The Influence of Regulation on Residential Land Prices in United States Metropolitan Areas

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Abstract

The authors measure how a one-unit change in the Wharton Residential Land Use Regulatory Index of overall regulatory strictness and its specific component categories raises the price of land available for new residential construction in United States metropolitan areas. This information is essential to assess the validity of claims that additional constraints on a local government's ability to impose restrictive residential land use regulations offer a means to generate more equitable and efficient outcomes in U.S. housing markets. The authors find that various measures of the stringency of local land use controls relevant to the development of residential projects do exert measurable positive influences on the average price of an acre of land available for single-family housing and thereby the price of such housing. A decrease in this regulatory stringency by one unit (or about 1 to 1.5 standard deviations from the variation observed in all metropolitan areas) could cut the price of new residential homes by about one-fourth of the standard deviation observed in residential land prices across the United States.

Introduction

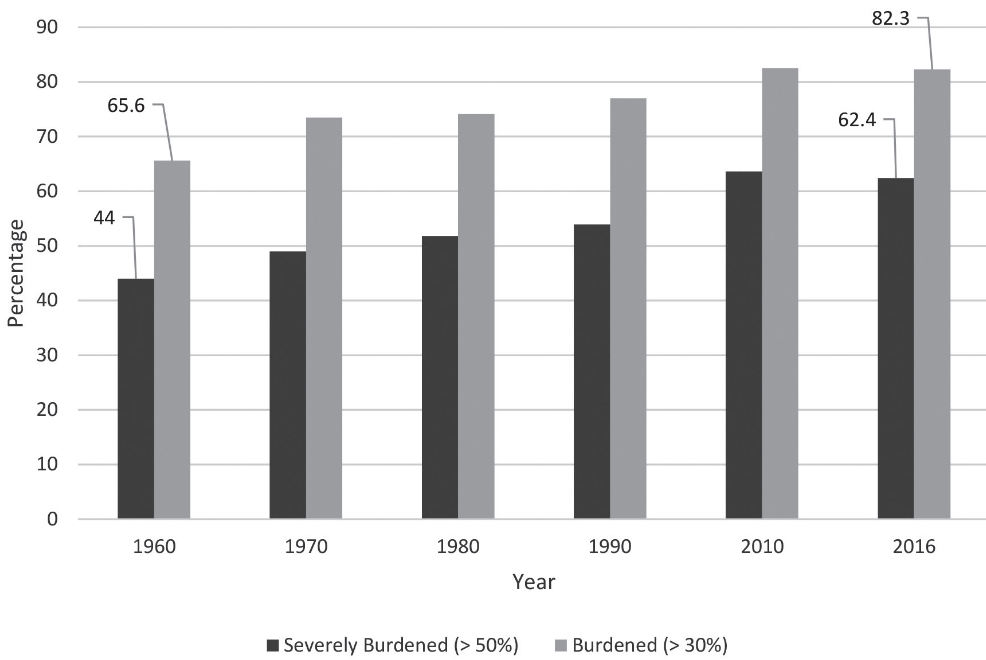
In 2016, more than 80 percent of U.S. renter households in the lowest income quartile reported spending nearly one-third of their income on housing. Moreover, 60 percent of the same households reported that shelter costs took up more than one-half of their income. Exhibit 1 illustrates that these burdens have risen over time. Note that these percentages are U.S. averages. The situation is demonstrably worse in specific metropolitan areas. In the Miami-Fort Lauderdale-West Palm Beach Metropolitan Area, more than 60 percent of all renter households devote more than 30 percent of their income to shelter. At the same time, more than one-third of these renter households devote at least one-half of their income to a landlord.[1] Such values quantify the

[1] Similar 2017 data for all U.S. metropolitan areas can be found at https://www.jchs.harvard.edu/ARH_2017_cost_burdens_by_metro.

financial stress and subsequent anxiety borne by low-income renter households throughout the United States and most renter households in many of its metropolitan areas.

Exhibit 1

Housing Cost-Burdened Renters in the United States' Bottom Income Quintile



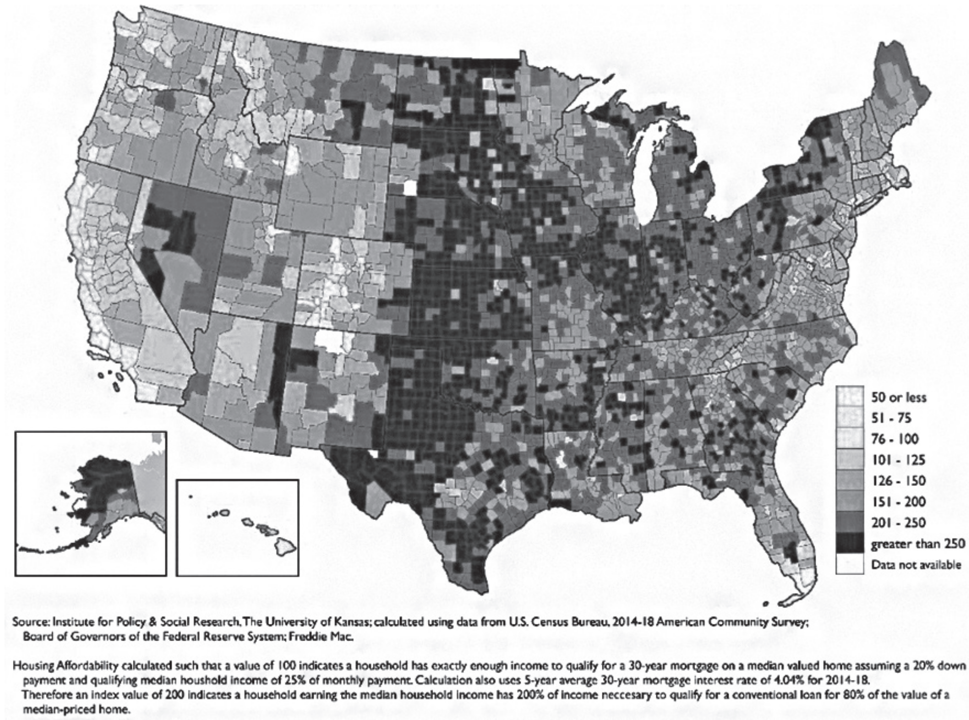
Source: Data from Appendix Table W-6 in America's Rental Housing 2017, https://www.jchs.harvard.edu/research-areas/reports/americas-rental-housing-2017

Exhibit 2 offers a 2017 index measure of homeowner affordability for every U.S. county based on median household income and the use of a conventional 30-year mortgage to finance a median-priced home. In this exhibit, black represents the greatest affordability, whereas white represent the least. The five metropolitan areas with the highest household incomes needed to purchase the median-priced home (with 20 percent down and a 30-year fixed-rate mortgage) were San Jose ($259K), San Francisco ($199K), San Diego ($132K), Los Angeles ($123K), and Boston ($107K). Understanding the hardship that high rents and home prices impose on low-income households throughout the country, it is not a surprise that more than three-fourths of Americans designate this a crisis.[2]

[2] A September 2019 poll by the National Association of Home Builders (2019) indicates that nearly 8 of 10 Americans believed that the United States suffers from a housing affordability crisis.

Exhibit 2

Housing Affordability Index in the United States, by County, 2014–18



Source: https://ipsr.ku.edu/sdc/images/HousingAffordUS.jpg, permission for use granted by Xan Wedel of Kansas State Data Center

The full extent of concern over the information contained in exhibits 1 and 2, however, must also include the realization that the high costs of renting or owning shelter extend beyond the household by effectively discouraging (encouraging) labor mobility into (out of) the most productive metropolitan areas in the United States. A metropolitan area's capacity to experience the growth in employment necessary for a healthy local economy depends on whether its housing market offers shelter to present and future residents at an affordable price. Since the early 1980s, real housing costs throughout the United States have risen faster than inflation-adjusted construction costs. Saks (2008) finds that local governments' strict residential land use regulations increase the inelasticity of the long- and short-run housing supply in a metropolitan area. Gyourko and Molloy (2015) offer a definitive summary of how local building codes and land use regulations reduce housing supply, increase price inelasticity, and raise local housing prices. Because migration into a metropolitan-wide labor market is the primary means through which increases in local demand are satisfied, Gyourko and Molloy assert that "the constraints imposed by regulation could have a meaningful influence on the economic health of local communities" (p. 1327). Glaeser (2020) offers an updated and eloquent explanation of the same concern and designates it "The Closing of America's Urban Frontier." For both the social justice reason that the burden of high housing costs falls on low-income households and the economic efficiency concern of reducing the country's economic productivity, the authors desire to measure the influence of regulation on housing prices across U.S. metropolitan areas.

A metropolitan area is the appropriate unit of analysis for this study because a household's employment and shelter opportunities are usually limited to this region. Glaeser and Gyourko (2018) note that it is difficult to quantify the relative strictness of residential housing and land use regulations in one U.S. metropolitan area with another due to the practice of ceding these choices to local governments. Nevertheless, previous studies have examined the effects of local residential land use regulations on the supply and consequent housing prices. Such regulations include minimum lot sizes, population density restrictions, and urban growth boundaries. The reduction of adverse local externalities through locally controlled land use regulation is a justification commonly cited by such regulations' proponents. Although there is truth to this rationale, there also exists a darker side. Responding to the persistent requests of established residents, local governments frequently implement housing and land use regulations with the motive of preserving neighborhood "character" by prohibiting alternative housing forms and deterring potential low-income or minority residents from moving in.[3]

Excessive residential land use regulation in some metropolitan regions has created both equity concerns and efficiency losses. Glaeser, Gyourko, and Saks (2006) establish that with an inelastic supply of housing to a metro area, increased local labor demand raises housing prices without equivalent higher nominal wages. Such a change decreases decreasing real wages for the local workforce. The result is a spatial misallocation of labor between high-skill workers who can afford to remain in the locality and low-skill workers compelled to seek housing and employment elsewhere. As found in Ganong and Shoag (2017), these effects are durable over time and impede a locality's ability to respond efficiently to sudden shocks in labor supply and demand.

This article describes a study that measures the influence of residential land use regulations on housing prices in U.S. metropolitan areas after 5 or more years of enactment. This measurement is made possible through the Wharton Residential Land Use Regulatory Index (WRLURI). Gyourko, Saiz, and Summers (2008) use survey-obtained information from 2006 on regulatory practices from the 2,649 U.S. localities responding to a nationwide survey to construct the WRLURI. These responses led to the creation of two statewide component measures (including state court or legislative behavior) and nine categories of local regulatory behavior, including political pressure, zoning/project approval, land assembly, supply/density restrictions, exactions, and approval delays. The aggregation of these 11 components yields a WRLURI value for each state and unique WRLURI values for 47 metropolitan areas with 10 or more jurisdictions within them responding.[4]

In this empirical investigation, we proxy for the housing price in a specific metropolitan area through the estimated selling price for an acre of land zoned for new residential housing in the

[3] See Wassmer and Wahid (2019) for a further discussion, an empirical investigation related to "Not-In-My-Backyard" (NIMBY) motivations, and a thought-provoking suggestion on how to overcome it.

[4] Gyourko, Hartley, and Krimmel (2019) gathered similar information on local housing and residential land use regulatory environment for 2018. This 2018-based regulatory index uses slightly different component measures and thus is less than entirely comparable to the 2006 WRLURI. The 2018 regulatory index exists for only 44 metropolitan areas, of which only 38 are the same as reported for 2006.

appropriate county or a population-based aggregation of the appropriate counties (Davis et al., 2019). As demonstrated by Glaeser and Gyourko (2018), the primary reason for variations in the price of similarly built homes across U.S. metropolitan areas is the difference in residential land prices between them, not differences in their physical construction costs. The authors measure how a one-unit change in an index of overall regulatory strictness and its specific component categories raises the price of land available for new residential construction in U.S. metropolitan areas. This information is essential to assess the validity of claims that imposing constraints on local governments' ability to impose restrictive residential land use regulations offers an effective means to generate more socially equitable and economically efficient outcomes in U.S. housing markets.

The authors begin their investigation by reviewing the previous literature on this topic through three themes essential for a complete understanding of the analysis. They follow this review with a simple model of the expected determinants of typical residential land prices in a metropolitan area. The authors then describe the data used in the regression analysis and describe this model in greater detail. The regression results and organization tables follow in the subsequent section. In conclusion, the authors offer a summary of their findings and recommendations for future interventions.

Previous Research

Three central themes offer the basis of the authors' review of previous research on the influence of regulation on housing prices. These are (1) the motivations behind imposing land use regulations and the outcomes of them, (2) the factors that determine residential land prices, and (3) the conclusions of earlier empirical studies regarding the magnitude of influence of different forms of regulation on housing prices or rents.

Motivations and Outcomes of Local Land Use Regulation

Gyourko and Molloy (2015) offer a comprehensive summary of this form of regulation's theoretical determinants in their overview of work on regulation and housing supply. In this summary, Fischel's (2001) "homevoter hypothesis" is a central element due to its focus on the voters' desire to use local development restrictions as a tool to maximize or preserve their home values. Gyourko and Molloy conclude that there is scant empirical evidence that jurisdictions with a higher fraction of homeowners adopt stricter residential land restrictions. They add that this is likely due to a lack of sufficient time-series data necessary for an analysis that addresses omitted variable and reverse causality concerns. However, they also conclude that developers and owners of potential land for residential development influence the local regulatory environment for their benefit and describe several studies that support this claim.

Cheshire and Sheppard (2002) hypothesize that the adoption of local land use regulations provides four categories of community benefits: (1) lowering the overall cost of providing public goods to residents, (2) limiting negative externalities caused by incompatible land uses, (3) generating new public goods and amenities for residents, and (3) maximizing the price obtainable (diminishing deadweight loss) by landowners. Chakraborty et al. (2010) describe three similar motivations for enacting local land use regulations: (1) minimizing negative externalities, (2) attracting fiscally net-positive development projects, and (3) excluding low-income and racial or ethnic minority populations. Gyourko, Saiz, and Summers (2008) report a strong correlation between measures of a community's income or wealth and the degree of its regulatory stringency toward residential development. Glaeser and Gyourko (2018) note that the potential dollar value of negative externalities—unrelated to the income, education, class, and race or ethnicity of a neighbor—do not justify the costs to a community of imposing restrictive building regulations at the level used in many U.S. jurisdictions.

Regardless of motive, previous research demonstrates that local land use regulations create detectable impacts on communities enacting them. For example, Chakrabarti and Zhang (2015) find that high land rents in a California city resulting from a restrictive regulatory environment producing a smaller and more inelastic supply of land for residential development ultimately result in slower employment growth for that city. Ganong and Shoag (2017) find that variations in housing affordability across U.S. metropolitan areas result in a spatial misallocation of the national labor force. This misallocation is due to low-skill workers seeking housing and employment outside high-productivity areas that are more likely to be heavily regulated. Hsieh and Moretti (2017a, b) conclude that the outcome is a staggering loss in overall U.S. gross domestic product (GDP). Additionally, Lens and Monkkonen (2016) correlate the degree of stringency in regulation in large U.S. cities with greater neighborhood segregation by income.

Determinants of Residential Land Prices

Cheshire and Sheppard (2002) theorize that the price of a vacant urban lot varies with surrounding amenities and its proximity to local employment centers. Local land use regulations can influence both the supply of local land available for residential development and its demand. Chakraborty et al. (2010) note, however, that the separate influences of these supply and demand effects are difficult to isolate. On the supply side, land use regulations decrease the local elasticity of housing supply by increasing time delays in the permit process and other associated costs of building new housing (Hilber and Vermeulen, 2016; Paciorek, 2013). On the demand side, regulations can also increase local demand for housing through the creation of new amenities and by serving as a signal to established homeowners the local political commitment to preserving the resale value of existing homes by restricting the construction of additional housing in the area (Kahn, Vaughn, and Zasloff, 2010).

Brueckner (2009) and Helsley and Strange (1995) use economic theory to respectively show the anticipated effect of a single jurisdiction adopting residential land use controls and the anticipated effect in a system of cities where such regulations vary across them. For most regulation forms, the result is higher land rents, a reduced local supply of housing, and subsequently higher house prices when considering a city in isolation. In cities with mobility, residents crowd into the unregulated city due to the greater housing availability and the lower market price. If the resulting congestion reaches an undesirable level, however, some households relocate and bid up housing prices and rents in the regulated communities lacking similar congestion. Higher housing prices in more regulated cities is the result achieved in both models.

Empirical Measurements of Residential Land Use Price Impact on Home Prices

Quigley and Rosenthal (2005) examine 40 empirical studies attempting to discern the relationship between residential land use regulation and housing prices. They conclude that these studies did not "establish a strong, direct causal effect because variations in both observed regulation and methodological precision frustrate sweeping generalizations" (2005: 69). Ten years later, Gyourko and Molloy (2015) summarize the same research and conclude that greater regulation leads to less housing supply and higher prices. Improvements in methodological practices since the 2005 survey and Gyourko and Molloy's choice to trust the findings only of surveys that used the new techniques yielded the difference in these conclusions. Even so, Gyourko and Molloy remain somewhat wary of the primarily cross-sectional data sets used to produce these findings due to a greater likelihood of omitted variable and reverse causality biases.

Zabel and Dalton (2011) find that raising the local minimum lot size by 1-acre (1.5 standard deviations) results in nearly a 10-percent increase in local house prices. Jackson (2014) similarly finds that adding one additional land use regulation in an existing community reduces local residential building permits issued by between 4 and 8 percent. Glaeser and Gyourko (2018) compare home prices in 98 metropolitan areas with the minimum profitable production cost (MPPC) of houses in those areas. They report the percentage of markets in which an average home priced substantially above the MPPC rose from 6 percent to 16 percent between 1985 and 2013. They attribute this result to excessive land use and building regulations rather than increases in house construction's physical cost.

Several studies demonstrate that housing price increases due to regulatory effects are quite large. Hilber and Vermeulen (2016) compare panel data on house prices and earnings in 353 local planning authorities (LPAs) in England between 1974 and 2008 with regulatory or physical constraint data in the same places and times. They conclude that house prices in the average English LPA would be about 20 to 40 percent lower by eliminating regulatory restraints on residential land use. Kahn, Vaughn, and Zasloff (2010) use a 1970-to-2000 panel data set to examine homes in California's Coastal Boundary Zone (CBZ) compared with homes outside the CBZ but within the same census tract. They find average home prices within the CBZ to be about 25 percent higher than average home prices outside it. As emphasized in Gray (2019), these empirical studies indicate that land use regulations can substantially affect local housing prices.

A Simple Model of Residential Land Price Determinants

To conduct a regression analysis absent omitted variable bias, one must first specify a theoretical model of the determinants of the dependent variable. The dependent variable under investigation is the price of a fixed type of a new home situated on a specified amount of land in the average community in different U.S. metropolitan areas over different years. The authors begin with equation (1), which assumes that the primary determinant of metropolitan area differences in new house prices is the typical price of an acre of residential land in the area.[5] Equation (2) indicates that such a price varies by the degree of local demand for residential land and its available supply. In equation (3), the authors account for differences in demand for residential land by metropolitan area

[5] As documented in RSMeans (2019) data on building construction cost differences across the United States, the authors recognize that the cost to construct a specific type of home varies somewhat based on the metro area in which the home is built. As noted by Glaeser and Gyourko (2018: 5–6), however, Gyourko and Saiz (2006) found the variance of such costs much smaller than differences in housing price, and thus it is reasonable to assume a single production cost.

population, nominal GDP, and the number of existing housing units. The limits of data availability drive the simple nature of this equation. Metropolitan area GDP approximates the degree of nonresidential demand for available land and differences in household incomes. There should also be less demand for available residential land in areas that already have many existing housing units.

As noted in equation (4), constraints on the supply of land available for new residential activity include the metropolitan area's square miles, the percentage of those miles found to be under water and thus undevelopable, and the presence of regulation. The authors also employ Saiz's (2010) measure of undevelopable land that includes both acreage under water and with a gradient too steep for viable housing construction. Due to endogeneity concerns, explanatory variables are from 2010 or earlier, which is at least 2 years before the yearly values (2012 to 2015) used for the dependent variable of the price of an acre of residential land. Equation (5) concludes the authors' regression model with a list of the various ways that they measure the strictness of the housing and residential land use regulatory environment in a U.S. metropolitan area. Specific details on the 19 different ways chosen to account for that environment follow in the next section, which describes the data sources and derivations.

$$\text{House Price}_{i,t} = f\,(\text{Acre\_Residential\_Land\_Price}_{i,t}); \quad (1)$$

where,

$$\boldsymbol{\mathit{Acre\_Residential\_Land\_Price}_{i,t}} = f(\text{Demand for Resid Land}_{i,t}, \text{Supply of Resid Land}_{i,t}); \quad (2)$$

where,

$$\text{Demand for Resid Land}_{i,t} = f(\mathbf{Population\_2010}_i, \mathbf{GDP\_2010}_i, \mathbf{Housing\_Units\_2010}_i); \quad (3)$$

and

$$\text{Supply of Resid Land}_{i,t} = f(\mathbf{Square\_Miles\_2010}_i, \mathbf{Perc\_Water\_2010}_i \text{ or } \mathbf{Saiz\_Perc\_Undev\_Land\_2010}_i, \mathbf{Residential\ Land\ Use\ Regulation}_i); \quad (4)$$

where,

$$\text{Residential Land Use Regulation}_i = (\mathbf{WRLURI\_State\_2006}_i \text{ or } \mathbf{WRLURI\_Metro\_2006}_i \text{ or } \mathbf{WRLURI\_State\_Lag6}_i \text{ or } \mathbf{WRLURI\_Metro\_Lag6}_i \text{ or } \mathbf{Saks\_House\_Reg\_Index}_i \text{ or } \{\mathbf{Loc\_Pol\_Press\_Index}_i, \mathbf{State\_Pol\_Inv\_Index}_i, \mathbf{State\_Court\_Inv\_Index}_i, \mathbf{Loc\_Zoning\_App\_Index}_i, \mathbf{Loc\_Proj\_App\_Index}_i, \mathbf{Loc\_Assem\_Index}_i, \mathbf{Supply\_Restric\_Index}_i, \mathbf{Density\_Restric\_Index}_i, \mathbf{Open\_Space\_Index}_i, \mathbf{Exactions\_Index}_i, \mathbf{Approv\_Delay\_Index}_i\}); \quad (5)$$

where,

i = 1 to a various number of United States Metropolitan/Micropolitan Statistical Areas,
t = 2012, 2013, 2014, and 2015.

The authors have included the explanatory variables described as controls necessary to isolate the independent effects of the different forms of regulation noted in equation (5). Also included in this panel-data regression analysis are 2013, 2014, and 2015 dummy variables to account for the year fixed effects relative to the year excluded of 2012. The authors also add a dummy explanatory variable set equal to 1 for the 62 percent of metro areas consisting of only one county. Unfortunately, it is impossible to include metro-specific fixed effects in this model due to data on regulation measures being only available for 1 year and thus fixed across a metro area.[6]

Data

Exhibit 3 provides a brief description of each variable in the regression model and its source. Exhibit 4 subsequently provides descriptive statistics for the same variables. The authors draw the dependent variable of this regression analysis (Acre_Residential_Land_Price) from a Federal Housing Finance Agency (FHFA) data set created by Davis et al. (2019). They describe the methodology used to capture differences in the typical value of an acre of land available for single-family home development in a U.S. county. The method does not rely upon the assessed value of land under a home generated by local governments for property tax purposes, nor does it rely upon data from vacant land sales zoned for residential development. Instead, it uses a database of more than 16 million home appraisals conducted between 2012 and 2018—as required by Fannie Mae, Freddie Mac, and other government-sponsored enterprises (GSEs) for mortgage default protection—that represent more than 80 percent of all single-family homes in the country. Davis et al. then determine land values under each of these privately appraised single-family houses by subtracting the housing structure's depreciated replacement cost. A potential cause for concern with this method is that some homes sell for less than the structure's replacement cost. An investigation of this occurrence by Davis et al. indicates that it is highly unlikely in homes less than 10 years old; thus, they limit their calculation to these homes (about 8 million) and also use a broadly accepted method of adjusting for the influence of lot size on land prices. Finally, they interpolate land price per acre for single-family homes less than 10 years old (obtained through CoreLogic, Inc. data) without a GSE assessment report. To inspire even greater confidence in their results, they use the data to conform to stylized facts concerning U.S. land prices for single-family homes. The authors aggregated the county values reported in this research up to the equivalent multi-county metropolitan areas based on population weights. Somewhat astonishingly, they discovered that the price of an acre of land available for residential development in the 347 U.S. metropolitan areas observed from the 4 years of 2012 through 2015 ranges from a maximum of $4,392,128 in 2015 (San Francisco-Oakland-Hayward, CA metropolitan statistical area [MSA]) to a minimum of $67,928 in 2013 (Savannah, GA MSA).

[6] This is also the case for Perc_Water_2010 or Saiz_Perc_Undev_Land_2010. The authors tried a full year and metropolitan area fixed effects panel-data estimation using a WRLURI index varying by year calculated through a linear extrapolation of the WRLURI 2006 to 2018 values discussed earlier. This estimation required the exclusion of the 2010 control variables and is perhaps an explanation for the authors' finding of the statistical insignificance of WRLURI measures in a panel-data regression analysis including both metropolitan area and time fixed effects.

Exhibit 3

Variable Description and Source (1 of 2)

Variable Name	Description	Source
Acre_ Residential_ Land_Price	Approximation of the selling price of an acre of land available for single-family home construction based on appraisal values for a home less than 10 years old with the land price determined by subtraction of home replacement cost with adjustments. Value calculated for the county and aggregated to the metropolitan area using population weights.	Davis et al. (2019)
Population_2010	Metropolitan area population derived from the 5-year American Community Survey data.	https://data.census.gov/cedsci/
GDP_2010	Metropolitan area all-industry gross domestic product.	https://www.bea.gov/data/gdp/gdp-county-metro-and-other-areas and Panek, Rodriguez, and Baumgardner (2019)
Square_ Miles_2010	Metropolitan area square miles, including inland water, coastal water, territorial sea, and the Great Lakes (allowing a maximum of 3 miles off the coastline).	https://data.census.gov/cedsci/ https://www2.census.gov/geo/pdfs/reference/GARM/Ch15GARM.pdf
Perc_ Water_2010	Percentage of metropolitan area square miles, including inland water, coastal water, territorial sea, and the Great Lakes (allowing a maximum of 3 miles off the coastline).	https://data.census.gov/cedsci/ and https://www2.census.gov/geo/pdfs/reference/GARM/Ch15GARM.pdf
Saiz_Perc_ Undev_ Land_2010	Percentage of undevelopable land within 50 kilometers of the metropolitan area's central city that exhibits a slope greater than 15 percent and consists of wetlands, lakes, rivers, and international bodies of waters. For 95 metropolitan areas with a population greater than 500,000 in 2010.	Saiz (2010)
Housing_ Units_2010	Total of houses, apartments, group of rooms, or a single room occupied or intended for occupancy as separate living quarters in a metropolitan area based on 5-year American Community Survey data.	https://data.census.gov/cedsci/
WRLURI_ State_2006	A higher value measures a more restrictive residential land use environment for the state in which the metropolitan area is primarily located—based on values discussed below from Loc_Pol_Press_Index to Approv_Delay_Index. Index calculation details in the source.	Gyourko, Saiz, and Summers (2008)
WRLURI_ Metro_2006	As above, but precisely calculated for the 47 metropolitan areas, with survey results from 10 or more localities in the metropolitan area.	Gyourko, Saiz, and Summers (2008)
WRLURI_Metro_ Expand_2006	As above, but precisely calculated for the 99 metropolitan areas, with survey results from five or more localities in the metropolitan area. The authors calculated with the source-provided data.	Gyourko, Saiz, and Summers (2008)
WRLURI_ State_Lag6	Like WRLURI_State_2006, but 2006 through 2009 yearly values based on a linear extrapolation between 2006 index value in Gyourko, Saiz, and Summers (2008) and 2018 index value reported in source for 77 metropolitan areas.	Gyourko, Hartley, and Krimmel (2019)

Exhibit 3

Variable Description and Source (2 of 2)

Variable Name	Description	Source
WRLURI_ Metro_Lag6	Like WRLURI_Metro_2006, but 2006 through 2009 yearly values based on a linear extrapolation between 2006 index value in Gyourko, Saiz, and Summers (2008) and 2018 index value reported in source for 38 metropolitan areas.	Gyourko, Hartley, and Krimmel (2019)
WRLURI_Metro_ Expand_Lag6	WRLURI_Metro_Expand_2006, but 2006 through 2009 yearly values based on a linear extrapolation between 2006 index value in Gyourko, Saiz, and Summers (2008) and 2018 index value reported in source for metropolitan areas.	Gyourko, Hartley, and Krimmel (2019)
Saks_House_ Reg_Index	A six-source index for which a higher value represents a more restrictive residential regulatory environment for the 75 metropolitan areas for which the source calculated. Index calculation details are in the source, with all six sources measured from before 2010.	Saks (2008)
Loc_Pol_ Press_Index	Positively reflects the 2006 degree of local actors' involvement in the development process and the standardized number of land preservation initiatives on the ballot between 1996 and 2005.	Gyourko, Saiz, and Summers (2008)
State_Pol_ Inv_Index	Positively reflects 2005 state-level legislative and executive branch activity in land use regulation and 2006 survey response of local officials to how involved state is in local residential building activity.	Gyourko, Saiz, and Summers (2008)
State_Court_ Inv_Index	Positively represents the state appellate courts' relative level of intervention to overrule or restrain locally enacted land use regulations.	Gyourko, Saiz, and Summers (2008)
Loc_Zoning_ App_Index	Records the number of regulatory organizations necessary to approve a local zoning change for a specific development project.	Gyourko, Saiz, and Summers (2008)
Loc_Proj_ App_Index	Records the number of regulatory organizations necessary to approve a specific local development project without requiring a zoning change.	Gyourko, Saiz, and Summers (2008)
Loc_Assem_ Index	A dummy value equal to 1 for the presence of a town hall meeting requirement in New England jurisdictions to approve a zoning change.	Gyourko, Saiz, and Summers (2008)
Supply_Restric_ Index	Records the number of positive responses to questions about statutory limits on annual building permits issued by a locality.	Gyourko, Saiz, and Summers (2008)
Density_Restric_ Index	A dummy value equal to 1 for the presence of a locally mandated 1-acre minimum lot-size requirement for land development.	Gyourko, Saiz, and Summers (2008)
Open_Space_ Index	Equals 1 if homebuilders in the locality are subject to open-space requirements or must pay fees in place of such, and zero if not the case.	Gyourko, Saiz, and Summers (2008)
Exactions_Index	A dummy value equal to 1 if developers pay their allocable share of the costs of infrastructure improvements for a project, and zero if not the case.	Gyourko, Saiz, and Summers (2008)
Approv_Delay_ Index	Indicates the difference in average months between building permit application and the builder's final receipt for a given project in a locality.	Gyourko, Saiz, and Summers (2008)

Exhibit 4

Descriptive Statistics

Variable Name	Observations	Mean	Standard Deviation	Minimum	Maximum
Acre_Residential_ Land_Price	1,388	194,587.90	327,111.20	67,927.51	4,392,128.28
Population_2010	1,388	718,703.95	1,614,975.00	29,393.00	18,897,109.00
GDP_2010 (1,000s)	1,388	36,996,198.90	99,216,920.46	1,708,671.00	1,286,777,512.00
Square_Miles_2010	1,388	2,675.74	3,038.96	31.22	27,408.25
Perc_Water_2010	1,388	13.06	31.17	0.0224	254.24
Saiz_Perc_Undev_ Land_2010	336	24.51	20.19	0.9300	79.6400
Housing_Units_2010	1,388	299,540.23	638,543.42	15,595.00	7,527,752.00
WRLURI_State_2006	1,388	-0.1186	0.6270	-1.13	2.32
WRLURI_Metro_2006	168	0.2224	0.6168	-0.80	1.79
WRLURI_Metro_ Expand_2006	396	0.2744	1.12	-1.19	7.50
WRLURI_State_Lag6	308	0.2528	0.9346	-1.19	7.50
WRLURI_Metro_Lag6	152	0.2799	0.5715	-0.8000	1.79
WRLURI_Metro_Expand_Lag6	308	0.2528	0.9346	-1.19	7.50
Saks_House_Reg_Index	300	-0.0665	1.01	-2.40	2.21
Loc_Pol_Press_Index	396	0.1175	0.6030	-0.7887	3.07
State_Pol_Inv_Index	396	0.0379	0.8914	-1.71	2.42
State_Court_Inv_Index	396	2.09	0.7077	1.00	3.00
Loc_Zoning_App_Index	396	2.01	0.3281	1.27	2.95
Loc_Proj_App_Index	396	1.61	0.4805	0.3657	3.63
Loc_Assem_Index	396	0.0556	0.2193	0.00	1.70
Supply_Restric_Index	396	0.2240	0.4138	0.00	2.48
Density_Restric_Index	396	0.2472	0.2314	0.00	1.00
Open_Space_Index	396	0.6042	0.2327	0.0734	1.00
Exactions_Index	396	0.7600	0.2083	0.1928	1.00
Approv_Delay_Index	396	5.96	2.32	0.00	14.79
Single_County_Dummy	1,388	0.6174	0.4862	0.00	1.00

Source: As listed in the last column of Exhibit 3

Also deserving further description is the authors' use of the lagged 2010 values of all industry GDP in U.S. metropolitan areas to account for this demand influence expected to drive up residential land prices in later years. The Bureau of Economic Analysis (BEA) produced these new estimates of metropolitan-wide GDP because previous subnational economic activity measures depended solely on labor data. The new GDP estimates better capture capital-intensive industries' output by relying on business revenue and production value data. Comparing their prototype GDP values to earlier earnings-based approaches, Panek, Rodriguez, and Baumgardner (2019) found the mean-absolute-percent-difference (MAPD) between estimates for the labor-intensive industries of services and government at around 4 percent. At the same time, it is near 14 percent for goods-producing industries. This divergence level indicates consistency in their estimation of production value in labor-intensive forms and additional output information now captured for more capital-intensive industries.

The explanatory variables of the 2010 values for metropolitan area population, housing units, and square miles all came from U.S. Census sources. As noted earlier, the authors desire a measure of the square miles that make up a metro area to account for all land potentially available for new housing development. The Census measure includes uninhabitable water areas found within a metropolitan area and up to 3 miles off coastlines (including the Great Lakes). To control for the fact that this land is undevelopable, they include the percentage square of miles in a metropolitan area covered by water. Saiz (2010) has taken this one step further and calculated for 95 metropolitan areas an expanded measure that determines land within 50 kilometers of a metro area to be undevelopable if covered by water or at a steeper-than-15-percent topographic grade. The authors use his reported percentage value in an alternative regression specification.

The authors are indebted to the previous derivations of Gyourko, Saiz, and Summers (2008); Gyourko, Hartley, and Krimmel (2019); and Saks (2008) for the measures of variation in regulatory stringency used in this analysis. The widely used WRLURI assesses local regulations' relative stringency related to new housing development. The index stems from a 2006 survey of nearly 7,000 local governments in the United States, of which about one-third responded. Gyourko, Saiz, and Summers aggregated these responses and relevant information from other sources into an index value for the 47 metropolitan areas where at least 10 or more localities in the area offered a response. As recorded in Table 11 of Gyourko, Saiz, and Summer (2008: 713), the calculated WRLURI ranged from the most restrictive at 1.79 for the Providence-Fall River-Warwick, RI-MA, MSA; to the least restrictive at -0.80 for the Kansas City, MO-KS, MSA. The authors record these values as the WRLURI_Metro_2006 explanatory variable in their regression.

As recorded in Table 10 of Gyourko, Saiz, and Summers (2008: 711), a similar index calculated at the state level results in Hawaii registering as most obstructive at 2.32 and Kansas the least at -1.13. The authors use these values as the WRLURI_State_2006 explanatory variable in their regression. The authors realize that the metropolitan-specific index better represents a metropolitan area's regulatory environment; however, it comes with a dramatic reduction in the number of metropolitan areas available for the authors' regression analysis (from 347 to 47). The authors chose to recalculate the metropolitan index to expand the number of metropolitan areas they could use, using the original survey data for metropolitan areas with at least five surveys returned from localities within them.[7] This variation more than doubles the metropolitan areas included in the index (from 47 to 99) and yields the explanatory variable WRLURI_Metro_Expand_2006.

To increase their arsenal of explanatory variables accounting for the influence of regulatory stringency in U.S. metropolitan areas on residential land prices between 2012 and 2015, the authors use an updated version of the WRLURI created by Gyourko, Hartley, and Krimmel (2019) based on 2018 survey data. The comparison between the 2006 and 2018 WRLURI values are not

[7] Gyourko, Saiz, and Summers (2008) generously offer this data to the public at http://real-faculty.wharton.upenn.edu/gyourko/land-use-survey/.

perfect due to slight differences in the sub indexes used to generate the data. Even so, the authors deem the values close enough to generate three new explanatory variables (WRLURI_State_Lag6, WRLURI_Metro_Lag6, and WRLURI_Metro_Expand_Lag6) that take on the WRLURI interpolated values for years 2006 through 2009, representing a 6-year lag to the acre price of residential land used for 2012 through 2015.

The authors would be remiss not to take advantage of a separate Saks (2008) index measure of the degree of housing supply regulation in 75 of the U.S. metropolitan areas used here. Her index, with larger values, again representing greater difficulty likely encountered in the building of new homes, ranges from 2.21 for the New York, NY MSA to -2.40 for Bloomington-Normal, IL MSA. This regulation index's basis is local government officials answering 24 survey questions across four different land use and housing-related surveys taken in the mid-1970s to the late 1980s. Consequently, in the authors' second regression specification using the Saks_House_Reg_Index to account for a metropolitan area's regulatory environment, any potential concern for this index's endogenous nature with residential land prices from the early to mid-2000s is not an issue.

Lastly, one of this research study's core goals is to detect the influence of the 11 different subindexes that Gyourko, Saiz, and Summers (2008: 698–702) develop to generate the aggregated WRLURI. Table 1 in Gyourko, Saiz, and Summers contains a brief description of what each subindex entails, beginning with the entry on the Loc_Pol_Press_Index and continuing through the Approv_Delay_Index. Gyourko, Saiz, and Summers do not report subindex values for separate metros. Still, the authors calculate them using the base survey results that are publicly available and the same aggregation method of restricting calculation to only those areas with 10 or more local observations or going with the 5 or more observations additionally used here. The tradeoff in this choice is again between potentially greater accuracy with a requirement of 10 or more metropolitan areas or a larger sample with a lesser requirement of 5 or more. Having tried both, the authors decided to report regressions using the five-sample calculation due to greater statistical significance and no large differences in calculated signs and magnitudes of influence.

Regression Analysis and Results

As specified earlier in equations (1) through (5), the authors record the results of 38 different regressions in exhibits 5 and 6. The distinction between the two tables is that the first uses the percentage of a metropolitan area's square miles covered by water as the supply-side constraint. The second uses Saiz's (2010) expanded measure that includes land at too steep a gradient for development. Multicollinearity—that biases the reported regression coefficient standard error downward and makes it more likely to find the variables statistically insignificant—among the explanatory variables included in these regressions may be an issue. The calculation of variance inflation factors (VIFs) for each explanatory variable yielded the multicollinearity concern of a VIF far larger than five for the population, housing units, and GDP measures. There was no detected concern for any other explanatory variables, including the regulatory measures. An investigation of the potential issue of heteroskedastic standard errors in the estimated regression coefficients through a Breusch-Pagan/Cook-Weisburg (Baum, 2001) rejected ($p < 0.00$) the null hypothesis of its absence in this regression. Consequently, the authors report robust standard errors clustered by the metropolitan area for all regression coefficients.

Exhibit 5

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Perc_Water_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (1 of 3)

Variable Name	1	2	3	4	5	6	7
Population_2010	0.1812	0.0544	0.0842	0.0724	0.1068	0.0748	0.1631
	(0.1540)	(0.1564)	(0.1587)	(0.1361)	(0.1327)	(0.1744)	(0.1488)
GDP_2010	0.0051***	0.0063***	0.0053**	0.0051***	0.0060**	0.0058**	0.0038**
	(0.0018)	(0.0022)	(0.0022)	(0 .0018)	(0.00256	(0.0024)	(0.0018)
Square_ Miles_2010	8.03**	6.85	5.52	7.02**	1.75	7.91	-6.50
	(3.29)	(6.42)	(8.01)	(3.31)	(11.28)	(9.40)	(8.12)
Perc_Water_2010	2,506.41*	436.33	1,483.21	984.18*	343.62	1,015.94	3,751.56
	(1,325.47)	(1386.73)	(975.94)	(567.70)	(1,285.07)	(1,194.88)	(2,493.51)
Housing_ Units_2010	-1.05***	-0.9840***	-0.8472***	-0.7732***	-1.07***	-0.9190***	-0.8576***
	(0.27)	(0.3619)	(0.2957)	(0.1990)	(0.3550)	(0.3326)	(0.2229)
WRLURI_ State_2006	**154,443.80*** **						
	(25,443.25)						
WRLURI_ Metro_2006		**271,285.60** **					
		(122,762.80)					
WRLURI_Metro_ Expand_2006			**104,224.20*** **				
			(23,580.39)				
WRLURI_ State_Lag6				**154,599.30*** **			
				(26,071.75)			
WRLURI_ Metro_Lag6					**338,685.30** **		
					(146,389.50)		
WRLURI_Metro_ Expand_Lag6						**135,782.80*** **	
						(37,307.10)	
Saks_House_ Reg_Index							**229,518.60*** **
							(64,547.52)
Single_County_ Dummy	-4,185.17	195294.70	-48,478.85	-3,990.45	186,014.90	-6,6439.73	139,212.50
	(24,943.55)	(208233.20)	(71,070.95)	(24,442.72)	(203,038.6,)	(85,653.81)	(91,962.45)
Year_2013_ Dummy	7,854.67***	33,535.32**	15,463.94***	2,649.09	36,336.22**	21,111.16***	26,727.44***
	(1,995.65)	(13,069.32)	(4,784.98)	(1,652.47)	(13,941.55)	(6,451.52)	(9,248.815)
Year_2014_ Dummy	25,420.02***	82,977.62**	43,433.59***	16,555.05***	89,852.44**	58,017.64***	71,861.12***
	(4,993.92)	(31,166.16)	(13,451.22)	(4,115.79)	(3,3941.33)	(17,753.51)	(20,523.37)
Year_2015_ Dummy	38,234.22***	118,748.40**	63,623.4***	26,040.88***	130,948.20**	85,211.3***	106,672.00***
	7,348.05	(48,808.15)	(20,716.36)	(6,029.16)	(51,830.50)	(27,309.62)	(30709.64)
Constant	139,871.70***	245,475.60**	150,533.20**	150,810.20***	236,229.10**	166,517.20***	198,466.50**
	(27,424,87)	(94,679.26)	(44,757.58	(26,355.34)	(98,943.66)	(46,692.09)	(2,763)
Std Dev of Dependent Variable [Regulation Influence as % Std Dev]	327,111	641,205	460,129	291,136	668,004	499,117	589,736
	[47.2]	[42.3]	[22.7]	[53.1]	[50.7]	[27.2]	[38.9]
Observations	1,388	168	396	1,380	152	308	300
R-Squared	0.4680	0.5219	0.5025	0.4516	0.5377	0.5245	0.5813

Exhibit 5

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Perc_Water_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (2 of 3)

Variable Name	8	9	10	11	12	13	14	15	16	17	18	19
Population_2010	0.0918	0.1105	0.1118	0.0722	0.1026	0.0954	0.10256	0.1015	0.0964	0.0890	0.0799	0.1248
	(0.1321)	(0.1549)	(0.1343)	(0.1661)	(0.1534)	(0.1540)	(0.1529)	(0.1518)	(0.1576)	(0.1523)	(0.1612)	(0.1198)
GDP_2010	0.0050***	0.0052**	0.0049**	0.0050**	0.0051**	0.0052**	0.0051**	0.0051**	0.0051**	0.0054**	0.0053**	0.0050**
	(0.0019)	(0.0023)	(0.0021)	(0.0021)	(0.0023)	(0.0022)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0019)
Square_Miles_2010	0.4829	4.40	1.53	-0.1327	4.83	5.78	4.81	4.91	4.62	4.94	3.05	6.17
	(7.24)	(8.91)	(7.18)	(9.96)	(8.96)	(8.23)	(8.83)	(8.78)	(9.04)	(8.62)	(9.01)	(6.62)
Perc_Water_2010	1,613.33	1,462.43	1,667.39*	1,775.64	1,814.93	1,755.69	1,820.36	1,734.65	1,822.64	1,755.13	1,854.03	1,654.74*
	(1,084.75)	(1,054.57)	(1,004.99)	(1,143.40)	(1,107.01)	(1,102.35)	(1,133.24)	(1,215.09)	(1,115.65)	(1,092.57)	(1,140.13)	(877.70)
Housing_Units_2010	-0.8402***	-0.8773***	-0.8648***	-0.7458***	-0.8485***	-0.8469***	-0.8485***	-0.8474***	-0.8308***	-0.8547	-0.8129***	-0.9256***
	(0.1788)	(0.2745)	(0.2158)	(0.2543)	(0.2678)	(0.2862)	(0.2708)	(0.2720)	(0.2644)	(0.2537)	(0.2673)	(24,506.64)
Loc_Pol_Press_Index	46,371.99	**72,301.02***										
	(37213.59)	(41,377.81)										
State_Pol_Inv_Index	**49,360.25*** $_1$		**136,564.50*****									
	(25,198.58)		(41,298.94)									
State_Court_Inv_Index	43,594.27			60,830.94								
	(53,632.65)			(72,562.50)								
Loc_Zoning_App_Index	85,505.49				891.15							
	(74,622.96)				(64,397.99)							
Loc_Proj_App_Index	-18,906.77					58,975.60						
	(52,798.19)					(37,612.97)						
Loc_Assem_Index	107,619.80						-8,620.62					
	(118,652.50)						(69,737.20)					
Supply_Restric_Index	-113,074.50							33,880.05				
	(95,977.44)							(75,342.91)				
Density_Restric_Index	-18,5540.4								-57.682.54			
	(128,603.2)								(120,980.70)			
Open_Space_Index	863.00									**242,785.20***		
	(105,789.1)									(145,469.00)		
Exactions_Index	44,302.69										209,668.20	
	(105,433.3)										(144,653.10)	
Approv_Delay_Index	**73,877.11**** $_2$											**70,732.32*****
	(30,676.37)											(24,506.64)

Exhibit 5

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Perc_Water_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (3 of 3)

Variable Name	8	9	10	11	12	13	14	15	16	17	18	19
Single_County_ Dummy	-107,032.10	11,667.43	-72,228.77	8,041.50	19,471.43	13,956.04	19,678.54	20,823.30	27,254.29	-5,288.58	26,544.68	-66,121.75
	(100,619.10)	(68,294.08)	(83,907.68)	(78,603.93)	(72,248)	(69631.7)	(70,617.49)	(71,866.75)	(71,088.34)	(80,702.98)	(68,595.91)	(82,431.83)
Year_2013_ Dummy	14,872.49***	16,071.47***	15,224.04***	16,034.85***	16,150.3***	16,094.59***	16,152.4***	16,163.96***	16,28.92***	15,900.20***	16,221.75***	15,285.73***
	(4,566.09)	5180.57	(46,83.519)	(5,067.98)	(5,209.38)	(5,186.26)	(5,209.82)	(5,203.46)	(5,344.75)	(5,026.42)	(5,264.60)	(4,653.14)
Year_2014_ Dummy	42,842.15***	44,041.13***	43,193.70***	44,004.51***	44,119.96***	44,064.25***	44,122.05***	44,133.62***	44,198.58***	43,869.86***	44,191.41***	43,255.38***
	(13,268.73)	13,795.81	(13,306.89)	(13,658.79)	(13,804.94)	(13,795.97)	(13,810.69)	(13,800.87)	(13,943.21)	(13,616.65)	(13,866.83)	(13,296.01)
Year_2015_ Dummy	63,031.95***	64,230.94***	63,383.50***	64,194.31***	64,309.76***	64,254.05***	64,311.86***	64,323.42***	64,388.38***	64,059.66**	64,381.21***	63,445.19***
	(20,635.43)	(21,008.54)	(20,565.91)	(20,867.71)	(21006)	(21,006.02)	(21,015.07)	(21,002.94)	(21,142.71)	(20,830.38)	(21,069.16)	(20,556.56)
Constant	-424,269.20	140,585.70***	192,143***	20,028.97	132,534.40	43,059.48	134,768.30***	127,456.40**	144,880.00**	1,414.65	-24,771.10	-229,779.8**
	(301,821.40)	(43,958)	(55,131.17)	(108,197.70)	(131,114.5)	(82.521.04)	(46,458.97)	(51,373.15)	(57,795.98)	(58,266.55)	(95,141.42)	(106,013)
Std Dev of Dep Variable	460,129	460,129	460,129	460,129	460,129	460,129	460,129	460,129	460,129	460,129	460,129	460,129
[Regulation % Std Dev]	$[10.7]_1$, $[16.1]_2$	[15.7]	[29.7]							[52.7]		[15.4]
Observations	396	396	396	396	396	396	396	396	396	396	396	396
R-Squared	0.5973	0.4528	0.5048	0.4523	0.4449	0.4485	0.4449	0.4457	0.4456	0.4591	0.4532	0.5600

*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*
Source: Authors' calculated regression results using STATA

Exhibit 6

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Saiz_Perc_Undev_Land_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (1 of 3)

Variable Name	1	2	3	4	5	6	7
Population_2010	0.1362 (0.1151)	0.0132 (0.1400)	0.0978 (0.1219)	0.1306 (0.1158)	-0.0016 (0.1502)	0.0338 (0.1348)	0.0687 (0.1266)
GDP_2010	0.0050*** (0.0019)	0.0065*** (0.0023)	0.0053** (0.0020)	0.0050*** (0.0019)	0.0074*** (0.0026)	0.0065*** (0.0023)	0.0048*** (0.0018)
Square_ Miles_2010	-2.91 (6.93)	4.77 (9.96)	1.05 (9.05)	-3.35 (6.95)	15.40 (12.15)	6.71 (10.23)	-3.88 (7.78)
Saiz_Perc_ Undev_Land_2010	7,302.35** (2,792.87)	12,557.94* (6,370.04)	10,636.50** (5,071.60)	7,163.00*** (2,745.75)	16,327.12** (7,987.95)	12,020.09** (5,360.52)	6,159.29** (2,935.62)
Housing_ Units_2010	-0.9539*** (0.1673)	-0.0924*** (0.2048)	-0.9176*** (0.1776)	-0.9321*** (0.1629)	-1.07*** (0.25)	-0.9645*** (0.2044)	-0.7778*** (0.1846)
WRLURI_ State_2006	**124,790.80***** (43,694.82)						
WRLURI_ Metro_2006		96,857.93 (71,329.48)					
WRLURI_Metro_ Expand_2006			27,188.27 (36,800.32)				
WRLURI_ State_Lag6				**144,050.60***** (49,400.09)			
WRLURI_ Metro_Lag6					57,473.16 (81,573.04)		
WRLURI_Metro_ Expand_Lag6						27,109.75 (38,332.55)	
Saks_House_ Reg_Index							**147,086.70**** (65,857.28)
Single_County_ Dummy	-27,815.96 (77,588.59)	37,818.98 (106,440.80)	-68,021.69 (117,987.9)	-30,879.68 (78,021.04)	-5.233.00 (137,185.80)	-11,970.53 (101,108.50)	60,524.28 (127,582.30)
Year_2013_ Dummy	18,958.04*** (5,759.71)	32,091.89*** (11,431.92)	21,732.41*** (6,833.175)	15,442.61*** (5,605.33)	32,530.61*** (10,947.10)	25,623.45*** (8,162.438)	27,734.83*** (8,892.23)
Year_2014_ Dummy	51,785.62*** (15,932.09)	86,069.32** (32,973.82)	59,938.75*** (19,761.12)	46,530.70*** (15,217.82)	89,286.92** (34,369.96)	68,308.65*** (22,748.79)	72,898.31*** (23,614.49)
Year_2015_ Dummy	75,307.26*** (24,383.09)	126,779.9** (51,389.54)	87,517.02*** (30,718.07)	68,312.87*** (23,240.44)	131,828.6** (54,443.2)	99,463.48*** (34,981.59)	100,6061.8*** (36,050.22)
Constant	64,700.22 (43,266.47)	-1,390.75 (81,586.82)	-5,841.24 (65,393.16)	70,421.92 (43,340.51)	-46,814.03 (102,907)	-9,042.75 (64,806.05)	120,288* (64,182.41)
Std Dev of Dependent Variable [Regulation Influence as % Std Dev]	479,041 [26.7]	654,404	537,249	479,041 [30.1]	678,030	567,394	568,537 [25.9]
Observations	336	152	260	336	140	228	224
R-Squared	0.6032	0.6461	0.6200	0.6043	0.6784	0.6562	0.6329

Exhibit 6

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Perc_Water_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (2 of 3)

Variable Name	8	9	10	11	12	13	14	15	16	17	18	19
Population_2010	0.0794	0.1074	0.1148	0.0683	0.1001	0.0959	0.0975	0.1008	0.0890	0.0843	0.0809	0.1236
	(0.1318)	(0.1250)	(0.1266)	(0.1460)	(0.1314)	(0.1189)	(0.1310)	(0.1244)	(0.1371)	(0.1351)	(0.1360)	(0.1058)
GDP_2010	0.0048***	0.0054***	0.0052**	0.0052***	0.0056**	0.0054**	0.0054**	0.0053**	0.0053**	0.0056**	0.0055**	0.0050***
	(0.0018)	(0.0020)	(0.0020)	(0.0019)	(0.0023)	(0.0020)	(0.0021)	(0.0020)	(0.0021)	(0.0021)	(0.0021)	(0.00198)
Square_Miles_2010	-4.57	0.9155	-1.11	-5.228	1.68	1.33	0.9051	0.9429	1.22	1.49	-1.11	1.31
	(9.15)	(9.44)	(9.274)	(10.87)	(10.51)	(9.11)	(10.09)	(9.49)	(10.17)	(9.55)	(9.70)	(7.22)
Saiz_Perc_Undev_Land_2010	7,182.70**	11,725.58***	10,269.01**	10,731.68***	11,615.14**	11,322.07**	12,187.81**	11,409.05**	11,327.02***	10,979.82***	11,174.14***	8,623.80****
	(2806.99)	(4,338.11)	(4,299.54)	(3714.06)	(4,466.27)	(4,445.87)	(4,803.06)	(4,539.17)	(4,240.51)	(3,998.87)	(4,146.41)	(3,225.64)
Housing_Units_2010	-0.8152***	-0.9668***	-0.9410***	-0.8065***	-0.9633***	-0.9157***	-0.9356***	-0.9218***	-0.8899***	-0.9161***	-0.8865***	-0.9535***
	(0.1761)	(0.1969)	(0.1716)	(0.1927)	(0.2054)	(0.1867)	(0.2046)	(0.1890)	(0.1821)	(0.1819)	(0.1863)	(0.1511)
Loc_Pol_Press_Index	22,082.75	**113,925.00****										
	(64,396.77)	(46,376.09)										
State_Pol_Inv_Index	22,677.31		**54,901.17***									
	(37,229.25)		(31,244.00)									
State_Court_Inv_Index	82,632.51			82,541.10								
	(72,613.06)			(75,608.68)								
Loc_Zoning_App_Index	5,7130.01				110,402.50							
	(108,969.70)				(127,068.70)							
Loc_Proj_App_Index	34,052.78					42,991.04						
	(106,556.50)					(75,560.91)						
Loc_Assem_Index	2,5816.69						-22,7162.00					
	(125,164.80)						(169,986.60)					
Supply_Restric_Index	-179,3231.50							4,354.64				
	(176,643.20)							(110,303.50)				
Density_Restric_Index	-390,269.30								-139,691.20			
	(244,828.10)								(154,626.70)			
Open_Space_Index	33,386.84									234,002.10		
	(187,775.9)									(187,363.70)		
Exactions_Index	-50,762.15										215,512.90	
	(133,978.8)										(146,388.90)	
Approv_Delay_Index	**76,796.13*****											**65,921.80*****
	(28,692.52)											(21,426.20)

Exhibit 6

Regression Results Using *Acre_Residential_Land_Price* as Dependent Variable (Perc_Water_2010 as Supply Constraint, Robust Standard Errors Clustered on Metropolitan Areas) (3 of 3)

Variable Name	8	9	10	11	12	13	14	15	16	17	18	19
Single_County_ Dummy	-186,849.50	-62153.69	-80,023.54	-86,853.07	-84,757.36	-52,189.23	-78,095.08	-55,915.87	-54,844.13	-64,228.86	-43,373.44	-107,842.60
	(164,702.90)	(121784.8)	(121,665.50)	(141,053.20)	(139,108.30)	(1240,45.10)	(136,981.30)	(131,699.20)	(122.791.10)	(123,898.90)	(116,275.80)	(118,210.50)
Year_2013_ Dummy	19,904.29***	21822.69***	21,547.77***	21,442.70***	21,474.94***	21,975.99***	21577.44***	21,988.66***	21,935.14***	21,790.76***	22,111.62***	21,119.78***
	(5,845.451)	(6819.40)	(6,753.71)	(6,519.27)	(6,636.03)	(6,835.98)	(6639.62)	(6,798.50)	(6,881.49)	(6,804.63)	(6,.986.74)	(6,394.34)
Year_2014_ Dummy	58,110.63	60029.03***	59,754.11***	59,649.04***	59,681.28***	60,182.33***	59783.78***	60,125.00***	460,141.49***	59,997.11***	60,317.96***	59,3426.12***
	(18,707.63)	(19706.2)	(19,630.01)	(19,321.55)	(19,419.46)	(19,704.4)	(19471.25)	(19,638.06)	(19,764.99)	(19,677.73)	(19,890.15)	(19,308.33)
Year_2015_ Dummy	85,688.9	87607.3***	873,32.38***	87,227.31***	87,259.55***	87,760.6***	87362.04***	87,703.26***	87,719.75***	87,575.37**	87,896.22***	86,904.39***
	(29,928.85)	(30641.83)	(30,574.95)	(30,253.71)	(30,337.97)	(30,620.8)	(30403.45)	(30,547.85)	(30,691.31)	(30,606.02)	(30,810.98)	(30,289.22)
Constant	-512,341.80	-22,011.22	30,454.29	-161,708.30	-234,972.30	-88,044.69	-19,182.78	-22,763.21	4,653.96	-149,209.60	-179,029.00	-314,746.80**
	(335,258.80)	(53,547.29)	(62,212.03)	(160,374.60	(272,235.20)	(111,257.20)	(54,366.69)	(49,648.65)	(46,951.07)	(136,057.80)	(141,271.60)	(125,053)
Std Dev of Dep Variable [Regulation % Std Dev]	537,249	537,249	537,249	537,249	537,249	537,249	537,249	537,249	537,249	537,249	537,249	537,249
	[14.3]	[21.2]	[10.2]									[12.3]
Observations	260	260	260	260	260	260	260	260	260	260	260	260
R-Squared	0.7012	0.6238	0.6228	0.6250	0.6197	0.6183	0.6250	0.6171	0.6191	0.6243	0.6225	0.674

*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*
Source: Authors' calculated regression results using STATA

The authors' interpretation of the findings in exhibits 5 and 6 begins with a quick examination of results for the control variables. Across all regressions, the metropolitan area population's detected influence and GDP on its residential land price is positive, whereas housing units' influence is negative. Only the latter two explanatory variables exhibit a statistically significant influence with greater-than-90-percent confidence in a two-tailed test of different-than-zero influence, however. The detected directions of effect match prior expectations. The insignificance of the population measure is likely due to multicollinearity. Although limited in its statistical significance, the square miles of a metropolitan area exhibit the expected positive influence on the residential land price. After controlling for the square miles of land theoretically available for development, the measured constraints of the undevelopable percentage being water (in exhibit 5) or the percentage being water or sloped land (in exhibit 6) also display the expected effect of raising a metropolitan area's residential land price. The more accurate measure of undevelopable land is desirable due to its statistical significance in all regressions. Of further note is the lack of significance regarding whether a metropolitan area consists of one or two counties. The dummy explanatory variables representing yearly fixed effects are statistically significant and rising consistently over time. The authors expected these findings given the U.S. macroeconomy's growth over the years under observation and nominal dollar-value use.

The authors turn to an examination of the explanatory variables in the middle horizontal portions of exhibits 5 and 6, whose determination of statistical significance and magnitude are the primary motivators of this study. In exhibit 5, where Perc_Water_2010 acts as the measured constraint on available land, the first page of results shows that the different aggregate forms of both the WRULRI and Saks indexes exert a statistically significant and positive influence on residential land prices. These indexes measure relative differences in land use regulations' stringency as they apply to new housing construction; thus, the authors found that greater regulatory strictness raises the price of land available for new homes and, subsequently, their price in the local housing market. The number of metropolitan area observations varies in each regression, as indicated by the second-to-the-bottom line of exhibits 5 and 6; thus, the mean and the standard deviation of the dependent variable also vary. A comparison of the magnitude of the influence of the different indexes used requires some accounting of those variances. The authors account for this in the third line from the bottom of each exhibit. There, they report the standard deviation of the dependent variable. Below that, they record the magnitude of the regression coefficient(s) divided by its standard deviation. In exhibit 5, these are in the 40- to 50-percent range, apart from a 20- to 30-percent range for the expanded WRLURI regulatory index measures requiring only a minimum of five observations. Such influences are substantial and worthy of consideration.

On the second page of exhibit 5 regression results, the regulatory indexes included are the 11 subindexes of the greater WRLURI calculated by Gyourko, Saiz, and Summers (2008). The authors' analysis strategy here is to first include all of these in a single regression (8) and then separately in regressions (9–11).[8] Only the State_Pol_Inv_Index and the Approv_Delay_Index indicate statistically significant influences when the authors include all the subindexes. These influences respectively measuring 10.7- and 16.1-percent increases in the standard deviation of the residential

[8] This step may be unnecessary because the pairwise correlations between these WRLURI components only exceed 0.50 for State_Pol_Inv_Index and Approv_Delay_Index at 0.55, and the variance inflation factors are all less than 3.

land prices included in the regression from 99 different metropolitan areas across 4 years. When the authors included the subindexes separately, the State_Pol_ Inv_Index's statistical significance and magnitude (29.7) and the Approv_Delay_Index (15.4) remained. Furthermore, the additional importance of the Loc_Pol_Press_Index (15.7) and the Open_Space_Index (52.7) is also detected.

In comparison, the regression results in exhibit 6 come from a duplication of the 19 regression specifications in exhibit 5, excepting only the substitution of the more comprehensive Saiz_ Perc_Undev_Land_2010 for Perc_Water_2010. This tradeoff of greater accuracy in measuring undevelopable land in a metropolitan area with a reduction in the regression sample size yields different findings regarding the WRLURI measures. Instead of both the state- and metropolitan-based indexes exerting a statistically significant influence different from zero (as in exhibit 5), only the statewide measures remain significant. The WRLURI_State_2006 index indicates a 26.7-percent increase in the residential land price standard deviation for a one-unit change toward more restrictiveness. Suppose this statewide index's values vary by year based on an interpolation between values in Gyourko, Saiz, and Summers (2008) and in Gyourko, Hartley, and Krimmel (2019). In that case, the detected influence of WRLURI_State_Lag6 indicates a slightly higher 30.1-percent increase in the standard deviation of the residential land price for a one-unit change in this index. Interestingly, a very similar relative effect of a one-unit change in the Saks_ House_Reg_Index results in a 25.9-percent increase in the standard deviation of that regression's dependent variable.

Examining the WRLURI component findings on the second page of exhibit 6, a few consistencies emerge. In regression (8), where all subindexes are accounted for, the Approv_Delay_Index is statistically significant. In regression (9) through (11), the influence of Loc_Pol_Press_Index, State_Pol_Inv_Index, and the Approv_Delay_Index remain, but the importance of the Open_ Space_Index is lost. Perhaps the loss of open-space preservation is related to the control of land in the metro area with a steeper-than-15-percent grade in exhibit 6 regression results, which was not present in exhibit 5.

Conclusion

High home prices and rental rates in a U.S. metropolitan area impose significant negative welfare implications for low- and even moderate-income households experiencing them. A lack of housing affordability in a metropolitan area also impedes labor's necessary migration into a burgeoning metro area's economy. It even serves to drive existing low-skill laborers out, which slows the potential for even greater economic activity.[9] Although a majority recognize these concerns as legitimate and warranting some form of government intervention to counteract them, policy reforms are slow to materialize. Perhaps this lack of government intervention is better understood if one frames the availability of new affordable shelter (either owned or rented) as a non-depletable and non-excludable "public good" that benefits new homeowners, renters, and the metro area's overall economic prosperity. Simultaneously, such a public good may impose disproportionate costs relative to benefits on the specific localities (and their established homeowners) that host the additional units. Established homeowners who are relatively affluent and members of the

[9] See Wassmer (Forthcoming) for an empirical study that finds evidence in support of this contention.

majority demographic group within those localities may be especially sensitive to these costs and the potential entry into their neighborhoods of new residents belonging to different demographic groups than their own. These homeowners may publicly decry the lack of affordable housing in their metropolitan area and generally support a lessening of restrictions by other localities in the region to construct more. Still, they do so with the politically potent caveat that the construction of such be "not-in-my-backyard." These NIMBYs are often able to command the attention of elected and appointed local government officials who oversee the implementation of local land use regulations. The result is the observed tendency for local decisionmakers to maintain or increase residential land use regulations' stringency in many U.S. metropolitan areas. A "tragedy-of-the-commons" results in an overall reduction in public welfare through the insufficient construction of affordable housing throughout the entire metropolitan area.

Thus, there is an argument to be made for state and federal governments to make more substantial efforts to reduce or rescind local land use regulatory authority. There is a need to legally compel more affordable housing in all neighborhoods and jurisdictions that constitute high-cost metropolitan areas. This encroachment on community-level decisionmaking is institutionally possible but politically unpalatable. Local authority over land use decisions is virtually sacrosanct in the United States. To combat this, more evidence identifying a strong relationship between a restrictive regulatory environment for the construction of new housing and subsequent housing unaffordability in a metropolitan area offers an essential start in supporting state and federal action on this policy front.

The authors grounded the regression results offered here in several practices used in previous analyses of this type. They also added newly available data on residential land prices in U.S. metropolitan areas as a reasonable complementary proxy for housing price variations across these areas. Furthermore, they used explanatory variable controls that include newly available data on the amount of economic activity in the metropolitan area and accurate accounting of the percentage of developable land in the area. The authors accomplish this through panel data, which allows for the control of time fixed effects and endogeneity through lagged values of the explanatory variables (as suggested by Gyourko and Molloy, 2015).

The emphasis here has been on the regression results in exhibit 6 that use the percentage of a metropolitan area's square miles that are undevelopable due to being under water or exhibiting too steep a topographical grade. The authors' rationale for this choice was that failing to control for an undevelopable grade likely prejudices the detected influence of metropolitan-specific development restrictions that exhibited a greater likelihood of statistical influence in exhibit 5. As the first page of exhibit 6 indicates, the WRLURI values calculated for a metropolitan area's primary state exhibit the hypothesized positive effect on metro-specific residential land prices. This effect consists of a one-unit-higher WRLURI state value in 2006, raising a metropolitan area's residential land price by about 27 percent of the standard deviation variation in residential land price for the following years of 2012 through 2015. Suppose the WRLURI state value varies between 2006 and 2009 and acts as a constant 6-year lag to the dependent variable of metropolitan area residential land price between 2012 and 2015. In that case, the calculated influence is slightly higher, at 30 percent. Interestingly, when the authors substitute the Saks' metropolitan-specific regulation index for the state-level

WRLURI, the derived effect of a one-unit change in this index is a similar increase, equivalent to 26 percent of the standard deviation residential land prices observed in the regression sample.

The stringency of local political pressure, state political processes, and the likelihood or length of approval delays all exert statistically significant and the hypothesized positive influences on residential land price variation across U.S. metropolitan areas—the highest magnitude detected influence being an increase in residential land price equivalent to about 21 percent of its standard variation across metropolitan areas for a one-unit change in the degree of local political pressure exerted on local land use decisions. As noted in Gyourko, Saiz, and Summers (2008, Table A1), the derivation of their local political pressure index comes from the survey response of a local official regarding their opinion (from "not at all important" to "very important") on local political activities, such as (1) city council, managers, and commissioners' involvement in, and community pressure on, local growth management; (2) the degree to which the local fiscal situation affects residential development choices; (3) the importance given to city council or citizen opposition to local residential development; (4) the importance of school crowding to single-family home development decisions; and finally (5) the number of local ballot initiatives passed in the past 10 years.

The second-in-magnitude subindex influence detected here was an account of the degree of approval delays typical for residential development. A one-unit change in this index in a U.S. metropolitan area raises residential land prices in that area by about 12 percent of the variation in residential land prices if other subindexes are not accounted for and about 14 percent if they are. The approval delay index is based on eight measures asking local survey respondents to choose among five categorical responses (1.5 for "less than three months" to 24 for "more than 24 months") regarding average lengths of time for their jurisdiction to complete the reviews of residential projects. It also accounted for the typical times between rezoning application and building permit issuance for single- or multifamily projects that are either less than or greater than 50 units.

The third-most-significant subindex influence detected is a measure of state political involvement in the local residential land development process. Specifically, suppose a metropolitan area exhibited a one-unit increase in this index of state involvement. In that case, the average residential land prices in the metropolitan area are higher by about 10 percent of the standard deviation in residential land prices across all metropolitan areas. Gyourko, Saiz, and Summers (2008, Table A1) chose to measure greater state involvement by the local responder's opinions of the state legislature's degree of involvement in affecting the locality's residential building activities and the governor's and state legislature's previous 10-year activity level in enacting statewide land use restrictions.

Considering these findings, the authors suggest the following policy-relevant takeaways. Of most importance is the authors' overall finding that the relative stringency of local land use controls exerts a measurable positive influence on the average price of an acre of land available for single-family housing and, thereby, the housing price. A decrease in this regulatory stringency by one unit (or about 1.0 to 1.5 standard deviations from the variation observed in all metropolitan areas) could cut the price of new residential homes by about one-fourth of the standard deviation observed in residential land prices across the United States. Second, if choosing among the categories of regulatory influences that make up Gyourko, Saiz, and Summers' (2008) WRLURI for the most potent policymaking opportunity to reduce metropolitan-area regulatory stringency, it would be finding a way to reduce local political involvement in the regulatory process. Doing so would likely result in a comparable reduction of NIMBY pressure on local decisionmakers when considering the construction of additional affordable housing in their jurisdictions. The policy should also include efforts to reduce state-level involvement in encouraging and authorizing local control of growth management policies and land use decisionmaking authority.

Moreover, reducing the time delay between the initial proposal and completion of residential development projects would encourage developers to acquire available land in high-cost metropolitan areas for new housing projects, thereby increasing the general supply of new housing and lowering its price across the metropolitan area. Housing developers are aware of the "time value of money." They are less likely to undertake new projects in jurisdictions with a high rate of uncertainty regarding the exact amount of time it will take to approve and construct a housing project.

The reforms just suggested are very likely to encounter significant resistance from numerous jurisdictions that have previously enacted them in the name of "local control." Furthermore, such resistance is also likely to come from the lower houses of state legislatures, where many members represent districts whose voters adhere to NIMBY principles. To overcome such opposition, Glaeser (2020) suggests the need for federal intervention in this arena through Congress establishing a direct link between federal highway funding and the construction of more single- and multifamily housing units where they are most needed. Another policy avenue for Congress is authorizing the HUD Secretary to withhold agency funds from jurisdictions that erect extreme housing and residential land use barriers. Congress could also amend the National Affordable Housing Act of 1990 to remove a prohibition on the non-approval of consolidated housing plans (HUD, 2020). As just suggested, intense federal pressure on states and municipalities to increase their inventories of affordable housing units could provide a politically convenient excuse for policymakers at those government levels to enact unpopular reforms in their jurisdictions to meet the new requirements. Perhaps state governors, elected to represent statewide interests and not subject to the legislature's local political pressures, could also draw courage from these federal directives and do more of the same for their states.

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