UC Irvine

UC Irvine Previously Published Works

Title

Land Use Change Dynamics in Southern California: Does Geographic Elasticity Matter?

Permalink

<https://escholarship.org/uc/item/8550k364>

Journal

Journal of Planning Education and Research, 38(1)

ISSN

0739-456X

Authors

Kim, JH
Hipp, JR
Basolo, V
[et al.](#)

Publication Date

2018-03-01

DOI

10.1177/0739456X16688252

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed

**Land Use Change Dynamics in Southern California:
Does Geographic Elasticity Matter?**

Accepted Version

(Note: Published in *Journal of Planning Education and Research* Vol.38, No.1, pp.39-53)

Jae Hong Kim
Department of Urban Planning and Public Policy
University of California, Irvine
206E Social Ecology I, Irvine, California 92697
Phone: 949.824.0449
Fax: 949.824.8566
jaehk6@uci.edu

John R. Hipp

Victoria Basolo

Harya S. Dillon

Land Use Change Dynamics in Southern California: Does Geographic Elasticity Matter?

Abstract: This article examines how municipal planning contexts can shape urban land use dynamics by investigating the parcel-level land use changes in a five-county Southern California metropolitan area between 1990 and 2005. An analysis, based on a multinomial logit model, shows that land use change patterns significantly vary by municipalities that were situated in heterogeneous planning contexts. More specifically, cities with limited ability to expand their jurisdictional boundaries are found to provide more recreational areas and urban open spaces, while restricting non-conventional land uses. However, no evidence of a shift from single-family to multi-family residential development is detected for such cities.

Keywords: Land Use; Geographic Elasticity; Municipal Planning; Density; Growth Management

Acknowledgements: This research was funded in part by a grant to the Metropolitan Futures Initiative in the School of Social Ecology at the University of California, Irvine. An earlier version of this paper was presented at the 53rd annual meeting of the Western Regional Science Association. The authors thank Mark Partridge and other conference participants for providing helpful comments and the Southern California Association of Governments and Bumsoo Lee for sharing their data.

Introduction

Given the importance of land use in urban planning and other policy decisions, numerous studies have been devoted to better understand the nature of land use change dynamics. In particular, recent years have witnessed a growing number of empirical studies utilizing advanced GIS technology and other computing resources that enable researchers to analyze complex land use changes more accurately with spatially-explicit, high-resolution data. These recent studies have greatly contributed to expanding and solidifying our knowledge base about land use dynamics by revealing the effects of various factors, including biophysical conditions, locational attributes, and neighborhood characteristics (see e.g., Bockstael, 1996; Irwin and Bockstael, 2002; Munroe and Müller, 2007; Huang et al., 2009).

A great deal of attention also has been paid to how land use can be affected by policy interventions that target certain land use outcomes or other objectives. For instance, Wu and Cho (2007) examined how the probability of land development is influenced by a range of government interventions in land use, such as development guidelines, zoning ordinances, and state land use planning. Other studies have tested the effects of preservation policies (Lynch and Liu, 2007; Towe et al., 2008; Butsic et al., 2011; Zhong et al. 2011) and growth management programs, both regulatory and incentive-based approaches (Irwin and Bockstael, 2004; Cho et al., 2008; Hanlon et al., 2012).

However, there is a dearth of research examining the importance of more fundamental factors, such as local politics, institutional environments, and other contextual circumstances, that can shape land development dynamics in urban areas. Land use in and around a city can be influenced substantially by the city's attitudes towards growth and/or resource management.

These attitudes are sometimes visible in the form of a discernible action (e.g., zoning, growth controls, building permit caps, etc.), but often can be invisible or not reflected by policy activity. Thus, in analyzing and understanding the nature of urban land use, it is crucial to reflect the unique situations that can determine a city's attitudes, going beyond a simple control for the presence or absence of a specific policy action.

In the U.S., metropolitan areas often consist of a large number of municipalities, ranging from one or few central cities and dozens of old (or inner-ring) suburbs to newly incorporated cities/towns in more remote locations. While all of these municipalities possess their own authorities for land use planning and regulation, they are situated in quite distinct circumstances and thus tend to have varying municipal planning contexts. In particular, a growing number of localities in many large metropolitan areas are physically built out. In addition, these cities (which were mainly created in the era of early American industrialization and (sub)urban expansion) have become surrounded by newly incorporated places (i.e., territorially locked-in and therefore geographically inelastic – see e.g., Rusk 1995) and have lost the ability to expand their jurisdictional boundaries.

Such territorial constraints combined with the depletion of developable land can put these municipalities in a situation wherein they need to use the limited land resources efficiently to attain their own fiscal or other objectives. Land use patterns in these municipalities can significantly differ from those of localities that can annex and absorb hinterland areas more easily, although existing research neglects the influences of such contextual differences. When constrained, municipalities may tend to favor more compact development (i.e., land use intensification). Urban open space provision may also be promoted within these municipalities

as a means to improve the quality of their built environments, while those without territorial constraints (i.e., elastic localities at the edge) would not be equally incentivized to do so.

Do territorial constraints lead to a more intensive use of land resources, urban open space provision, or other systematic differences in land use? More broadly, how do urban land use change patterns vary across cities with different municipal planning contexts? This study empirically examines these questions through an investigation of parcel-level land use changes in a five-county (Los Angeles, Orange, Riverside, San Bernardino and Ventura counties) Southern California metropolitan area. This is accomplished by employing a multinomial logit model that is designed to determine the effects of the variables on land development for various urban purposes, while controlling for other factors. The remainder of this article begins with a brief discussion of the determinants of urban land use changes. The next section describes the empirical analysis of parcel-level land use change, including the model, variables, and the data. Results are then presented and interpreted in the following section, and the article concludes with a summary of the study and research implications.

Determinants of Land Use Change

Land use changes can be characterized and explained in a variety of ways (see e.g., Briassoulis, 2000; Walker, 2004; Koomen and Stillwell, 2007, for more detailed explanations of various theories and models). Urban economists and many other social scientists have often viewed land use as an outcome of the choice made by land owners who seek to maximize the amount of expected returns from their land resource, based on the well-known bid-rent theory or some other

microeconomic foundation (see e.g., Irwin and Geoghegan, 2001; Bella and Irwin, 2002; Bakker and van Doorn, 2009). Another group of researchers have defined land use change dynamics as an evolutionary process and modeled land use conversion from an ecological perspective using cellular automata or other techniques (see e.g., White and Engelen, 1993; White et al., 1997; Almeida et al., 2003 and 2008). Recently, agent-based modeling and some hybrid approaches have also gained popularity, as they provide a flexible and effective environment for the analysis of land use change (Parker et al., 2003; Verburg et al., 2004; Irwin, 2010).

Although the approaches to framing and modeling land use changes do vary, there are multiple groups of determinants that are commonly found significantly related to land use changes. First of all, most empirical land use studies, if not all, have detected sizable effects of the biophysical conditions of individual land parcels (or land cells in the cases of cell-based land use change analyses) on their development probabilities. These features include parcel size, slope, and soil type that determine the cost of (or feasibility for) land development. Some recent studies, such as those by Carrion-Flores and Irwin (2004), Zhou and Kockelman (2008), and Wang et al. (2011), have also considered parcel shapes (e.g., perimeter-to-area ratio) as a determinant of land use changes, since some land uses cannot be easily accommodated in a parcel with a certain shape.

Another set of explanatory variables taken into account are accessibility measures that represent locational advantages/disadvantages of each land parcel. In recent GIS-based spatially-explicit land use research, it has become the norm to include the proximity to employment centers, transportation hubs/networks, and other natural or man-made amenities, because urban land use dynamics cannot be thoroughly explained without the consideration of such locational factors that play a significant role in determining the market profitability of development. While

the Euclidean distance has been widely used to construct the accessibility metrics, more recent studies have sometimes utilized the expected travel times, when the information is available, to better reflect the real-world implications of the variables (see e.g., Braimoh and Onishi, 2007; Wang and Kockelman, 2009; Deal et al., 2013).

Neighborhood characteristics (i.e., attributes of the neighborhood in which each land parcel is located) also appear important in explaining where a certain type of land development is more likely to occur and why. At least two motivations seem to be behind the consideration of neighborhood characteristics in empirical land use analyses. First, neighborhood variables are included to reflect the potential effects of socio-economic factors, such as income (e.g., Wang and Kockelman, 2009), educational attainment (e.g., Wilson and Song, 2010), and school quality (e.g., Irwin and Bockstael, 2004), which often vary significantly across neighborhoods. Second, neighborhood-level land use mix and/or share of each type of land use are employed to capture the interactions and spillover effects that are likely to exist among land use decisions (see e.g., Irwin and Bockstael, 2004; Braimoh and Onishi, 2007; Zhou and Kockelman, 2008).

Other major determinants of land use changes include macroeconomic situations and various forms of government interventions. Macroeconomic factors (e.g., regional population and employment growth trajectories) are considered important when land use conversions over multiple time spans are analyzed, as the macroeconomic growth rates can govern the rise and fall of the aggregate demand for new development in study regions (see e.g., Verburg, 2004; Kim and Hewings, 2011; Kim, 2013). Also, as mentioned previously, consideration has been given to the effects of various policies, implemented by local, state, or federal government units (see e.g., Irwin and Bockstael, 2004; Wu and Cho, 2007; Hanlon et al., 2012).

One important layer missing in the literature is municipal planning contexts that could largely shape urban land use dynamics not only through the implementation of visible policy actions, but also via other channels that cannot be easily reflected by the policy, macroeconomic, or neighborhood variables discussed above. In contemporary metropolitan areas in the U.S. and many other countries, municipalities (i.e., cities and towns) are the entities in which collective visions and strategies for growth (or growth controls) are mainly formulated through various forms of interactions among diverse stakeholders. At the same time, municipalities are the primary authorities managing land use through a series of everyday planning reviews, negotiations, and approvals based on the collective visions/strategies and other interests/concerns shared among the residents. Therefore, land use dynamics, particularly in urban areas where systematic coordination of land use is critical due to the concentration of various socio-economic activities, could not be thoroughly understood without consideration of municipal planning contexts.

Arguably, there is no single, perfect method to measure municipal planning contexts and take them into account in investigating urban land use change dynamics. However, the contextual circumstances can be considered to some extent by quantifying individual localities' conditions associated with their land resources and development opportunities/challenges. These include not only municipal growth trajectories but also their visions for growth or development. Moreover, future availability of land resources (or ability to expand jurisdictional boundaries) can be crucial, as it shapes the formulation of local land use planning strategies.

The territorial situation can shape each municipality's attitude toward growth and/or resource management that underlies various local policies and their implementation. In the U.S., municipal boundary expansion has played a pivotal role in enabling cities to grow and achieve

their visions (Jackson, 1985; Edwards, 2008). Stakeholders, including both residents and business groups, can also obtain substantial gains from the expansion (Fleischmann, 1986). Difficulties of expansion can deprive them of the benefits annexation could bring and pose various challenges. In terms of land use, an inelastic city may have to focus on the efficient use of land resources within its jurisdictional boundary, whereas another city may easily absorb additional hinterlands and thus establish different land use/development strategies. When geographically constrained and built out, municipalities may provide more urban open space within their jurisdictional boundaries as they can no longer take advantage of proximity to natural areas. The territorial constraint can also lead to an intensification of urban land use, such as a shift toward more multi-family residential development. It is, however, also possible for the municipalities to resist such a fundamental shift due to institutional inertia or local political coalition (see e.g., Lewis, 1996; Bronin, 2006 and 2008). The so-called ‘externality’, ‘fiscal’, and ‘exclusionary’ motives (Ihlanfeldt, 2004, p.273-275) can also prevent them from being more proactive or inclusive.

It is worthwhile to note that a wide array of theories related to urban development provide useful ways to think about why land use changes are likely to be affected by unique opportunities/challenges arising in each municipality (although this is not the main focus of the present study). Multiple branches of thought, including the viewpoints of structuralists, institutionalists, and public choice theorists, suggest that urban development dynamics can be significantly influenced by complex politics, governance settings, or bureaucratic/democratic procedures, rather than simply determined by independent land owners or land developers (see e.g., Lewis, 1996; Guy and Henneberry, 2000; Byun and Esparza, 2005; Adams and Tiesdell, 2010). The importance of the municipality’s own characteristics also has been highlighted by

many studies on the behaviors of local governments, not only in implementing certain policies but also in conducting its budget allocation and incentive provisions (see e.g., Basolo, 2000; Pendall, 2001; Brody et al., 2006; Lewis, 2002; Lubell et al., 2009).

This article provides an empirical analysis of urban land use change in which explicit attention is paid to the potential influences of individual municipalities' territorial situations as a key aspect of municipal planning contexts. The next section presents the methods, data, and variables used in this analysis.

Methodology, Variables and Data

Study Area

To examine how municipal planning contexts can shape urban land use dynamics, this study analyzes land use changes in the Los Angeles – Long Beach combined statistical area (CSA) that consists of the following three core-based statistical areas: i) Los Angeles-Long Beach-Anaheim, CA, ii) Oxnard-Thousand Oaks-Ventura, CA, and iii) Riverside-San Bernardino-Ontario, CA, according to the most recent version (February 2013) of the Census metropolitan area delineation. In terms of population, the metropolitan region is the second largest CSA in the U.S. (about 18 million persons), and it covers Los Angeles, Orange, Riverside, San Bernardino and Ventura counties in the state of California.

In 1990, there were 168 municipalities (i.e., incorporated areas – cities and towns) in the region, ranging from the City of Vernon, predominantly industrial space with an extremely small population (152, according to Census 1990), to the City of Los Angeles in which approximately

3.5 million people resided (figure 1). These localities have their own authorities for the management of land resources in and around their jurisdictional boundaries. Furthermore, they play key roles in developing their collective visions and strategies and exercising relevant actions, although the state government and regional planning agencies, such as the Southern California Association of Governments (SCAG), are also involved to some extent. Importantly, in California, the state mandates that each city and county prepare a general plan. This comprehensive plan is “the ‘constitution for future development’ ... [that] expresses the community’s development goals and embodies public policy relative to the distribution of future land uses, both public and private. ... the policies of the general plan are intended to underlie most land use decisions.” (California Governor’s Office of Planning and Research, 2003, p. 10). Although the state requires a general plan to guide development, the control of land use-related decision making largely rests with individual municipalities, as in other states. Consequently, substantial variation in land use decisions (or their attitudes towards various types of development) exists across municipalities, as revealed in annual planning surveys conducted by the California Governor’s Office of Planning and Research.

<< Insert Figure 1 about here >>

Furthermore, these municipalities are situated in quite distinct contexts. The City of Los Angeles, for instance, has the vision of “World Class City / Quality of Life” through “comprehensive zoning code reform, ... process improvements, ... [utilization of] development services technology” and other endeavors (City of Los Angeles, 2011, p.vii-ix). Some other cities (e.g., the City of Irvine) have become emerging job centers in the region and now seek innovative ways to accomplish their future goals. However, many other municipalities have experienced difficulties in promoting their economic bases and/or addressing community

problems during the last few decades, while the entire region has grown continuously with an average population growth rate of +1%/year between 1990 and 2010 (Hipp et al., 2012). In addition, as shown in figure 1, many of the municipalities (located in southern Los Angeles County and northern Orange County) were territorially locked in, whereas localities in other parts of the region remained elastic.¹ In other words, attitudes toward growth, as well as resource availability and management, differ by place, and this difference results in significant variation in municipal planning contexts that may possibly affect the land use dynamics within individual municipalities.

Model

To empirically analyze the effects of municipal planning contexts on urban land use change, this study employs a multinomial logit model that has been used by McMillen (1989), Zhou and Kockelman (2008), Fragkias and Geoghegan (2010) and others addressing multiple choice options. In the model, the land use change decision is assumed to be made by individual land owners who seek to maximize the expected net profit by converting their parcel's land use or maintaining the existing land use without any conversion. As explained by Bockstael (1996), Irwin and Bockstael (2002), and subsequent studies, a parcel (referred to as k) with an existing land use i can experience a conversion to land use j at time t , if

$$R_{k,j,t|i} - C_{k,j,t|i} \geq R_{k,m,n|i} - C_{k,m,n|i}$$

for all land uses m (including the existing land use i that indicates no conversion) and all possible conversion time points n (e.g., this year, where $R_{k,j,t|i}$ and $C_{k,j,t|i}$ represent the expected amount of the future stream of returns and the cost for conversion, respectively). In other words, this type of land use conversion (from land use i to j at time t) can happen if the expected amount of

profit obtained through the conversion (i.e., $R_{k,j,t|i} - C_{k,j,t|i}$) exceeds that of any other alternatives with a different land use type and/or a different timing.

When a single time span is considered as done in this study (as explained in the following sub-section), the choice problem can be simplified. In this case, assuming that both R and C can be explained by a set of determinants X and that there are M land use choice options including the existing land use i , a multinomial logit model with the following probability equation can be applied.

$$P(y_{k|i} = j) = \frac{\exp(\beta_{ij} \cdot X_k)}{\sum_{m=1}^M \exp(\beta_{im} \cdot X_k)}$$

where β_j indicate the coefficients to be estimated to determine the effect of each (potential) determinant (i.e., each element of X) on the probability of the conversion from land use i to j .

Variables & Data

In this study, consideration is given to the parcels undeveloped (e.g., vacant or agricultural lands) in year 1990. These parcels ended up with one of the following six types of land use in year 2005: 1) Single-family Residential, 2) Multi-family Residential, 3) Commercial & Industrial, 4) Recreational & Urban Open Space, 5) Other Types of Development, and 6) (Remained) Undeveloped.² The land uses are identified based on the SCAG's parcel-level land use shapefile, one of the most important sources of information used in this study. The third category, Commercial & Industrial, covers a range of business activities including retail stores, offices, manufacturing sites, and public facilities. Recreational & Urban Open Space mainly represents community/regional parks and golf courses, while the category, Other Types of Development, includes trailer parks, mobile home courts, and properties with mixed land uses. Generally, land parcels falling in the last development category (i.e., Other Types of Development) have more

flexibility to be converted to other uses in the future, although some exceptions exist. A high proportion of these parcels, particularly mobile home sites, is found in Riverside County (e.g., Hemet, Indio, Perris) where population has been growing rapidly over the last several decades.

As discussed previously in this article, the land use changes can be affected by a variety of factors, ranging from biophysical conditions and accessibility measures to municipal planning contexts. First, to capture the influences of biophysical conditions, each parcel's size, slope, and the area-to-perimeter ratio are taken into account. For accessibility measures, the present analysis considers each parcel's distances to the metropolitan area's central business district (located in Los Angeles downtown), employment sub-centers, beaches, airports, freeways, and public transit stations. Similar to previous research, a set of neighborhood variables (aggregated at the Census block group) are also incorporated into the analysis: each neighborhood's median income, educational attainment, population density, and land use compositions. A dummy variable, indicating the parcels within the boundaries of protected wilderness areas (e.g., San Jacinto Wilderness area), is also included in the list of explanatory variables to control for the impacts of land use regulations to the extent possible. By excluding the parcels outside of 1990 city boundaries and investigating the land use conversions during a single period of time: 1990~2005, the analysis also is designed to minimize the potential disturbance due to macroeconomic fluctuations or rural preservation policies.

In addition to the above determinants, this study attempts to capture the effects of heterogeneous municipal planning contexts which are the main interest of this work. The analysis employs a municipality-level metric (*City.Elasticity*) to represent the feasibility of an individual municipality's territorial expansion through annexation. The metric, which operationalizes the concept of Rusk's (1995) city elasticity, is computed through the following

three steps: 1) creating a 1.5-mile buffer zone for each city, 2) determining the nearest locality from all location points in the buffer zone, and 3) calculating the proportion of the area that has a shorter distance to the city than to any other surrounding municipalities (see figure 2, illustrating how the metric is computed using the example of the City of Irvine, California). It gives a value ranging from 0 to 1 that indicates the percentage of the area within each city's 1.5 mile buffer zone which is not incorporated by, or closer to, any other jurisdictions.

Figure 3 shows how the *City.Elasticity* varies within the study region. As demonstrated in the figure, many cities in the southern part of Los Angeles County and northern Orange County that were incorporated early in the (sub)urbanization history of Southern California have a small value on the metric, as they are surrounded by other municipalities and thus cannot easily expand through annexation in the future. However, in the case of some other cities, a large share of their hinterlands is available for potential annexation – this circumstance is captured by a relatively higher value for the *City.Elasticity* measure.

<< Insert Figures 2 and 3 about here >>

The present analysis also utilizes information about individual cities/towns' growth trajectories and planning activities to reflect other aspects of municipal planning contexts. More specifically, it takes into account each locality's population (*City.Pop*) and its growth rate over the past 10 years (*City.PopGR*). In addition, it reflects the variation in a locality's attitudes by identifying which municipalities adopted certain (optional) elements as part of their general plans as of 1990 (the initial year) and 1997 (the mid-year).³ Using the annual planning surveys conducted by the California Governor's Office of Planning and Research, the presence of economic development (*City.Econ*) and growth management (*City.GM*) elements is codified and used in the analysis as a proxy for the municipality's attitudes toward future growth (figures 4

and 5).⁴ The surveys, which are well established in California, collect detailed information about various dimensions of local planning for most localities in the state every year. In this study, the data for multiple survey years are used to determine the presence or absence of the selected elements in each of all 168 municipalities at two time points (i.e., in the initial year and in the mid-year) in a precise manner. If a city did not answer a survey question of interest in a particular year, we used the response from an adjacent year as the value to avoid missing data.

Table 1 provides a summary of the explanatory variables and their data sources.

<< Insert Figures 4 and 5 about here >>

<< Insert Table 1 about here >>

Results

Using the data for all undeveloped parcels in 1990 located in the 168 Southern California municipalities, the multinomial logit model is estimated, and the results are presented in table 2. First of all, *City.Elasticity*, the main variable of interest representing each locality's territorial situation, is found to have significant, negative impacts on the probability of development for single-family residential (-1.058**) and for recreational & urban open space (-1.916***), while its estimate has a positive sign for the land use conversion to other types of development (+1.733**). This finding suggests that undeveloped land parcels located in territorially constrained municipalities were more likely to be converted to single-family housing or residential/open space areas than other types of development, with all other conditions held constant. Specifically, a one standard deviation increase in *City.Elasticity* (i.e., a more elastic

geographic circumstance) reduces the odds for conversion to single family residential development by 24% and reduces the odds of conversion to recreational and urban open space development by 40%. These coefficient patterns are detected even when the multinomial logit model is estimated with the sub-groups of the parcels drawn from spatial sampling to address potential spatial autocorrelation issues (see e.g., Overmars et al., 2003; Brady and Irwin, 2011), although the level of significance varies to some extent (see Appendix 1).

<< Insert Table 2 about here >>

The significant, negative effect of the *City.Elasticity* variable on recreational & urban open space is consistent with the hypothesis that geographical constraints combined with the depletion of undeveloped land can motivate municipalities to provide more urban open space within their jurisdictional boundaries. From the perspective of locked-in localities, the provision of recreational areas and other types of urban open spaces can be perceived as a viable strategy to elevate the quality of life, whereas the municipalities at the metropolitan edge (showing a high value on *City.Elasticity*) might not need to provide additional recreational areas given the greater availability of existing open spaces within their jurisdictional boundaries and hinterlands. The negative impact on the conversion to single-family residential purposes, however, was not a fully anticipated outcome, especially if one assumes that the territorial constraint would lead to an intensification of land use or that single-family housing would be well received by edge cities rather than inelastic municipalities. The result suggests no evidence of a notable shift from single-family to multi-family residential development in the territorially locked-in cities. In terms of parcel-based land use, single-family housing tends to occupy the bulk of the developable properties in these municipalities over the past 15 years. In contrast, the municipalities with high *City.Elasticity* levels (i.e., those with the possibility of future expansion)

might be more favorable to (or appealing for) other urban land uses over single-family housing units that tended to be somewhat dominant in these places. An example appears to be other types of development whose probabilities are found to be positively associated with *City.Elasticity*. Elastic localities could accommodate these types of development which include trailer parks, mobile home courts, and properties that cannot be easily classified into one of the traditional urban land use categories. When facing a trade-off, the territorially locked-in cities tend to focus on more conventional residential development or urban open space provision rather than non-conventional uses, given the pressure to use their limited land spaces more efficiently.

Among the estimates for other city-level variables, the size of city population (logged – i.e., *City.Pop*) shows a significant, negative effect on the probability of land development for commercial and industrial uses, whereas its relationship with other land use categories is insignificant. The past (1980-1990) population growth rates (i.e., *City.PGR*) are found to affect land use change dynamics in a different manner, as it discourages development for recreational & urban open space and other types of development. In other words, open space provision or non-traditional development was less likely to take place in the cities that had to accommodate rapidly growing populations.

Regarding the local planning variables considered, the presence of the optional elements for economic development does not show a very clear pattern of association with land use change dynamics. Growth management, however, presents some notable effects. In particular, *City.GM.Mid* (i.e., the presence of the optional elements for growth management in 1997) exhibits positive coefficients not only on single-family residential (+1.143***), but also on multi-family residential (+1.179**), and commercial & industrial (+1.012***). The positive coefficients indicate that new development had been directed to the municipalities with optional

elements for growth management between 1990 and 2005 more than other places. Although the present analysis alone does not fully reveal the exact mechanism between such growth management efforts and detailed land use change, these results highlight the point made earlier in this article (note #3) that plans tend to represent the municipality's general vision and do not reflect regulatory actions aimed at suppressing development. Moreover, developers might believe that the plan's vision would eventually lead to the adoption of restrictive land use regulations and therefore rush their investment in these municipalities during this period of time. The results can also be attributed in part to the possibility that places growing quickly adopted growth management elements, but they continued to grow rapidly as the growth management plans did not function as a significant barrier to new development. Rather, a city's growth management could bring benefits to these places and thus spur development in the short run. As Nelson and Peterman (2000) contended, "To developers, growth management [can] promise more certainty." (p. 277).

Other explanatory variables in the model exhibit estimates consistent with the findings of previous research, although there are several estimated coefficients requiring careful interpretation. For instance, the land parcel size is found to have substantial effects on the probability of land development in a way that is anticipated (i.e., large parcels were more likely to be used for commercial and industrial spaces rather than residential purposes). Also, the parcel slope shows significant deterrent impacts on the probabilities for all types of urban development, as reported by other micro-level land use studies.

Furthermore, the accessibility measures demonstrate the importance of proximity to transportation infrastructure and other attractors in shaping the dynamics of urban development. More specifically, *Dist.Highway* has significant, negative impacts on the odds for conversion to

multi-family residential and commercial & industrial uses, while it shows an opposite relationship with single-family residential and other types of development, suggesting that areas nearby highways (i.e., parcels with a shorter distance to highways) tended to be developed for multi-family housing or business purposes. *Dist.Transit*, however, turns out to be insignificant for most types of development. The insignificant *Dist.Transit* estimates do not necessarily suggest that the proximity to transit stations does not matter. Rather, this finding could be attributed to the fact that most land parcels within a short threshold distance from transit stations were already developed and thus not included in the sample. Beyond a very short distance, *Dist.Transit* is not likely to modify land development probabilities significantly, when other land use change factors are controlled.

The estimated coefficients for neighborhood characteristics also reveal some informative patterns, such as a higher probability of commercial and industrial development in highly populated neighborhoods (i.e., *Nbhd.Density*) and more residential and open space development in areas with higher educational attainment levels (i.e., *Nbhd.Edu*). The neighborhood level land use variables (i.e., *Nbhd.LUMix*, *Nbhd.SFRes%*, *Nbhd.MFRes%*, *Nbhd.ComInd%*, *Nbhd.RecOS%*, and *Nbhd.OtherDev%*) that are employed to control for the interactions among various land uses demonstrate somewhat complex patterns of interrelationships, including both positive and negative effects, although the estimated coefficients generally suggest that i) a highly mixed neighborhood tends to attract further development (e.g., significant, positive effects of *Nbhd.LUMix*), and ii) a sort of agglomeration pattern exists (e.g., significant, positive effect of *Nbhd.ComInd%* on commercial-industrial development). Finally, it needs to be noted that *ProtectedAreas* is found to have a very strong, deterrent effect on every type of urban development, indicating the wilderness area preservation suppressed development as intended.

Conclusion

Land use change dynamics can be determined not only by individual parcel characteristics, but also by many other forces operating at multiple layers ranging from neighborhood level attributes to global factors. In particular, the way land resources are managed in urban settings can largely be influenced by the unique situations within individual municipalities where visions and strategies for future growth are formulated and materialized into various concrete actions. This study directed attention to the importance of the role of localities in land use decisions and examined how municipal planning contexts can affect land use changes in their jurisdictional boundaries through an empirical investigation using a parcel-level land use change (multinomial logit) model.

The results of the analysis based on the spatially-explicit land use data for the Southern California metropolitan region suggest that municipal planning contexts do matter. The cities that are territorially locked-in and therefore forced to improve the quality of their built environments with limited land resources show quite distinct patterns of land use changes compared to others that can easily expand their jurisdictional boundaries. These locked-in municipalities are found to provide more recreational areas and urban open spaces, while showing a lower tendency to consume their properties for non-conventional land uses (i.e., category 5: other types of development). However, no evidence of a shift from single-family to multi-family residential development is detected, suggesting that land use intensification remained difficult in these cities.

These findings suggest that land use analysis even when conducted with high-resolution data can be misleading without careful consideration of municipal planning contexts. A failure to take ‘municipality’ into account can also prevent us from identifying significant challenges in promoting more compact development, such as institutional inertia, local politics, and/or other barriers to reforming the way we organize our built environments. A salient dialogue (toward a more sustainable future of our cities or large metropolitan areas) can be made when more attention is paid to the life cycle of municipalities and their varying concerns and needs at the stages of creation, expansion, and locked-in. Such a long-term perspective along with stage-specific approaches would be beneficial not only for local planners who are responsible for taking care of their own municipalities but also for state or regional planning agencies who often need to guide hundreds of localities and promote interjurisdictional cooperation to achieve common goals.

It should be stressed that other city-level variables, including the presence of optional elements for growth management as well as the size of city population and the past growth trend, are also found to contribute to explaining the variation in the probability of urban land development. This finding may indicate that municipal planning contexts are formulated by multiple factors in a complex manner. The plans (which are not conventional regulations) reflect individual municipalities’ unique situations that are critical for urban land use changes as examined in this study, but largely neglected in previous research.

The present empirical analysis, admittedly, is not without limitations. Although it considers a wide range of potential determinants of urban land use change, it is likely that the list of control variables could be expanded given additional data availability. The way municipal planning contexts are quantified/measured may also need improvements. In particular, a close

investigation of the detailed content and quality of each municipality's plan could capture the planning contexts more effectively than the dichotomous variables indicating whether or not a local government has certain elements. Nevertheless, this study highlights the significance of the role of 'municipality' which has attracted little attention in the recent land use literature, by demonstrating some sizable impacts of municipal planning context variables in a parcel-level empirical analysis setting.

The study also demonstrates the need for further research on the impact of a broader range of planning contexts and other institutional circumstances on urban land use changes. How can we measure these critical factors and capture their consequences effectively? Under what circumstances do these factors tend to intersect with other forces and then create more complex trajectories of land development dynamics? Are there any creative approaches to analyzing the potential feedback effects from land use changes back to the formulation of the planning contexts? It is worthy of further study to address these issues and other relevant inquiries toward a more complete understanding of the dynamics and complexity of urban land use change processes.

Notes

¹ The territorial lock-in is not something unique to the Los Angeles – Long Beach CSA. In many other U.S. metropolitan areas, an increasing number of localities, particularly inner-ring suburbs, have experienced this issue, as American metropolises have had many newly

incorporated places and become increasingly fragmented (see e.g., Rice et al, 2014; Ulfarsson and Carruthers, 2006).

² Approximately 3.4 million parcels exist within the boundaries of the 168 municipalities under study. Although a large proportion of the parcels had been used for urban purposes in 1990, there were more than 400,000 parcels that had not been developed prior to 1990 (i.e., vacant or agricultural uses in 1990). Nearly half of these areas are found to have experienced development (i.e., conversion to one of the five categories of land uses) between 1990 and 2005.

³ California Government Code requires seven elements for the General Plan: land use, circulation, housing, conservation, open space, noise, and safety. Government Code Section 65303 permits optional elements related to physical development of the jurisdiction at the discretion of the city or county. Optional elements of general plans in California are the manifestation of a locality's vision, presumably shared by its stakeholders, and they provide relevant information about specific planning issues considered important in the place. They are not regulatory actions, but rather can be understood as a guideline and/or symbol signifying the municipality's identity and directions toward the goal (see Hopkins, 2001 for the distinction between regulations and plans). Therefore, the presence of a certain type of optional element is used as a variable that represents municipal planning contexts (as opposed to a certain policy) in this study. Also, given that a number of municipalities adopted these optional elements (particularly growth management elements) in the early 1990s, consideration is given to the presence at two different time points: 1990 (the initial year) and 1997 (the mid-year). In 1990,

there were only three municipalities having an optional element for growth management, but the number increased to 31 during the first half of the study period (i.e., 1990-1997).

⁴ In identifying the presence of these two types of elements, a range of optional elements are first grouped together and then considered an effort for economic development or growth management. For instance, the optional elements for ‘fiscal’ and ‘commerce’ as well as those under the name of ‘economic development’ are regarded as an indication of the presence of the voluntary effort for local economic development. Since 1990, cities in the Southern California region have proactively made amendments to their general plans and adopted various optional elements. As noted above, between 1990 and 1997, 28 out of 168 cities newly adopted an optional element for growth management as part of their general plan amendment. Growth management is exceptionally popular among cities in Orange County, because in 1990 voters approved a measure (Measure M) which raised infrastructure funding from sales tax and required cities to include a growth management strategy to be eligible for the infrastructure funding. The number of the municipalities with an optional element for economic development also increased substantially for the same period of time (from 23 to 63), but there doesn’t seem to be a strong county-specific effect. An economic development element is usually adopted “based upon a desire to maintain and enhance the economic character of the community while providing for a stable annual budget. ... [It] establish[es] a consistent set of policies that provide general direction to local government on how the community can focus resources [including their land areas] to retain local business, attract new industries, support the tax base, and sustain the ability to provide public services for current and future residents.” (California Governor’s Office of Planning and Research, 2003, p. 109).

Table 1. Explanatory Variables and Data Sources

Variables	Description	Data Sources
<i>Parcel.Size</i>	Log of the area of the parcel	SCAG ^a
<i>Parcel.Slope</i>	Slope of the parcel	SCAG
<i>Parcel.Shape</i>	Each parcel's perimeter-to-area ratio	SCAG
<i>Dist.CBD</i>	Log of the distance to the central business district	Lee (2007) ^b
<i>Dist.Subcenter</i>	Log of the distance to the nearest employment sub-center	Lee (2007)
<i>Dist.Beach</i>	Log of the distance to the nearest beach	SCAG; TIGER ^c
<i>Dist.Highway</i>	Log of the distance to the nearest highway network	SCAG; NTAD ^d
<i>Dist.Transit</i>	Log of the distance to the nearest public transit station	SCAG
<i>Dist.Airport</i>	Log of the distance to the nearest airport	SCAG; NTAD
<i>Nbhd.Income</i>	Per capita income of the census block group in which the parcel is located	Census 1990; TIGER
<i>Nbhd.Density</i>	Population density of the census block group in which the parcel is located	Census 1990; TIGER
<i>Nbhd.Edu</i>	Share of population aged 25+ with bachelor's degree or higher	Census 1990; TIGER
<i>Nbhd.LUMix</i>	Land use entropy index of the census block group in which the parcel is located	SCAG
<i>Nbhd.SFRes%</i>	Share of the land area used for single-family residential purposes in the block group	SCAG
<i>Nbhd.MFRes%</i>	Share of the land area used for multi-family residential purposes in the block group	SCAG
<i>Nbhd.ComInd%</i>	Share of the land area used for commercial or industrial purposes in the block group	SCAG
<i>Nbhd.RecOS%</i>	Share of the land area used for recreational or open space purposes in the block group	SCAG
<i>Nbhd.OtherDev%</i>	Share of the land area used for other urban purposes in the block group	SCAG
<i>ProtectedAreas</i>	Dummy variable, indicating the parcels within the federally protected areas	NWPS ^e
<i>City.Elasticity</i>	Municipality's easiness of annexation in 1990	TIGER
<i>City.Pop</i>	Log of the municipality's population in 1990	Census 1990
<i>City.PopGR</i>	Log of the municipality's population growth rate between 1980 and 1990	Census 1980 and 1990
<i>City.Econ.Ini</i>	Presence of the optional element(s) for local econ. development in the municipality in 1990	California OPR ^f
<i>City.Econ.Mid</i>	Presence of the optional element(s) for local econ. development in the municipality in 1997	California OPR
<i>City.GM.Ini</i>	Presence of the optional element(s) for growth management in the municipality in 1990	California OPR
<i>City.GM.Mid</i>	Presence of the optional element(s) for growth management in the municipality in 1997	California OPR
<i>LACity</i>	Dummy variable, indicating the parcels within the city of Los Angeles	SCAG; TIGER
<i>Cty.Orange</i>	Dummy variable, indicating the parcels in Orange County	SCAG; TIGER
<i>Cty.Riverside</i>	Dummy variable, indicating the parcels in Riverside County	SCAG; TIGER
<i>Cty.SanBernardino</i>	Dummy variable, indicating the parcels in San Bernardino County	SCAG; TIGER
<i>Cty.Ventura</i>	Dummy variable, indicating the parcels in Ventura County	SCAG; TIGER

^a Shapefiles provided by the Southern California Association of Governments; ^b Employment center shapefile, provided by Bumsoo Lee. The detailed explanations of the methodology are presented in Lee (2007).; ^c TIGER(Topologically Integrated Geographic Encoding and Referencing)/Line data provided by US Census; ^d National Transportation Atlas Database; ^e National Wilderness Preservation System shapefile provided by National Atlas; ^f Annual planning survey results, provided by the California Governor's Office of Planning and Research

Table 2. Model Estimation Outcomes

Variables	(1) Single-family Residential	(2) Multi-family Residential	(3) Commercial & Industrial	(4) Recreational & Urban Open Space	(5) Other Types of Development
<i>C (intercept)</i>	9.119 ***	4.402	-2.057 **	-5.986 ***	-6.663 **
<i>Parcel.Size</i>	-1.079 ***	-1.550 ***	0.238 ***	0.084	-0.119 **
<i>Parcel.Slope</i>	-0.093 ***	-0.169 ***	-0.172 ***	-0.072 ***	-0.135 ***
<i>Parcel.Shape</i>	-4.449 ***	-2.352 ***	0.001	0.006	0.003
<i>Dist.CBD</i>	-0.007	0.009	-0.007 *	0.024 ***	0.014
<i>Dist.Subcenter</i>	-0.018 **	-0.029 *	-0.011	0.016	0.000
<i>Dist.Beach</i>	0.005	-0.001	-0.005	-0.015 **	-0.011
<i>Dist.Highway</i>	0.194 **	-0.661 ***	-0.883 ***	-0.211	0.514 ***
<i>Dist.Transit</i>	0.018	0.042	0.015	-0.028	0.020
<i>Dist.Airport</i>	-0.013 **	-0.037 ***	-0.025 ***	-0.032 ***	-0.040 ***
<i>Nbhd.Income</i>	-0.009	0.012	-0.002	-0.028 ***	-0.022
<i>Nbhd.Density</i>	-0.001 **	-0.001 *	0.001 **	0.000	-0.001
<i>Nbhd.Edu</i>	0.021 ***	0.028 ***	0.002	0.042 ***	0.007
<i>Nbhd.LUMix</i>	2.636 ***	2.576 ***	2.410 ***	5.223 ***	2.297 **
<i>Nbhd.SFRes%</i>	0.042	0.843	-0.390	-2.060 ***	-2.706 **
<i>Nbhd.MFRes%</i>	-1.219	3.567	-1.511 *	-4.174	-0.937
<i>Nbhd.ComInd%</i>	-2.965 ***	-0.819	2.324 ***	-3.822 ***	2.033 **
<i>Nbhd.RecOS%</i>	-0.349	-1.283	-0.074	-0.184	-6.491
<i>Nbhd.OtherDev%</i>	-1.681	0.775	-0.849	1.516	4.451 ***
<i>ProtectedAreas</i>	-1.723 ***	-13.306 ***	-13.461 ***	-14.246 ***	-16.606 ***
<i>City.Elasticity</i>	-1.058 **	-0.464	0.061	-1.916 ***	1.733 **
<i>City.Pop</i>	-0.060	0.258	-0.169 **	0.096	0.169
<i>City.PGR</i>	0.216	-0.073	0.200	-0.502 **	-0.852 ***
<i>City.Econ.Ini</i>	0.458 *	0.186	-0.021	-0.411	-1.258 **
<i>City.Econ.Mid</i>	0.100	-0.306	0.184	0.311	0.920 **
<i>City.GM.Ini</i>	-0.684	0.250	-0.405	-1.781 **	-0.543
<i>City.GM.Mid</i>	1.143 ***	1.179 **	1.012 ***	0.488	1.053
<i>LACity</i>	-0.149	-1.744 *	0.385	-0.092	-0.002
<i>Cty.Orange</i>	0.802 *	-0.153	0.163	-0.507	0.516
<i>Cty.Riverside</i>	1.025 ***	-0.355	0.460	-0.332	0.514
<i>Cty.SanBernardino</i>	0.427	0.457	0.254	-1.132 ***	0.623
<i>Cty.Ventura</i>	2.149 ***	2.865 ***	1.737 ***	0.734	2.428 ***

Note: *** 1% level; ** 5% level; * 10% level significant. Unstandardized coefficients. Pseudo $R^2 = 0.280$

Figure Captions

Figure 1. Study area: Los Angeles – Long Beach CSA

Figure 2. City.Elasticity computation

Figure 3. City.Elasticity in 1990

Figure 4. Presence of the optional elements for economic development

Figure 5. Presence of the optional elements for growth management

References

- Adams, D., and S. Tiesdell. 2010. "Planners as Market Actors: Rethinking State–Market Relations in Land and Property." *Planning Theory & Practice* 11 (2): 187-207.
- Almeida, C. M., et al. 2003. "Stochastic Cellular Automata Modeling of Urban Land Use Dynamics: Empirical Development and Estimation." *Computers, Environment and Urban Systems* 27 (5): 481-509.
- Almeida, C. M., J. M. Gleriani, E. F. Castejon, and B. S. Soares-Filho. 2008. "Using Neural Networks and Cellular Automata for Modelling Intra-urban Land-use Dynamics." *International Journal of Geographical Information Science* 22 (9): 943-963.
- Bakker, M. M., and A. M. van Doorn. 2009. "Farmer-specific Relationships between Land Use Change and Landscape Factors: Introducing Agents in Empirical Land Use Modelling." *Land Use Policy* 26 (3): 809-817.
- Basolo, V. 2000. "City Spending on Economic Development versus Affordable Housing: Does Inter-city Competition or Local Politics Drive Decisions?" *Journal of Urban Affairs* 22 (3): 317-332.
- Bella, K. P., and E. G. Irwin. 2002. "Spatially Explicit Micro-level Modelling of Land Use Change at the Rural–Urban Interface." *Agricultural Economics* 27 (3): 217-232.
- Bockstael, N. E. 1996. "Modeling Economics and Ecology: The Importance of a Spatial Perspective." *American Journal of Agricultural Economics* 78 (5): 1168-1180.
- Brady, M., and E. Irwin. 2011. "Accounting for Spatial Effects in Economic Models of Land Use: Recent Developments and Challenges Ahead." *Environmental and Resource Economics* 48 (3): 487-509.

- Braimoh, A. K., and T. Onishi. 2007. "Spatial Determinants of Urban Land Use Change in Lagos, Nigeria." *Land Use Policy* 24 (2): 502-515.
- Briassoulis, H. 2000. "Analysis of Land Use Change: Theoretical and Modeling Approaches." In *The Web Book of Regional Science* (www.rri.wvu.edu/web_book), edited by S. Loveridge. Morgantown, WV: Regional Research Institute, West Virginia University.
- Brody, S. D., V. Carrasco, and W. E. Highfield. 2006. "Measuring the Adoption of Local Sprawl Reduction Planning Policies in Florida." *Journal of Planning Education and Research* 25 (3): 294-310.
- Bronin, S. C. 2006. "Rehabilitating Rehab through State Building Codes." *Yale Law Journal* 115 (7): 1744-1781.
- Bronin, S. C. 2008. "The Quiet Revolution Revived: Sustainable Design, Land Use Regulation, and the States." *Minnesota Law Review* 93 (1): 231-273.
- Butsic, V., D. J. Lewis, and L. Ludwig. 2011. "An Econometric Analysis of Land Development with Endogenous Zoning." *Land Economics* 87 (3): 412-432.
- Byun, P. and A. X. Esparza. 2005. "A Revisionist Model of Suburbanization and Sprawl the Role of Political Fragmentation, Growth Control, and Spillovers." *Journal of Planning Education and Research* 24 (3): 252-264.
- California Governor's Office of Planning and Research. 2003. *General Plan Guidelines*. http://opr.ca.gov/docs/General_Plan_Guidelines_2003.pdf (accessed September 19, 2013).
- Carrion-Flores, C. and E. G. Irwin. 2004. "Determinants of Residential Land-use Conversion and Sprawl at the Rural-Urban Fringe." *American Journal of Agricultural Economics* 86 (4): 889-904.

- Cho, S. H., N. Poudyal, and D. M. Lambert. 2008. "Estimating Spatially Varying Effects of Urban Growth Boundaries on Land Development and Land Value." *Land Use Policy* 25 (3): 320-329.
- City of Los Angeles. 2011. *Development Reform Strategic Plan: Building a Better LA*. http://www.losangelesworks.org/resources/uploads/Dev_Reform_Strategic_Plan_Vol_1.pdf (accessed September 19, 2013).
- Deal, B., J. H. Kim, G. J. D. Hewings, and Y. W. Kim. 2013. "Complex Urban Systems Integration: The LEAM Experiences in Coupling Economic, Land Use, and Transportation Models in Chicago, IL." In *Employment Location in Cities and Regions: Models and Applications*, edited by F. Pagliara, M. de Bok, D. Simmonds, and A. Wilson, 107-131. Heidelberg, Germany: Springer.
- Edwards, M. M. 2008. "Understanding the Complexities of Annexation." *Journal of Planning Literature* 23 (2):119-135.
- Fleischmann, A. 1986. "The Goals and Strategies of Local Boundary Changes: Government Organization or Private Gain?" *Journal of Urban Affairs* 8 (4):63-76.
- Fragkias, M., and J. Geoghegan. 2010. "Commercial and Industrial Land Use Change, Job Decentralization and Growth Controls: A Spatially Explicit Analysis." *Journal of Land Use Science* 5 (1): 45-66.
- Guy, S., and J. Henneberry. 2000. "Understanding Urban Development Processes: Integrating the Economic and the Social in Property Research." *Urban Studies* 37(13): 2399-2416.
- Hanlon, B., M. Howland, and M. P. McGuire. 2012. "Hotspots for Growth: Does Maryland's Priority Funding Area Program Reduce Sprawl?" *Journal of the American Planning Association* 78 (3): 256-268.

- Hipp, J. R., V. Basolo, M. Boarnet, and D. Houston. 2012. *The Metropolitan Futures Initiative (MFI) Regional Progress Report, 2012*. Metropolitan Futures Initiative. Irvine, CA: School of Social Ecology, University of California, Irvine.
http://socialecology.uci.edu/sites/socialecology.uci.edu/files/users/pdevoe/uc_irvine_mfi_first_regional_report_final_0.pdf (accessed September 19, 2013).
- Hopkins, L. D. 2001. *Urban Development: The Logic of Making Plans*. Washington, DC: Island Press.
- Huang, B., L. Zhang, and B. Wu. 2009. "Spatiotemporal Analysis of Rural–Urban Land Conversion." *International Journal of Geographical Information Science* 23 (3): 379-398.
- Ihlanfeldt, K. R. 2004. "Exclusionary Land-Use Regulations within Suburban Communities: A Review of the Evidence and Policy Prescriptions." *Urban Studies* 41(2): 261-283.
- Irwin, E. G. 2010. "New Directions for Urban Economic Models of Land Use Change: Incorporating Spatial Dynamics and Heterogeneity." *Journal of Regional Science* 50 (1): 65-91.
- Irwin, E. G., and N. E. Bockstael. 2002. "Interacting Agents, Spatial Externalities and the Evolution of Residential Land Use Patterns." *Journal of Economic Geography* 2 (1): 31-54.
- Irwin, E. G. and N. E. Bockstael. 2004. "Land Use Externalities, Open Space Preservation, and Urban Sprawl." *Regional Science and Urban Economics* 34 (6): 705-725.
- Irwin, E. G. and J. Geoghegan. 2001. "Theory, Data, Methods: Developing Spatially Explicit Economic Models of Land Use Change." *Agriculture, Ecosystems & Environment* 85 (1): 7-24.

- Jackson, K. T. 1985. *Crabgrass Frontier: The Suburbanization of the United States*. New York, NY: Oxford University Press.
- Kim, J. H. 2013. "Spatiotemporal Scale Dependency and Other Sensitivities in Dynamic Land-Use Change Simulations." *International Journal of Geographical Information Science* 27 (9): 1782-1803.
- Kim, J. H., and G. J. D. Hewings. 2011. "Framing Urban Systems and Planning Concerns as a Multi-level Problem." In *The Oxford Handbook of Urban Economics and Planning*, edited by N. Brooks, K. Donaghy, and G. Knaap, 674-700. Oxford: Oxford University Press.
- Koomen, E., and J. Stillwell. 2007. "Modelling Land-use Change: Theories and Methods". In *Modelling Land-Use Change: Progress and Applications*, edited by E. Koomen, J. Stillwell, A. Bakema, and H. J. Scholten, 1-21. Dordrecht, Netherlands: Springer.
- Lee, B. 2007. "'Edge' or 'Edgeless' Cities? Urban Spatial Structure in US Metropolitan Areas, 1980 to 2000." *Journal of Regional Science* 47 (3): 479-515.
- Lewis, P. G. 1996. *Shaping Suburbia: How Political Institutions Organize Urban Development*. Pittsburgh, PA: University of Pittsburgh Press.
- Lewis, P. G. 2002. "Offering Incentives for New Development: The Role of City Social Status, Politics, and Local Growth Experiences." *Journal of Urban Affairs* 24 (2): 143-157.
- LeSage, J., and R. K. Pace. 2009. *Introduction to Spatial Econometrics*. New York: CRC Press.
- Lubell, M., R. Feiock, and S. Handy. 2009. "City Adoption of Environmentally Sustainable Policies in California's Central Valley." *Journal of the American Planning Association* 75 (3): 293-308.

- Lynch, L., and X. Liu. 2007. "Impact of Designated Preservation Areas on Rate of Preservation and Rate of Conversion: Preliminary Evidence." *American Journal of Agricultural Economics* 89 (5): 1205-1210.
- McMillen, D. P. 1989. "An Empirical Model of Urban Fringe Land Use." *Land Economics* 65 (2): 138-145.
- Munroe, D. K., and D. Müller. 2007. "Issues in Spatially Explicit Statistical Land-Use/Cover Change (LUCC) Models: Examples from Western Honduras and the Central Highlands of Vietnam." *Land Use Policy* 24 (3): 521-530.
- Nelson, A. C., and D. R. Peterman. 2000. "Does Growth Management Matter? The Effect of Growth Management on Economic Performance." *Journal of Planning Education and Research* 19 (3): 277-285.
- Nelson, G. C., and D. Hellerstein. 1997. "Do Roads Cause Deforestation? Using Satellite Images in Econometric Analysis of Land Use." *American Journal of Agricultural Economics*, 79 (1): 80-88.
- Overmars, K. P., G. H. J. De Koning, and A. Veldkamp. 2003. "Spatial Autocorrelation in Multi-scale Land Use Models." *Ecological Modelling* 164 (2): 257-270.
- Parker, D. C., et al. 2003. "Multi-agent Systems for the Simulation of Land-use and Land-cover Change: A Review." *Annals of the Association of American Geographers* 93 (2): 314-337.
- Pendall, R. 2001. "Municipal Plans, State Mandates, and Property Rights: Lessons from Maine." *Journal of Planning Education and Research* 21 (2): 154-165.

- Rice, K. T., L. S. Waldner, and R. M. Smith. 2014. "Why New Cities Form: An Examination into Municipal Incorporation in the United States 1950–2010." *Journal of Planning Literature* 29 (2): 140-154.
- Rusk, D. 1995. *Cities without Suburbs* (2nd edition). Washington, DC: Woodrow Wilson Center Press.
- Towe, C. A., C. J. Nickerson, and N. Bockstael. 2008. "An Empirical Examination of the Timing of Land Conversions in the Presence of Farmland Preservation Programs." *American Journal of Agricultural Economics* 90 (3): 613-626.
- Ulfarsson, G. F. and J. I. Carruthers. 2006. "The Cycle of Fragmentation and Sprawl: A Conceptual Framework and Empirical Model." *Environment and Planning B: Planning and Design* 33 (5): 767-788.
- Verburg, P. H., P. P. Schot, M. J. Dijst, and A. Veldkamp. 2004. "Land Use Change Modelling: Current Practice and Research Priorities." *GeoJournal* 61 (4): 309-324.
- Walker, R. 2004. "Theorizing Land-cover and Land-use Change: The Case of Tropical Deforestation." *International Regional Science Review* 27 (3): 247-270.
- Wang, X., and K. M. Kockelman. 2009. "Application of the Dynamic Spatial Ordered Probit Model: Patterns of Land Development Change in Austin, Texas." *Papers in Regional Science* 88 (2): 345-365.
- Wang, Y., K. M. Kockelman and X. Wang. 2011. "Anticipation of Land Use Change through Use of Geographically Weighted Regression Models for Discrete Response." *Transportation Research Record: Journal of the Transportation Research Board* 2245 (1): 111-123.

- White, R., and G. Engelen. 1993. "Cellular Automata and Fractal Urban Form: A Cellular Modelling Approach to the Evolution of Urban Land-Use Patterns." *Environment and Planning A* 25 (8): 1175-1199.
- White, R., G. Engelen, and I. Uljee. 1997. "The Use of Constrained Cellular Automata for High-resolution Modelling of Urban Land-use Dynamics." *Environment and Planning B* 24 (3): 323-344.
- Wu, J., and S. H. Cho. 2007. "The Effect of Local Land Use Regulations on Urban Development in the Western United States." *Regional Science and Urban Economics* 37 (1): 69-86.
- Zhong, T. Y., X. J. Huang, X. Y. Zhang, and K. Wang. 2011. "Temporal and Spatial Variability of Agricultural Land Loss in Relation to Policy and Accessibility in a Low Hilly Region of Southeast China." *Land Use Policy* 28 (4): 762-769.
- Zhou, B., and K. M. Kockelman. 2008. "Neighborhood Impacts on Land Use Change: A Multinomial Logit Model of Spatial Relationships." *Annals of Regional Science* 42 (2): 321-340.

Appendix 1. Estimation with Spatial Sampling

We assessed possible spatial correlation and its impact on the results by conducting ancillary analyses using a spatial sampling technique – an iterative two-step process of 1) random (one) parcel selection and 2) exclusion of all nearby parcels (within a 0.5-mile radius of the selected one), repeated until nothing is left in the selection pool. More specifically, five spatial samples were created through the iterative sampling process in which a minimum distance spacing of 0.5 miles is maintained between any pair of parcels in a sample. Each sample has a size slightly greater than ten thousand parcels and provides an opportunity to estimate the multinomial logit model without having observations (i.e., land parcels) located close to each other. This is one method to account for potential spatial autocorrelation issues in empirical analyses of land use changes (see e.g., Nelson and Hellerstein, 1997; Carrion-Flores and Irwin, 2004; Huang et al., 2009). Studies suggest that the method is “effective at minimizing spatial dependence, [although] ... results are not always robust to the sampling routines.” (Brady and Irwin, 2011, p.499). The following table summarizes the coefficients on the *City.Elasticity* variable obtained from these additional rounds of estimation with spatial sampling.

Sample	(1) Single-family Residential	(2) Multi-family Residential	(3) Commercial & Industrial	(4) Recreational & Urban Open Space	(5) Other Types of Development
Set #1	-0.292	0.437	0.418	-0.538	1.700 ***
Set #2	-0.441 **	0.255	0.411 *	-0.628	1.889 ***
Set #3	-0.407 *	0.267	0.438 *	-0.413	1.637 ***
Set #4	-0.355	0.419	0.326	-0.754 *	2.017 ***
Set #5	-0.474 **	0.187	0.487 **	-0.503	0.937 *

Note: *** 1% level; ** 5% level; * 10% level significant.

Similar to the findings drawn from the entire set of parcels, *City.Elasticity* has a strong, positive impact on other types of development. In addition, *City.Elasticity* is again found to be negatively

associated with the probability of development for single-family residential and for recreational & urban open space, while the coefficient magnitudes tend to be larger when estimated with the full set of parcels. The larger coefficients detected in the full set of parcels compared to the samples can happen, because *City.Elasticity*'s total effects, as opposed to its direct effects on parcel development, are captured in our model of the complete set of parcels (see e.g., LeSage and Pace, 2009, for a fuller discussion of direct and indirect effects in spatial models). Such effects are likely, as the variable impacts development in some parcels, which then have a spatial spillover effect onto adjacent parcels.