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

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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. This study uses a difference-in-differences design to estimate the effect of the 2013 reform on land values. Across many specifications, no evidence emerged that the reform increased land values, and in some models, the evidence showed that the reform reduced land values relative to land in the control group. This result may have occurred because Houston's reform has facilitated a large amount of housing construction. The downward pressure on rents due to increased housing supply—and downward pressure on land values as a result—may offset the effect of an increase in land's option value.

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, Monkkonen, and Lens, 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 subdivisions to an average lot size of 1,400 square feet when each lot met open space requirements.

Then, in 2013, they extended the reform to cover all the land in the city with wastewater collection services. Since those reforms, tens of thousands of small-lot, single-family houses have been built across the city.

Some recent research (Freemark, 2020; Kuhlmann, 2021) on the effects of land use liberalization has found that land prices have increased after upzoning—policy changes that permit denser development than previous rules—presumably reflecting the greater option value of land following deregulatory reform. Houston is the only major U.S. city without use zoning, but its reforms permitting denser small-lot development over time can nonetheless be considered an example of upzoning. Just before passage of the 2013 reform, residents expressed concerns that permitting more density in Houston would have the effect of increasing land values and property taxes (Johnson, 2013). This article uses a difference-in-differences model to explore the effects of Houston's 2013 reform on assessed land values outside the I-610 Loop. The reform created a discontinuity in policy across a border, and the author exploits this discontinuity to estimate the causal impact of the 2013 reform. Estimates of the effect of the reform are sensitive to specification, but in some cases, the evidence shows that the 2013 reform had a negative effect on assessed land values. No evidence indicated that the reform increased land values.

Section 2 reviews the literature on minimum-lot-size requirements and the effects of upzoning on prices. Then, section 3 provides details on Houston's minimum-lot-size reform, as well as its land use restrictions and entitlement process more broadly. Section 4 presents the data, section 5 describes the methodology, section 6 provides the results, and section 7 concludes.

Section 2: Literature Review

This article 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 U.S. 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 homebuyers and furthering segregation and sprawling patterns of 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 although relatively small lot-size requirements

may not bind construction, particularly large lot-size requirements do (Isakson, 2004; Kopits, McConnell, and Miles, 2009).

Glaeser and Gyourko (2003) point out that in highly constrained housing markets, houses with larger yards do not sell for substantial premiums 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 those 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 [1981] 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.

A few studies examine the effects of Houston's lot-size reforms. Gray and Millsap (2020) find that the 1998 reform created a by-right process for development that was previously being permitted within the I-610 Loop through variances. Following the rule change, however, townhouse construction shifted to higher-income neighborhoods relative to where it had taken place through the variance process. 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 article is most similar to Shortell's (2022) master's thesis on the same 2013 Houston lot-size reform, analyzing 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. Shortell finds that the reform increased the value of land and houses in unincorporated Harris County. Using a different

study design, this study finds some evidence of a negative effect of the reform on land prices and no evidence of a statistically significant positive effect.[1]

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-differences approach, he finds evidence that those policy changes increased prices by 15 to 23 percent but did not increase permitting during his study period.

Kuhlmann (2021) studies the effects of a Minneapolis planning reform on house 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's 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. Kuhlmann uses hedonic regression, comparing houses near Minneapolis borders to those outside it with a difference-in-differences study design. He estimates that the option to replace single-family houses with triplexes in Minneapolis increased single-family house prices by 3 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" (2021: 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. However, in general, developers and home builders will provide more housing until the marginal revenue is equal to 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. In addition, new development will have positive and negative local externalities, including potentially facilitating the improvement of neighborhood amenities or causing congestion disamenities. In different conditions, upzoning could potentially increase or decrease property values.

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

[1] Some of the land in Shortell's 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 uses Harris County Appraisal District (HCAD) data on individual parcels with no reported clustering of standard errors. Section 4 explains why the data in this study are aggregated to the level of HCAD's neighborhoods and standard errors are clustered at the census tract level. Whereas Shortell chose to study the effects of the 2013 reform on land outside the I-610 Loop but inside Houston's city limits, section 4 proposes that estimating the effect on land outside I-610 relative to land inside it is the best study design for identifying effects of the reform.

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, land prices are higher in markets where land use restrictions are more binding than in markets where they are less binding. Land prices ultimately reflect the net present value of the stream of income that land can produce (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 and potential positive or negative externalities of new construction. This 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 was not permitted previously. That change took place in what was already the least regulated land market among large U.S. cities.

Section 3: 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, 2022a). Comparing Houston to other fast-growing Sunbelt metropolitan areas again paints a favorable picture of its relative affordability. Selecting benchmarks for affordability in Houston, this study uses other Sunbelt cities that do not have major geographic barriers to development and excludes California cities due to statewide affordability problems. Because the city of Houston makes up a disproportionately large share of its metropolitan area relative to other principal cities, the study compares prices at the regional level. Houston has a lower median house price than all the other Sunbelt regions with more than 2 million residents except San Antonio, as shown in exhibit 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 household income for all the regions is shown in exhibit 2.

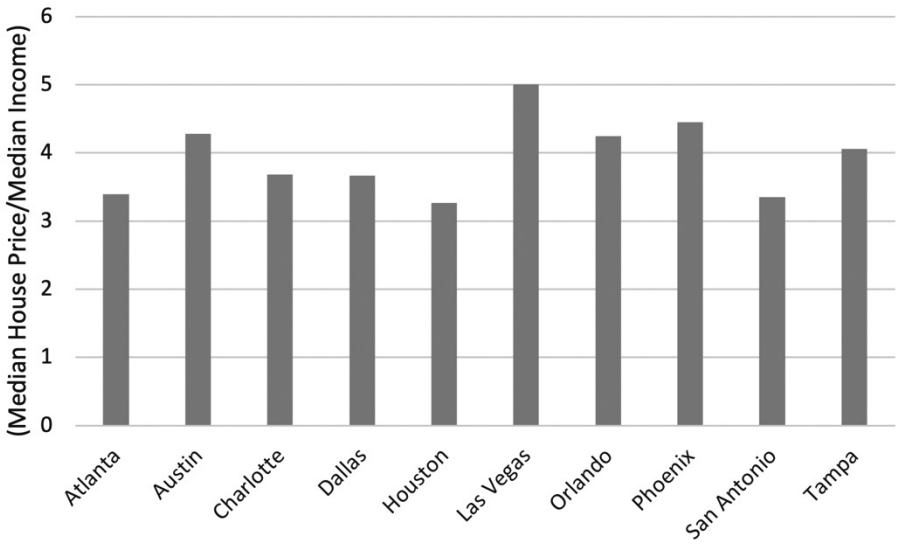
Exhibit 1

Median House Prices Across Metropolitan Statistical Areas (in 2021 dollars)

Source: Zillow, 2022b

Exhibit 2

Median House Price Relative to Median Household Income



Sources: U.S. Census Bureau, 2022; Zillow, 2022b

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. By comparison, new-construction houses nationwide have a median lot size between 7,000 and 8,999 square feet (U.S. Census Bureau, 2023).

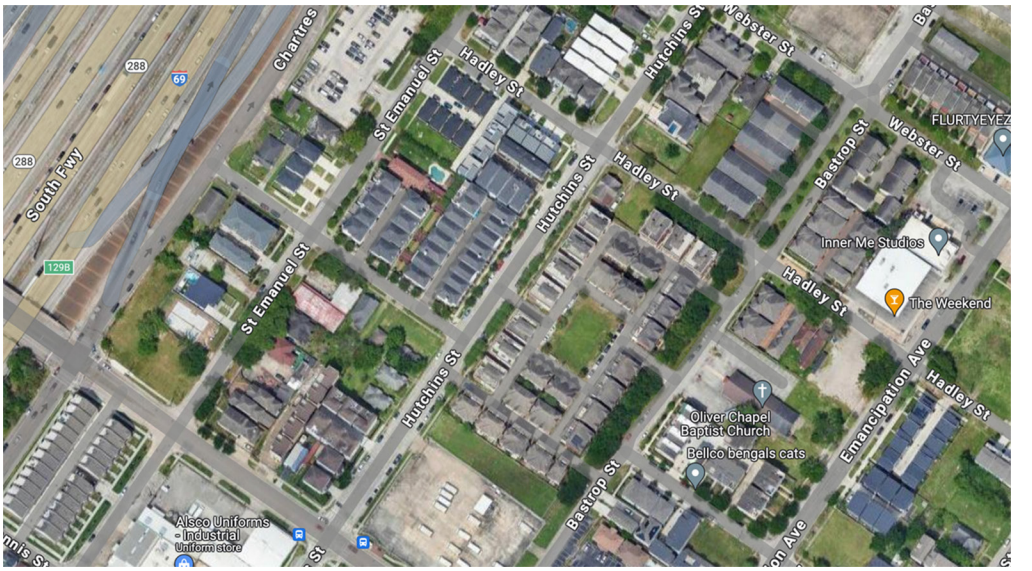
Although before 1998, the city's minimum-lot-size requirement for detached houses was 5,000 square feet, attached townhouses were allowed by-right on lots as small as 2,500 square feet. Gray and Millsap (2020) point out that pre-1998 townhouse regulations encouraged the construction of large, wide townhouses 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 create subdivisions within the I-610 Loop with average lot sizes as small as 1,400 square feet for subdivisions with 600 square feet of compensating open space per lot less than 3,500 square feet. As an alternative, 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 size 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 and land in the Extraterritorial Jurisdiction, which falls outside city limits but under the city's ordinance. In those areas, the 1998 rules allowed for 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). Performance standard subdivisions—those meeting standards for wastewater collection, lot coverage, and permeable space—were not allowed outside I-610.

The rule at the center of this article 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 on the basis of performance standards. Subdivisions built to the performance standards often take the form of "shared-driveway townhouses," as shown in exhibit 3 west of Hutchins Street. The townhouses are oriented toward a driveway that runs perpendicular to a city street. Small-lot houses with compensating open space are pictured east of Hutchins Street. Shared-driveway townhouses allow about 50 percent more townhouses to be built on a given piece of land relative to subdivisions with compensating open space under the 1998 rules outside I-610. Shared-driveway developments are more easily achieved on large parcels; many subdivisions of 5,000-square-foot lots result in two 2,500-square-foot lots. One Houston homebuilder explained how the rules before 2013, which required more land for subdivisions outside I-610, made building there infeasible for him: "I'd like to build outside the Loop. It's just, right now, because of the different rules under Chapter 42 between suburban and urban, it's not competitive to be able to build homes there, and I've tried" (Morris, 2012).

Exhibit 3

Small-Lot Subdivisions Relying on Performance Standards and Open Space Provision



Note: Shared driveway townhouses are west of Hutchins St; older small-lot houses with open space are to the east.

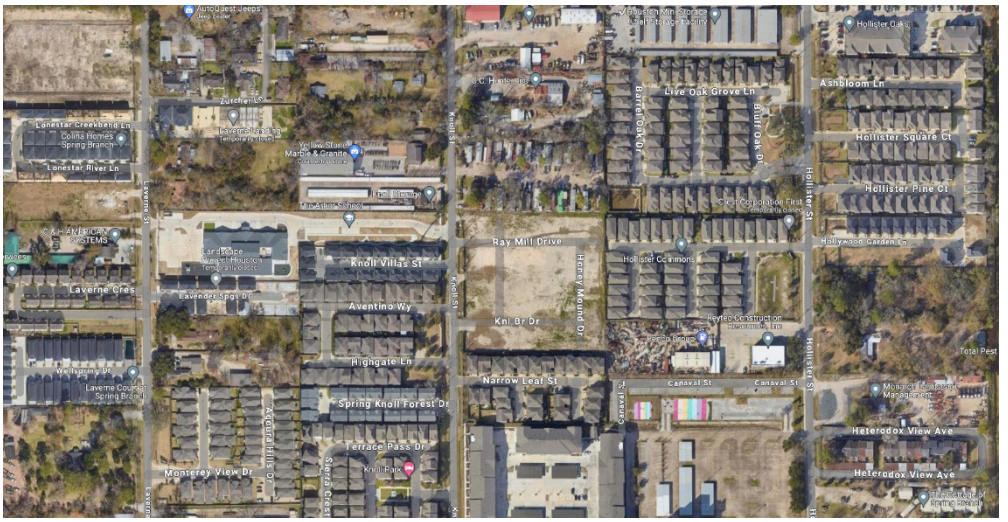
Source: Imagery copyright 2002 CNES/Airbus, Houston-Galveston Area Council, Maxar Technologies, Texas General Land Office, U.S. Geological Survey, USDA/FPAC/GEO, Map data 2022, https://www.google.com/maps/@29.7403815,-95.36251,511m/data=!3m1!1e3

Houston property owners have the option to seek a Special Minimum Lot Size Block 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 (Hamilton, 2023). The Spring Branch neighborhood is one example, with Spring Branch Central pictured in exhibit 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.

Exhibit 4

Spring Branch Central Townhouses



Source: Imagery copyright 2002 CNES/Airbus, Houston-Galveston Area Council, Maxar Technologies, Texas General Land Office, U.S. 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 Size Blocks, the subdivision reforms adopted in 2013 did not go into effect immediately.[2] Subdivision plats of one acre or more submitted within 1 year after the ordinance was signed on April 24, 2013, had to meet the previous requirements, and subdivision plats of less than 1 acre submitted 2 years after the ordinance needed to meet the previous requirements. Those 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, changes in land values brought about by the policy change are expected to happen quickly, because future development opportunities and the effects of new construction should be reflected in current values.

Section 4: Data

This study uses 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. These regressions may suffer from omitted variable bias that would affect studies of upzoning on land prices if, for example, larger lot sizes are correlated with houses that have unobserved improvements that increase the property value. These

[2] City of Houston, Texas. 2013. Ord. No. 2013-343.

same unobserved repeat sales indices cannot disentangle land from improvement value without hedonic controls and their limitations.

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, 2022a). In about one-half of those transactions, the seller was a government entity, and the other one-half appears to include many non-arm's-length transactions that are not easily identified.[3] The Federal Housing Finance Agency (Sunbelt) (FHFA) also provides land price estimates at the census tract and ZIP Code levels based on appraisal data provided to government-sponsored enterprises. Analysis in this study is limited to land within 2 miles of I-610. The FHFA provides estimates for only 19 of the 194 tracts that include neighborhoods within 2 miles of I-610. Of the 53 ZIP Codes that include land within 2 miles of I-610, 27 cross the freeway, so neither dataset is well suited to studying Houston's 2013 reform.

Although 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 this study does. 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, Palmer, and Pathak (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 this study, appraised land values are aggregated to the neighborhood level as HCAD defines them, using neighborhoods' land value per acre as the 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. This study uses 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 the extent to which HCAD's

[3] Nolte et al. (2021) have developed a set of helpful tools for filtering ZTRAX data, but following their methods for dropping non-arm's-length transactions left many below-market-rate transactions in the Harris County data with no discernible pattern.

propensity to give the same land value to 5,000-square-foot lots in a single neighborhood reflects the actual value of those lots as opposed to their correctly adjusted lot prices is not known to the author. About 13 percent of neighborhoods in the 2021 HCAD data have identical appraised land values for all of their 5,000-square-foot lots.

Most of HCAD's neighborhoods are quite small. The sample in this study includes neighborhoods close to the I-610 Loop between the years 2005 and 2021, which totaled 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, this study uses shapefiles provided by HCAD and QGIS (2022). A small number of neighborhoods lie on both sides of I-610; those neighborhoods are not included in the sample. Regressions rely on subsets of those neighborhoods within 2 miles, 1 mile, and 0.5 mile of the I-610 Loop. If a neighborhood includes any parcel with a centroid that lies within those bounds, it is included in the relevant sample.

Houston townhouse development occurs on a wide variety of types of land, including vacant land, land in existing residential neighborhoods, and land developed for commercial or light-industrial use. For that reason, this study includes parcels of all existing uses in the sample; however, the study excludes parcels of more than 100 acres. Those parcels are outliers and likely difficult to appraise accurately. Parcels that have an assessed value of zero are also dropped, which removes large parcels owned by nonprofit entities, including universities.

In addition to HCAD data, this study uses 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 the author identifies the percentage of each neighborhood's land area that falls within a 2010 census tract and creates a weighted average of the census data based on those 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 (B.A.) 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, this study instead uses census data on mean commute at the census tract level because of Houston's polycentric employment centers. For the years 2005 to 2009, the author uses linear interpolation to estimate these demographic controls for the years between the 2000 Census and the start of American Community Survey data. Some specifications also include a ZIP Code-specific linear time trend for the 53 ZIP Codes in the sample, using ZIP Codes in HCAD's address data. Neighborhoods sometimes cross ZIP Codes, in which case the author matches each neighborhood to the ZIP Code that contains the largest share of that neighborhood's land area.

Exhibits 5 and 6 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 2 miles of the I-610 Loop and in the city of Houston. For context, the I-610 Loop encircles an area that is about 9 miles north to south and 11 miles east to west. Although the regressions use neighborhood-level data for land values, the summary statistics given in these tables use parcel-level data to convey the complete dataset.

Exhibit 5

Parcel-Level Summary Statistics for Parcels in the Sample Within 2 Miles of the I-610 Loop, 2005–21

Variable	Number of 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 data, 2005–21

Exhibit 6

Tract-Level Summary Statistics for Tracts with Parcels Within 2 Miles of the I-610 Loop, 2005–21

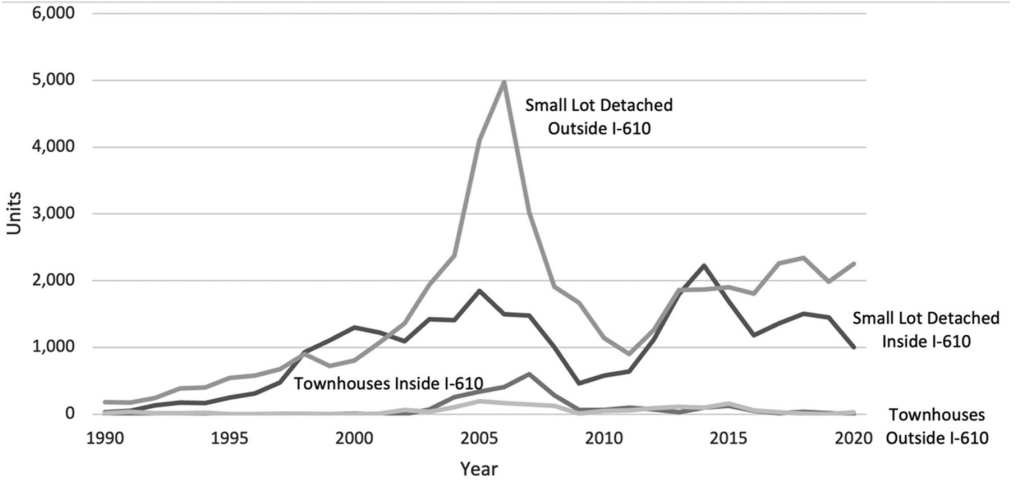
Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Population	3,293	4,118.67	1,618.92	562.00	15,023.00
Population Density per Square Mile	3,293	6,107.10	5,779.05	388.13	68,892.06
Percentage of Individuals in Poverty	3,293	21.98	12.18	0.00	54.50
Percentage of Individuals 25 or Older with a B.A. Degree or Higher	3,293	32.54	27.44	0.00	99.30
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	27.02	26.16	0.00	100
Mean Commute (minutes)	3,293	25.52	5.03	14.20	41.40

Note: Observations, means, and standard deviations reflect linear interpolation of missing years.
Sources: American Community Survey, 2010–21; U.S. Census Bureau, Decennial Census 2000

Exhibits 7 and 8 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, small-lot, single-family construction is defined 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, and variances were not offered to allow performance standard subdivisions.

Exhibit 7

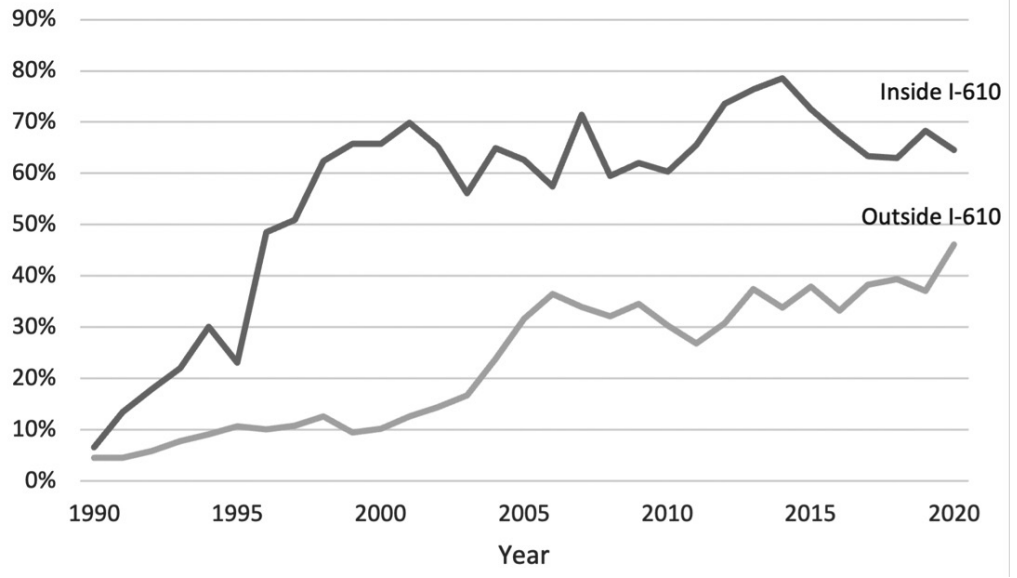
Units on Lots Less Than 5,000 Square Feet, by Year Built



Source: Harris County Appraisal District data on lot size and year built for detached single-family houses and attached townhouses, 2021

Exhibit 8

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

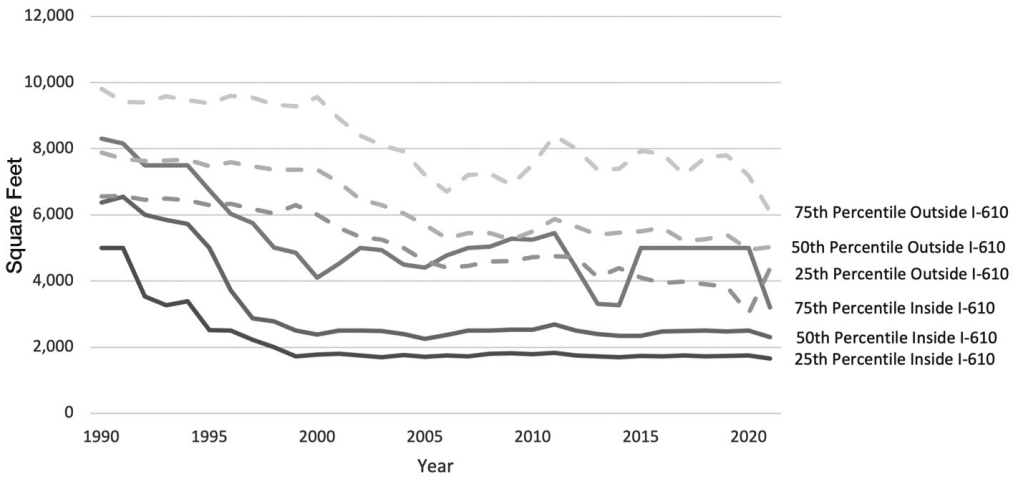


Source: Harris County Appraisal District data on lot size and year built for detached single-family houses and attached townhouses, 2021

Exhibit 9 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. Although 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.

Exhibit 9

Lot-Size Percentiles Over Time in the City of Houston



Source: Harris County Appraisal District data on lot size and year built for single-family houses, 2021

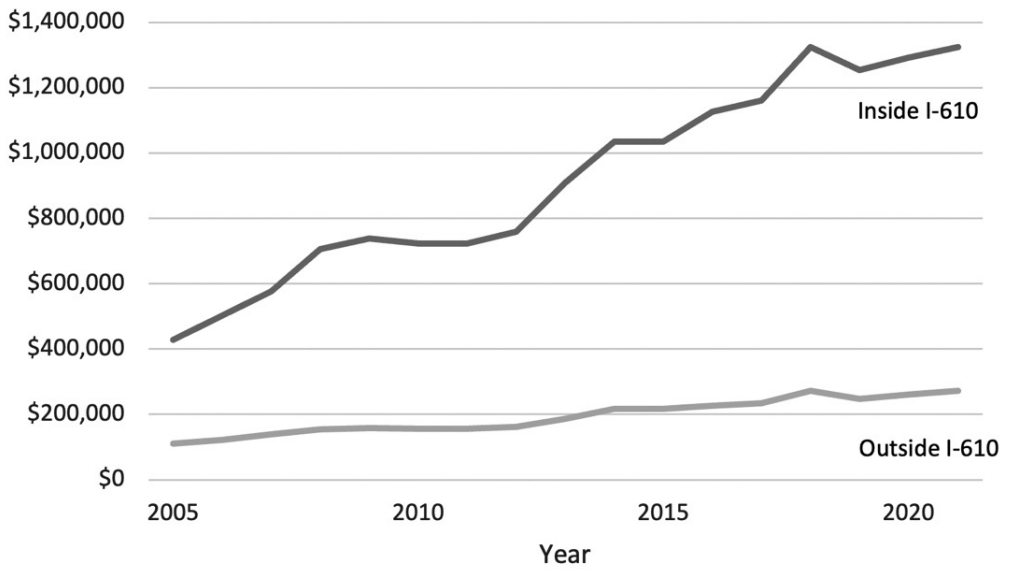
Although small-lot, single-family-house development was common outside the I-610 Loop before 2013, the reform reduced the amount of land required to build small-lot houses and reduced their land costs, as described in section 3. As a result, the author hypothesizes that the 2013 reform increased assessed land values outside the I-610 Loop relative to land inside the I-610 Loop as a result of its increased option value, the effect identified in prior upzoning event studies.

Turning now to data on assessed land values in Houston, exhibit 10 shows assessed land values per acre over time for parcels that appear in the HCAD data every year from 2005 to 2021.

Exhibit 11 shows assessed land values per acre over time for the subset of those parcels that are in neighborhoods within 2 miles of the I-610 Loop, indexed to 2005 values. Unlike the full dataset, the price per acre for parcels within 2 miles of the I-610 Loop demonstrates qualitatively parallel trends before the 2013 minimum-lot-size reform. As exhibits 10 and 11 show, appraised land values increased substantially over the study period. After adjusting for inflation, the appraised land value within 2 miles of the I-610 Loop more than doubled.

Exhibit 10

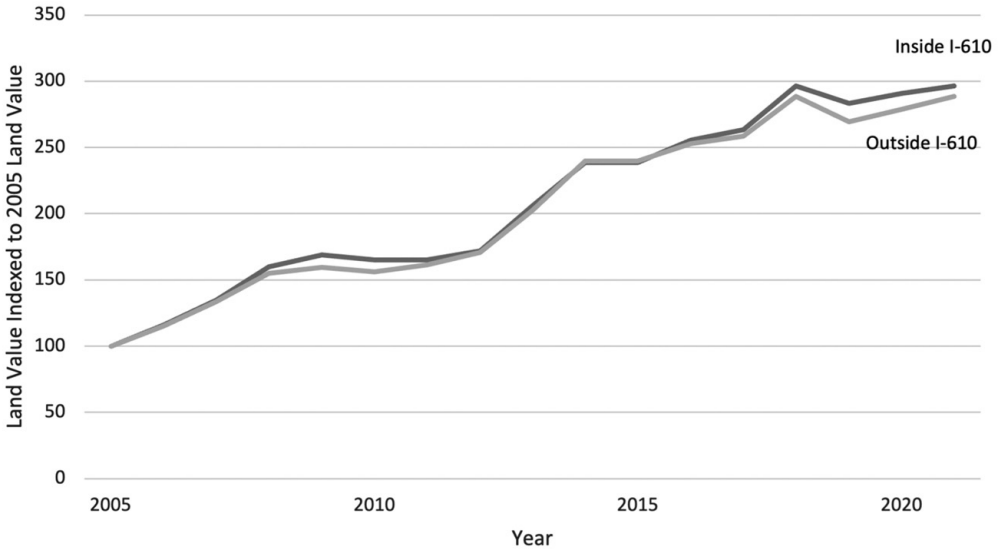
Land Value per Acre Over Time in Houston



Source: Harris County Appraisal District data on land values and lot sizes, 2005–21

Exhibit 11

Land Value per Acre in Neighborhoods Within 2 Miles of the I-610 Loop, Indexed to 2005 Values



Source: Harris County Appraisal District data on land values and lot sizes, 2005–21

Exhibit 12 shows the geography of assessed land prices in Houston at the census tract level. Whereas the regressions in this study rely on neighborhood-level data, here the author uses census tracts because of the availability of a shapefile for creating the maps shown here. The sample of neighborhoods used in the regressions hews closer to 2 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. Land prices seem to correlate highly between adjacent census tracts, which is not surprising. From 2005 to 2021, the average price per acre of land in the 2-mile band inside the I-610 Loop increased from $747,000 to $1,454,000 in 2021 dollars relative to an increase from $279,000 to $569,000 for the 2-mile band outside the I-610 Loop. Houston's core within the I-610 Loop is outlined in exhibit 12.

Exhibit 12

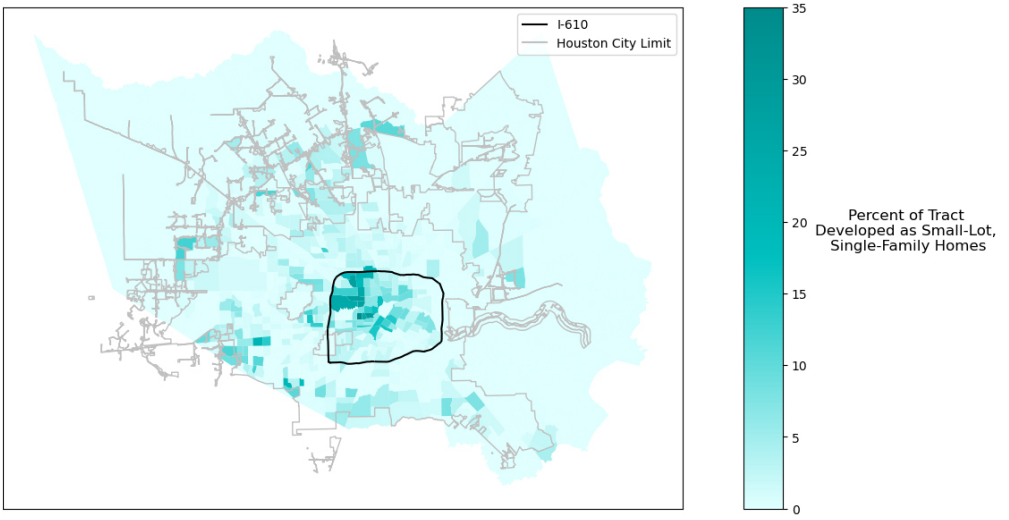
Average Price per Acre in Houston Census Tracts That Include Neighborhoods Within 2 Miles of the I-610 Loop

Sources: Harris County Appraisal District data on land values and lot sizes, 2005, 2012, and 2021; maps by Eli Kahn

Exhibit 13 shows the percentage of land area in 2021 by census tract that is developed with small-lot, single-family housing, including detached houses and attached townhouses on lots of less than 5,000 square feet. Exhibit 14 then shows the percentage of land area developed on lots of less than 2,500 square feet (the citywide minimum lot size for attached 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.

Exhibit 13

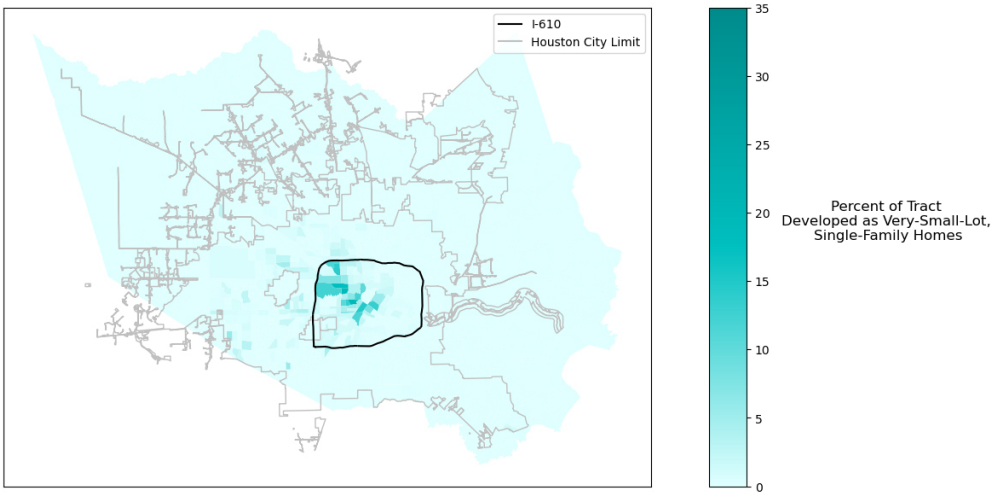
Acreage in Each Harris County Census Tract Developed as Single-Family Housing on Lots of Less Than 5,000 Square Feet, as a Percentage of the Census Tract's Total Parcel Acreage



Sources: Harris County Appraisal District data property type and lot size, 2021; map by Eli Kahn

Exhibit 14

Acreage in Each Harris County Census Tract Developed as Single-Family Housing on Lots of Less Than 2,500 Square Feet, as a Percentage of the Census Tract's Total Parcel Acreage



Sources: Harris County Appraisal District data property type and lot size, 2021; map by Eli Kahn

This study explores the effects of the 2013 reform on land immediately outside the I-610 Loop border. As exhibits 12, 13, and 14 show, prices in this area have changed significantly, and

although pockets of high levels of small-lot construction are occurring 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 of 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 exhibit 14 shows that they are visible just outside the I-610 Loop, including in Spring Branch. So far, small-lot development on lots of less than 2,500 square feet has a very low concentration in areas farther from downtown. 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 this study examines the reform in the geography where the author thinks the reform is most likely to have had an effect.

Section 5: Methodology

This study uses a difference-in-differences design to estimate the average treatment 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 "treated" with the 1998 minimum-lot-size reform. However, no major reforms to land-use policy were adopted within 2 miles of the I-610 Loop inside the Loop during the period of interest, from 2005 to 2021.[4]

This study disregards the year of treatment, 2013, using 2012 as the final year when the neighborhoods outside the I-610 Loop were untreated. Online records of Houston City Council agenda and meeting minutes only extend back to 2015, so the time or extent to which this issue played in council meetings before passage of the reform is unknown. However, minimal mention of the proposed 2013 reform appears in the media before 2013. Two 2012 articles in the *Houston Chronicle* discussed a proposed reform to subdivision rules outside the I-610 Loop but described different details of the proposed reform than what were actually adopted (Baird, 2012; Shauk, 2012). A third, published in December 2012—at the very end of the pretreatment period and only 4 months before the final reform was signed—described the proposed reform as it was adopted but emphasized the uncertainty of passage:

> A council committee will discuss the changes next month, but Mayor Annise Parker has no timeline for bringing the proposed changes to the full council, spokeswoman Janice Evans said (Morris, 2012).

Given the scant coverage of the reform, it was likely not anticipated by market actors or reflected in HCAD data before 2013.

[4] 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 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. The special minimum-lot-size rules apply both inside and outside the I-610 Loop. During the period this 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 this study sample, which are limited to those within 2 miles of the I-610 Loop (City of Houston, "Code of Ordinances," Ch. 26, Sec. 26–471).

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. Although parcels inside the I-610 Loop were subject to minimum-lot-size reform before the 2005–2021 period, any price effect of that treatment probably ultimately affected the price level of land inside the I-610 Loop relative to land outside it rather than creating disparate price trends. After a period of adjustment to a new postreform price level, parcels inside and outside of the I-610 Loop would likely follow parallel trends. Exhibit 9, earlier in this article, shows that in fact, this circumstance appears to have been the case.

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

$$\ln(V_{ilt}) = \alpha_i + \beta_1 \, Treated_l * After_t + \varepsilon_{ilt} \quad (1)$$

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. *Treated* is equal to 1 for land outside I-610, and *After* is equal to 1 for years after 2013. β_1, the coefficient on the interaction of the treatment area and treatment time, 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 outside I-610. Also included are specifications that include year fixed effects, demographic controls at the census tract level, and a ZIP Code-specific linear time trend. Following Freemark and Kuhlmann, this model is applied to parcels within 2 miles, 1 mile, and 0.5 mile of the I-610 Loop. All available years between 2005 and 2021 are used except the treatment year, 2013.

Next, the author tests 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. Census tract-level characteristics in 2012 are regressed on small-lot construction between 2013 and 2021, and then a prediction function is used to estimate the level of small-lot development across tracts. Drawing on the findings of Wegmann, Baqai, and Conrad (2023), the author uses many of the factors that they find affect small-lot redevelopment on formerly single-family homes in this regression. Included are 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 older than 25 with a B.A. 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 1 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. The bottom three-quarters of census tracts citywide are then dropped, those predicted to see fewer than about 60 townhouses built between 2013 and 2021 on the basis of their economic and demographic characteristics.

The author hypothesizes that the effects of the 2013 reform are most likely to be significant for those tracts with a high likelihood of townhouse construction within 0.5 mile of I-610. For this sample, the estimated individual annual coefficients before and after 2013 are plotted, as shown in equation (2):

$$ln(V_{ilt}) = \alpha_i + \lambda_t + \sum_{k \neq 2013} \beta_k \, Treated_l * After_t + \varepsilon_{ilt} \quad (2)$$

The results are shown in a coefficient plot in exhibit 21 in section 6.

As shown in exhibit 11, 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 (p-value 0.0002). Therefore, equation (1) is also estimated using Conley standard errors, allowing for spatial autocorrelation within standard errors (Colella et al., 2019).

Whereas Freemark and Kuhlmann use total property values as their dependent variables, this study uses 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 those properties. Thus, a given estimate of the effect of the 2013 reform on land value would likely have a much smaller effect on total property values.

Section 6: Results

In exhibit 15, the author applies the basic model in equation (1) to 1,226 neighborhoods over 16 years in an unbalanced panel of neighborhoods within 2 miles of the I-610 Loop. The regression in column 1 reflects equation (1) directly. Columns 2 through 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.

Exhibit 15

Effect of Minimum-Lot-Size Reform on Ln (Land Value) Within 2 Miles of the I-610 Loop, 2005–21

Variables	1	2	3	4	5	6
Minimum-Lot-Size Reform	– 0.067	– 0.061	– 0.001	0.003	– 0.007	– 0.003
	(0.072)	(0.074)	(0.056)	(0.057)	(0.057)	(0.050)
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	0.417	0.550	0.612	0.579	0.616	0.585
Number of Neighborhoods	1,226	1,226	1,226	1,226	1,226	1,226

Ln = natural log.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

Note: Robust standard errors clustered by ZIP Code in parentheses.

Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Exhibit 16 shows the same regressions as those in exhibit 15 using only those census tracts that are both within 2 miles of the I-610 Loop and among the top quarter 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 one-quarter of the neighborhoods in the regressions in exhibit 15 are retained in the regressions in exhibit 16.

Exhibit 16

Effect of Minimum-Lot-Size Reform on Ln (Land Value) Within 2 Miles of the I-610 Loop, Top Quarter of Predicted Townhouse Tracts, 2005–21

Variables	7	8	9	10	11	12
Minimum-Lot-Size Reform	– 0.060	– 0.047	– 0.103	– 0.098	– 0.113	– 0.117
	(0.052)	(0.054)	(0.087)	(0.086)	(0.085)	(0.087)
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	0.453	0.599	0.640	0.599	0.641	0.602
Number of Neighborhoods	611	611	611	611	611	611

Ln = natural log.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

Note: Robust standard errors clustered by ZIP Code in parentheses.

Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Here, each specification reveals a negative but insignificant coefficient on the treatment variable. In exhibit 17, those same regressions are repeated for neighborhoods within 1 mile of the I-610 Loop. Exhibit 18 then shows neighborhoods within 1 mile of the I-610 Loop and among the city's census tracts most likely to see townhouse construction. With this sample, most specifications are highly statistically significant.

Exhibit 19 shows the results for neighborhoods within 0.5 mile of the I-610 Loop, revealing a negative effect of the reform on land values, significant at the 10-percent level in one specification and negative, insignificant coefficients in others. Exhibit 20 shows the results for neighborhoods within 0.5 mile of the I-610 Loop and among the city's census tracts most likely to see townhouse construction. This sample is located where the effects of the 2013 reform are most likely to show up and reveals negative effects of minimum-lot-size reduction significant at the 1-percent level in most specifications.

Exhibit 17

Effect of Minimum-Lot-Size Reform on Ln (Land Value) Within 1 Mile of the I-610 Loop, 2005–21

Variables	13	14	15	16	17	18
Minimum-Lot-Size Reform	– 0.075	– 0.071	– 0.041	– 0.039	– 0.040	– 0.038
	(0.088)	(0.090)	(0.058)	(0.058)	(0.062)	(0.063)
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
R2	0.384	0.508	0.578	0.548	0.583	0.554
Number of Neighborhoods	655	655	655	655	655	655

Ln = natural log.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

Note: Robust standard errors clustered by ZIP Code in parentheses.

Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Exhibit 18

Effect of Minimum-Lot-Size Reform on Ln (Land Value) Within 1 Mile of the I-610 Loop, Top Quarter of Predicted Townhouse Tracts, 2005–21

Variables	19	20	21	22	23	24
Minimum-Lot-Size Reform	– 0.069	– 0.062	– 0.246***	– 0.246***	– 0.246***	– 0.258***
	(0.076)	(0.077)	(0.081)	(0.080)	(0.078)	(0.079)
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	0.425	0.572	0.628	0.585	0.631	0.588
Number of Neighborhoods	319	319	319	319	319	319

Ln = natural log.
** p < 0.1. ** p < 0.05. *** p < 0.01.*
Note: Robust standard errors clustered by ZIP Code in parentheses.
Sources: Harris County Appraisal District data, 2010–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Exhibit 19

Effect of Minimum-Lot-Size Reform on Ln (Land Value) within 0.5 Mile of the I-610 Loop, 2005–21

Variables	25	26	27	28	29	30
Minimum-Lot-Size Reform	– 0.143	– 0.133	– 0.103	– 0.099	– 0.106*	– 0.100
	(0.100)	(0.103)	(0.061)	(0.062)	(0.063)	(0.064)
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	0.341	0.456	0.537	0.507	0.539	0.511
Number of Neighborhoods	383	383	383	383	383	383

Ln = natural log.
** p < 0.1. ** p < 0.05. *** p < 0.01.*
Note: Robust standard errors clustered by ZIP Code in parentheses.
Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Exhibit 20

Effect of Minimum-Lot-Size Reform on Ln (Land Value) within 0.5 Mile of the I-610 Loop, Top Quarter of Predicted Townhouse Tracts, 2005–21

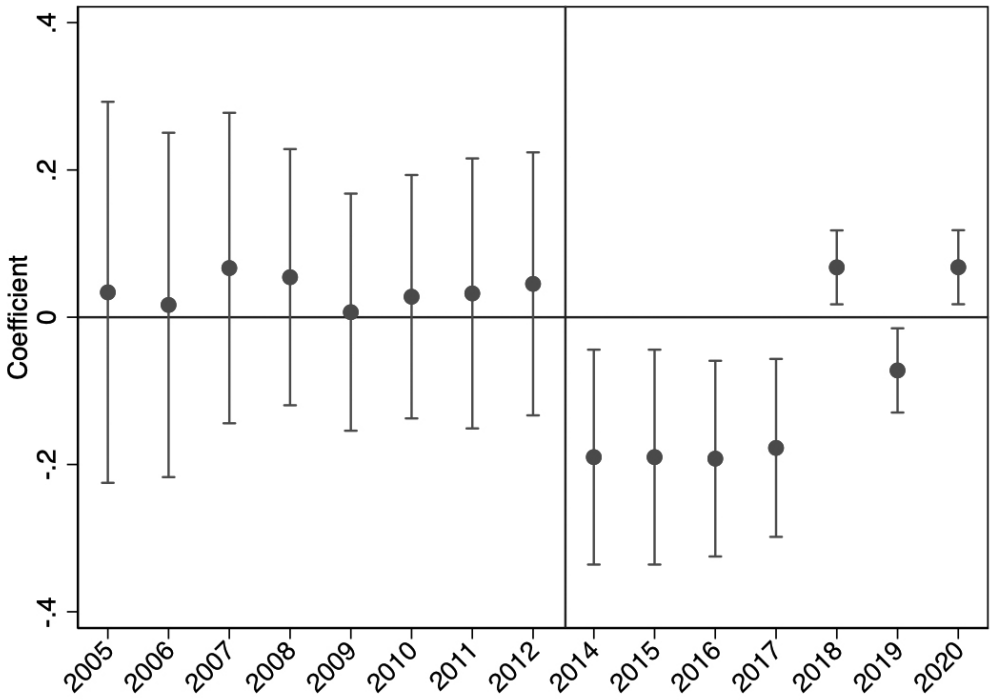
Variables	31	32	33	34	35	36
Minimum-Lot-Size Reform	– 0.156	– 0.159	– 0.277***	– 0.267***	– 0.283***	– 0.279***
	(0.096)	(0.098)	(0.076)	(0.073)	(0.065)	(0.069)
Demographic Controls	No	No	No	No	Yes	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	No
Neighborhood Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
ZIP Code-Specific Time Trend	No	No	Yes	Yes	Yes	Yes
R^2	0.432	0.565	0.637	0.594	0.637	0.596
Number of Neighborhoods	186	186	186	186	186	186

Ln = natural log.
** p < 0.1. **p < 0.05. *** p < 0.01.*
Note: Robust standard errors clustered by ZIP Code in parentheses.
Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

Exhibit 21 presents the results of equation (2) for this narrowest sample. During each pretreatment year, the coefficients are statistically insignificant, indicating parallel trends. Although the annual coefficients are noisy, most years after 2013 have statistically significant, negative estimated effects. As expected, those negative effects are largest in the years immediately after 2013, with the treatment effect appearing to dissipate over time.

Exhibit 21

Effect of Minimum-Lot-Size Reform on Ln (Land Value) within 0.5 Mile of the I-610 Loop, Top Quarter of Predicted Townhouse Tracts, Annual Coefficient Estimates 2005–21



Turning now to a spatial model, the author uses equation (1) with Conley standard errors, first using all of the observations within 0.5 mile of I-610 and then only those within census tracts in the top quarter of predicted townhouse construction. With each sample, the author first applies equation (2) directly, then adds year fixed effects and then demographic controls. Exhibit 22 shows the results of those regressions.

Exhibit 22

Effect of Minimum-Lot-Size Reform on Ln (Land Value) in a Spatial Model, 2005–21

Variables	0.5 Mile		0.5 Mile Top Tracts			
	37	38	39	40	41	42
Minimum-Lot-Size Reform Total Effect	– 0.104**	– 0.093*	– 0.051	– 0.094*	– 0.071	– 0.028
	(0.041)	(0.038)	(0.037)	(0.053)	(0.046)	(0.051)
Neighborhood Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	Yes
Demographic Controls	No	No	Yes	No	No	Yes
Number of Neighborhoods	275	275	275	136	136	136
R^2	0.344	0.005	0.047	0.105	0.207	0.073

Ln = natural log.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

Note: Robust Conley standard errors clustered by ZIP Code in parentheses.

Sources: Harris County Appraisal District data, 2005–21; U.S. Census Bureau, Decennial Census 2000; American Community Survey, 2010–21

The author's preferred models are shown in exhibit 22 in columns 40, 41, and 42. 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 the author would expect the reform to be most likely to have a measurable effect and with fully robust standard errors that account for spatial autocorrelation. In the basic model shown in column 40, the reform was found to reduce land values outside I-610 relative to that inside by 9.4 percent, significant at the 10-percent level, and a positive effect of the reform any larger than 1 percent at a 95-percent confidence level can be ruled out. The more highly significant results with the full 0.5-mile sample shown in columns 37, 38, and 39 indicate that the author's preferred sample may be underpowered.

Section 7: Conclusion

Houston's 2013 lot-size reforms enabled more small-lot, single-family houses to be built on a given amount of land outside the I-610 Loop, increasing the option value of that land relative to land across this border. The reform, however, 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.

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. In contrast to the Chicago and Minneapolis studies, the Houston case may provide an example of upzoning that reduces land value relative to a control or at least does not increase it.

The statistically significant estimates of the effect of the 2013 reform range from -9 percent to -28 percent. Taking the midpoint of that range and a 40-percent share of total property value for land value, the reform reduced property values outside I-610 relative to those inside I-610 by about 7.5 percent. As exhibit 11 illustrates, that result is in a context of large increases in assessed land values on both sides of the border during the study period; although the reform may have reduced land price appreciation relative to the counterfactual, both sides of I-610 saw large increases in land values over the study period.

Houston's experience of minimum-lot-size reform has facilitated infill construction, including in single-family neighborhoods, to a level unprecedented in U.S. history since the adoption of zoning in the 20th 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; however, across many specifications, no evidence emerged that the reform increased assessed land values, and some evidence indicated that it had the opposite effect. 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.

Acknowledgments

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