Minimum Lot Size Restrictions:
A Border Effects Analysis of Impacts on Urban Form and House Price

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Abstract

Using a border analysis research design, we estimate the impact of more stringent minimum lot size restrictions across neighboring communities using data from the Wharton Residential Land Use Regulatory Index (WRLURI) surveys. Economically meaningful impacts are found on the built environment, not just house prices. Housing density as reflected in the number of single family homes per square mile is about 13% lower in the border areas of the most restricted communities compared to the border areas of the least restricted communities in terms of minimum lot sizes. Individual homes are bigger by about 135 square feet, too, which amounts to around 7% of typical unit square footage. Lots are about 2,800 square feet greater in the most restricted compared to the least restricted communities' border areas. This increase is about one-quarter of the sample mean lot size. Finally, house prices are about $42,000 higher in the more regulated border areas compared to the least regulated border areas. Higher prices appear to be due entirely to higher quality homes being built in more regulated places.

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I. Introduction

Interest in the potential impact of restrictions on residential building activity has exploded, as growing concerns about housing affordability raised the public salience of the issue.[1] In this paper, we perform a border effects estimation to measure the impacts of density restrictions, using Wharton Residential Land Use Regulatory Index (WRLURI) data covering 37 metro areas across the nation.[2] The WRLURI data are used to construct 615 border pairs across these urban areas. These pairs reflect the border areas of physically contiguous jurisdictions, and are the empirical foundation for our border effects specifications.

We estimate impacts on urban form, not just pricing. Price impacts are important, of course, but changes to urban form are likely to be long-lived. Hence, knowing whether they occur and if so, in what magnitude, is of first-order relevance. Density of single-family housing in the border area is one such outcome investigated. Other outcomes include the size of the homes themselves, the size of the lots on which they sit, and house price.

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[1] While traditionally conceived of as a local issue, one sign of the growing importance of affordability concerns is in the activity of the executive branch of the national government. The Trump Administration established a White House Council on Eliminating Regulatory Barriers to Affordable Housing (https://www.whitehouse.gov/presidential-actions/executive-order-establishing-white-house-council-eliminating-regulatory-barriers-affordable-housing/). The Biden Administration announced a program to award grants to localities allowing more and denser housing development as part of its infrastructure plan proposal (https://www.wsj.com/articles/biden-seeks-to-ease-housing-shortage-with-looser-zoning-rules-11617796817?page=1). Political activity at the state and local level also has increased markedly. California saw debate on a bill that would have limited a locality's ability to stop dense development around transit nodes (see the Vox article at https://www.vox.com/cities-and-urbanism/2018/2/23/1701154/sb827-california-housing-crisis for more on this). In late 2018, the Minneapolis City Council voted to eliminate single family zoning as a category and now permits up to three units on those sites (https://nytimes.com/2018/12/13/us/minneapolis-single-family-zoning.html.) Bills to pass or augment actual rent controls or enhance rent regulation in California, New York, and Oregon can also be seen as a response to growing concern with housing affordability. This debate also is related to the broader issue raised by Glaeser (2020) of a mismatch between capabilities of the private versus public sectors in some of our major urban areas that led to dominance by insiders (existing landowners in our context). The most recent academic review of the literature on supply side restrictions in housing markets is Gyourko and Molloy (2015).

[2] We use data from both the 2006 and 2018 surveys in the empirical analysis and discuss their usage below in Section III. Gyourko, Saiz & Summers (2008) and Gyourko, Hartley & Krimmel (2021) describe each cross section in detail.

The rationale for our empirical strategy is straightforward. Homes on either side of the border effectively have access to the same local amenities that likely influence property values. However, because school district boundaries often change at the border, we also control for school quality with the third-grade reading score in the school district of the underlying border area.

The WRLURI data show minimum lot sizes to be virtually omnipresent throughout the United States, so estimating their potential impacts on urban form and house prices is natural.[3] Controlling for border pair fixed effects, we find that housing density is materially lower—by 119 few single family homes per square mile or 13% of sample mean density--in border areas of jurisdictions that report having the most stringent minimum lot size requirements (i.e., a 1+ acre mandate in at least one neighborhood in the border area's jurisdiction) relative to that in jurisdictions that we categorize as having the least stringent requirements (i.e., no minimum lot size in any neighborhood that exceeds one-half acre).

House quality is influenced by regulatory strictness, too. Making the same comparison of the most stringent to the least stringent communities in terms of minimum lot sizes finds 135ft^2 more living area for the typical home in the border area of the more restrictive community. This amounts to 7%-8% of sample mean structure size, roughly the size of an additional bedroom in scale. The impact on lot size is even bigger. Here, we find the typical lot in the border area of the most-regulated community to be 2,800ft^2 larger than in the least-regulated community, which amounts to one quarter of the sample mean. Not only are there fewer homes per acre in these places, but among the smaller number of homes that do exist, they have larger structures and use more land. At the individual parcel level, these two impacts counterbalance one another, so that

[3] Recent research by Cui (2022), Shanks (2021) and Song (2021) also finds widespread adoption of this type of residential land use constraint using different data and samples.

the structure-to-land ratio of the typical home is only slightly lower (by about 3%) in the more highly-regulated places.

Finally, we estimate house prices to be about $42,000 higher in the border areas of communities with the largest minimum lot sizes of at least one acre compared to those communities that never exceed 0.5 acres We also document below that this impact can be explained entirely by the fact that homes on the more regulated side of the border are of higher quality.

Our work is related to an expanding body of research into the impacts of residential building restrictions. While we use the more recently collected Wharton surveys, they are part of a longer running collection effort that dates back to the 1990s.[4] More recently, Cui (2022) shows that the modern era of minimum lot size regulation from which our data are drawn largely was established between 1940-1970.

Until recently, empirical efforts to measure the impact of regulatory strictness has focused on the influence on price. Turner, et. al. (2014) is the classic examination of the impact of regulatory constraint on raw land value, reporting an economically meaningful negative effect on land value via its reduction of option value. Our work focuses on house value—i.e., land + structure.[5] Glaeser & Gyourko (2018) provides an overview of work on house price impacts,

[4] See Linneman, et. al. (1990) and Glickfield & Levine (1991) for example. Pendall, Puentes & Martin (2006) is an example of a more recent survey. In addition, there are data collection and mapping efforts that focus on more narrowly defined geographies. The Terner Center's Land Use data (http://californialanduse.org/index.html) is a prominent example.

[5] Their empirical strategy yielded a negative effect of regulation, based on what effectively was a comparison of two nearby vacant land parcels, only one of which was constrained by regulation. This is as expected because regulation decreases the option value of one of the vacant parcels. In contrast, we observe house prices that reflect the combined value of structure + land, and our results indicate that regulation increases both living area and lot size square footage. Hence, neither underlying structure nor land quality (i.e., size) is held constant in our empirical analysis of price impact across borders.

which has documented large differences across metropolitan areas.[6] To our knowledge, our within-metro house price effects are the first to be estimated on a national sample.

This paper also is part of a small, but growing, body of newer research studying the impact of residential land use regulation on aspects of the built environment. Much of this other work is more geographically focused on individual metropolitan areas such as the Boston area and its surroundings (Zabel & Dalton (2011); Kulka, Sood & Chiumenti (2023); Shanks (2021)), the state of Connecticut (Song (2021)) or Portland, OR, (Grout, Jaeger & Plantinga (2011)). The relatively narrow geographic focus raises the question of whether their results generalize beyond their locales, which is something our use of a broader sample can help answer.[7]

However, there are clear benefits to the different research designs employed in these related papers in localized settings. For example, Kulka, Sood & Chiumenti (2023) and Song (2021) build theoretical frameworks so that they can evaluate counterfactuals that could help us get at important, but challenging, questions such as what would happen to the density of a state or metropolitan area if minimum lot size restrictions were relaxed in a certain way. Our purely empirical approach obviously cannot do this, but we can identify what effect regulation already has had on the built environment across a large number of metropolitan housing markets, which could be an important input into estimating key parameters of such models.

Shanks (2021) and Song (2021) present new methods to measure the regulatory environment in the absence of survey data like that employed in this paper--the former by natural

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[6] That our estimate uses within-metropolitan area variation helps explains why it is smaller than the larger implied price effects found across urban areas in previous research (e.g., Glaeser & Gyourko (2018); Gyourko & Krimmel (2021)). Most of this earlier work studying impacts on house prices did not have within-metropolitan area variation that would allow estimation of effects across communities within a given market.

[7] See also Schoenholzer (2018) for a broader examination of the role of local and state public policy on urban form and economic development.

language processing and the latter by break detection algorithm. These methods could be tremendously valuable as the data collection and measurement of land use restrictiveness is particularly costly. Such methods may allow researchers to estimate land use restrictiveness in entire metro areas rather than only the jurisdictions where survey collection was possible. One can view our approach, based on traditional and relatively expensive survey collection, as both a useful comparison with and potential validation of the results of the studies using more novel, indirect data measurement methods.

The plan of the paper is as follows. The next section describes the data in detail. Section III then presents our baseline empirical specification and reports results. There is a brief conclusion that interprets our findings and suggests paths for future research into regulation and housing markets.

II. Data

Conducting the border effects analysis requires data on land use regulations, maps of administrative boundaries, house prices and housing characteristics such as lot and physical structure size. We also merge in data on school district reading test scores to control for school quality, which may change discretely at the administrative boundary.

II.A The Wharton Surveys and Administrative Boundaries

We use regulation data from both the 2006 and 2018 WRLURI surveys. Each contains responses from over 2,000 primarily suburban jurisdictions to an array of questions covering the myriad restrictions local governments use (e.g., capping the number of building permits, requiring zoning board approval, imposing density restrictions, etc.). In our primary analysis, we focus on density restrictions in the form of minimum lot size restrictions that exist anywhere within the community and how large they are. The range of possible answers varied across the two surveys, which requires us to adopt a standardized set of ranges for density restrictions.

Both surveys asked if there was at least one neighborhood within the community's political boundaries that was in one of the following four categories: (a) either no minimum lot size or the most stringent one is less than one-half acre; we call such places 'Least Strictly Regulated' in the regression analysis below; (b) those in which the largest minimum lot size ranges from one-half acre to (just under) one acre; these places are termed 'Moderately Regulated'; or (c) those in which the largest minimum is either from 1-2 acres or for 2+ acres; because there were so few communities that reported a 2+ acre minimum, we group these two categories into a single one for 1+ acre minimums; these places are labelled 'Most Strictly Regulated' below.[8]

Because our research design relies on exploiting variation across administrative borders, we must restrict our sample to WRLURI survey respondents sharing a border. The U.S. Census provides maps of the administrative boundaries used in our analysis.[9] Along these boundaries, we construct border areas 250 meters in depth and remove any area covered in water. We then separate each border area into its two administrative sides which vary in their respective regulatory strictness. The geographic area for a border side ranges from 241 acres at the 25^{th} percentile to 565 acres at the 75^{th} percentile. Figure 1 depicts one border pair for Allen City and Fairview Town, which are in the northeast corner of the Dallas, TX, metropolitan area. The two light blue lines in the bottom figure mark the 250 meter depth of each border area with a given city. A complete list of markets and the number of contiguous respondents to the Wharton

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[8] Each survey question is reproduced in the online appendix.

[9] In the WRLURI data, local governments are typically at the Census Place level, and less frequently at the County Subdivision, or County level. Shapefiles for these geographies and bodies of water were downloaded from the U.S. Census Tiger/Line site at https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html

surveys from each of the 37 CBSAs in our sample is reported in Online Appendix Table 1. There is substantial variation in the number of respondents, with those from the Chicago (79), Los Angeles (65), and Detroit (61) areas comprising almost 17% of our sample. The other four-fifths of the observations are widely dispersed across the country's top urban agglomerations.

Our final sample contains 1,230 jurisdictions comprising 615 border pairs. Of the 1,230 total, 742 jurisdictions have regulatory survey values from the 2018 survey, while 488 jurisdictions use the 2006 vintage of the WRLURI. Of the 615 border pairs, 110 are such that both jurisdictions use 2006 data; in 268 border pairs, one jurisdiction uses 2018 data and one uses 2006 data; and 237 pairs use 2018 data for both jurisdictions. For those jurisdictions that answered both surveys, we rely on the 2018 vintage regulation data.[10]

II.B Housing Characteristics

We use parcel-level data from the CoreLogic tax assessment files to measure single-family unit density, lot size, and housing structure size. CoreLogic reports data on the near universe of parcels in all major CBSAs. These parcels are precisely located by census block coordinates, allowing us to restrict observations to the parcels within the relevant WRLURI jurisdiction border area. Because of outliers and potentially faulty observations, we winsorize the data at the top (99th) and bottom (1st) percentile for living area, lot size, and house price. For the parcel-level structure-to-land ratio, we winsorize at the 10 percent level because the outliers were more extreme. We restrict our sample to border areas which have at least 50 single family housing parcels. The interquartile range for the number of observations on a border side runs from 188 parcels to 628 parcels. Given this and the fact that there are 1,230 border areas implies that we have many hundreds of thousands of observations on single family homes within those

[10] As is discussed below, our results are robust to including controls for which survey the data are derived from.

areas. For all border areas in jurisdictions for which regulation data come from the 2018 WRLURI survey, we use housing traits reported as of the 2019 CoreLogic files in our empirical analysis. For those whose regulation data come from the 2006 survey, we exclude all homes built after 2007 in our calculations and analysis. This reduces the micro samples of homes across all border areas by about 20,000, or about 2% of the total.

Two density measures are created with these data. One is the number of homes per acre in each border area. This is the count of single-family units from the CoreLogic data in a border area divided by the total acreage of that border area. The second is a parcel-level measure of the structure-to-land ratio for each house. This is the ratio of living space square footage-to-lot size square footage at the individual home level.

II.C House Prices

The foundation of the house prices used in our analysis is the microdata on all single-family house sales from 1990-2019 listed in CoreLogic. We observe sales prices for virtually all single-family transactions in each border area. Because relatively few houses sell each year, we construct real 2018 values using the Federal Housing Finance Agency House Price Index (FHFA HPI ®) to adjust nominal values in different sales years to constant 2018 prices.

II.D School District Test Scores

Because school district boundaries often coincide with administrative boundaries, school quality is an obvious potential confounder of the impact of regulation. Access to high quality schools likely affects housing characteristics and could be correlated with regulation itself. To address this problem, we include controls for school quality by matching school district test score data from the *Stanford Education Data Archive* (*SEDA*) to each side of a border.[11]

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[11] These data may be downloaded at http://purl.stanford.edu/db586ns4974 from the Stanford Education Data Archive (Version 4.1), Reardon, S.F., *et. al.*

Specifically, we measure a border side's school quality by the standardized average 3rd grade reading score in its respective school district. By construction, every parcel on the same side of the border is associated with the same school district.[12]

We discretize our school quality measure as follows. Each border area is assigned its jurisdiction's 3rd grade reading score for 2018 or the most recent year available. We then assign each border area to one of three categories: (a) 'Lowest School Quality', which is comprised of those with scores in the bottom quartile of the sample distribution; (b) 'Average School Quality', which is comprised of those with scores in the interquartile range of the distribution; or (c) 'Highest School Quality', which is comprised of those with scores in the top quartile of the distribution.

II.E Summary Statistics

Table 1 provides summary statistics on the outcomes of interest in the border areas, as well as test scores, by level of density restriction in the broader community.[13] We report means and standard deviations of the underlying median values in each border area. There are 629 Least Strictly Regulated border areas, 214 Moderately Regulated border areas and 387 Most Strictly Regulated border areas. Within the 629 Least Strictly Regulated areas, there are 562,154 observations on individual homes, with 354,493 having been sold between 1990 and 2019. The analogous figures for the Moderately Regulated area are 158,695 and 97,237, respectively; those for the Most Strictly Regulated areas are 217,204 and 146,488, respectively.

Note that our outcome measures always covary as economic intuition would suggest with the degree of regulation as reported in the survey instrument. That is, density falls as one moves

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[12] We also experimented with 8th grade reading scores, as well as math scores from the 3rd and 8th grades. None of our key conclusions is affected if one of these other proxies for school quality is used.

[13] Means and standard deviations based on the full distributions of micro data in CoreLogic also are reported in the Online Appendix (see Table 12 there). The patterns in those data are similar.

from low to high regulation areas, structure and lot size are larger in more regulated places, etc. More specifically, density at the border area level falls from 1.6 houses per acre in places with minimum lot size constraints below one-half acre to just under 1.0 houses per acre in places with at least one minimum lot size restriction that is greater than one acre. The typical house in Least Strictly Regulated areas contains roughly 1,700 square feet in living area and sits on an 8,874 ft^2 lot. In comparison, the typical house in the Most Strictly Regulated areas is roughly 2,070 ft^2 in size and sits on a 19,560 ft^2 lot. Moving from least to most strictly regulated, house prices increase by over \$67,000. Test scores increase nearly one-third of a standard deviation, with students in the typical district in places with the least restrictive minimum lot size regulations reading at 0.09 grades above the national average, while those in places with the most restrictive minimum lot size regulations read at 0.30 grades above the national average. While suggestive, these patterns obviously do not imply causation, which lead us to employ a border effects estimation research design.

III. Empirical Specification and Results

We estimate the impact of local residential land use regulation on five outcomes, four covering different aspects of urban form plus house price. Outcome #1 is housing density, measured by the number of single-family homes per acre in a border area. Outcome #2 is house size as reflected in the square footage of living area reported for each single-family unit in the border area. Outcome #3 is lot size as reflected in the square footage of land on which each single-family housing unit in a border area sits. Outcome #4 is our second density measure--structure-to-land intensity at the parcel level, which is created by taking the ratio of the previous two outcomes (i.e., house size divided by lot size). Outcome #5 is house price in constant 2018 dollars based on recorded sales transactions across various years.

In terms of the specifications estimated below, let a *border pair b* be the entire border area. Each border pair has two sides, one for each WRLURI jurisdiction *j*. Let the *jurisdiction j side* be the subsection of the border area only contained in jurisdiction *j*. For Outcome #1, our baseline specification regresses the density of homes in the jurisdiction *j* side of border pair *b* on measures of minimum lot size restriction severity ($MinLotSize_j$), 3rd grade reading scores for the jurisdiction ($School_j$), and a full set of border pair fixed effects (δ_b):

(1) $HomesPerAcre_{j,b} = \beta*MinLotSize_j + \gamma*School_j + \delta_b + \varepsilon_{j,b.}$

For Outcomes #2-#5, our unit of observation is a parcel. Every *parcel p* sits in a jurisdiction *j* side of a border pair *b*. Following a similar specification, we have:

(2) $Outcome_{p,j,b} = \beta*MinLotSize_j + \gamma*School_j + \delta_b + \varepsilon_{p,j,b.}$

Because parcels can sit on either of the two sides of a border depending on which jurisdiction they are in, we expect the exposure to regulatory strictness to vary by the respective jurisdiction. The border pair fixed effects then allow us to compare outcomes across jurisdiction boundaries.[14]

Table 2 reports a summary of the impacts implied by our regression results. In all specifications, the Least Strictly Regulated and Lowest School Quality categories always are

[14] Severen and Plantinga (2018) estimate a specification that also controls for what would be the distance of each house from the border in our context, as well as the interaction of the distance measure with whether the home is on the highly-regulated side of the border. Allowing for heterogeneous effects made excellent sense given their focus on measuring the impact of the California Coastal Act on parcels and communities of highly varying distance from the coastline. Our border areas are so small (a 250 meter depth is only 16% of a mile) that each unit is within 1/7th of a mile of every other unit on its side of the border. Given this, we prefer our simpler specification as there should be little to no differential impact across units that are only very slightly closer to the border. Robustness results results reported in the online appendix are consistent with this. In that work, we compared a given side of the border to an inland area next to the immediately adjacent area on the other side of the border (i.e., not the other border area itself, but the area next to it that is further away from the border). There was no change in results, consistent with modestly greater distances from the border not affecting our results in any meaningful way.

omitted.[15] Turning first to the effect of variation in the minimum lot size on housing density measured as the number of single-family homes per acre in a border area (first row of column 1), being Moderately Regulated is associated with 0.126 few homes per acre compared to the Least Strictly Regulated areas. Quantitatively, this estimated impact is around 10% of the underlying variable's standard deviation or mean value.[16]

The second row of column one reports that the border areas of communities with at least one 1+ acre minimum lot size constraint have even lower housing densities: being in the Most Strictly Regulated border area is associated with 0.185 fewer homes per acre. Because the meaning of this estimate is hard to interpret, we translate it into more readily understandable metrics. For example, our regression results imply 631 single family homes per square mile in the Least Strictly Regulated places with average reading scores versus 512 per square mile in the Most Strictly Regulated border areas with the same reading scores, for a difference of 119 homes per square mile.[17] Yet another interpretation of this result is that it implies an additional 10,201ft^2 of land is used per home in the border areas of communities in the Most Strictly Regulated category compared to those in the Least Strictly Regulated category.[18] This nearly

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[15] The full set of regression results is reported in the Online Appendix Table 2. Standard errors are clustered at the metropolitan area level. Different clustering choices, including at the border pair level, do not change any conclusion reached below in a meaningful way.

[16] Qualitatively, the underlying t-statistics is 1.44, so one cannot conclude there is a robust difference between being in the border area of a Moderately Regulated versus Least Strictly Regulated community.

[17] This can be calculated as follows. The underlying regression results imply 0.9861 single family homes per acre in the Least Strictly Regulated category, presuming it also has a 3rd grade reading score in the interquartile range of the distribution. [The intercept is 1.0040, with a coefficient of -0.0179 for the Average School Quality control; 1.0040 – 0.0179 = 0.9861. See the regression results in the Online Appendix Table 2 for more detail.] To get to the density of homes per square mile, we use the fact that there are 640 acres, or 27,878,400ft^2, in a square mile. Thus, 0.9861 homes/acre*640 acres ~=631 homes per square mile in the Least Strictly Regulated border area. For the Most Strictly Regulated category, there are 0.8011 homes per acre, where 0.8011=.9861-0.1850 from the regression result. Finally, 0.8011 homes per acre*640 acres ~= 512 homes per square mile in the Most Strictly Regulated border areas.

[18] Given that there are 43,560ft^2 in an acre, this implies 44,174ft^2 of land is used per home in the Least Strictly Regulated border areas (i.e., 43,560/0.9861 ~ 44,174). The analogous calculation yields 54,375ft^2 in the Most Strictly Regulated border areas (i.e., 43,560/0.8011 ~ 54,375, where 0.8011 = 0.9861-0.1850, reflecting the influence of the underlying regression coefficient on the density measure).

one quarter acre amount does not simply reflect larger lot sizes, as land in the border areas is used for many other purposes, ranging from apartments to roads, schools, parks and nonresidential buildings. Finally, while our interest in school quality is primarily as a control for possible unobserved location quality, it is interesting that higher school quality is not as strongly associated with materially lower housing density at the border area level.

Column 2 of Table 2 reports results for the impact on structure size as reflected in living area square footage. In this case, being Moderately Regulated is associated with having a larger house, although the estimated impact of 43ft^2 is small in economic terms. The effect is three times larger at 135ft^2 in the border areas of the Most Strictly Regulated communities compared to those in the Least Strictly Regulated places. This is more economically meaningful, as it represents 15% of the standard deviation in living square footage and about 7% of the sample mean house size. Physically, this is the equivalent of a large bedroom. And, this effect holds controlling for school quality, for which we find even larger impacts on house size for those in the top quartile of school districts.

Column 3 documents that the regulatory impact on lot size is even larger economically. While being Moderately Regulated is associated with a 424ft^2 larger lot compared to being in the Least Strictly Regulated communities, that is economically small as it amounts to no more than 3%-4% of a standard deviation in or the mean of lot size. Lot sizes are much larger—2,800ft^2 or nearly 7% of an acre—in the border areas of the Most Strictly Regulated communities. This amounts to 21% of a standard deviation in lot size and one-quarter of the sample mean for this variable. The fact that individual home structure and lot size both increase helps make for only a modest change in parcel-level structure-to-land intensity (column 4 of Table 2).[19]

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[19] The results in the bottom two rows of the table show that being in the interquartile range or the top quartile of school district quality compared to the bottom quartile as reflected in reading scores is associated with materially

The final column of this table documents that more stringent minimum lot sizes also influence house prices across jurisdiction borders within a metropolitan area. The price impact of regulation is economically meaningful only for places in the Most Strictly Regulated categories. Prices in those places are $42,045 higher than in the Least Strictly Regulated places, all else constant. This is below the much higher cross-market price differences noted in the Introduction, but it still is economically meaningful, as it amounts to well over one-third of mean household income even in the highest paid labor markets in the country.[20] It is noteworthy that this impact can be explained entirely by adding controls for house quality. In Online Appendix Table 3, we show that adding controls for individual housing unit lot size and living area reduces the estimated impact by 96% to $1,552, while also eliminating its statistical significance. Including other controls available in the CoreLogic data (e.g., the number of stories, the number of bathrooms and the number of bedrooms) turns the coefficient negative, although never meaningfully so. Thus, the price effect estimated in the final column of Table 2 can be interpreted as entirely reflecting higher house quality in the border area of the more regulated community.[21]

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larger homes and lot sizes. The house size effects are roughly double (or more) those reported above for more strict minimum lot size regulation. The impacts on lot size are in the same range as seen above for density regulation strictness.

[20] For example, the Census reports a median household income of $75,157 in 2021 dollars based on *American Community Survey* (*ACS*) samples spanning 2017-2021 for the New York City CBSA. Note also that the influence of density regulation on prices pales in comparison to that of good schools. Being in the interquartile range of school quality is associated with a price impact comparable to that of being in a community with at least one neighborhood with a one acre+ minimum lot size regulation (row 3, column 5). Being in the top quartile of school quality is associated with nearly a $175,000 higher house price compared to being in the bottom quartile of the reading score distribution. Finally, not controlling for reading scores is associated with about a 20% higher price impact for the Most Strictly Regulated places.

[21] While the focus of Kulka, Sood & Chiumenti (2023) is on constraints to the provision of multifamily housing, they do report some results on the single-family sector. Using a slightly different measure than ours, they also find that stricter density restrictions increase single family house prices, but by a modestly lower value of $28,488 (section 5.2.1, pp. 28). They also report that controlling for house traits reduces the estimated price effect to zero. Song (2021) concludes that doubling minimum lot size in her sample increases house prices by 14% (and rents by 6%). Controlling for house characteristics reduces the effect size by roughly two-thirds. There could be other factors that influence any price gap, including a Turner, *et. al.* (2014)-like option value, as well as the potential

III.A. Robustness Checks

Our findings, both qualitatively and quantitatively, are robust to a number of alternative specifications. For example, controlling for the survey year from which a border area's regulatory intensity measure comes from changes the findings only modestly as shown in Online Appendix Table 4. Thus, there is no evidence that mixing observations from the 2006 and 2018 surveys is driving our results.

The same can be said of our use of micro data on homes within the border areas. Online Appendix Table 5 reports results from a specification that uses information for the median owner-occupied home (in terms of price) in a border area. This regression contains 1,230 observations based on the 615 unique border pairs. Relative to our baseline estimates reported above in Table 2, using border area-level medians changes the results only minimally[22]

To obtain substantially different impacts, one has to drop the border pair fixed effects. As expected, doing so results in far higher estimated impacts of more stringent regulation. Online Appendix Table 6 shows that the impact on house size as reflected in living area square footage almost doubles to 249ft^2 in the Most Strictly Regulated places if border pair fixed effects are not included. Lot sizes in the same border areas are estimated to be 5,233ft^2 larger versus 2,800ft^2 in the baseline case. However, we cannot envision a justification for not including border pair fixed effects.[23]

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impact of different types of households sorting into the more regulated areas. Our results are consistent with Kulka, Sood & Chiumenti (2023) in the sense that these other factors appear to cancel one another out.

[22] For example, the estimated increase in living area square footage in the most regulated places is 7ft^2 greater; the impact on lot size is about 200ft^2 higher, but that difference is well within the range of the underlying estimation error. Finally, the impact on house prices is within $3,000 of our baseline estimate in Table 2.

[23] Other robustness checks and investigations are reported in the Online Appendix. For example, logging house prices does not change the results qualitatively or quantitatively in a meaningful fashion (Online Appendix Table 8). Neither does comparing a given border area to an inland area on the other side of the border (i.e., not the other border area itself, but the area next to it that is farther away from the border; see Online Appendix Table 9). Those estimated impacts were slightly larger, although still qualitatively similar. Estimates of the cost of living area and lot size per square foot do not yield appreciably different results either (Online Appendix Table 7). Finally, the

IV. Conclusion

We investigated the impact of more stringent minimum lot size restrictions on housing density, structure size, lot size and house price using a border effects estimation strategy that compared these outcomes across the boundaries of physically contiguous local jurisdictions. Economically meaningful impacts were found on all outcomes.

That minimum lot size constraints affect urban form raises an important question for future research about whether the broader nature of the housing stock, not just the quality of single-family product, has been affected by regulation. In other analysis included in the Online Appendix Table 10, we investigated whether there is less multifamily housing in places with more stringent minimum lot size controls pertaining to single-family units. Unfortunately, data limitations prevent us from using the border analysis approach used above. However, using Census data at the jurisdiction level allowed us to estimate a similar specification which showed that being in the most strictly regulated category of communities is associated with a 4.5 percentage point lower share of multifamily units in the overall housing stock than exists in the least strictly regulated places. That difference is large economically, as it amounts to over one-quarter of a standard deviation change in multifamily unit share in our sample of jurisdictions. This is consistent with an implication of Cui (2022) that adoption of minimum lot size restrictions in the past could lock a jurisdiction into certain types of land usage and housing types. Panel data will be needed for this analysis, but our preliminary results suggest that developing it will be worth the effort.

Other analysis reported in Online Appendix Table 13 further highlights the need for researchers to start constructing panel data to analyze time series variation. Those results

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online appendix also reports the results of the impact of regulation on house age (see Table 11 in that posting). It always is minimal both in an economic and statistical significance sense.

suggest a marked difference in the impact on lot size after 1970 in particular. Dividing the sample by whether the home was built prior to 1970 finds that being in the most highly regulated category (as of 2006 or 2018) is associated with a 1,332 square foot larger lot size relative to being in the least regulated category. After 1970, the coefficient jumps to 4,123 square feet. This suggests the initial change in density regulation happened some time in the past, probably around 1970.[24]

Finally, in work not reported in this paper or the online appendix, we investigated whether other aspects of local residential land use regulatory regimes also impacted housing density, structure size, lot size and house prices. No other subcomponent of the overall WRLURI index approaches the economic (and typically the statistical) significance of minimum lot size restrictions on housing density. Hence, this is the aspect of the local regulatory environment that researchers and policy makers must focus on if they want to understand or alter single family housing density *per se*.

Other aspects of the regulatory environment such as the average time lag between permit application and approval, the number of entities that must approve any building permit or zoning change request, and whether there is some type of open meeting requirement also are associated with larger house structure sizes and lot sizes. However, none of these other regulations approach the magnitude of the impacts found for stringent minimum lot size restrictions. All this suggests that it would be beneficial for economists to expand their interest beyond minimum lot size and overall housing density. Going forward, research should more carefully study the set of components of the local regulatory environment that appear to have the largest impact on urban

[24] Experimentation with finer breakdowns showed no appreciable changes in results if we estimated impacts for homes built between 1970 and 1990 versus 1990-2019. Finally, the impacts on structure size are qualitatively the same, but quantitatively are much smaller.

form and price. Not all regulation is the same, and we should begin to identify that which is most important in terms of its influence on the urban environment.

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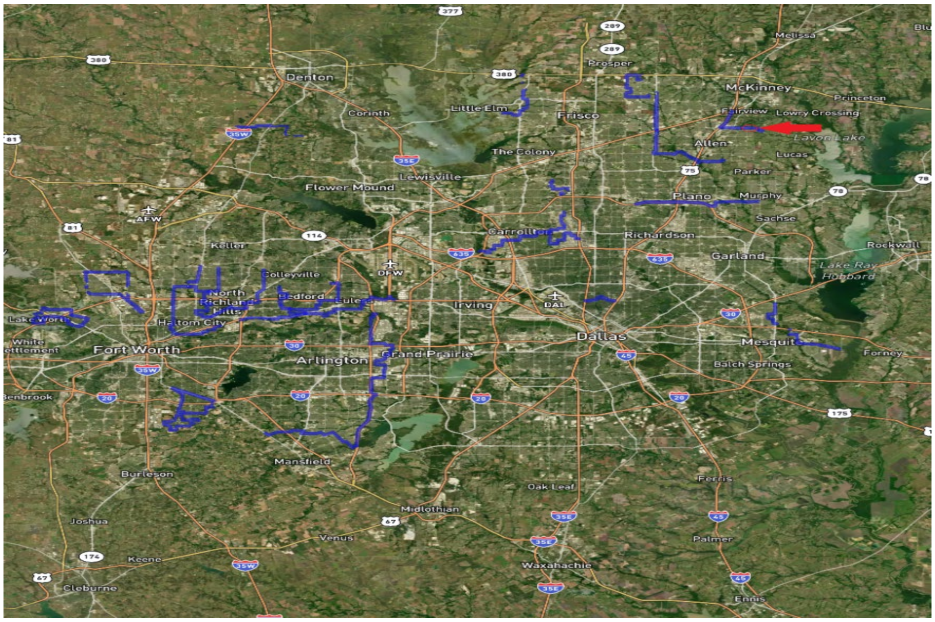
Figure 1: Border Pair Example from the Dallas, TX, Metropolitan Area

All Dallas CBSA Border Pairs, Allen City-Fairview Border at the Red Arrow



Allen City-Fairview Town Border
Border Area Boundaries Marked by Purple Lines

Table 1: Sample Characteristics by Density Restriction

	Level of Density Restriction		
	< 1/2 acre	1/2 - 1 acre	1+ acres
Dependent Variables			
Homes per Acre	1.63	1.33	0.97
	(1.01)	(0.84)	(0.82)
Median Living Area sqft	1,696	1,924	2,065
	(559)	(679)	(826)
Median Lotize sqft	8,874	13,193	19,557
	(6,172)	(11,401)	(20,066)
House Price ($2019)	$277,810	$322,290	$345,348
	(198,469)	(227,359)	($251,020)
Average Test Score	0.09 (0.41)	0.25 (0.44)	0.30 (0.39)
# Obs, Living Area/Lot Size	562,154	158,695	217,204
# Obs, House Prices	354,493	97,237	146,488
# of Border Sides	629	214	387

Note: The top panel reports the mean and standard deviation of the underlying median value of an outcome in each border area by the level of density restriction reported in a jurisdiction.

The middle panel reports the mean 3rd grade reading score for the community's school district in 2018 or the most recent year when 2018 data is unavailable from the Stanford Education Data Archive (SEDA). Here, a score of 0.09 indicates that the mean school district in the most lightly regulated communities are 0.09 grades above average, while mean scores are 0.30 grades above average in the most highly regulated communities.

House price observations in the second to last panel only report house transactions between 1990 and 2019. Micro-data is 1% Winsorized.

The bottom panel reports the number of border areas in each category of minimum lot size restriction.

Table 2: Minimum Lot Size Regressions

	(1) Homes per Acre	(2) Living Area (Square Feet)	(3) Lot Size (Square Feet)	(4) K/L Ratio	(5) Real House Price
Moderately Regulated 0.5-1.0 Acre Minimum Lot Size					
Coefficient[1]	-0.126*	43*	424	-0.003	$5,765
Marginal Impact/Standard Deviation[2]	13%	5%	3%	1%	1%
Marginal Impact/Mean[3]	9%	2%	4%	1%	1%
Most Strictly Regulated 1.0+ Acre Minimum Lot Size					
Coefficient	-0.185***	135***	2,800***	-0.010	$42,045***
Marginal Impact/Standard Deviation[2]	19%	15%	21%	6%	6%
Marginal Impact/Mean[3]	13%	7%	25%	4%	8%
Average School Quality Interquartile Range 3rd Grade Reading Scores					
Coefficient	-0.0179	83***	509	-0.004	$39,555**
Marginal Impact/Standard Deviation[2]	2%	10%	4%	3%	5%
Marginal Impact/Mean[3]	1%	4%	5%	2%	7%
Highest School Quality Top Quartile of 3rd Grade Reading Scores					
Coefficient	-0.0922	286***	2,162**	-0.001	$174,408***
Marginal Impact/Standard Deviation[2]	10%	33%	17%	1%	23%
Marginal Impact/Mean[3]	7%	15%	20%	0%	33%

Notes:

1. All regressions include 615 border pair fixed effects. Column (1) includes 1,230 observations at the border area level, while the use of parcel-level data leads columns (2)-(4) include 938,053 observations, and column (5) includes 598,218 observations. See the discussion in the next for more on the different types of specifications. A single star indicates a p-value of < 0.10, a double star indicates a p-value of < 0.05, and a triple star indicates a p-value of < 0.01. Standard errors are in parentheses.
2. Marginal Impact/Standard Deviation represents how much a one-unit change in the independent variable impacts the independent variable as a percentage of the independent variable's standard deviation, where the standard deviation is constructed using the number of observations in the regression for the full sample.
3. Marginal Impact/Mean represents how much a one-unit change in the independent variable impacts the independent variable as a percentage of the independent variable's mean, where the mean is constructed using the number of observations in the regression for the full sample.