by exacerbating various locational inefficiencies; likewise, special districts, which have rapidly reshaped public finance over the past several decades (Foster 1997), appear to have a positive, rather than negative, influence. Second, in the *Growth and Demographics* category, the parameter on the rate of population change is almost always highly significant and negative; the parameter on per capita income is positive whenever significant; the parameter on the percentage of the population that is white is mostly significant, but its sign differs from equation-to-equation; the parameter on the percentage of the population that is less than five years old is mostly insignificant but is very large and positive in the education equation; and the average household size is negative and statistically significant in all but a few of the models. Overall, this category of explanatory variables indicates that rapid population growth negatively influences existing residents' share of spending and that, other things being equal, per capita spending is greater in regions with a high per capita income (at least for select services, like libraries and parks and recreation), a greater proportion of minorities, and younger, smaller families. Third, members of the *Sources of Revenue* category, which, with the exception of the percentage of tax revenue that comes from property taxes, nearly always have a positive influence when significant, provide insight how local governments finance their spending. In two cases, fire protection and parks and recreation, per capita state revenue carries the perverse (negative) sign and is statistically significant, but these may be spurious correlations—or, it may be that certain state funding comes with strings attached that end up causing communities to divert spending away from these particular services. The tax price is interesting because it positively influences per capita spending on education; although this variable, as a demand factor, is expected to carry a negative sign, the positive sign in this case makes at least tentative sense given the interdependency between school quality and property values (Fischel 2001). Fourth, in the

County Size and Primacy category, the parameters on the three cost factors, county land area, the ratio of employment to population, and the average government wage, are always positive when significant and the metropolitan and micropolitan dummy variables show how the different types of spending vary up and down the regional hierarchy. Finally, note that, in order to conserve space, all of the state fixed effects have been suppressed from the tables.

4. Policy Evaluation

The introduction to this paper posed four questions about the reasoning behind the kind of fiscally motivated, anti-sprawl policy frameworks that have swept the United States over the past several decades: Do low-density, spatially extensive land use patterns cost more to support? If so, how large of an influence does sprawl actually have? How does the influence differ among types of spending? And, how does it compare to the influence of other relevant factors? The answers to these questions, which are based on the findings of the empirical analysis, yield clear evidence that smart growth matters to public finance.

4.1 Do Low-density, Spatially Extensive Land Use Patterns Cost More to Support?

The estimation results listed in Tables 4 – 7 show that the density of developed land has a negative effect on five key measures of local government spending: Total direct, education, parks and recreation, police protection, and roadways. The four disaggregate measures are particularly important because, going in order, they are the first, second, sixth, and third largest of the nine types of spending considered here: On average, they account for 44.95%, 6.33%, 1.45%, and 3.76% of total direct spending. Further, if one-tailed hypothesis tests had been assumed—on the grounds that the direction of influence was anticipated in advance—density would have registered a negative effect on fire protection, libraries, and sewerage, too. Density carries the expected negative sign in the model for spending on solid waste management but it does not come close to being statistically significant, even assuming a more liberal one-tailed hypothesis test. The remaining case, housing and community development, which is positively influenced by density, is sensible, because of the higher cost of land acquisition and construction, among other things, in built-up areas. Next, the spatial extent of developed land, measured as the percentage of county land area that is developed while holding county land area constant, has a positive influence in all but two instances, where it does not approach statistical significance. In sum, the results for these two variables show that, other things being equal, the kind of low-density, spatially extensive development patterns that characterize sprawl cost more to support than the high-density, compact development patterns that the smart growth movement advocates.

4.2 How Large of an Influence Does Sprawl Actually Have?

The magnitude of sprawl's overall influence on public finance in the United States is estimated by applying the elasticities for density (η = –0.0136) and percent developed (η = 0.0246) from the total direct expenditure model to two alternative land use scenarios: The first assumes that all counties nationwide developed in a way that was 25% more compact (more dense and less expansively developed) than they are and the second assumes that all counties in the country developed in a way that was 50% more compact.[10] The dollar values associated with these changes are calculated by obtaining the product of: (1) the relevant elasticity, (2) the relevant percent difference, (3) per capita total direct spending during the 2002 fiscal year, and (4) county population. The first scenario suggests that, if the nation's land use patterns had somehow evolved differently, and development everywhere was 25% more dense, public services would cost, in net, $3.63 billion less annually; if it were that much less expansive, public services would cost $6.56 billion less annually. The second scenario suggests that, if development everywhere was 50% more dense, public services would cost $7.25 billion less annually; if it were that much less expansive, public services would cost $13.12 billion less annually. Capitalized at 5%—more-or-less the current long-term interest rate that most local governments are subject to—as an approximation of opportunity costs, the annual values from the two scenarios translate into $72.75 billion and $131.20 billion (25%) and $145.07 billion and $262.40 billion (50%).

Clearly, these numbers are artificial in that they assume a uniformly different outcome of growth throughout the entire country but they nonetheless give a general sense of just how large of an influence sprawl may have had on public finance. That said, the hypothetical savings, especially vis-à-vis the long-term (capitalized) opportunity costs, are nontrivial enough that some places may wish to identify how to better connect financial planning to land use planning: With a population of 88,000 and per capita total direct expenditures of about $3,200, the average county would annually save $1.18 million ($2.36 million) if it were 25% (50%) more dense and $2.13 million ($4.27 million) if it were that much less developed. Like before, capitalizing these values shows that the opportunity costs are large: $23.59 million ($47.18 million) and $42.67 million ($85.33 million) if development was 25% (50%) more compact. In an era of far reaching budget cuts and increased fiscal conservatism among the general public, these figures seem big enough to merit consideration.

[10] The average density of all counties in the country is 2.49 people plus jobs per acre of developed land, so, on average, these scenarios imply densities of 3.11 and 3.73 people plus jobs per acre of developed land, respectively; the average proportion of county land area that is developed 8% so, on average, these scenarios imply 6% and 4%, respectively.

4.3 How Does the Influence Differ Among Types of Spending?

The elasticities reported for the individual expenditures in Tables 5 – 7 show that the magnitude of sprawl's influence depends on the service in question. The density of developed land has the largest absolute effect on housing and community development (η = 0.1124); then on roadways (η = –0.0562); then on parks and recreation (η = –0.0362); then on education (η = –0.0345); and then on police protection (η = –0.0222). So, sprawl lowers the cost of the first of the services affected by density, likely because land and other inputs cost less, but raises the cost of the last four to a decreasing degree. The spatial extent of developed land, meanwhile, has the largest effect on parks and recreation (η = 0.1048); then on fire protection (η = 0.0872); then on sewerage (η = 0.0718); then on libraries (η = 0.0534); then on police protection (η = 0.0370); then on roadways (η = 0.0321); and then on education (η = 0.0128). In more qualitative terms, this dimension of sprawl has the largest influence on services having centralized facilities that may have to be replicated when they otherwise would not; a more moderate influence on linear infrastructure systems that connect to centralized facilities; and the smallest influence on facilities/services that receive heavy day-to-day use. As a set, the elasticities illustrate that there is wide variation in how public finance is affected by the underlying pattern of land use.

4.4 How Does the Influence of Sprawl Compare to the Influence of Other Relevant Factors?

Direct comparison of the various elasticities needs to be tempered by a recognition that they relate different types of explanatory variables, expressed in different units of measurement, to per capita spending. That said, the parameters are, by definition, unit-free metrics and so lend themselves to the kind of general comparison that is of interest here, as long as differences in the nature of what they describe are kept in mind. The column of elasticities listed for the spatial lag model of total direct expenditure in Table 4 shows that the influence of many factors, including the density of developed land (η = –0.0136) and the spatial extent of developed land (η = 0.0246), turns on the one-hundredths of a percent mark. Exceptions to this, where the relationships turn on the tenths of a percent mark, are the spatially lagged dependent variable (η = 0.2039), the percentage of the population that is less than five years old (η = 0.4065), the average household size (η = –0.7777), per capita state revenue (η = 0.1416), and the ratio of employment to population (η = 0.2836).

The larger an elasticity, the more responsive spending is to changes in the corresponding variable, so, at first glance, the figures reported in Table 4 suggest that, categorically, demographic factors have the largest influence on public spending patterns. This finding is not surprising, given that people's socioeconomic circumstances are what determines what they demand from their local governments. But, in practice, demographic conditions do not vary too far from their mean, so modest cross-sectional differences end up corresponding to relatively large differences in per capita spending. Consider, for example, that the standard deviation of the average household size is only 8.80% of the mean, whereas, for the density and spatial extent of developed land, the standard deviations are 104.94% and 161.75% of the mean, respectively. In short, factors with little variance register a larger influence, because they rarely, if ever, differ from place-to-place by much. Moreover, compared to other factors that may readily be influenced by public policy—most demographic conditions, such as the number of young children, are not among them—the influence of sprawl is large. In particular, the elasticities on the density and spatial extent of developed land are on the level with those for median housing value (η = 0.0843), the percentage of housing built prior to 1940 (η = 0.0337), the rate of population change (η = –0.0251), and most sources of revenue. And, here again, the two measures of sprawl deviate much further from their mean than most of these, which are generally more uniform across the country. So, to answer the question in brief: Compared to other relevant factors, the influence of sprawl is sizable.

5. Summary and Conclusion

This paper began by outlining the connections between smart growth and public finance, then opened an investigation into them by: (1) reviewing previous research pertaining to the topic; (2) estimating a series of spatial econometric models for measuring how the built environment and other relevant cost and demand factors influence local service expenditures; and (3) evaluating the nature and extent of the relationship. The results of the analysis link one of the main ideas behind smart growth—namely, that low-density, spatially extensive development patterns are more expensive to support—directly to public finance. While there is a lot of variation in how the density and the spatial extent of development influence different types of services, other things being equal, sprawl, as a cost factor, nearly always raises per capita spending, and the effects translate into large dollar values when summed across the entire country. They are also quite large on a case-by-case basis when capitalized at a conventional long-term lending rate as approximations of opportunity costs. These findings strongly suggest that the reasoning behind fiscally motivated, anti-sprawl smart growth policy frameworks is sound. Several conclusions and directions for future research follow.

Foremost, the results of the analysis link one of the main ideas behind smart growth to public finance via local government spending, an intermediate output, but they do not necessarily extend to the final outputs that residents eventually enjoy. Going forward, a key question that must be addressed is: Do high-density, compact development patterns make any difference for service quality, or do they just make services less expensive to provide? This question is critical for the smart growth movement because it cuts to the core of its holistic, quality-of-life orientation. It is important to remember, for example, that the point of departure for much of the previous research on how development patterns affect public finance was concern for the poor fiscal health and corresponding depravity that the 1960s, 1970s, and 1980s visited upon many built-up areas of the United States (Ladd and Yinger 1991). Public finance in-and-of itself is closely related to quality-of-life (Gyourko and Tracy 1989, 1991) but, ultimately, it is the low crime rates, good schools, and other tangible outcomes of local government spending that influence where people choose to live (see, for example, Bayoh et al. 2006). For this reason, to the extent that it can ensure that public services are delivered both cost effectively and at a high level of quality, smart growth stands to play a major part in determining places' comparative advantage.

In addition, given its holistic orientation, further evaluations of smart growth should examine its ability to actually achieve more desirable living conditions. The land use reform movement that produced most of the contemporary anti-sprawl policy frameworks was led, at first, by an environmental awakening (Popper 1981) and, later, by critical thought regarding the extent to which development patterns actually serve the best interests of their inhabitants (Calthorpe 1993; Duany et al. 2000). Recent work by Song and Knaap (2003, 2004) shows that people place a premium on housing located in "neo-traditional," or "new urbanist," developments, suggesting that a distinct market for smart growth may have emerged. Whether this is simply a product of aesthetics or of a more complex blend of architectural, environmental, fiscal, and other factors remains an open question, though. The need to resolve the issue is brought into stark relief by the fact that, even though urban and regional policymakers are responsible for shaping settlement patterns into what they somehow "ought to be," they have so far advanced few defensible criteria for favoring one outcome over another (Talen and Ellis 2002). Lynch's (1981) classic work, *Good City Form*, delineates a set of very specific normative criteria—vitality, sense, fit, access, control, efficiency, and justice—for evaluating alternative modes of land use, but policymakers have too often failed to rigorously connect smart growth, or any of its goals, to a framework of this sort. The results presented here indicate that sprawl is not efficient from the standpoint of public finance but, with further research, other criteria, such as equity and justice, may turn out to be important as well. Lynch’s framework holds great promise for helping to advance the cause of smart growth because it provides a source of structure for analyzing land use policies in terms of the quality-of-life benefits they are meant to produce.

Each of these conclusions is highly general because the analysis presented in this paper focuses on aggregate, county-level patterns of public spending. It is not clear that the findings would apply in exactly the same way on a community-by-community basis, so readers should be cautious about interpreting the results in that way. That is, the analysis observes the relationship between sprawl and public finance at the county level, not at the municipal or neighborhood levels, where the principals of smart growth are normally applied. Counties can contain literally hundreds of individual governmental entities—Cook County, Illinois, where Chicago is located, had 539 general and special purpose governments in 2002—so a great deal of heterogeneity lies beneath the surface of the results presented here. Determining whether or not, and just how, the financial consequences of sprawl play out across more localized areas requires further research using individual jurisdictions as the unit of analysis. It may be, for example, that that the size of jurisdictions and the size of the regions they are embedded in are important mediating factors. Similarly, the overall trajectory of growth through time may also make a difference, especially in instances where large areas are often committed to development via comprehensive planning, zoning, and other forms of land use planning before they are actually filled in (Carruthers and Mulligan 2007). In future research, these and other important jurisdiction-level issues deserve careful thought and analysis.

Finally, as an extension of this need for more locally oriented work, the nature of the strategic interaction registered by the empirical models should be investigated further. Specifically, a procedural goal of many smart growth programs is to promote cooperation among local governments as a means of meeting broader societal objectives (Carruthers 2002). Theoretical research (Haughwout 1997, 1999) and applied policy analysis (Orfield 1997, 2002) alike show that, in the case of public finance, there is a great deal of fiscal interdependency within regions and that cooperation, rather than competition, can produce net benefits for all of those involved. Determining how the spillovers captured by the kind of spatial reaction functions estimated here reconcile with this “regionalist” view would also require with the use of disaggregate, jurisdiction-level data, plus, at the very least, discriminating among different forms of interaction in order to more precisely represent the motivations and behavior of individual governments. Although a project like this would be highly involved, particularly if it were done for the entire country, taking the step would add great depth to the study of smart growth by better integrating it with theory of local government behavior. In the end, such an approach is necessary in order to develop a full understanding of the complex ways in which smart growth matters to public finance; in the meantime, this paper has taken key steps in that direction.

References

Altshuler AA, Gómez-Ibáñez JA (1993) Regu*lation for Revenue: The Political Economy of Land Use Exactions*. Lincoln Institute of Land Policy, Cambridge, MA.

Anselin L (2003) *GeoDa 0.9 User's Guide*, Spatial Analysis Laboratory, University of Illiniois, Urbana-Champaign, IL.

Anselin L (2002) Under the hood: Issues in the specification and interpretation of spatial regression models. *Agricultural Economics*, 27: 247 – 267.

Anselin L (1992) Space and applied econometrics. *Regional Science and Urban Economics*, 22: 307 – 316.

Anselin L (1988) *Spatial Econometrics: Methods and Models*. Kluwer Academic Publishers, Boston, MA.

Anselin L, Syabri I, Kho Y (2006) *GeoDa*: an introduction to spatial data analysis. *Geographical Analysis*, 38: 5 – 22.

Baicker K (2005) The spillover effects of state spending. *Journal of Public Economics*, 89: 529 – 544.

Bayoh I, Irwin EG, Haab T (2006) Determinants of residential location choice: How important are local public goods in in attracting homeowners to central city locations? *Journal of Regional Science*, 46: 97 – 120.

Bergstrom TC, Goodman RP (1973) Private demands for public goods. *American Economic Review*, 63: 280 – 296.

Borcherding TE, Deacon RT (1972) The demand for the services of non-federal governments. *American Economic Review*, 62: 891 – 901.

BEA (2006) Gross State Product. Available online from the U.S. Bureau of Economic Analysis: *http://bea.gov/bea/regional/gsp.*

BEA (2006) Regional Economic Information System. Available online from the U.S. Bureau of Economic Analysis: *http://bea.gov/bea/regional/reis.*

Bordignon M, Cerniglia F, Revelli, F (2003) In search of yardstick competition: A spatial analysis of Italian municipality property tax setting. *Journal of Urban Economics*, 54: 199 – 217.

Brueckner JK (2003) Strategic interaction among governments: An overview of empirical studies. *International Regional Science Review*, 26: 175 – 188.

Brueckner JK (2000) Urban sprawl: Diagnosis and remedies. *International Regional Science Review*, 23: 160 – 171.

Brueckner JK (1998) Testing for strategic interaction among local governments: The case of growth controls. *Journal of Urban Economics*, 44: 438 – 467.

Brueckner JK (1997) Infrastructure financing and urban development: The economics of impact fees. *Journal of Public Economics*, 66: 383 – 407.

Brueckner JK, Fansler DA (1983) The economics of urban sprawl: Theory and evidence on the spatial sizes of cities. *Review of Economics and Statistics*, 65: 479 – 482.

Bruegmann R (2005) *Sprawl: A Compact History*. University of Chicago Press, Chicago, IL.

Burchell RW (1998) *Transportation Cooperative Research Program Report 39: The Costs of Sprawl—Revisited*. National Academy Press, Washington, DC.

Burchfield M, Overman HG, Puga D, Turner MA (2006) Causes of sprawl: A portrait from space. *Quarterly Journal of Economics*, 121: 587 – 633.

Calthorpe P (1993) *The Next American Metropolis: Ecology, Community, and the American Dream*. Princeton University Press, Princeton, NJ.

Case AC, Rosen HS, Hines JR (1993) Budget spillover and fiscal policy interdependence: evidence from the states. *Journal of Public Economics*, 52: 285 – 307.
Carruthers JI (2002) The impacts of state growth management programs: A comparative analysis. *Urban Studies*, 39: 1959 – 1982.
Carruthers JI, Mulligan GF (2007) Land Absorption in U.S. Metropolitan Areas: Estimates and Projections from Regional Adjustment Models. *Geographical Analysis*, 39: 78 – 104.
Carruthers JI, Úlfarsson GF (2003) Urban sprawl and the cost of public services. *Environment and Planning B*, 30: 503 – 522.
Census (2000, 1990) Summary File 3. Available online from the U.S. Census Bureau at: *www.census.gov.*
Census of Governments (2005) 2002 *Compendium of Government Finances*. U.S. Government Printing Office, Washington, DC.
Census of Governments (2001) 1997 *Compendium of Government Finances*. U.S. Government Printing Office, Washington, DC.
Das D, Kelejian HH, Prucha IR (2003) Finite sample properties of estimators of spatial autoregressive models with autoregressive disturbances. *Papers in Regional Science*, 82: 1 – 26.
DeGrove JM (2005) *Planning Policy and Politics: Smart Growth and the States. Lincoln Institute of Land Policy*. Cambridge, MA.
DeGrove JM (1992) *The New Frontier for Land Policy: Planning and Growth Management in the States. Lincoln Institute of Land Policy*. Cambridge, MA.
DeGrove JM (1984) *Land, Growth, and Politics*. Planner's Press, Washington, DC.
Duany A, Plater-Zyberk E, and Speck J (2000) *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream.* North Point Press, New York, NY.
Esteller-Moré Á, Solé-Ollé A (2001) Vertical income tax externalities and fiscal interdependence: Evidence from the U.S. *Regional Science and Urban Economics*, 31: 247 – 272.
Farhan B, Murray AT (2006) Distance decay and coverage in facility location planning. *Annals of Regional Science*, 40: 279 – 296.
Fingleton B (2005) Beyond neoclassical orthodoxy: A view based on the new economic geography and UK wage data. *Papers in Regional Science* 83: 351 – 375.
Fingleton B, Igliori D, Moore B (2005) Cluster dynamics: new evidence and projections for computing services in Great Britain. *Journal of Regional Science*, 45: 283 – 312.
Fingleton B, López-Bazo E (2003) Explaining the distribution of manufacturing activity in the EU regions. In (ed.) *European Regional Growth*. Amsterdam: Springer.
Fischel WA (2001) *The Homevoter Hypothesis: How Home Values Influence Local Government Taxation, School Finance, and Land Use Policies*. Harvard University Press, Cambridge, MA.
Foster, KA (1997) *The Political Economy of Special Purpose Governments*. The Georgetown University Press, Washington, DC.
Frank, J (1989) *The Costs of Alternative Development Patterns: A Review of the Literature*. The Urban Land Institute, Washington, DC.
Fulton W, Pendall R, Nguyen M, Harrison A (2001) *Who Sprawls the Most? How Growth Patterns Differ Across the U.S.* The Bookings Institution, Center on Urban and Metropolitan Policy, Washington, DC.
Glaeser EL, Kahn ME (2004) Sprawl and Urban Growth. In Henderson JV, Thisse JF (eds.) *Handbook of Urban and Regional Economics*, 4. North-Holland, The Netherlands.
Glickfield M, Levine N (1992) *Regional Growth… Local Reaction: The Enactment and Effects of Local Growth Control and Management Measures in California*. Lincoln Institute of Land Policy, Cambridge, MA.
Gordon P, Richardson HW (1997) Are compact cities a desirable planning goal? *Journal of the American Planning Association* 63: 95 – 106.

Gray R (2005) *Growing Expectations: Understanding the Politics of Smart Growth in the American States*. Ph.D. dissertation prepared for the Department of Government and Politics, University of Maryland, College Park, MD.

Gyourko J, Tracy J (1991) The structure of local public finance and the quality of life. *Journal of Political Economy*, 91: 774 – 806.

Gyourko J, Tracy J (1989) The importance of local fiscal conditions in analyzing local labor markets. *Journal of Political Economy*, 97: 1208 – 1231.

Haughwout AF (1999) Regional fiscal cooperation in metropolitan areas: An exploration. *Journal of Policy Analysis and Management*, 18: 579 – 600.

Haughwout AF (1997) Central city infrastructure investment and suburban house values. *Regional Science and Urban Economics,* 27: 199 – 215.

Hopkins LD, Xu X, Knaap GJ (2004) Economies of scale in wastewater treatment and planning for urban growth. *Environment and Planning B: Planning and Design*, 31: 879 – 893.

Irwin EG, Bockstael NE (2006) The spatial pattern of land use in the United States. In Arnott R, McMillen D (eds.) *Companion to Urban Economics*. Blackwell Publishing, Boston, MA.

Kaiser EJ, Godschalk DR, Chapin SF (1995) *Urban Land Use Planning*. University of Illinois Press, Chicago, IL.

Kelejian HH, Prucha IR (1998) A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances. *Journal of Real Estate Finance and Economics*, 17: 99 – 121.

Kelejian HH, Robinson DP (1993) A suggested method of estimator for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model. *Papers in regional Science*, 72: 297 – 312.

Kelejian HH, Robinson DP (1992) Spatial autocorrelation, a new computationally simple test with an application to per capita county police expenditures. *Regional Science and Urban Economics*, 22: 317 – 331.

Kennedy P (2003) *A Guide to Econometrics*. Cambridge: The MIT Press.

Knaap GJ, Nelson AC (1992) *The Regulated Landscape: Lessons on State Land Use Planning From Oregon*. Lincoln Institute of Land Policy, Cambridge, MA.

Knaap GJ, Ding C, Hopkins, LD (2001) Managing urban growth for the efficient use of public infrastructure: Toward a theory of concurrency. *International Regional Science Review*, 24: 328 – 343.

Ladd HF (1998) Land Use Regulation as a Fiscal Tool. In Ladd HF (ed.) *Local Government Tax and Land Use Policies in the United States: Understanding the Links*. Lincoln Institute of Land Policy, Cambridge, MA

Ladd HF (1994) Fiscal impacts of local population growth: A conceptual and empirical analysis. *Regional Science and Urban Economics*, 24: 661 – 686.

Ladd HF (1992) Population growth, density, and the costs of providing public services. *Urban Studies*, 29: 273 – 295.

Ladd HF, Yinger J (1991) *America's Ailing Cities: Fiscal Health and the Design of Urban Policy*. Johns Hopkins University Press, Baltimore, MD.

Lösch A (1954) *The Economics of Location*. New Haven, Connecticut: Yale University Press.

Lundberg J (2006) Spatial interaction model of spillovers from locally provided public services. *Regional Studies,* 40: 631 – 644.

Lynch K (1981) *Good City Form*. MIT Press, Cambridge, MA.

McFarlane A (1999) Taxes, Fees, and Urban Development. *Journal of Urban Economics*, 46: 416 – 436.

Mulligan GF (2000) Resolving location conflict with standardized space-cost curves. *Professional Geographer*, 52: 50 – 60.

Mulligan GF (1991) Equality measures and facility location. *Papers in Regional Science*, 70: 345 – 365.

Orfield M (2002) *American Metropolitics: The New Suburban Reality*. The Brookings Institute Press Washington, DC.

Orfield (1997) *Metropolitics: A Regional Agenda for Community and Stability*. The Brookings Institute Press Washington, DC.

Pendall R (2000) Why voucher and certificate users live in distressed neighborhoods. *Housing Policy Debate*, 11: 881 – 910.

Pendall R (1999) Do land-use controls cause sprawl? *Environment and Planning B*, 26: 555 – 571.

Popper FJ (1981) *The Politics of Land Use Reform*. University of Wisconsin Press, Madison, WI.

RERC (1974) *The Costs of Sprawl: Environmental and Economic Costs of Alternative Residential Development Patterns at the Urban Fringe*. The Environmental Protection Agency, Washington, DC.

Revelli F (2005) On spatial public finance empirics. *International tax and Public Finance*, 12: 475 – 492.

Revelli F (2003) Reaction or interaction? Spatial process identification in multi-tiered government structures. *Journal of Urban Economics*, 53: 29 – 53.

Revelli F (2002) Testing the tax mimicking versus expenditure spill-over hypotheses using English data. *Applied Economics*, 14: 1723 – 1731.

Revelli F (2001) Spatial patterns in local taxation: Tax mimicking or error mimicking? *Applied Economics*, 33: 1101 – 1107.

Solé-Ollé A (2006) Expenditure spillovers and fiscal interactions: Empirical evidence from local governments in Spain. *Journal of Urban Economics*, 59: 32 – 54.

Solé-Ollé A, Bosch N (2005) On the relationship Between Authority Size and the Costs of Providing Local Services: Lessons For the Design of Intergovernmental Transfers in Spain. *Public Finance Review*, 33: 343 – 384.

Song Y, Knaap GJ (2003) New urbanism and housing values: A disaggregate assessment. *Journal of Urban Economics*, 54: 218 – 238.

Song Y, Knaap GJ (2004) Measuring the effects of mixed land uses on housing values. *Regional Science and Urban Economics*, 34: 663 – 680.

Song Y (2005) Smart growth and urban development patterns: A comparative study. *International Regional science Review*, 28: 239 – 265.

Speir C, Stephenson K (2002) Does sprawl cost us all? Isolating the effects of housing patterns on public water and sewer costs. *Journal of the American Planning Association*, 68: 56 – 70

State of Maryland (1998) Smart Growth and Neighborhood Conservation Act. Available online from the State of Maryland: *http://www.mpd.state.md.us/smartgrowth/pdf/sb0389.pdf*.

Talen E, Ellis C (2002) Beyond relativism: Reclaiming the search for good city form. *Journal of Planning Education and Research*, 22: 36 – 49.

Thisse JF, Zoller HC (eds.) (1983) *Locational Analysis of Public Facilities*. North-Holland, the Netherlands.

Tiebout, CM (1956) A Pure theory of local expenditures. *Journal of Political Economy*, 64: 416 – 424.

Úlfarsson GF, Carruthers JI (2006) The cycle of fragmentation and sprawl: A conceptual framework and empirical model. *Environment and Planning B* 33: 767 – 788.

USDA (2001) 1997 National Resources Inventory. Machine readable data available on CD-ROM from the National Cartography and Geospatial Center, PO Box 6567, Fort Worth Texas, TX 76115-0567.

Table 1. 2002 Population, Gross State Product, and Local Government Expenditures by State

State	Population	GSP ($ mil.)	Expenditure			State	Population	GSP ($ mil.)	Expenditure		
			Total ($ mil.)	Per Capita	Percent GSP				Total ($ mil.)	Per Capita	Percent GSP
US	287,984,799	$10,412,244	$1,140,082	$3,959	10.95%	MO	5,681,045	$187,090	$17,266	$3,039	9.23%
AL	4,480,139	$123,763	$14,642	$3,268	11.83%	MT	910,395	$23,913	$2,262	$2,485	9.46%
AK	640,699	$29,741	$3,051	$4,762	10.26%	NE	1,726,753	$60,571	$7,769	$4,499	12.83%
AZ	5,438,159	$173,052	$20,404	$3,752	11.79%	NV	2,167,867	$82,389	$9,055	$4,177	10.99%
AR	2,706,606	$71,221	$6,123	$2,262	8.60%	NH	1,274,666	$46,106	$3,493	$2,740	7.58%
CA	34,988,088	$1,363,577	$181,512	$5,188	13.31%	NJ	8,576,089	$377,824	$31,826	$3,711	8.42%
CO	4,498,407	$181,246	$19,363	$4,304	10.68%	NM	1,855,400	$53,414	$5,397	$2,909	10.10%
CT	3,458,382	$167,235	$11,211	$3,242	6.70%	NY	19,164,755	$802,866	$123,857	$6,463	15.43%
DE	805,767	$46,991	$2,127	$2,640	4.53%	NC	8,312,755	$301,254	$28,577	$3,438	9.49%
DC	564,624	$67,176	$7,832	$13,871	11.66%	ND	633,571	$20,007	$1,766	$2,787	8.82%
FL	16,677,860	$522,340	$61,756	$3,703	11.82%	OH	11,404,651	$385,657	$42,720	$3,746	11.08%
GA	8,581,731	$307,443	$30,960	$3,608	10.07%	OK	3,487,076	$95,343	$9,384	$2,691	9.84%
HI	1,234,401	$43,806	$2,077	$1,683	5.74%	OR	3,522,342	$115,113	$13,916	$3,951	12.09%
ID	1,343,973	$38,276	$3,743	$2,785	9.78%	PA	12,324,415	$424,820	$43,527	$3,532	10.25%
IL	12,586,839	$486,182	$51,384	$4,082	10.57%	RI	1,069,550	$37,040	$2,894	$2,706	7.81%
IN	6,154,739	$203,296	$20,687	$3,361	10.18%	SC	4,102,568	$122,274	$12,374	$3,016	10.12%
IA	2,934,340	$97,810	$9,928	$3,383	10.15%	SD	760,368	$25,826	$2,011	$2,645	7.79%
KS	2,712,454	$89,875	$9,098	$3,354	10.12%	TN	5,790,312	$191,394	$21,128	$3,649	11.04%
KY	4,088,510	$121,633	$9,995	$2,445	8.22%	TX	21,722,394	$775,459	$77,108	$3,550	9.94%
LA	4,475,003	$134,360	$13,523	$3,022	10.07%	UT	2,336,673	$73,646	$7,599	$3,252	10.32%
ME	1,296,978	$39,027	$3,386	$2,611	8.68%	VT	616,274	$19,419	$1,616	$2,622	8.32%
MD	5,442,268	$202,840	$17,682	$3,249	8.72%	VA	7,286,061	$288,840	$24,033	$3,298	8.32%
MA	6,411,568	$287,191	$25,035	$3,905	8.72%	WA	6,066,319	$233,971	$26,875	$4,430	11.49%
MI	10,039,379	$347,014	$39,489	$3,933	11.38%	WV	1,804,529	$45,259	$3,980	$2,206	8.79%
MN	5,023,526	$199,271	$22,200	$4,419	11.14%	WI	5,439,137	$189,508	$22,077	$4,059	11.65%
MS	2,866,349	$68,550	$8,000	$2,791	11.67%	WY	499,045	$20,326	$2,365	$4,739	11.63%

Sources: Bureau of Economic Analysis (2002, 2006) and Census of Governments (2005).

Table 2. Public Expenditure Variables

Variable	Description
Total Direct Expenditures	Sum of direct expenditures, including salaries and wages
Education	Expenditures on local schools.
Fire Protection	Expenditures incurred for fire fighting and fire prevention, including contributions to volunteer fire units.
Housing and Community Development	Expenditures on urban renewal, slum clearance, and housing projects.
Natural Resources	Flood control, soil and water conservation, drainage, and any other activities for promotion of agriculture and conservation of natural resources.
Libraries	Expenditures on libraries.
Parks and Recreation	Expenditures on parks and recreation, including playgrounds, golf courses, swimming pools, museums, marinas, community music, drama, celebrations, zoos, and other cultural activities.
Police Protection	Expenditures on municipal police agencies, including coroners, medical examiners, vehicular inspection activities, and traffic control and safety activities.
Roadways	Expenditures for construction and maintenance of municipal streets sidewalks, bridges and toll facilities, street lighting, snow removal, and highway engineering, control, and safety.
Sewerage	Expenditures for construction, maintenance, and operation of sanitary and storm sewer systems and sewage disposal plants.
Solid Waste Management	Expenditures on street cleaning and the collection and disposal of garbage.

Source: Census of Governments, form F-28, 2005 Annual Survey of Local Government Finances.

Table 3. Source, Units, and Description of Continuous Variables

			Descriptive Statistics				
Variable	Source	Units	Mean	Median	Maximum	Minimum	Standard Deviation
Per Capita Total Direct	COG, REIS	$	3,220.77	2,970.36	23,676.37	227.93	1,362.98
Per Capita Education	COG, REIS	$	1,449.76	1,357.08	6,935.84	44.79	480.60
Per Capita Fire	COG, REIS	$	49.31	38.44	1,442.15	0.05	51.57
Per Capita Housing	COG, REIS	$	53.08	35.06	870.33	0.04	63.57
Per Capita Libraries	COG, REIS	$	20.43	15.04	356.51	0.02	22.84
Per Capita Parks	COG, REIS	$	47.68	31.22	1700.40	0.07	66.63
Per Capita Police	COG, REIS	$	120.94	108.79	1200.66	0.60	75.84
Per Capita Roadways	COG, REIS	$	205.34	154.61	1914.18	0.13	175.55
Per Capita Sewerage	COG, REIS	$	67.67	50.93	1164.47	0.10	71.03
Per Capita Solid Waste	COG, REIS	$	46.43	38.89	990.33	0.01	42.31
Density	NRI, REIS	#	2.49	2.04	64.26	0.04	2.61
% Developed	NRI, COG	%	0.09	0.04	1.00	0.00	0.13
Median Housing Value	Census	$	85,634.15	76,521.00	759,966.00	5,174.65	45,962.78
% Housing >1940	Census	%	0.20	0.16	0.61	0.00	0.13
Per Capita Municipalities	COG	# (1,000s)	0.30	0.17	4.09	0.00	0.38
Per Capita Special Districts	COG, REIS	# (1,000s)	0.53	0.22	14.44	0.00	0.88
Population Change	COG, REIS	%	0.06	0.05	0.77	–0.39	0.08
Per Capita Income	REIS	$	22,716.03	22,051.55	78,125.29	5,498.18	5,131.32
% White	Census	%	0.86	0.92	1.00	0.05	0.16
% <5 Years Old	Census	%	0.10	0.10	0.18	0.06	0.01
Average Household size	Census	#	2.66	2.62	5.38	0.83	0.23
% Property Tax	COG	%	0.79	0.82	1.00	0.16	0.16
Per Capita Federal Revenue	COG, REIS	$	79.38	45.70	5,038.61	0.00	163.14
Per Capita State Revenue	COG, REIS	$	1,033.36	953.99	7,415.72	0.00	439.59
Per Capita Long-term Debt	COG, REIS	$	1,917.46	1,072.07	12,2810.20	0.00	4,950.10
County Land Area	COG	# (1,000s ac)	616.00	396.00	12,841.00	10.00	836.00
Employment Ratio	REIS	%	0.38	0.37	2.93	0.08	0.14
Average Wage of Government Job	REIS	$	27,614.64	26,528.16	61,626.56	14,534.40	5,840.15

Notes: COG is the US Bureau of Commerce's Census of Governments; REIS is the US Bureau of Economic Analysis' Regional Economic Information System; NRI is the US Department of Agriculture's National Resources Inventory; Census is the US Census Bureau; all dollar values are expressed in 2002 constant dollars; zero values are excluded from the capital facilities, education, fire protection, housing and community development, libraries, natural resources, parks and recreation, roadways, sewerage, and solid waste calculations.

Table 4. OLS and S2SLS Estimates of Total Direct Equation

	OLS			S2SLS		
	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value
Constant	7.59E+00 ***	-	42.06	6.06E+00 ***	-	18.29
Spatial Lag	-	-	-	2.04E-01 ***	0.2039	5.93
Built Environment						
Density	–6.49E-03 ***	–0.0162	–2.51	–5.45E-03 **	–0.0136	–2.10
% Developed	3.05E-01 ***	0.0259	5.97	2.89E-01 ***	0.0246	5.59
Median Housing Value	1.15E-06 ***	0.0985	6.18	9.85E-07 ***	0.0843	5.28
% Housing <1940	1.97E-01 ***	0.0384	2.72	1.73E-01 ***	0.0337	2.40
Political Structure						
Per Capita Municipalities	3.98E-02 n/s	0.0119	1.49	2.79E-02 n/s	0.0084	1.04
Per Capita Special Districts	5.68E-02 ***	0.0299	4.06	5.53E-02 ***	0.0291	4.13
Growth and Demographics						
Population Change	–4.88E-01 ***	–0.0295	–4.37	–4.15E-01 ***	–0.0251	–3.76
Per Capita Income	1.88E-06 *	0.0427	1.64	1.60E-06 n/s	0.0363	1.39
% White	–1.18E-01 *	–0.1008	–1.84	–1.16E-01 *	–0.0993	–1.86
% <5 Years Old	4.31E+00 ***	0.4470	5.85	3.92E+00 ***	0.4065	5.36
Average Household size	–2.85E-01 ***	–0.7588	–4.45	–2.93E-01 ***	–0.7777	–4.66
Sources of Revenue						
% Property Tax	2.27E-01 ***	0.1790	3.52	1.96E-01 ***	0.1545	3.04
Per Capita Federal Revenue	1.31E-04 *	0.0104	1.73	1.28E-04 *	0.0102	1.69
Per Capita State Revenue	1.33E-04 ***	0.1374	3.36	1.37E-04 ***	0.1416	3.49
Per Capita Long-term Debt	1.71E-05 ***	0.0328	11.98	1.70E-05 ***	0.0326	11.73
County Size and Primacy						
County Land Area	2.85E-05 ***	0.0176	3.80	2.49E-05 ***	0.0154	3.54
Employment Ratio	7.62E-01 ***	0.2898	6.87	7.46E-01 ***	0.2836	6.64
Average Government Wage	–1.25E-06 n/s	–0.0345	–0.83	–1.23E-06 n/s	–0.0340	–0.80
Metropolitan	–2.92E-02 **	-	–2.25	–2.55E-02 **	-	–2.00
Micropolitan	8.22E-03 n/s	-	0.61	1.00E-02 n/s	-	0.76
n			3,075			3,075
Adjusted R^2			0.60			0.61

Notes: All models were estimated using White-adjusted standard errors clustered by state; all state fixed effects have been suppressed to conserve space; *** denotes two-tailed hypothesis test significant at $p < 0.01$; ** denotes two-tailed hypothesis test significant at $p < 0.05$; * denotes two-tailed hypothesis test significant at $p < 0.10$; n/s denotes two-tailed hypothesis test not significant.

Table 5. S2SLS Estimates of Education, Fire Protection, and Housing and Community Development Equations

	Education			Fire Protection			Housing and Community Development		
	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value
Constant	5.40E+00 ***	-	18.30	3.80E+00 ***	-	7.07	6.26E+00 ***	-	8.76
Spatial Lag	1.12E-01 ***	0.1119	3.08	2.23E-01 ***	0.2235	4.01	1.97E-01 ***	0.1970	3.58
Built Environment									
Density	–1.39E-02 ***	–0.0345	–6.07	–1.27E-02 $^{n/s}$	–0.0318	–1.64	4.22E-02 ***	0.1124	2.91
% Developed	1.50E-01 ***	0.0128	4.08	1.02E+00 ***	0.0872	5.88	2.92E-01 $^{n/s}$	0.0276	1.34
Median Housing Value	9.49E-07 ***	0.0813	4.57	4.87E-07 $^{n/s}$	0.0418	0.70	–2.80E-06 ***	–0.2463	–3.37
% Housing < 1940	–1.56E-01 *	–0.0303	–1.81	5.34E-01 **	0.1039	2.41	2.83E-01 $^{n/s}$	0.0549	0.81
Political Structure									
Per Capita Municipalities	4.89E-02 **	0.0147	1.99	–1.01E-01 $^{n/s}$	–0.0304	–1.22	–3.78E-01 ***	–0.1028	–2.56
Per Capita Special Districts	3.56E-02 ***	0.0186	3.62	3.71E-02 $^{n/s}$	0.0193	1.09	1.15E-01 **	0.0526	2.05
Growth and Demographics									
Population Change	–3.96E-01 ***	–0.0240	–3.29	–1.33E-01 $^{n/s}$	–0.0081	–0.39	–9.97E-01 **	–0.0594	–2.12
Per Capita Income	9.96E-07 $^{n/s}$	0.0226	1.24	8.93E-06 **	0.2029	2.38	–2.59E-06 $^{n/s}$	–0.0590	–0.43
% White	–5.81E-02 $^{n/s}$	–0.0496	–0.96	–1.20E-01 $^{n/s}$	–0.1025	–0.71	–1.81E+00 ***	–1.5376	–7.42
% < 5 Years Old	6.33E+00 ***	0.6561	9.41	1.38E+00 $^{n/s}$	0.1426	0.71	–1.50E+00 $^{n/s}$	–0.1547	–0.44
Average Household size	–1.36E-01 **	–0.3606	–2.37	–5.92E-01 ***	–1.5753	–4.57	–9.02E-01 ***	–2.3975	–3.69
Sources of Revenue									
% Property Tax	4.29E-01 ***	0.3391	8.44	–1.16E+00 ***	–0.9120	–4.56	–2.43E-01 $^{n/s}$	–0.1903	–0.84
Per Capita Federal Revenue	4.44E-05 $^{n/s}$	0.0035	1.27	2.33E-04 ***	0.0186	3.03	1.06E-03 ***	0.0853	3.46
Per Capita State Revenue	2.32E-04 ***	0.2399	5.44	–2.14E-04 ***	–0.2214	–3.43	6.99E-05 $^{n/s}$	0.0718	0.69
Per Capita Long-term Debt	–6.35E-07 $^{n/s}$	–0.0012	–0.84	3.46E-06 $^{n/s}$	0.0067	0.80	–6.57E-06 $^{n/s}$	–0.0131	–1.28
County Size and Primacy									
County Land Area	1.16E-05 **	0.0072	2.45	6.05E-05 **	0.0374	1.96	4.42E-05 $^{n/s}$	0.0262	1.23
Employment Ratio	1.81E-01 **	0.0690	3.30	1.80E+00 ***	0.6841	6.34	1.86E+00 ***	0.7240	5.29
Average Government Wage	2.26E-06 $^{n/s}$	0.0624	1.63	7.04E-06 $^{n/s}$	0.1946	1.39	–3.35E-06 $^{n/s}$	–0.0940	–0.41
Metropolitan	–1.11E-02 $^{n/s}$	-	–0.99	2.89E-01 ***	-	5.32	1.73E-01 ***	-	2.61
Micropolitan	–3.14E-05 $^{n/s}$	-	0.00	3.32E-01 ***	-	7.55	5.91E-02 $^{n/s}$	-	0.92
n			3,071			3,056			2,564
Adjusted R^2			0.51			0.42			0.25

Notes: All models were estimated using White-adjusted standard errors clustered by state; all state fixed effects have been suppressed to conserve space; *** denotes two-tailed hypothesis test significant at $p < 0.01$; ** denotes two-tailed hypothesis test significant at $p < 0.05$; * denotes two-tailed hypothesis test significant at $p < 0.10$; $^{n/s}$ denotes two-tailed hypothesis test not significant.

Table 6. S2SLS Estimates of Libraries, Parks and Recreation, and Police Protection Equations

	Libraries			Parks and Recreation			Police Protection		
	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value
Constant	7.52E-01 n/s	-	1.62	7.09E-01 n/s	-	1.24	3.76E+00 ***	-	12.21
Spatial Lag	1.63E-01 ***	0.1628	3.06	2.60E-01 ***	0.2598	5.34	3.77E-01 ***	0.3767	9.17
Built Environment									
Density	–1.25E-02 n/s	–0.0320	–1.59	–1.44E-02 **	–0.0362	–2.30	–8.91E-03 *	–0.0222	–1.76
% Developed	6.02E-01 ***	0.0534	2.80	1.22E+00 ***	0.1048	6.38	4.36E-01 ***	0.0370	4.27
Median Housing Value	2.25E-06 ***	0.1966	2.77	1.91E-06 **	0.1649	2.51	1.13E-06 ***	0.0968	2.91
% Housing < 1940	4.60E-02 n/s	0.0088	0.14	1.82E-01 n/s	0.0354	0.65	1.60E-01 n/s	0.0312	1.28
Political Structure									
Per Capita Municipalities	–3.10E-01 ***	–0.0869	–2.89	–2.01E-01 *	–0.0592	–1.91	–7.96E-02 *	–0.0239	–1.91
Per Capita Special Districts	6.81E-02 **	0.0332	2.04	–2.58E-02 n/s	–0.0133	–0.41	2.94E-02 n/s	0.0155	1.16
Growth and Demographics									
Population Change	–3.27E-01 n/s	–0.0204	–1.04	–9.34E-01 **	–0.0568	–2.33	–4.08E-01 **	–0.0247	–2.53
Per Capita Income	8.84E-06 *	0.2013	1.81	1.20E-05 ***	0.2734	2.65	1.20E-06 n/s	0.0273	0.63
% White	3.98E-01 *	0.3401	1.87	9.48E-01 ***	0.8101	5.19	–3.32E-01 ***	–0.2836	–4.11
% < 5 Years Old	8.91E-01 n/s	0.0923	0.36	2.96E+00 n/s	0.3066	1.55	1.44E+00 n/s	0.1495	1.35
Average Household size	–1.74E-01 n/s	–0.4625	–1.08	–1.53E-01 n/s	–0.4071	–1.20	–4.58E-01 ***	–1.2183	–5.91
Sources of Revenue									
% Property Tax	3.37E-01 n/s	0.2662	1.21	–7.73E-01 ***	–0.6099	–3.37	–4.01E-01 ***	–0.3171	–3.82
Per Capita Federal Revenue	9.35E-05 n/s	0.0075	0.90	1.88E-04 *	0.0150	1.67	–2.82E-05 n/s	–0.0022	–0.54
Per Capita State Revenue	–3.96E-05 n/s	–0.0412	–0.60	–1.68E-04 ***	–0.1740	–2.71	5.83E-05 **	0.0602	2.14
Per Capita Long-term Debt	1.41E-05 ***	0.0269	3.59	6.19E-06 *	0.0121	1.81	6.60E-07 n/s	0.0013	0.33
County Size and Primacy									
County Land Area	8.10E-05 ***	0.0511	2.58	1.16E-04 ***	0.0721	3.97	1.44E-05 n/s	0.0089	1.20
Employment Ratio	1.60E+00 ***	0.6151	5.24	2.67E+00 ***	1.0197	7.19	1.01E+00 ***	0.3837	6.54
Average Government Wage	2.15E-06 n/s	0.0599	0.34	3.76E-06 n/s	0.1042	0.63	5.03E-06 **	0.1389	2.06
Metropolitan	4.23E-02 n/s	-	0.81	1.53E-01 ***	-	3.09	8.95E-02 ***	-	3.94
Micropolitan	–6.19E-02 n/s	-	–1.08	1.46E-01 ***	-	3.12	5.04E-02 ***	-	2.81
n			2,818			3,012			3,075
Adjusted R^2			0.34			0.46			0.60

Notes: All models were estimated using White-adjusted standard errors clustered by state; all state fixed effects have been suppressed to conserve space; *** denotes two-tailed hypothesis test significant at $p < 0.01$; ** denotes two-tailed hypothesis test significant at $p < 0.05$; * denotes two-tailed hypothesis test significant at $p < 0.10$; n/s denotes two-tailed hypothesis test not significant.

Table 7. S2SLS Estimates of Roadways, Sewerage, and Solid Waste Management Equations

	Roadways			Sewerage			Solid Waste Management		
	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value	Estimated Parameter	Elasticity	*t*-value
Constant	3.18E+00 ***	-	8.47	3.78E+00 ***	-	7.01	3.39E+00 ***	-	5.51
Spatial Lag	1.90E-01 ***	0.1898	5.23	1.45E-01 ***	0.1448	2.84	3.06E-01 ***	0.3064	6.16
Built Environment									
Density	–2.25E-02 ***	–0.0562	–3.29	–1.58E-02 n/s	–0.0399	–1.64	–8.85E-03 n/s	–0.0222	–0.89
% Developed	3.78E-01 **	0.0321	2.09	8.33E-01 ***	0.0718	4.49	2.66E-01 n/s	0.0229	1.41
Median Housing Value	1.35E-06 ***	0.1155	2.76	2.36E-06 ***	0.2035	3.82	3.87E-07 n/s	0.0333	0.42
% Housing < 1940	5.97E-01 ***	0.1164	3.75	7.40E-01 ***	0.1451	3.30	3.11E-01 n/s	0.0603	1.07
Political Structure									
Per Capita Municipalities	2.45E-01 ***	0.0738	4.66	–1.16E-01 n/s	–0.0347	–1.49	–2.52E-01 ***	–0.0750	–3.12
Per Capita Special Districts	9.42E-02 ***	0.0497	3.23	–6.45E-03 n/s	–0.0033	–0.21	7.47E-02 **	0.0376	1.98
Growth and Demographics									
Population Change	–3.77E-01 *	–0.0227	–1.66	–5.50E-02 n/s	–0.0033	–0.16	–1.35E+00 ***	–0.0812	–3.94
Per Capita Income	8.92E-07 n/s	0.0203	0.32	1.51E-06 n/s	0.0344	0.35	–5.07E-06 n/s	–0.1153	–1.16
% White	5.18E-01 ***	0.4428	3.63	–1.22E-01 n/s	–0.1046	–0.72	–2.81E-01 n/s	–0.2397	–1.70
% < 5 Years Old	3.72E+00 ***	0.3857	2.65	–4.29E+00 **	–0.4435	–2.32	–1.26E-01 n/s	–0.0130	–0.06
Average Household size	–2.86E-01 ***	–0.7610	–3.62	–1.77E-01 n/s	–0.4712	–1.21	–5.04E-01 ***	–1.3409	–2.86
Sources of Revenue									
% Property Tax	1.35E-01 n/s	0.1067	0.76	–6.92E-01 ***	–0.5456	–2.68	–5.44E-02 n/s	–0.0429	–0.25
Per Capita Federal Revenue	1.36E-05 n/s	0.0011	0.27	1.09E-04 n/s	0.0087	1.21	–1.15E-04 n/s	–0.0090	–1.23
Per Capita State Revenue	1.24E-04 ***	0.1283	2.64	3.64E-05 n/s	0.0377	0.59	8.31E-05 n/s	0.0859	1.56
Per Capita Long-term Debt	6.95E-06 ***	0.0134	2.91	5.89E-06 n/s	0.0114	1.37	1.91E-06 n/s	0.0037	0.46
County Size and Primacy									
County Land Area	4.79E-05 ***	0.0296	3.13	5.26E-05 ***	0.0327	2.44	8.33E-05 ***	0.0509	2.49
Employment Ratio	7.66E-01 ***	0.2916	4.87	1.56E+00 ***	0.5946	3.59	1.49E+00 ***	0.5674	6.13
Average Government Wage	–1.67E-06 n/s	–0.0461	–0.51	–5.58E-06 n/s	–0.1545	–1.18	6.14E-07 n/s	0.0170	0.10
Metropolitan	–1.49E-01 ***	-	–4.56	2.07E-01 ***	-	4.13	–9.22E-02 **	-	–1.94
Micropolitan	–1.19E-01 ***	-	–5.08	2.41E-01 ***	-	6.65	3.34E-02 n/s	-	0.68
n		3,056			2,979			2,995	
Adjusted R^2			0.68			0.36			0.31

Notes: All models were estimated using White-adjusted standard errors clustered by state; all state fixed effects have been suppressed to conserve space; *** denotes two-tailed hypothesis test significant at $p < 0.01$; ** denotes two-tailed hypothesis test significant at $p < 0.05$; * denotes two-tailed hypothesis test significant at $p < 0.10$; n/s denotes two-tailed hypothesis test not significant.

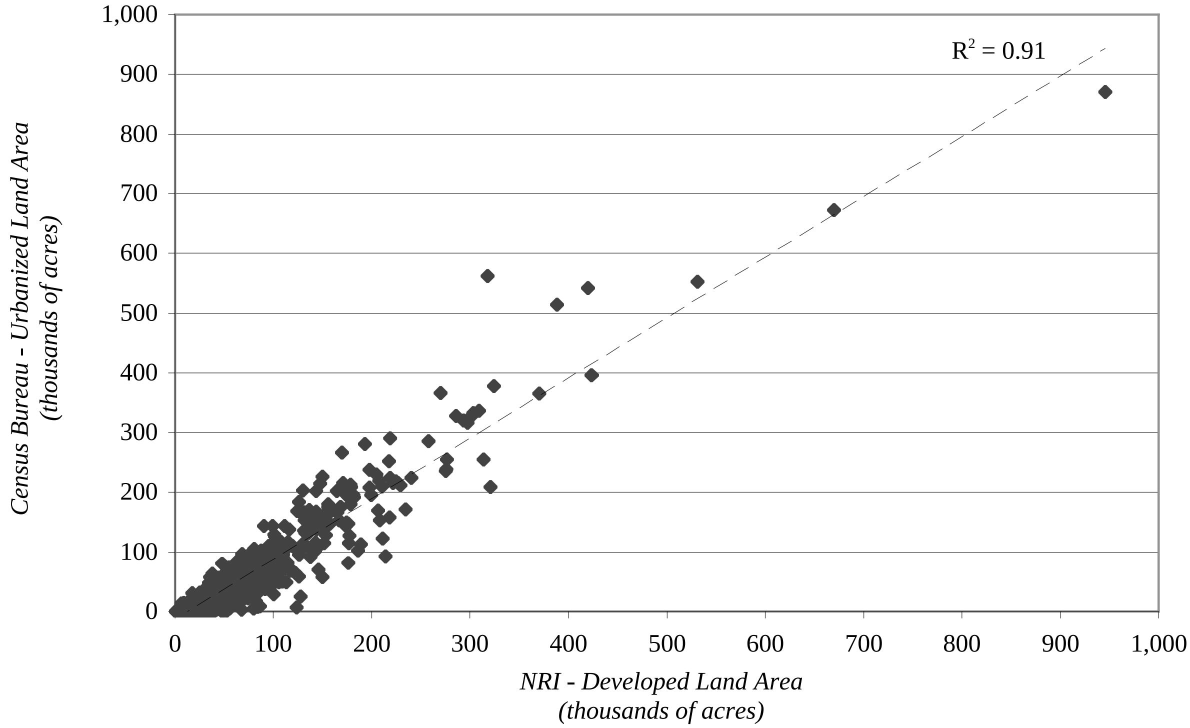

Figure 1. The NRI Measure of Developed Land Versus the Census Bureau's Measure of Urbanized Land

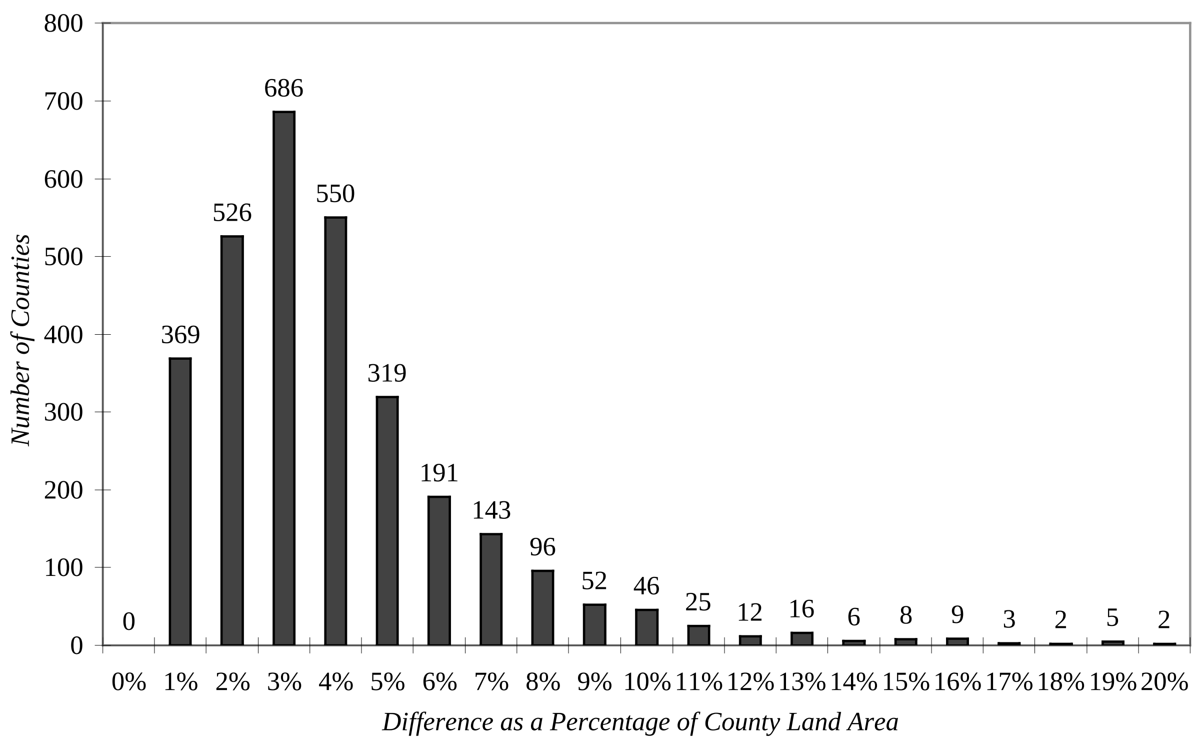

Figure 2. Absolute Value of the Difference Between Acres of Developed Land (NRI) and Acres of Urbanized Land (Census) as a Percentage of County Land Area

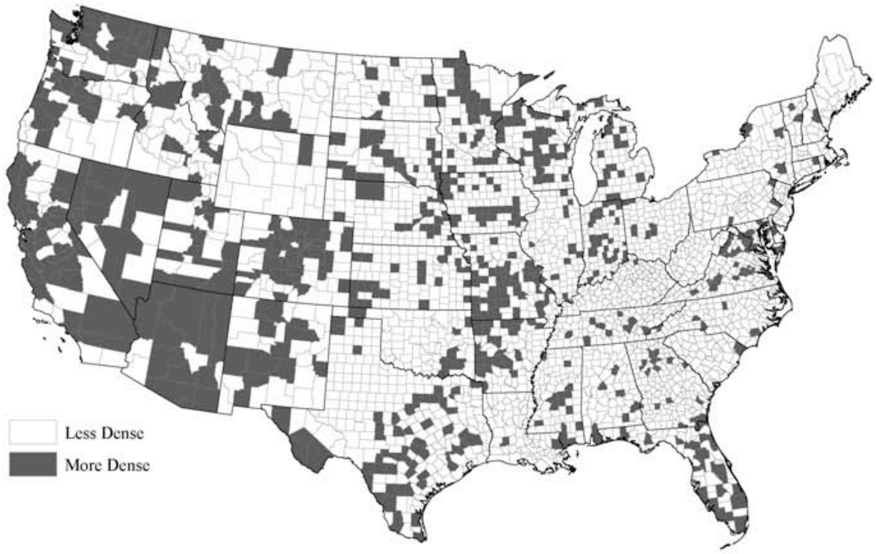

Figure 3. Change in Density, 1982 – 1997

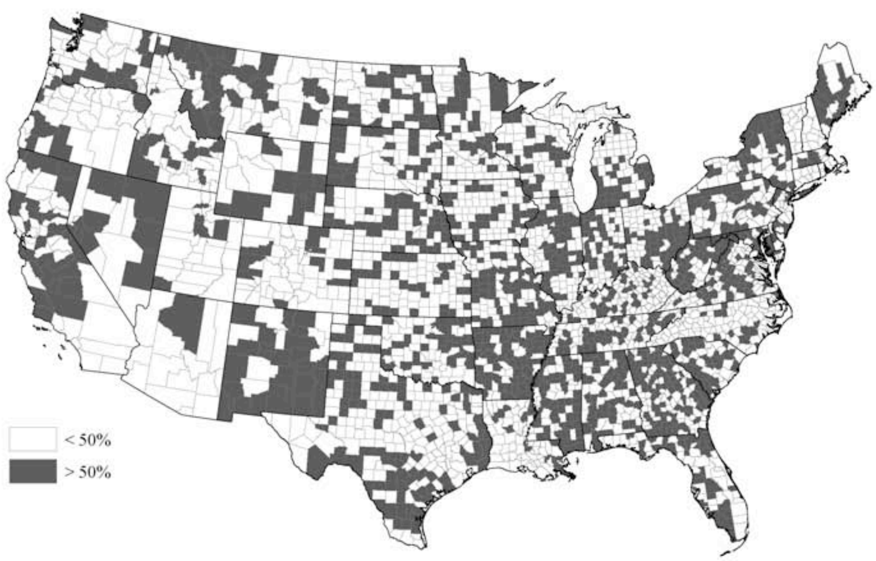

Figure 4. Percent Land Absorption, 1992 – 1997

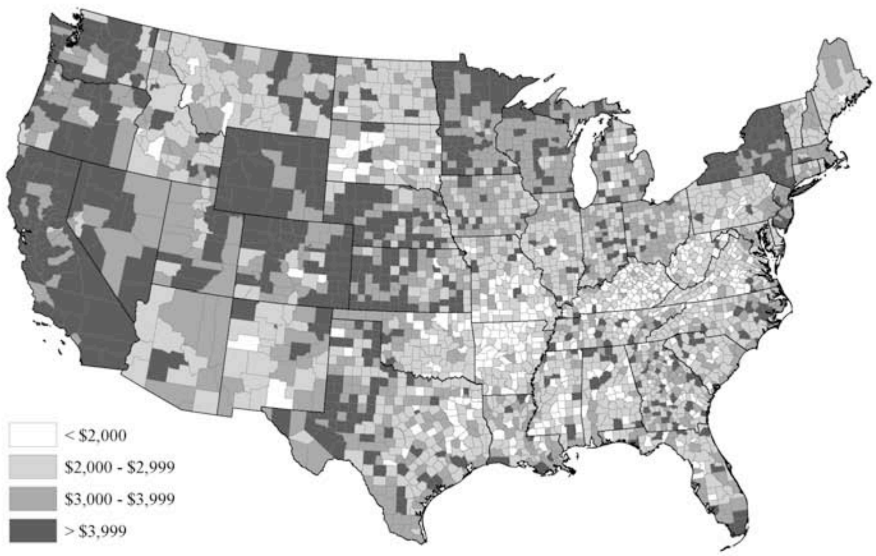

Figure 5. Per Capita Total Direct Expenditure, FY 2002

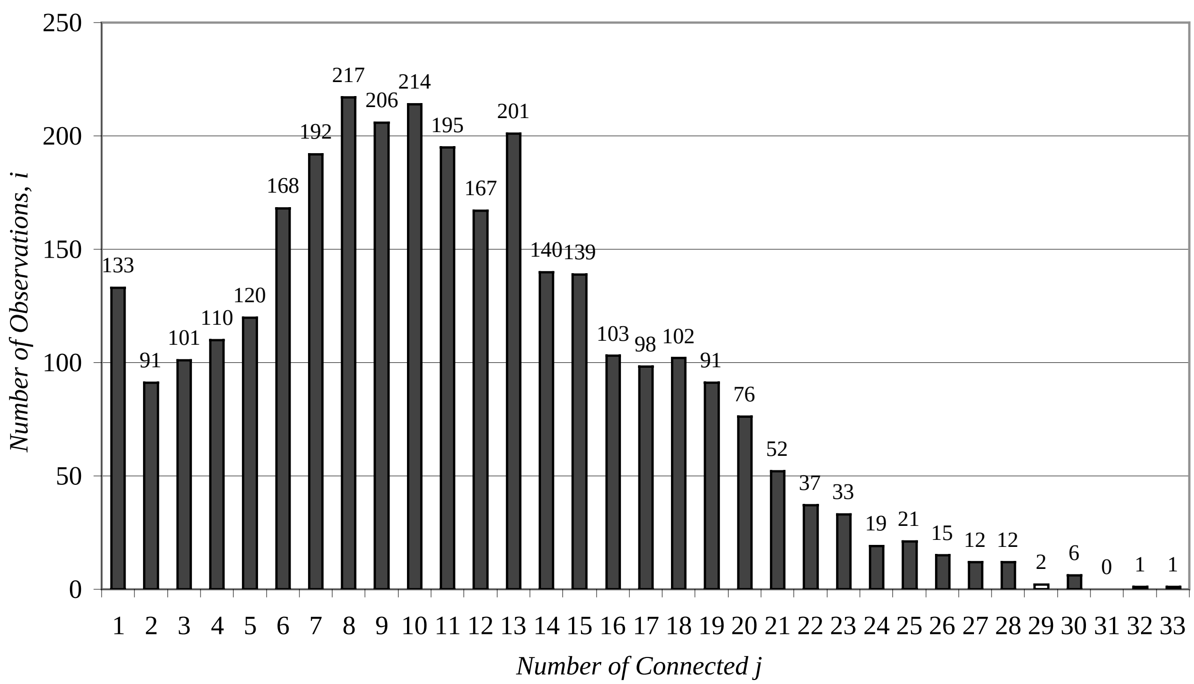

Figure 6. Connectivity of W_{ij}