Out of Bounds: An Examination of Portland, OR's Urban Growth Boundary

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Abstract

Urban growth boundaries reduce the supply of developable land; economic intuition suggests that such policies will increase land prices within the boundary and lead to greater density of development. Using a series of expansions in Portland, OR's urban growth boundary from 2008-2019, I conclude that zoning changes caused by annexation to the boundary led to a 67% increase in land value per acre and a 68% increase in total valuation for annexed parcels. Renovation and new construction likewise increase by 5-7 percentage points. Spillover effects on nearby parcels are negligible, and though newly-annexed areas do see about 18% more street intersections and 13% fewer parcels. The effects are largely concentrated in the period of zoning change, which may reflect (re)development in affected areas—not a lasting increase in local housing density.

JEL Codes: D61, R21, R31

Keywords: housing, land use, zoning, matching

1 Introduction

The median sale price of a home in the United States has risen by 34% in the last five years.[1] While some of this increase can be attributed to the ongoing economic repercussions of the COVID-19 pandemic,[2] the affordability of American housing is a perennial topic of discussion and debate, with the popular press more recently speculating about the connection between zoning restrictions and the ongoing "housing shortage."[3] One commonly-cited reason for this "shortage" is zoning, which is one way of restricting what landowners and developers can do with a given plot of land. Zoning reduces the supply of land for any individual purpose, and shapes the city's form in part by increasing costs. For instance, it can take years of work—as well as funding—to change a parcel from single-family to multi-family residential zoning, affecting land use in the neighborhood and beyond.

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[1]In Q1 2019, this number was $313,000; by Q1 2024, $420,800. Source: `https://fred.stlouisfed.org/series/MSPUS`.

[2]Source: `https://www.dallasfed.org/research/economics/2021/1228`

[3]For a discussion, see Peck (2023).

Another way to constrain land use, urban growth boundaries (UGBs) place hard limits on urban development at a regional rather than a parcel level, as zoning does. Outside of a UGB, urban development is difficult and costly, if not prohibited outright. In 1973, the state of Oregon required all cities to maintain UGBs, the only statewide implementation of such a policy to date. This means that land use in areas outside UGBs is restricted to farmland, forestland, and rural residences (on large, multi-acre lots), and cannot be "upzoned" for more intensive use without first being incorporated into a UGB. This supply restriction should intuitively result in higher land and property values, though this is complicated by Oregon's dynamic implementation of the boundary. Local UGBs must be reassessed at least every six years (though sometimes more frequently), leading to staggered expansions, and as recently as February 29, 2024, this policy faced adjustment and resistance from lawmakers in the form of a Senate push for UGB expansion.[4]

Using novel administrative data and a difference-in-differences approach, I examine this local land-use control. My work leverages property assessments to capture changes in UGB status over time in the Portland metropolitan area, focusing on both the direct impacts on annexed parcels and how changes to the UGB spill over into nearby areas. I conduct four main analyses following a UGB annexation. The first deals with how annexation affects the newly-urban parcels. Appraisal data demonstrate a substantial (67%) increase in land price following a parcel's reclassification as being zoned "urban," with sales data suggesting that this price effect is realized for owners before the parcel becomes officially developable. Second, I look into development itself, finding that new construction in annexed areas increases dramatically—an almost four-fold increase of 7.7 percentage points over a yearly average of 2%. Because changes in the UGB are acted on so quickly, I believe the boundary is locally binding. Third, I study how annexation affects nearby parcels to estimate how local changes spill over into nearby land. I find small decreases (2-3%) in the price of parcels that were and remain inside the UGB following a nearby UGB annexation, with no corresponding effect on nearby parcels that begin and remain outside the UGB. Fourth, I estimate how density changes in census blocks undergoing UGB annexation, though my estimates are both statistically and economically small. It does not appear that annexation increases local housing density, which goes against part of the modern logic of maintaining the policy. The combination of these strands informs a stylized welfare analysis, which suggests that landowners whose parcels experienced UGB annexation received an increase in land value of approximately $500 million USD. With no significant effects on parcel density, if policymakers want to incentivize higher-intensity land use in newly-annexed areas, they may need to use additional policy levers, such as zoning or other building requirements, to encourage the kind of development they seek.

This paper makes several contributions to the existing literature. First, it complements previous work on the effects of land-use controls—such as minimum lot sizes, construction requirements such as septic or sewer, local zoning, and urban growth boundaries. Researchers find consistent correlations between the number of such restrictions that localities have and higher land prices, along with lower density of development. Evidence for higher land prices is found in Kok, Monkkonen, and Quigley (2014), who employ San-Francisco-area communities' voting shares for Proposition 13 (a property tax rollback) as an instrumental variable for local restrictions. Kulka, Sood, and Chiumenti (2023) use a regression discontinuity design (RDD) with time effects along the boundaries of school districts for the greater Boston area, finding that relaxing policies reduces home valuations, though does not lead to significant new construction.

Strong indications of restrictions' association with larger lot sizes, as in the Portland case, most often employ property valuation data. While Zabel and Dalton (2011) use home sales from eastern Massachusetts, Ihlanfeldt (2007) analyzes property assessments in Florida, with findings corroborated by newer evidence

[4] Source and discussion from Oregon Capital Chronicle (2024).

from Shanks (2021) and Gyourko and McCulloch (2023) using an RDD approach. In particular, Gyourko and McCulloch (2023) use county assessor data to find that more stringent restrictions—that is, higher minimum lot sizes—lead to larger houses as well as lots, with a roughly 80 ft^2 (4% of the mean) increase in housing and a 3,000 ft^2 (28% of the mean) increase in lot size. The authors also find that housing prices were approximately $30,000 higher in more-regulated areas. Shanks (2021) finds a similar effect of minimum lot size on home sizes, an impact that notably did *not* lead to more land being developed, resulting in a 20% reduction in housing supply near border areas. While many of these analyses employ similar data to my own, they tend to consist of a single cross-section. Like Kulka, Sood, and Chiumenti (2023), my longitudinal appraisal data allows me to observe how individual parcels are affected by policy changes across time—which is necessary in this policy environment.

The paper perhaps most similar to this one is Gluszak and Zygmunt (2018), which examines zoning and building permit issuance in western Krakow, Poland. Land parcels in Poland are not always zoned, nor do they have the permits necessary for development, which makes parcels that already have permits more valuable to prospective landholders. The process for approval can incur considerable costs, helping to explain the authors' finding that land with a valid building permit sold for 47-50% more than land without any such permit—which is similar to the estimates I derive for a U.S. context.

I also contribute to the literature focused on UGBs in particular. They do appear to effectively bind development; scholarly evidence suggests that UGBs reduce outside development, relative to periods before their establishment (Gennaio, Hersperger, and Bürgi (2009) on Swiss "building zones"; Fu, Gu, and Long (2019) on Beijing; Dempsey and Plantinga (2013) on Portland, OR). For Portland in particular, Nelson and Moore (1993) note that the UGB was largely effective in limiting development to within its boundaries, though Jun (2004) subsequently concludes that the policy led to commuters relocating north to Washington, lengthening average commute times. Previous research regarding price effects is more mixed—in part due to data limitations. Using data from 1990 and 2000 from the U.S. Census, Jun (2006) finds no effect across the static boundary at the block-group level. By contrast, Grout, Jaeger, and Plantinga (2011), using a regression discontinuity design on 2008 data, find a significant price effect on the western and southern sides, but not in the east.[5] But as previously discussed, using a single year misses how prices evolve over time, as well as how changes in the boundary affect local markets—a gap I seek to fill.

Finally, theory-focused papers analyze UGBs in the context of mechanism design. By contextualizing UGBs as one of several policy options that social planners can use in shaping cities' growth. Brueckner (2007) outlines the reasons that such a policy—while functional—is not as efficient as a congestion toll. The main reason is due to insufficient density incentives near employment centers. Brueckner (2011) incorporates an examination of how such policies serve to benefit landowners, at the expense of resident renters. To my knowledge, there have been no prior empirically-motivated estimates of the welfare effects of a UGB. This is because general equilibrium effects make estimation quite complex. While the estimates provided here should be taken as suggestive values, by estimating how annexed parcels, nearby parcels, and neighborhood density are all affected by the same policy, this paper seeks to provide the first empirical indication of how policy alterations could improve welfare in regions with UGBs.

To outline the remainder of the paper: Section 2 discusses the Portland-area UGB's institutional background; Section 3 further illustrates the research questions and identification; Section 4 outlines the data source; Section 5 examines and discusses the results, and Section 6 concludes.

[5] This is exhaustive: Washington state serves as a binding northern boundary.

2 Institutional background

In 1973, the Oregon legislature passed Senate Bill (SB) 100 with the stated goal of restricting development and protecting forests and small farms throughout Oregon. This expanded on and refined previous legislation: 1969's SB 10 required city and county governments to develop comprehensive land-use plans, though had provided no means to evaluate or enforce said plans.[6]

SB 100 mandated that every urban area in the state begin the process of creating and maintaining an urban growth boundary, outside of which farm and forestland would be kept largely the same. For the Portland region, Metro[7] handles this, and has since the organization's 1978 inception. Because land outside the UGB is zoned for rural use, it is much more difficult to have a residence or business outside than inside the boundary. Outside the UGB, there are three main zoning types: agricultural, forest, and rural residential. Farms and forest land (for timber harvesting) fit the first two categories, while rural residential areas can only have one residence per few acres.[8] In addition to restrictions on new construction, city services are also affected: for instance, most areas outside the UGB are served by wells, and there are no sewer connections to urban areas.

Areas outside the UGB cannot be annexed by cities within the boundary. But inclusion in the boundary does not mean that parcels are necessarily incorporated into a city or town—rather, it means that they now *can* be.[9] Even if a parcel is not annexed into a city, if it falls within Metro's jurisdictional boundary, there is an effect on taxation and city services, as Metro provides and charges for trash pickup for residents. In addition to small property tax rate differences, there is also a construction excise tax placed on new construction within Metro's jurisdiction, though cities and counties provide all other "city" services. Effectively, the UGB strictly demarcates where development can occur—but not where taxes or Metro services may extend, decoupling urban services and urban zoning when estimating the effects of UGB annexation.

The UGB is strict, but it also changes over time. SB 100 mandates that cities reevaluate their UGBs at least every six years,[10] and must contain—based on residential, industrial, and other projections made by the planning departments of the city—land sufficient for 20 years of growth[11] in the region. During the study period (2008-2019), there were seven expansions—in 2008, 2011, 2012, 2013, 2014, 2017, and 2018—though the expansions in 2011, 2014, and 2018 were the largest. All others added less than a square mile of land each, while the larger ones added 3.15, 1.84, and 3.43 mi^2, respectively. These additions serve as my main source of identification.

[6] Both bills were passed following decades of sustained growth in the state—Oregon's population increased from 1.1 million in 1940 to 2.1 million in 1970—and the election of 1970 saw a gubernatorial call for a strengthening of SB 10 as well as a statewide referendum on said bill (which saw 55% support). (For more information, see `https://www.oregon.gov/lcd/op/pages/history.aspx` and `https://www.oregonencyclopedia.org/articles/senate_bill_100/`.) Then-Governor Tom McCall referenced development as "unfettered despoiling of the land", reflecting contemporary fears of environmental destruction associated with suburbanization.

[7] Metro is a directly-elected regional government, with duties that extend across the 24 cities and three counties on the Oregon side of the metropolitan area. It is between the levels of city and county government, and has jurisdiction over parts of Clackamas, Multnomah, and Washington counties.

[8] This varies by county and time period. The smallest minimum parcel size permitted as of 2020 is 2 acres. See `https://www.oregon.gov/lcd/rp/pages/index.aspx` for more details.

[9] This requires further action by the city/town or the landowner.

[10] See `https://www.oregonmetro.gov/urban-growth-boundary`.

[11] Why 20 years? This dates back to the mid-1990s, and the recommendation of a professional construction organization—that 20 years was a convenient time horizon for planning. Given that Clark County, WA (directly north of Portland) places a similar requirement on its growth areas, this appears to be "standard" in some way. This requirement is subject to state oversight, but does allow discretion.

2.1 Where to expand?

There are stricter legal requirements to the process of expanding the UGB as compared to the "traditional" process of upzoning found in many jurisdictions.[12] Due to the preservationist reasoning for the passage of SB 100, any expansions to UGBs from 1980-2010 were required to take land "quality" into account. The "worse" the land in a given area was for forest use or growing crops, the more likely that area (typically multiple plots/parcels of land) was to be incorporated into the urban growth boundary. In other words, any time that planners concluded that an expansion was necessary, expansions consisted of less-fertile land. However, this made for poor-quality urban additions—to quote Metro, "The system provided a way to decide where *not* to develop,"[13] rather than where *to* develop. To make urbanization efforts more effective, the Oregon legislature passed SB 1011 in 2007, which changed the way UGB expansions would be conducted in the Portland metropolitan region.

In 2010, due to SB 1011, non-UGB land was designated with one of three classifications; I describe them here in decreasing likelihood of UGB annexation, with Figure 1 providing a visual reference. *Urban reserves* are of first priority for expansion over the following 50 years (that is, until 2060). They are effectively marked for eventual urban use. *Exception land* is land that is not a part of an urban or a rural reserve, and is also neither farm nor forestland. Exception land can also be "low-value" farm/forestland that is surrounded by other exception land. This land does not have an official classification as reserve land does, so in Figure 1, it takes the form of "gaps" or white space between reserves. If urban reserve land is unavailable, exception land is of next priority for urban development.[14] *Rural reserves* are specifically protected against UGB expansion before the other two categories; for a rural reserve parcel to face development, urban reserve land and exception land would need to both be unavailable. Within this third tier—assuming development occurs—the prior soil-quality index is still used for expansion priority.

When a UGB expansion occurs (such as in one of the areas outlined in Figure 2), the full process takes several years; the basic steps are outlined in Figure 3. First, cities must develop a *concept plan* for the urban reserve that is within their sphere of influence.[15] This concept plan is a stylized idea of how the area would be developed upon its incorporation into the UGB, and includes proposals for changes in zoning as well as estimates of the cost of laying urban infrastructure such as roads and sewer systems. This is necessary for an area to be considered for expansion eligibility. Second, Metro issues an urban growth report (UGR) no less frequently than every six years. As part of the mandated reevaluation process, the UGR outlines the amount of vacant or redevelopable land in the region, estimates current growth rates, and uses other information in order to determine whether and by how much the UGB needs to expand. Third, Metro decides on how the boundary moves. This is notably constrained in recent years by the existence of a concept plan: as cities *must* have a concept plan in place before any land in their urban reserve area can be considered for incorporation into the UGB, cities that do not develop concept plans will not see any expansion. Fourth, for those concept plans accepted by Metro, cities must come up with a *comprehensive plan*, which fully outlines the zoning and developmental possibilities of the area now annexed to the UGB, and better estimates the costs of developing infrastructure. Cities enact these plans by amending their existing comprehensive plans, a process which requires approval from the Oregon Department of Land Conservation and Development

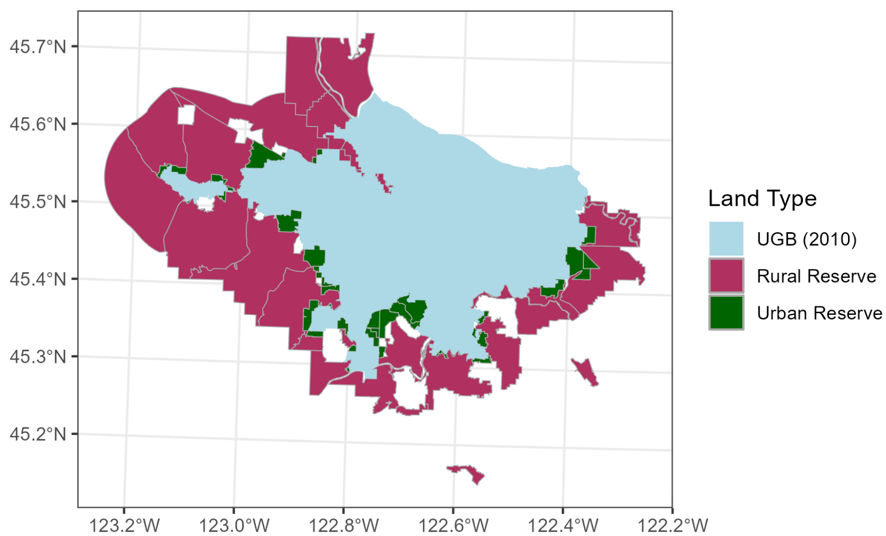
[12] Based on conversations with land-use governing bodies in Lansing, MI. Landowners can file for upzoning themselves in many jurisdictions, which is not true in the Portland region.

[13] Source: `https://www.oregonmetro.gov/urban-and-rural-reserves`. Emphasis original.

[14] There is a variation of exception land called marginal land, which is exclusive to Washington County, but is very similar.

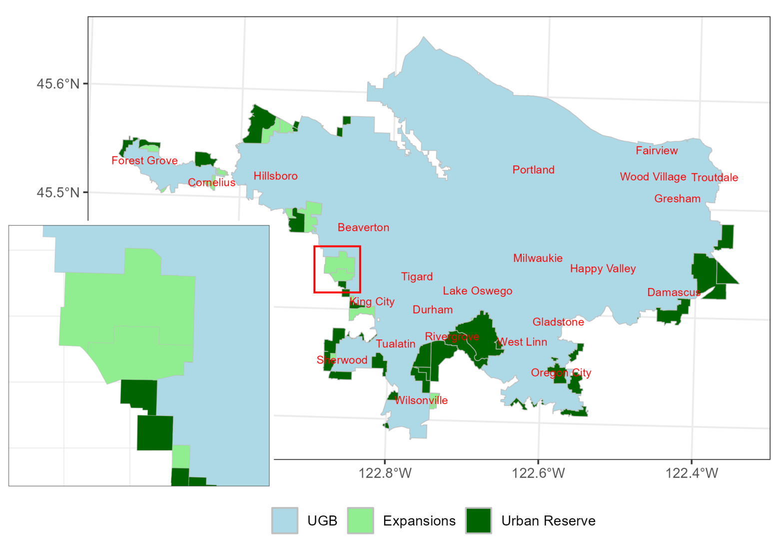
[15] Cities in the region, given that Metro supercedes all individual city governments, have come to agreements regarding this. The agreements vary by level of formality.

Figure 1: 2010 UGB and reserve boundaries



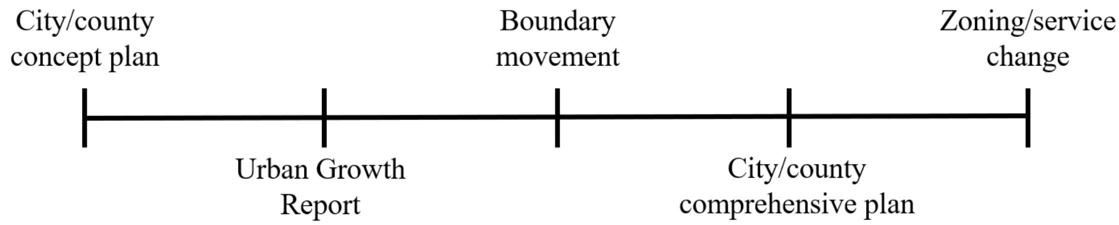
Notes: This figure displays the boundaries of the UGB as of 2010 alongside Portland-area urban and rural reserves. The "gaps" or white space between reserves are exception land. Archival data sourced from Metro (accessed April 4, 2023). Current boundaries are viewable at RLIS Discovery and the Metro ArcGIS portal.

Figure 2: UGB expansion(s) and reserves, 2008-2019



Notes: This figure shows UGB annexations from 2008-2019, with the UGB as of 2008 presented in blue, annexed areas in light green, and urban reserves in dark green. Approximate city locations are shown in red. As noted elsewhere, cities cannot extend beyond the limits of the UGB.

Figure 3: The main steps of a property's incorporation into the UGB.



Notes: This figure outlines the steps a parcel passes through over the course of its annexation into the UGB. The figure is based on private correspondence with a representative from Metro; copies of written correspondence and notes from meetings available upon request.

(DLCD), and can take several years to take effect.[16] Fifth and finally, the updated comprehensive plan is approved, the parcel is rezoned for urban use, and the land is finally developable. After this change in zoning, while developers are still required to get building permits, the land is explicitly allowed to develop according to the zoned use. Upon full annexation into the UGB, the land use restrictions present outside of the boundary no longer apply.

The multiple steps of the process suggest many possible treatment timings for newly-annexed land, and any step of the process in Figure 3 could serve to "treat" a parcel. For clarity, I focus on two steps in particular: UGB annexation and zoning changes (steps 3 and 5, respectively). These steps are the cleanest to assign treatment to individual parcels, as steps 1 and 2 define initial areas of interest and amount of land, respectively. Likewise, step 4 is more a revision than a separate treatment in itself. The gap in time between these two steps also allows me to estimate interim effects, such as *anticipatory* changes in value, after treatment is announced but before development is allowed. Some of these questions of arbitrage are addressed in Section 5.5.1.

Based on economic theory, what do we expect to occur? Compared to not having a UGB, Metro claims[17] that urban growth boundaries increase the price of developable land in the region. Theory and the literature tend to agree: when the supply of a good is reduced or otherwise restricted, prices generally increase. Metro speaks about density in a similar way, saying that Oregonian regulations "favo[r] places that have a variety of development types," including multi-family housing. Parcels that become part of the UGB should therefore see their prices and resulting density increase.

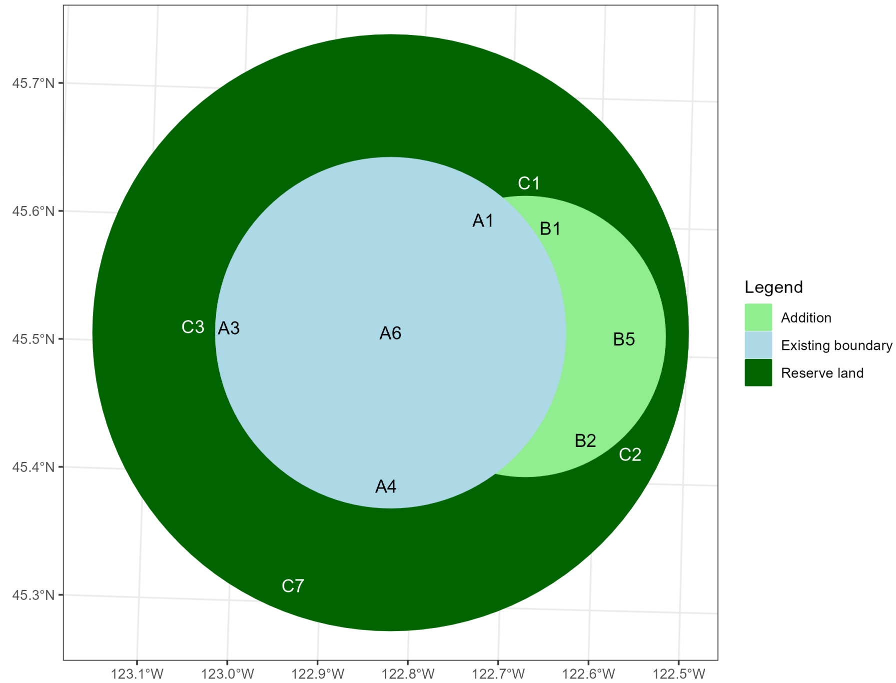
3 Conceptual approach

To further examine this policy environment, consider a stylized example of a boundary expansion occurring at time t, visualized in Figure 4. Here, "treatment" consists of a parcel being newly added to the UGB. This means the treated populations at time t are located in circle B. Parcels already within the boundary at $t-1$ are denoted by A, while parcels outside the boundary at all points in time are denoted by C. For ease of comparison, I demarcate "neighborhoods" where geographically-close populations of different types can be found near one another. For instance, A_1, B_1, and C_1 are all near one another.

[16] Anecdotally, the 2018 UGB expansion is only partially "complete"; as of September 2023, only two of the four cities affected by the expansion have had their comprehensive plans approved.

[17] See `https://www.oregonmetro.gov/news/ugb-101-everything-you-wanted-know-about-urban-growth-boundary-were-afraid-ask`.

Figure 4: A stylized example of boundary changes



Notes: This figure serves as an illustrative example of UGB annexation, using the same color scheme as Figure 2. All C parcels are located in the urban reserves; this is true across all specifications.

This paper focuses on the effect of this boundary expansion on the newly-treated B populations. So what populations could serve as a valid control group? In this stylized setting, populations differ only by treatment status. As B populations were previously part of the C population (in time periods 1, ..., $t-1$), C parcels serve as a natural point of comparison. Effectively, by comparing newly-annexed B parcels such as B_1 to parcels unaffected by the UGB—parcels that are neither annexed nor affected by local spillovers from annexation—like C_3, I can estimate the effect on a parcel when it becomes part of the UGB for the first time.

3.1 Model overview

Using the environment of Figure 4, consider the relationship between the outcomes (land value per acre, for instance) of some parcel i and its UGB status at time t. Other characteristics may matter, but are not identical across populations—in seeking to account for these characteristics, the model becomes more complex. A foundational paper in this area, Brigham (1965) states that land valuations are affected by five major factors: proximity to economic activities, local amenities, type of topography, present and future use of the land, and historical factors. With this in mind, consider the following, based on that approach:

$$Y_{it} = f(\mathbf{A}_t, \mathbf{R}_{it}, \mathbf{U}_{it}) \tag{1}$$

In this specification, $\mathbf{A_t}$ consists of measures of "absolute" location, $\mathbf{R_{it}}$ of "relative" location, and $\mathbf{U_{it}}$ of land usage—both for parcel i and the surrounding neighborhood. In expanding this equation, I can rewrite it in the following form:

$$
\begin{aligned}
Y_{it} &= \alpha + \beta \mathbf{R}_{it} + \gamma \mathbf{A}_t + \nu\tau + \delta \mathbf{U}_{it} + \varepsilon_{it} \\
&= \alpha + \beta \mathbf{R}_{it} + \gamma \mathbf{A}_t + \nu\tau + \delta_1 \, UGB_{it} + \delta_2 \, Urb.Zng_{it} + \delta_3 \, UGB.Dist_{it} + \delta_4 Expn.Dist_{it} + \delta_5 \mathbf{X_{it}} + \varepsilon_{it}
\end{aligned} \tag{2}
$$

where UGB status is the main treatment. The variables that make up $\mathbf{U}$ are generally of interest, as they indicate either some kind of land-usage change, such as moving from rural to urban zoning, or exposure to a spillover effect (changing distance to the outside of the UGB; distance to a new expansion area). I consider whether a parcel is zoned in an urban way ($Urb.Zng$) and a parcel's distance to newly-annexed land ($Expn.Dist$) as treatments in their own right in Section 5. The $\mathbf{X}$ vector of controls are still use-related, but $\mathbf{X}$ contains characteristics that are unlikely to significantly change due to treatment alone, such as parcel acreage.

Given the panel structure of the data, $\mathbf{A_t}$ and τ constitute the unit and time fixed effects, respectively. As parcels do not move over time, $\mathbf{A}$ is a reliable measure of "absolute" location. $\mathbf{R}$, on the other hand, is made up of neighborhood characteristics. This includes demographic/income information, as well as the distance to the nearest highway and to downtown Portland. Equation (2) serves as the basis for my empirical approach.

3.2 Spillovers

UGB expansions affect parcels beyond the annexed B units. This is why, in Equation (2), δ_4 is the coefficient on a parcel's distance to a given expansion—it affects land use patterns nearby. Consider "neighborhood" 1 (the area encompassing A_1, B_1, and C_1) in Figure 4 as an example area to illustrate these spillovers.

Following a UGB expansion in period t, what happens to A_1 in periods $t,\ t+1,\ ...$? Expansion of the supply of developable land should lead to lower land prices at A_1. However, if B_1 comes to include more amenities for nearby residents, we might expect positive amenity effects; the sign of the overall effect will depend on the sizes of these supply/amenity effects. Similar arguments can be made with regards to the C_1 area: if people in the area are pleased to have more urban amenities in the area, land prices might increase; if some kind of urban congestion such as traffic overrides the size of that amenity effect, then we might expect to see an overall negative impact on land prices.

In seeking to take all of this into account, for my main specifications in Section 5, I focus on comparing B and C populations to one another, while, by including a term for this proximity, allowing those C populations that are "sufficiently close" to an expansion to vary differently. This allows me to measure how the prices of B and C parcels evolve differently over time. In Section 5.3, I estimate the heterogeneous effects of proximity, δ_4, on outcomes for both A and C parcels, which remain either in (A) or out (C) of the UGB during the study period.

3.3 Empirical strategy and validity

Due to concerns about the two-way fixed-effects estimator outlined in Roth et al. (2023),[18] I use the modern difference-in-differences approach of Sun and Abraham (2021) for a variety of outcomes, including land valuation, building valuation, likelihood of new construction, and likelihood of renovation. I also estimate

[18] The main issue that Roth mentions, and that I am likewise concerned with, are so-called "forbidden comparisons" between already-treated units, which can result in negative weighting of certain coefficients in aggregation. This can result in estimates with the "wrong" sign—even though all estimates are positive, the aggregate value may be negative. I also use Sun and Abraham (2021) for event-study figures as well, though such figures tend to look quite similar across different methods.

effects at the census block level using the same estimation methods for length of roads (in miles), number of intersections, and number of parcels.

However, because Metro does not randomly designate areas for UGB annexation, the treatment variables **U** may not be strictly exogenous. Cities choose to propose a plan for the areas that they wish to expand into. Some agent (the city itself, a developer) has an interest in changing how a property or properties are used. If the preference is for more housing, then properties that are "preferred" to become housing will be the first to be incorporated. This means that the order in which properties are incorporated into the UGB could be nonrandom. It *also* means that said properties do not necessarily resemble properties that are left outside the UGB.

How are these expansion areas chosen? Since 2010, treated (annexed) areas have been required to be a part of the "urban reserves" designated by Metro. These areas are all marked for eventual future expansion, which means that parcels within are more comparable to treated parcels. Additionally, it is costly for a city to develop a plan for a given area, and costs increase with the size of the area.

In this institutional setting, we may be concerned about some cities expanding more than others, pre-existing population distributions, ease of building on a given lot, and accessibility to other urban land—all factors that determine how desirable an area may be. With this in mind, following Hoynes and Schanzenbach (2009),[19] I estimate the following equation:

$$\begin{aligned} Treat.Year_i = \beta_0 + \beta_1 Nearest.City_i + \beta_2 Acres_i + \beta_3 Dist.Nearest.Highway_i + \\ + \beta_4 Block.Slope_i + \beta_5 Dist.1979.UGB_i + u_i \end{aligned} \tag{3}$$

where $Treat.Year_i$ is the calendar year in which parcel i is treated; $Nearest.City_i$ denotes the nearest city to parcel i in 2007, before the study period; $Acres_i$ is the acreage of the parcel prior to annexation; $Dist.Nearest.Highway_i$ is the straight-line distance from parcel i to the nearest highway; $Block.Slope_i$ is the mean slope at ground level of the census block the parcel belongs to, in degrees; and $Dist.1979.UGB_i$ is the distance from the parcel i to the 1979 boundary of the UGB. As different cities experience different levels of growth over time, $Nearest.City_i$ takes these nearby changes into account. $Dist.Nearest.Highway_i$ and $Dist.1979.UGB_i$ are included to measure proximity to the urban core. $Acres_i$ and $Block.Slope_i$ are measures of how easy a parcel/area is to build on—for either for a speculator (as larger lots can be subdivided) or builder (as hilly terrain and rough soil make building more costly).

If the variables in Equation (3) do not affect how UGB annexation is determined, then their potential omission will not introduce any bias. On the other hand, if the R^2 of these regressions is sufficiently high that they *do* seem to have an impact on treatment timing, this suggests that the use of propensity-score methods may be appropriate, in order to compare parcels that are similarly prone to UGB annexation at certain times.

In Table 1, I estimate Equation (3) using all parcels annexed into the UGB from 2008-2019. To avoid using post-treatment measures, I use observations from 2008 only—at worst, measures such as acreage are contemporaneous with annexation, and precede annexation by several years for the vast majority of parcels. While a parcel's nearest city has a great deal of explanatory power (the R^2 of the regression of

[19] Hoynes and Schanzenbach (2009), in studying the rollout of the Food Stamp Program (FSP) in the United States, note that some states/counties had existing programs that would have been "competitors" of the FSP. As said programs largely consisted of subsidized purchasing of crops from local farmers (to then be distributed to participating households), farmers preferred these alternatives over the FSP. This is one possible reason behind the differences in observable characteristics between early and late adopters of the FSP—early adopters tend to be more urban, less white, more impoverished, etc.

Table 1: Linear fits with propensity-score variables

Dependent Variables:	Year of UGB Annexation		Year of Zoning Change	
	(1)	(2)	(3)	(4)
Variables				
Acreage	-6.696	-0.4965	-1.235	2.015
	(4.286)	(3.966)	(3.070)	(4.167)
Dist. to nearest highway (mi.)	-64.69	124.4	-162.3	-415.7**
	(213.3)	(255.9)	(144.0)	(171.3)
Mean slope (deg.)	87.22*	143.6**	25.74	27.80
	(41.56)	(60.04)	(17.43)	(21.68)
Dist. to 1979 UGB (mi.)	462.4	1,232.5**	232.0	494.0
	(292.9)	(483.5)	(196.4)	(383.6)
Fixed-effects				
Nearest City	X	X	X	X
2010 Census Tract		X		X
Fit statistics				
Observations	5,596	5,596	5,596	5,596
R^2	0.48685	0.69977	0.08377	0.28217
Within R^2	0.03275	0.09342	0.00971	0.01631

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table reports coefficients and goodness of fit for treatment (UGB annexation or zoning change) timing based on pre-treatment observable characteristics. The variables used for propensity-score analysis are: pre-treatment acreage; distance in miles to the nearest highway; mean slope (topographical) of Census block; distance in miles to the 1979 UGB; and nearest city (as of 2007). In the interest of legibility, a parcel's nearest city was treated as a fixed effect and omitted.

UGB annexation on nearest city alone is around 0.4), other variables appear to matter much less. For UGB annexation in columns (1) and (2), hillier parcels and parcels further from the 1979 UGB seem to be annexed later, though parcel size and highway distance are not statistically significant. Of most concern could be the high R^2 values from these regressions, however, as including a parcel's location (via 2010 Census tract) helps the regression to explain almost 70% of the variation in annexation timing. This is not the case for zoning changes, as columns (3) and (4) show—the only statistically significant relationship is that parcels nearer to highways tend to change zoning sooner.

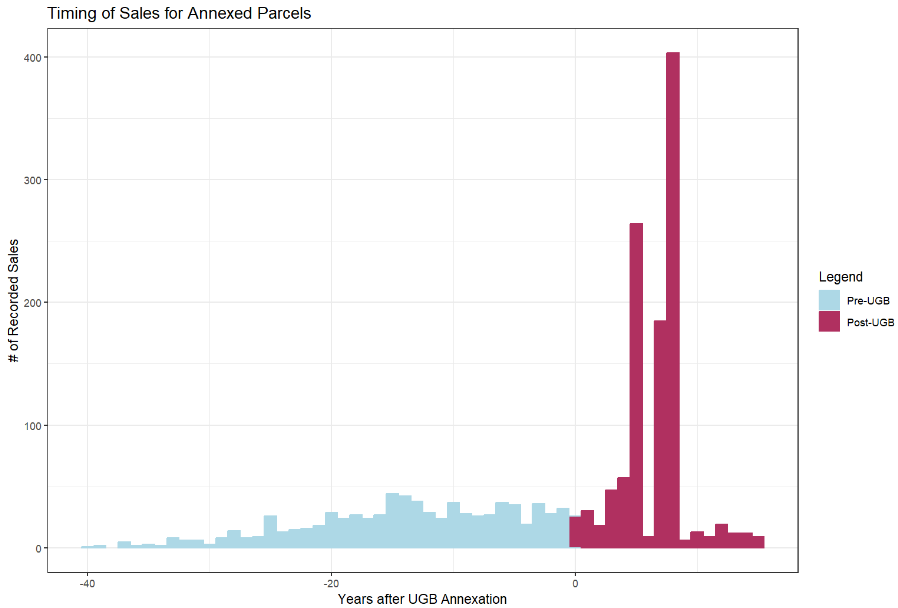
It appears that observable characteristics are more correlated to UGB annexation than to zoning changes, though it is unclear whether this poses a threat to identifying the effects of treatment. As such, continuing to follow the example of Hoynes and Schanzenbach (2009), I include the variables from Equation (3) interacted with linear time trends in all analyses. This serves to test and control for correlations in annexation timing. In addition, to allay concerns that characteristics like the above inform Metro's decision-making process, I employ propensity-score approaches as robustness checks. In particular, I use both a matching approach and inverse-probability weighting (IPW) for the average treatment effect on the treated (ATT). I go into more detail on the propensity-score approach in Appendix A, and other robustness checks that I employ in Section 5.5.

3.4 Other concerns

To be sure that I am correctly identifying the capitalized benefits of a parcel's annexation into the UGB, I briefly discuss two other possible threats to exogeneity: developer lobbying and changes in taxation.

Suppose a developer in the area were to purchase a large parcel of land near the UGB and subsequently lobby Metro to incorporate this parcel into the boundary. This would allow the developer to make a great deal of money building and selling homes. Were this to happen, that UGB annexation would be entirely endogenously dictated by developers, and could not be used to accurately determine how the price of a

Figure 5: Property sales timing for annexed parcels



Notes: This figure plots the timing of all 1,897 sales for properties annexed to the UGB from 2008-2019, based on years of sale and of UGB annexation. Source: Author's calculations from Metro tax-roll data, 2008-2019.

parcel increases following UGB annexation. In such a setting, we would expect to see a spike in sales shortly before a parcel is annexed to the UGB—as this sale would be followed by developer lobbying and subsequent annexation. Figure 5, which shows every sale for UGB-annexed properties from 2004 to 2019, exhibits no such spike. There is also little evidence of potential resale, as of the 1,897 sales recorded across 1,519 distinct parcels, 1,205 (79.3%) of said parcels have two or fewer sales recorded. This suggests that, if developer actions introduce bias, it seems liable to be quite small in magnitude.

Now suppose that UGB annexation is not necessarily desirable. I generally assume that, because annexation does not prevent landowners from using their parcel as previously, that the benefits outweigh the costs. However, one potential avenue through which UGB annexation may be undesirable would be through tax rates. An increase in assessed value can be realized through sale of the property, but if the parcel is taxed at a higher rate, landowners could conceivably lobby against their parcel being considered for annexation. While Metro does levy property taxes on those landowners that live within the boundary,[20] the amount levied is quite low. The permanent levy is 9.66 cents per $1,000 of assessed value—which, for a $500,000 home, comes out to $48.30. While other levies currently apply—including a 2019 bond measure that applies a $0.48 increase per $1,000 assessed value, for a $240 bill on a $500,000 home—Metro states that property taxes only account for 29% of its annual regular revenue. Given that county property taxes in 2018 varied from $8.60 per $1,000 assessed in Curry County to $20.12 per $1,000 assessed in Multnomah County,[21] and that parcels can be in the UGB without being in a city, UGB incorporation should not cause a large tax increase for landowners.

[20]Source: `https://www.oregonmetro.gov/property-tax-information`.

[21]Source: `https://www.oregonlive.com/news/erry-2018/10/7273fa75401636/property-tax-rates-in-oregons.html`.

4 Data

My primary data source is annual property assessment information from 2008-2019 for the three most populous counties on the Oregon side of the Portland, OR metropolitan area (Multnomah, Washington, and Clackamas counties), provided by Metro's Regional Land Information System (RLIS). Observed characteristics include parcel acreage, zoning, building square footage and year of construction, sale date and price for the parcel's most recent sale,[22] and assessed valuation broken down into land and building values. Each parcel has a unique taxlot ID, which I use to identify parcels across time.

I supplement this with additional data sources from Metro's RLIS. To determine a parcel's UGB status, I use a map of historical UGB annexations, which outlines all additions to the UGB since its 1979 inception. If the centroid of a parcel is located within the UGB for a given year, the parcel is taken to be inside the UGB for that year. I perform identical calculations using annual boundaries of urban and rural reserves from 2010-2019 to determine if a parcel was eligible for expansion in any given year. Using data on all highways in the region, I calculate each parcel's distance from the nearest highway, as closer proximity to a highway may be desirable for commuters. Finally, I calculate each parcel's distance from downtown Portland[23] as an additional measure of economic access.

I use data from the American Community Survey (ACS)[24] to supplement this information by matching parcels to the 2010 census block and block group they fall into.[25] Block-group information allows me to match each parcel to its neighborhood's demographic data, such as the proportion of residents that are white, proportion of households that rent their home, and proportion of households whose income falls below the federal poverty line. Because steep land may be more difficult to develop, I incorporate LANDFIRE LF2020 topographic information to determine the mean slope of each parcel's census block.[26]

4.1 Samples and treatment

In my analysis, I compare treated parcels to untreated, but eligible, parcels. Because the process for a parcel to become developable is quite long, parcels "annexed" from 2004-2008 did not have the chance to experience a zoning change by 2008—which yields two slightly-different samples based on whether I examine UGB annexation or zoning changes. To this end, I keep all observations from parcels that were either newly annexed to the UGB during the study period or at some point fell within the bounds of an urban reserve—this covers all land eligible for annexation during the study period. After removing the few parcels of public land, as well as any non-purchasable "parcels" that appear in the data,[27, 28] I am left with 65,297 parcel-year observations when examining UGB annexation, and 69,005 for zoning changes. In the interest of space (as these samples are highly similar), I only include descriptive statistics for the zoning-change sample in Table 2.

[22] As parcels are observed over time, I observe all sales during the study period, and sales that predate it for parcels that have not sold recently.

[23] The coordinates used are 45°30'46.0584"N, 122°40'46.434"W.

[24] Accessed via IPUMS at the University of Minnesota: Manson et al. (2022).

[25] I adjust 2009 data using areal-weighted interpolation, which assumes that populations are evenly distributed across boundaries. As this is not necessarily true, I omit 2008 and 2009 as a robustness check in Section 5.5.

[26] The Portland region is fairly flat, as over 93% of blocks in the region have a slope of under 10°.

[27] Roads as "parcels" were added in the mid-2010s, filling in space between all other parcels. As roads—and similar pseudo-parcels such as rivers and lakes—are not relevant, I remove them.

[28] Minor noise in the recorded locations of around 20 parcels means that, based on the year, they "change" which annexation area they were part of. To avoid this, I remove said parcels.

For UGB annexation, determining when a parcel was treated is simple: if the parcel's centroid falls within the boundary of an annexation, that is the year that parcel was incorporated into the UGB. As property valuations are finalized in November, I consider the first year of annexation—regardless of when in the year the expansion occurred—to be the first year of treatment. Zoning changes are more complex. The year of a parcel's zoning change (rural to urban) is based on Metro's zoning definitions,[29] recording the first year of any type of "urban" zoning when the parcel had a "rural" zoning in the previous year. "Rural" land uses consist of rural residential, agricultural, and forest zoning, and "urban" includes all other[30] zoning types.

However, this does not mean that nearby parcels are wholly unaffected. I conduct a spillover analysis as well, considering parcels within a half-mile of a UGB annexation to be treated, using parcels 0.5-2.5 miles away as controls. For urban-reserve parcels, this results in a sample of 27,570 parcel-years, while denser housing and smaller lot sizes means that the spillover sample of urban parcels consists of around 4.2 million parcel-year observations, both of which are found in Table 2. I study density by aggregating parcels to a small "neighborhood," determined by census block. Detailed in Table 3, this yields a universe of 432,228 block-years in total, with 4,815 block-years being either annexed or eligible for annexation during the study period. For treatment, I focus on UGB annexation, using the earliest year a parcel in the block is annexed. For instance, if a block saw one parcel be annexed in 2011 and another in 2014, its date of treatment would be 2011.

4.2 Discussion of relevant variables

My key outcome variables are building valuations per constructed square foot and land valuations per acre as measures of value. Because parcels can be of different sizes—and therefore be worth wildly different amounts based on this—I divide by a parcel's acreage or constructed square footage as a partial measure of size. (I additionally control for the broad "category" of size that each parcel falls into; see Section 5 for details.) I also use total assessed value to observe the effect on overall price, as land and building valuations may move in opposite directions. While valuations exhibit high standard deviations (only dropping below the mean for rural land in Table 2), the raw valuations across different populations do not differ greatly. Rural parcels are assessed at somewhat higher average values overall, however—around \$560,000 vs. \$460,000. I focus on assessed values because of very low rates of sale for both newly-annexed and newly-urban parcels (previously mentioned in Section 3.4); however, the majority of assessed values follow sale prices closely—see Figure C.2 in Appendix C for a visual example—and I analyze how sales are affected by UGB annexation as a robustness check in Section 5.5.1.

I also calculate when parcels experienced renovation or new construction based on changes in square footage from the year prior. These outcomes reflect either new development or building improvement, considering that there is *some* (rural) residential land outside the UGB. In particular, I define "renovation" as an increase in square footage on a parcel that already contains a building, while "new construction" is an increase for a parcel with zero square footage recorded in the year prior. These are relatively rare outcomes across the sample, with the most frequent result—a change in square footage—only occurring in around six percent of parcel-years in my main sample of interest, and seen at lower rates for the spillover samples.

To measure density, I use a block's number of parcels, number of buildings, road length, and the number of intersections found within the block. The number of parcels and number of buildings are measures of

[29]I corroborate the numbered zoning types with information from Metro (here).

[30]This is besides "vacant", a land-use umbrella that contains both urban and rural types. I ignore vacant-to-vacant zoning changes.

Table 2: Descriptive statistics

Variable	Main Sample	Urban Spillovers	Rural Spillovers
Parcel-Level Variables			
Acreage	4.103	0.342	6.693
	(14.14)	(49.16)	(12.05)
Built Square Footage	1,900.6	2,236.6	2,052.5
	(3,590.4)	(9,268.3)	(2,943.8)
Land Value (Assd.)	238,822.0	173,197.8	287,761.5
	(442,491.2)	(668,345.1)	(220,223.2)
Building Value (Assd.)	221,384.7	275,120.6	268,710.4
	(672,720.7)	(2,632,945)	(689,793.4)
Total Value (Assd.)	462,793.3	448,324.9	560,542.8
	(850,299.5)	(2,906,099)	(783,794.6)
New Construction	0.024	0.034	0.031
	(0.153)	(0.182)	(0.174)
Change in Square Footage	0.061	0.042	0.050
	(0.239)	(0.200)	(0.218)
Parcel Has Building	0.686	0.843	0.679
	(0.464)	(0.364)	(0.467)
Distance to Downtown (mi.)	13.05	9.04	12.88
	(2.764)	(3.965)	(2.721)
Distance to Nearest Highway (mi.)	1.955	1.227	1.553
	(1.594)	(0.995)	(1.408)
Prop. of Parcels Annexed	0.117	0.00	0.001
	(0.321)	(0.004)	(0.023)
Prop. of Parcels Changed Zoning	0.058	0.007	0.037
	(0.234)	(0.085)	(0.189)
Prop of Parcels Ever in Urban Res.	0.927	0.000	1.000
	(0.260)	(0.0160)	(0.000)
$N =$	*69,005*	*4,185,915*	*27,570*

Notes: This table includes summary statistics of variables measured at the parcel level. This includes parcel characteristics such as property size and building size, valuation (denoted by "assessed," or "Assd."), and location information such as proximity to highways or downtown Portland. Observations are counted by parcel-year. Source: Metro RLIS.

property and housing density, respectively, as higher numbers necessarily mean smaller properties: I use static 2010 census blocks across all time periods. Road length and intersection count reflects development in different ways, considering that roads are necessary to access a given parcel. Table 3 shows that the mean number of parcels found within a given Census block is 23-27, though blocks vary widely in size—from 1.5 acres in an urban setting to closer to 20 acres outside it. Areas newly annexed to the UGB tend to have fewer buildings, with an average of 16 per census block, compared to the 19-20 typically seen in nearby urban/rural areas. Blocks tend to have small amounts of roadways within them (a mile or less), though contain a little under two intersections on average.

Table 3: Descriptive statistics

Variable	Main Sample	Urban Spillovers	Rural Spillovers
Block-Group-Level Variables			
Prop. Renters	0.230	0.373	0.264
	(0.174)	(0.245)	(0.220)
Prop. Below FPL	0.075	0.129	0.088
	(0.063)	(0.109)	(0.079)
Prop. White	0.886	0.816	0.860
	(0.090)	(0.127)	(0.111)
$N =$	*858*	*10,813*	*726*
Block-Level Variables			
Num. Parcels	23.76	23.01	27.07
	(35.97)	(41.00)	(39.31)
Num. Buildings	16.00	19.71	19.07
	(27.02)	(31.97)	(30.52)
Road Length (mi.)	0.951	0.301	1.049
	(1.331)	(0.531)	(1.292)
Num. Intersections	1.784	1.734	1.973
	(2.901)	(3.226)	(2.976)
Acreage	18.81	1.53	18.66
	(38.41)	(5.58)	(27.36)
Mean Slope (degrees)	4.994	3.017	5.228
	(3.644)	(3.199)	(3.245)
$N =$	*4,815*	*186,858*	*3,057*

Notes: This table includes summary statistics for variables measured at a higher level than the parcel. Observations are counted by unit-year; this is the census block group-year or census block-year, respectively. Block group-level variables include demographic and other information on residents, and are typically used as neighborhood controls. Block-level variables are used to estimate effects on local housing and infrastructure density, including parcel counts, road length and intersections, though also include the slope of a parcel's general vicinity. The source for block group-level variables is the ACS, while sources for block-level variables are Metro RLIS and LANDFIRE LF2020.

5 Results

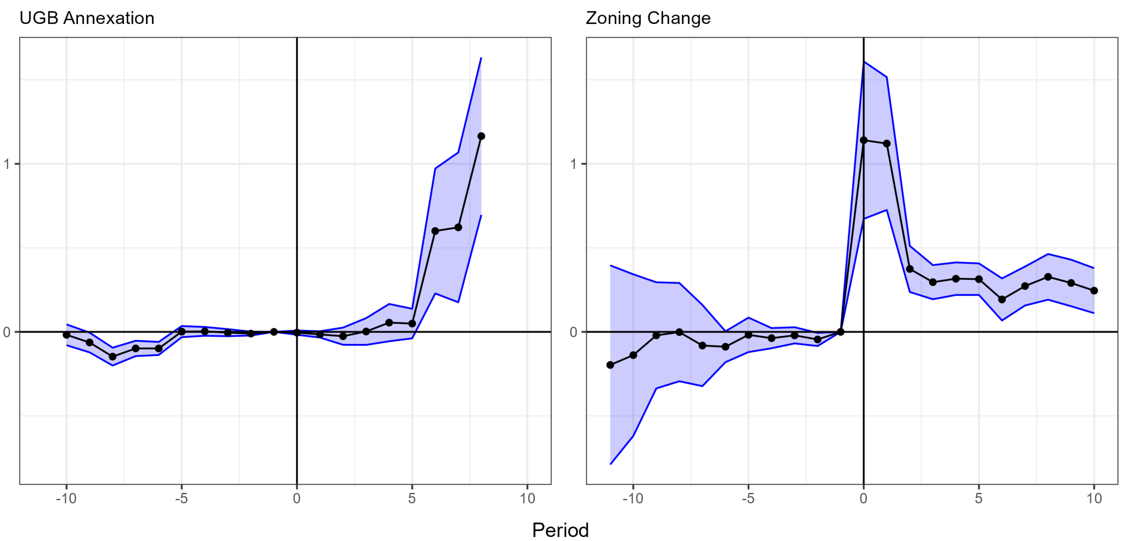
5.1 Price and valuation

Table 4 (Panel A) and Figure 6 show the results of estimations on the effect of UGB annexation on appraised land value per acre.[31] The results in columns (1)-(4) add progressively more controls using UGB annexation as treatment, while columns (5)-(8) do the same for zoning changes. These controls include "proximity" (in the main specification, whether a parcel is close enough to be considered "treated" in a spillover analysis); parcel "characteristics", in the form of distance to downtown Portland and the UGB, as well as dummy variables for particular ranges of acreage and building square footage;[32] and "propensity variables," controls

[31] Regarding how properties are assessed: new construction is assessed at the extent to which it increases the value of the overall property; using depreciation and housing quality, the same logic applies to preexisting buildings as well.

[32] More specifically, these are sets of variables that denote lots with 0, 0-0.1, 0.1-0.2, 0.2-0.3, 0.3-0.5, 0.5-0.75, 0.75-1, 1-2, 2-3, 3-5, 5-10, 10-25, 25-50, and over 50 acres. Building square footage is split into parcels with 0, 0-1000, 1000-1500, 1500-2000, 2000-2500, 2500-3000, 3000-3500, 3500-4000, 4000-5000, 5000-6000, and over 6000 ft^2. This yields a total of 14 groups of parcel size and 11 groups of building/home size, plus the two distance controls.

Figure 6: Parcel-level event study on land value



Notes: This event study uses all controls described elsewhere: namely, whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland, distance to the UGB, and the propensity-variable controls outlined in Section 3.3. The dependent variable estimated here is the log of land value per acre.

like those used in Hoynes and Schanzenbach (2009) and Acemoglu, Autor, and Lyle (2004) that could influence a parcel's likelihood of UGB entry, interacted with a linear-time term.[33]

My preferred results, in columns (4) and (8), suggest that UGB annexation yields a 37% increase in land valuation relative to unannexed parcels, with a 67% increase following a parcel's move from "rural" to "urban" zoning (relative to parcels that stay "rural"). Figure 6 allows us to see how this change is realized across time, and suggests that the estimated effect in column (4) could be a byproduct of zoning changes; it frequently takes about five years for a parcel to change its zoning, and there is no significant effect until this period.

I examine the effects on building value per square foot as well. Relative to unannexed parcels, Panel B shows no significant changes following UGB annexation, but does estimate a large decrease (21%) in building value per square foot after zoning changes. The reason behind this is unclear; the decrease could reflect a desire for redevelopment and newer/denser housing stock, or reallocation by the appraisers more than a "real" change in valuation during the period. As total valuations—and therefore tax burdens—reflect the value of both land and improvements, it is interesting that these effects appear to move in opposite directions. Panel C shows, however, that the increase in land prices is more important, as the overall effect on total valuation is positive and of a similar magnitude to the estimates from Panel A. That is, UGB annexation appears to increase a property's valuation by 23%, and a change to "urban" zoning increases it by 68%. At the mean valuation of $460,000, this represents an average expected increase of over $300,000 per affected parcel.

[33]Specifically, I include pre-treatment acreage, the mean slope of the Census block in which the parcel is located, distance to the 1979 UGB, distance to the nearest highway, and dummy variables for the nearest city in 2007. Some of these may influence how desirable a location is based on what it's near (nearest city, distance to 1979 UGB, distance to the highway); others affect how easy construction is on the lot or area in question (acreage, slope—how flat an area is).

Table 4: Appraised Values

Panel A: Land Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	0.1912*	0.1856*	0.2893*	0.3679*				
	(0.0855)	(0.0854)	(0.0864)	(0.0868)				
Zoning Ch.					0.7009*	0.6977*	0.6342*	0.6654*
					(0.0919)	(0.0919)	(0.0914)	(0.0925)
Proximity		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	39,546	39,546	39,546	39,546	42,461	42,461	42,461	42,461

Panel B: Building Value

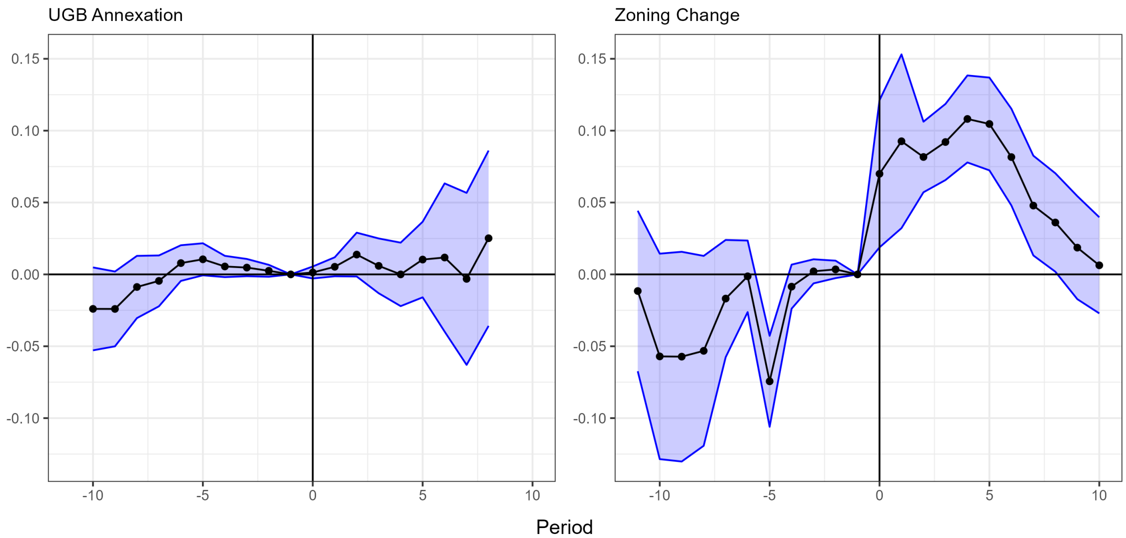
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	0.0290	0.0238	0.0087	-0.0377*				
	(0.0159)	(0.0159)	(0.0166)	(0.0189)				
Zoning Ch.					-0.2208*	-0.2337*	-0.2543*	-0.2060*
					(0.0669)	(0.0671)	(0.0739)	(0.0730)
Proximity		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	45,408	45,408	45,408	45,408	47,360	47,360	47,360	47,360

Panel C: Total Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	0.2842*	0.2808*	0.2662*	0.2324*				
	(0.0787)	(0.0787)	(0.0612)	(0.0620)				
Zoning Ch.					0.6175*	0.6138*	0.6793*	0.6845*
					(0.0852)	(0.0852)	(0.0848)	(0.0845)
Proximity		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	64,682	64,682	64,682	64,682	68,387	68,387	68,387	68,387

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include, in order: (1) whether a non-UGB parcel was within 0.5 miles of an annexation; (2) acreage, square footage, distance to downtown Portland, and distance to the UGB; (3) propensity-variable controls, outlined in Section 3.3. Panel A looks at the land value per acre, Panel B at building value per square foot, and Panel C at total valuation. All dependent variables are natural logs.

Figure 7: Parcel-level event study on new building construction



Notes: This event study uses all controls described elsewhere: namely, whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland, distance to the UGB, and the propensity-variable controls outlined in Section 3.3. The dependent variable estimated here is the likelihood of new construction, defined as an increase from no built square footage in the year prior to some positive, non-zero amount.

5.2 Home renovation and new construction

UGB expansions allow more land to be developed. The intensity of land use—such as the square footage of a building constructed on a particular parcel—is explicitly controlled by zoning and UGB status in the region. Because of that, some kind of construction on a parcel could be a natural consequence of that parcel's annexation into the UGB. I distinguish two different measures for this: new construction and renovations. Results for new construction are found in Figure 7 and Panel A of Table 5. UGB annexation alone is not associated with any increased likelihood of new construction, most likely because such construction remains restricted, while changes in a parcel's zoning increase the likelihood of new construction by 7.7 percentage points. Considering that new construction only occurs in around 2% of parcel-years, this is a substantial proportional increase.

Square footage can also increase on properties that *already* contain homes or other buildings. While there are many administrative restrictions surrounding the construction of residential properties outside of the UGB, certain areas are still zoned for rural residential use. Due to the relative low supply of housing like this, owners of these houses may have incentive, following a change in UGB status, to improve their house and expand its square footage by adding an additional room, finishing out an attic, etc. If these parcels are more likely to change ownership, the new owners might want to renovate instead; the expected outcome is thus the same. However, that story is not supported by Panel B. If anything, UGB annexation decreases the likelihood of renovation (though not statistically significantly), while parcels with existing buildings are five percentage points more likely to see renovation than un-annexed, "rural"-zoned parcels following a shift to "urban" zoning.

Figure 7 shows the effect over time for new construction.[34] It seems that this effect is largest during the

[34] In the interest of space, a similar graph for renovation is omitted. The main difference is a more negative tendency after UGB annexation.

Table 5: Construction/Renovation

Panel A: New Construction

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	-0.0481*	-0.0478*	0.0184	0.0099				
	(0.0132)	(0.0133)	(0.0111)	(0.0117)				
Zoning Ch.					0.1283*	0.1288*	0.0809*	0.0768*
					(0.0178)	(0.0178)	(0.0134)	(0.0136)
Proximity		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	65,297	65,297	65,297	65,297	69,005	69,005	69,005	69,005

Panel B: Renovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	-0.0676*	-0.0656*	0.0005	-0.0183				
	(0.0136)	(0.0136)	(0.0127)	(0.0143)				
Zoning Ch.					0.1217*	0.1236*	0.0606*	0.0501*
					(0.0191)	(0.0190)	(0.0158)	(0.0161)
Proximity		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	65,297	65,297	65,297	65,297	69,005	69,005	69,005	69,005

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include, in order: (1) whether a non-UGB parcel was within 0.5 miles of an annexation; (2) acreage, square footage, distance to downtown Portland, and distance to the UGB; (3) propensity-variable controls, outlined in Section 3.3. Panel A looks at new construction and Panel B on increases in square footage for existing buildings; both are binary outcomes.

first few years following a zoning change, which in turn indicates that the region's UGB binds (at least in certain areas). The UGB ostensibly contains land sufficient for 20 years of future growth, but if construction generally occurs within the first few years of it becoming feasible, market pressures may be quite high.

5.3 Spillovers

To consider whether parcels that are not directly affected by the treatment but that are located nearby may be affected by UGB expansions, I conduct a spillover analysis on parcels that are close to these expansions.[35] I compare parcels of the same UGB status to each other—so rural parcels are not compared to urban parcels, and vice versa.

Panel A of Table 6 suggests that parcels within the UGB see their land value fall by about 1.1% per acre, while Panel B shows that the value of within-UGB parcels' buildings increases by 0.54%. While these are precisely estimated effects, they are practically small. We might anticipate changes in the other direction for columns (4)-(6), since parcels outside the UGB—if near an annexation—may benefit from closer proximity to urban amenities, as well as a reduction in the supply of land in the rural market. However, I observe no statistically significant results when using all controls, though Panel B shows that the propensity-variable

[35]Treatment is defined as being within 0.5 miles of an expansion, with control parcels being 0.5-2.5 miles away, as outlined in Section 4.1.

Table 6: Appraised Values - UGB Spillover

Panel A: Land Value

	(1)	(2)	(3)	(4)	(5)	(6)
In UGB	-0.0331*	-0.0360*	-0.0113*			
	(0.0014)	(0.0014)	(0.0026)			
Outside UGB				-0.0490	-0.0266	0.0194
				(0.0279)	(0.0308)	(0.0468)
Characteristics		X	X		X	X
Propensity Vars			X			X
N =	2,128,425	2,128,416	2,128,306	20,009	20,009	20,009

Panel B: Building Value

	(1)	(2)	(3)	(4)	(5)	(6)
In UGB	0.0230*	0.0136*	0.0054*			
	(0.0016)	(0.0016)	(0.0017)			
Outside UGB				0.0765*	0.0480*	0.0002
				(0.0100)	(0.0150)	(0.0207)
Characteristics		X	X		X	X
Propensity Vars			X			X
N =	3,522,177	3,522,177	3,522,117	18,709	18,709	18,709

Panel C: Total Value

	(1)	(2)	(3)	(4)	(5)	(6)
In UGB	0.0134*	-0.0061*	-0.0028			
	(0.0023)	(0.0019)	(0.0021)			
Outside UGB				-0.0094	0.0108	-0.0201
				(0.0438)	(0.0273)	(0.0360)
Characteristics		X	X		X	X
Propensity Vars			X			X
N =	4,037,733	4,037,724	4,037,585	27,237	27,237	27,237

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021) to estimate spillover effects. Controls include, in order: (1) acreage, square footage, distance to downtown Portland, and distance to the UGB; and (2) propensity-variable controls, outlined in Section 3.3. Panel A looks at the land value per acre, Panel B at building value per square foot, and Panel C at total valuation. All dependent variables are natural logs.

controls are quite impactful when estimating this effect. This suggests that the rural and urban land markets in the region, possibly due to the administrative requirements for development, are separate from one another.

Perhaps unsurprisingly, when examining the potential impact on total value, Panel C of Table 6 estimates no statistically significant effect of proximity to annexations on either population, though the effect on within-UGB parcels tends to be insignificantly negative. When considering UGB annexations as expansions of local land supply, we would anticipate a negative coefficient, as increasing supply leads to a lower equilibrium price. This effect in column (3) is still precisely measured, though is close to zero in both a statistical and economic sense.

Figure 8 plots how the estimates of Table 6 are affected by the choice of bandwidth; while I keep the sample population the same (within 2.5 miles of an expansion during the study period), I allow parcels of different distances to have different treatment effects, from a low of 0.05 miles to a high of 1 mile. All outcomes

Table 7: Construction/Renovation - UGB Spillover

Panel A: New Construction

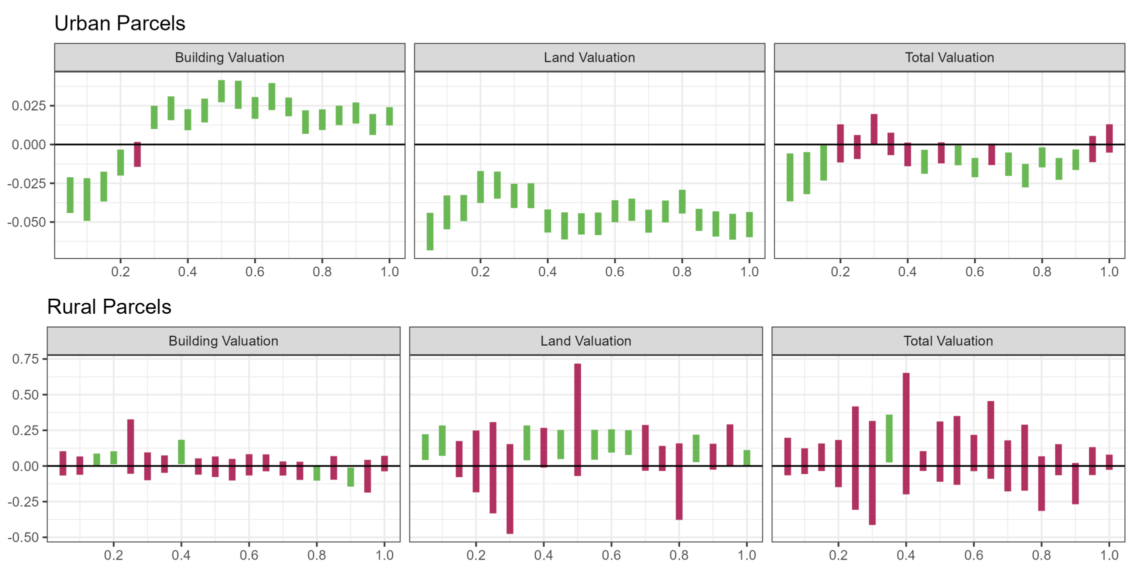
	(1)	(2)	(3)	(4)	(5)	(6)
In UGB	0.0099*	0.0007	0.0004			
	(0.0013)	(0.0005)	(0.0005)			
Outside UGB				-0.0082	0.0092	0.0166
				(0.0062)	(0.0073)	(0.0097)
Characteristics		X	X		X	X
Propensity Vars			X			X
N =	4,185,915	4,184,307	4,184,022	27,570	27,570	27,570

Panel B: Renovation

	(1)	(2)	(3)	(4)	(5)	(6)
In UGB	-0.0134*	-0.0081*	-0.0053*			
	(0.0010)	(0.0009)	(0.0011)			
Outside UGB				-0.0121	-0.0183*	-0.0099
				(0.0077)	(0.0066)	(0.0085)
Characteristics		X	X		X	X
Propensity Vars			X			X
N =	4,185,915	4,184,307	4,184,022	27,570	27,570	27,570

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021) to estimate spillover effects. Spillovers affect urban (in-UGB) and rural (outside-UGB) parcels differently, with columns (1)-(3) focusing on urban spillovers and (4)-(6) on rural spillovers. Controls include, in order: (1) whether a non-UGB parcel was within 0.5 miles of an annexation; (2) acreage, square footage, distance to downtown Portland, and distance to the UGB; (3) propensity-variable controls, outlined in Section 3.3. Panel A looks at new construction and Panel B on increases in square footage for existing buildings; both are binary outcomes.

Figure 8: Varying bandwidths and valuation spillovers



Notes: This graph outlines how parcels' proximity to a UGB expansion (using the earliest exposure within one mile) affects land valuation. Because there are 19 distinct treated groups, ranging from within 0.05 to between 0.95 and 1 mile from a UGB annexation, the results outlined here use the TWFE estimator to determine the importance of treatment bandwidth on the estimated ATT. All regressions use the full set of controls (see columns (3) and (6) of Table 6). For a slightly different approach, using Sun and Abraham (2021) estimation with varying bandwidths, see Figure B.1. Statistical significance is denoted by color, with green indicating significance and red insignificance.

are the same as those in Table 6. Figure 8 shows that while rural parcels do not experience statistically significant changes in valuation, urban parcels do—in particular, land valuation is always slightly negative, while building valuation displays notable heterogeneity. Parcels within about 0.2 miles of an annexation see a negative effect, while parcels further away see an increase in building valuation per square foot. The total effect on valuation tends to be negative, though this is most economically significant for parcels that are very close to UGB annexations.

I also examine whether nearby areas see greater rates of new home construction or renovation, perhaps to "compete" with the increase in local land supply. Table 7 suggests that nearby areas are, practically, no more likely to see new construction or renovation than those further away from new UGB additions. For rural areas, there are few properties on which new construction is possible or allowed, so these outcomes see no change when compared to nearby, similar parcels. In urban areas, I estimate a statistically significant 0.5 percentage point decrease in renovation likelihood, a 12% decrease relative to the mean; this could be due to prospective homeowners in the area preferring to purchase developable land rather than renovate an existing structure. While I do vary the bandwidths of treatment as in Figure 8, estimates tend to be more consistent across bandwidths, and aside from urban renovation, tend towards zero. For more information, see Figure B.1 in the appendix.

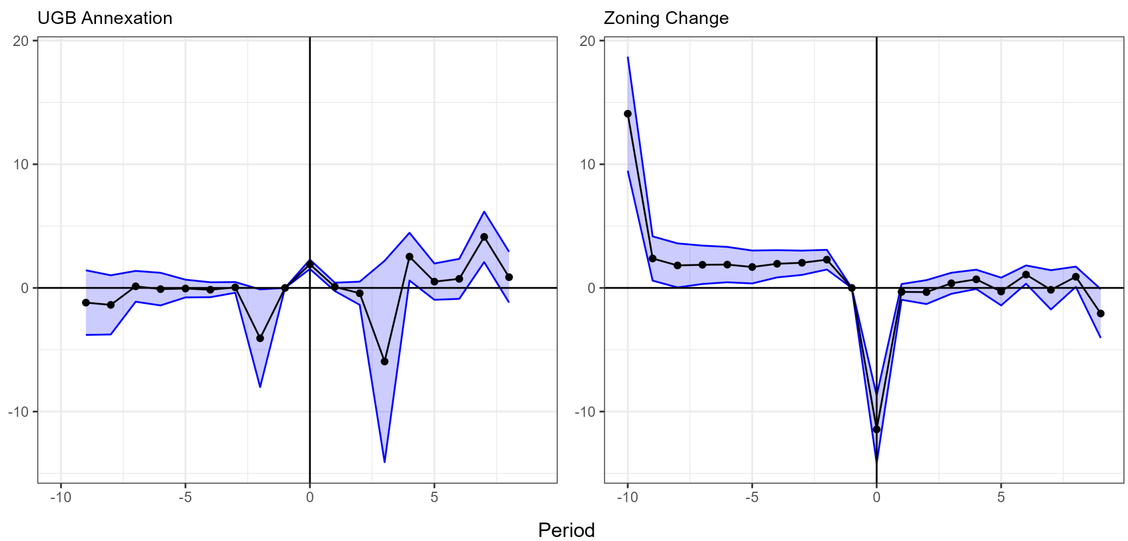
5.4 Neighborhood density

One of the modern goals of the UGB is to increase neighborhood density within the boundary's limits. To explore this, I aggregate parcels up to the census block level, exploring potential impacts on infrastructure and parcel counts. Panel A of Table 8 suggests that there is no significant change in road length based on UGB status or zoning changes. This indicates that these areas tend to use pre-existing infrastructure—or that development tends to be concentrated in locations with existing infrastructure. Panel B, examining the number of intersections, tells a different story. A statistically significant 0.36 increase in the expected number of intersections after annexation represents an 18% increase from the mean of 1.9, though it is difficult to make sense of this without a meaningful increase in road length. It is possible that small, connecting roads are being built, but which are small enough that they do not increase the average road length (about 0.8-1.0 miles in these blocks).

Table 9 uses parcel, rather than infrastructure, information to see how the density of development changes, if at all. Panel A suggests some level of consolidation within blocks as zoning changes, with a decrease of 3.5 parcels found in a given block following a zoning change—if using the rural average of 27 parcels per block, a 13% change. This could reflect developer activity in these areas, though the lack of significant activity prior to changes in zoning is surprising. If developers are sufficiently risk-averse, it is feasible that they wait to consolidate until they are certain that the areas in question can be developed. Indeed, this explanation may be corroborated by Panel B, which identifies a predicted *decrease* of about 2.4 buildings per census block (15% of the average of 16 buildings per block). However, an event-study analysis of how the effect is spread across time suggests a very short period of reconsolidation—Figure 9 shows little, if any, changes relative to a block experiencing annexation into the UGB.[36] However, zoning changes exhibit a marked negative shock in the year of change alone, which may reflect redevelopment of parcels that *already had* buildings prior to treatment. Most years following treatment have no more or fewer parcels or buildings than the year prior to treatment, suggesting little—if any—effect of the policy on local density.

[36] The figure for the number of parcels looks extremely similar, and so is not included. Said figure is available upon request.

Figure 9: Block-level event study on intersection count



Notes: This event-study uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include, in order: (1) (log of) the area of the Census block; (2) average acreage, square footage, distance to downtown Portland, and distance to the UGB of parcels within the block; (3) propensity-variable controls, outlined in Section 3.3. The dependent variable here is the number of distinct parcels with a building (positive built square footage) within a given block (count).

5.5 Robustness checks

My results are qualitatively similar across a number of alternative specifications, which I employ as robustness checks.[37] I first use sales as a separate sample of interest to corroborate my findings regarding how UGB annexation affects prices; subsequently, I examine selected subsamples of my main data set.

5.5.1 Sales

Being the result of a market operation, property sales are better signals of value than appraisals are. However, sparse data regarding parcels newly annexed to the UGB (due to lack of sales and repeat sales)[38] severely limits any analysis using such a sample. As such, I examine the effect of UGB annexation on sale price as a robustness check rather than as a main outcome.

This secondary sample consists of sales with a reported sale price of over $100, as sales below this value are unlikely to be representative of the broader population of property sales. This population is quite different from the exhaustive appraisal population I employed in Section 5.1; with very few repeat sales, I therefore employ a hedonic two-way fixed effects (TWFE) approach while allowing the level of fixed effect to vary.

In attempting to hedonically estimate the impact of UGB annexation and zoning changes on sale prices, I use the following equation:

[37] Full results for these specifications can be found in Appendix B.

[38] Only 584 parcels that move from rural to urban zoning from 2008-2019 experience more than one sale during this period. For newly-annexed parcels, only 34 distinct properties have more than one sale during the study period.

Table 8: Neighborhood Density—Road Extent

Panel A: Road Length (mi.)

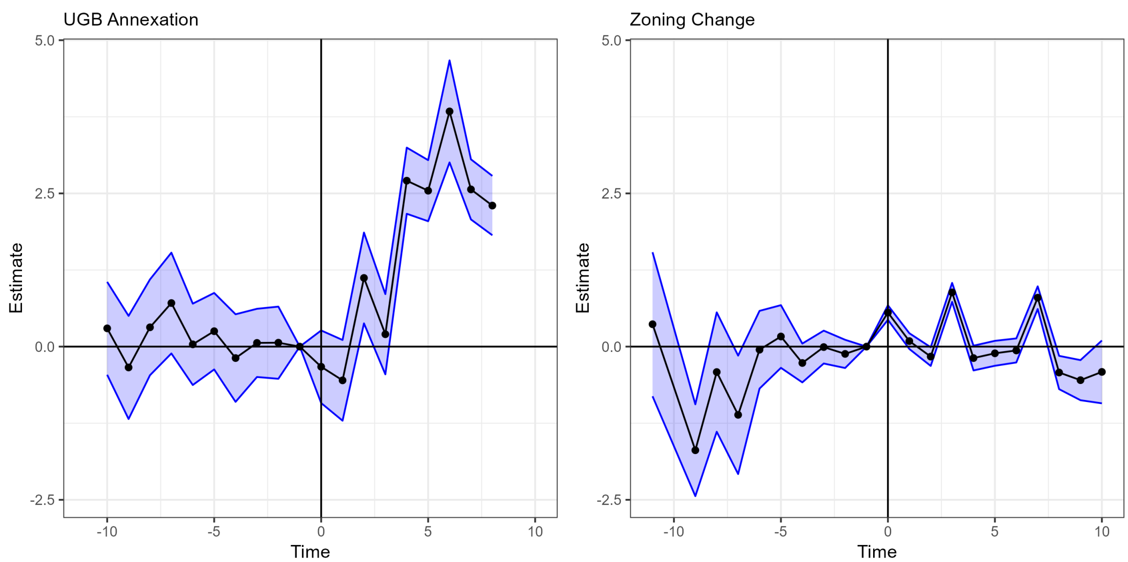
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	0.0135	0.0135	0.0242	0.0265				
	(0.0139)	(0.0139)	(0.0205)	(0.0200)				
Zoning Ch.					-0.0534*	-0.0534*	0.0040	0.0056
					(0.0219)	(0.0219)	(0.0153)	(0.0153)
Area		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	84,456	84,456	47,450	47,450	84,588	84,588	47,549	47,549

Panel B: Number of Intersections

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	0.3202*	0.3202*	0.3972*	0.3601*				
	(0.1199)	(0.1199)	(0.1693)	(0.1715)				
Zoning Ch.					0.0084	0.0084	0.0486	0.0438
					(0.0461)	(0.0461)	(0.0401)	(0.0398)
Area		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	84,456	84,456	47,450	47,450	84,588	84,588	47,549	47,549

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include, in order: (1) (log of) the area of the census block; (2) average acreage, square footage, distance to downtown Portland, and distance to the UGB of parcels within the block; (3) propensity-variable controls, outlined in Section 3.3. Panel A looks at road length in miles and Panel B the number (count) of street intersections within the block.

Figure 10: Parcel-level event study on total sale value



Notes: This figure uses a two-way fixed-effects approach, as there are insufficient repeat sales to use a more robust variant. All sales used here occurred during the study period, 2008-2019. Estimates calculated using Equation (4), with propensity-variable controls and block-group-level fixed effects. The dependent variable is the natural log of sale price.

Table 9: Neighborhood Density—Parcel/Home Density

Panel A: Number of Parcels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	-0.2125	-0.2125	-0.8439	0.8311				
	(0.7515)	(0.7515)	(1.1893)	(1.2253)				
Zoning Ch.					-2.9942*	-2.9942*	-3.5375*	-3.5168*
					(0.6783)	(0.6783)	(0.6180)	(0.6180)
Area		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	84,456	84,456	47,450	47,450	84,588	84,588	47,549	47,549

Panel B: Number of Homes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UGB Annex.	-0.3502	-0.3502	-0.8436	0.1849				
	(0.3979)	(0.3979)	(0.6295)	(0.6603)				
Zoning Ch.					-2.0717*	-2.0717*	-2.4301*	-2.4166*
					(0.4354)	(0.4354)	(0.4098)	(0.4114)
Area		X	X	X		X	X	X
Characteristics			X	X			X	X
Propensity Vars				X				X
N =	84,456	84,456	47,450	47,450	84,588	84,588	47,549	47,549

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include, in order: (1) (log of) the area of the census block; (2) average acreage, square footage, distance to downtown Portland, and distance to the UGB of parcels within the block; (3) propensity-variable controls, outlined in Section 3.3. Panel A looks at the number of distinct parcels within the block, while Panel B examines the number of parcels with buildings on them (non-zero square footage), both measured as counts.

$$\begin{aligned} log(Sale.Price)_{is} = \alpha + \beta_1 * Acreage.Grp_{is} + \beta_2 * Sqft.Grp_{is} + \beta_3 * Home.Age.Grp_{is} + \\ + \delta_1 * UGB_{is} + \delta_2 * Urb.Zng_{is} + \delta_3 * \mathbf{D}_{is} + \\ + \delta_4 * Expn.Dist_{is} + \delta_5 * Zng.Grp + \varepsilon_{is} \end{aligned} \tag{4}$$

In Equation (4), for parcel i at sale-time s, $Acreage.Grp$ and $Sqft.Grp$ are split out as in Table 4; $Home.Age.Grp$ indicates how old a home is;[39] $Zoning.Grp$ indicates the overarching zoning type of the parcel;[40] and $\mathbf{D}_{is}$ is a vector of distances (distance to downtown Portland and the UGB border). Equation (4) is intended to imitate Equation (2).

The regressions in Table 10 and the event studies in Figure 10 follow the model outlined in Equation (4). To capture the influence of location on the housing market, I use (and cluster on) either the 2010 Census tract, 2010 Census block, or the individual parcel level. In columns (4)-(6), I also introduce the propensity-variable controls previously outlined in Section 3.3.

[39]This is rounded to the lowest decade. For instance, homes that are 0-9 years old are grouped together, while 10-19 are a separate grouping.

[40]This includes agricultural, commercial, forest, industrial, manufacturing, public, rural residential, single-family residential, and "vacant."

Table 10: Logged total sale price as outcome

	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
UGB Annex.	1.362***	0.3245	-0.5148	1.331***	0.3535	-0.7124
	(0.2571)	(0.3098)	(0.5644)	(0.3039)	(0.3027)	(0.8539)
Zoning Ch.	0.4312***	0.2035***	0.4274**	0.4372***	0.2012***	0.3998**
	(0.1032)	(0.0738)	(0.1694)	(0.1030)	(0.0737)	(0.1687)
Proximity variables				X	X	X
Fixed-effects						
Sale date (year)	X	X	X	X	X	X
2010 Census tract	X			X		
2010 Census block		X			X	
Parcel			X			X
Fit statistics						
N =	39,154	39,154	39,154	39,154	39,154	39,154
R^2	0.34687	0.55456	0.92729	0.35700	0.55568	0.92776
Within R^2	0.20123	0.16599	0.20141	0.21361	0.16808	0.20651

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table reports estimated coefficients from two-stage least-squares regressions, with (the natural log of) sale price as outcome. All sales used here occurred during the study period, 2008-2019. Estimates calculated using Equation (4), with propensity-variable controls and neighborhood/parcel fixed effects, depending on the column. Columns (4)-(6) also include a dummy variable indicating whether a sold parcel was within 0.5 miles of a UGB annexation, as this could be considered "treated" in a spillover analysis.

The estimates in Table 10 should be taken as purely suggestive. Without being able to observe and control for the number of rooms of the home, alongside many other property amenities, it is likely that the underlying processes here are not being fully captured in this specification. However, what we can see is remarkably consistent: UGB annexation does not appear to affect sale price, while zoning changes increase prices by about 40% (in columns (3) and (6), my preferred estimates). This is quite large, and similar to the 67% increase in valuation estimate I discussed previously. Moreover, this is very close to the Polish estimates of the value of being able to developt a parcel from Gluszak and Zygmunt (2018), which were on the order of 47-50%.

However, Figure 10 paints a more confusing picture. It seems that the value of UGB annexation increases over time, while the value of urban zoning *decreases* slightly. This could be driven by increased supply—the longer a parcel has been part of the UGB or been developable, the more likely it is that neighboring areas are experiencing the same phenomenon. These estimates also suggest that the market does not internalize the increase in value that should accompany UGB annexation. For one, we should expect some speculation to occur, and for some of the price effect of zoning changes to be realized in periods prior to the change. The information would be available to potential buyers and sellers of the property. Without an increase in sale price commensurate to the expected future value of the property, it is no wonder that very few of these parcels are sold during the study period.

5.5.2 Appraisal subsamples

Returning now to the main data set of appraised parcels, I examine certain subpopulations to prove that my findings are robust to sample specification. To begin, I isolate one particular instance of boundary expansion—the UGB expansion brought about by the passage of HB 4078, also known as the "Grand Bargain."

HB 4078 was first read on February 3, 2014, and was signed by the governor of Oregon on April 1, 2014. This bill did not contain provisions for expanding the Portland-area UGB on February 3rd, instead acquiring that language following amendments, sometime prior to February 27th. This means that, rather than the years-long, community-focused analysis that Metro generally undertakes when preparing UGRs, decisions were made in less than two months. This *also* means that there was much less time in which local residents could politically agitate—rather than landowners, this decision was made by legislators.

Estimates of the effects of the 2014 expansion tend to be smaller than the overall estimated effects, as Table B.1 shows; zoning changes still result in a 27% increase in land prices, and a 43% increase in overall property valuation, though the act of annexation itself appears to have no statistically significant effect on parcels' valuation. Regarding new construction, however, the estiamted effects (following a change in zoning) are larger—a 13-percentage-point increase in new construction (vs. 7.7) and an 11-percentage-point increase in renovation (vs. 5.1). Other estimated effects—such as spillovers and neighborhood-density effects—are more quantitatively similar to the preferred results outlined previously.

I also test using only data from 2010 and after, in case the imputed census-block-group controls proved incorrect. Interestingly, using only 2010-2019 for analysis yields larger estimated effects: close to 100% gain of value rather than 67-68%, slightly higher construction and renovation likelihood increases (about 11 and 7.5 percentage points, respectively), and significant spillover effects. These spillovers do not result in a significant change in total valuation, however, though land values inside the UGB decrease slightly as those outside increase, both by 4-6%. Most estimates are not *statistically* different from those presented in Tables 4-7, however.

For annexed parcels and spillovers, I also check for robustness using the propensity-score approach mentioned in Section 3.[41] While Section 3.3 outlines the case for UGB expansion timing being quasi-random, were this to be in doubt, then a propensity-score approach would be appropriate. As such, I use both a matching estimator and inverse propensity scores, with both specifications resulting in findings similar to the results with full controls.

Table A.2 outlines the contribution of each variable to the propensity score regression, where the coefficients reported are derived from a logistic regression. Column (1) uses UGB status as the binary outcome of interest, while column (2) uses a parcel's zoning status ("urban" or not). Broadly speaking, each variable's contribution to calculating a propensity score is logical. It seems that hillier parcels and land further from the 1979 UGB are less likely to be annexed or become zoned for urban use. Smaller parcels are also preferred, though this may be due to underlying land-use patterns—for instance, if parcels near the boundary's edge tend to be smaller because of their location. Distance to the nearest highway likewise matters in both specifications, though quite differently—it seems that zoning changes tend to happen further from highways.

Generally speaking, UGB expansion is concentrated in the west, and the impacts of being nearest to different cities supports what we see in Figure 2. Cities in the west (such as Beaverton, Cornelius, and Forest Grove) saw significantly more expansion in nearby areas, while the same cannot be said for parcels south or east of the boundary (near Tualatin, for instance). Interestingly, there is much more variety in changes

[41] More details in Appendix A.

in zoning, with no clear spatial pattern. Given the importance of a parcel's nearest city on annexation, at least, this weaker relationship might help to explain the much lower pseudo-R^2 for zoning status—roughly 0.2 for zoning changes, compared to 0.49 for UGB status.

As a further check, following Deshpande and Li (2019), I try using only not-yet-treated parcels as controls for treated parcels. If parcels that are eventually chosen are meaningfully different from parcels that are not chosen over the study period, then using not-yet-treated parcels should yield different results. While the small number of treated parcels leads to issues with power in Tables B.1 and B.2, the estimates—especially following changes in zoning—are qualitatively similar to baseline estimates. Table B.2 does see generally consistently lower results, though the standard errors are so high as to make them uninformative. Spillover results—with a larger "treated" population to pull from—are consistent with baseline estimates.

5.6 Welfare implications

A back-of-the-envelope calculation suggests that UGB expansions such as those carried out by Metro from 2008 to 2019 serve to increase the wealth of local landowners. A 68% increase in property valuation for the 1,721 distinct parcels annexed to the UGB from 2008-2019, with an average valuation (in 2008) of $441,503, yields an increase in wealth for those landowners of around $300,000 each.

This means that changes in the UGB from 2008-2019 represent an approximately $500 million (USD) increase in landowner wealth without significant spillovers on nearby land markets. Given that this figure is the result of the addition of around 8.67 mi^2 (22.4 km^2) to the UGB, annexing 17.5 mi^2 (45.3 km^2) to the UGB over the next decade—4.3% of the size of the UGB in 2010—could increase welfare in the region on the order of $1 billion. Given that the Portland region's population grew by around 12% from 2010 to 2020,[42] even such a large expansion of developable area would lag behind the number of new residents in the region. While Brueckner (2011) states that UGBs can serve to enrich landowners and harm renters by limiting housing supply, separate policy interventions by Metro and other local goverments could encourage housing density and benefit renters, which would help to spread the welfare gains of such an approach.

6 Conclusion

Considering the substantial recent increase in housing prices without corresponding supply increases, land development or higher-intensity land use might prove necessary to better connect housing to those who need it. Market controls on land markets aim to protect certain areas of land from development while increasing the density of development in permitted locales. Portland's UGB is one such example, a city intentionally limiting the availability of developable land. In this paper, I leverage staggered UGB expansions from 2008-2019 to provide some of the first cross-time evidence of the price and density effects of Portland, OR's UGB. I estimate not only the large positive impact of UGB annexation on the value of annexed parcels, but also find no significant effects on nearby, otherwise-unaffected parcels. Using the universe of reported sales over the time period, I also estimate similar increases in price for sold parcels.

This study has faced several important limitations. First, as it largely depends on assessed values of parcels, it may not fully reflect market valuations, considering the low volume of sales for affected parcels over the study period. Second, I am restricted to using appraisals in 2008 and after. Because the UGB was first established in the 1970s, it is possible that these long-run effects of adjustment may not be indicative of

[42]In 2010, the estimated population or the region—which includes Vancouver, WA—was 2.2 million residents; by 2020, it was over 2.5 million. Source: U.S. Census Bureau.

the short-term effects for cities that newly adopt such a policy. Third and finally, while the policy of UGB expansion does restrict the zoning policies of cities in the Portland area, the fact remains that these cities still hold sway over the decision-making process. No decision or passed law with community involvement and representation can be held to be entirely exogenous. I employed a propensity-score matching approach to alleviate these concerns, but local involvement remains a potential confounding factor.

While UGB annexation certainly seems to be in the interest of landowners on the nearby fringe due to the large increase in land value it brings, it is not clear that the market controls result in the increased density of development that Metro is seeking to encourage. As cities across the country begin to reexamine their own land-use policies and limitations—including with respect to zoning, as in the effective abolition of single-family zoning in Minneapolis—it is important to fully explore the impacts of market controls like UGBs. They are effective at limiting the supply of land (as research like Dempsey and Plantinga (2013) finds), but given the goals of landowners and policymakers alike, that may not be sufficient to ensure the responsible application of such policies.

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A Propensity-score approach

A.1 Spillover timing

In Section 3.3, I explained the test that Hoynes and Schanzenbach (2009) perform in arguing their case for quasi-random rollout of the Food Stamp program in the United States—functionally, they see how well variables of interest (for them, largely associated with agricultural productivity) predict treatment timing. In Table 1, I did the same for the parcels that were treated. I include the results of similar regressions, testing whether timing can be predicted for spillover populations, in Table A.1; the R^2 values are qualitatively similar to those of columns (1) and (2) of Table 1.

Table A.1: Linear fits with propensity-score variables

Dependent Variable:	In UGB		Outside UGB	
Model:	(1)	(2)	(3)	(4)
Variables				
Acreage	0.3876*	-0.0799	3.177	-1.924
	(0.1928)	(0.1873)	(6.540)	(3.329)
Dist. to nearest highway (mi.)	-43.62	19.26	164.7	963.1
	(144.1)	(215.6)	(314.3)	(713.3)
Mean slope (deg.)	13.03	1.599	55.75	123.4
	(18.99)	(9.072)	(69.34)	(119.0)
Dist. to 1979 UGB (mi.)	620.6*	755.5**	101.6	45.71
	(333.4)	(341.1)	(358.7)	(388.8)
Fixed-effects				
Nearest City	X	X	X	X
2010 Census Tract		X		X
Fit statistics				
Observations	340,641	340,641	2,285	2,285
R^2	0.21172	0.64759	0.50750	0.61335
Within R^2	0.05342	0.01805	0.01104	0.06256

Clustered (nearest_city) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table reports coefficients and goodness of fit for treatment (UGB annexation or zoning change) timing based on pre-treatment observable characteristics. The variables used for propensity-score analysis are: pre-treatment acreage; distance in miles to the nearest highway; mean slope (topographical) of Census block; distance in miles to the 1979 UGB; and nearest city (as of 2007). In the interest of legibility, a parcel's nearest city was treated as a fixed effect and omitted.

A.2 Propensity-score assumptions

There are two potential forms for the unconfoundedness assumption. The first is stronger, and provides unconfoundedness of treatment for the average treatment effect (ATE). Conditional on $\mathbf{X}$, the potential outcomes $[Y(0), Y(1)]$ are independent of W, treatment status:

$$[Y(0), Y(1)] \perp W|\mathbf{X} \tag{1A}$$

or, alternatively, a weaker, unconfoundedness-in-mean form, where the potential outcomes are mean-independent of W given $\mathbf{X}$:

$$E[Y(w)|W, \mathbf{X}] = E[Y(w)|\mathbf{X}], w = 0, 1. \tag{2A}$$

Table A.2: Logit regression results

Dependent Variables:	UGB Status	Zoning Status
Model:	(1)	(2)
Variables		
Acreage	-0.0038***	-0.0447***
	(0.0013)	(0.0042)
Dist. to nearest hwy	-0.6768***	0.7889***
	(0.0392)	(0.0381)
Mean slope (block)	-0.4227***	-0.1261***
	(0.0215)	(0.0118)
Dist. to 1979 UGB	-1.452***	-1.373***
	(0.0658)	(0.0551)
Nearest city		
Beaverton	7.508***	-0.6027***
	(0.3718)	(0.2144)
Cornelius	4.163***	0.2654
	(0.3646)	(0.2155)
Damascus	-11.43	1.449***
	(190.8)	(0.2010)
Forest Grove	4.464***	-2.042***
	(0.4114)	(0.3822)
Gresham	-15.60	0.1802
	(566.2)	(0.1977)
Hillsboro	4.413***	2.555***
	(0.3620)	(0.1666)
King City	3.907***	-0.5910*
	(0.3644)	(0.3410)
Oregon City	-13.88	-3.514***
	(283.8)	(0.2579)
Sherwood	0.4894	0.1135
	(0.4673)	(0.2612)
Tigard	4.239***	-0.1784
	(0.4381)	(0.6087)
Tualatin	-15.51	2.767***
	(356.5)	(0.1596)
West Linn	-15.04	0.3877**
	(317.2)	(0.1935)
Wilsonville	2.978***	1.863***
	(0.3744)	(0.1766)
Portland		-10.53
		(254.6)
Troutdale		-10.55
		(90.10)
Fit statistics		
Observations	65,297	69,005
Squared Correlation	0.31072	0.11482
Pseudo R^2	0.49025	0.19630
BIC	14,417.5	17,826.2

IID standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table report results from a logit regression of the propensity-score variables on binary treatment status (for UGB annexation or urban zoning). Lake Oswego is used as the reference group for "nearest city".

The equivalent forms for valid estimation of the ATT are weaker still, replacing $Y(w)$ with just $Y(0)$. Intuitively, Dehejia and Wahba (1999) phrase the unconfoundedness assumption as an assumption that "assignment to treatment is associated only with observable preintervention variables". The process of expanding the UGB into a particular area necessarily depends on observable characteristics—Metro takes into account a wide variety of factors when deciding where expansion should take place.[43] For propensity-score analysis, I use acreage, distance to the nearest highway, mean slope of the parcel's block, which in-UGB city the parcel is nearest to, and distance to the (original) 1979 UGB.

We also need proof of sufficient overlap—that is, that for all $\mathbf{x}$ in the support of $\mathbf{X}$,

$$0 < P(W = 1|\mathbf{X} = \mathbf{x}) < 1 \tag{3A}$$

or, in other words, that all units in the population have a chance of being either treated or not treated. For ATT estimation, propensity scores are allowed to equal zero. This $P(W = 1|\mathbf{X} = \mathbf{x})$ can be reframed as a *propensity score* $p(\mathbf{x})$, which is the likelihood (propensity) of a unit being treated. This assumption in equation (3A), often called "overlap", is called such due to the stated goal of ensuring a common (overlapping) support for treated and untreated units.

The $\mathbf{X}$ variables here include information in Equation (2), such as notions of the "absolute" and "relative" location of a parcel. Thus, the assumption in Equation (2A) states that after controlling for these observable characteristics $\mathbf{X}$, treated outcomes should be have the same (un)treated expected value as untreated outcomes. By combining Equations (2A) and (3A), we can assemble a reasonable control population for the treated units such that the estimated average treatment effects are unbiased estimates of the true effects.

Figure A.1 shows the raw and matched propensity scores based on the equation

$$ps_{it} = nearest.city_i + acres_{it} + dist.nearest.highway_{it} + block.slope_{it} + dist.1979.UGB_i \tag{4A}$$

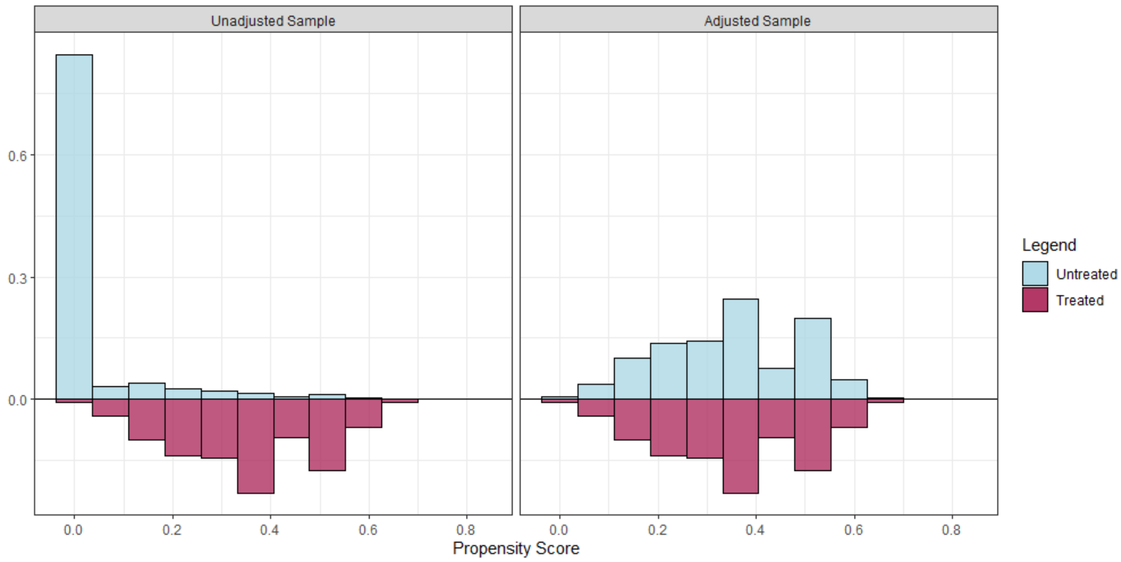
demonstrating that the overlap condition is satisfied, where ps_{it} is based on the treatment of interest—either UGB status or urban zoning. $block.slope_{it}$ measures the average slope of the 2010 Census block in which the parcel is located, and $dist.1979.UGB_i$ denotes the distance between the parcel and the original,

[43]The first step is based on Oregon's Statewide Planning Goal 14, which includes (quoting from a contact at Metro, though numbers are my addition): "(1) Ability of the reserve to efficiently accommodate the identified land needs (e.g., how much buildable land does the reserve have, how big and dispersed are its parcels, how close are they to transportation facilities, employment areas, parks, etc.); (2) Ability of the reserve to accommodate the orderly and economic provision of public facilities and services (i.e., how difficult/expensive would it be to extend water, sewer, stormwater, and transportation services to urban development in the reserve, and what impacts would such extensions have on lands already in the UGB); (3) Comparative environmental, energy, economic, and social consequences of urbanizing the reserve (e.g., impacts to nearby natural areas and on 'rural character' of an area); and (4) Compatibility of urban uses in the reserve with nearby agricultural and forest activities on farm and forest land outside the UGB (e.g., impacts of urban development on nearby commercial farms and timber harvesting)."

After verification that these conditions have been met, further information is taken into account (again, quoting from a Metro contact and adding numbers): "(1) Equitable and efficient distribution of housing and employment opportunities throughout the Metro region; (2) Contribution to the purposes of 2040 'Centers' and 'Corridors' (i.e., how well would urbanization of the reserve support or detract from the 2040 Growth Concept's vision of certain denser, transit-oriented urban centers); (3) Protection of farmland that is most important for the continuation of commercial agriculture in the region; (4) Avoidance of conflict with regionally significant fish and wildlife habitat; and (5) A desire for a clear transition between urban and rural lands, using natural and built features to mark the transition."

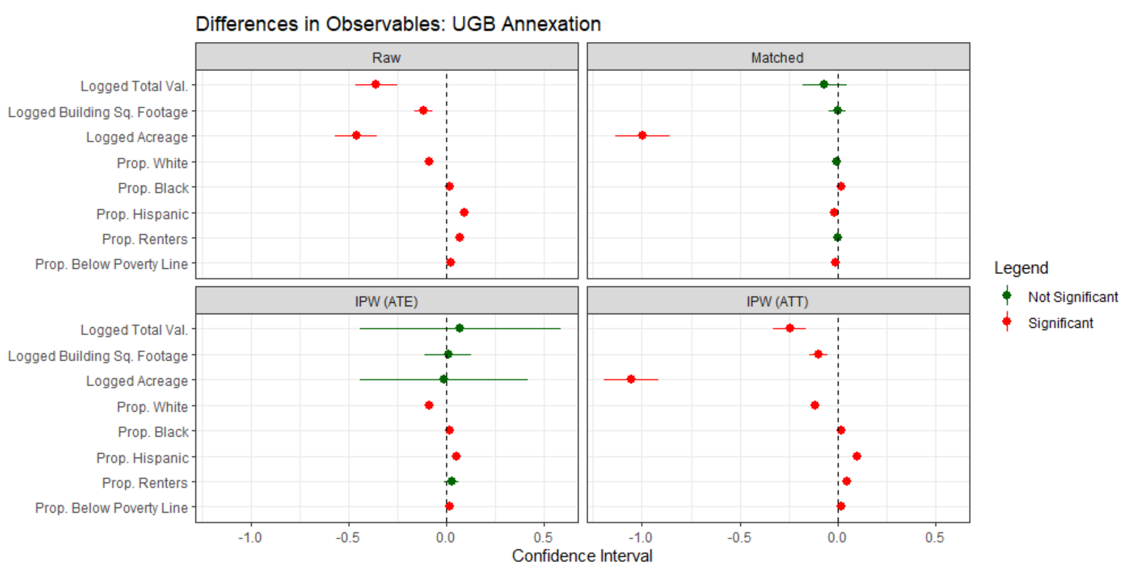
These factors are in addition to the procedural requirements, such as a city's development of a concept plan, that were previously outlined in Section 2.

Figure A.1: Matched propensity score(s)



Notes: This figure depicts the propensity scores of the analysis sample before and after propensity-score matching. Matching used UGB annexation as the treatment outcome.

Figure A.2: Balance of observable characteristics



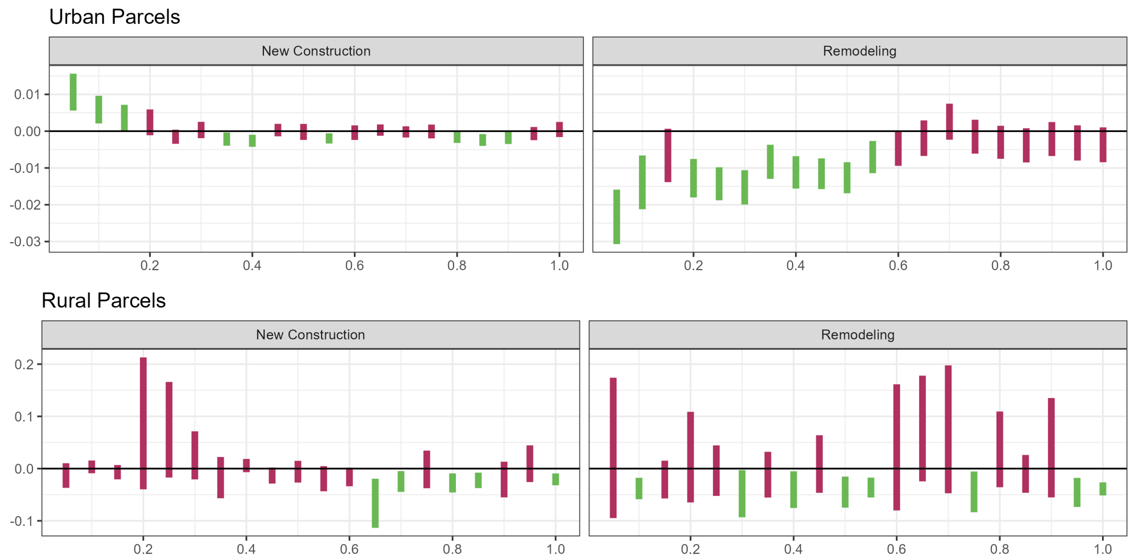
Notes: This figure depicts the statistical difference between observable characteristics across a the main sample and various propensity-score-score based samples used for robustness. Matching used UGB annexation as the treatment outcome.

1979 UGB. Figure A.2 outlines the balance given different usages of the logit-estimated propensity scores—matching and the ATE weights seem to yield better balance on many observable characteristics, even though many were not included in the regression. Section 5.5 discusses results using these methods.

B Robustness checks

This appendix serves to compile all the alternate specifications of my analysis in one place.

Figure B.1: Varying bandwidths and construction spillovers



Notes: This graph outlines how parcels' proximity to a UGB expansion (using the earliest exposure within one mile) affects land valuation. Because there are 19 distinct treated groups, ranging from within 0.05 to between 0.95 and 1 mile from a UGB annexation, the results outlined here use the TWFE estimator to determine the importance of treatment bandwidth on the estimated ATT. All regressions use the full set of controls (see columns (3) and (6) of Table 6). For a slightly different approach, using Sun and Abraham (2021) estimation with varying bandwidths, see Figure B.1. Statistical significance is denoted by color, with green indicating significance and red insignificance.

Table B.1: Land and Building Values

Panel A: Land Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
UGB Annexation	0.3679* (0.0868) N = 39,546	0.4703* (0.1120) N = 32,898	-0.0331 (0.0343) N = 34,569	0.2358 (580.1373) N = 5,957	0.3642* (0.0859) N = 39,546	0.5539 (12813.5568) N = 6,800
Zoning Change	0.6654* (0.0925) N = 42,461	0.9608* (0.1713) N = 33,712	0.2791* (0.1323) N = 34,569	0.7780* (0.0950) N = 4,042	0.6684* (0.0920) N = 42,461	0.2488 (900.7314) N = 3,111

Panel B: Building Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
UGB Annexation	-0.0377* (0.0189) N = 45,408	-0.0419* (0.0207) N = 37,690	-0.0011 (0.0238) N = 41,971	-0.0235 (0.0221) N = 4,341	-0.0345 (0.0192) N = 45,408	-0.0796* (0.0277) N = 5,008
Zoning Change	-0.2060* (0.0730) N = 47,360	-0.0119 (0.0347) N = 38,259	-0.0916 (0.1356) N = 41,971	-0.1319 (0.0777) N = 2,895	-0.2029* (0.0747) N = 47,360	0.0125 (0.0593) N = 2,019

Panel C: Total Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
UGB Annexation	0.2324* (0.0620) N = 64,682	0.2778* (0.0624) N = 53,843	0.0013 (0.0591) N = 59,041	0.1181 (0.0714) N = 7,140	0.2322* (0.0612) N = 64,682	-0.0830 (54.9294) N = 7,937
Zoning Change	0.6845* (0.0845) N = 68,387	1.0052* (0.1962) N = 54,869	0.4266* (0.1225) N = 59,041	0.6766* (0.1270) N = 5,076	0.6971* (0.0844) N = 68,387	0.6100 (1959.7205) N = 3,859

Notes: This table uses the robust difference-in-differences approach of Sun and Abraham (2021), using all controls: whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland/the UGB, and the Hoynes-Schanzenbach controls outlined in Section 3.3. Panel A looks at the land value per acre, Panel B at building value per square foot, and Panel C at total valuation. All dependent variables are natural logs. The columns include various robustness checks. Column (1) reproduces results from Table 4; column (2) uses only observations (and treatments) from 2010-2019; column (3) uses only the 2014 expansion; column (4) uses propensity-score matching based on equation 3; column (5) uses inverse-propensity weighting based on the same equation; and column (6) uses only not-yet-treated units as controls, as in Deshpande and Li (2019).

Table B.2: Development and Renovation

Panel A: New Construction

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
UGB Annexation	0.0099	0.0396*	0.0091	-0.0174	0.0077	0.1316
	(0.0117)	(0.0123)	(0.0110)	(109.0255)	(0.0118)	(2725.8155)
	N = 65,297	N = 54,351	N = 59,559	N = 7,210	N = 65,297	N = 8,063
Zoning Change	0.0768*	0.1099*	0.1301*	0.0806*	0.0774*	-0.4057
	(0.0136)	(0.0348)	(0.0272)	(0.0210)	(0.0139)	(828.9500)
	N = 69,005	N = 55,377	N = 59,559	N = 5,124	N = 69,005	N = 4,003

Panel B: Square Footage Change

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
UGB Annexation	-0.0183	0.0055	-0.0028	-0.0115	-0.0188	-0.0569
	(0.0143)	(0.0155)	(0.0148)	(136.5358)	(0.0144)	(4130.1274)
	N = 65,297	N = 54,351	N = 59,559	N = 7,210	N = 65,297	N = 8,063
Zoning Change	0.0501*	0.0757*	0.1109*	0.0702*	0.0506*	-0.3747
	(0.0161)	(0.0358)	(0.0380)	(0.0253)	(0.0163)	(1004.5716)
	N = 69,005	N = 55,377	N = 59,559	N = 5,124	N = 69,005	N = 4,003

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021), using all controls: whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland, distance to the UGB, and the Hoynes-Schanzenbach controls outlined in Section 3.3. Panel A looks at new construction and Panel B on increases in square footage for existing buildings; both are binary outcomes. The columns include various robustness checks. Column (1) reproduces results from Table 5; column (2) uses only observations (and treatments) from 2010-2019; column (3) uses only the 2014 expansion; column (4) uses propensity-score matching based on equation 3; column (5) uses inverse-propensity weighting based on the same equation; and column (6) uses only not-yet-treated units as controls, as in Deshpande and Li (2019).

Table B.3: Land and Building Values - UGB Spillover

Panel A: Land Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
In UGB	-0.0113*	-0.0415*	-0.0286*	-0.0231*	-0.0095*	-0.0274
	(0.0026)	(0.0015)	(0.0032)	(0.0031)	(0.0025)	(14.0354)
	N = 2,128,306	N = 1,887,458	N = 196,889	N = 159,562	N = 2,128,306	N = 169,958
Outside UGB	0.0194	0.0591*	0.1482	0.0750	0.0157	0.0187*
	(0.0468)	(0.0270)	(0.0912)	(0.0743)	(0.0431)	(0.0081)
	N = 20,009	N = 16,039	N = 1,493	N = 2,959	N = 20,007	N = 3,457

Panel B: Building Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
In UGB	0.0054*	0.0284*	0.0131*	0.0150*	0.0030	0.2384
	(0.0017)	(0.0014)	(0.0039)	(0.0030)	(0.0017)	(4.1194)
	N = 3,522,117	N = 3,197,984	N = 235,935	N = 191,860	N = 3,522,117	N = 194,381
Outside UGB	0.0002	-0.0075	-0.1000*	-0.0425	0.0058	-0.0078
	(0.0207)	(0.0165)	(0.0495)	(0.0379)	(0.0196)	(0.0108)
	N = 18,709	N = 15,101	N = 1,393	N = 2,592	N = 18,707	N = 2,886

Panel C: Total Values

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
In UGB	-0.0028	-0.0012	0.0073	-0.0025	-0.0043*	-0.0715
	(0.0021)	(0.0016)	(0.0048)	(0.0044)	(0.0022)	(0.0927)
	N = 4,037,585	N = 3,662,049	N = 266,584	N = 211,835	N = 4,037,585	N = 214,797
Outside UGB	-0.0201	0.0240	-0.0289	0.0046	-0.0123	-0.0317
	(0.0360)	(0.0228)	(0.0644)	(0.0331)	(0.0357)	(2.0062)
	N = 27,237	N = 21,915	N = 2,288	N = 3,930	N = 27,235	N = 4,235

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021), using all controls: whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland, distance to the UGB, and the Hoynes-Schanzenbach controls outlined in Section 3.3. Panel A looks at the land value per acre, Panel B at building value per square foot, and Panel C at total valuation. All dependent variables are natural logs.

The columns include various robustness checks. Column (1) reproduces results from Table 6; column (2) uses only observations (and treatments) from 2010-2019; column (3) uses only the 2014 expansion; column (4) uses propensity-score matching based on equation 3; column (5) uses inverse-propensity weighting based on the same equation; and column (6) uses only not-yet-treated units as controls, as in Deshpande and Li (2019).

Table B.4: Development and Renovation - UGB Spillover

Panel A: New Construction

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
In UGB	0.0004	0.0003	-0.0024*	0.0009	0.0003	-0.0051
	(0.0005)	(0.0003)	(0.0009)	(0.0008)	(0.0005)	(0.0142)
	N = 4,184,022	N = 3,796,025	N = 276,326	N = 222,814	N = 4,184,022	N = 225,958
Outside UGB	0.0166	0.0062	-0.0169	0.0198*	0.0166	0.0028
	(0.0097)	(0.0057)	(0.0179)	(0.0088)	(0.0096)	(0.9506)
	N = 27,570	N = 22,197	N = 2,288	N = 3,932	N = 27,568	N = 4,239

Panel B: Square Footage Change

	Raw (1)	Raw post-2010 (2)	Raw 2014 (3)	PSM (4)	IPW ATT (5)	Not-yet-treated (6)
In UGB	-0.0053*	-0.0034*	-0.0090*	-0.0042*	-0.0050*	0.0049
	(0.0011)	(0.0007)	(0.0018)	(0.0019)	(0.0011)	(0.0322)
	N = 4,184,022	N = 3,796,025	N = 276,326	N = 222,814	N = 4,184,022	N = 225,958
Outside UGB	-0.0099	-0.0138*	0.0121	0.0147*	-0.0119	-0.0257
	(0.0085)	(0.0047)	(0.0179)	(0.0054)	(0.0085)	(1.8309)
	N = 27,570	N = 22,197	N = 2,288	N = 3,932	N = 27,568	N = 4,239

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021), using all controls: whether a non-UGB parcel was within 0.5 miles of an annexation, parcel acreage, building square footage, distance to downtown Portland, distance to the UGB, and the Hoynes-Schanzenbach controls outlined in Section 3.3. Panel A looks at new construction and Panel B on increases in square footage for existing buildings; both are binary outcomes. The columns include various robustness checks. Column (1) reproduces results from Table 7; column (2) uses only observations (and treatments) from 2010-2019; column (3) uses only the 2014 expansion; column (4) uses propensity-score matching based on equation 3; column (5) uses inverse-propensity weighting based on the same equation; and column (6) uses only not-yet-treated units as controls, as in Deshpande and Li (2019).

Table B.5: Block-Level Density

Panel A: Raw Results

	Road Length (mi.) (1)	# Intersections (2)	# of Parcels (3)	# of Homes (4)
UGB Annexation	0.0265	0.8311	0.0056	-3.5168*
	(0.0200)	(1.2253)	(0.0153)	(0.6180)
	N = 47,450	N = 47,450	N = 47,549	N = 47,549
Zoning Change	0.3601*	0.1849	0.0438	-2.4166*
	(0.1715)	(0.6603)	(0.0398)	(0.4114)
	N = 47,450	N = 47,450	N = 47,549	N = 47,549

Panel B: 2014 Results

	Road Length (mi.) (1)	# Intersections (2)	# of Parcels (3)	# of Homes (4)
UGB Annexation	0.0170	1.4160	0.0054	-3.5231*
	(0.0154)	(2.1111)	(0.0154)	(0.6249)
	N = 47,256	N = 47,256	N = 47,256	N = 47,256
Zoning Change	0.2989	0.4721	0.0440	-2.4167*
	(0.2393)	(0.7304)	(0.0403)	(0.4158)
	N = 47,256	N = 47,256	N = 47,256	N = 47,256

Panel C: Post-2010 Results

	Road Length (mi.) (1)	# Intersections (2)	# of Parcels (3)	# of Homes (4)
UGB Annexation	0.0335	0.3328	0.0244*	-7.6695*
	(0.0173)	(1.2339)	(0.0117)	(1.1038)
	N = 44,888	N = 44,888	N = 44,931	N = 44,931
Zoning Change	0.4055*	-0.1239	0.1245*	-5.3380*
	(0.1565)	(0.6958)	(0.0582)	(0.7793)
	N = 44,888	N = 44,888	N = 44,931	N = 44,931

Notes: This table uses the robust difference-in-differences approach developed by Sun and Abraham (2021). Controls include (log of) the area of the Census block, average acreage, average square footage, average distance to downtown Portland, average distance to the UGB of parcels within the block, and Hoynes-Schanzenbach controls, outlined in Section 3.3. Panel A reproduces the results from Table 8, while Panels B and C serve as robustness checks. Panel B uses only parcels affected by the 2014 expansion and excluding all newly-affected parcels from other years, while Panel C excludes observations from 2008 and 2009.

C Supplemental figures

This section contains additional figures outlining where UGB expansion occurred over time, as well as the relationship between assessed and sale values in the region.

Figure C.1: UGB expansions, 2008-2019

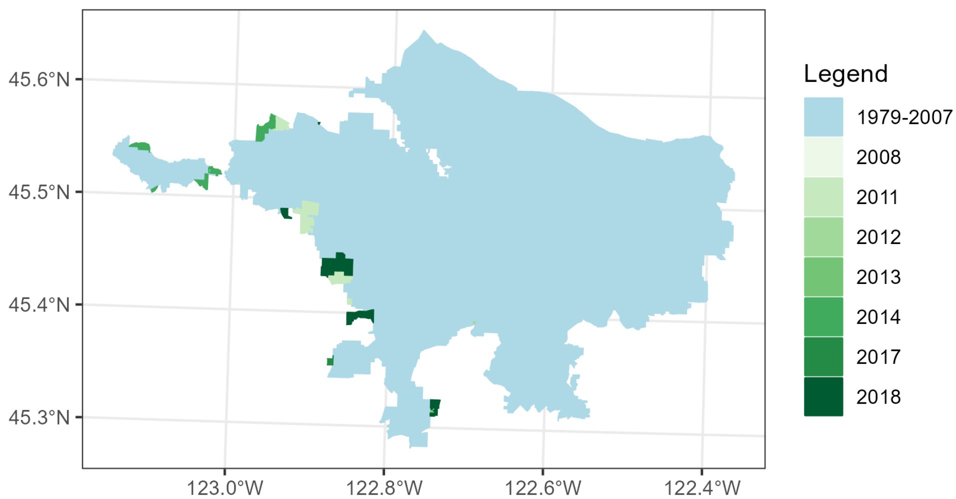
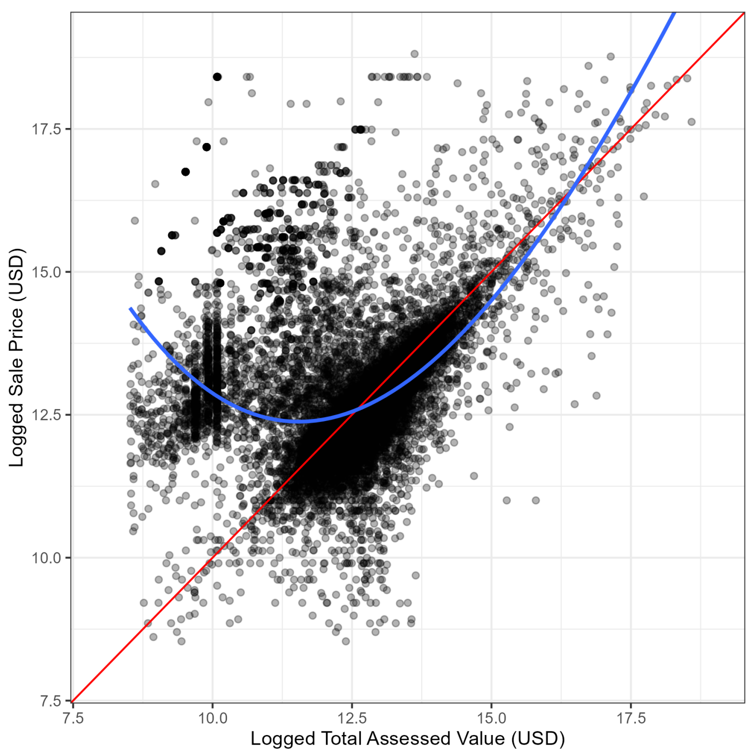


Figure C.2: Correlation between assessed and sale values



Notes: This figure uses the natural log of assessed and sale values; the red line is the identity line (such that perfectly assessed properties will lie on the line) and the blue line is a cubic fit line. Properties valued at or sold for less than \$5,000 are excluded.