MERCATUS WORKING PAPER

THE EFFECTS OF MINIMUM-LOT-SIZE REFORM ON HOUSTON LAND VALUES

Emily Hamilton, *Mercatus Center*

MERCATUS.ORG

MERCATUS CENTER
George Mason University

Emily Hamilton, “The Effects of Minimum-Lot-Size Reform on Houston Land Values,” Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, December 2023.

ABSTRACT

In 1998 Houston policymakers cut minimum-lot-size requirements by about two-thirds—from 5,000 square feet to 1,400 square feet—within the center city. A 2013 expansion of this minimum-lot-size reform is the policy change at the center of this study. Relative to recent zoning changes intended to facilitate denser construction in single-family neighborhoods, such as those in Minneapolis and Oregon, Houston’s reform has received less media attention but has facilitated greater rates of construction. One concern critics raise about increasing property owners’ development rights is that the resulting greater option value of the land may increase the prices of the existing stock of housing with the potential to worsen housing affordability, at least in the short term. I use a difference-in-difference study design to estimate the effect of the 2013 reform on land values. Across many model specifications, I find no evidence that minimum-lot-size reform increased land values. In general, I find that the reform had no measurable effect on land values. This may be because Houston’s reform has facilitated a large amount of housing construction. The downward pressure on structure rents due to increased housing supply, and to house’s structure values as a result, may offset the effect of an increase in land’s option value.

METADATA

Keywords: upzoning, minimum-lot-size requirements, Houston land-use regulations, starter homes

JEL codes: R520, R310, R380

AUTHOR CONTACT INFORMATION

Emily Hamilton, Senior Research Fellow, Mercatus Center at George Mason University, ehamilton@mercatus.gmu.edu

ACKNOWLEDGEMENTS

The author thanks Salim Furth, Tracy Miller, Jake Wegmann, and anonymous referees for thoughtful feedback and participants in the American Enterprise Institute Housing Research Collaborative for their comments. The author also thanks Margaret Wallace Brown, other Houston planning staff, Mike Dishburger, and Barbara Tennant for sharing their experiences with Houston’s minimum-lot-size policy change. Thank you to Eli Kahn for creating the maps in this paper.

DISCLAIMER

The Effects of Minimum-Lot-Size Reform on Houston Land Values

Emily Hamilton

SECTION 1: INTRODUCTION

From California to Maine, policymakers are passing reforms intended to improve housing affordability by liberalizing land-use restrictions that stand in the way of housing construction. Many recent reforms have focused on permitting slightly greater density per lot in existing neighborhoods of single-family houses (Manville et al. 2019).

Before this recent wave of reform, policymakers in Houston took a different approach to liberalizing the city's already relatively loose land-use regulations. In 1998, they reduced the by-right minimum lot size from 5,000 square feet to 3,500 square feet within the city's I-610 Loop, permitting even smaller lots for subdivisions meeting certain conditions. Then, in 2013, they extended the reform to cover all the land in the city with wastewater collection services. Following these reforms, tens of thousands of small-lot, single-family houses have been built across the city.

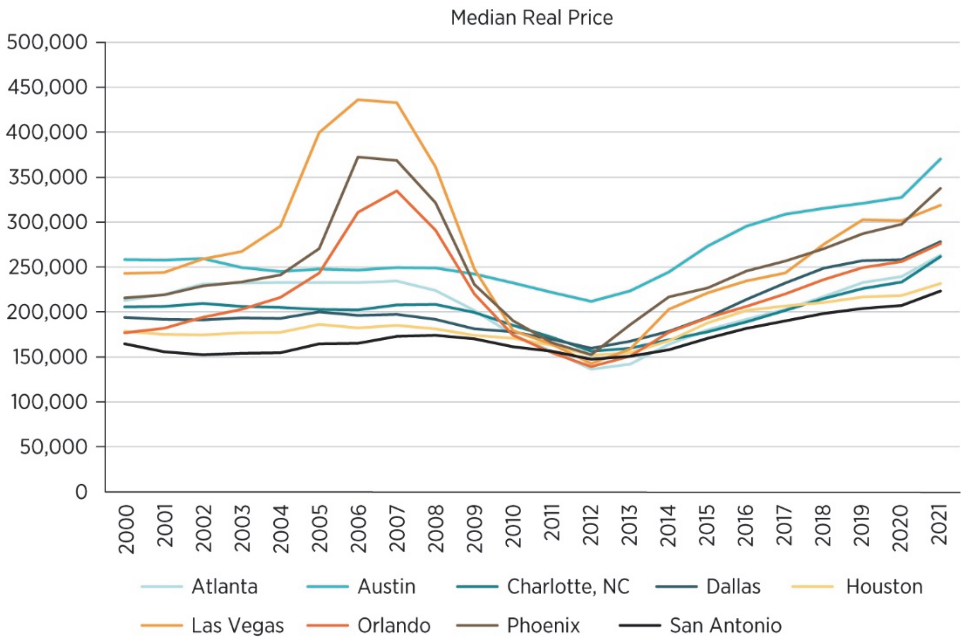
Some recent research (Freemark 2019; Kulhmann 2021) on the effects of land-use liberalization has found that land prices have increased following upzoning—policy changes that permit denser development than prior rules—presumably reflecting the greater option value of land following deregulatory reform. Houston is the only major US city without use zoning, but its reforms permitting denser small-lot development over time can nonetheless be considered an example of upzoning. When the 2013 reform was under consideration, residents expressed concerns that permitting more density in Houston would have the effect of increasing land values and property taxes (Johnson 2013). In this paper, I use a difference-in-difference model to explore the effects of Houston's 2013 reform on assessed land values outside the I-610 Loop. In most specifications, I do not find that the 2013 reform had a statistically significant effect on land prices, but in some, I find evidence that it reduced assessed land values outside the I-610 Loop.

Section 2 provides details on Houston's minimum-lot-size reform, as well as its land-use restrictions and entitlement process more broadly. Then section 3 reviews the literature on minimum-lot-size requirements and the effects of upzoning on prices. Next, section 4 presents my data on Houston, section 5 describes my methodology, and finally, section 6 provides my results and conclusions.

SECTION 2: HOUSTON LAND-USE REGULATIONS AND MINIMUM-LOT-SIZE REFORM

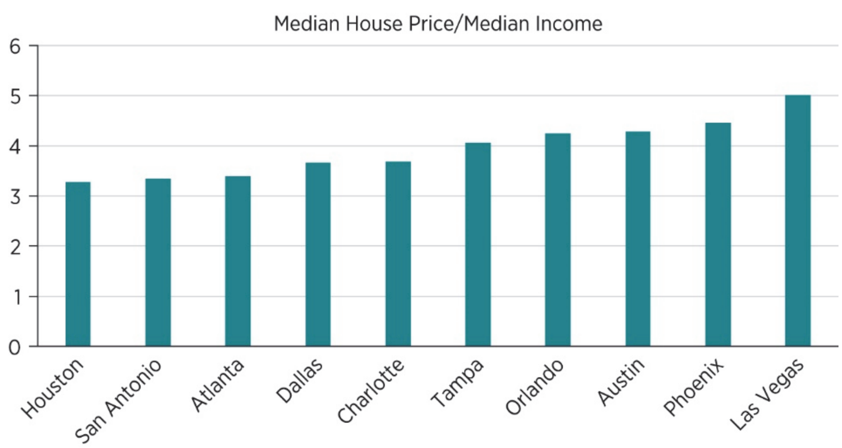
In Houston, zoning proposals have been on the ballot three times, and three times residents have voted against adopting a zoning ordinance. The city's relative permissiveness toward housing construction has helped it maintain a median house price below the national median in spite of decades of population growth faster than national population growth (Zillow 2022). Comparing Houston to other fast-growing Sunbelt metropolitan areas again paints a favorable picture of its relative affordability. Because the city of Houston makes up a disproportionately large share of its metropolitan area relative to other principal cities, I compare prices at the regional level. Houston has a lower median house price than all the other Sunbelt regions with more than two million residents, except San Antonio, as shown in figure 1. Adjusting for income, Houston is the most affordable of the regions, with a median house price 3.3 times its median income. Median house price divided by median income for all the regions is shown in figure 2.

FIGURE 1. Median House Prices across Metropolitan Statistical Areas (in 2021 dollars)



Source: Zillow Research, Housing Data (database), “ZHVI All Homes Time Series ($),” accessed March 24, 2023, https://www.zillow.com /research/data/.

FIGURE 2. Household Median Incomes as Multiples of Median House Prices of Metropolitan Statistical Areas



Source: Zillow Research, Housing Data (database), “ZHVI All Homes Time Series ($),” accessed March 24, 2023, https://www.zillow.com /research/data/; US Census Bureau, American Community Survey (ACS) (database), accessed March 24, 2023, https://www.census.gov/programs -surveys/acs.

Putting Houston's minimum-lot-size reform in context, at the time of the 2013 reform, the median lot size for a new-construction single-family house in Houston outside the I-610 Loop was about 5,500 square feet, as opposed to between 9,000 and 10,999 square feet for new-construction houses nationwide.

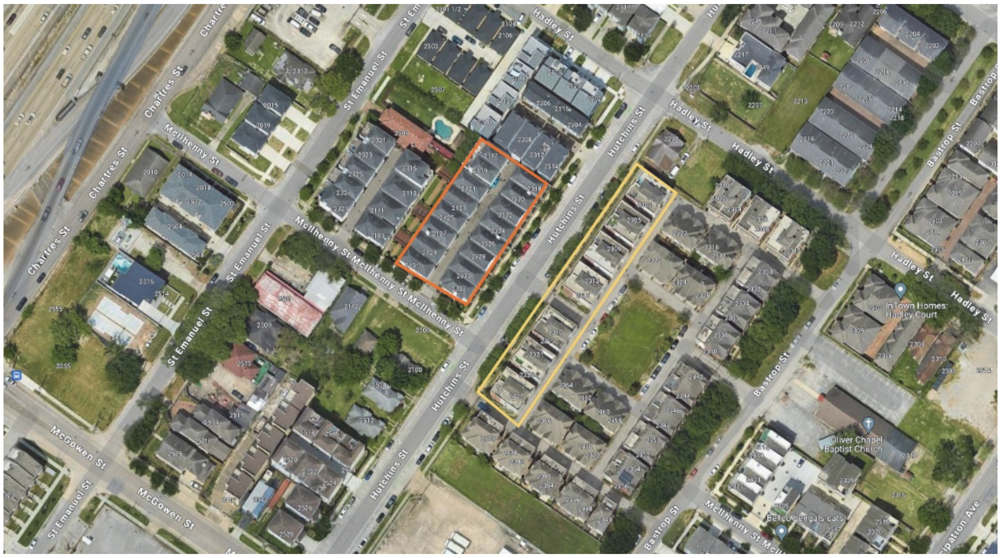
Gray and Millsap (2020) provide an analysis of construction within the I-610 Loop following Houston's 1998 lot-size reform, along with a history of the city's land-use regulation. Before 1998, the city had a minimum-lot-size requirement of 5,000 square feet for detached, single-family houses and 2,500 square feet for townhouses. They point out that pre-1998 townhouse regulations encouraged the construction of large townhouses and precluded low-cost townhouse construction. The 1998 reform reduced the by-right minimum lot size to 3,500 square feet within the I-610 Loop. It also created the opportunity to have subdivisions in this portion of the city with average lot sizes as small as 1,400 square feet if a subdivision includes 600 square feet of compensating open space per lot that is less than 3,500 square feet. Alternatively, subdivisions may result in average lot sizes as small as 1,400 square feet if they meet performance standards that include having adequate wastewater collection service, buildings that cover no more than 40 percent of each lot, and at least 150 square feet of permeable area on each lot (Houston Code of Ordinances 42–184).

Under the 1998 reform, the by-right minimum lot outside the I-610 Loop for land with wastewater collection services remained 5,000 square feet, but smaller lot development was permitted with larger amounts of compensating open space relative to subdivisions within the Inner Loop. The same rules applied to the land within the city of Houston outside I-610, as well as land in the Extraterritorial Jurisdiction, which falls outside city limits but under the city's ordinance. The reform legalized lots as small as 1,400 square feet with 720 square feet of compensating open space. Before 2013, all small lot development outside the I-610 Loop was permitted with compensating open space; variances were not issued for minimum lot sizes outside the Inner Loop (Margaret Wallace Brown, personal communication, April 14, 2022).

The rule at the center of this paper is a 2013 reform that extended the 1998 rules to all the land in the city of Houston with wastewater collection services. Outside I-610, the change reduced the compensating open-space requirements for small lot subdivisions and created the option for subdivisions that qualify based on performance standards.

Subdivisions built to the performance standards often take the form of "shared driveway townhouses," as shown in figure 3 west of Hutchins Street. The townhouses are oriented toward a driveway that runs perpendicular to a city street. Older, small-lot houses with compensating open space are pictured east of Hutchins Street. By eliminating the requirement of 720 square feet of open space per 1,400-square-foot lot, the reform increased the number of houses that could be built on a given piece of land by about 50 percent. This is more easily achieved on large parcels; many subdivisions of 5,000-square-foot lots result in two 2,500-square-foot lots.

FIGURE 3. Small Lot Subdivisions Outside the I-610 Loop Built Before and After 2013



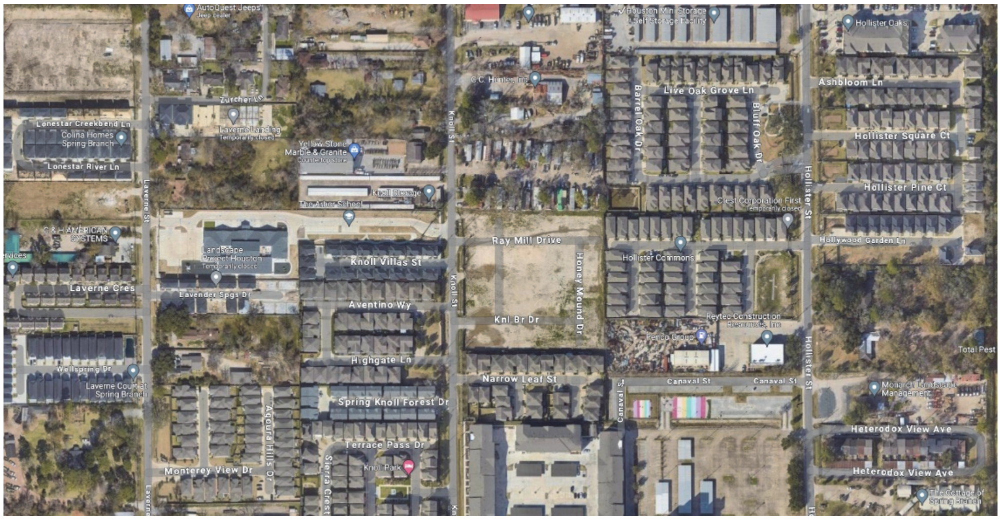
Source: Imagery copyright 2002 CNES/Airbus, Houston-Galveston Area Council, Maxar Technologies, Texas General Land Office, US Geological Survey, USDA/FPAC/GEO, Map data 2022, https://www.google.com/maps/@29.7403815,-95.36251,511m/data=!3m1!1e3.

Note: Orange box signifies shared driveway townhouses; Yellow signifies older small-lot houses with open space.

Houston property owners have the option to seek a Special Minimum Lot Size that is larger than the city's requirements if 70 percent of the houses in their area (60 percent of houses in historic districts) would comply with the larger lot-size requirements. Gray and Millsap (2020) argue that the opportunity for residents to live in neighborhoods with restrictions that are less permissive than citywide land-use restrictions has helped make Houston's minimum-lot-size reductions politically feasible.

Since the 2013 reform was implemented, some neighborhoods that sit just outside the Inner Loop, particularly those northwest of it, have been transformed by shared driveway townhouse development. The Spring Branch neighborhood is one example, with Spring Branch Central pictured in figure 4. These houses were built to the performance standard option made possible by the 2013 rule change. Historical images on Google Street View show that townhouses in Spring Branch replaced single-family houses, light industrial buildings, and strip malls.

FIGURE 4. Spring Branch Central Townhouses



Source: Imagery copyright 2002 CNES/Airbus, Houston-Galveston Area Council, Maxar Technologies, Texas General Land Office, US Geological Survey, USDA/FPAC/GEO, Map data 2022, https://www.google.com/maps /place/Spring+Branch+West,+Houston,+TX/@29.8061518,-95.5110672,717m/data=!3m1!1e3!4m5!3m4! 1s0x8640c4d1e3fe62e7:0x79b1bdebce356dbb!8m2!3d29.7908472!4d-95.5446297.

In part to allow neighborhoods to establish Special Minimum Lot Sizes, the subdivision reforms adopted in 2013 did not go into effect immediately (City of Houston Ordinance No. 2013–343). Subdivision plats of one acre or more submitted within one year after the ordinance was signed on April 24, 2013, had to meet the previous requirements, and subdivision plats of less than one acre submitted two years after the ordinance needed to meet the previous requirements. These delays in the new subdivision rules taking effect created delays in permitting small-lot development with less open space or with shared driveways in Houston outside the I-610 Loop. However, I expect changes in land values brought about by the policy change to happen quickly, since future development opportunities should be reflected in current values. In a separate policy brief (Hamilton 2023), I provide details of the policy making process of the 2013 reform, as well as more background on Houston’s unique approach to land-use regulation.

SECTION 3: LITERATURE REVIEW

This paper contributes to the growing body of literature on the effects of land-use regulations on house prices (Hamilton 2020) and the effects of minimum-lot-size requirements in particular. Boudreaux (2016) explores the centrality of minimum-lot-size requirements to US land-use restrictions and determines that they are one of the most effective tools that local governments have for restricting population density and housing construction. He concludes that minimum-lot-size requirements benefit a locality’s current residents who prefer low-density living, while harming home buyers and furthering segregation and sprawling development. Fischel (2004) points to minimum-lot-size requirements as a core tool that local government policymakers use to exclude low-cost housing developments and, as a result, low-income people. Gray and Furth (2019) study minimum lot size in Texas suburbs, which are some of the most liberally zoned, fastest-growing parts of the United States, and find evidence that actual lot sizes bunch together at some of these localities’ required minimum lot sizes, indicating that lot-size requirements are likely binding.

One set of studies estimates the costs of minimum-lot-size requirements, finding that larger minimum-lot-size requirements lead to less housing construction (Glaeser, Schuetz, and Ward 2006) and higher house prices (Zabel and Dalton 2011). Gyourko and McCulloch (2023) use survey data to study the effects of minimum-lot-size requirements at borders between jurisdictions. They find that places with larger lot-size requirements have larger lots, slightly larger houses, and higher house prices. Some studies indicate that while relatively small lot-size requirements may not bind construction, particularly large lot-size requirements do (Kopits, McConnell, and Miles 2009; Isakson 2004).

Glaeser and Gyourko (2003) point out that in highly constrained housing markets, houses with larger yards do not sell for substantial premia over houses with smaller yards. In this context, the right to build a house on a lot contributes much more to its value than the size of the lot. Furth (2021) develops a model of the costs of minimum-lot-size and lot-coverage restrictions and uses data from Harris County and Dallas County to estimate these costs. He finds that minimum lot sizes bind in most cases, even in these relatively liberally regulated places.

In a study of vacant lot sales, White (1988) finds that minimum-lot-size requirements are binding and that, ceteris paribus, relaxing the lot-size requirement for one parcel would increase its value. White makes the important point that the price effect of liberalizing land-use restrictions in a small area cannot be extrapolated to estimate the price effect of broad-based land-use deregulation:

> [My] results show the difference in land prices under a market equilibrium with zoning. The estimated coefficients cannot be used to infer either the magnitude or direction of land price changes if the zoning on a significant portion of the lots in the residential land market was to be changed. Grieson and White showed, using a general equilibrium model, that in such a case the prices of all land and structure would change. Therefore, the results are evidence that zoning is binding; they are not an estimate of what land prices would have been with no zoning in the market. (1981)

A few studies examine the effects of Houston's reforms. In addition to Gray and Millsap (2020), Mei (2022) studies the effect of Houston's 1998 lot-size reform on house size and finds that the policy change reduced the size of new-construction houses, as expected. He also finds that a typical Houston household benefited from the reform by a windfall equivalent to $18,000, with lower-income households benefiting more than higher-income households. Wegmann, Baqai, and Conrad (2023) study the factors that lead to single-family houses being redeveloped as smaller-lot single-family houses in Houston. They find that this accounts for only 20 percent of townhouse development, with the rest occurring on commercial, industrial, or vacant land. They also report that townhouses most often replace single-family houses on relatively large lots within I-610, displacing relatively low-value houses in areas with relatively high house prices.

This paper is most similar to Shortell's (2022) study of the same 2013 Houston lot-size reform. He studies the effects of the reform on residential properties in Harris County outside the city of Houston relative to land inside the border but outside the I-610 Loop, using a matching strategy and a difference-in-difference study design. Some of the land in his untreated group is part of Houston's Extraterritorial Jurisdiction, which was subject to the same reform in 1998 as land in the city but is located outside I-610; small-lot development has been permitted there since 1998 with compensating open space.

Shortell finds that the reform increased the value of land and houses in unincorporated Harris County. Using a different study design, I find some evidence of a negative effect of the reform on land prices and no evidence of a statistically significant positive effect. I explain my methodological choices that lead to these different approaches and findings in the following sections of this paper.

In addition to the literature on minimum-lot-size requirements, this study builds on recent studies of the effect of upzoning on land prices. Freemark (2020) uses land-use liberalization surrounding Chicago transit stations in 2013 and 2015 to study the effect of zoning liberalization on property sale prices and building permits. Using a difference-in-difference approach, he finds evidence that these policy changes increased prices by 15 percent to 23 percent but did not increase permitting during his study period.

Kuhlmann (2021) studies the effects of a Minneapolis planning reform on real estate prices. In 2019, Minneapolis policymakers adopted a new, binding comprehensive plan that permits up to three units on all residential lots. As is the case with Houston lot-size reform in many of its single-family neighborhoods, the Minneapolis triplex reform permits three houses to be built where only one was permitted previously. Relative to Houston, however, the Minneapolis reform permits much less new residential square footage because of its limits on the height and bulk of new triplexes. Like Freemark, Kuhlmann uses hedonic regression, comparing houses near Minneapolis's borders to those outside of it with a difference-in-difference study design. He estimates that the option to replace single-family houses with triplexes in Minneapolis increased single-family house prices by 3 percent to 5 percent. Whereas Houston has seen extensive small-lot development following its policy changes, Minneapolis has seen only a small number of duplexes and triplexes built due to its reform.

Kuhlmann writes that land-use reforms that lead to increased housing construction "must first increase the price of affected houses" (385). Is this true? Increasing the rate at which landowners put their properties on the market for potential sale to home builders perhaps requires upzoning to increase the price of the affected properties. But in general, developers and home builders will provide more housing when the marginal revenue exceeds the marginal cost. Upzoning may facilitate increased housing supply by lowering the unit cost of building, regardless of its effect on the prices of land and rental rates.

Phillips (2022) draws a distinction between geographically narrow upzonings and broader upzonings such as the Minneapolis example. He defines the "zoning buffer" as the difference between a city's current housing stock and the total number of housing units permissible under its zoning code. He argues that in cases where broad upzoning creates new development opportunities on many new parcels, it may have a small effect on land prices. Houston's 2013 reform is an example of very broad upzoning in a region characterized by a large zoning buffer both before and after the reform.

In the extreme, upzoning a single parcel in a tightly constrained housing market very likely will increase that parcel's land value. But in a much broader context, we observe higher land prices in markets where land-use restrictions are more binding than in markets where they are less binding. Land prices ultimately reflect the stream of income that land produces (in urban areas, generally rents for buildings). In a case where upzoning leads to a large amount of newly built space, the effect on reduced rents may be equal to or greater than the value of the right to build more on a given piece of land.

The effects of a specific reduction in minimum-lot-size requirements thus depend on the extent to which land-use restrictions limit housing construction before the zoning change and the extent to which the upzoning facilitates construction that puts downward pressure on rents. My study builds on past work on minimum-lot-size requirements and land-use deregulation by analyzing the effects of an upzoning that, unlike the policy changes in Chicago and Minneapolis, has facilitated extensive construction of a type of housing that wasn't permitted previously. This change took place in what was already the least-regulated land market among large US cities.

SECTION 4: DATA

I use data from the Harris County Appraisal District (HCAD) for Houston land values from 2005 to 2021. Relying on tax assessment data for land prices has the downside of not reflecting market transactions. However, all sources of data on urban land prices have their own weaknesses. Observing vacant land sales in an urban context generally leads to relatively small datasets and may not be representative of a locality's land prices generally, given that developed and vacant parcels likely have unobserved differences. Hedonic regression on transactions has the benefit of capturing market exchanges, but it also has the downside of relying on more limited data for isolating land value from improvements. Similarly, repeat sales indices may fail to capture property improvements or depreciation over time.

As a nondisclosure state, Texas presents a particular challenge for using transaction data in social science research. Unlike many states, property owners in Texas are not required to provide the sale prices of their properties to their counties. One source of real estate transaction data, Zillow's ZTRAX, includes sale price data for only about 5 percent of transactions in the city of Houston between 1998 and 2021 (Zillow 2022). About half of these were transactions in which the seller was a government entity, and the other half appear to include many non-arm's-length transactions that are not easily identified.[1]

While property owners in Texas are not required to disclose transaction prices to county assessors, any listing broker who lists a property on a Multiple Listing Service (MLS) is required to disclose the sale price to that MLS. HCAD appraisers have access to the Houston Association of Realtors' (HAR) MLS, giving them the same access to transaction data that area Realtors have, so the lack of data available to the public on Harris County real estate sales prices does not affect their access to this information. One benefit of using tax appraisal data is that tax assessors likely have better information about improvements and their values than social scientists do (Clapp, Salavei Bardos, and Wong 2012).

Other recent studies also use tax appraisal data. Shortell (2022) uses the same HCAD data source that I do. Furth (2021) also uses tax assessment data from Harris County, as well as Dallas County. He points out that in Harris County, 27 percent of owners protested their assessed values in 2019, indicating a process that likely pushes assessed values close to market values. Furth also points to Avenancio-Leon and Howard (2020), a study that identifies significant racial bias in tax assessments across the country, but not in Texas, where contested assessments are common. Other recent research relying on tax assessment data includes Epple, Gordon, and Sieg (2010) and Resseger (2022). In an important paper on the effects of rent control, Autor et al. (2014) use tax assessment data as a preferred data source, which they complement with transaction data. However, this strategy is ruled out here due to the paucity of transaction price data in Houston and the unusual nature of many transactions for which HCAD records price.

In his study, Shortell (2022) uses HCAD data on individual parcels with no reported clustering of standard errors. In this study, I aggregate appraised land values to the neighborhood

[1] Nolte et al. (2021) have developed a set of helpful tools for filtering ZTRAX data, but following their methods for dropping non-arms-length transactions left many below-market-rate transactions in the Harris County data with no pattern that I could discern.

level as HCAD defines them, using neighborhoods' land value per acre as my dependent variable. HCAD estimates a primary land price for a 5,000-square-foot lot in each neighborhood, with some adjustments for lots based on their size, topography, view, and other characteristics. I use neighborhoods rather than parcels as the unit of observation, because the HCAD methodology likely biases all lots toward the price of the neighborhood's standard primary lot, and I don't know the extent to which HCAD's propensity to give the same land value to 5,000-square-foot lots in a single neighborhood reflects the actual value of these lots as opposed to their correctly adjusted lot prices. About 13 percent of neighborhoods in the 2021 HCAD data have identical appraised land values for all their 5,000-square-foot lots.

Most of HCAD's neighborhoods are quite small. My sample includes neighborhoods close to the I-610 Loop between the years 2005 and 2021, with 1,230 neighborhoods in 2021. The mean area of these neighborhoods is 55.2 acres, with a range of 0.005 acres to 1,022 acres.

To identify neighborhoods inside and outside the I-610 Loop, I use shapefiles provided by HCAD and QGIS (2022). A small number of neighborhoods lie on both sides of I-610, and I drop them from my sample. My regressions rely on subsets of these neighborhoods within two miles, one mile, and a half mile of the I-610 Loop. If a neighborhood includes any parcel with a centroid that lies within these bounds, I include it in the relevant sample.

In addition to HCAD data, I use Census Tract–level data from the 2000 Decennial Census and the 2010 through 2020 American Community Surveys for Census Tract–level demographic controls. Many HCAD neighborhoods cross Census Tracts, so I identify the percentage of each neighborhood's land area that falls within a 2010 Census Tract, and I create a weighted average of the Census data based on these proportions. The regression specifications that have demographic controls include independent variables on population density, the percentage of individuals in poverty, the percentage of individuals aged 25 or older with a bachelor of arts (BA) degree or higher, the natural log of median household income, the percentage of individuals who are white and not Hispanic, and mean commute time. Whereas many studies of land prices use parcel distance from a region's central business district as a control variable, I instead use Census data on mean commute at the Census Tract level because of Houston's polycentric employment centers. For the years 2005 to 2009, I use linear interpolation to estimate demographic data. In some specifications, I also include a zip code–specific linear time trend. Neighborhoods sometimes cross zip codes, in which case I match each neighborhood to the zip code that contains the largest share of that neighborhood's land area.

Tables 1 and 2 provide the summary statistics for parcel-level data and the Census Tract–level data for parcels that appear in the 2005 through 2021 HCAD data that are within two miles of the I-610 Loop and in the city of Houston. For context, the I-610 Loop encircles an area that is about nine miles north to south and 11 miles east to west. The land inside it takes up 96 square miles. While my regressions use neighborhood-level variations for land values, I use parcel-level data in the summary statistics given in these tables to convey the complete dataset.

Houston townhouse development occurs on a wide variety of types of land, including vacant land, land in existing residential neighborhoods, and land developed with commercial or light-industrial uses. For this reason, I include parcels of all existing uses in my sample rather than restricting it to residential properties as Shortell does. I do, however, exclude parcels over 100 acres. These parcels are outliers and likely difficult to appraise accurately. In addition, I drop parcels that have an assessed value of zero. This removes large parcels owned by nonprofit entities, including universities.

TABLE 1. Parcel-Level Summary Statistics for Parcels in the Sample within Two Miles of the I-610 Loop, 2005–2021

Variable	Observations	Mean	Standard deviation	Minimum value	Maximum value
Lot size (square feet)	2,721,292	11,623.88	45,225.08	1	4,117,291
Land value	2,720,944	$170,197	$628,472	$1	$144,722,400
Building value	2,720,944	$162,065	$1,183,378	$0	$374,951,030
Year structure built	2,212,771	1960	24.42	1840	2021

Source: Harris County Appraisal District (HCAD) (database), 2005–2021, https://hcad.org/hcad-online-services/pdata/.

TABLE 2. Tract Level Summary Statistics for Tracts with Parcels within Two Miles of the I-610 Loop, 2005–2021

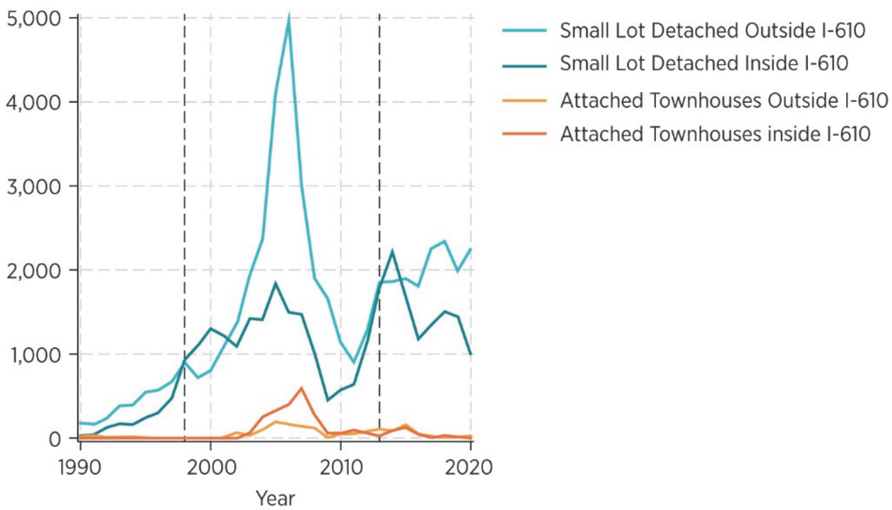
Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Population	3,293	4,118.67	1,618.92	562.00	15,023.00
Population density per square mile	3,293	6,107.10	5,779.05	388.13	68,892.06
Percentage of individuals in poverty	3,293	0.22	0.15	0.00	0.79
Percentage of individuals 25 or older with a BA degree or higher	3,293	0.32	0.29	0.005	0.95
Median household income	3,293	$58,137.65	$46,631.36	$8,678.00	$244,219.00
Percentage of individuals who are white and not Hispanic	3,293	0.27	0.29	0.00	0.97
Mean commute (minutes)	3,293	25.52	5.03	14.20	41.40

Source: US Census Bureau, Decennial Census 2000; ACS 2010–2021.

Note: Observations, means, and standard deviations reflect linear interpolation of missing years.

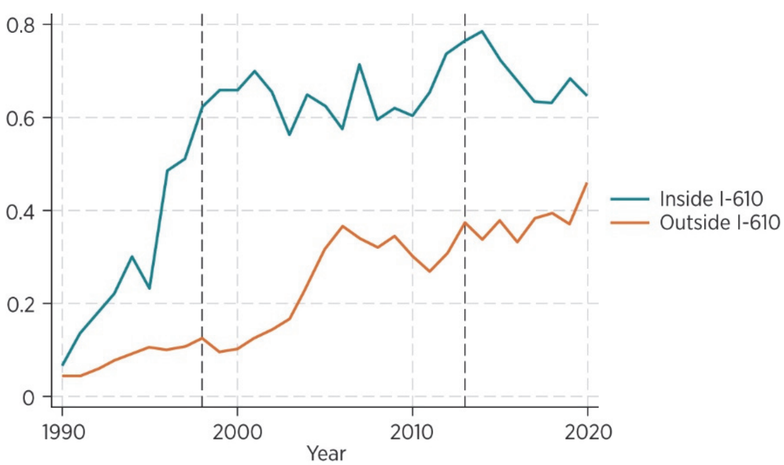
Figures 5 and 6 show small-lot construction in Houston from 1990 to 2021, first in raw numbers and then as a percentage of all single-family and townhouse development inside and outside the I-610 Loop. Throughout, I define small-lot, single-family construction as that done on lots less than 5,000 square feet. Both charts show that small-lot construction began increasing inside the I-610 Loop before 1998 and outside the I-610 Loop before the 2013 reform reduced the amount of land needed for small-lot construction. Before 1998, small-lot construction was permitted through a variance process inside the I-610 Loop. Before 2013, small-lot construction was exclusively permitted outside the I-610 Loop, with compensating open space.

FIGURE 5. Units on Lots Less Than 5,000 Square Feet, by Year Built



Source: HCAD 2021 data on lot size and year built for detached single-family houses and attached townhouses.

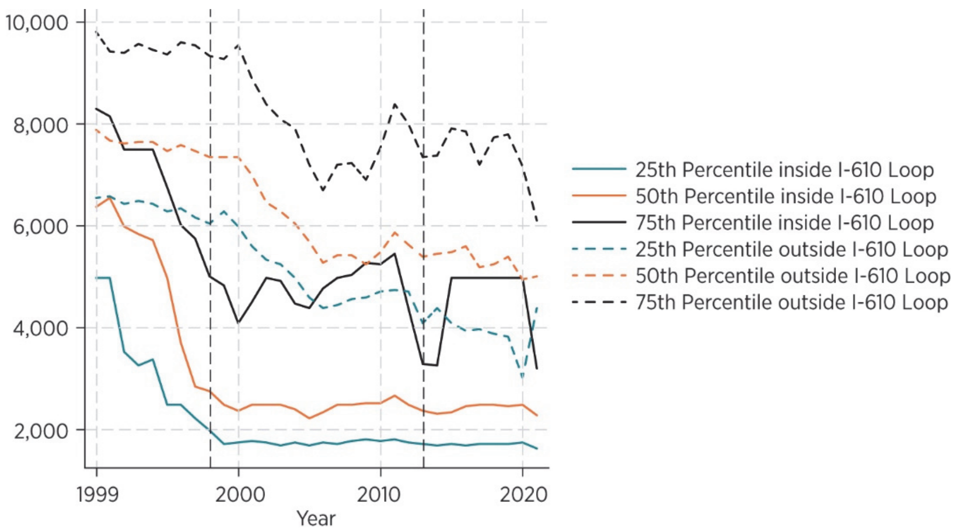
FIGURE 6. Single-Family Houses and Attached Townhouses on Lots Less Than 5,000 Square Feet As a Percentage of All Single-Family Houses and Attached Townhouses, by Year Built



Source: HCAD 2021 data on lot size and year built for detached single-family houses and attached townhouses.

Figure 7 provides more granularity on Houston residential lot sizes over time, breaking out the 25th-, 50th-, and 75th-percentile single-family lot size inside and outside the I-610 Loop. In 1998, when the minimum-lot-size reform was adopted within the I-610 Loop, the 25th-percentile lot size for new residential construction size reached 2,000 square feet. While lot sizes outside the I-610 Loop are unsurprisingly larger, the 25th-percentile lot size fell below 5,000 square feet several years before the 2013 reform increased opportunities for small-lot development.

FIGURE 7. Lot Size Percentiles over Time in the City of Houston

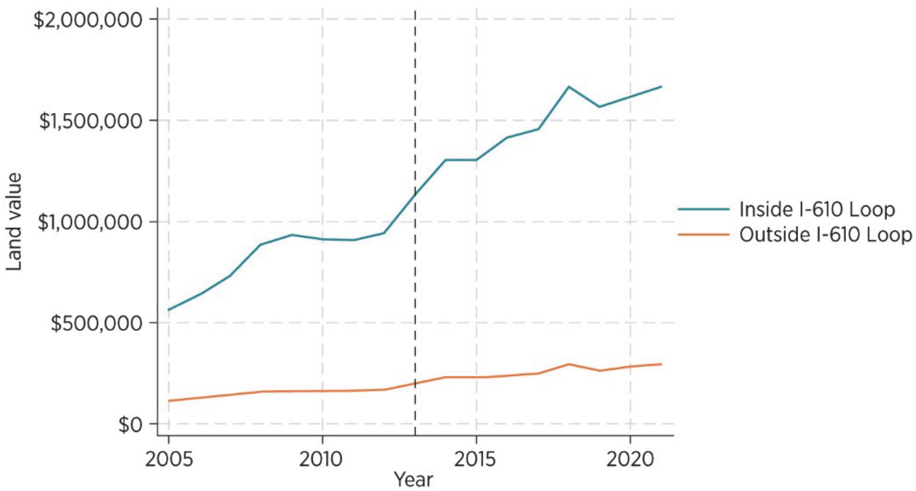


Source: HCAD 2021 data on lot size and year built for single-family houses.

In spite of the prevalence of small-lot, single-family development outside the I-610 Loop before 2013, the reform reduced the amount of land required to build small-lot houses and reduced their land costs as described in section 2 of this paper. As a result, I hypothesize that the 2013 reform increased assessed land values outside the I-610 Loop relative to land inside the I-610 Loop as a result of its increased option value.

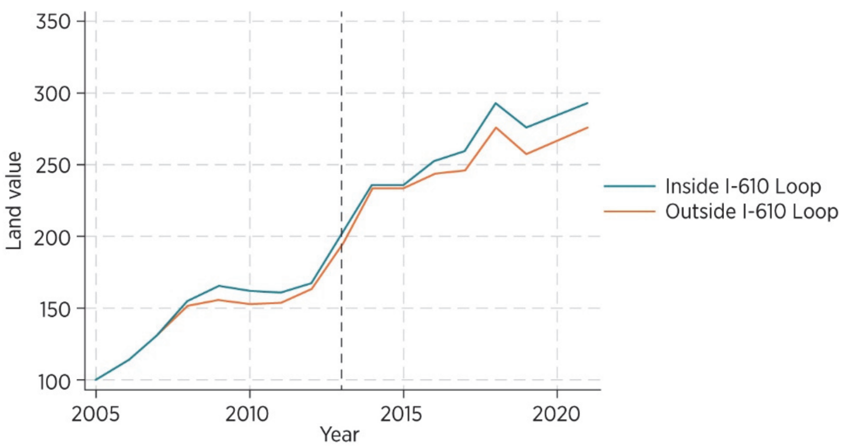
Turning now to data on assessed land values in Houston, figure 8 shows assessed land values per acre over time for parcels that appear in the HCAD data every year from 2005 to 2021. Figure 9 shows assessed land values per acre over time for the subset of these parcels that are in neighborhoods within two miles of the I-610 Loop, indexed to 2005 values. Unlike the full dataset, the price per acre for parcels within two miles of the I-610 Loop demonstrates qualitatively parallel trends before the 2013 minimum-lot-size reform.

FIGURE 8. Land Value per Acre over Time in Houston



Source: HCAD data on land values and lot sizes, 2005–2021.

FIGURE 9. Land Value per Acre in Neighborhoods within Two Miles of the I-610 Loop, Indexed to 2005 Values

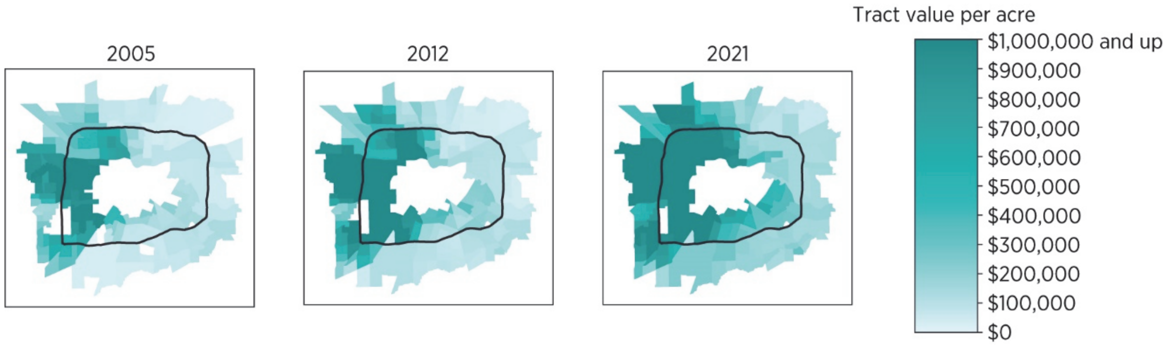


Source: HCAD data on land values and lot sizes, 2005–2021.

As figures 8 and 9 show, appraised land values increased substantially over the study time period. After adjusting for inflation, the appraised land value within two miles of the I-610 Loop more than doubled.

Figure 10 shows the geography of assessed land prices in Houston at the Census Tract level. While my regressions rely on neighborhood-level data, here I use Census Tracts because of the availability of a shapefile for creating the maps shown here. The sample of neighborhoods that I use in my regressions hews closer to two miles on either side of the I-610 Loop because HCAD neighborhoods are much smaller than Census Tracts. Per-acre land prices are highest closer to the center of the I-610 Loop and to the west of the city's center. Unsurprisingly, there appears to be a high correlation of land prices between adjacent Census Tracts. From 2005 to 2021, the average price per acre of land in the two-mile band inside the I-610 Loop increased from $747,000 to $1,454,000 in 2021 dollars relative to an increase from $36,900 to $569,000 for the two-mile band outside the I-610 Loop. The I-610 Loop is shown in black in figure 10.

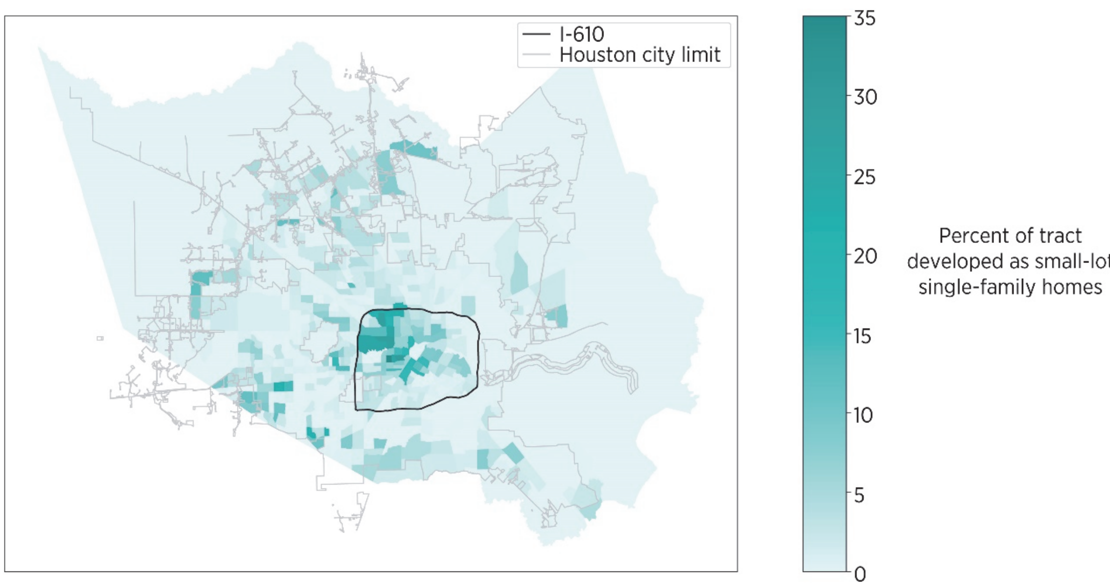
FIGURE 10. Average Price per Acre in Census Tracts That Include Neighborhoods within Two Miles of the I-610 Loop



Source: HCAD data on land values and lot sizes, 2005, 2012, and 2021. Maps by Eli Kahn.

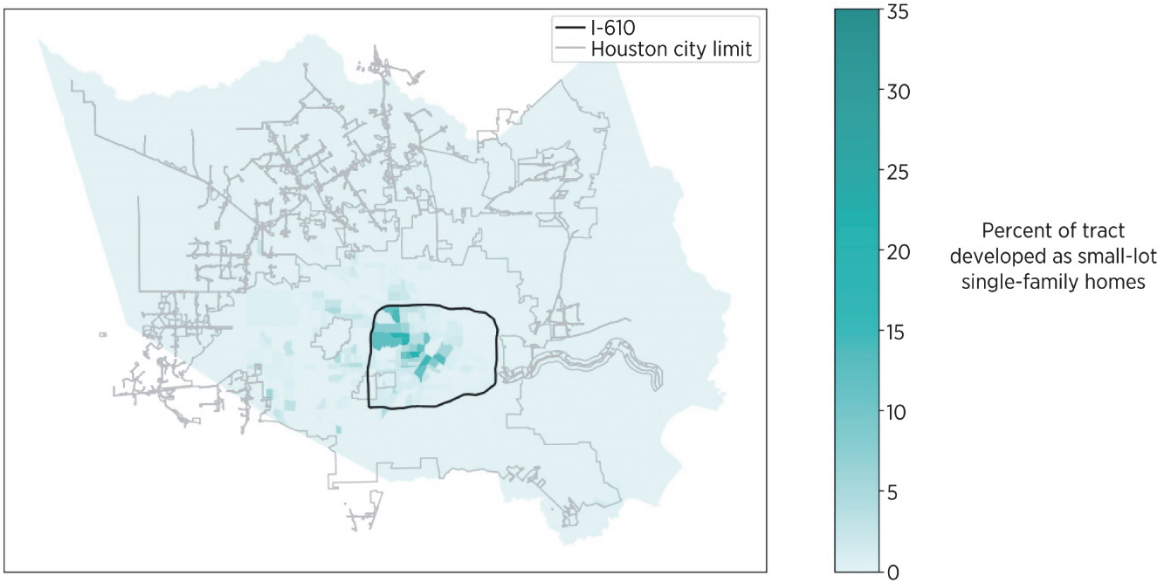
Figure 11 shows the percentage of land area in 2021 by Census Tract that is developed with small-lot, single-family housing. I include both detached houses and attached townhouses on lots less than 5,000 square feet. Figure 12 then shows the percentage of land area developed on lots less than 2,500 square feet. This captures development on lots smaller than what was permitted for townhouses before 1998. Shared-driveway subdivisions that have been permitted inside the I-610 Loop since 1998 and outside the I-610 Loop since 2013 generally have less than 2,500 square feet of land per house.

FIGURE 11. Acreage in Each Census Tract Developed as Single-Family Housing on Lots Less Than 5,000 Square Feet, As a Percentage of the Census Tract's Total Parcel Acreage



Source: HCAD data property type and lot size, 2021. Map by Eli Kahn.

FIGURE 12. Acreage in Each Census Tract Developed As Single-Family Housing on Lots Less Than 2,500 Square Feet, As a Percentage of the Census Tract's Total Parcel Acreage



Source: HCAD data property type and lot size, 2021. Map by Eli Kahn.

While Shortell chose to study the effects of the 2013 reform on land outside the I-610 Loop but inside Houston's city limits, I choose to study its effects on land immediately outside the I-610 Loop border. As figures 10, 11, and 12 show, there have been big changes to prices in this area, and while there are pockets of high levels of small-lot construction throughout Harris County, this development has been particularly concentrated inside the I-610 Loop and in neighborhoods just outside it to the north and west of the Loop. In particular, construction on lots less than 2,500 square feet, the developments most likely to have been affected by the 2013 reform, are highly concentrated inside the I-610 Loop, and figure 12 shows that they are visible just outside the I-610 Loop, including in Spring Branch. So far, small-lot development on lots less than 2,500 square feet has a very low concentration in areas farther from downtown on either side of the city's borders. Both the effect of the 2013 reform on land's option value and on rents through the effect of new supply may be heterogeneous across different parts of Harris County, and I choose to study the reform in the geography where I think it's most likely to have had an effect.

SECTION 5: METHODOLOGY

I use a difference-in-difference study design to estimate the effect of the minimum-lot-size reduction on land prices outside the I-610 Loop. Neighborhoods outside the I-610 Loop are the treatment group and years after 2013 are the treatment years. The control group—parcels inside the I-610 Loop—were themselves "treated" with the 1998 minimum-lot-size reform. However, no major reforms to land-use policy were adopted within two miles of the I-610 Loop inside the Loop during my period of interest from 2005 to 2021.[2]

[2] Houston policymakers adopted some relatively minor changes to subdivision right-of-way provisions in 2013 and 2018, which apply both inside and outside the I-610 Loop. In 2015, policymakers reformed the Special Minimum Lot Size program to permit residents to seek a larger lot-size requirement for primarily residential neighborhoods if at least 70

I disregard the year of treatment, 2013, using 2012 as the final year when the neighborhoods outside the I-610 Loop were untreated. I can find no mention of the proposed 2013 reform in the media before 2013. Given this lack of coverage of the reform, I do not think it was anticipated in appraisals or by market actors before public discussion of the reform began in 2013.

While parcels inside the I-610 Loop were subject to minimum-lot-size reform before the 2005–2021 period, I expect that any price effect of this treatment ultimately affected the price level of land inside the I-610 Loop relative to land outside rather than the price trend. Both before and after the 1998 and 2013 minimum-lot-size reforms, land in Houston inside and outside the I-610 Loop has been subject to the same local and national factors that affect the supply and demand of built space and land prices. Following a period of adjustment to a new postreform price level, I expect parcels inside and outside of the I-610 Loop to return to a parallel trend. Figure 7, earlier in this paper, shows that in fact, this appears to have been the case.

Roth et al. (2022) synthesize recent advances in the difference-in-difference study design. Advances in the methodology draw attention to "forbidden comparisons" in the common two-way fixed-effects study design, in which treated units are compared to other treated units (7). Problems arise when units treated in period *t* are compared to those treated shortly before period *t*. Units treated in recent periods are likely in an adjustment phase between trend lines. But in this case, I'm comparing treated units to those treated seven years before the study period, and in some specifications fourteen years prior, avoiding the period of transition from pretreatment to posttreatment price levels, which I argue avoids a forbidden comparison problem.

I use a model similar to other studies of recent land-use deregulatory reforms, including Freemark (2020), Kuhlmann (2021), and Shortell (2022). The basic model is shown in equation (1) here:

$$\ln(V_{ilt}) = \alpha + \beta_1 A_{ilt} + \beta_3 N_i + \varepsilon_{ilt} \qquad (1)$$

where V_{ilt} indicates the appraised value of land in neighborhood i in treatment area l (either inside or outside the I-610 Loop), in year t, A is a dummy variable equal to 1 for "treated" observations (those outside the I-610 Loop and after 2013), and N is a neighborhood fixed effect. β_1, the coefficient on the treatment variable is the parameter of interest. It provides an estimate of the effect of 2013 minimum-lot-size reform on land values of the treated neighborhoods. I apply this model to parcels within 2 miles, 1 mile, and 0.5 miles of the I-610 Loop. I also include specifications that include year fixed effects, demographic controls at the Census Tract level, and a zip code–specific linear time trend.

percent of the lots in the area meet the larger lot-size requirements, or 60 percent of lots in a historic district. For program details, see City of Houston, "Minimum Lot Size (MLS)/Minimum Building Line (MBL)," Planning and Development, *https://www.houstontx.gov/planning/Min-Lot_Size-Min_Bldg_Line.html,* accessed March 6, 2022. The Special Minimum Lot Size rules apply both inside and outside the I-610 Loop. During the period that my study covers, Houston policymakers adopted a policy known as "market-based parking," which eliminated parking requirements downtown and expanded market-based parking to cover the East End and parts of the Midtown neighborhoods. Market-based parking does not apply to any parcels in my sample, which are limited to those within two miles of the I-610 Loop. City of Houston, "Code of Ordinances," Ch. 26, Sec. 26–471.

As shown in figure 9, land prices in Houston are geographically clustered. A Moran test confirms this visual assessment; the residuals in equation (1) are neither independent nor identically distributed. Therefore, I also use a fixed-effects model with a spatially autoregressive error term, as shown in equation (2):

$$\begin{aligned} \ln(V_{ilt}) &= \alpha + \beta_1 A_{ilt} + \beta_3 N_i + \varepsilon_{ilt} \\ \varepsilon_{ilt} &= \rho W \varepsilon_{ilt} + v_{ilt} \end{aligned} \tag{2}$$

The variables in equation (2) are the same as those in equation (1), with the addition of W, an inverse distance spatial weighting matrix of neighborhoods. This spatial model requires a strongly balanced panel, resulting in a smaller sample size than the regression results without a spatial lag. Both the dependent variable and the independent variables are spatially correlated; however, I do not add a spatial lag to these terms. Based on the insights of Gibbons and Overman (2012), I forgo spatial lags on these terms to maintain the straightforward interpretability of coefficients and to avoid making assumptions about the specific spatial process underlying this dataset, which could introduce identification problems.

Following Freemark and Kuhlmann, I include land within varying distances of the I-610 Loop boundary to estimate the effect of the 2013 reform. I use samples within 2 miles, 1 mile, and 0.5 mile. In my primary models, I use all available years between 2005 and 2021 except for the treatment year, 2013. In the appendix, I also include a canonical two-time-period, two-group setup using the years 2012 and 2021 as the pretreatment and posttreatment periods. While Freemark and Kuhlmann use total property values as their dependent variables, I use assessed land values, the portion of total property value potentially directly affected by the option to subdivide land. In the city of Houston, assessed land values for single-family houses make up about 40 percent of the total assessed value of these properties. A given estimate of the effect of the 2013 reform on land value thus likely would have a smaller effect on total property values.

SECTION 7: RESULTS AND CONCLUSION

I apply the basic model in equation (1) to a total of 1,230 neighborhoods over 16 years in an unbalanced panel of neighborhoods within two miles of the I-610 Loop in table 3. The regression in column 1 reflects equation (1) directly. Columns 2–6 add combinations of year fixed effects, a zip code–specific linear time trend, and a vector of Census demographic variables. In each case, the coefficient on the treatment dummy is insignificant.

TABLE 3. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within Two Miles of the I-610 Loop, 2005–2021

Variables	1	2	3	4	5	6
Minimum-lot-size reform	−0.063	−0.056	0.003	0.007	−0.001	0.003
	(0.072)	(0.074)	(0.055)	(0.056)	(0.056)	(0.057)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.415	0.546	0.606	0.574	0.609	0.579
Number of neighborhoods	1,230	1,230	1,230	1,230	1,230	1,230

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

I next test whether minimum-lot-size reform had a measurable effect on land values within only those Census Tracts most likely to see small-lot, single-family construction. I regress Census Tract–level characteristics in 2012 on small-lot construction between 2013 and 2021 and then use a prediction function to estimate the level of small-lot development across tracts. Drawing on the findings of Wegmann, Baqai, and Conrad (2023), I use many of the factors that they find affect small-lot redevelopment on formerly single-family-homes in my regression. I include median house value, median house value squared, median year structure built, median land value per acre, mean commute time, the percentage of residents who are white and not Hispanic, median household income, the percentage of residents over 25 with a BA or higher, the number of vacant lots by tract, median lot size, and the number of likely subdivision target lots—those that are at least one acre and where the ratio of assessed improvement value to land value is 0.2 or less. This regression explains about 21 percent of the variation in small-lot development across Census Tracts between 2013 and 2021. I then drop the bottom half of Census Tracts citywide, those predicted to see fewer than about 30 townhouses built between 2013 and 2021 based on their economic and demographic characteristics.

Table 4 shows the same regressions as those in table 3 using only those Census Tracts that are both within two miles of the I-610 Loop and among the top half of Census Tracts citywide in terms of predicted townhouse construction. Because Census Tracts near the I-610 Loop are disproportionately well suited to small-lot, single-family construction, more than half of the neighborhoods in the regressions in table 3 are retained in the regressions in table 4.

TABLE 4. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within Two Miles of the I-610 Loop, Top Half of Predicted Townhouse Tracts, 2005–2021

Variables	7	8	9	10	11	12
Minimum-lot-size reform	−0.018	−0.012	−0.013	−0.009	−0.018	−0.014
	(0.077)	(0.079)	(0.069)	(0.070)	(0.069)	(0.071)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.412	0.546	0.600	0.559	0.600	0.565
Number of neighborhoods	924	924	924	924	924	924

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Here, with each specification, I find a negative but insignificant coefficient on the treatment variable. In table 5, I repeat these same regressions for neighborhoods within 1 mile of the I-610 Loop, and table 6 shows neighborhoods within 1 mile of the I-610 Loop and among the city's Census Tracts most likely to see townhouse construction. Then table 7 shows the results for neighborhoods within 0.5 mile of the I-610 Loop, and in table 8 within 0.5 mile of the I-610 Loop and among the city's Census Tracts most likely to see townhouse construction. With the 0.5-mile samples, I find a negative effect of the reform on land values in some specifications, significant at the 10 percent level.

TABLE 5. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within One Mile of the I-610 Loop, 2005–2021

Variables	13	14	15	16	17	18
Minimum-lot-size reform	−0.077	−0.073	−0.047	−0.045	−0.047	−0.045
	(0.089)	(0.090)	(0.055)	(0.055)	(0.058)	(0.060)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.388	0.512	0.579	0.548	0.583	0.553
Number of neighborhoods	658	658	658	658	658	658

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

TABLE 6. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within One Mile of the I-610 Loop, Top Half of Predicted Townhouse Tracts, 2005–2021

Variables	19	20	21	22	23	24
Minimum-lot-size reform	−0.072	−0.068	−0.088	−0.086	−0.094	−0.093
	(0.096)	(0.099)	(0.067)	(0.067)	(0.069)	(0.072)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.371	0.492	0.556	0.523	0.561	0.529
Number of neighborhoods	514	514	514	514	514	514

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

TABLE 7. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within a Half Mile of the I-610 Loop, 2005–2021

Variables	25	26	27	28	29	30
Minimum-lot-size reform	−0.144	−0.134	−0.104*	−0.100*	−0.106*	−0.101
	(0.100)	(0.103)	(0.059)	(0.060)	(0.060)	(0.062)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.340	0.455	0.536	0.506	0.539	0.510
Number of neighborhoods	385	385	385	385	385	385

Source: HCAD data 2010–2021; Decennial Census 2000, ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

TABLE 8. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within a Half Mile of the I-610 Loop, Top Half of Predicted Townhouse Tracts, 2005–2021

Variables	31	32	33	34	35	36
Minimum-lot-size reform	−0.166	−0.159	−0.141*	−0.137*	−0.140*	−0.137*
	(0.121)	(0.126)	(0.072)	(0.072)	(0.067)	(0.071)
Demographic controls	No	No	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	No
Neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Zip code–specific time trend	No	No	Yes	Yes	Yes	Yes
R^2	0.334	0.439	0.526	0.493	0.527	0.498
Number of neighborhoods	290	290	290	290	290	290

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Robust standard errors clustered by Census Tract in parentheses.

* p < 0.1; **p < 0.05; *** p < 0.01

Turning now to the spatial model, I apply equation (2). Again, I first use the observations within 2 miles of the I-610 Loop, those within 2 miles within the top half of Census Tracts in terms of predicted townhouse construction, and then the same for tracts within 1 mile. Due to sample size constraints with this model, I do not use a 0.5-mile sample with the spatial model. For these regressions, I use the spxtregress command in Stata. This approach requires a strongly balanced panel and forecloses the use of year fixed effects. Instead, I include a zip code–specific time trend in each specification. With each sample, I first apply equation (2) directly and then add demographic controls. Table 9 shows the complete results of these regressions.

TABLE 9. Effect of Minimum-Lot-Size Reform on Ln (Land Value) in a Spatial Model

	Two Miles		One Mile	
Variables	37	38	39	40
Minimum-lot-size reform total effect	−0.047*	−0.049**	−0.040*	−0.043*
	(0.024)	(0.024)	(0.024)	(0.024)
Demographic controls	No	Yes	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes	Yes
Zip code–specific time trend	Yes	Yes	Yes	Yes
Number of neighborhoods	491	491	249	249
Spatial autocorrelation λ	0.895***	0.889***	0.889***	0.882***
	(0.022)	(0.023)	(0.023)	(0.024)
Pseudo R^2	0.000	0.018	0.0457	0.118

Source: HCAD data 2010–2021; Decennial Census 2000; ACS 2010–2021.

Note: Ln = natural log. Spatial autoregressive standard errors in parentheses. The pseudo R^2 is $\{corr(y,\hat{y})\}^2$.

* p < 0.1; ** p < 0.05; *** p < 0.01

Unlike the models without a spatially lagged error term, these models indicate that the 2013 minimum-lot-size reform reduced land prices outside the I-610 Loop, a finding that is significant in each specification at either the 10 percent or 5 percent levels. However, while studying the effects of this minimum-lot-size reform calls for a spatially lagged error term, this spatial model has the disadvantage of requiring a balanced panel. I prefer the unbalanced panel in the models without a spatial lag because these samples include land in neighborhoods that were created during the study period due to townhouse redevelopment, perhaps the places most likely to see a land price effect from the policy change. Further, the spxtregress command does not allow clustered errors, while the model calls for geographically clustered errors as I use in the models without a spatially lagged error term.

My preferred model is the one shown in table 8. It is the most restrictive sample—those parcels within 0.5 mile of the I-610 Loop and in Census Tracts predicted to be most likely to see townhouse construction—where I would expect the reform to be most likely to have a measurable effect. It includes all the land in these bands, including neighborhoods created as a result of small-lot development. I can rule out a positive effect of the reform on land values of more than 0.2 percent in the model shown in column 36 with 95 percent certainty.

While I find some evidence that the 2013 reform reduced the land values outside the I-610 Loop, in many specifications my estimates are imprecise and statistically insignificant.

The 2013 reform made it possible to build more small-lot, single-family houses on a given amount of land outside the I-610 Loop, increasing the option value of land outside the I-610 Loop. But the reform also increased the "zoning buffer" over a huge area of land—the 541 square miles of the city of Houston that lie outside the Inner Loop. This policy change differs starkly from, for example, Freemark's study of upzoning in Chicago, which increased development potential within small radii around transit stations, about 6 percent of the city's land area.

In contrast to the Chicago and Minneapolis studies, the Houston case may provide an example of upzoning that does not increase land prices. And, relative to the Chicago upzoning and Minneapolis triplex reforms that have had only muted effects on construction, townhouse construction in Houston has transformed large swaths of the city with infill construction.

Houston's experience of minimum-lot-size reform has facilitated infill construction, including in single-family neighborhoods, to a level unprecedented in US history since the adoption of zoning in the twentieth century. Before the adoption of the 2013 reform, some Houston residents expressed concern that the upzoning would increase property tax bills for homeowners outside the Inner Loop. But across many specifications, I identify no evidence that the reform increased assessed land values. Houston has developed a set of institutions that facilitate growth and a highly elastic housing supply (Gray 2022). Minimum-lot-size reform, first in 1998 and then in 2013, has been one part of maintaining that trajectory.

REFERENCES

Autor, David H., Christopher J. Palmer, and Parag A. Pathak. 2014. "Housing Market Spillovers: Evidence from the End of Rent Control in Cambridge, Massachusetts." *Journal of Political Economy* 122 (3): 661–717.

Avenancio-Leon, Carlos, and Troup Howard. 2020. "The Assessment Gap: Racial Inequalities in Property Taxation." Working Paper, Washington Center for Equitable Growth, Washington, DC.

Blumgart, Jake. 2022. "How Important Was the Single-Family Zoning Ban in Minneapolis?" *Governing,* May 26, 2022.

Boudreaux, Paul. 2016. "Lotting Large: The Phenomenon of Minimum Lot Size Laws." *Maine Law Review* 68 (1): 1–43.

City of Houston, Texas. Code of Ordinances. 2022. § 42-22.

City of Houston, Texas. 2013. Ord. No. 2013-343.

Clapp, John M., Katsiaryna Salavei Bardos, and S. K. Wong. 2012. "Empirical Estimation of the Option Premium for Residential Redevelopment." *Regional Science and Urban Economics* 42 (1–2): 240–56.

Epple, Dennis, Brett Gordon, and Holger Sieg. 2010. "A New Approach to Estimating the Production Function for Housing." *American Economic Review* 100 (3): 905–24.

Fischel, William. 2004. "An Economic History of Zoning and a Cure for Its Exclusionary Effects." *Urban Studies* 41(2): 317–40.

Freemark, Yonah. 2020. "Upzoning Chicago: Impacts of a Zoning Reform on Property Values and Housing Construction." *Urban Affairs Review* 56 (3): 758–89.

Furth, Salim. 2021. "Foundations and Microfoundations: Building Houses on Regulated Land." Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA.

Gibbons, Stephen, and Henry G. Overman. 2012. "Mostly Pointless Spatial Econometrics?" *Journal of Regional Science* 52 (2): 172–91.

Glaeser, Edward L., and Joseph Gyourko. 2003. "The Impact of Building Restrictions on Housing Affordability." *FRBNY Economic Policy Review* 9 (2): 21–39.

Glaeser, Edward L., Jenny Schuetz, and Bryce Ward. 2006. "Regulation and the Rise of Housing Prices in Greater Boston: A Study Based on New Data from 187 Communities in Eastern Massachusetts." Cambridge, MA: Rappaport Institute for Greater Boston, Harvard University; and Boston: Pioneer Institute for Public Policy Research.

Gray, M. Nolan. 2022. *Arbitrary Lines: How Zoning Broke the American City and How to Fix It*. Washington, DC: Island Press.

Gray, M. Nolan, and Salim Furth. 2019. "Do Minimum-Lot-Size Regulations Limit Housing Supply in Texas?" Mercatus Research, Mercatus Center at George Mason University, Arlington, VA.

Gray, M. Nolan, and Adam Millsap. 2020. "Subdividing the Unzoned City: An Analysis of the Causes and Effects of Houston's 1998 Subdivision Reform." *Journal of Planning Education and Research*.

Grieson, Ronald E., and James R. White. 1981. "The Effects of Zoning on Structure of Land Markets." *Journal of Urban Economics* 10 (3): 271–85.

Gyourko, Joseph, and Sean McCulloch. 2023. "Minimum Lot Size Restrictions: Impacts on Urban Form and House Price at the Border." Working Paper 31710, National Bureau of Economic Research, Cambridge, MA.

Hamilton, Emily. 2020. "Land Use Regulation and Housing Affordability." In *Regulation and Economic Opportunity: Blueprints for Reform*, edited by Adam Hoffer and Todd Nesbitt, 186–202. Logan, UT: Center for Growth and Opportunity at Utah State University.

Hamilton, Emily. 2023. "Learning from Houston's Townhouse Reforms." Mercatus Policy Brief, Mercatus Center at George Mason University, Arlington, VA.

Harris County Appraisal District (HCAD) (database). 2005–2021. https://hcad.org/hcad-online-services/pdata/.

Isakson, Hans. 2004. "Analysis of the Effects of Large Lot Zoning." *Journal of Real Estate Research* 26 (4): 397–416.

Johnson, Laurie. “Houston Planners Change Rules to Draw Residential Density and Growth.” 2013. *Houston Public Media*, https://www.houstonpublicmedia.org/articles/news/2013/04/10/42694/houston-planners-change-rules-to-draw-residential-density-and-growth/.

Kopits, Elizabeth, Virginia McConnell, and Daniel Miles. 2009. “Lot Size, Zoning, and Household Preferences: Impediments to Smart Growth?” Discussion Paper. Resources for the Future, Washington, DC.

Kuhlmann, Daniel. 2021. “Upzoning and Single-Family Housing Prices: A (Very) Early Analysis of the Minneapolis 2040 Plan.” *Journal of the American Planning Association* 87 (3): 383–95.

Manville, Michael, Paavo Monkkonen, and Michael Lens. 2019. “It’s Time to End Single-Family Zoning.” *Journal of the American Planning Association* 86 (1): 106–12.

Mei, Mike. 2022. “House Size and Household Size: The Distributional Effects of the Minimum Lot Size Regulation.” Working Paper, University of Michigan, Ann Arbor.

Nolte, Christoph, et al. 2021. “Studying the Impacts of Environmental Amenities and Hazards with Nationwide Property Data: Best Data Practices for Interpretable and Reproducible Analyses.” WVU College of Law Research Paper No. 2021–013.

Phillips, Shane. 2022. “Building up the ‘Zoning Buffer’: Using Broad Upzones to Increase Housing Capacity Without Increasing Land Values.” Report, UCLA Lewis Center for Regional Policy Studies, Los Angeles.

QGIS.org. 2022. QGIS Geographic Information System. QGIS Association. http://www.qgis.org.

Resseger, Matthew. 2022. “The Impact of Land Use Regulation on Racial Segregation: Evidence from Massachusetts Zoning Borders.” Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA.

Roth, Jonathan, et al. 2022. “What’s Trending in Difference-in-Differences? A Synthesis of the Recent Econometrics Literature.” *Journal of Econometrics* 235 (2): 2218–44.

Shortell, Joseph. 2022. “The Effect of a Minimum Lot Size Reduction on Residential Property Values: The Case of Houston.” Master’s thesis, Universitat de Barcelona.

US Census Bureau. American Community Survey (ACS) (database). 2012 and 2021. Accessed March 24, 2003. https://www.census.gov/pgorams-surveys/acs.

US Census Bureau. Decennial Census 2000 (database).

Wegmann, Jake, Aabiya Noman Baqai, and Josh Conrad. 2023. “Here Come the Tall Skinny Houses: Assessing Single-Family to Townhouse Redevelopment in Houston, 2007–2020,” *Cityscape* 25 (2): 171–202.

White, James R. 1988. “Large Lot Zoning and Subdivision Costs: A Test.” *Journal of Urban Economics* 23 (3): 370–84.

Zabel, Jeffrey, and Maurice Dalton. 2011. “The Impact of Minimum Lot Size Regulations on House Prices in Eastern Massachusetts.” *Regional Science and Urban Economics* 41 (6): 571–83.

Zillow. 2022. ZTRAX: Zillow Transaction and Assessor Dataset, accessed April 2022.

Zillow Research. 2022. “ZORI (Smoothed): All Homes Plus Multifamily Time Series ($)” (dataset), accessed February 2022, https://www.zillow.com/research/data.

APPENDIX

Here, I include regression specifications using just the years 2012 and 2021 in the canonical two-group, two-time-period difference-in-differences study design. Following Autor et al. (2014), I use the year before treatment as the pretreatment period and the most recent year that all data is available as the posttreatment period. I expect that the full effects of the treatment on neighborhoods outside of the I-610 Loop will be realized by 2021, eight years after treatment.

Like the nonspatial models in the body of the paper, my samples include neighborhoods within 2 miles, 1 mile, and 0.5 mile of the I-610 Loop. For each, I include first the full sample and then only neighborhoods in Census Tracts that are predicted to have more townhouse construction than half of the Census Tracts in the city. As in most of the specifications of the nonspatial models with results shown in Tables 3 through 8 in the body of this paper, here I find an insignificant effect of lot-size reform on land values outside of the I-610 Loop relative to land inside.

TABLE A.1. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within Two Miles of the I-610 Loop

Variables	1	2	3
Minimum-lot-size reform	−0.017	−0.015	0.052
	(0.085)	(0.103)	(0.077)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.676	0.783	0.698
Number of neighborhoods	1,091	1,091	1,091

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.

TABLE A.2. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within Two Miles of the I-610 Loop, Top Half of Predicted Townhouse Tracts

Variables	4	5	6
Minimum- lot-size reform	0.048	−0.077	-0.071
	(0.097)	(0.151)	(0.147)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.666	0.777	0.783
Number of neighborhoods	821	821	821

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.

TABLE A.3. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within One Mile of the I-610 Loop

Variables	7	8	9
Minimum- lot-size reform	−0.021	−0.030	0.039
	(0.118)	(0.088)	(0.113)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.662	0.816	0.688
Number of neighborhoods	576	576	576

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.

TABLE A.4. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within One Mile of the I-610 Loop, Top Half of Predicted Townhouse Tracts

Variables	10	11	12
Minimum-lot-size reform	0.031	−0.082	−0.118
	(0.147)	(0.146)	(0.177)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.644	0.815	0.821
Number of neighborhoods	446	446	446

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.

TABLE A.5. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within a Half Mile of the I-610 Loop

Variables	13	14	15
Minimum-lot-size reform	−0.087	−0.032	−0.068
	(0.109)	(0.089)	(0.096)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.686	0.845	0.852
Number of neighborhoods	342	342	342

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.

TABLE A.6. Effect of Minimum-Lot-Size Reform on Ln (Land Value) within a Half Mile of the I-610 Loop, Top Half of Predicted Townhouse Tracts

Variables	16	17	18
Minimum-lot-size reform	−0.101	−0.087	−0.113
	(0.131)	(0.145)	(0.172)
Demographic controls	No	No	Yes
Neighborhood fixed effects	Yes	Yes	Yes
Zip code–specific time trend	No	Yes	Yes
R^2	0.689	0.849	0.860
Number of neighborhoods	259	259	259

Source: HCAD data 2012 and 2021; ACS 2012 and 2021.