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# Impact of Urban Growth Boundary on Housing and Land Prices: Evidence from King County, Washington

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**ABSTRACT** *This study provides evidence of the impact of an urban growth boundary (UGB) on housing and land prices. The study uses a data-set that inventories sales transactions of single-family homes and of vacant lots zoned for single-family homes within two miles of either side of the eastern boundary of the primary UGB in King County, Washington. The results show that although the UGB increases land prices by 230 per cent, it decreases housing prices by 1.3 per cent. These findings should encourage policy-makers to adopt a policy framework in which a UGB's anticipated inflationary land price effect is mitigated by policies that increase housing supply. Such policies could include minimum density requirements, zoning for multifamily housing, and ordinances enabling the construction of accessory dwelling units.*

**KEY WORDS:** Housing affordability, housing economics, planning, urban growth boundary, hedonic regression, spatial econometrics, housing prices, land prices

## Introduction

In the decades since the 1970s, state, regional, and local governments across the USA have increasingly used growth management tools to mitigate the perceived social, economic, and environmental ill effects of rapid suburbanization. The states of California, Florida, New Jersey, Oregon, and Washington lead in the use of growth management tools. Except for California, the other states have instituted state-level growth management programs wherein the major mechanisms used to manage growth include requiring adequate infrastructure to serve growth; implementing rate of growth programs that frequently limit the total population or the number of building permits issued by a jurisdiction; requiring intra- and inter-jurisdiction consistency among comprehensive plans, capital improvement programs, and other urban development policies; and finally, urban containment policies such as the use of urban growth

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boundaries (UGBs), urban service boundaries, and greenbelts to regulate the location and timing of growth.

Growth management tools are also widely used internationally. In the UK, greenbelts surround several cities such as Gloucester, Cambridge, and York. In fact, the London metropolitan area greenbelt was instituted as early as the 1930s (Munton, 1983). Other major international cities with greenbelts include Seoul, South Korea, and Istanbul, Turkey. More recently, the renewed focus on urban regeneration in the UK, through the ‘urban renaissance,’ has brought to attention growth management tools that can contain sprawl, protect the environment, and drive growth into existing urban areas (Department of the Environment, Transport and The Regions [DETR], 2000).

A very popular growth management tool, a UGB is often used to preserve farmland or environmentally sensitive land (for example, hill slopes and forests), direct urban development toward the core, and promote denser development. However, researchers highlight the potential negative impacts of UGBs. For example, Fischel (2002) notes a UGB’s dampening effect on economic development, and Lillydahl & Singell (1987) and Miller (1986) point to a UGB’s potential for increasing land and housing prices.

However, existing research points to a lack of consensus on the effect of a UGB on land and housing prices. Furthermore, most US studies focus on the Portland UGB. Considering the number of maturing comprehensive growth management programs across the USA, including UGBs in a number of metropolitan areas, the time is ripe for focusing on an area outside Portland to empirically estimate the effect of a UGB on housing and land prices. This study focuses on one such case—the King County, Washington, UGB.

This study examines the effect of the King County, Washington, UGB on land and housing prices. The research questions this study seeks to answer are as follows:

- (1) Controlling for other factors, what is the impact of a UGB on land and housing prices?
- (2) Furthermore, if a UGB increases housing prices, how much of the price increase is due to increased land prices?

## **Literature Review**

### *Conceptual Framework*

Developing a conceptual framework for understanding a UGB’s impact on land markets, Knaap & Nelson (1988) argue that a UGB can increase land prices in the following ways.

First, a UGB may restrict the supply of developable land. At the time the UGB is delineated, it is typical to ensure that adequate developable land lies within the UGB for housing supply for a predetermined number of years. For example, in both Oregon and Washington, the UGBs need to include buildable land adequate for a 20-year housing supply. Jurisdictions make periodic assessments to ensure that this land supply is maintained. If needed, a UGB can be redrawn to include more developable land within its boundary. Second, a UGB may control the timing of future zoning changes, and third, a UGB may specify ‘the boundary between non-conforming land uses. In this respect, UGBs define the location of future urban development which may alter current location decisions’ (Knaap & Nelson, 1988, p. 40). However, a UGB that does not constrain the supply of developable land is unlikely to increase land prices.

Jaeger *et al.* (2012) note two additional ways in which land use regulations might impact property values, namely ‘restriction effects’ and ‘amenity effects’ (Jaeger *et al.*, 2012, p. 63). ‘Restriction effects’ prevent the highest and best use of land. Such effects are likely to be significant for land parcels outside the UGBs whose intensity and type of use might be regulated. Furthermore, land use regulations, through their ‘amenity effects,’ can positively impact housing prices. For example, regulations could enhance the desirability of a neighborhood by promoting health and safety, increase the neighborhood’s environmental quality (for example, by preserving open spaces), and reduce nuisances such as noise, smell, and pollution (Jaeger *et al.*, 2012, p. 63). Empirical research finds strong evidence for the positive impact of environmental amenities and neighborhood quality on housing prices (see, for example, Cho *et al.*, 2008c; Geoghegan, 2002; Seo & von Rabenau, 2011). UGBs can enhance the environmental quality of land parcels that are inside but located very close to the UGB. Such parcels might enjoy the open space and the expansive views afforded by the low-density development outside the UGB. Similarly, land parcels outside the UGB might also enjoy these amenity effects.

The impact of a UGB on housing prices depends on housing demand and supply elasticities (Dawkins & Nelson, 2002). A UGB may not increase housing prices if housing demand is elastic. For example, homebuyers could choose to locate in neighboring jurisdictions in response to UGB-led land supply constraints. On the other hand, the land supply constraint imposed by a UGB is likely to increase housing prices if the housing demand is inelastic. Such a scenario could arise if the jurisdiction with the UGB has very desirable housing stock or when alternate housing markets do not exist.

On the supply side, elastic housing supply could mitigate the inflationary pressure on housing prices by bringing in new supply. For example, developers might respond to land supply constraints by building homes at higher densities, thereby reducing the cost of land in comparison to overall housing costs. Furthermore, infill development might become financially viable due to the higher cost of acquiring raw urban land.

On the other hand, inelastic housing supply is likely to increase housing prices. For example, zoning constraints or developers’ lack of interest might limit the development of denser housing. Examples of inelastic housing supply abound in California, where individual cities have the power to adopt a UGB. Several San Francisco Bay Area cities (for example, San Jose, Pittsburg, and Antioch) have locally defined UGBs. These UGBs limit the supply of developable land and could increase housing prices.

In summary, although a UGB very likely increases land prices, its impact on housing prices depends on housing demand and supply elasticities. Government policies often influence housing demand and supply. For example, policies that enable greater housing supply—such as zoning policies and building bylaws that promote compact development, accessory dwelling units, and a variety of housing types, including multifamily housing—could offset UGB-led land supply constraints (Aurand, 2010; Dong & Gliebe, 2012). However, policies that limit housing supply, such as minimum density requirements, could exacerbate supply constraints (Dawkins & Nelson, 2002; Levine, 1999). In summary, the prediction of the direction and the magnitude of the price effect of a UGB on the housing market is an empirical question.

#### *Empirical Studies Measuring the Effect of Land Use Regulations on Land and Housing Prices*

The impacts of government interventions on land and housing markets have received significant scholarly attention over the last four decades (see Buxton & Taylor, 2011;

Grout *et al.*, 2011; Jaeger *et al.*, 2012; Katz & Rosen, 1987; Knaap, 1985; Knaap & Nelson, 1988; McMillen & McDonald, 1991; Pollakowski & Wachter, 1990; Quigley & Raphael, 2005; Wu & Cho, 2007; Zorn *et al.*, 1986). Arguably, government regulations and growth control measures such as zoning, housing permit caps, and UGBs exert an upward pressure on land and housing prices by restricting developable land supply (Fischel, 1989), which, in turn, restricts housing supply (Quigley & Raphael, 2005; Wu & Cho, 2007). Furthermore, these regulations' negative impact on low- and moderate-income households raises equity-related concerns (Zorn *et al.*, 1986). For example, Schwartz *et al.* (1984) find that the strategy of the City of Petaluma, California, to control growth by issuing a limited number of housing permits raised the city's housing prices. Similarly, Pollakowski & Wachter (1990), examining the impact of the zoning and growth control measures adopted by Montgomery County, Maryland, find that these government regulations increased both land and housing prices. Furthermore, the study reports that the combined impacts of zoning and growth control measures exceed their individual impacts. Studies conducted at the state and subnational levels report similar findings. For example, Quigley & Raphael (2005) find that the degree of regulatory stringency directly impacts housing prices in California. Ihlanfeldt (2007) and Anthony (2006) report similar findings for Florida, and Wu & Cho (2007) find that local land use regulations restrict housing supply in the Western United States.

Portland, Oregon, was among the first to adopt a UGB in the USA. Therefore, it is the focus of several studies estimating the effect of UGBs on land and housing prices. Among the first such studies is Knaap (1985). This study finds that the Portland UGB impacts land prices by controlling the timing of zoning changes. The study postulates that a UGB grants certainty of conversion of land use from nonurban to urban use for undeveloped parcels inside the UGB and signals very low probability of zoning change for land parcels outside the UGB. Hence, the nonurban land prices must be higher inside the UGB compared to the prices outside. Using sales data for lots zoned for single-family homes in Washington County and Clackamas County, Oregon, from September 1979 through August 1980, the hypothesized effect is observed in the study. Furthermore, the study hypothesizes that the price of land already zoned for urban densities should be the same inside and outside the UGB. The analysis of urban land prices on either side of the 'Intermediate Growth Boundary' (IGB) finds that the IGB has no effect on urban land prices. However, the study notes the need for a larger time series study before more conclusive findings can emerge (Knaap, 1985, p. 33). In contrast to Knaap (1985), Nelson (1986) finds that the residential land prices were higher inside the Portland UGB compared to the prices outside.

The studies by Downs (2002) and Phillips & Goodstein (2000) take a different methodological approach to estimating the effect of the Portland UGB on housing prices. These studies compare Portland with similar metropolitan areas across the USA. Downs (2002) compares the mean housing price of Portland with the mean housing prices of other metropolitan areas and suggests that during the period 1990–1994 the Portland UGB (measured by a dichotomous dummy variable), in combination with strong employment growth, might have contributed to a housing price increase. However, Fischel (2002) notes methodological deficiencies in Downs' analysis. Most notable is the potential for selectivity bias due to the inclusion of a disproportionately large number of western metropolitan areas in the data-set. Fischel (2002) further argues that the dummy variable for Portland could be measuring Portland-specific effects (including the effect of the UGB)

compared to a large number of western metropolitan areas that had strong housing markets.

Similar to Downs (2002), Phillips & Goodstein (2000) measure the impact of Portland's UGB on housing prices by comparing Portland with 36 other major cities across the nation for the year 1996. The study finds that the Portland UGB increases housing prices by approximately \$10 000, or 7 per cent, of the year 1996 median housing price of \$144 000. However, the findings of Jun (2006) counter Downs (2002) and Phillips & Goodstein (2000). Jun (2006), using the 1990 and 2000 census-block-group-level data to estimate the impact of the Portland UGB on housing prices inside and outside the UGB, finds no such effect.

One of the few empirical studies of regions outside the state of Oregon, Cho *et al.* (2008a) use parcel-level data for the years 1997–2004 and find that the Knoxville, Tennessee, UGB increases housing prices inside the UGB. Furthermore, Cunningham (2007) uses parcel-level data for the year 2002 and finds that the King County, Washington, UGB reduces the rate of development of new housing outside the UGB by 28–39 per cent. However, Cho *et al.* (2008b) find that other mediating factors could alter the impact of a UGB on the probability of residential development. The study finds that the Knoxville, Tennessee, UGB's impacts on the probability of development within and outside the UGB vary depending on factors such as the probability that the City of Knoxville would annex the neighborhood in which the land parcel is located. The higher the probability of annexation is, the lower the probability of the development of the vacant land becomes. Furthermore, this study finds that the impact of the UGB on land prices is statistically insignificant.

A search for international studies on the use of urban containment policies reveals an analysis of Swiss UGBs, Seoul's greenbelt, and UK's urban containment policies across various dimensions of urban development. It should be noted that greenbelts are actual physical spaces, often several kilometers wide. UGBs, on the other hand, are administrative boundary lines, not actual physical spaces. Therefore, greenbelts differ from UGBs in the following key ways with respect to their potential impacts on land and housing prices: (a) more demand-side factors are associated with a greenbelt than with a UGB. A greenbelt often consists of green open spaces, hills, lakes, and streams. Therefore, it provides scenic views and could be used for recreational purposes. Further, a greenbelt could provide several environmental benefits such as air and water purification, flood control, protection to endangered plant and animal species, and ground water recharge (Bengston & Youn, 2006), whereas a UGB by itself does not provide any such amenity; it only limits urbanization to within its boundaries, thereby helping to preserve open space outside the boundary. (b) On the supply side, whereas land within a greenbelt could be released for development, no such opportunity exists with a UGB.

An analysis of four Swiss cities revealed that their UGBs were able to limit urban development outside and increase density within their boundaries (Gennaio *et al.*, 2009). This study, however, did not estimate the impacts of UGBs on land and housing prices. However, several studies examine the land and housing price impacts of UK's containment policies and Seoul's greenbelt. For example, Dawkins & Nelson's (2002) review of several studies on UK's urban containment policies notes that these policies, by limiting supply of land, increase housing prices. Jun (2012) and Kim (1993) find that Seoul's greenbelt increases land and housing prices. Kim (1993) estimates that if 1.2 per cent of the land within the greenbelt were to be released, land and housing prices would

decrease by 1.4 and 0.2 per cent, respectively. The Jun (2012) findings are similar though more modest. The study shows that if the entire land within the greenbelt had been released in 2006, the residential and the nonresidential rents would have decreased by 0.4 and 13.7 per cent, respectively.

In summary, the existing research points to a lack of consensus on the effect of a UGB on land and housing prices. Furthermore, most of the studies conducted outside the USA focus on greenbelts rather than on UGBs, whereas US studies focus on the Portland UGB. Considering the number of maturing comprehensive growth management programs across the USA, including UGBs in a number of metropolitan areas, the time is ripe for focusing on an area outside Portland to make an empirical estimate of the effect of a UGB on housing and land prices. This study focuses on one such case—the King County, Washington, UGB.

## **Study Area**

### *Growth Management in Washington State*

Washington State is among the few states with a strong and comprehensive state-level growth management program. Washington adopted the statewide Growth Management Act (GMA) in 1990. Furthermore, unlike other strong growth management states (notably, Florida and Oregon) Washington adopted a bottom-up approach to growth management, with county-level planning as its ‘cornerstone’ (Staley & Gilroy, 2001, p. 15). Currently, 29 counties, approximately three-fourths of the total 39 counties in the state, plan under the GMA. Of these, 18 are *required* to plan under the GMA, and 11 have *chosen* to do so.

Population size and population growth rate are the two criteria used by the GMA to determine whether a county is *required* to plan under the GMA.<sup>1</sup> The state provides a 20-year population projection to each of the 29 counties. In turn, each county must ensure that its county and city plans accommodate the projected population. The GMA requires the participating counties to adopt countywide planning policies (CPP), prepare and implement the comprehensive plan, and ensure that the plans of the jurisdictions within the county are consistent with the CPP. Designation of an urban growth area (UGA) and a corresponding UGB is an important element of the CPP.

The King County CPP clearly requires the county to limit urban growth to within the UGA. Accordingly, local governments are required to ensure adequate zoning capacity and infrastructure to serve housing and employment within the UGA (King County, 2010). Furthermore, the 1997 Buildable Lands Amendment to the GMA requires the six most populous counties, including the King County, to examine city plans every five years to ensure that the cities and counties are on track to accommodate the projected population (King County, 2007). Moreover, each of these six counties is required to review the UGA at least every 10 years to ensure urban development at adequate densities (Staley & Gilroy, 2001).

### *King County, Washington, Urban Growth Boundary*

King County adopted a UGB in 1985 as part of its comprehensive plan. After the adoption of the GMA by Washington State in 1990, King County adopted the CPP in 1992. The CPP designated the UGA and delineated the UGB. The 1992 UGB is virtually the same as the 1985 boundary, except for one major change entailing the transfer of 130 square kilometers (50 square miles) area from inside to outside the UGB. Since 1992, barring

minor changes, the boundary has not changed (The Online Encyclopedia of Washington State History, 2006). The present King County UGB comprises a primary UGB and six smaller satellite areas (five to the east and one, Vashon Island, to the west of the primary UGB). The northern and southern boundaries of the primary UGB coincide with the King County boundary. Beyond Vashon Island, the UGB is bounded by the Puget Sound in the west. Only the eastern boundary of the primary UGB has urban development on both sides. Therefore, the residential lots and homes sold on both sides of the eastern boundary of the primary UGB are the focus of this study. [Figure 1](#) provides the UGB location.

## **Materials and Methods**

### *Data Description*

The data used in this study include sales of vacant lots zoned for single-family homes and sales of single-family homes. The data cover for the period January 2004–December 2006. The King County tax assessor's office collects sale and building attribute data for the unincorporated area and the cities and towns of King County. The data availability constraints limited the study to the period 2004–2006.

The UGBs have been criticized for their potential to negatively impact housing affordability by constraining the supply of developable land (see Lillydahl & Singell, 1987; Miller, 1986). This study would garner support for the use of UGBs as a growth management tool should it find that the King County UGB did not increase housing prices even during the 2004–2006 strong housing demand period when, as per Puget Sound Trends (2007), the median price of existing single-family homes increased from \$325 000 in 2004 to \$425 000 in the year 2006—an annualized rate of increase of 9.3 per cent.

The real property records for sales of residential buildings and land parcels are merged to create a data-set that includes the sale price, and the structural and locational attributes of the single-family lots and homes sold during the study period. The data for structural attributes of each single-family home include the number of bedrooms, the number of bathrooms, the size of the living space, lot size, the most recent sale date, the construction year, and the quality of the structure (the King County tax assessor's records use a variable called 'Building Grade,' which assesses the quality of each house using the following 13 categories, in ascending order of quality: cabin, substandard, poor, low, fair, low average, average, good, better, very good, excellent, luxury, and mansion). For King County, these data are obtained from the Washington State Geospatial Data Archive (WAGDA, 2008).

The original tax assessor's files contain all property types. Data pertaining to single-family lots and homes are selected by filtering out the sale and parcel data for all other property types and land uses. Data for a few other factors that could impact housing prices, such as differences in homebuyers' preferences for homes within and outside the UGB, were not available.

The data-set also contains the name of the jurisdiction and the school district in which the parcel was located at the time of assessment. GIS software is used to associate spatial features with parcel centroids and to measure proximity to key features such as the UGB, nearest neighborhood center, the Seattle Central Business District, nearest freeway, nearest major freeway intersection, and other regional amenities such as Lake Washington and Lake Sammamish.

Additional data for median income, population growth rate, and mortgage rates are collected for the period 2004–2006 and merged with the data-set. Median income and

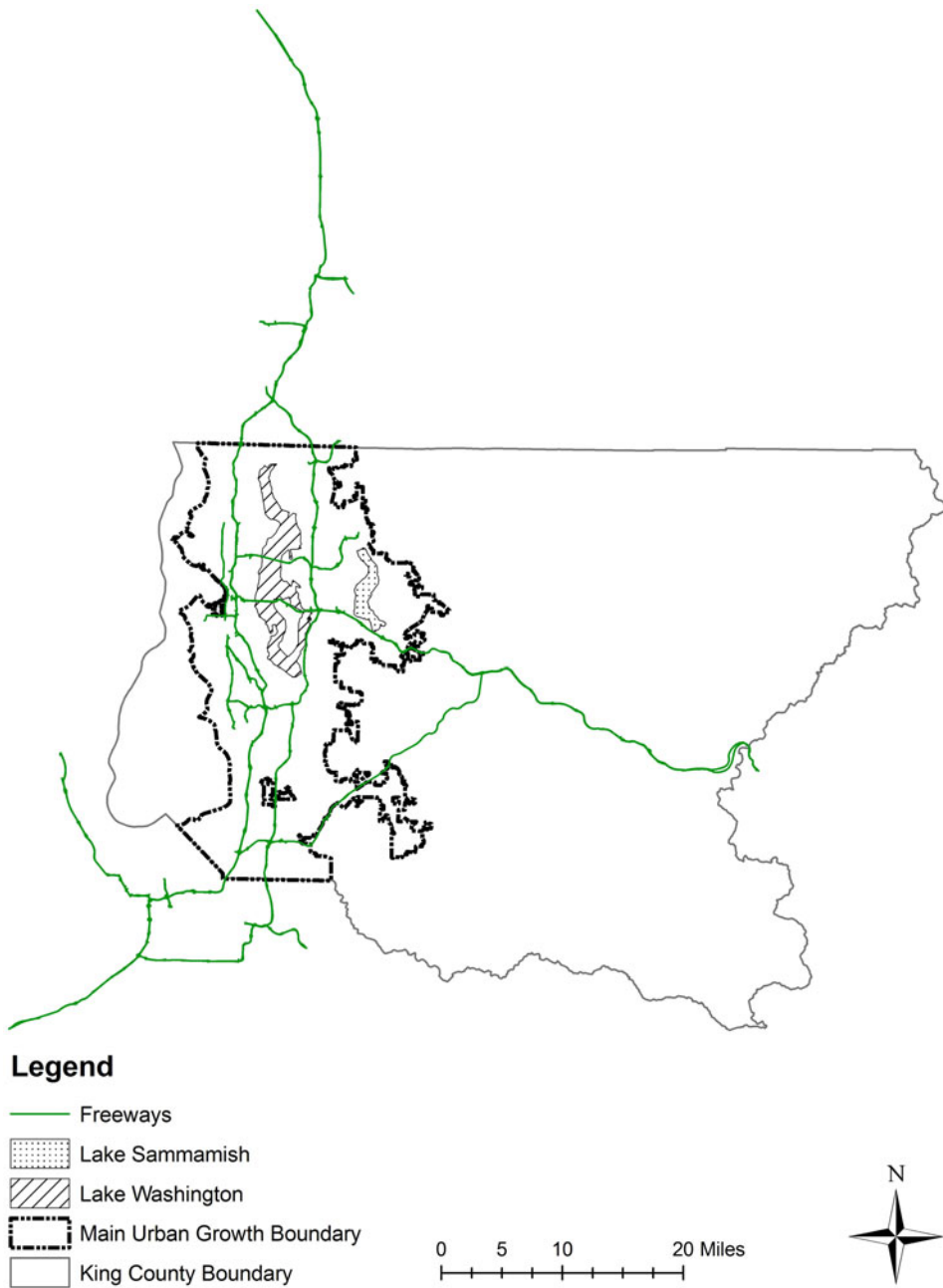


Figure 1. King County, WA, urban growth boundary.

population growth rate data are obtained from the US Census GIS files available from WAGDA. Mortgage rate data for 30-year fixed mortgages are obtained from the Board of Governors of the Federal Reserve System.

*Model Structure and Study Hypothesis*

*Model structure.* Four regression models are estimated. The first three models measure the impact of the UGB on land prices. Model 1 measures the change in the price of vacant lots zoned for single-family use inside the UGB with respect to their distance from the UGB, *ceteris paribus*. Model 2 measures the same for lots outside the UGB. Model 3 compares lot prices inside the UGB to lot prices outside the UGB. The ‘Natural Log of Sale Price per Square Feet of the Lot’ is the dependent variable for Models 1–3.

The fourth model measures the impact of the UGB on housing prices. This model also parses out the land and nonland components of the UGB-specific housing price increase. ‘Natural Log of Sale Price of the House’ is the dependent variable for Model 4.

*Study hypothesis.* By law, every Washington State UGA is required to ensure adequate buildable land to accommodate a 20-year population. Therefore, land parcels inside the UGB are expected to be developed within 20 years. Hence, these parcels are assured urban-level infrastructure and services in the short to medium term. This infrastructure and services certainty should be capitalized into land prices inside the UGB. Hence, Model 1 tests the hypothesis that, controlling for other factors, prices of lots zoned for single-family housing inside the UGB should not change with the lots’ distance from the UGB.

The hypothesis tested in Model 2 is more complex. For lots outside the UGB, the effect of the ‘distance from the UGB’ variable primarily depends on the expectation of UGB expansion. If UGB expansion is expected, the lots closer to the UGB should be priced higher than those farther away to capitalize the future stream of revenues boundary expansion might confer on these lots. Conversely, the distance to the UGB should not impact lot prices if UGB expansion is not expected.

Model 3 tests the hypothesis that a tightly drawn UGB should raise the price of developable land inside the UGB compared to similar land outside the UGB. Furthermore, compared to the lots outside the UGB, the lots inside the UGB are granted certainty of development at urban levels of density through zoning, building bylaws, and other regulations governing urban development. Finally, the jurisdictions that plan under the Washington State GMA are required to provide an urban level of infrastructure and services to the lots inside the UGB. Hence, the lots inside the UGB are assured a higher level of infrastructure and services compared to the lots outside the UGB. This assurance should be capitalized into lot prices. In this model, a dummy variable for the UGB captures the effect of the UGB on lot prices. A statistically significant positive coefficient for the UGB dummy variable would indicate that the lot prices are indeed higher inside the UGB, *ceteris paribus*.

The independent variables in the first three models include lot characteristics (lot size, water supply system type, and dummy variables classifying large vs medium and small lots); locational attributes (proximity to the nearest park, freeway, Seattle Central Business District, and important local environmental amenities such as Lake Washington and Lake Sammamish); neighborhood quality (measured through median household income and race/ethnic composition at the census-block-group level, and the dummy variables for the school district); season of sale; year of sale; and other fixed unobservable city-level effects, such as jurisdiction-level housing demand and supply, measured through municipal dummy variables. Finally, a dummy variable is created to determine whether a land parcel is inside and within 300 feet of the UGB. This variable aims to estimate the amenity effect of the UGB.

**Table 1.** Description of the independent variables.

Variables	Description
UGB dummy	Indicates whether a parcel is inside (value 1) or outside (value 0) the UGB.
DisUGB	Distance of the parcel from the UGB measured in meter.
WUGB	For the parcels inside the UGB, measures whether a parcel is within 91 meters (300 feet) (value 1) or more than 91 meters (300 feet) (value 0) from a UGB.
InUGB × Lot	Interaction variable created by the interaction of a dummy variable that measures whether a parcel is inside UGB with the variable that measures the lot size of the parcel.
LivSpace	Living space of the house measured in square meter.
LotSize	Measures the size of the parcel in square meter.
SLOT	Lots that are within the first quartile of lot sizes.
LLot	Lots that are in the top quartile of lot sizes.
Age	Number of years passed since the house was constructed.
Bed	Number of bedrooms in the house.
Bath	Number of bathrooms in the house.
Water	Measures whether a parcel is serviced by private water supply.
Income	Year 1999 median household income of the census block group in which the parcel falls.
CBD	Distance of the parcel to the major regional employment center—Seattle Business District measured in meter.
QSamm	Measures whether the parcel falls within a radius of quarter mile from Lake Sammamish.
QWash	Measures whether the parcel falls within a radius of quarter mile from Lake Washington.
HSamm	Measures whether the parcel falls within a radius of one-half mile from Lake Sammamish.
HWash	Measures whether the parcel falls within a radius of one-half mile from Lake Washington.
Parks	Distance of a parcel from a park that is less than 2 hectares (5 acres) in size, measured in meter.
Freeway	Distance of a parcel from the nearest freeway measured in meter.

Model 4 measures two UGB-specific price effects. First, the UGB dummy variable measures the UGB’s overall impact on housing prices by estimating the difference in housing prices inside and outside the UGB. Second, a variable created by the interaction of the UGB variable with the lot size variable measures the incremental effect of lot size on housing prices for the homes inside the UGB compared to the homes outside the UGB.

Table 1 describes the independent variables included in the models, and Tables 2–5 provide descriptive statistics. Preliminary testing was performed by analyzing the partial Pearson correlations and by checking for multicollinearity. Mortgage rates and proximity to the nearest freeway intersection and the nearest neighborhood center were dropped due to the multicollinearity problem.

### *Model Estimation Strategy*

The basic econometric approach is an ordinary least squares (OLS) regression that controls for time-invariant temporal and spatial effects such as the season and the year of sale and

**Table 2.** Descriptive statistics for variables in Model 1.

Variables	Minimum	Maximum	Mean	SD
DisUGB	12.70	3197	1447	1069
WUGB	0	1	0.05	0.22
SLot	0	1	0.08	0.28
LLot	0	1	0.32	0.47
Water	0	1	0.01	0.12
Income	\$20 096	\$142 881	\$74 475	\$23 517
Park	14.02	7765	1542	1303
Freeway	41.55	8023.56	2866.64	1732.79
CBD	12 950.34	39 491.72	23 134.93	6915.00
HSamm	0	1	0.11	0.32
HWash	0	1	0.01	0.12
<i>N</i>	215			

**Table 3.** Descriptive statistics for variables in Model 2.

Variables	Minimum	Maximum	Mean	SD
DisUGB	23.16	3094.63	1211.88	786
SLot	0	1	0.06	0.24
LLot	0	1	0.46	0.5
Water	0	1	0.16	0.37
Income	\$49 375	\$140 752	\$74 303	\$13 476
Park	81.38	7287.46	2432.00	1424.33
Freeway	81.31	7287.61	2626.03	1662.73
CBD	20 015.91	43 187.42	32 855.61	6037.78
<i>N</i>	83			

**Table 4.** Descriptive statistics for variables in Model 3.

Variables	Minimum	Maximum	Mean	SD
UGB dummy	0	1	0.71	0.46
SLot	0	1	0.06	0.24
LLot	0	1	0.53	0.5
Water	0	1	0.06	0.24
Income	\$20 096	\$142 881	\$74 330	\$21 211
Parks	14.02	7765.08	1858.67	1496.26
Freeway	41.55	12 610.70	3448.23	2390.37
CBD	12 950.34	44 896.43	26 019.86	8102.19
HSamm	0	1	0.08	0.27
<i>N</i>	306			

the jurisdiction and the school district in which the land parcel/house is located. The resulting model is of the form

$$P_{ij} = \alpha_0 + \beta S_i + \pi L_i + \alpha_1 P_k + \alpha_2 S_d + \alpha_3 T_d + \alpha_4 J_d + \alpha_5 SC_d + \varepsilon_i, \quad (1)$$

where  $P_{ij}$  is the sale price of the  $i$ th land parcel/house in the  $j$ th jurisdiction.  $S_i$  is a vector of structural attributes of the  $i$ th land parcel/house.  $L_i$  is a vector of locational attributes of the

**Table 5.** Descriptive statistics for variables in Model 4.

Variables	Minimum	Maximum	Mean	SD
UGB dummy	0	1	0.87	0.34
InUGB $\times$ Lot	0	52 708	9027	7040
LivSpace	78.97	454.28	192.02	68.93
LotSize	278.70	29 541.09	1413.75	2077.71
Age	0	106	25	16
Bedrooms	1	6	3.43	0.7
Bath	1	5	1.5	0.57
Bldggrade	3	13	7.73	1.138
Water	0	1	0.02	0.15
Income	\$14 648	\$156 303	\$76 042	\$21 516
CBD	12 553.49	45 844.66	24 802.80	7025.64
QSamm	0	1	0.02	0.12
QWash	0	1	0.03	0.05
Freeway	0.05	12 860.82	3051.03	2117.75
<i>N</i>	17 993			

$i$ th land parcel/house. The locational attributes include, among others, proximity to the UGB for Models 1 and 2, whether the land parcel is inside the UGB (for Model 3), and whether the house is inside the UGB (for Model 4).  $P_k$  is a vector of jurisdictional/regional attributes such as proximity to regional lakes and freeways.  $S_d$  is a vector of season dummies,  $T_d$  is a vector of time (year) dummies,  $J_d$  is a vector of jurisdiction dummies, and  $SC_d$  is a vector of school district dummies.  $\varepsilon_i$  is the error term.

Next, the basic OLS assumptions of normality and homoscedasticity are tested. Models 1, 3, and 4 display heteroscedasticity. Hence, White's estimator is used to estimate heteroscedasticity-consistent standard errors. Finally, spatial autocorrelation is suspected due to the data's spatial-temporal nature. First, Global Moran's  $I$ -test is conducted to test for spatial autocorrelation. The test indicates that all four models suffer from spatial autocorrelation. Next, following Anselin (1988), Lagrange Multiplier (LM) tests are used to examine the type of spatial dependence exhibited by the models—spatial lag or spatial error, or both. The LM tests include the simple LM test for error dependence (LMerr), the simple LM test for a missing spatially lagged dependent variable (LMlag), the Robust LMerr (RLMerr) test for error dependence in the possible presence of a missing lagged dependent variable, and the Robust LMlag (RLMlag) test for a missing lagged dependent variable in the presence of error dependence (Bivand & Bernat, n.d.).

The LM tests indicate that Model 1 suffers from spatial error and Models 3 and 4 suffer from spatial lag autocorrelation. The LM tests for Model 2 are statistically insignificant. However, because the Global Moran's  $I$ -test is significant for Model 2, a conservative approach is taken and spatial autocorrelation is assumed for this model. Therefore, both spatial lag and spatial error models are estimated for Model 2. The log likelihoods of these two models are very similar ( $-61.0284$  for the spatial lag model and  $-61.0141$  for the spatial error model). The marginally higher log likelihood of the spatial error model is indicative of a better model fit.

Data for spatial models are weighted to take into account both the physical and temporal proximity of the sale transactions. Four nearest sale transactions are included in the spatial weights calculation. Furthermore, the transactions are weighted by their sale year.

The transactions in the same year are given a weight of 1, transactions two years apart a weight of 0.5, and transactions three years apart a weight of 0.33.

Table 6 presents the regression results, along with the Global Moran's  $I$ -test and LM test results. The coefficients and standard errors for the dummy variables representing the season of sale (winter, fall, and spring, with summer as a referent), the year of sale (year 2005 and year 2006, with year 2004 as a referent), school districts, and jurisdictions are not shown in Table 6 to minimize table size. The preliminary models were estimated using both the log and the nonlog transformations of the dependent and the independent variables. The final models include the transformations that provide the best model fit.

## Results and Discussion

### *Model 1. Regression Model Estimating the Effect of Distance from the UGB on Land Price for Lots inside the UGB*

The number of observations is 215, and the adjusted  $R^2$  for the model is 0.36. Because the model suffers from spatial error autocorrelation, further discussion will focus on the spatial error model results.

The distance to the UGB variable is statistically insignificant at the  $p = 0.10$  level, indicating that the prices of vacant single-family lots inside the UGB, after controlling for other factors, do not change with distance from the UGB. This finding supports the argument made by Knaap (1985) that once the UGB imparts certainty of development, the distance from the UGB should not impact land prices.

Among the other variables included in the model, large lot size and proximity to Lake Sammamish and freeway are statistically significant at the  $p = 0.10$  level and above. Controlling for other factors, the large lots sell for lower prices compared to the medium-sized lots (the referent), which is perhaps indicative of the lower demand for large lots for single-family residential development.<sup>2</sup> Furthermore, compared to those in the year 2006, lot prices were lower in the year 2005. The lots within half a mile of Lake Sammamish sold at a premium, confirming the regional amenity status of this lake. Finally, proximity to the freeways decreased lot prices. This counterintuitive finding might be due to the negative capitalization of the noise and pollution effects of freeways into lot prices.

### *Model 2. Regression Model Estimating the Effect of Distance from the UGB on Land Prices for Lots outside the UGB*

The number of observations is 83, and the adjusted  $R^2$  for the model is 0.62. Because the spatial error model provides the best data fit, further discussion will focus on the spatial error model results.

The 'distance from the UGB' variable is statistically insignificant at the  $p = 0.10$  level. For the vacant lots sold outside the UGB, it was hypothesized that the effect of the 'distance from the UGB' variable on land prices would depend upon the UGB expansion expectation. If the expansion is expected, the lots closer to the UGB should sell for a higher price to capitalize the future stream of revenues that boundary expansion might confer on these lots. Conversely, the distance from the UGB should not impact lot prices if expansion is not expected. The model results indicate that the lot prices do not change with the distance from the UGB, which is perhaps indicative of a very low expectation of UGB



Table 6. Continued

Variables	Model 1				Model 2				Model 3				Model 4			
	OLS	Lag	Error		OLS	Lag	Error		OLS	Lag	Error		OLS	Lag	Error	
Income	-8.57E-07 (4.62E-06)	-8.24E-07 (4.14E-06)	-8.71E-07 (4.13E-06)	-2.23E-05 (8.01E-06)***	-2.17E-05 (7.09E-06)***	-2.22E-05 (6.98E-06)***	-3.82E-06 (3.88E-06)	-3.53E-06 (3.59E-06)	-2.89E-06 (3.61E-06)	1.01E-06 (1.82E-07)***	1.02E-06 (1.83E-07)***	1.21E-06 (9.23E-08)***	1.01E-06 (1.82E-07)***	1.01E-06 (1.82E-07)***	1.02E-06 (1.83E-07)***	
White	(3.87E-06)			(7.93E-06)***			(3.91E-06)					(9.84E-08)***				
CBD	-7.77E-05 (6.14E-05)	-7.08E-05 (5.51E-05)	-7.36E-05 (5.48E-05)	-1.57E-05 (2.88E-05)	-1.59E-05 (2.53E-05)	-1.59E-05 (2.48E-05)	9.77E-06 (2.57E-05)	1.18E-05 (2.39E-05)	9.08E-06 (2.37E-05)	1.35E-06 (1.43E-06)	2.02E-06 (1.42E-06)	-7.73E-07 (7.15E-07)	1.35E-06 (1.43E-06)	1.35E-06 (1.43E-06)	2.02E-06 (1.42E-06)	
White	(6.04E-05)			(2.77E-05)			(2.27E-05)					(7.94E-07)				
QSanm	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0729 (0.0113)***	0.0807 (0.0233)	0.0807 (0.0233)	0.0834 (0.2329)***	
White	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	(0.0112)***	0.2085 (0.0523)***	0.2085 (0.0523)***	0.2095 (0.0522)***	
QWash	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1325 (0.0249)***	0.2085 (0.0523)***	0.2085 (0.0523)***	0.2095 (0.0522)***	
White	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	(0.2810)***	NA	NA	NA	
HSamim	0.4812 (0.3094)	0.4336 (0.2782)	0.4363 (0.2652)*	NA	NA	NA	0.7024 (0.2900)**	0.6813 (0.2685)**	0.6495 (0.2705)**	NA	NA	NA	NA	NA	NA	NA
White	(0.26049)						(0.2522)***									
HWash	0.3933 (0.7049)	0.3773 (0.6326)	0.5165 (0.6298)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
White	(0.7275)															
Parks	5.60E-05 (1.05E-04)	4.14E-05 (9.42E-05)	2.61E-05 (9.28E-05)	-1.22E-04 (8.01E-05)	-1.21E-04 (7.03E-05)*	-1.16E-04 (7.09E-05)	-9.69E-06 (6.76E-05)	-5.63E-06 (6.23E-05)	-1.28E-05 (6.30E-05)	NA	NA	NA	NA	NA	NA	NA
White	(1.03E-04)			(6.50E-05)*			(6.73E-05)									
Freeway <sup>e</sup>	0.1952 (0.1158)*	0.1922 (0.1042)*	0.2295 (0.1021)**	-0.1762 (0.1872)	-0.1934 (0.1667)	-0.1826 (0.1668)	0.0875 (0.0903)	0.0713 (0.0839)	0.0816 (0.0837)	0.0816 (0.0837)	-5.22E-06 (1.06E-06)***	-5.22E-06 (1.06E-06)***	-4.65E-06 (2.10E-06)**	-4.65E-06 (2.10E-06)**	-4.42E-06 (2.11E-06)**	
White	(0.1002)*			(0.1721)			(0.0913)					(1.16E-06)***				
Dependent variable	Natural log of sale price per square foot				Natural log of sale price per square foot				Natural log of sale price per square foot				Natural log of sale price			
N	215	215	215	83	83	83	306	306	306	306	306	17 993	4435	4435	4435	
Adj. R <sup>2</sup>	0.3556			0.6204			0.4454					0.8145				
Log likeli- hood		-246.5538	-244.789		-61.0284	-61.01414						-358.1943		1424.444	1421.132	
Global Mor- an's I	3.8473***			1.2534*			2.7775***					3.3729***				
LMerr	9.6461***			0.7633			2.9551*					8.9276***				
LMlag	4.4212***			0.08			3.4169*					15.34***				
RLMerr	5.2743**			2.0182			0.3218					1.5363				
RLMlag	0.0495			1.3349			0.7835					7.9488***				

Note: Figures in parentheses are standard errors. NA = not applicable.  
 \*\*\*Significant at 1 per cent; \*\*significant at 5 per cent; \*significant at 10 per cent.  
<sup>a</sup> Lots in the bottom quartile of lot sizes.  
<sup>b</sup> Lots in the top quartile of lot sizes.  
<sup>c</sup> Natural log of distance to freeway for Models 1-3.

expansion. This expectation is entirely plausible given that the King County UGB has undergone only minor changes since its implementation in 1985.

Regarding the other variables, the model indicates that although a large lot sells for a lower price compared to a medium-sized lot (see above for probable reason for this finding), a small lot sells at a premium. The model also indicates that the lots that are serviced through a private water supply are lower in price compared to the lots serviced through the public water supply, which is perhaps indicative of the better quality and more reliable service provided by the public water supply system. Furthermore, a public water supply system could be desirable for insurance purposes. Many cases of failure of private or lot-based water systems have been discussed in the literature.<sup>3</sup> The lots sold in the years 2004 and 2005 are lower in price compared to the lots sold in the year 2006, indicating that the residential real estate market was stronger in the year 2006 compared to the years 2004 and 2005. Furthermore, the lots sold in winter are lower in price compared to the lots sold in summer, capturing the cyclical nature of the real estate market, where real estate sold in the summer or fall typically commands a premium.

The model shows that the median household income of the census block group negatively affects lot prices. The median household income is commonly used as a proxy for neighborhood-level quality of life and for housing demand. The counterintuitive finding is perhaps a result of the disproportionately large proportion of lots sold in lower-income census block groups during the study period. In fact, a deeper analysis of the data-set reveals that 53 per cent of all lots were sold in two lower-income census block groups.

### *Model 3. Regression Model Estimating the Aggregate Effect of the UGB on Land Prices*

The number of observations is 306, and the adjusted  $R^2$  for the model is 0.45. Because the model suffers from spatial lag autocorrelation, further discussion will focus on the spatial lag model results.

The model uses a semilog specification with the natural log of sale price per square feet of land as the dependent variable. The UGB variable is statistically significant at the  $p = 0.01$  level. The coefficient for the UGB dummy variable is 1.1944, which in percentage terms translates to  $(e^{1.1944} - 1) \times 100$  per cent =  $(3.30 - 1) \times 100$  per cent = 230 per cent, indicating that during the period 2004–2006, lot prices inside the UGB were, on average, 230 per cent higher than lot prices outside the UGB. This finding is consistent with the theoretical expectation that a tightly delineated UGB very likely increases land prices. The other supportive growth management policies that increase the demand for the lots inside the UGB also likely contribute to this price increase. Such policies could include the provision of a higher level of infrastructure and services inside the UGB than outside the UGB.<sup>4</sup> However, because the regression model controls for several such infrastructure and services (for example, water supply, transportation accessibility, and proximity to parks and lakes), it is very likely that the bulk of the difference in the lot prices is due to the UGB-led land supply constraint.

The signs of all statistically significant variables (large lots, private water supply, year of sale, season of sale, proximity to the regional amenity—Lake Sammamish) are as theoretically expected.

*Model 4. Regression Model Estimating the Effect of the UGB on Housing Prices*

The number of observations is 17 993, and the adjusted  $R^2$  is 0.8145 for the model. Because the model suffers from spatial lag autocorrelation, further discussion will focus on the spatial lag model results. It must be noted that due to computing power limitations, a smaller sample (4435 observations, or 25 per cent of the original sample) is used to estimate spatial lag and error models. To verify the robustness of these models, the OLS model is reestimated with the 25 per cent sample. The magnitude and significance of the coefficients are very similar for the full data model (with 17 993 observations) and the 25 per cent sample model.

The UGB variable is statistically significant at the  $p = 0.01$  level, indicating that housing prices inside the UGB are lower than those outside the UGB. The interaction variable measuring the additional effect of lot size on housing prices inside the UGB is also statistically significant at the  $p = 0.01$  level. The coefficient of the UGB variable is  $-0.0588$ , and the coefficient of the interaction variable is  $4.22 \times 10^{-6}$ . For this data-set, the model coefficients indicate that for an average-priced home inside the UGB (\$395 000), built on an average-sized lot (10 400 square feet), the main effect of the UGB decreases the house price by approximately \$22 515, or 5.7 per cent of the \$395 000 sale price (the coefficient for the UGB dummy variable is  $-0.0588$ , which in percentage terms translates to  $(e^{-0.0588} - 1) \times 100$  per cent =  $(0.942901 - 1) \times 100$  per cent =  $-5.7$  per cent. The approximate value of  $e$  is 2.718, and the interaction effect increases the price by approximately \$17 336 ( $4.22 \times 10^{-6} \times \$395\,000 \times 10\,400$ ), or 4.4 per cent of the \$395 000 mean sale price. Therefore, the aggregate effect of the UGB variable and the interaction variable is a decrease of approximately \$5179 (\$22 515 - \$17 336), or 1.3 per cent, for an average-priced home.

The above finding is significant for several reasons. First, it indicates that housing prices are lower inside the UGB compared to the prices outside. Second, the finding indicates that land prices are indeed higher inside the UGB. This result is consistent with the Model 3 findings. Third, although land prices inside the UGB are higher, they do not lead to an overall increase in housing prices. In fact, at an aggregate level, single-family housing prices are lower inside the UGB. The lower housing prices could indicate that, in the case of King County, Washington, the supporting policies (requiring higher densities and providing an urban level of infrastructure inside the UGB) indeed ensure an adequate supply of developable land for housing inside the UGB. Therefore, even though on a per-unit basis the land prices are higher, more houses are developed per unit of land inside the UGB. In simpler terms, the higher land prices inside the UGB have led to more efficient land utilization for housing purposes. This efficient use of land is reflected in the mean lot size for homes included in the data-set. The mean lot size outside the UGB is approximately 4320 square meters (46 500 square feet), while it is a meager (in comparative terms) 966 square meters (10 400 square feet) inside the UGB. Furthermore, the smaller lot sizes indicate that the UGB is promoting compact urban form.<sup>5</sup>

The signs of all but two statistically significant variables (square feet of living space, lot size, age, number of bathrooms, median income of the census block group, distance to Seattle CBD, proximity to Lake Sammamish and Lake Washington, year of sale, and season of sale) are as theoretically expected. The counterintuitive negative sign for the variable 'Number of Bedrooms' perhaps indicates that controlling for the total living space of a house, an increase in the number of bedrooms reduces bedroom size. Moreover, the

published literature disagrees on the effect of the number of bedrooms on housing prices. Zietz *et al.* (2007) note that of the 40 studies reviewed by Sirmans *et al.* (2005), 21 studies find that the number of bedrooms has a positive impact on housing prices, 9 studies find a negative impact, and the remaining 10 find no impact. The counterintuitive positive sign for the variable 'Water' is perhaps reflective of the fact that in this data-set a large number of homes outside the UGB that are high in quality, large in size, and high in price are served by a private water supply.

## **Conclusions**

The impact of land use regulations, including UGBs, on land and housing prices remains an area of interest for researchers and policy-makers. Several studies find that land use regulations increase housing prices. However, the extant literature, which primarily focuses on Portland's UGB, does not point to a consistent price effect of a UGB on land and housing prices—whereas several studies find that a UGB increases land prices, others indicate that the effect on housing prices is mixed.

This study adds to the body of literature by estimating the price effect of the UGB in King County, WA. The study is significant for several reasons. First, it estimates the effect of a UGB on the housing market of a metropolitan area other than Portland. Second, it estimates the effect of the UGB on land as well as housing prices. Third, the study's estimation of the effect of the UGB on housing price parses out the contribution of the land price.

This study reports four important findings. First, the land prices inside the UGB do not vary with the distance from the UGB, a finding consistent with the theoretical expectation that distance to the UGB should not impact land prices in jurisdictions that provide an adequate supply of buildable land and the certainty of urban-level infrastructure and services. Second, the land prices outside the UGB do not vary with the distance from the UGB, a finding consistent with the theoretical expectation that the distance to the UGB should not impact lot prices if UGB expansion is not expected.

The third and the fourth findings combined have significant implications for land use policy and advance our understanding of the price effects of UGBs. The results demonstrate that although the King County, Washington, UGB increases land prices by 230 per cent, it does not increase housing prices—in fact, the UGB decreases housing prices by 1.3 per cent. These findings could be explained by King County's planned efforts to maintain the UGB firm while attracting growth within the UGB through the provision of an urban level of infrastructure and services and by zoning enough land for the anticipated 20-year housing supply. Furthermore, the county discourages growth outside the UGB through large-lot zoning and by not providing infrastructure and services in these areas. Therefore, although the land prices are higher inside the UGB due to the provision of an urban level of infrastructure and services and the low probability of UGB change, the housing prices are not. In fact, the housing prices inside the UGB are slightly lower compared to the prices outside.

From a broader policy perspective, effect of the King County UGB on land and housing prices indicates that a UGB, if part of a comprehensive growth management program, might not increase housing prices—a point made very frequently in recent studies. In fact, Dong & Gliebe (2012) criticize many studies for failing to recognize the key role of supporting planning policies in the success of a UGB. Several of these studies (see, for

example, Anas & Rhee, 2006) rather simplistically focus on the land supply constraints imposed by UGBs, failing to consider the fact that UGBs are very rarely implemented in isolation. In most instances, they are implemented in combination with other planning policies.

I hope that this study's findings should encourage the adoption of policies that would mitigate the inflationary effect of a UGB on housing prices by facilitating an adequate housing supply. Such policies could include minimum density requirements, zoning for multifamily housing, and ordinances enabling the construction of accessory dwelling units. Furthermore, such policies would help jurisdictions achieve other objectives, such as farmland preservation, infrastructure cost savings, reduction of air and water pollution, and compact development, while promoting housing affordability.

Finally, if the King County UGB results in cost savings, preservation of natural resources, and overall economic efficiency, then such benefits should be capitalized into housing prices. However, it is likely that the King County housing market may not have matured to fully capitalize these benefits. Future studies could parse out the price effects of such benefits.<sup>6</sup>

## Notes

- <sup>1</sup> See Revised Code of Washington, RCW, 36.70A.040 at <http://apps.leg.wa.gov/RCW/default.aspx?cite=36.70A.040>, for a detailed description of the criteria.
- <sup>2</sup> In this data-set, the large lots are minimum 1-acre lots and the medium-sized lots range from approximately one-half to 1 acre in size.
- <sup>3</sup> I thank an anonymous referee for offering this explanation.
- <sup>4</sup> I thank an anonymous referee for offering this potential explanation.
- <sup>5</sup> I thank an anonymous referee for suggesting this impact of the UGB.
- <sup>6</sup> I thank an anonymous referee for providing this suggestion.

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