Measuring the Effects of a Land Value Tax on Land Development

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Abstract: The objective of this research is to evaluate a land value tax as a potential policy tool to moderate sprawling development in Nashville, TN, the nation's most sprawling metropolitan community with a population of one million or more,.To achieve this objective, the hypothesis is empirically tested that a land value tax encourages more development closer to preexisting development than farther from preexisting development. Specifically, the marginal effects of a land value tax on the probability of land development is hypothesized to be greater in areas around preexisting development than in areas more distant from preexisting development. The findings show that the marginal effects of a land value tax on the probability of developing parcels that neighbored previously developed parcels was greater than the probability of develping parcels that did not neighbor previously developed parcels. This finding suggests that land value taxation could be used to design compact development strategies that address sprawling development.

Keywords: Land value tax, Land development model, Urban Sprawl

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Introduction

Urban sprawl has become a notable phenomenon in the United States since World War II (Plantinga and Bernell 2005). Many urban areas are expanding while housing densities are decreasing, with urban areas growing at about twice the rate of the populations in many cities (U.S. Department of Housing and Urban Development 2000). Urban sprawl is well-described as the leapfrogging of development beyond the city's outer boundary into smaller rural settlements (Hanham and Spiker 2005). Rated as one of the most important local issues in 2000 (Princeton Survey Research Associates 2000), urban sprawl has emerged as a challenging urban development perplexity in the United States over the past few years. A poll shows that 78% of Americans support the control of urban sprawl in land use planning (Smart Growth America 2000).

Sprawl conditions appear to be worse in the South than elsewhere in the country. Recent population and economic growth in the South have contributed to pressures that create sprawl. Half of the top 10 most sprawling major U.S. metro areas are in the South (Smart Growth America 2003; Southeast Watershed Forum, 2001), and half of the top 20 states that lost the most open space and farmland to urban sprawl during the 1990's are Southern States (Southeast Watershed Forum 2001).

Nashville, TN is an example of sprawl in the South. It is identified as the nation's most sprawling metro area with a population of one million or more (Nasser and Overberg 2001). The Nashville metro area had a population of approximately 1.2 million in 2000, with a projected increase to two million within the next two decades (Cumberland Commercial Partners 2009; Alexander 2004). The U.S. Census Bureau predicts that the population of Nashville will outpacing most other major southern cities (Cumberland Commercial Partners 2009). A number of service sectors, e.g., schools and hospitals, have been unable to keep pace with the rate of growth.

Of serious concern to planners is the rapidly increasing rate of land consumption. Between 1970 and 1990, Nashville's population grew by 28% while its urbanized area grew by 41% (Sierra Club 2009). Land was reportedly developed at a rate of 60 acres per day during the early 2000s (Chief Executive Magazine 2005). Much of this additional land consumption has taken place in suburban or exurban areas, causing loss of farmland and open space, higher costs of infrastructure and community services, roadway congestion, racial segregation, and concentrated poverty (Katz 2000, 2002; Snyder and Bird 1998; Gordon and Richardson 1998; Daniels and Bowers 1997; Brookings 2000; Nelson and Sanchez 2005).

The negative effects of urban sprawl in Nashville have received increased scrutiny from elected officials and other interested citizens attempting to moderate urban growth. These concerns have encouraged Nashville's political leadership and its urban planners to tackle urban sprawl through a strategic development initiative (Cumberland Commercial Partners 2009). The main goal of the initiative is to moderate sprawl by directing future development closer to the city center with more affordable urban housing and increased urban transit.

The initiative has involved various instruments to moderate sprawl including zonal territorial policies (e.g., zoning and growth boundary) and acquisition policies (e.g., conservation easements, purchase of and transfer of development rights, government purchases of land for parks, and similar initiatives). Policy implementation in Nashville is particularly challenging because many of the policy instruments are often viewed as an infringement on private property rights that many Southerners hold as sacrosanct. Thus, there is interest in alternative instruments, other than zonal and acquisition types of policies, to moderate sprawl in the area.

A higher tax rate on land than on land improvement or a "land value tax" is a potential policy tool to moderate sprawl in the Nashville area because it does not directly infringe on private property rights. The land value tax was first proposed by an American political economist Henry George in the 19th Century as a way to eliminate land speculation. In theory, switching to a higher land tax and a lower tax on structures can encourage compact development. Because land is immobile and higher land taxes reduce land prices, land owners cannot avoid a tax on land values or pass it on to land users. Thus, a higher land tax motivates landowners to generate income to pay the tax. The greatest economic incentive to develop land will exist where land values are highest, which is typically adjacent to preexisting development. At the same time, a reduction in the tax rate applied to structures makes development of structures more profitable. On average, areas far from preexisting development will have low land values and taxes and, thus less economic incentive for development (Rybeck 2004).

While appealing in theory, only a handful of U.S. municipalities, including Pittsburgh and a score of towns in Pennsylvania, have implemented the land value tax. There is limited empirical evidence of the policy implications of implementing a two-rate property tax (different rates for land and structures) for sprawl management (e.g., Bourassa 1990; Brueckner 1986; Brueckner and Kim 2003; Case and Grant 1991; Mills 1998; Nechyba 1998; Oates and Schwab 1997; Skaburskis 1995). The unpopularity of land value taxation in the United States flows from two alleged legal obstacles: "uniformity clauses", which require that all taxation be applied evenly within a jurisdiction, and "Dillon's Rule", which implies that municipal corporations owe their origins to, and derive their powers and rights wholly from the legislature (Fisher 1997;

Schoettle 2003). Notwithstanding the alleged legal obstacles, the Supreme Court directly acknowledged that a land value tax was constitutional, so long as it was apportioned equally among the states (Dixler 2006). Thus, switching from the typical residential real estate property tax in the United States, in which the assessed values of land and structures are taxed equally, to a land value tax can be considered as an alternative sprawl management tool.

The objective of this research is to evaluate the land value tax as a potential tool to moderate sprawl development in the Nashville area. To achieve this objective, the hypothesis is empirically tested that a land value tax encourages more development around preexisting development than in areas distant from preexisting development. Specifically, the marginal impact of a land value tax on the probabilities of land development is hypothesized to be greater around preexisting development than the areas distant from preexisting development. The hypothesis is empirically tested using a land development model that corrects for spatial dependence.

Empirical Model

Land development decisions by a landowner at the parcel level have been modeled using discrete choice models. These models estimate the probability of land development as a function of individual parcel-level attributes (e.g., Bockstael and Bell 1998; Bockstael 1996; Cho and Newman 2005; Cho et al. 2008; Bell and Irwin 2002; Irwin, Bell, and Geoghegan 2003; Irwin and Bockstael 2002, 2004).

We suppose that y_t is a binary indicator of the choice whether to develop a parcel in time period t ($y_t = 1$) or not ($y_t = 0$). Suppose the probability follows the logistic distribution, then the probability of land development is expressed as:

(1) Prob (y_t =1) = $\frac{e^{\boldsymbol{\beta}'\mathbf{x}_t}}{1+e^{\boldsymbol{\beta}'\mathbf{x}_t}}$.

where $\mathbf{x}_t$ is a vector of exogenous variables explaining development decisions: individual parcel characteristics (i.e., distance and physical factors), neighborhood characteristics (i.e., socioeconomic factors at the census-block group level), and tax on land value. $\boldsymbol{\beta}$ is a vector of parameter to be estimated.

To control for spatial spillover effects of development from neighboring locations, equation (1) can be re-specified as:

(2) Prob (y_t =1) = $\frac{e^{\boldsymbol{\beta}'\mathbf{x}_t+\alpha' d_t}}{1+e^{\boldsymbol{\beta}'\mathbf{x}_t+\alpha' d_t}}$,

where d_t is a dummy variable indicating existence of development in the neighboring locations around a parcel in time period t and α is a conformable parameter (d_t = 1 if there is at least one developed parcel in a parcel's neighborhood in time period t, 0 otherwise).

Because the existence of current development in the neighboring locations is expected to be a function of the existence of past development in the neighboring locations, it is hypothesized that d_t is a function of (d_{t-1}, d_{t-2}, …, d_{t-p}) where p is number of time lagged periods. Following a p^{th}-order difference equation in a time series analysis, d_t can be generalized in the following vector autoregression (VAR) form (Hamilton 1994, pp. 291):

(3) $d_t = \phi_1 d_{t-1} + \phi_2 d_{t-2} + ... + \phi_p d_{t-p} + w$.

where ϕ is a conformable parameter and w is an error term capturing random disturbances. The VAR model describes the existence of development in the neighboring locations over the current period as a linear function of the existence of past development in the neighboring locations.

To the best of our knowledge, there is no method in the land development literature that suggests an adequate procedure for determining the order of the time lagged period p to capture the existence of current development in neighboring locations. On the other hand, order selection based on the Akaike Information Criterion (AIC) (Akaike 1974; Schwarz 1978; Hannan and Quinn 1979) are often applied in time series model selection. AIC is chosen as an order selection criterion in this study because the error of asymptotic normality is small and the degree of accuracy of the AIC is high for large and realistic sample sizes (Shao 1997; Shinkai et al. 2008).

A series of VAR models (3) for $p = 1, 2, \ldots, n$ generates AICs for different orders of time lagged periods. Once the p that minimizes AIC is identified, equation (2) can be re-specified by substituting d_t into equation (3).

(4) $$\text{Prob}\,(y_t = 1) = \frac{e^{\boldsymbol{\beta}'\mathbf{x}_t + \phi_1 d_{t-1} + \phi_2 d_{t-2} + \ldots + \phi_p d_{t-p} + w}}{1 + e^{\boldsymbol{\beta}'\mathbf{x}_t + \phi_1 d_{t-1} + \phi_2 d_{t-2} + \ldots + \phi_p d_{t-p} + w}}.$$

Equation (4) can be estimated for the full sample and a separate regression for each of the sample regimes determined by the existence of past development in the neighboring locations (d_{t-1}, d_{t-2}, …, d_{t-p}). For example, if the optimal time lag is identified as $p = 2$, sample regimes are divided into four ($d_{t-1} = 1$ and $d_{t-2} = 1$; $d_{t-1} = 1$ and $d_{t-2} = 0$; $d_{t-1} = 0$ and $d_{t-2} = 1$; and $d_{t-1} = 0$ and $d_{t-2} = 0$).

A likelihood ratio (LR) test is used to verify whether the model should be estimated with separate regressions for the four sample regimes or a single, pooled regression. Denoting the maximum log-likelihoods for the four sample regimes and pooled regressions (with time-lagged dummy variables in the equation) as $f_{[1]}$, $f_{[2]}$, $f_{[3]}$, $f_{[4]}$, and f_P, with corresponding numbers of parameters $k_{[1]}$, $k_{[2]}$, $k_{[3]}$, $k_{[4]}$, and k_P, then the LR statistic $2(f_{[1]} + f_{[2]} + f_{[3]} + f_{[4]} - f_P)$ is Chi-square distributed with $(k_{[1]} + k_{[2]} + k_{[3]} + k_{[4]} - k_P)$ degrees of freedom.

The model can be used to evaluate the effects of alternative variables on land development. For example, the marginal effect of a land value tax on the probability of land development equals $\partial \Pr ob[y_t = 1] / \partial \tau_t = f(\boldsymbol{\beta}'\mathbf{x}_t + \phi_1 d_{t-1} + \phi_2 d_{t-2} + \ldots + \phi_p d_{t-p} + w)\beta_{\tau_t}$, where β_{τ_t} is the coefficient on the land value tax and f is the logistic density function given by

$$\gamma(\boldsymbol{\beta}'\mathbf{x}_t) = \Lambda(\boldsymbol{\beta}'\mathbf{x}_t + \phi_1 d_{t-1} + \phi_2 d_{t-2} + \ldots + \phi_p d_{t-p} + w)[1 - \Lambda(\boldsymbol{\beta}'\mathbf{x}_t + \phi_1 d_{t-1} + \phi_2 d_{t-2} + \ldots + \phi_p d_{t-p} + w)]$$

where Λ is logistic distribution.

The parameters in equation (4) are estimated by the generalized method of moments (GMM) estimator to address potential interactions in land development (Conley 1999; Conley and Udry 2005). Heteroskedasticity consistent standard errors are estimated to remove residual spatial autocorrelation caused by codetermined development decisions. The covariance-matrix estimators are modified to allow regression disturbance terms to be correlated across neighborhood parcels as a general function of their Euclidean distances. The error term is permitted to be conditionally heteroskedastic and spatially correlated across parcels using the spatial GMM approach.

Study Area and Data

Four major GIS data sets are used to collect data for Nashville-Davison County, Tennessee: individual parcel data, census-block group data, boundary data, and environmental feature data. The individual parcel data are obtained from the Metro Planning Department, Davidson County (MPD 2008) and the Davidson County Tax Assessor's Office. The study area consists of 467 census-block groups. Information from these census-block groups such as per capita income and unemployment rate is assigned to parcels located within the boundaries of the census-block groups. Boundary data, i.e., high school districts and jurisdiction boundaries, are obtained from MPD. Environmental feature data, i.e., water bodies and golf courses, are collected from Environmental Systems Research Institute Data and Maps 2004 (ESRI 2004). Other environmental feature data, i.e., shape files for railroads and parks, are acquired from MPD.

Definitions of variables used in the regressions are listed in Table 1 and detailed statistics for the variables are reported in Table 2.

Dummy variables indicating the existence of development in the neighboring locations around parcel i in time period t, $t\text{-}1$,…, *and* $t\text{-}p$ (d_t, d_{t-1},…, and d_{t-p}) are created based on a minimum threshold spatial matrix using GeoDa's (GeoDa Center 2009) default distance threshold (Anselin 2004). The default distance threshold ensures that every observation has at least one neighbor observation. When observations are coupled with their closest observations, the minimum threshold is the distance between the pair whose distance is the longest among the pairs. The minimum threshold spatial matrix enables the creation of a dummy variable that takes on a value of 1 if any development exists in a time period within the minimum threshold and 0 otherwise. The default distance in our data is identified as 3,657 feet (about 0.9 mile). The correlation decreases as the time lag increases. For example, the correlations of 2007 dummy variable with dummy variables for 2006, 2000, 1997, and 1994 are 0.54, 0.36, 0.21, and 0.17, respectively.

At the start of 2007, the number of vacant arcels in Nashville-Davison County was 22,244. Developed parcels are defined as single-family houses that were built during 2007. Only single-family housing development is considered in the model because the development decision process for different land uses are influence by different development factors and property characteristics. After eliminating parcels developed to other land uses, 19,606 useable observations remained. Of the 19,606 parcels, 1,718 parcels (8.8 %) were developed for single-family housing during 2007. The average size of undeveloped parcels was 162,885 square feet (3.7 acres), whereas the average size of parcels developed for single-family housing was 17,102 square feet (0.4 acres). Smaller sizes of developed parcels indicate that parcels are segmented when they are developed for a single-family housing.

Empirical Results

Figure 1 shows the percentage change in AIC with respect to an increase in the time lag period *p* where time period *t* is 2007. A significant drop of AIC (8%) is observed from $d_{2007} = \phi_1 d_{2006} + w$ to $d_{2007} = \phi_1 d_{2006} + \phi_2 d_{2005} + w$. Beyond the 2005 lagged period, the percentage change in AIC remains relatively small (within 2%), indicating insignificant gain of goodness-of-fit with additional time lagged variables in the model. Thus, equation (4) could be estimated for the full sample with d_{2006} and d_{2005} in the model and a separate regression for each of the four sample regimes, i.e., [1] $d_{2006} = 1$ and $d_{2005} = 1$, [2] $d_{2006} = 1$ and $d_{2005} = 0$, [3] $d_{2006} = 0$ and $d_{2005} = 1$, and [4] $d_{2006} = 0$ and $d_{2005} = 0$. Parcels in sample regimes [1] and [2] were the most developed (11% and 6% of the parcels developed, respectively). See Figure 2 for spatial distributions of the sample regimes.

The null hypothesis that all slope parameters (i.e., except the constants) are equal is rejected (LR =230.44, df = 54, p-value < 0.001), suggesting that the inclusion of time-lagged dummy variables in the pooled regression does not fully capture spatial differences in the existence of preexisting development in neighboring locations and, thus, separate regressions for the four sample regimes are appropriate.

Marginal effects based on parameter estimates for each sample regime using the spatial GMM approach are presented in Table 3. The effects of proximity to water body, proximity to golf course, proximity to central business districts (CBD), proximity to greenway, proximity to railroad, proximity to interstate highway, and slope variables are found to be significant at the

5% level in at least one of the four sample regimes. The discussion below is limited to variables that are statistically significant at the 5% level.

Parcels farther from water bodies were more likely to be developed for single-family housing for sample regime [2]. The negative effects of proximity to water bodies may be explained by the fact that undeveloped land closer to water bodies was already developed prior to 2007. The parcels closer to a golf course were more likely to be developed for sample regimes [2] and [4], reflecting the recent development of golf courses within residential communities in suburban area (e.g., River Landing Subdivision near Riverside Golf Course and Pennington Bend Chase Subdivision near Springhouse Golf Course). Parcels farther from the CBD were more likely to be developed for spatial regime [1]. The negative effects of proximity to the CBD reflect a scarcity of developable parcels closer to the CBD. An increase in distance to a railroad increases the probability of development for sample regimes [1] and [2]. The negative effect of proximity to a railroad is likely due to noise disamenities or inconvenience. A decrease in distance to an interstate highway increases the probability of development for sample regime [3] and decreases the probability of development for sample regime [4]. The negative effect is likely due to noise disamenities associated with interstate highway traffic, whereas the positive effect is likely due to the convenience of being closer to the interstate highway. A decrease in slope (i.e., flatter building surfaces) increases the probability of development for sample regimes [1], [2], and [4], whereas the opposite is the case for sample regime [3].

The probability of development increases as the tax rate on land value per acre increases in all four sample regimes (with current tax rate of \$2.69 per \$100 of assessed value in the county per year). An increase in the tax rate on land value per acre by \$1,000 (or tax rate of \$3.84 per \$100 of assessed value per year) increases the probability of development by 25%, 4%, 5%, and 1% for sample regimes [1], [2], [3], and [4], respectively. These results reveal a substantially greater marginal effect for sample regime [1] than for the other sample regimes, with the lowest marginal effect for sample regime [4]. This finding implies that marginal effect of a land value tax on the probability of land development in 2007 is greater for parcels with neighboring development in 2006 and 2005 than for parcels that did not have developed neighboring parcels in 2006 and 2005. Thus, the marginal effect of a land value tax on the probability of land development is greater around preexisting development than in areas distant from preexisting development. This finding empirically validates the hypothesis that a land value tax encourages more development around preexisting development than in areas where preexisting development does not exist.

Conclusions

Compact development is a key component in reducing the pressure of urban sprawl. Compact development can be achieved by encouraging the development of vacant land parcels in neighborhoods where development already exists. Our objective was to determine if a land value tax would be an effective policy tool in promoting compact development in Nashville, TN. A land development model was used to evaluate the hypothesis that a land value tax increases the probability of land development in neighborhoods where development already exists relative to areas distant from preexisting development. Results show that the marginal effect of a land value tax on the probability of a vacant lot being developed in 2007 is greater for parcels in neighborhoods with preexisting development in 2006 and 2005 than for parcels in neighborhoods without preexisting development in those years. This finding suggests that land value taxation could be used to design compact development strategies to address sprawl in the Nashville area.

This research benefits local community leaders involved with land-use policy decision making and property tax law in the Nashville area. The quantitative estimates produced by this research are uniquely suited to those policy makers as they consider land value taxation as a policy tool to moderate sprawl development. Further, the methods and procedures presented in this research could be used by policy makers in other metro areas where similar data are available.

The heterogeneous effects of a land value tax across the sample regimes specified in this research can help decision makers establish land use development patterns that make the most efficient and feasible use of existing infrastructure and public services. The results also provide guidelines for new development that maintains or enhances the quality of the Nashville area. For example, policy makers could make more efficient use of existing infrastructure and public services in previously developed parts of the Nashville area through land value taxation that encourages growth toward locations where development, infrastructure and public services already exist.

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Table 1. Names and descriptions of variables

Variables	Description
Develop	Dummy variable for development in 2007 (1 if the single family house was built in 2007, 0 if no improvement until 2007)
Lot size (1,000 feet^2)	Lot size in 1,000 square feet
Per capita income (1,000 $)	Per capita income in thousand dollars in 2000
Housing density	Housing density per square feet in 2000
Travel time to work (min)	Average travel time to work in 2000
Unemployment	Unemployment rate in 2000
Vacancy	Vacancy rate in 2000
ACT	Average composite score of American College Test by high school district in 2007
Water (1,000 feet)	Distance in 1,000 feet to the nearest water body
Park (1,000 feet)	Distance in 1,000 feet to the nearest park
Park size (1,000 feet^2)	Park size in 1,000 square feet to the nearest park
Golf (1,000 feet)	Distance in 1,000 feet to the nearest golf course
CBD (1,000 feet)	Distance in 1,000 feet to CBD
Greenway (1,000 feet)	Distance in 1,000 feet to the nearest greenway
Rail (1,000 feet)	Distance in 1,000 feet to the nearest railroad
Interstate (1,000 feet)	Distance in 1,000 feet to the nearest interstate highway
Slope (°)	Slope in degree at the place of parcel
Tax on land value per acre ($)	Amount of tax in dollars on land value per acre in 2007
Development dummy	d_t = 1 if there is at least one developed parcel in a parcel's neighborhood in time period t, 0 otherwise

Table 2. Descriptive statistics

Variables	Pool	[1] $d_{2006} = 1$ and $d_{2005} = 1$	[2] $d_{2006} = 1$ and $d_{2005} = 0$	[3] $d_{2006} = 0$ and $d_{2005} = 1$	[4] $d_{2006} = 0$ and $d_{2005} = 0$
Develop	0.088	0.112	0.056	0.014	0.014
	(0.283)	(0.315)	(0.230)	(0.117)	(0.117)
Lot size	150.111	72.649	268.174	288.484	430.343
(1,000 feet^2)	(637.566)	(334.516)	(704.363)	(926.932)	(1,274.457)
Per capita income	22.808	22.707	24.133	22.171	22.795
(1,000 $)	(13.072)	(14.286)	(11.238)	(8.236)	(8.218)
Housing density	1.237	1.442	0.782	0.778	0.640
	(1.275)	(1.316)	(1.102)	(1.066)	(0.850)
Travel time to	23.619	23.102	25.557	24.789	24.579
work (min)	(4.652)	(4.331)	(4.273)	(4.383)	(5.968)
Unemployment	0.055	0.059	0.043	0.042	0.049
	(0.054)	(0.056)	(0.025)	(0.047)	(0.058)
Vacancy	0.069	0.072	0.055	0.054	0.067
	(0.049)	(0.050)	(0.035)	(0.045)	(0.052)
ACT	17.731	17.777	17.433	17.614	17.738
	(1.441)	(1.445)	(1.365)	(1.433)	(1.447)
Water	6.929	6.522	8.611	7.371	7.824
(1,000 feet)	(4.613)	(4.357)	(5.430)	(5.128)	(4.715)
Park	10.360	8.916	14.969	13.406	13.703
(1,000 feet)	(7.587)	(6.477)	(9.256)	(8.586)	(8.673)
Park size	5,067.063	4,695.516	4,510.264	4,905.090	7,598.140
(1,000 feet^2)	(12,100.000)	(10,900.000)	(11,700.000)	(14,200.000)	(16,600.000)
Golf	31.102	27.758	40.619	40.786	38.291
(1,000 feet)	(17.767)	(15.813)	(20.068)	(21.420)	(18.043)
CBD	46.080	41.692	59.709	57.500	55.399
(1,000 feet)	(24.570)	(23.628)	(22.459)	(21.975)	(24.478)
Greenway	17.362	14.892	24.643	25.349	22.075
(1,000 feet)	(12.565)	(9.459)	(16.667)	(17.264)	(16.154)
Rail	7.647	6.221	12.032	13.807	9.445
(1,000 feet)	(7.988)	(5.762)	(10.127)	(13.036)	(10.328)
Interstate	11.655	10.429	15.730	15.470	13.760
(1,000 feet)	(9.178)	(8.112)	(10.389)	(10.198)	(11.365)
Slope (°)	5.296	4.397	7.864	7.456	7.448
	(4.989)	(3.771)	(6.579)	(6.704)	(6.752)
Tax on land value	(2,330.876)	2661.895	748.866	1,065.192	(2,211.803)
per acre ($)	(5,847.749)	(5,046.317)	(1,900.325)	(2,707.715)	(10,690.380)
N	19,606	14,068	1,719	1,293	2,526

Note: Numbers in parenthesis are standard deviations.

Table 3. Estimated Marginal Effects from the Land Development Model

	[1] $d_{2006} = 1$ and $d_{2005} = 1$	[2] $d_{2006} = 1$ and $d_{2005} = 0$	[3] $d_{2006} = 0$ and $d_{2005} = 1$	[4] $d_{2006} = 0$ and $d_{2005} = 0$
ln(Lot size)	0.000 (0.003)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)
ln(Per capita income)	0.004 (0.019)	0.013* (0.007)	0.005 (0.008)	-0.004 (0.003)
Housing Density	-0.007 (0.007)	0.000 (0.002)	0.000 (0.001)	0.000 (0.001)
Travel time to work	0.000 (0.002)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)
Unemployment	-0.347* (0.194)	-0.010 (0.044)	-0.036 (0.056)	-0.001 (0.020)
Vacancy	-0.281 (0.213)	-0.014 (0.044)	0.021 (0.057)	0.002 (0.029)
ACT	0.001 (0.007)	-0.001 (0.002)	-0.002 (0.002)	0.001 (0.001)
ln(Water)	-0.005 (0.006)	0.005*** (0.002)	0.000 (0.001)	0.001 (0.001)
ln(Park)	0.004 (0.010)	-0.001 (0.001)	0.001 (0.002)	0.001 (0.002)
ln(Park size)	-0.005 (0.004)	0.000 (0.001)	-0.002 (0.001)	-0.001 (0.000)
ln(Golf)	0.016 (0.010)	-0.012*** (0.003)	-0.001 (0.002)	-0.004** (0.002)
ln(CBD)	0.042** (0.018)	0.009* (0.005)	0.009* (0.005)	0.002 (0.003)
ln(Greenway)	-0.003 (0.005)	-0.001*** (0.000)	0.000 (0.001)	0.003* (0.002)
ln(Rail)	0.022*** (0.006)	0.007*** (0.002)	0.001 (0.001)	0.000 (0.001)
ln(Interstate)	-0.008 (0.009)	0.000 (0.002)	-0.002*** (0.001)	0.004** (0.002)
Slope	-0.003** (0.001)	-0.001** (0.000)	0.001** (0.000)	-0.000** (0.000)
ln(Land tax per acre)	0.025*** (0.003)	0.004*** (0.001)	0.005*** (0.001)	0.001*** (0.000)
N	14,068	1,719	1,293	2,526

Note: The asterisks represent p value based on spatial standard error. * p < .1, ** p < .05, and *** p < .01. Numbers in parenthesis refer standard errors.

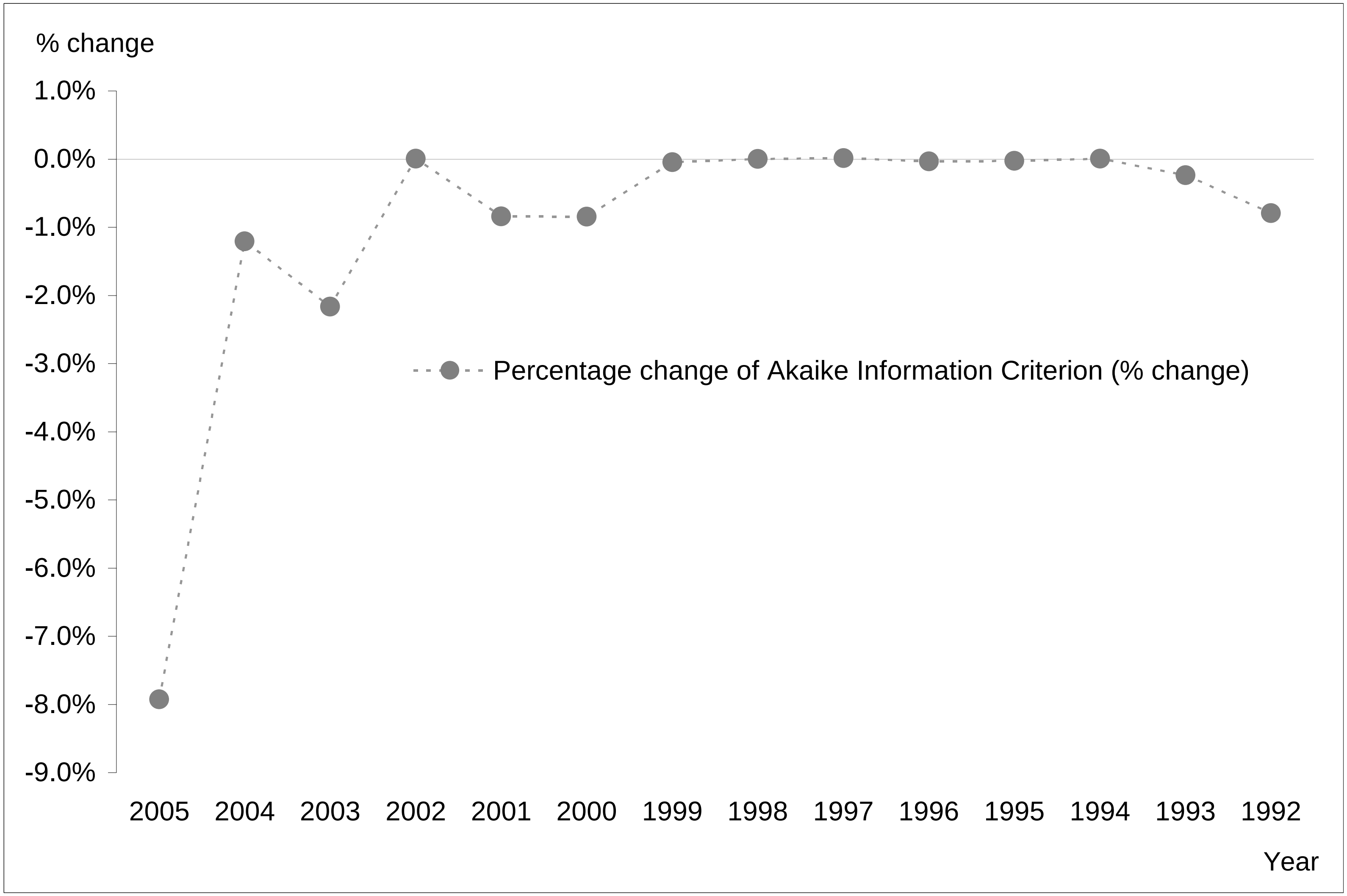

Figure 1. Percentage change of AIC with respect to the increase in the time lagged period

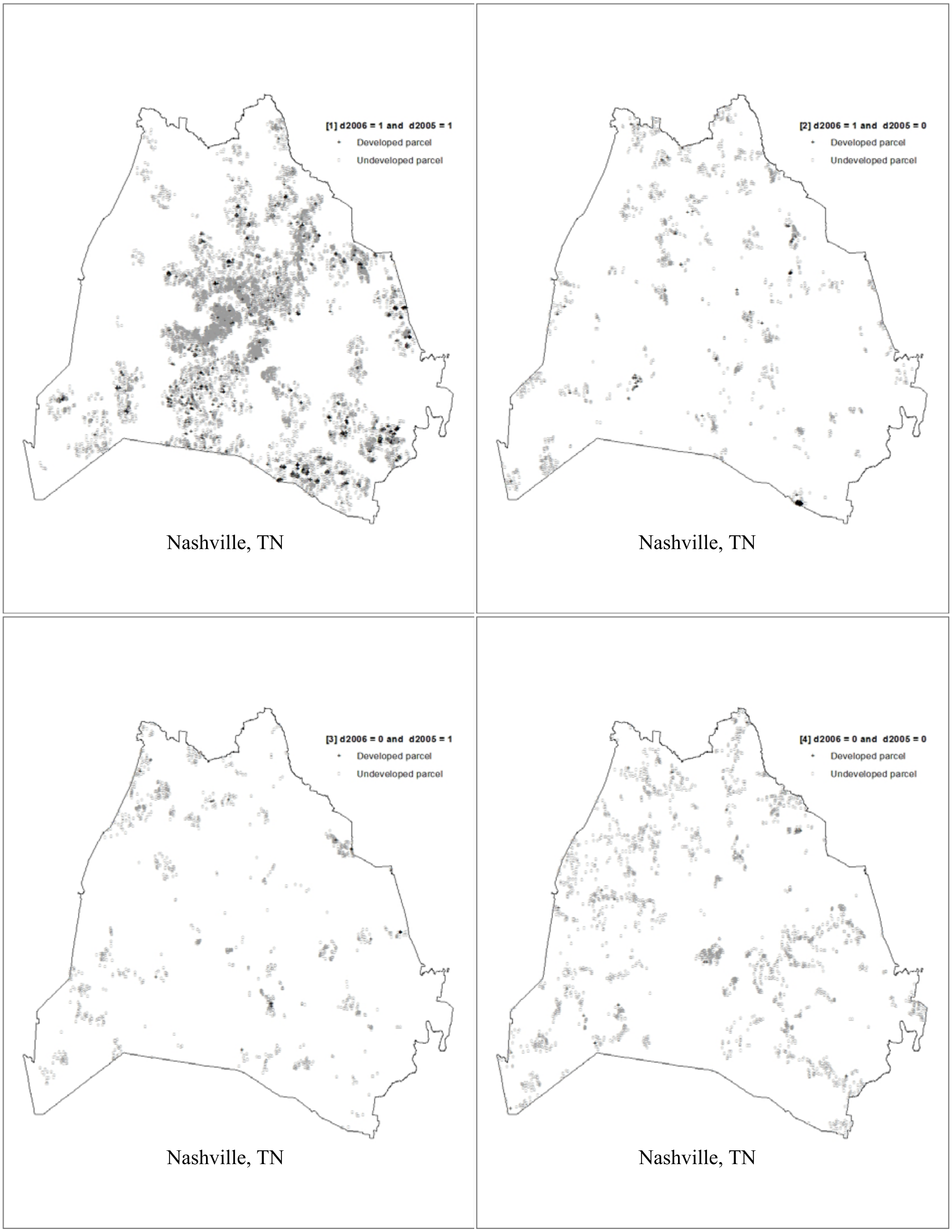

Figure 2. Spatial distributions of the sample regimes