Determinants of Urban Land Market Outcomes: Evidence from California

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Abstract

Our understanding of the effects of land use regulations and other aspects of urban form has been hindered by limited aggregate data and gradual temporal changes in policies. More widely available GIS data on land use and land economics presents opportunities to overcome these obstacles. This study was undertaken to explore the potential for land economics research that draws on parcel level spatial data for urban land markets, and uses differences across a sample of cities as the source of variation. Policy obstacles such as protected open spaces and other land use regulations, like the limitations caused by land forms such as water bodies and mountains, can be expected to alter the supply of land in ways that will be reflected in land market outcomes across cities. Based on a sample of data for 46 California cities, this exploratory analysis analyzed land market outcomes as a function of population, income and other factors in a closed-economy model, including a ratio that measures the concentration of developed lands within a city's radius or perimeter. The approach produced robust relationships consistent with other studies, and results consistent with expectations not just in terms of the signs of the estimated coefficients but in terms of their magnitudes as well. Indeed, the elasticity of land development with respect to population has been estimated to be 0.79-0.82 based on open city models. The evidence suggests that both land forms and land use regulations have a positive effect on land prices; however, it was not possible with the current data to distinguish the amenity effects of proximity to oceans and mountains from the supply constraints on radial city expansion. The analysis, nevertheless, provides encouraging evidence for future research of this kind.

Keywords: land use regulations, urban land market, identification problem, closed city model

1. Introduction

Understanding urban land markets and the factors affecting the prices and quantities of land developed within a given land market is often important for evaluating a variety of urban planning and policy objectives. For example, a better understanding of how land use regulations and other constraints on the spatial expansion of urban development affects land markets could provide a basis for evaluating the net social benefits of these policies. Despite a large literature on related topics, limited data has made some of these kinds of analysis difficult in the past; but the increased availability of spatially explicit economic data presents new opportunities to examine, for example, the effects of land use regulations on land markets. Recent controversies surrounding land use regulations, conservation and the demands for compensation from landowner groups who oppose land use regulations represent one important area where this kind of research could be valuable.

Economics analyses both empirical and analytical suggest that the effects of land use regulations may be positive, negative or neutral in a given setting. There is much theoretical work on this question (see, for example, Wu (2006) and Wu and Plantinga (2003), as well as recent conceptual contributions and empirical work (see, for example, Jaeger 2006; Runge et al. 2006; Jaeger and Plantinga 2007; Grout et al. 2010). The overall effects of land use regulations have been extremely difficult to estimate for several reasons. First, the land use regulations themselves are complex and are hard to characterize quantitatively (Quigley 2007), although some indices have been compiled recently (see, for example, Gyourko et al. 2008). Second, attempts to estimate their effects have suffered from small samples for disparate regulations imposed in a single town or metropolitan area (Quigley 2006). And third, among those studies which have tried to estimate the effect of land use regulations on property values, few if any studies have tried to overcome the identification problem that arises because land use regulations can have positive “amenity effects” (including greater predictability of the kinds of activities to occur in close proximity to a given parcel) which can affect demand positively. As a result, a positive relationship between land prices and land use regulations could be due to either supply shifts or demand shifts (or some combination of the two)(Phillips and Goodstein 2000). Existing empirical studies have tended to assume that any relationship is due to supply rather than demand effects (see, for example, Malpezzi, Chun and Green, 1998, Quigley 2006).

The current study represents one additional empirical approach to estimating the overall demand for land in a given urban area as a function of income, population and other factors, or the spatial dispersion of land development and price gradients, or how they would be affected by constraints on land use within a specified zone. Approaches to estimation that allow both positive and negative effects, distinguish supply and demand effects, and estimate the demand for land may provide a much stronger basis in some settings than is currently available for evaluating policy options and their potential effects. And the ability to select a sample of cities with well-defined and largely independent land markets, as described below, may be advantageous because it helps isolate markets.

The current study attempts to estimate a model of the market outcomes for developed land from cross-sectional data based on a comprehensive parcel-level data set of land uses and other characteristics for a sample of cities in California. The current effort is exploratory, intended to assess the potential usefulness of a methodology. That methodology takes individual cities as the unit of observation, collects data for a sample of cities, and draws on detailed parcel-level spatial data to characterize developed land markets for each city. Although using a sample of cities to evaluate the effects of land use regulations is not new, prior studies have relied on aggregate measures of growth and land price indicators such as median housing price (e.g., Phillips and Goodstein 2000).

Studies of land market changes in single cities over relatively short time periods typically involve gradual changes in land use regulations, the effects of which are difficult to separate from trends in a variety of other correlated variables. A potential advantage of using data from a cross-section of cities to evaluate the effects of land use constraints on land markets is the possibility to observe greater differences in land use regulations, differences in natural constraints on land supply or other causal factors, and to make inferences about how those differences produce differing land market outcomes across cities. When only aggregated city data such as average housing cost is available, however, such shortcomings obstruct the potential gains from drawing on data from a cross-section of cities.

In light of those tradeoffs, the first objective in the current study is to draw on detailed, disaggregated data for a sample of cities to estimate reduced-form models of land use and land value as a function of population, income, and other characteristics to see how robust the results appear to be in relation to expectations. The second objective is to look for evidence of the effects of limits on land availability on market outcomes. Although inclusion of a comprehensive representation of the specific city-level land use regulations, open space, and other public lands limitations in each city is beyond the scope of the current analysis, natural restrictions on available land such as large bodies of water and mountainous areas can limit the amount of land available in proximity to a given urban center, and thus the effects of these natural limitations can be expected to have similar effects as some land use regulations. This similarity has been used in this way in Rose (1989). In Rose’s analysis the restrictive effects of water bodies on the supply of land is examined, as is urban zoning. The effects of both types of supply restraints were found to be significant based on data for 45 cities. Rose concludes that the combined effects of these two sources of land supply constraints can explain 40% of typical interurban price differentials.

In the next section, the economic models for the study are presented. This is followed in section III with a discussion of data and methods. Section IV presents the results, followed by discussion and conclusions in section V.

2. Economic Model

Models of urban land markets are traditionally developed to reflect either a “closed-city model” or an “open-city model.” The former model takes population and income to be exogenous or at least proximate determinants of market outcomes; the latter attempts to model the endogenous process for migration of individuals and businesses that reflect connected national markets for labor and products. A number of closed-city models have been estimated; these include Muth’s (1969) model of urban residential housing markets based on a cross-sectional regression model using data for 46 US cities. Muth’s analysis found that population was the dominant determinant of city size (developed land area). He also found that cities in the southern and western parts of the US used more land, but no other explanatory variables were statistically significant. Mills (1969) estimated an urban growth model based on time series data for Chicago (92 years) and showed that land rents in the central business district increased and the price gradient decreased as the city grew. More complex models of urban development have also been developed by Brueckner and Fansler (1983), Hartwich et al. (1976), and Wu (2006).

Wu, Adams and Plantinga (2004) estimated an urban equilibrium model of residential choices and developers decisions responding to amenities such as open space for Portland, Oregon. See also Ke et al. (2009).

The classic closed-city model in this literature is characterized by a fixed population of urban residents who maximize utility by consuming land and commodities subject to a budget constraint and considering commuting costs. The urban land market equilibrium conditions require that a) there is a price equilibrium at the city boundary between urban and agricultural uses of land, b) that marginal utility is equalized across all properties in the city, and c) an equilibrium quantity of land demanded and supplied in the urban land market. In the closed city model utility is endogenous when population is exogenous (Ke et al. 2007). For the open city model population is endogenous when utility is exogenous: households migrate among cities to a maintain utility levels (see Wheaton 1974). Most empirical studies have estimated closed economy models. The main independent variables used to estimate these models empirically are population, income per capita, agricultural land rents, and commuting costs.

The current analysis relies extensively on a closed city model, but also includes estimates reflecting an open city approach. In reality, cities are probably somewhere in between the assumptions for these two approaches: cities are neither entirely closed nor entirely open. For our purposes, in each case we estimate reduced form equations with sets of right-hand side variables that include population, income per capita, and agricultural land prices. These are the core variables for a closed city model. A novelty of the current approach is in the measure devised to reflect how spatial constraints might affect the radial expansion of the city concentrically around its center.

Land use regulations of various kinds can alter the population density of a city, and they can also affect the density of developed lands relative to the city's overall land area. Some land use regulations can have the effect of lowering the overall land use density in a city. Low-density zoning, parks, greenbelts, protected wetlands, and other forms of open space will have the effect of lowering the density of developed lands. High-density zoning or limits on low-density residential zoning may increase the concentration of population. To reflect the way in which these land use regulations affect the spatial distribution of developed lands, we define the Development Concentration Ratio (DCR) to measure the share of land that is developed within a concentric circle that encompasses nearly all of the developed area (i.e., 90-95%). If all of the land within that circle is developed, then the DCR would be 0.8 or 0.9 (assuming some fraction of the land is required for roads, public buildings, etc.). If large areas are undevelopable areas, designated parks, open space, wetlands, etc., then the DCR may be below 0.5.

In addition to the effects of land use regulations, natural barriers to urban development such as water bodies and mountains can also reduce the DCR by limiting urban expansion in particular directions from the city center, and thus mimic the effects of some kinds of land use regulations.

Approaching the analysis with an open city model in mind, one would want to include variables that explain migration and differences in scale across cities, such as those that would affect individuals' or businesses' desire to migrate to a particular city as a way to explain the long-term, full range of determinants of urban growth and land use. These variables included a "natural amenity scale," or index based on the following factors: warm winters, winter sun, temperate summer, low summer humidity, water area, and topographical variation (see McGranahan 1999 for additional details). Other variables include whether the city is at the coast (dummy variable), and a measure of remoteness (distance to other large metro area such as Los Angeles, the San Francisco Bay Area, or San Diego). An open-city model would try to include the historic processes that determine the evolution of a city's economy, size and composition of industries over long periods of time.

The general model underlying our approach, drawing on the extensive literature addressing urban size and land markets, are as follows. Demand for land among *n* residents can be characterized as

$$D_i^L = D^L(y, a, d, r, p_d) \qquad \text{for individuals } i = 1 \text{ to } n$$

where y=income per capita, a=amenties, d=distance from the parcel to the city's central business district, and p=price. Income is influenced by the businesses located in a given city, which in turn depends on factors such as distance from this city to other major urban markets, or "r" for remoteness. The supply of land for development can be described as a function,

$$S_j^L = S^L(d, z_j, p_{aj}),$$

The supply of land at a given distance d from the city center will depend on that distance d, and factors that may limit the availability of lands at that distance. These factors z may include natural limitations such as bodies of water or mountains, but also land use regulations. The supply of land will also depend on its opportunity cost given other potential uses, typically reflected in the agricultural land price, p_a. For a population of n individuals, market clearing prices require p_s=p_d.

Based on prior studies we expect that population will be the most significant determinant of a city's spatial scale and varying positively with population. We also expect agricultural land values to be inversely related to a city's scale, since this raises the costs of spatial expansion. We also expect income to be positively related to city scale. To the extent that geographic or regulator barriers limit the concentration of development surrounding a central business district, this will limit S^L for a range of distances and we expect this to negatively affect the developed land area. Below we will define and compute a city's "development concentration ratio" (DCR) as a measure of sparseness of development in a city's urban radius.

We can also investigate the factors affecting land prices. From the standard models we expect average land values to be positively related to income per capita and population. We expect obstacles that limit the concentration of development to lead to higher land prices at a given distance *d* from the city center because the supply of land at distances *d* (and closer) is lower.

For an open city model we want to explain urban land markets in terms of those long-term exogenous factors that explain urban patterns of population and income; the factors that have affected migration of individuals and labor market developments. The two main ways that we can do this in the current context is with indicators of amenities including a natural amenity scale (McGranahan 1999) and a binary variable for coastal cities. On the labor demand side, access to markets for producers (and consumers) is affected by proximity to major markets. Here we define "remoteness" as the driving distance from a given city to the nearest large metropolitan area (Los Angeles, San Diego, or the San Francisco Bay area). Summary statistics for the sample of cities are presented in Table 1.

3. Data and Methodology

The approach taken here involves using a city as the unit of observation and computing a set of land and non-land indicators for a sample of cities and their surrounding lands. The indicators are computed from spatial parcel-level data including land uses, characteristics and ownership, as well as land prices and estimated market values for each city's land market (from city center to periphery). GIS-based data for these purposes are now available from many county assessors, including estimates of real market value for land, and separately for "improvements" (buildings). These data make it possible to estimate for developed lands the total value, total acreage, average values, number of parcels, etc.

Parcel-level GIS datasets make it easy to identify and aggregate data on the quantities and prices of developed lands for a given city. To the extent that a city has a relatively distinct land market associated with its population (where a significant buffer of undeveloped rural or agricultural lands separates it from other cities), a relationship between the characteristics of the city's population and its developed land can be assumed to exist. By computing comparable measures of price and quantity for a sample of cities with different demographic, economic, amenity, and geophysical characteristics, a closed city demand function for developed land can be estimated using the city as the unit of observation.

The current study utilizes land datasets from 19 California counties, made available by CD-Data, a private data company that assembles, cleans and maintains electronic GIS county tax assessor databases for all of California's counties. The first step of the process was to identify cities with relatively distinct and separate land markets – where the correspondence between a specific urban economy, its population and the corresponding land market are relatively distinct.

This eliminated considering any cities in the Los Angeles area, or the San Francisco Bay area where markets overlap and commuting distances are relatively small. This process was accomplished visually by examining GIS map layers and looking for a degree of "separation" between the developed areas surrounding each city under consideration. Only cities of 20,000 population or larger were considered because US Census estimates on income per capita are only available from the American Community Surveys for cities of that size and larger.

Based on these and other considerations, a sample of 46 cities formed the basis of the current analysis. For each, a circle was drawn around each city of a radius that would include all or nearly all developed lands. All parcels within the circle were chosen for further analysis and extraction of parcel characteristics. Data for each parcel within a given city's radius include characteristics of acreage, value of land, value of improvements, etc. Developed lands were identified on the basis of a filter that looked at the value of improvements. All parcels with either $30,000 in improvements or $30,000 in improvements per acre were included as developed. This cut-off is intended to filter parcels that may have a minor "improvement" (shed, barn or well) from parcels that are likely to be occupied for residential, commercial or industrial use. Other parcels designated as government-owned (e.g., highways, power line right-of-way) were considered to be undeveloped. From that pool of developed parcels, a set of descriptive variables were collected.

Since these data are based on county tax assessor's estimates, the assessed values will diverge from real market values because of California's law Proposition 13 which limits assessed values to rise at a maximum of 2 % per year. The exception to this limit is when a transfer of ownership takes place, or when improvements are made. Of course, if market prices rise by 2 percent or less per year, assessed values of properties should reflect market prices. Since market prices have risen by more than 2 percent per year in most years prior to 2008, we expect these assessed values to undervalue properties, and we expect the degree of undervaluation to differ significantly between cities.

To correct for this problem we use the fact that when a property is sold its assessed value will be "reset" to market prices. Our 2008 parcel-level data include the date of the most recent sale. Parcels for which the most recent sale was in 2008 will presumably have values reflecting current market prices; parcels with sales in 2006 are likely to have assessed values reflecting some divergence from market prices, but less than for parcels where the most recent sale was at an earlier date. By looking at the relationship between assessed value, the date of the most recent sale, and parcel size, we can estimate the rate at which assessed values appear to diverge from market prices. With this average rate of divergence for a given city, we can make a correction to the assessed values so that they are closer to market values as follows: For a city where the average rate of divergence between assessed versus market values was estimated to be 5% per year (i.e., where market values increased by 7% per year), and where the average time since the most recent sale of a parcel is 6 years, the aggregate values of land and improvements can be increased by approximately 34% to correct for the restrictions on growth in assessed values. Indeed, the average rate of divergence for the cities sampled was 3.51% per year and the number of years since the most recent sale averaged 6.5 years. This suggests that assessor's estimates for these cities are, on average, 25% below market prices.

The natural amenity scale variable described above is from McGranahan (1999). Table 1 indicates that all cities have relatively high natural amenities (the mean nationally is approximately zero). Most cities in the sample are somewhat "remote" as defined here: the mean distance from a large metro area is 117 miles, with a maximum of 217 miles. Only about 15 percent of the cities are designated coastal according to Table 1.

Table 1 also summarizes with descriptive statistics the main land data derived from the GIS parcel data. The value per acre of agricultural lands surrounding each city averages about \$8,000/acre, but range from \$3,158 to \$27,122. The total value of improvements on developed lands averages \$12.2 million. The variation in city size and affluence produces values for these improvements ranging from \$0.34 million to \$170 million. The mean parcel size for the sample of cities averaged 0.46, but ranged from 0.1 acres in Los Banos to nearly 2 acres in Solvang.

This initial filtering and data compilation across 46 cities resulted in the data summarized in Table 1. We have included cities ranging in size from a population of 21,000 to 486,000. In terms of the average per capita income the range is \$8,500 to \$39,000. A sample of city maps illustrating the spatial data and DCRs are included in the Appendix.

4. Results

We look first at the model specifications reflecting a closed city model. Table 2 provides a range of reduced-form estimations along these lines.[1] Model 1 confirms the dominant role of population in explaining the variation in land area developed, with 59% of the variation explained. The coefficient in this log-log model represents an elasticity of 0.96, or not statistically different from 1.0. Model 2 includes income per capita which adds to the explanatory power of the estimation. Income per capita is positively associated with land area developed

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[1] Two-stage least squares methods to estimating supply and demand structural relationships were attempted but were unsuccessful. The data do not appear to include adequate instruments for estimating supply. Agricultural land values and the DCR were tried, but these produced insignificant coefficients with the wrong sign.

suggesting a 10% increase in income per capita results in an 18% increase in land area. With the inclusion of income per capital in the model, the elasticity of land development with respect to population is reduced from 0.96 to 0.79, and is now significantly different from 1.0.

One of our primary interests is how deviations from compact, mono-centric expansion affect land markets. Obstacles to uniform and compact radial expansions, such as open space and land use regulations, will affect land markets in our model primarily by reducing the total supply of land at distances less than or equal to d, and thus causing a larger share of the population to reside farther from the city center. This will increase average commuting costs, and we expect average land prices to be higher because non-compact development reduces the supply of developed land within a given distance d.

The remainder of model estimations presented in Table 2 include the variable "development concentration ratio" (DCR) which is the ratio of the actual acreage of developed land in the city to the area of a circle that contains at least 90-95% of those developed lands within its perimeter (the inner circle shown in the Appendix maps). For model 3, and indeed for models 3 to 9, this variable is found to have a negative sign but is not statistically significant in any of these models. Finally, we include the agricultural land price reflecting the opportunity cost of land at the city boundary. This variable is not statistically significant except for model 9 (discussed below). Estimated coefficients are very small because this variable was entered in nominal dollars rather than natural logs. The alternative of log form does not affect the significance of the variable or overall equation.

Estimations 5 to 9 in Table 2 can be understood to reflect open city models where exogenous factors such as amenities and proximity are the determinants of the more proximate differences in cities such as population and income per capita. When some variables from both the closed city and open city approaches are included, the direct factors (population and income) dominate and the exogenous variables/instruments are not statistically significant (amenities, remoteness). However, when income and population are excluded (model 9) the dummy variable for coastal location is positive and statistically significant at the 10% level. In addition, agricultural land prices are also (weakly) statistically significant. The DCR comes close to being statistically significant in this model as well. One confounding factor for this model is that cities where the DCR is low also includes many of the coastal cities where radial expansion is limited by the presence of the ocean and coastal mountain range (e.g., Santa Barbara). This correlation makes it difficult to separate the effects of coastal amenities from supply limitations.

Table 3 presents results for a set of models aimed at explaining variation is land values per acre. Our model suggests an ambiguous relationship between population and land prices. We expect land prices to be positively related to income per capita, amenities and agricultural land prices. We expect a negative relationship for remoteness. And finally, we expect a lower DCR to have a positive effect on land prices because the supply of land within distance *d* is limited. The causality here is ambiguous, however. To the extent that the DCR is low because of land use regulation that protects open space and makes a city more attractive (in the open city model), this could also produce higher land prices due to higher demand.

Table 3 also combines results for closed city and open city specifications. The closed city model confirmed a positive relationship between income per capita and land prices, suggesting an elasticity of land price with respect to income per capita of 0.9. No other variables were statistically significant for the closed city estimation in Model A. Models B, C and D combine exogenous factors such as remoteness and amenities with income per capita. Here the exogenous variables appear to draw the explanatory power away from the income variable. Remoteness and amenities are consistently strong explanatory factors in these models with coefficients having the expected signs; although the dummy variable for coastal location was not statistically significant. By contrast in the open city approach reflected in Models E, F and G, results indicate that amenities and remoteness are strong influences on city land values.

Once again the results for DCR are not statistically significant (except for the case of Model D). However, the estimated coefficients are positive in all models, suggesting some evidence of a positive effect of (a higher) DCR on land prices, or that highly concentrated cities (high DRC) have higher land prices. This, however, is opposite of what we would expect to find if a low DCR reflects limits on land supply which in turn pushes up the prices of land. In that case – reflecting supply factors – we would expect to see an inverse relationship between DCR and land prices. What may be producing these results (even though they are not statistically significant) is more of a demand effect. There may be a relationship between “naturally occurring” restrictions (caused by oceans and mountains), and the strong positive correlation between these DCR effects and the positive effects from their corresponding amenities. Or it may be that land use regulations such as provisions for open space are also creating demand effects that raise land prices. With significant measurement error in amenities (the Natural Amenity Scale is estimated at the county level), this is a plausible explanation for this result.

5. Discussion and Conclusions

This study was undertaken to explore the potential for research that relied on parcel level spatial data for urban land markets, and that took a city as the unit of observation. As a method to estimate urban land market outcomes as a function of population, income and other factors in a closed economy model, this approach appears to have estimated robust relationships that are consistent with other studies, and that give us results consistent with expectations not just in terms of the signs of the estimated coefficients but in terms of their magnitudes as well. Indeed, the elasticity of land development with respect to population has been estimated to be 0.79-0.82 based on open city models. Our theoretical models lead us to expect an elasticity that is slightly less than one: as population rises, increased commuting costs and land costs put pressure on developers to reduce parcel size per capita. The elasticity of developed land area with respect to per capita income is estimated here to be between 1.7 and 2.0. The study by Brueckner and Fansler (1983) estimated these income elasticities to be 1.49.

The results for open city models were somewhat less satisfactory in explaining land area developed. This is not surprising since the proximate causes of land area development (income and population) are likely to be more directly related to area developed compared to endogenous variables such as amenities and remoteness which are imperfectly measured in the current study.

The models seeking to explain value per acre of developed lands were more satisfactory for the open city specifications but less satisfactory in the closed economy models. We find that amenities and remoteness are strong explanatory variables of land values per acre as expected.

The second level of exploration in the current study was to see whether this approach could provide evidence of how limitations on urban expansion affect land markets. Collecting detailed data on the specific land use regulations in each of these cities was beyond the scope of the current study. We instead computed measures of the actual concentration of developed lands around a central business district. In cities where the degree of radial concentrations of land development is lower, this could be the result of land use regulations or it could be due to geographic constraints on radial expansion of cities such as mountains or water bodies. The results of this aspect of the study were not definitive, but the approach is promising. The measure of sparseness, the DCR, was not statistically significant except in one model explaining land value per acre. Indeed, in the models seeking to explain land area developed the estimated coefficient on DCR did not have the expected sign based on the supply-related relationship being hypothesized. So the results point weakly to a demand story, and the lack of statistical significance could be the result of small sample size, measurement error, or misspecification of the model (this is likely to be a non-linear relationship with the DCR having little effect for small cities).

The results for DCR in the value per acre specifications were positive, and statistically significant in one version of the model. The positive sign is not what we would expect of supply restrictions were the dominant underlying cause. However, we were unable to distinguish between the effects of land use regulations versus geographical limits. Geographical limits in our sample were correlated with amenities (ocean and mountain views), and these results may reflect the positive effects of amenities that confound the effects of limits on the supply of land, or the ways in which geographic features affect urban concentration.

Despite these limitations in terms of robust results, this approach appears to be promising, especially if data from a larger, more diverse set of cities could be assembled (e.g., cities from different states), and if city-specific information on regulations could be included in the analysis. The ambiguities in the results of the current effort are most likely due in part a) to the limited sample size and b) to the inability to directly measure the effects of land use regulations so that they could be distinguished from exogenous geographic factors. Future work should attend to these two sources of limitations in the current study. Indeed, with data from different states, state-level differences in land use regulations could provide additional variation in land use regulation types, as well as a larger sample of cities. This could improve the ability to separate the effects of amenities from those of land use regulations. Moreover, indices of the degree of land use regulations could be used. For example, the Wharton Residential Land Use Regulatory Index (Gyourko et al. 2008) has computed state-level differences in land use regulations (and also for some major cities), and these could provide an appropriate measure in future multi-state analyses.

Moreover, future research of this kind can take advantage of the capabilities in the spatial data that would allow, for example, computation of land value gradients at a range of distances from the central business district. The data base constructed for the current study has the potential to be expanded, in detail and in sample size, to enable future work on these important policy questions.

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Table 1. California Cities: Descriptive Characteristics by City

	Mean	Median	Minimum	Maximum
Total land value ($ millions)	7,251	1,944	73	132,936
Population	119,735	56,289	5,555	1,336,865
Income per capita ($/person)	21,669	20,199	8,467	38,718
Land developed (acres)	19,240	6,463	682	279,566
Land value ($/acre)	309,834	214,000	57,245	1,007,132
Number of parcels developed	42,243	15,771	2,377	486,380
Natural Amenity Scale	6.11	5.65	3.48	10.97
Concentration ratio	0.35	0.35	0.10	0.61
Remoteness (miles)	117	115	0	217
Coastal (dummy variable)	0.15	0	0	1
Agricultural land values ($/acre)	7,954	7,210	3,158	27,122
Total value of improvements ($ million)	12,290	4,222	340	169,743
Parcel size (acres)	0.46	0.38	0.10	1.96

Note: values are for sample of 46 cities reflecting city-level averages.

Table 2. Determinants of Urban Spatial Scale for California Cities: cross-section regression results

Dependent variable: Developed land area (ln of acres)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8		Model 9	
Constant	-1.72		-17.70	***	-16.90	***	-17.66	***	-17.33	***	-19.29	***	-17.55	***	-10.47	*	10.00	***
	1.31		*2.57*		*2.63*		*2.96*		3.00		3.34		3.56		6.16		1.03	
Population (ln)	0.965	***	0.790	***	0.812	***	0.826	***	0.833	***	0.862	***	0.858	***				
	0.118		*0.087*		*0.088*		*0.092*		0.093		0.095		0.093					
Income per capita (ln)			1.810	***	1.729	***	1.795	***	1.733	***	1.850	***	1.698	***	1.995	***		
			0.270		*0.274*		*0.299*		*0.309*		*0.319*		*0.337*		*0.590*			
Development Concentration ratio					-0.879		-0.720		-0.671		-0.549		-0.567		-0.614		-1.910	
					0.642		*0.703*		*0.708*		*0.709*		*0.702*		*1.242*		*1.320*	
Agricultural land price							-0.00001		-0.00002		-0.00001		-0.00001		0.00006		0.00013	*
							2.3E-05		*2.4E-05*		*2.4E-05*		*2.8E-05*		*4.8E-05*		*5.0E-05*	
Amenities									0.04		0.05		-0.03		-0.10		-0.19	
									0.046		*0.047*		*0.076*		*0.134*		*0.147*	
Remoteness											0.0026		0.0030		-0.0013		-0.0041	
											0.002		*0.593*		*0.004*		*0.003*	
Coast													0.5930		0.7140		1.6530	*
													0.454		*0.803*		*0.844*	
Adjusted R-Squared	0.59		0.80		0.80		0.82		0.80		0.80		0.80		0.38		0.22	
F-statistic	66		88.7		61		45		35.9		30.7		27		5.62		3.56	

Figures in italics are standard errors. N=46.

Statistical significance is indicated at the 10%, 5% and 1% levels by *, ** and ***, respectively.

Table 3.Determinants of Urban Land Values: cross-section regression results

Dependent variable: Value per acre of developed land (ln of dollars/acre)

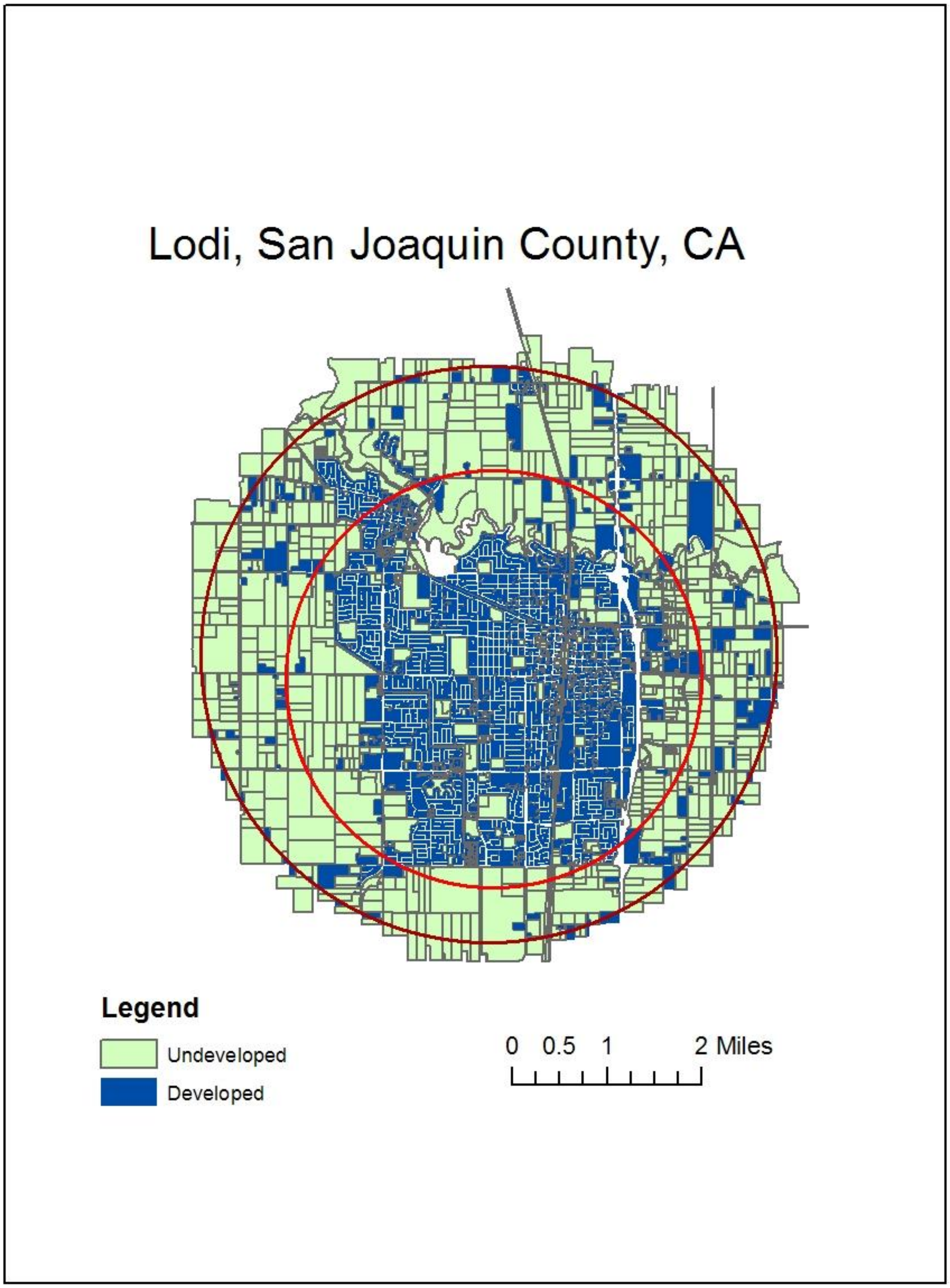
	Model A	Model B	Model C	Model D	Model E	Model F	Model G
Constant	1.63	7.50 ***	9.39 ***	4.14	11.88 ***	11.85 ***	11.93 ***
	3.52	*2.79*	*2.52*	*2.57*	*0.40*	*0.42*	*0.41*
Population (ln)	0.11						
	0.11						
Income per capita (ln)	0.91 **	0.420	0.244	0.653 **			
	0.36	*0.269*	*0.243*	*0.261*			
Development Concentration ratio	0.80	0.81	0.62	1.14 *	0.49	0.53	0.57
	0.84	*0.56*	*0.52*	*0.60*	*0.51*	*0.55*	*0.54*
Agricultural land price	0.00002	-0.00003				-0.00002	-0.00001
	2.8E-05	*2.2E-05*				*2.0E-05*	*1.8E-05*
Amenities		0.242 ***	0.176 ***	0.217 ***	0.183 ***	0.224 ***	0.187 ***
		0.061	*0.036*	*0.041*	*0.036*	*0.061*	*0.037*
Remoteness		-0.0070 ***	-0.0064 ***		-0.0070 ***	-0.0076 ***	-0.0073 ***
		0.0016	*0.0015*		*0.0014*	*0.0016*	*0.0015*
Coast		-0.463				-0.265	
		0.364				*0.347*	
Adjusted R-Squared	0.21	0.65	0.68	0.52	0.65	0.68	*0.644*
F test	4.1	15.1	22	17	28.95	17	21.39

Figures in italics are standard errors. N=46.

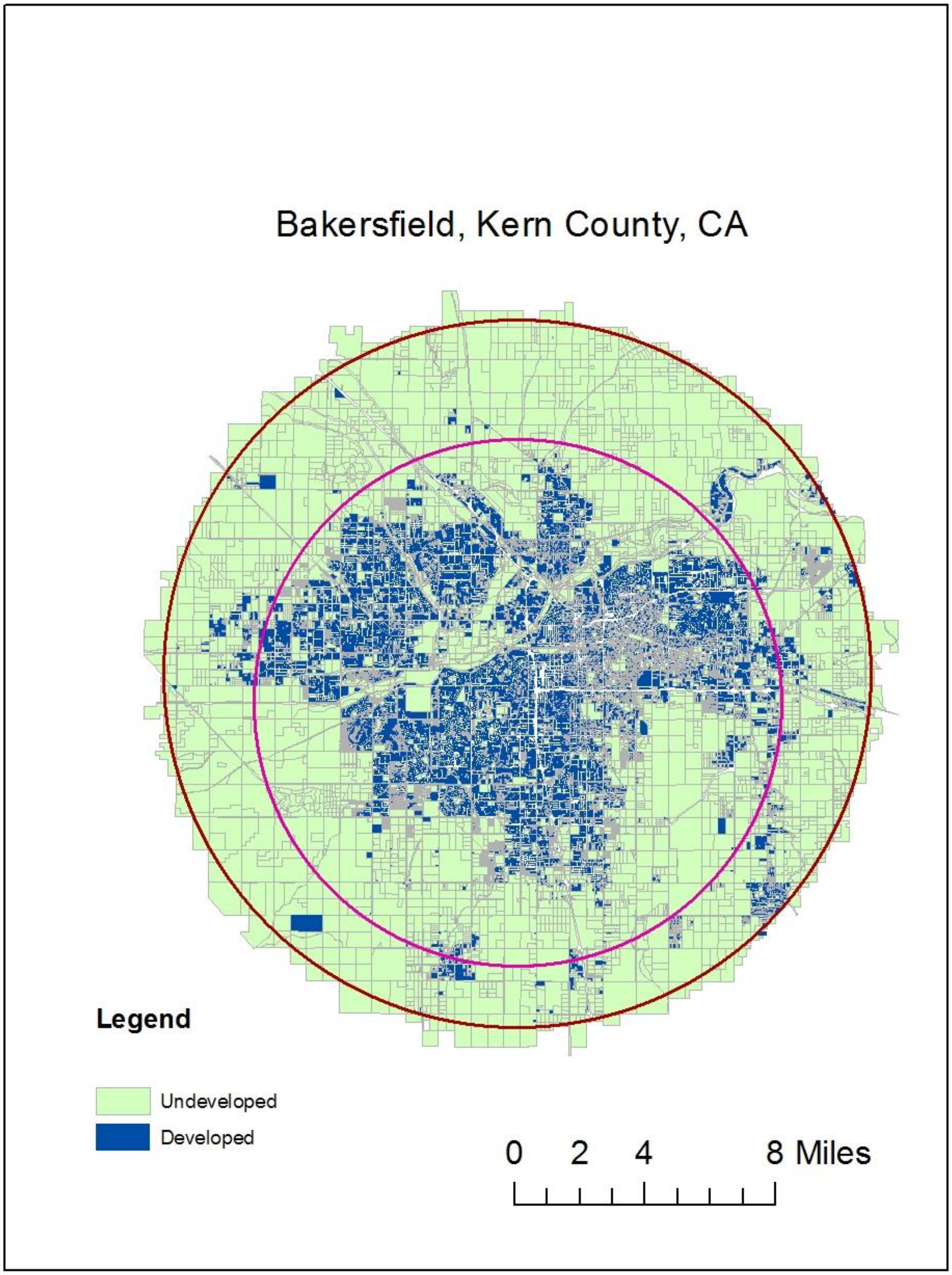
Statistical significance is indicated at the 10%, 5% and 1% levels by *, ** and ***, respectively.

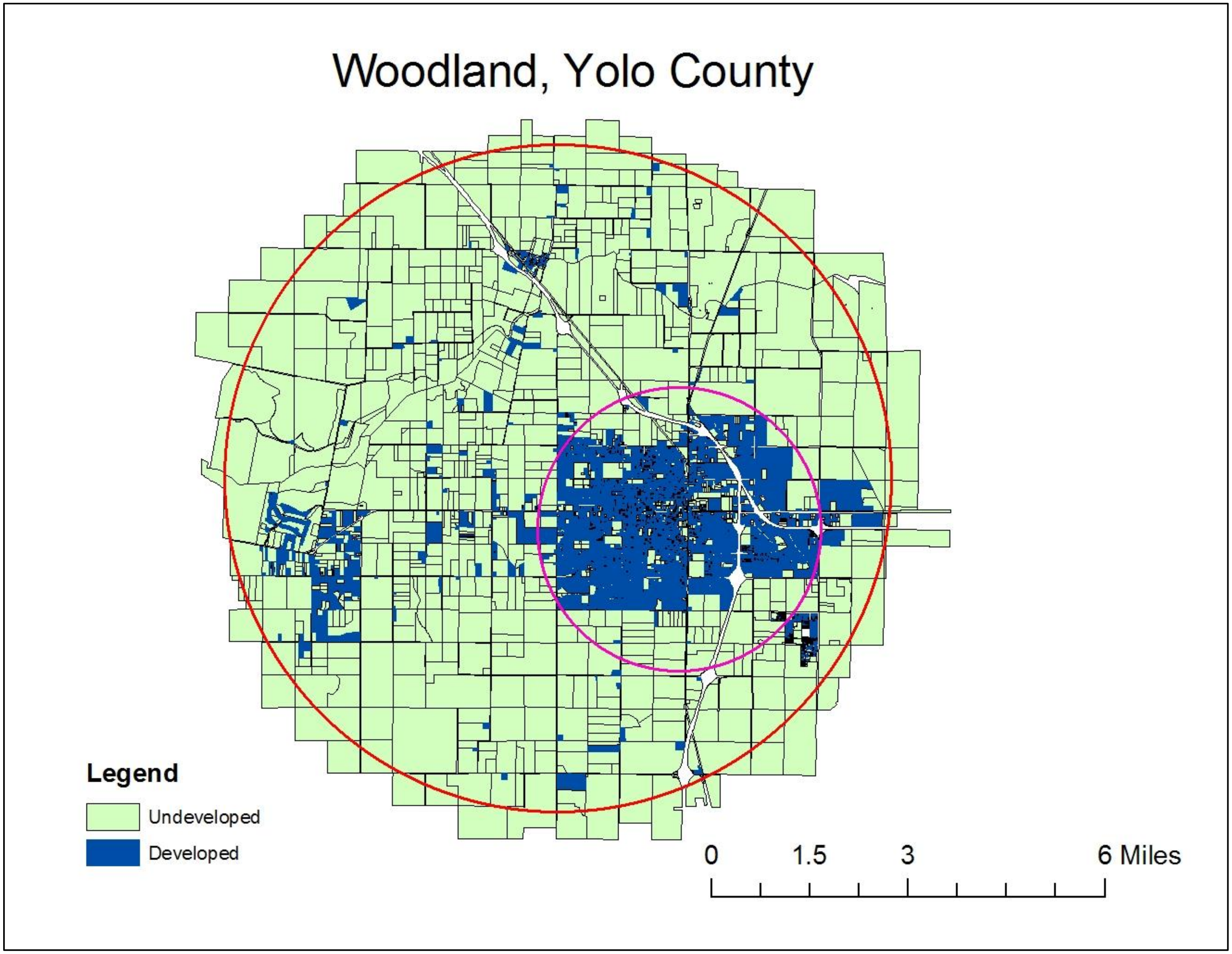
Appendix

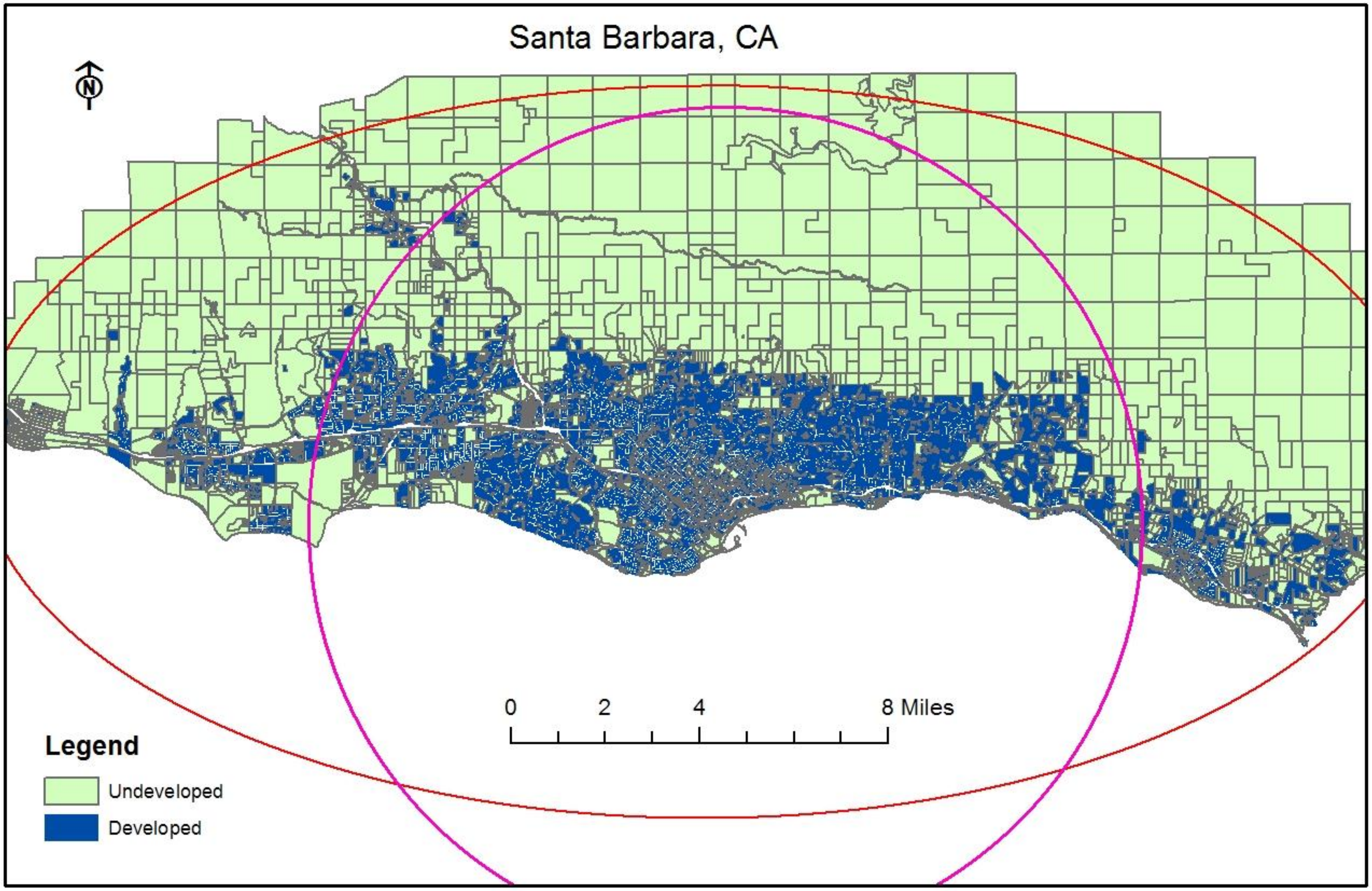
This sample of maps indicates a number of features of the data used in this study. Developed parcels are shaded yellow and have dark borders. The outer circle indicates the range of land considered to be part of the land market for a given city. The cities varied in many ways including their size, the density or concentration of developed lands around a central business district. Dense circular city expansion was observed in some cities such as Lodi, and sparse on asymmetric expansion in places like Santa Barbara where natural features prevent radial expansion.



Lodi, San Joaquin County, CA


Bakersfield, Kern County, CA
Legend
Undeveloped
Developed
0 2 4 8 Miles


Woodland, Yolo County
Legend
Undeveloped
Developed
0
1.5
3
6 Miles


Santa Barbara, CA
N
0
2
4
8 Miles
Legend
Undeveloped
Developed