The Impact of Local Residential Land Use Restrictions on Land Values Across and Within Single Family Housing Markets

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Abstract

Using new data on vacant land parcels bought by builders for the purpose of single-family home development between 2013-2018, we estimate that restrictive residential land use environments have increased prices for a one-quarter acre lot with the right to build on it by over $400,000 in the San Francisco metropolitan area, by from $150,000-$200,000 in the Los Angeles, New York City and Seattle markets, and by just over $100,000 in the San Jose market. The same amount of land costs from $60,000-$80,000 more in the Chicago, Philadelphia, Portland (OR), and Washington, DC regions and is $35,000-$45,000 higher in the Boston, Miami (FL) and Riverside-San Bernardino metro areas. These magnitudes, which have been called 'zoning taxes' in the urban literature, reflect the difference between land values on the extensive and intensive margins. They are negligible to economically modest in a wide range of other markets including Atlanta, Charlotte, Cincinnati, Columbus (OH), Dallas, Deltona (FL), Denver, Detroit, Minneapolis, Nashville, Orlando and Phoenix. Our estimates also are strongly positively correlated with the new Wharton Residential Land Use Regulatory Index for 2018, which is increasing in the degree of regulatory constraint imposed in the underlying market. This relationship is not mechanically driven as the regulatory index is constructed from survey data that does not incorporate land or house prices in any way. Finally, our results are important inputs for future research into housing affordability, as well as how housing markets change in response to land use regulation.

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I. Introduction

Extremely high house prices, especially in America's large coastal markets, have raised concerns about housing affordability for the middle class, not just the poor. This is highlighted by the $1 million+ average house values reported by the *American Community Survey* (*ACS*) in the San Francisco and San Jose metropolitan areas in 2017, which many highly-skilled and well-remunerated tech sector workers cannot afford based on standard lending guidelines that limit price-to-income ratios below four in the absence of substantial down payments.[1]

Housing markets like those in the Bay Area have not always been such outliers in terms of prices. This is documented in Figure 1's kernel density plot of the distribution of mean house values across metropolitan areas in 1970, 1990, and 2017. A half century ago in 1970, prices in the most expensive market were no more than 3-4 times greater than those in the least costly market, and the gap between the 25th and 75th percentile markets was barely more than $25,000, with the 75th percentile market costing 27% more than the 25th.[2] Conditions clearly had changed by 1990. There is an upper tail visible in that year's data, with the most expensive market costing about seven times more than the least expensive market. The interquartile range had

[1] More generally, affordability conditions across the county have become much more salient recently. For example, a recent Presidential Executive Order 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/). 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 (2019) of a mismatch between capabilities of the private versus public sectors in some of our major urban areas that lead to dominance by insiders (existing landowners in our context).

[2] All monetary figures are in 2018 dollars throughout the paper. The 25th percentile market's average house price was $97,580, while the 75th percentile market's mean price was $124,323.

expanded, too--to just over $60,000; in percentage terms, the 75th percentile market was 53% more costly than the 25th in 1990.[3] The elongation of the upper tail is even more striking in 2017. The most expensive market is now about ten times costlier than the cheapest housing market in the country. The gap between the 25th and 75th percentile markets grew to just over $100,000, with the 25th percentile market priced at $156,954 and the 75th percentile market valued at $260,369 (or 66% greater than the 25th). These gaps are now large compared to typical incomes, so rising concerns about affordability for the middle class are understandable.[4]

High and rising real house prices, which have been shown to be well above what previous literature terms the minimum profitable production cost (MPPC) of a home, have not always engendered robust supply responses, contrary to the prediction of basic price theory in a free market (Glaeser & Gyourko (2018)). The top panel of Figure 2 shows this for the San Francisco metropolitan area.[5] Homes there have traded at values well in excess of their fundamental production costs (i.e., what all factors of production would cost in free markets) since the late 1980s, but there never has been a material upsurge in supply. Moreover, from 1998 to the peak of the housing boom in 2005/6, home prices rose from about 1.8 times MPPC to almost four times those costs (see the orange and blue lines in the figure). Yet, the intensity of new housing construction as reflected in the ratio of permits to the 2000 housing stock stayed flat and never exceeded more than 1% of the stock in any year (see the green line in the figure). In contrast, the magnitude of annual new housing supply varies widely over time in the Atlanta metropolitan area (see the bottom panel of Figure 2), ranging from a low of 0.5% of its 2000 stock in the

[3] The 25th percentile market's mean home value was $116,671 in 1990, compared to $178,405 at the 75th percentile.
[4] For example, the median household income in the Atlanta Core Based Statistical Area (CBSA) was $65,381 according to the 2017 *ACS*, while that in the San Francisco CBSA was $101,714. Throughout this paper, we use the terms CBSA and metropolitan area interchangeably. All data are for the CBSA unless explicitly noted otherwise.
[5] Minimum profitable production costs are those that would pertain in a free market for both land and materials. See the notes to Figures 2a and 2b, as well as Glaeser & Gyourko (2018) for the details.

depths of the Great Recession in 2009-2010 to over 4% of the stock at the peak of the housing boom only 3-4 years earlier. It looks as if the supply side of Atlanta's housing market is so elastic, at least within the 1-year intervals plotted, that home value always is pinned down by MPPC.

This paper investigates the role of local residential land use regulation in accounting for an inflexible supply side to housing markets and its influence on land prices. The regulatory environment itself is hard to measure because of the myriad ways by which communities can restrict housing development should they so desire. Later in the paper, we explore a new measure of regulatory restrictiveness developed by Gyourko, Hartley and Krimmel (2019) which shows the San Francisco area housing market to be the most strictly regulated in the country, while Atlanta's is slightly below average in terms of restrictiveness. Their metric, the Wharton Residential Land Use Regulatory Index for 2018 (WRLURI2018), is increasing in the degree of supply side constraint imposed. It is strongly positively correlated with house prices as documented in Figure 3's plot of house prices from the 2017 *ACS* for 24 major markets that we study below against each market's 2018 regulatory index value. The fitted OLS linear regression line implies that a 1-unit change in regulatory index value (which equals a one standard deviation change in regulatory strictness) is associated with just over a $400,000 gap in prices between San Francisco and Atlanta given the 1.3 standard deviation difference between those two market's WRLURI2018 index values.

Nothing causal is implied by this simple correlation, of course. However, if regulation is driving the relationship, we should see very high prices being paid by residential builders for vacant land on which new housing could be built. This is in stark contrast to what we would expect in a completely free and unregulated market. In that case, there should be no difference in the value that an existing homeowner or homebuilder places on an extra square foot of land. If the value an existing homeowner puts on having a bit more land (i.e., the intensive margin value) is significantly less than that a builder places on the same amount of land with the right to build on it (the value of land on the extensive margin), then the owner-occupier should subdivide and sell out to the builder. However, if there are regulations preventing that increase in density, there would be a gap between the intensive and extensive margin prices. Land prices on the extensive margin would be bid up until there were no unexploited profit opportunities left for builders in the highly regulated housing markets.[6] The gap between extensive and intensive margin land values has been called the 'zoning tax' (Glaeser & Gyourko (2003, 2018)).

We use newly available information from an industry data provider to compare extensive versus intensive margin prices in order to compute the level of the implicit zoning taxes in different land markets. These data, which allow us to directly observe the price of vacant land bought specifically for the purposes of single-family home development, greatly improve upon previous efforts along these lines which were forced to make strong assumptions in order to impute the (unobserved) value of vacant land on the extensive margin (e.g., Glaeser and Gyourko (2003, 2018)). Our new empirical analysis finds that the gap between extensive and intensive margin land values of a quarter acre plot exceeds $400,000 in the San Francisco metro, ranges between $150,000-$200,000 in three other large coastal markets (Los Angeles, New York City and Seattle), and is over $100,000 in the San Jose metro area. Smaller differences of $60,000-$80,000 are found in Chicago, Philadelphia, Portland (OR) and Washington, DC. The zoning tax in the Boston market area is just under $50,000 for a standardized quarter acre lot. Differences of $35,000-$40,000 per quarter acre lot are estimated for the Miami (FL) and

[6] This presumes free entry in the homebuilding industry. There is no evidence of monopoly power in this sector. See Glaeser, Gyourko & Saks (2005) for data on the New York City market.

Riverside-San Bernardino markets. There is no evidence of an economically meaningful zoning tax in a wide range of other markets spread throughout the interior of the United States. Almost none of these latter markets is on a coast, but many are quite large and have experienced strong growth in demand (e.g., Atlanta, Charlotte, Dallas, Deltona (FL), Denver, Nashville, Orlando and Phoenix). Hence, the absence of meaningful zoning taxes is not restricted to declining markets in the Rust Belt (e.g., Cincinnati and Detroit).

Price theory suggests that the magnitude of our zoning tax estimates should be increasing with the actual degree of regulatory strictness in the market. We confirm this to be the case by documenting that they are strongly positively correlated with WRLURI2018 index values. This relationship is not mechanically driven as the regulatory index is created from survey data that does not use land or house prices in any way in its construction. This suggests there actually is a causal relationship plotted in Figure 3, with the pathway running from binding supply-side restrictions to a higher price of residential land paid by builders who supply costlier homes to higher market-wide house prices.

Beyond these average impacts of supply side constraints on a market's house prices, we also are able to investigate how the zoning tax varies by location within each CBSA. The zoning tax declines with distance from the metro core in the vast majority of our metropolitan areas, but there is much interesting variation around that basic pattern. Of the dozen metro areas for which we estimated economically small zoning taxes on average, seven were found to have low values throughout their regions. That is, in the Charlotte, Cincinnati, Columbus (OH), Deltona (FL), Detroit, Nashville and Orlando markets, estimated zoning taxes are small for parcels close to the metro core (i.e., within 15 miles of the centroid) as well as for those far away (i.e., greater than 30 miles from the centroid). Others such as Atlanta, Dallas, Minneapolis and Phoenix had higher zoning taxes on close in parcels within 15 miles of the core, but not elsewhere in their metropolitan areas. This pattern, which also was evident in the Riverside-San Bernardino market, suggests that there is something in scarce supply near the metro center that cannot be replicated further out in these markets.

A number of other metropolitan areas (e.g., Boston, Chicago, Miami (FL), New York City, Philadelphia and San Jose) also had sharply higher zoning taxes for closer in parcels, but they differed by having economically meaningful taxes for parcels further out (e.g., 15-30 miles from the urban core). Some markets had relatively similar levels of higher zoning taxes throughout their regions. For example, Portland (OR) and Washington, D.C. had zoning taxes per quarter acre of land ranging from \$50,000-\$75,000 for parcels within 0-15 miles of the centroid, as well as those that were further out from 15-30 miles.

The big three west coast metros had very high zoning taxes everywhere. San Francisco's gradient with respect to distance from the metro core sloped down, and was a very high \$410,000 for close in parcels within 15 miles of the urban core. However, it still was a hefty \$270,000 per quarter acre for sites more than 30 miles from the urban core. The zoning tax was a very high \$306,000 for close-in parcels in the Seattle market, but still was just above \$100,000 per quarter acre on sites more than 30 miles out. There was no negatively sloped distance gradient in the Los Angeles market, as our estimated zoning taxes averaged nearly \$200,000 per quarter acre of land no matter where the parcel was located within that metropolitan area. These are large values even compared to the high average incomes in these high wage markets.

Given that, it is not surprising that our estimates have important implications for a host of needed future research into American housing markets. They seem likely to be critical for improving our understanding of the wide dispersion in house prices across markets that we now see in the data. They are also likely to be a key driver of an endogenous response by housing markets in terms of housing density and structure-to-land ratio differences across markets that we discuss in the final section of the paper. Given the magnitudes of our estimates in certain markets, it also seems likely that zoning taxes are affecting who can own a home and how early in one's life cycle. Finally, the variance in our estimates of zoning taxes begs the question of efficiency. As we discuss at the end of the paper, the optimal zoning tax probably is positive, but we have little current insight into what the efficient level is.

The plan of the paper is as follows. Section II outlines a simple model underpinning our interpretation of a gap between extensive and intensive margin land valuations as evidence of binding supply side regulation. This section also describes the different and new data sources used in our estimations. Section III then reports our baseline results, and documents heterogeneity by distance from the urban core within each metropolitan area. This section ends by relating our zoning tax estimates to the measure of regulatory restrictiveness from the new Wharton index. Section IV discusses the broader implications of our results for the future study of how housing markets likely are changed by the presence of zoning taxes.

II. Evidence of Binding Regulation: Land Prices on the Extensive vs. Intensive Margins

II.A. A Simple Model

The price of a house [P(H)] can be defined as the sum of physical construction costs (CC) and the price of land [P(L)].

$$(1)\ P(H) = CC + P(L) = CC + qA + Z.$$

Moreover, the value of land can be conceived as being made up of two components. One is the price an existing homeowner places on having an extra square foot of lot (q) times the amount of acreage (*A*) on which the house sits—*qA*. This is the value of land on the intensive margin. Market prices of land could exceed *qA* if additional value is generated by binding supply restrictions. Glaeser and Gyourko (2003, 2018) call that increment the 'zoning tax' or *Z*. Thus, $P(L) = qA + Z$ in equation (1); if Z=0 so that there is no binding regulation creating artificial, policy-induced scarcity value, then $P(L) = qA$, with extensive and intensive margin land values being identical.

Until recently, it was not feasible to directly observe *P(L)* on the extensive margin. In the absence of such data on prices paid by homebuilders for vacant land, the value of *P(L)* had to be imputed. One strategy was to start with the price of a given quality house in some year and use that to proxy for *P(H)*, as we did in Figure 2. Physical construction costs for a similar quality home would be matched as best as possible to data from engineering consultants in the homebuilding industry. The residual from the differencing of *P(H)-CC* was presumed to equal the price of land on the extensive margin. This was then compared to hedonic-based estimates of *q*, the price on the intensive margin, times typical lot sizes (*A*) available from large data bases of transactions. If $P(H)\text{-}CC > qA$, then $Z>0$ and a zoning tax was presumed to exist.[7]

In this paper, we use newly available data from a private real estate data vendor on the prices paid for vacant land bought explicitly for the purpose of building single-family homes. In these data, P(L) still is the extensive margin value of land, but now it is the product of the number of houses the buyer intends to build on the land (*N*), times the difference between what it can sell those houses for [*P(H)*] and what it costs to build those homes (*CC*). Thus,

$$(2)\ P(L) = N*[P(H) – CC].$$

Substituting in from (1) yields

[7] See Glaeser and Gyourko (2003, 2018) and the notes to Table 2 for more detail on this process.

$$(3)\ P(L) = N^*[CC + qA + Z - CC] = N^*[qA + Z] \text{ or } P(L)/N = qA + Z.$$

The price of land paid per expected housing unit equals the sum of the intensive margin value and the zoning tax. If $P(L)/N = qA$, the zoning tax per home is zero; if the extensive margin value is far higher than the estimated intensive margin prices, then the zoning tax per home is large.

II.B. Computing the Zoning Tax: Data and Assumptions

We observe *P(L)* via proprietary vacant land data compiled by CoStar, an industry data provider that has been used in other research (although not for our specific purpose).[8] CoStar categorizes land sales by intended use. More specifically, they are organized by property sector—residential, industrial, retail, etc.[9] Within the residential sector itself, CoStar distinguishes between parcels to be used for single-family versus multifamily housing. We restrict our analysis to parcels whose future use is identified as single family. Not only is this subsample a better comparison group with the single unit home sale observations used in the hedonic analysis to estimate the intensive margin price (discussed below), but it better suits our research interest which is centered around the extent to which the value of a typical single family home (which can be detached or attached) may have been increased by restrictive supply side regulation.

[8] Turner, Haughwout and van der Klaauw (2014) were among the first to exploit this new data source.

[9] There is great detail in this particular variable, as CoStar includes codes for many types of uses, which range from parking lots to specialty buildings. CoStar also identifies non-arms-length transactions, which we exclude from our analysis. For analytical purposes, we also cannot use trades that do not have complete sales price and land area data. CoStar employees claim to verify property detailed by interviewing brokers, owners and property managers, in addition to making site visits. Their data quality has passed an important market test in terms of the firm being financially viable. In addition, we have confirmed the quality of the data in detail in a couple of markets (San Francisco and Atlanta in particular) by engaging in web searches and speaking with knowledgeable real estate professionals in these areas. In these markets, the statistical outliers in terms of price or parcel size in the CoStar samples were confirmed as accurately reflecting actual trades.

In the baseline results reported below in Table 1 on the magnitude of the zoning tax, we restrict our analysis to 24 large CBSAs. For these markets, we were able to identify at least 20 valid vacant land purchases for single family development over the 2013-2018 period that also were within 30 miles of the centroid of each metropolitan area.[10] The five-year time period is chosen because there are only relatively small numbers of such vacant land transactions within any one year. We want the shortest and most recent period available. Extending back in time to 2013 gets us valuable observations without coming too close to the Great Recession. The distance restriction is imposed to standardize across metropolitan areas of sometimes vastly differing sizes. We would like observations on extensive margin prices from as common an area as possible across different markets. The 30 mile radius is large enough to cover much of any metropolitan area within reasonable commuting times, and is similar to that used by Saiz (2010) in his analysis of the geographic determinants of supply elasticity. The CBSAs in our sample include Atlanta, Boston, Charlotte, Chicago, Cincinnati, Columbus (OH), Dallas, Deltona (FL), Denver, Detroit, Los Angeles, Miami (FL), Minneapolis, Nashville, New York City, Orlando, Philadelphia, Phoenix, Portland (OR), Riverside-San Bernardino (CA), San Francisco, San Jose,

[10] There is no agreed upon answer to what the centroid of a large metropolitan area should be. We use the address that Google provides when you ask the question 'what route should I take to travel from City A to City B?'. For New York City, that is City Hall, which is located at 11 Centre Street in Lower Manhattan near the Wall Street area; in San Francisco, the centroid is near the Marconi Center in the downtown of the city. Neither of these places is near the physical center of the group of counties that make up the CBSA. Atlanta is different, as it turns out that that the Georgia state capitol building in downtown Atlanta (which is where Google directs us to if we ask it for a route from our hometown of Philadelphia to Atlanta) is near the physical center of that metropolitan area. We also experimented with different radii, ranging from 20 to 40 miles. Our conclusions are robust to the precise distance used. Moreover, we use data from more than 30 miles out in the next section which reports findings on heterogeneity within a CBSA.

Seattle, and Washington, D.C.[11] There are 3,640 observations on vacant parcels purchased with the intention of building single family housing units across these 24 markets.[12]

Appendix 2 reports summary statistics on vacant parcel sizes and transactions prices for each metropolitan area. There are noteworthy differences in mean and median parcel sizes transacted. In Atlanta, the average parcel size is about 1.1 million square feet, or nearly 25 acres; the size distribution is skewed by some very large parcels, but even the median vacant land parcel in this metropolitan area (within 30 miles of the area centroid) is 10 acres in size. There are some large residential land tracts traded in the Bay Area, too. In the San Francisco and San Jose CBSAs, the mean parcel sizes are about 14 and 27 acres, respectively. However, the medians are much smaller at about 3 and 7 acres, respectively. Prices differ materially on a per square foot basis, too, but this still needs to be adjusted for the number of units the buyer expects to build on each vacant parcel. It is to that issue that we now turn.

In 18% of the observations, the number of housing units the buyer intends to put on the vacant land parcel being bought (or the number of units for which the site is zoned or permitted) is noted in a ‘special comments’ field in the CoStar files. Whenever that information is available, we use it as our measure for N. In all other cases, the number of housing units (N)

[11] Appendix 1 plots concentric circles with 20, 30, 35, and 40-mile radii for three CBSAs--Atlanta, New York City, and San Francisco—to provide visual evidence on how our standardization works for metropolitan areas of different physical size. Pictures of the others are available upon request. The red dots mark the location of each vacant parcel transaction from the 2013-2018 period. It is worth emphasizing that the vast majority of these transactions are from suburban regions of each metropolitan area. For example, there is only one such transaction in Manhattan (New York County). The rest are almost always from outlying areas within what can be conceived of as a reasonable commuting distance.

[12] This final sample is arrived at after eliminating any observations we considered to be duplicates of the same parcel transaction. A duplicate is defined as having the same address, price and square footage as a previous sale and occurred with one month of the previously listed transaction. There were various cases where prices fell slightly within a month over time. Our conversations with the data provider and homebuilders indicated that those observations usually reflected a discount for some defect discovered in the land. It also was not uncommon to observe a homebuilder quickly transfer a parcel to a subordinate entity with a very similar name. The only exception to dropping the first of such observations was if we observed seller and purchaser names so that we could ascertain that this was a quick ‘flip’ of a land parcel from one party to another third (independent) party.

expected to be built on the vacant parcel being purchased must be imputed, as is described later in this section.

Before getting to that imputation procedure, we use a couple of examples for which we know *N* to illustrate precisely how *Z* is computed for specific parcels. Our strategy naturally starts from equation (3)'s implication that the zoning tax can be defined as the difference between the extensive [*P(L)/N*] and the intensive margin (*qA*) values of the same land.

For nearly one-fifth of vacant parcel observations, both variables determining extensive margin value come directly from the CoStar files on vacant residential land purchases, with both *P(L)* and *N* being observed directly for this subset of parcels. We impute intensive margin valuation using data from recent single unit housing transactions that are close to the vacant parcel site. Essentially, we presume that the houses to be built on the vacant parcel will be like those in nearby neighborhoods. More specifically, our estimation of the intensive margin value per square foot (*q*) is obtained from a hedonic specification described more fully below that regresses (log) house price on (log) lot size and other controls using a sample of 1,000 home sales during the 2013-2018 period that are physically closest to the vacant land parcel. That estimate of what an existing homeowner is willing to pay for an added square foot of lot is multiplied by the average lot size (*A*) of the 100 geographically closest *new* homes delivered between 2013-2018 to arrive at the intensive margin value of land for a newly-delivered house in close proximity to the vacant residential land to be developed.

To better see how these calculations are performed using actual data, consider the following two cases. The first is from Cobb County, GA, which is in a suburban area to the north of the city of Atlanta. The precise location of the site is depicted by the red dot in Figure 4. This parcel, which is 54.5 acres in size (2,374,020ft^2), sold for \$6,479,937 (or \$2.73 per square foot). The CoStar data also tell us that the purchaser intended to construct 96 houses on the site. From this, we can compute P(L)/N, so that the extensive margin value of land per intended housing unit is $67,499 ($6,479,937/96).

We begin our computation of the intensive margin value of the same amount of land by estimating *q* via hedonic specification using data on 1,000 observations of recent sales from 2013-2018 that are physically closest to the vacant parcel site. These data come from the CoreLogic files which contain the universe of house transactions. Their locations are given by the orange dot cluster in Figure 4.[13] More specifically, our estimates of *q* are based on an underlying hedonic model specified below in equation (4) that regresses the log of home sale price (*HP*) on the log of lot size in square feet (*LOT*), the log of the living area of the home in square feet (*LIVE*), a dichotomous dummy controlling for the number of stories in the house (*STORY*) which takes on a value of one if there is more than one story and is zero otherwise, whether the transaction is of a detached unit or a townhome (*DETACHED*), the age of home entered in quadratic form (*AGE*, AGE^2), and census tract dummies (*TRACT*). Thus,

$$(4)\ logHP_i = \alpha logLOT_i + \beta logLIVE_i + \gamma STORY_i + \delta AGE_i + \delta' AGE2_i + \phi DETACHED + \eta TRACT_i + \varepsilon_i,$$

where the coefficient of interest is α. We convert this from an elasticity into a price per square foot by multiplying by the ratio of house price-to-lot size, with both variables evaluated at their means from the relevant regression sample. Doing so yields an intensive margin price per square foot of $1.72 for this location in Cobb County, GA.

We then impute lot size (*A*) based on the mean lot size of the 100 closest newly-constructed homes delivered in 2013-2018. These data are from the CoreLogic files, too, and are

[13] The average distance from the land parcel to a home sale is 0.76 miles, with the furthest home sale being just over a mile away (1.13 miles, specifically).

depicted with the green dots in Figure 4.[14] The mean lot size among this subsample of new home was 16,866 square feet, which is nearly 0.4 acres.[15] Multiplying this square footage, which is our proxy for *A*, by *q* yields an intensive margin land value of $29,010.

Thus, we estimate a Z (zoning tax) value for this large 54.5 acre site of $3,694,944 (($67,499 - $29,010)*96). Per expected home on this particular site, the zoning tax is $38,489; per square foot, the zoning tax is $2.28, so that a standardized quarter acre of vacant lot within this residential parcel has an implied zoning tax of $24,829.

The same procedure yields a much greater estimated Z-value for a different land parcel in Marin County, which is part of the San Francisco CBSA. This particular site was 3.93 acres in size (171,388ft^2) and sold for $9,701,312 (or $56.60 per square foot), which is more than 20 times the price of vacant land for residential development in the suburban Atlanta case just discussed. Its location is indicated by the red dot in Figure 5. The CoStar files further note that the purchaser intended to place only 12 homes on the site. This implies that the price of land per home (P(L)/N) on the extensive margin is a whopping $808,443 for this parcel. Land values per square foot on the intensive margin also are high in this location. Using the same hedonic estimation procedure described above on the 1,000 closest homes that sold recently (i.e., from 2013-2018) yields a value of *q* equal to $24.06/ft^2, which is nearly nine times larger than the analogous value computed above for the Atlanta region parcel. The homes used in that

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[14] In this subsample, the mean distance from the land parcel is 0.36 miles, with the furthest new home being 0.66 miles away.

[15] For the fourth-fifths of our CoStar observations for which N is not explicitly noted, we have to make an assumption about the share of the parcel that can be used for housing versus non-housing (e.g., road infrastructure and the like). Other evidence on subdivision development cited later in this section indicates that no more than 65% of a large parcel can be used for housing. That guideline fits this case very well, as 0.65*2,374,020=1,543,113 square feet, and allocating that land equally over the 96 planned homes implies a lot size of 16,074ft^2, which is very close to the 16,866ft^2 that we observe for new homes constructed within the last five years in surrounding neighborhoods.

regression are plotted in orange in Figure 5.[16] The mean lot size of the closest 100 newly built homes (plotted in green in Figure 5) is 13,107ft^2.[17] The implied intensive margin value of the typical lot on which one of the dozen homes will sit is $315,354 (~$24.06*13,107).

Thus, the Z (zoning tax) value per home is $493,089 ($808,443-$315,854). For all 12 homes, the zoning tax is $5,917,068. Per square foot of land, the zoning tax is $37.62/ft^2; for a standardized quarter acre of land, the Z-value is $409,682.

When the number of homes to be placed on the site is not explicitly noted in the CoStar files, we have to impute it in order to make calculations like those just described. Information on the density of building on vacant parcels is available from different sources. One is a recent National Association of Homebuilders (NAHB) report, *Typical American Subdivisons*, on large land site housing development.[18] It notes that for the typical (i.e., median) single-family detached subdivision in the country which was comprised of nearly 26 acres, about 65% of the acreage was taken up by housing, with the rest used for other purposes (e.g., roads, parks, public facilities, etc.). The net residential density, or number of units per acre, was 3.2, which implies *N*=6.4 for a two-acre site, *N*=9.6 for a three-acre site, and so on.

While this NAHB survey is the best source we know of regarding vacant land to be used expressly for single-family development, its nationwide aggregate results likely are masking important variation in building densities across markets. Hence, we supplement this with CoreLogic data on density just described. That is, we start by presuming that only 65% of the

[16] The mean distance of these observations from the land parcel is 1.47 miles, with the furthest home sale being 2.33 miles away.

[17] The median among these 100 new homes is 10,776ft^2, so the large mean is not driven by a very few really large properties. These 100 homes are 2.83 miles from the land parcel on average, with the furthest being 4.91 miles away.

[18] This 2016 report is accessible electronically at https://www.nahbclassic.org/generic.aspx?sectionID=734&genericContentID=253886. The NAHB surveyed almost 1,500 homebuilders and received data on 254 subdivisions of four or more housing units.

land on a large parcel (i.e., which we define as being more than two acres in size) can be used for housing development. We then impute the density of housing to be delivered on the remaining area available for residential development to be equal to that in nearby neighborhoods as reflected in the lot sizes of the 100 closest new home delivered between 2013-2018. Because there is substantial variation in new home lot size both within and across CBSAs, this leads to large differences in estimated *N*'s for a given-sized vacant land parcel.[19]

We use a modified version of this procedure to impute *N* on smaller vacant land parcels of less than two acres. For these sites, we presume that more of the land can be used for housing (80% versus 65% for larger parcels). While we do not have hard data on this, a larger share seems sensible. Some type of access still has to be provided, but it could be a smaller alley rather than a wider road; and, it is plausible to presume that at least some public buildings and facilities such as schools and parks already exist elsewhere in the area. Other than assuming a

[19] To illustrate how the zoning tax is computed for observations like this, we use a parcel in Fulton County near the center of the Atlanta CBSA as an example. This parcel was 429,937ft^2 in size and sold for $533,999. We estimated the per square foot intensive margin value of land (*q*) as $0.43/ft^2 using the 1,000 closest transactions between 2013-2018; the mean lot size of new homes (*A*) among the 100 closest newly-delivered homes during the same period was 8,521ft^2. Based on this mean lot size in surrounding neighborhoods, we impute N to be approximately 33 houses ((0.65*429,937ft^2) / 8,521ft^2). This implies the extensive margin value of land per house P(L)/N is $16,182 and the intensive margin value of land is $3,664. Per expected home, the zoning tax is $12,518; per quarter acre the zoning tax is $15,998 (($12,518 / 8,521ft^2)*10,890ft^2). An analogous example from the San Francisco CBSA involves a 442,134ft^2 parcel in Alameda County that sold for $20,395,778. We estimate the value of *q* as $17.18/ft^2 using the 1,000 closest home transactions between 2013-2018 and find a mean lot size of the 100 closest new homes (*A*) of 4,228ft^2. We then impute N based on these values to be approximately 68 houses ((0.65*442,134ft^2) / 4,228ft^2). This implies the extensive margin value of land per house [P(L)/N] is $299,938 versus an intensive margin value of land equal to $72,637. Per expected home, the zoning tax is $227,301 for this parcel; per quarter acre, the zoning tax is $585,456 (($227,301 / 4,228ft^2)*10,890ft^2).

larger share of land is available for home development, the imputation procedure is the same as just described.[20,21]

In the next section reporting our results, we report the median Z value for a standardized unit of land (e.g., a square foot or a quarter acre) rather than its mean. The extensive heterogeneity and skewness in extensive margin values for small-size land parcels in particular is evident from the large standard deviations about mean extensive margin prices documented in Appendix 2. They tend to be driven by variation in the prices of small vacant lot size trades. Figure 6 illustrates this with its plots of vacant land sale prices by parcel size for the Atlanta and San Francisco markets. While some of these cases do not end up generating high estimated zoning taxes because we also see a large number of housing units planned for the site based on comments made by CoStar employees in describing the transaction, others do.

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[20] The median number of housing units per acre to be built in each CBSA is reported in Appendix Table 3. If we had presumed a density of 3.2 homes per acre of developable land based on the NAHB survey, the results for markets such as Dallas would be little changed from those reported below in Tables 1 and 2 because its median of 3.14 is very close to the NAHB survey national average. However, we would end up reporting far higher zoning taxes for the big coastal markets in particular because their estimates of N would be much lower based on the NAHB mean for all markets. The appendix shows that the density of recently delivered new homes per acre is much higher in expensive housing markets and those data lead us to impute about 30% more single unit homes per acre for the typical parcel in markets such as San Francisco (i.e., housing unit density per acre at the median in the San Francisco metro is 4.45 units versus 3.14 units in the Dallas metro).

[21] There is a literature that has investigated the density of building on previously undeveloped land. It finds far lower densities than we report in Appendix 3. For example, Romem and Buildzoom.com (https://www.buildzoom.com/blog/can-cities-compensate-for-curbing-sprawl-by-growing-denser) look at building density for census block groups that recently transitioned from undeveloped to developed across a decade. When we replicate their methodology on census block groups that transitioned between 2000 and 2010 using *American Community Survey* (*ACS*) data, we find much lower densities than are reported in Appendix 3. Non-economists such as the ecologist David Theobold (2005) have also examined this issue for land at the outer edge of suburban regions. He classifies suburban areas as those that have between 0.59 and 1.67 units per acre, with anything denser classified as an already-developed urban area. Exurban areas, according to his classification, are those between 0.25 and 0.59 units per acre. Thus, the density on the urban fringe is much lower on average than what we report in this study. The difference arises from the fact that the vast majority of our vacant parcel purchases are not on the urban fringe. Thus, using densities reported on exurban development would bias up substantially our zoning tax estimates. In sum, we believe that the strategy of presuming the density of new development on our sites will be similar to that of recent development in nearby neighborhoods makes good sense.

A canonical example of the latter type of case where an extremely high price is paid for the land on which we impute a small number of housing units will be delivered comes from the San Francisco market. There is one trade that we confirmed with a local broker in which a purchaser bought a small parcel of barely more than 5,000 square feet for just over $1,600 per square foot (which implies an extraordinarily high price per acre of about $70 million). Further examination showed this site to be located on the side of a hill in a lovely owner-occupied residential area between Nob Hill and Telegraph Hill in the heart of the city of San Francisco. The Street View function of Google Maps then documented that this prospective unit would have an unobstructed view down to the Bay Bridge. This is an extreme example for sure, but cases like this exist in all markets. Even in Atlanta, there are trades of small parcels for very high prices per square foot (and per expected housing unit development) usually in or near well-developed elite suburbs (e.g., those near Emory University to the northeast of the city of Atlanta proper). We still use these data points in the analysis if we could confirm the prices were based on arms-length trades. However, they can be so influential as to move mean values at the CBSA level given the sometimes relatively small sample sizes. This underpins our decision to focus on medians when reporting findings on the magnitudes of zoning taxes across markets in the analysis below. We believe this measure of central tendency is more indicative of the size of the zoning tax per given unit of land faced by a typical middle-class household that wants to live in owner-occupied housing and is not confined to searching only the urban core of a CBSA or its most elite suburbs (where few vacant development parcels exist almost by definition and housing densities tend to be low).

III. Results

III.A. Baseline Findings: How Big Is the Zoning Tax Per Unit of Land By Market?

Table 1 reports the zoning tax for the median parcel in each market. Results are available for the 24 metropolitan areas for which we have at least 20 valid transactions on vacant land intended for single family development, all of which are within 30 miles of the centroid of each market. The first column reports the number of vacant parcel sales in each metropolitan area. The number of observations ranges from a low of 20 (Cincinnati) to a high of 788 (Phoenix). The second column reports the implied tax per generic square foot of land, which we then convert into the zoning tax for on a standard quarter across lot (which contains 10,898ft^2) in the third column.[22]

There are a dozen markets—including the Atlanta, Charlotte, Cincinnati, Columbus (OH), Dallas, Deltona (FL), Denver, Detroit, Minneapolis, Nashville, Orlando and Phoenix CBSAs—in which the typical zoning tax ranges from negligible to small, with 'small' defined as a median zoning tax per quarter acre of land that is less than \$25,000 (and typically much lower) or a per square foot value no more than \$2. [23,24] Not only are zoning taxes modest compared to typical house value in these markets, but land's value on the intensive margin also tends to be

[22] We abstract from considering the value of the zoning tax per house until the concluding section of the paper. The Z-value per house can vary depending upon how the local housing market responds endogenously to the presence of the tax (e.g., via smaller lots sizes and/or higher structure-to-land ratios). Modelling those outcomes is well beyond the scope of this already long paper and is the subject of other research in progress. We return to these issues at the end of the paper.

[23]As noted above, we report medians rather than means because the averages are skewed by outliers in most markets. This is the case even in the Atlanta CBSA, which has a relatively large number (301) of single-family residential vacant parcel transactions. The mean zoning tax per quarter acre of residential land is \$46,853, which is about three times greater than the median value of \$15,111 reported in Table 1. In the San Francisco CBSA, the mean across all 69 parcel observations is \$759,840, which is nearly double the median value of \$409,706 in Table 1. More detail on the distribution of Z-values per quarter acre is available upon request. There are at least a few observations with very large zoning taxes in all metropolitan areas.

[24] Putting Phoenix in this category is a judgment call. It has the highest zoning tax per quarter acre among this group and its tax per square foot is just above \$2. Still, the gap between its median Z-value per quarter acre of \$21,872 and that of the market with the next highest value (Riverside-San Bernardino at \$32,771) is greater than the gap with the next lowest value (Atlanta at \$15,111).

economically small in these markets, too (see the discussion below and the data in Appendix 4).[25] Hence, land is cheap in general in these markets.[26]

On the other end of the spectrum is a small group of five large coastal metros—Los Angeles, New York City, San Francisco, San Jose and Seattle--with very high median parcel zoning taxes. San Francisco is the outlier among this group, with the extensive margin value of a standard quarter acre on the median development site being $409,706 (or $37.62/ft^2) more than the intensive margin value of the same land area. This median also masks substantial skewness in the underlying distribution for this market. One-quarter of the observations on vacant parcels bought for single family development in this CBSA have zoning taxes per quarter acre above $763,000, with the mean being $759,959.

Median zoning taxes in the other four metropolitan areas range from $150,000-$200,000 per quarter acre of land in Los Angeles, New York City and Seattle, to just over $100,000 in the San Jose market. As was the case in San Francisco, these gaps between extensive and intensive margin values generally are not being driven by abnormally low estimates of the latter number (see Appendix 4 again). Finally, these zoning tax estimates are economically large amounts, as they not only exceed the mean household income in the nation ($86,590), but they are equal to or

[25] Appendix 4 provides more detail on the intensive margin values used as in input into creating median zoning tax values by reporting the interquartile ranges for *q*, *A* and *qA*. The general pattern of results is that intensive margin valuations are higher in higher zoning tax CBSAs. Thus, it is not the case that San Francisco's high median zoning tax is associated with an abnormally low per square foot intensive margin value (*q*). The interquartile range of its intensive margin valuations per square foot of land range from $4.63 to $12.05; the analogous figures for the Atlanta market are $0.10 and $1.38. Lot sizes are smaller on average in San Francisco, but the percentage gap is not nearly so large as that for q-values, so intensive margin values still tend to be systematically higher in markets like San Francisco. That we find such a large zoning tax in this (and other coastal) market(s) implies that extensive margin values must be dramatically higher. See just below in the text for more on this.

[26] Note that the Cincinnati CBSA has a slightly negative median zoning taxes per square foot of residential land. This is mechanically driven by market prices of vacant residential land per square foot available for development ((P(L)/N)/A) going for less than we estimate the same amount of land is valued on the intensive margin (*q*). We interpret this as indicating a market with (roughly) no or zero zoning taxes.

exceed the analogous local market means of $101,821 in Los Angeles, $113,556 in New York City, and $112,296 in Seattle.[27]

The seven remaining CBSAs have smaller median zoning taxes, but they cannot be considered economically *de minimis* as was the case with the dozen markets discussed first. This group includes Boston, Chicago, Miami (FL), Philadelphia, Portland (OR), Riverside-San Bernardino, and Washington, D.C. Among this group, the median zoning tax ranges from $35,000-$40,000 per quarter acre of land in the Riverside-San Bernardino and Miami (FL) markets, is just over $45,000 in the Boston metro, and runs from $60,000-$85,000 per quarter acre in the Chicago, Philadelphia, Portland (OR), and Washington, D.C. areas.[28]

III.C. Heterogeneity—Variation in the Zoning Tax by Distance to the Metro Core

Standard urban theory dating back to the monocentric city model suggests that the central tendencies in zoning tax amounts reported in Table 1 could mask substantial variation across space within a metropolitan area. One likely hypothesis is that there is a negative gradient of zoning tax amount (or share) with distance from the urban core. To investigate this potential heterogeneity, we divided each CBSA into three regions (defined by concentric circles): (a) any parcel within 0-15 miles of the CBSA center; (b) any parcel within 15.01-30 miles of the CBSA

[27] These figures are based on data from the *American Community Survey 2017* and are converted into constant 2018 dollars to be consistent with all house and land prices reported throughout the paper.

[28] We performed the same analysis on another group of 21 CBSAs, none of which had 20 valid observations on extensive margin prices from CoStar. Those metros, all of which are non-coastal, included Akron, Albany (NY), Allentown (PA), Buffalo, Cleveland, Dayton (OH), Grand Rapids, Harrisburg, Houston, Indianapolis, Kansas City, Lancaster (PA), Lansing (MI), Madison (WI), Milwaukee, Pittsburgh, Reading (PA), Rochester (NY), San Antonio, St. Louis and Worcester (MA). One of these markets—Lansing, MI--had only one such observation; none had more than Kansas City, MO's, 18. Given the heavy concentration of Rust Belt markets in this group, land values tended to be low in general, with most of their estimated median zoning taxes being slightly negative and none exceeding that reported earlier for Atlanta. The highest median zoning tax value was found in Houston at $14,329. These findings should be viewed with caution given the small underlying sample sizes, but they are consistent with the implications of Table 1 in that zoning taxes tend to be economically small in most markets off the coasts (with the exception of a handful of a very few larger, growing interior markets such as Chicago and Philadelphia). Detailed results for these markets are available upon request.

center; and (c) any parcel more than 30 miles from the CBSA but still within a county that is part of the CBSA; data from this region of the metro area were not included in the analysis reported in Table 1. We then recomputed everything based on observations in each of the three regions.[29] Those results are reported in Table 2.

The fact that Cincinnati, OH, barely made our original sample with 20 extensive margin purchases of vacant land intended for single family development means that the breakdowns by distances within the CBSA sometimes have very small numbers of observations. For example, there are only four relevant CoStar observations within 15 miles of Cincinnati's CBSA core and another four that were more than 30 miles out. Obviously, caution is in order when interpreting results for smaller markets like this one. Fortunately, the situation is much different (and better) for others such as Atlanta, where the 301 observations used in Table 1 are comprised of 77 that are less than 15 miles from the urban core (row 1, panel 1) and 224 from 15-30 miles out (row 1, panel 2). In this new table, we work with an additional 219 vacant land sales that were in the Atlanta CBSA, but more than 30 miles from the center (row 1, panel 3).

There are a number of interesting patterns in Table 2's findings. First, our estimated zoning tax falls in absolute value and as a share of median house value with distance from the CBSA center in most cases. However, heterogeneity across space within a metropolitan area manifests itself differently across markets. For most of the dozen large metropolitan areas that we concluded are lightly regulated because they have small imputed zoning taxes for their median parcel, there is no evidence that focusing on the median was masking important spatial

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[29] This means that not only are observations on extensive margin transactions prices of vacant land reported for the three distinct geographic areas within each CBSA, but comparisons to intensive margin prices and median house values occurs at the same geography. That is, the share of estimated zoning tax in median house value for the first region within 15 miles of the CBSA center uses CoStar and CoreLogic data only from that geography (i.e., within the part of the relevant county that is within 15 miles of the metro centroid). The same holds for the other parts of the metropolitan area.

variation. In the Charlotte, Cincinnati, Columbus, Deltona (FL), Detroit, Nashville and Orlando markets, the median zoning tax per quarter acre for close-in parcels within 15 miles of the metro center is not appreciably greater than the overall median reported in Table 1 which only included observations from 15-30 miles out. Basically, residential land is cheap everywhere in these markets. By no means are most of them in long-term economic decline either. Thus, there clearly are expanding housing markets with no evidence of supply constraints anywhere within their metropolitan boundaries.

The same cannot quite be concluded for the Atlanta, Dallas, Minneapolis and Phoenix metropolitan areas. These markets report zoning taxes for closer-in parcels within 15 miles of the respective metro center that range from about $30,000 per quarter acre (Atlanta and Phoenix) to just over $45,000 in Dallas and Minneapolis. Beyond 15 miles out, zoning taxes are quite modest in the Atlanta and Phoenix metros and are *de minimis* in the Dallas and Minneapolis areas. This suggests that there is something in scarce supply close to the urban core that cannot easily be replicated further out in these metropolitan areas (e.g., perhaps a good school district, nearness to an elite university medical complex, etc.). Stated differently, even markets that look to have highly elastic supply sides to their overall housing markets can have exclusive areas with binding regulatory restrictions that drive up land prices in submarkets of the metropolitan area.

A similar pattern is evident in the Riverside-San Bernardino CBSA. In this market, the median zoning tax for closer-in parcels within 15 miles of the center is more than three times that for those 15-30 miles out ($47,000 versus $15,000). And the median tax is very close to $0 more than 30 miles out. In this sense, this market looks more like Dallas, Miami, Minneapolis and Phoenix than it does like the other CBSAs with modestly high median zoning taxes per quarter acre. That is, the reason we estimated an economically meaningful median Z-value for the overall area in Table 1 is because of a relatively high value for close-in parcels. A similar phenomenon holds in the San Jose, CA, CBSA, but its median Z-value among close-in parcels is much higher at just over $160,000 per quarter acre of land. Beyond 15 miles from its centroid, there is no evidence of a binding supply constraint.[30]

A number of other CBSAs similarly had sharply higher zoning taxes among closer-in parcels, but they also exhibited at least modestly large Z-values for parcels 15-30 miles out. These markets include Boston, Chicago, Miami (FL), New York City, and Philadelphia. For example, the median zoning tax within 15 miles of the Wall Street area in New York City is very high at over one-half million dollars. This is ten times the median for parcels 15-30 miles out, but the Z-value for those further out parcels still exceeds $50,000 per quarter acre of land in the New York City metro. Even more than 30 miles out in this physically very large CBSA[31], the median zoning tax is nearly $27,000 for a standard quarter acre lot with the right to build on it. There also is a very steeply-sloped negative gradient of zoning tax with respect to distance in the Chicago and Philadelphia markets[32], with Boston and Miami (FL) having less steeply-sloped gradients. In the Boston and Miami (FL) markets, even parcels more than 30 miles out have

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[30] San Jose's unique geography probably plays a role in this outcome. This market is bordered to the north by the San Francisco CBSA well before we get to 30 miles from the metro centroid in San Jose. However, the CBSA boundary extends far to the south past Santa Clara County to San Benito County. The latter is characterized by a narrow valley between rugged mountains, so the potential for residential development is limited. Moreover, the micro climate becomes even hotter and dryer as one proceeds southward. There are only 19 total observations more than 15 miles out in this metropolitan area, and our results based on them indicate that vacant residential land value is not being bid up in that part of the CBSA.

[31] As the plot in Appendix 1 documents, this expansive CBSA extends to parts of Pennsylvania to the north and west and to the far end of Long Island to the east, so the distances can be great in this market.

[32] The close-in parcels are not randomly distributed within either market's 15-mile concentric circle. In Chicago, over two-thirds (11/15) of the observations are smaller parcels in and around the downtown Loop and Lincoln Park areas or in elite northern suburbs such as Evanston, Wilmette and Park Ridge. It is easy to imagine one would have to pay a high scarcity value to access these particular places, but some of our high estimated zoning tax could be due to underestimating the number of units to be put on these sites. In larger samples, this is not so much a worry because it is less likely that measurement error of this type would contaminate the median observation. The subsample size is greater within 15 miles of the Philadelphia CBSA center—30 vacant parcel transactions. However, 17 of those are in or around the downtown area of the central city of Philadelphia itself. As with Chicago, we worry about imputing too low a value of N on the typically smaller sites located close to urban downtowns.

median zoning tax values in excess of $20,000 for a quarter acre plot. In contrast, there is no evidence of supply constraint that far out in the Chicago and Philadelphia metros.

The Washington, D.C. metropolitan area has a negative gradient with respect to distance, but its slope is much gentler. Close-in Z-values are about $70,000 and only drop to about $59,000 for parcels between 15 and 30 miles out. It is only beyond 30 miles that the median zoning tax falls to just below $13,000 per quarter acre.[33]

The Portland (OR) market is somewhat similar in nature, but it has a very flat gradient out to 30 miles, with the typical zoning tax being about $50,000 per quarter acre within 15 miles of the center and is slightly higher at about $62,000 for parcels 15-30 miles out. There is only one observation more than 30 miles out.

The remaining three large west coast metros of Los Angeles, San Francisco and Seattle are unique in their own ways. The zoning tax for close-in parcels in the Seattle market is quite high at just over $300,000 per quarter acre, then declines by 50% to about $130,000 for parcels 15-30 miles out. However, it is still just over $100,000 per quarter acre more than 30 miles out. Unlike the New York City market, zoning taxes in Seattle are economically large everywhere in the metropolitan area. Even more than 30 miles out, the median parcel's zoning tax for this region of the market is almost as high as the mean household income for the entire metro.

The zoning tax gradient in the Los Angeles market does not really slope down at all. Its median zoning taxes are very close to $200,000 per quarter acre in each region of its market. The zoning tax-distance gradient is negative in the San Francisco CBSA, but the smallest typical

[33] The spatial distribution of the near-in parcels in the Washington, DC, metro also is interesting. Because the White House is the metro centroid, the District of Columbia itself constitutes a meaningful fraction of the area within 15 miles. There were zero vacant parcels bought for single family residential development inside the District proper in the CoStar data. Moreover, the vast majority of the 37 observations that are within 15 miles of the White House lay to the east, moving towards Annapolis, MD. In contrast, the vast majority of the observations from 15-30 and 30+ miles out lay in counties to the west of the capital. This is another case like those for Chicago and Philadelphia discussed above in which parcels are far from randomly distributed within zones of a concentric circle.

zoning tax in any part of that metropolitan area is over one-quarter million dollars ($246,540). A quarter acre of residential land is over $400,000 more expensive if the site is within 15 miles of the centroid, is just under $300,000 costlier if from 15-30 miles out and still is about $270,000 more if more than 30 miles out. These are very large amounts even compared to high household income in that labor market area.

III.C. Are Zoning Taxes Related to External Measures of Regulation?

Extensive margin land values far in excess of intensive margin prices are a clear prediction from price theory of the presence of binding supply side regulation. In this subsection, we investigate whether the size of a market's zoning tax is positively correlated with a recent index of local regulatory strictness in Gyourko, Hartley and Krimmel (2019). The WRLURI2018 index is created from survey responses to a series of questions about the general characteristics of the regulatory process and key rules by which housing production is restricted. The aggregate index itself represents the first principal component extracted from a dozen subindexes which are described in detail in Gyourko, Hartley and Krimmel (2019). The index is standardized with a mean of zero and a standard deviation of one; index values are increasing with the degree of regulation, so that a value of one implies the underlying regulatory environment is one standard deviation more restrictive than that for the national average environment. The 25 percent most highly regulated communities in the country have aggregate index values above 0.64.

Figure 7 plots each of our 24 CBSA's median zoning tax per quarter acre values against the CBSA-level WRLURI2018 value. This is the mean of individual community values for those places within each metro area that answered the Wharton survey.[34] The size of the gap between extensive and intensive margin land values in a market is strongly positively correlated with its average WRLURI2018 value. The simple correlation is 0.65, with a one unit (or one standard deviation) increase in the measure of regulatory strictness being associated with about a $125,000 increase in a market's zoning tax per quarter acre in a simple bivariate regression. Casual visual inspection indicates that the actual relationship is not linear. Further analysis shows the fit can be improved by presuming a quadratic or spline with the knot at a WRLURI2018 value around 0.7, but our point here is not to engage in an exercise that maximizes R^2 in a sample with 24 observations.

Rather, it is to emphasize that the correlation is strong and is not mechanically driven. The Wharton regulatory index value is based on responses to survey questions about the nature of the local regulatory process, who is involved in that process (and at what level of intensity), and what types of rules and regulations actually are imposed on the ground in each market. These questions and responses never utilize or reference house or land prices in any way.[35] The zoning tax measure is based on visible (on the extensive margin) and implicit (on the intensive margin) land values using market transactions. As theory predicts, the land value-based zoning tax is strongly positively correlated with this independent measure of regulatory strictness in the cross section.[36]

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[34] Our figures are not identical to those in Table 5 of Gyourko, Hartley and Krimmel (2019) because we only use observations on the subset of communities within 30 miles of the CBSA center.

[35] That survey does ask about how land development costs have changed over time, but that information is not used in the index values being plotted.

[36] As noted earlier, the Wharton index is itself comprised of a dozen subindexes. Unfortunately, it is not feasible to exploit variation in those data to identify whether a specific component or part of the local regulatory environment is driving this correlation. Gyourko, Hartley and Krimmel (2019) note that these subcomponents tend to move together. That is, they are consistently higher (lower) together in more (less) strictly regulated metropolitan areas. Hence, there is no reason to presume they vary independently of one another. Absent an instrument or other source of exogenous variation (which we do not have for this analysis), they cannot be used to show that a certain

An additional noteworthy stylized fact from Figure 7 is that there appears to be something special about the underlying residential land use regulatory environments of those metropolitan areas with average WRLURI2018 index values that place them in the top quarter of the most regulated places nationwide (i.e., index values above 0.64). An intriguing feature of those few CBSAs with high average regulatory index values is that most of their individual communities have high values, rather than a few having extraordinarily strict regulatory environments.[37] It would not be unreasonable to presume that the impact of regulatory strictness is amplified when there are not many alternative communities with less strict building restrictions within the metro area, but that is an issue for future research.

IV. Conclusions: Implications for Housing Markets and Future Research

Our results also have a number of important implications for the nature of American housing markets and should help guide future research into these issues. First, the magnitude of our zoning tax estimates, especially for the large coastal markets, suggests that binding supply side regulation could have driven up land prices enough to play a meaningful role in accounting for the wide geographic dispersion in house prices we now see, as documented in Figure 1. The main alternative explanation would be differences in construction costs across these markets. Prior research reports material differences across metropolitan areas in the cost of putting up a given quality housing structure--up to 80% between the most- and least-costly building markets

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component of the regulatory environment is what really drives the extensive versus intensive margin price gap in land values.

[37] Among the San Francisco and New York City CBSAs, between two-thirds and three-quarters of the responding communities to the Wharton survey themselves had WRLURI2018 values that put them among the top quartile of all communities nationwide that answered the survey. Among more modestly-regulated markets with average WRLURI2018 values below the cutoff for the 75th percentile in terms of regulatory strictness, the average share of such highly-regulated communities ranges from one-tenth to one-third. See Table 6 and the associated discussion in Gyourko, Hartley and Krimmel (2019) for more detail.

(Gyourko & Saiz (2006)). The range is a bit less among the relatively large metropolitan areas investigated in this paper. For example, the most recent data shows that it costs 46% more to put up a given quality housing structure in the San Francisco market than it does in the Atlanta market (R.S. Means Company (2017)). That is not nothing, for sure, but it still pales in comparison to the house price differences that Figure 1 documents can be up to 10 times as large. Gauging the precise role of regulation is an issue in need of further research especially since the geographic variation in construction costs is not nearly large enough to account for much of the house price dispersion.

One would expect endogenous responses in local housing markets to land price impacts of the magnitude reported in Table 1. That the zoning tax per standardized unit of land is just under 200 times greater in the San Francisco CBSA than in the Dallas CBSA (i.e., [$37.62/ft^2]/[$0.20/ft^2]~188 from Table 1) suggests that lot sizes will be smaller in San Francisco relative to Dallas, *ceteris paribus*. Moreover, given how expensive land is in San Francisco, we also would expect more (and better) physical structure to be put on a given amount of land in that area compared to in Dallas. While these are consequences that future research must evaluate carefully, the zoning tax per house for units we forecast to be built on the median parcel in each market is consistent with both predictions. Recall that the zoning tax per house is given by [P(L)/N]-qA. This is different from the Z-values per standardized unit of land reported in Table 1 because the per house value reflects any market response to the gap between extensive and intensive land values.

For the median parcel in the San Francisco market, the zoning tax per house to be built on the median vacant parcel still is an absolutely and relatively large value of $183,979, but that is well under one-half the added cost of a quarter-acre of land. This is in marked contrast to what we see in the Dallas market, where the zoning tax per house on the median parcel actually is slightly higher than the zoning tax per quarter acre ($2,623 versus $2,217).

In the samples of 100 new homes close to vacant residential land sales across the San Francisco metro area, the median of the new house sample mean lot sizes is 7,828ft^2, while the analogous figure for Dallas is 9,129ft^2. Thus, in the San Francisco market, the typical new single unit home sits on about 15% less land than the analogous new unit does in the Dallas market. Comparing living area square footage to lot size in the CoreLogic data finds more living area per unit of land in the San Francisco market. For example, the median of the mean living area square footage of the clusters of 100 new homes close to each of the 69 vacant land parcels in the San Francisco market is 2,782ft^2, which is 36% of the 7,828ft^2 lot size figure from above. And, this distribution has a fat right tail in San Francisco, as the median ratio across all 69 groupings is 57%; the analogous figures for the Dallas market are 30% and 37%, respectively. Other back-of-the-envelope calculations show the same pattern in terms of the value of structure per unit of land.[38]

While it certainly looks like the market is endogenously responding to reduce the magnitude of the zoning tax that has to be paid on newly-built homes in San Francisco, the tax still is large and is greater than the annual median income in the area. This suggests that who owns, as well as when homeownership becomes financially feasible, could differ substantially across markets as a result. Data from the *2013-2017 5-Year ACS* highlight differences in

[38] The following, admittedly rough calculation suggests that the value of structure per square foot land is four times higher in the San Francisco market than in the Dallas area. We start by computing the median of the mean sale prices of the clusters of 100 new homes close to each of the 69 vacant land parcels in the San Francisco market—which was $1,225,812. Structure value is backed out of this price by subtracting off the sum of intensive margin land value plus the zoning tax. Dividing that by the 7,828ft^2 median of the mean lot sizes for the 69 clusters yields structure value of $126 per square foot of lot in San Francisco. The analogous chain of calculations yields a structure value of $36 per square foot of yard in Dallas. Given the large difference between these figures, it seems likely that the quality, not just the quantity, of structure is higher in San Francisco, but that remains to be addressed by future research.

patterns of homeownership across markets with varying levels of zoning tax consistent with these implications.

We start by grouping observations from our 24 major metropolitan areas into one of three categories: (1) high zoning tax markets, defined as the five CBSAs with median zoning taxes per quarter acre in excess of $100,000; (2) medium zoning tax markets, comprised of the seven CBSAs with zoning taxes per quarter acre ranging from $35,000 to $80,000; and (3) low zoning tax markets comprised of the dozen CBSAs with negligible to small zoning taxes that never exceed $22,000 and often are much lower. The panels in Figure 8 plot rates of homeownership by household income percentile for each group of markets.[39] The horizontal red lines at the 50th percentile of homeownership helps us identify at what income percentile each group of households is more likely than not to own a home. There are a number of noteworthy stylized facts documented in Figure 8 that clearly warrant further research into how homeowning across the lifecycle and by skill level or occupation may be responding to large differences in zoning tax across markets.

The first such fact is apparent from the first panel—namely, that high zoning tax CBSAs (Los Angeles, New York, Seattle, San Francisco, and San Jose) look significantly different from middle and low zoning tax CBSAs. At the national median household income (~$60,000), only 37 percent of households in high-zoning tax CBSAs are homeowners, in contrast to the 52 and 56 percent in mid- and low-zoning tax CBSAs, respectively.[40] Households in high zoning tax metros are more likely to own only once they pass the 68th income percentile (~$92,000). In contrast, households in middle and low zoning tax CBSAs are more likely to own from the 48th

[39] These are smoothed local polynomials of the underlying data.
[40] See Appendix Table 5 for details on homeownership rates by income percentile in aggregate and by household age and skill/occupation sector, across the CBSA zoning tax categories.

percentile of income (~$58,000) or the 41st percentile (~$49,000) onwards, respectively. These differences by CBSA zoning tax level persist even at higher incomes. At the 90th income percentile (~$170,000), a much greater 72 percent of households in high zoning tax CBSAs own, but this is no higher than the rate achieved by a household earning just over $60,000 less (i.e., about $108,000) in a medium zoning tax CBSA.

There are additional interesting insights from disaggregating these data along age and skill/occupation lines. Our age split is as follows: 'young' households are defined by having a head between 25-44 years of age; 'old' households are from 45-64. We also created three skill/occupation categories: high skill, local nontradable, and all others.[41] The gap in homeownership between high and low-zoning tax metros is especially stark among the young, as illustrated by the second panel in Figure 8. Among young, highly skilled households plotted on the left side of this panel, households at the 75th percentile of the household income distribution nationally (about $108,000) in high zoning tax CBSAs own at a 42 percent rate. This is 27 percentage points lower than the 69 percent ownership propensity for similarly aged and skilled households making the same income in low zoning tax metros. As with the more aggregate data, this gap persists even as we move up the income distribution. At the 90th percentile of the income distribution (~$170,000), 82 percent of young, highly-skilled households in low-Z metros are

[41] All household heads in our sample are between the ages of 25 and 64, in the labor force, earn positive income, and live in one of the 24 CBSAs analyzed. We define a household head as the spouse/partner who makes more income. The sample consists of 1,286,493 (unweighted) households (27,759,298 weighted). To create the skill occupation categories, we assign each of the 441 unique occupations of household heads in the *ACS* data to one of our three categories. This breakdown is *ad hoc*, but is done in what we believe is a sensible manner, and is for illustrative purposes. We categorized 41 occupations as high skill, with typical examples being software developers, accountants and auditors, computer scientists, lawyers, and physicians. Eighteen percent of households hold high-skill positions by our definitions. Our local nontradable category includes 53 specific occupations and comprises 32 percent of our household sample. Some of the most common local nontradable occupations include registered nurses, drivers, elementary and middle school teachers, chefs, and home health aides. The All Other category includes the other 338 occupations. The most common of this group includes managers not elsewhere classified, supervisors of sales workers, customer service representatives, and sales representatives. The full list of occupations and categories is available upon request.

owners compared to just 52 percent in high-Z metros. Stated differently, young highly-skilled households at the 90th percentile in high-Z metros own at the same rate as households of a similar age-skill profile earning less than half as much in a low-Z metro. The income thresholds for likely ownership vary substantially by age, too. The right-most plot in the second panel shows that older (aged 45-64), highly-skilled households are more likely than not to be homeowners at virtually all income levels, regardless of CBSA zoning tax level.[42]

The third panel depicts the analogous plots for households working in what we term the local, nontradable sector. Among older households (right-most plot), those in low and mid-Z metros are more likely to own once they make around $38,000 (i.e., the 32nd percentile of the national household income distribution), while those in high-Z metros must earn at least $63,500 (52nd percentile) to be more likely to own. To be more likely than not to own, the income thresholds for younger households are much higher, regardless of skill sector or CBSA zoning tax level. Younger households earning the national median income are more likely to rent than to own in all CBSA types and in either skill category. Across all income levels, older households are more likely to own than analogous younger households of the same geographic area and skill type. These age-specific gaps are especially large for high income, highly-skilled households in high-Z metros. There are other interesting patterns from just these data, but the point is that future research needs to investigate more deeply how the nature of homeownership is being affected across markets by differing levels of zoning taxes.[43]

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[42] A small caveat is that those living in high zoning tax metros and also earning below the 30th percentile of the national income distribution are about as likely to own as rent. This certainly looks to reflect sampling variation and should not be interpreted as fundamentally contradicting the point being made.

[43] Just one such pattern is that while age seems to matter more than skill in terms of explaining variation in homeownership across metros, skill seems to matter more among the old than the young. In other words, there is more variation in homeownership propensity across skill types at older ages than at younger ages (i.e., the left-most plots in panels 2 and 3 are more similar to one another than are the right-most plots in the same panels). For example, at the 75th percentile of the national household income distribution (~$108,000), the gap in homeownership rates for older households working in a local nontradable occupation is 17 percentage points (67% versus 84%)

Zoning taxes of the magnitudes reported above in our major coastal markets look large enough to affect the aggregate distribution of wealth, too. Just in the San Francisco CBSA for example, multiplying the implied mean (not median) zoning tax of $69.77/ft^2 times the 41.2 million square feet of total residential land bought in the 69 vacant parcel transactions within 30 miles of the centroid of the San Francisco CBSA yields an added $2.875 billion in land value. The price impact should not be restricted to the select parcels observed in the CoStar data, of course, but should affect all land in the market. Future research should try to estimate the latter value in this and other markets.

A final issue in need of good economic analysis is on the optimality (or lack thereof) of our estimated zoning taxes. Since development tends to have at least some negative spillovers on nearby sites (e.g., pollution, noise, etc.) and the broader community (e.g., congestion in the schools or on the roads), the optimal zoning tax appears to be positive, although it is conceivable that increasing returns from agglomeration effects associated with greater population could more than counterbalance the negative externalities per Hsieh & Moretti (2019) and Duranton & Puga (2019). Other than the back-of-the-envelope calculations in Glaeser, Gyourko and Saks (2005), we know of no estimates of this item. Given how large our estimates are in a handful of markets and how small they are in many others, good public policy requires sounder estimates of the gross and net external effects.[44]

across high and low zoning tax CBSAs. The analogous gap for older households in high-skilled occupations is 13 percentage points (75% vs. 88%). Comparing median and low-income older households across sector types, we see that the local nontradable households in high-Z metros own at significantly lower rates than their highly skilled counterparts. This pattern does not exist for younger households and should be a subject of future research.

[44] The aggregate impacts on land values among transacted prices discussed above in Section III.A (see footnote 27 especially) provide useful baselines against which economists might measure potential harms caused by residential development.

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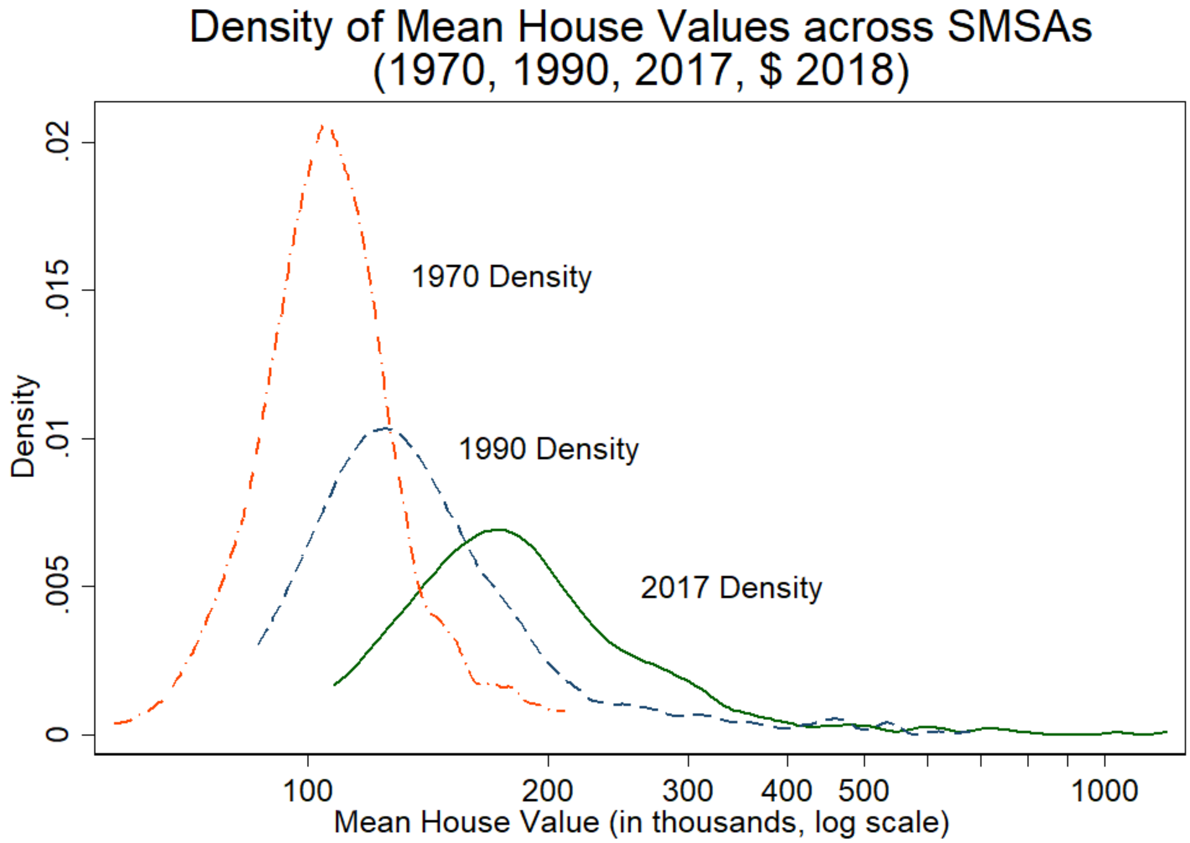
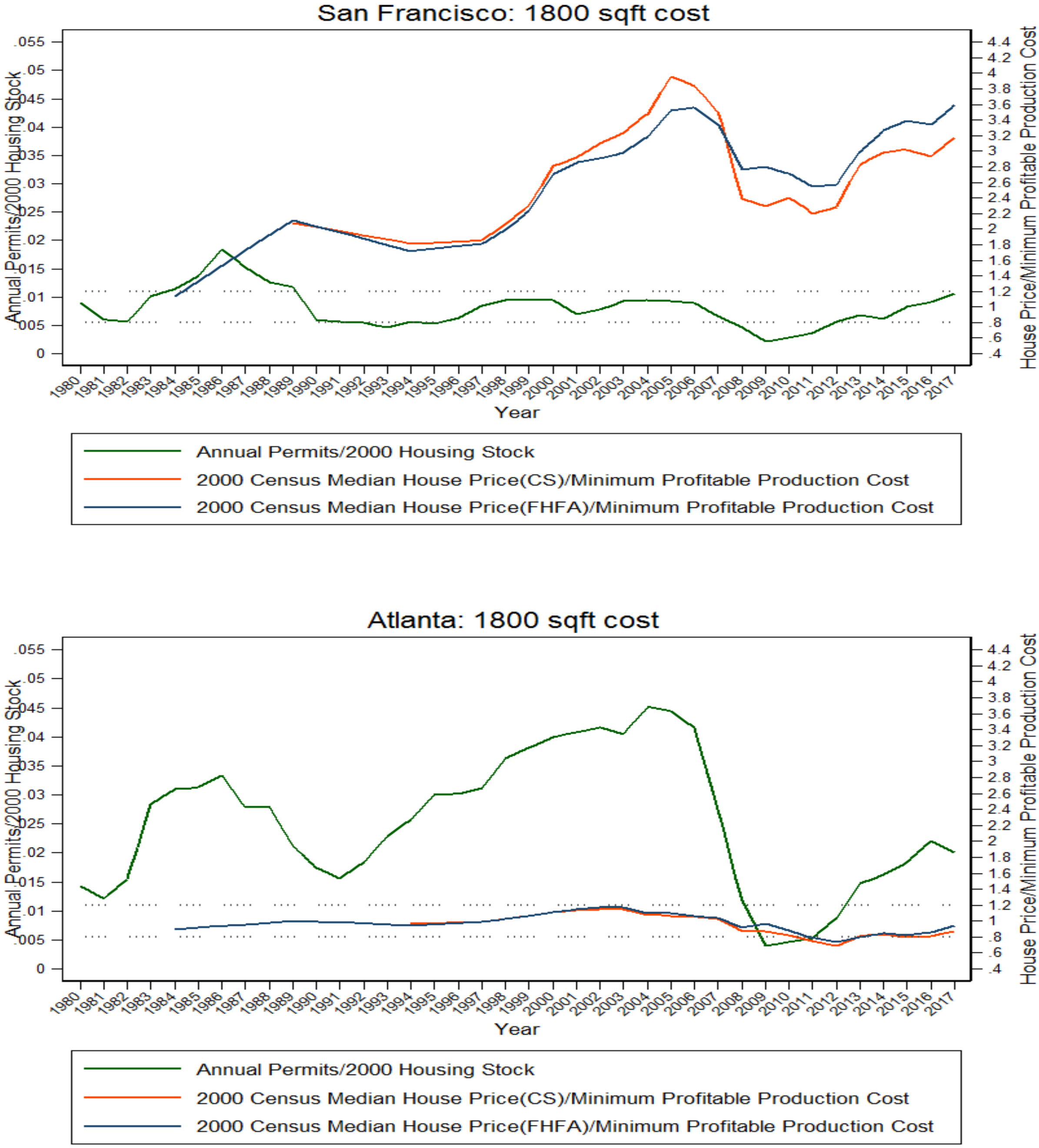
Figure 1:



Notes: Metropolitan areas in this plot are based on 1990 county boundaries to create consistent physical areas over time. Data collected at the county level were then aggregated to Standard Metropolitan Statistical Areas (SMSAs). Classifications of county groupings may be found at https://www.census.gov/population/estimates/metro-city/90mfips.txt.

Figure 2: Price-to-Minimum Production Costs and Permitting Intensity, San Francisco and Atlanta CBSAs



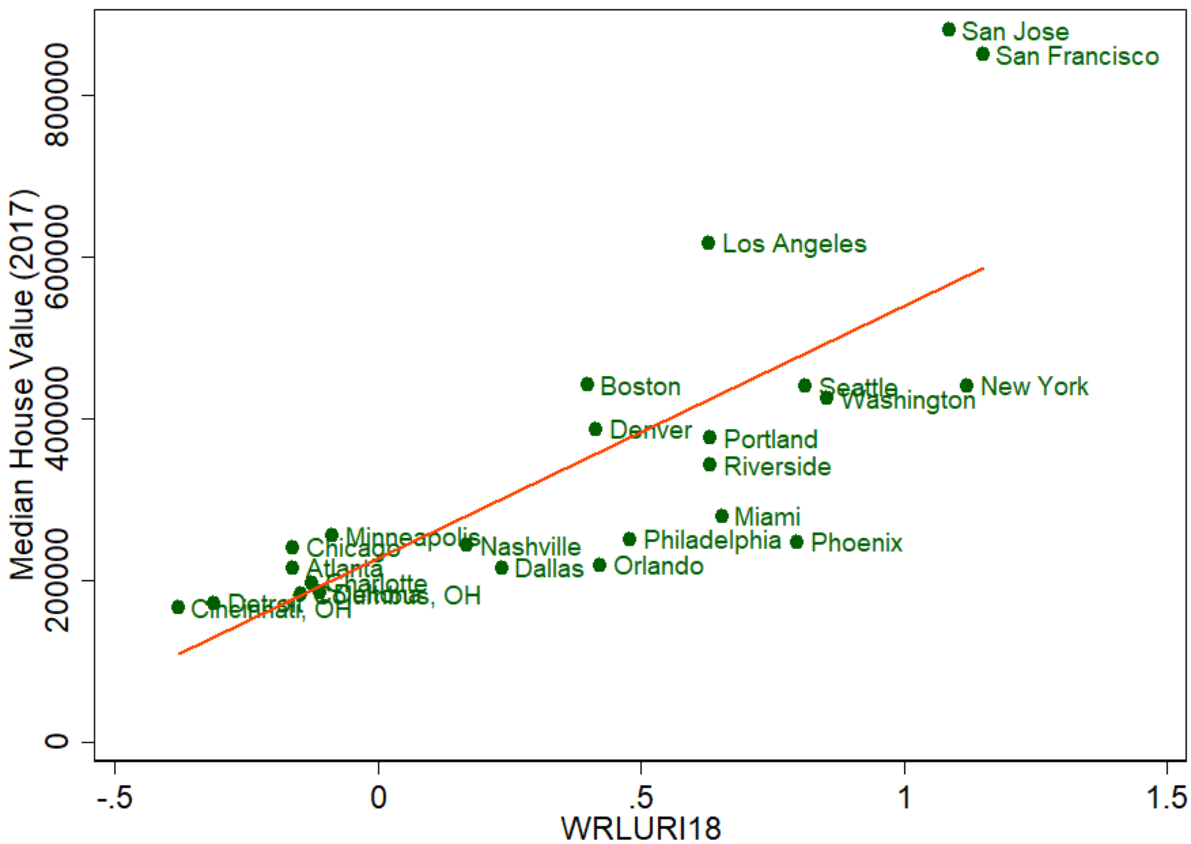
Notes to Figures 2a and 2b: The term minimum profitable production costs (MPPC) refers to the cost of replicating a housing unit. This is defined as the sum of the construction costs incurred to deliver the structure, plus the cost of the land on which the home sits, plus a normal profit for the builder—all presuming competitive markets for materials, land, and labor and free entry into the homebuilding sector. Research indicates the market for structure is highly competitive and that features such as roofs or basements are in highly elastic supply in any given market (Gyourko & Saiz (2006)). Physical construction costs (CC) are taken from the R.S. Means Company (2017), an engineering consultant and data provider to the homebuilding industry. Their costs used here are for a modest quality home of 1,800ft^2 that meets all local building codes and zoning requirements. That home was chosen because it is thought to reflect the quality of the median home from the 2000 Census. That home is then priced forward and backward in time using the Case-Shiller and FHFA constant quality house price series.

Land value here is presumed to equal 20% of total house value. That is at the upper end of what surveys of homebuilders tell us is the land share in a typical, lightly regulated market with free entry into building whenever house prices rise above fundamental production costs. The third component of MPPC is a 17% gross margin on structure plus land for the builder. That margin is sufficient to yield the 9%-11% net returns for homebuilders across the cycle.

The price-to-cost ratio is measured on the right axis, with the horizontal dotted lines marking 20% above and below 1. In a well-functioning market, house value (HV) would be pinned down by MPPC. Thus, MPPC = HV = 1.17(CC+L), where L=.2HV by assumption, so that HV = MPPC = 1.52CC. Stated differently, in a market with no binding supply constraints so that land never cost more than 20% of overall house value and developers earn their normal rate of return on building, minimum profitable production costs of a house should be about 150 percent of physical construction costs. See Glaeser and Gyourko (2018) for more on these items and their use.

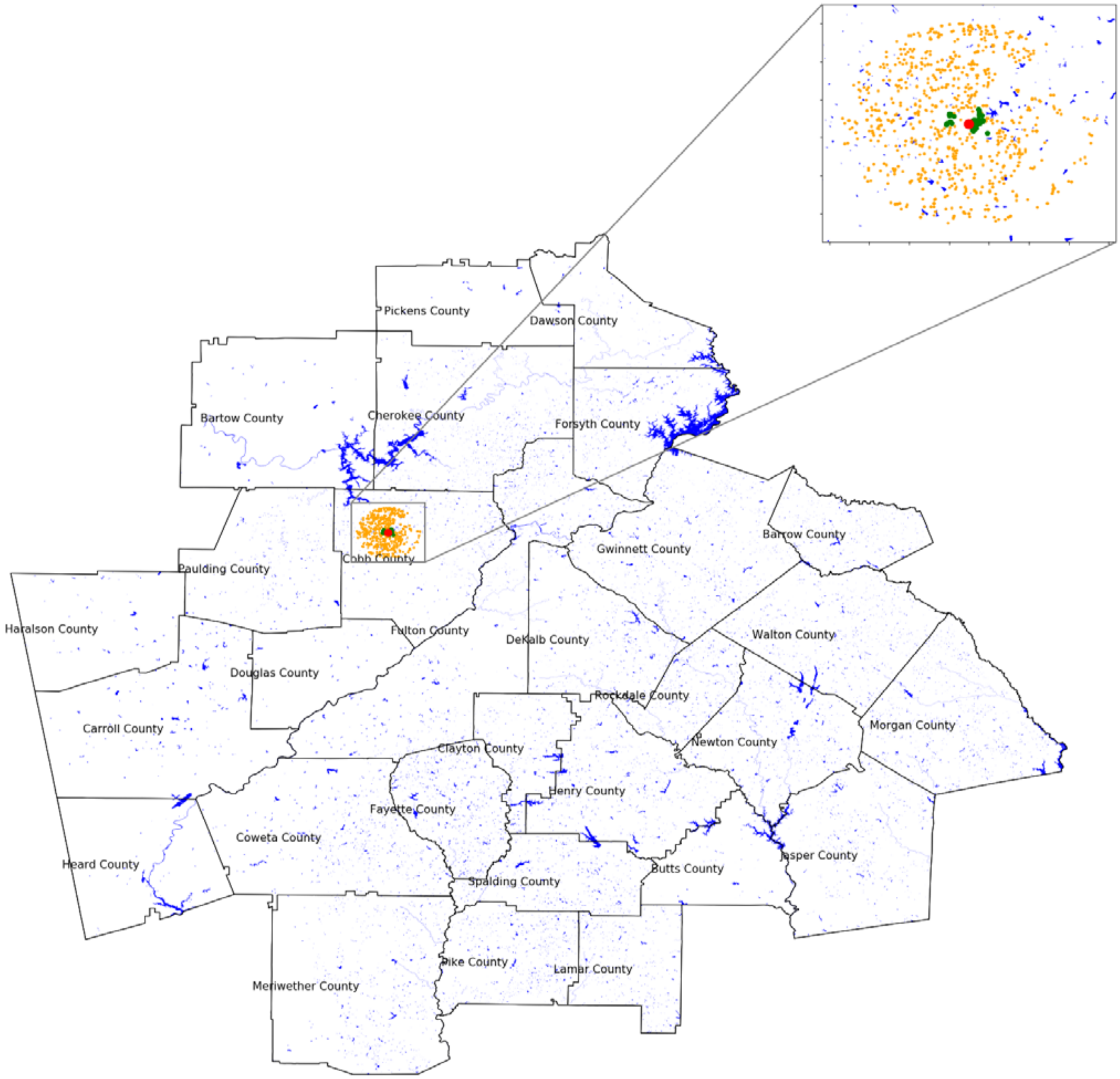
Home building is measured with housing permits and is plotted in the green line as the ratio of annual permits to the metro area stock of housing in the year 2000. Shares of permits in the 2000 stock are measured on the left axis. Annual permits are taken from the U.S. Census Bureau publication *Building Permits Survey, Permits by Metropolitan Area* (2018) and may be downloaded at https://socds.huduser.gov/permits/. The 2000 housing stock figures come from the 2000 Census (U.S. Census Bureau. *2000 Decennial Census, Summary File 1 100% Data.*)

Figure 3: House Prices vs. Supply Side Regulatory Strictness
24 Major CBSAs



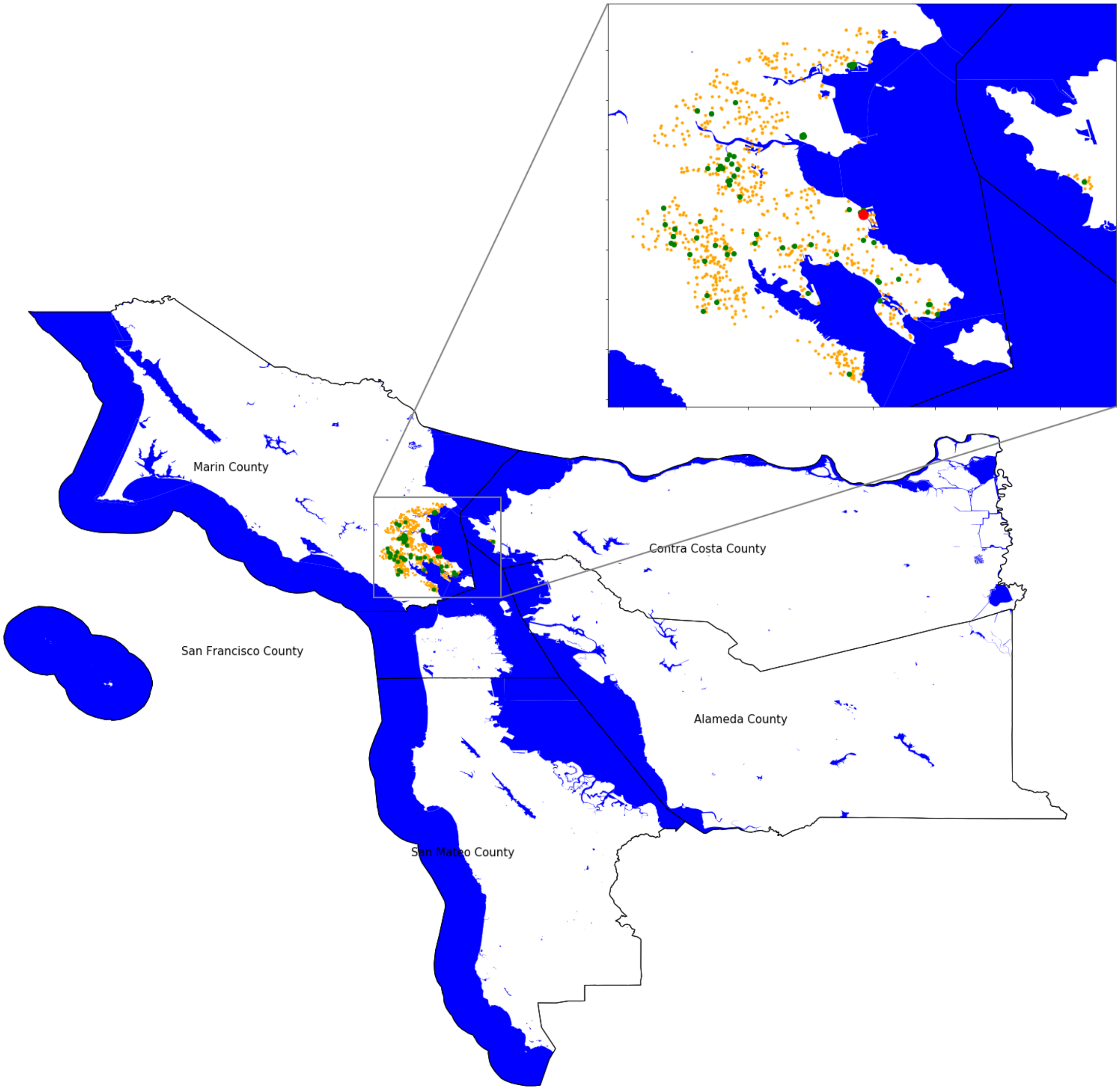
Notes: CBSA Median House Value is taken from the 2017 *American Community Survey*, *1 Year Estimates*, which can be downloaded at https://data.census.gov/cedsci. The WRLURI18 index value is the average of communities 30 miles of the relevant CBSA centroid. Those data are available at http://real-faculty.wharton.upenn.edu/gyourko/land-use-survey/.

Figure 4: CoStar and CoreLogic Data Used to Compute the Zoning Tax for a Vacant Land Parcel in Cobb, County, GA



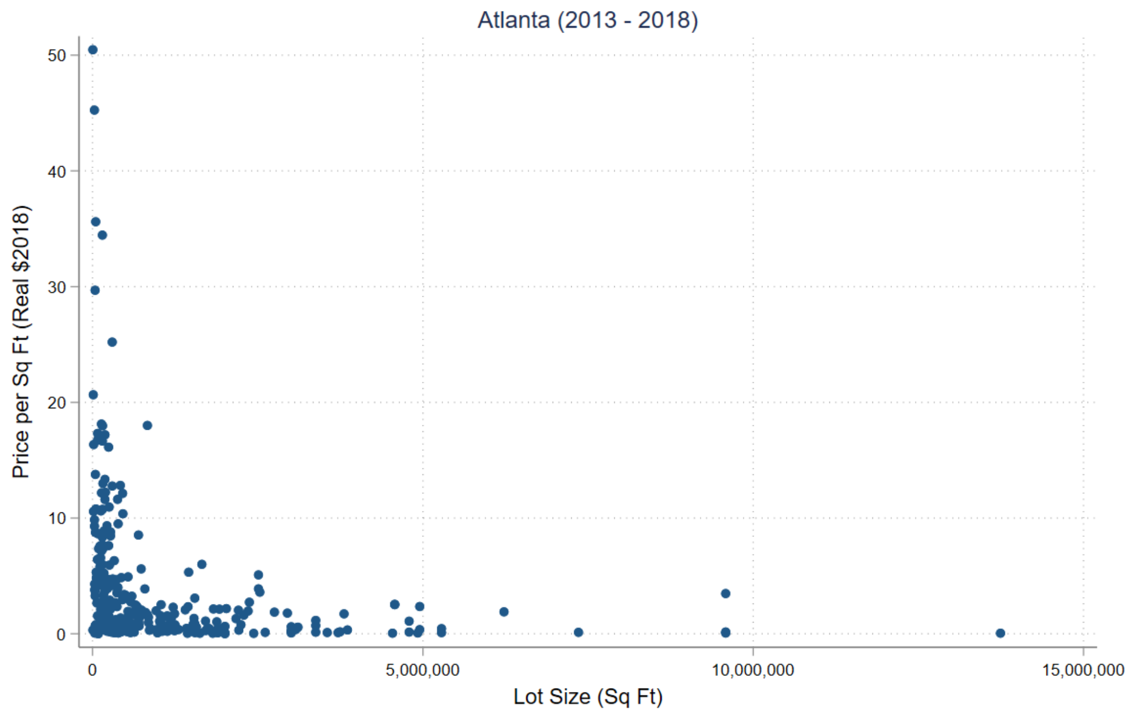
Notes: A red dot (.) indicates the location of a recently purchased vacant residential land parcel. Orange dots (.) indicate the locations of the 1,000 home sales between 2013-2018 that are physically closest to the vacant parcel. These observations are used in a hedonic specification to estimate *q* (intensive margin land value per square foot). Green dots (.) mark the locations of the 100 new homes delivered between 2013-2018 that are physically closest to the vacant parcel. These observations are used to determine A, the average lot size. The blue dots are small bodies of water—lakes, ponds, etc.

Figure 5: CoStar and CoreLogic Data Used to Compute the Zoning Tax for a Vacant Land Parcel in Marin County, CA



Notes: A red dot (.) indicates the location of a recently purchased vacant residential land parcel. Orange dots (.) indicate the locations of the 1,000 home sales between 2013-2018 that are physically closest to the vacant parcel. These observations are used in a hedonic specification to estimate *q* (intensive margin land value per square foot). Green dots (.) mark the locations of the 100 new homes delivered between 2013-2018 that are physically closest to the vacant parcel. These observations are used to determine A, the average lot size. The blue dots are small bodies of water—lakes, ponds, etc.

Figure 6: Heterogeneity in Extensive Margin Land Prices by Parcel Size
Atlanta and San Francisco CBSAs



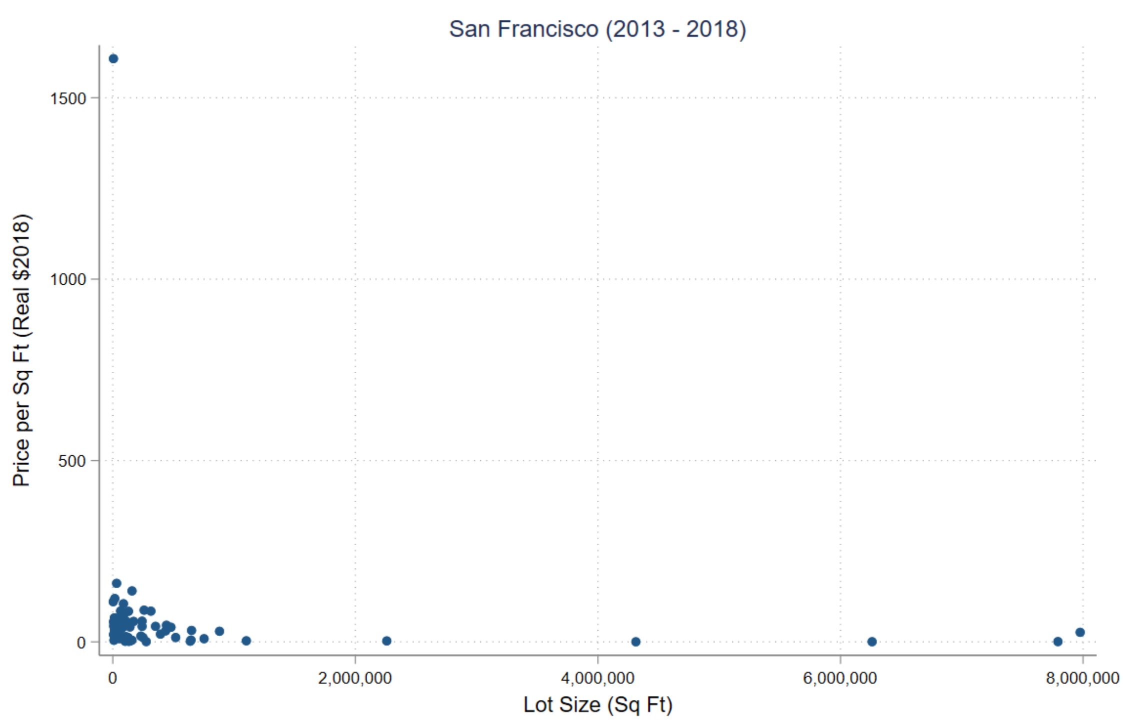
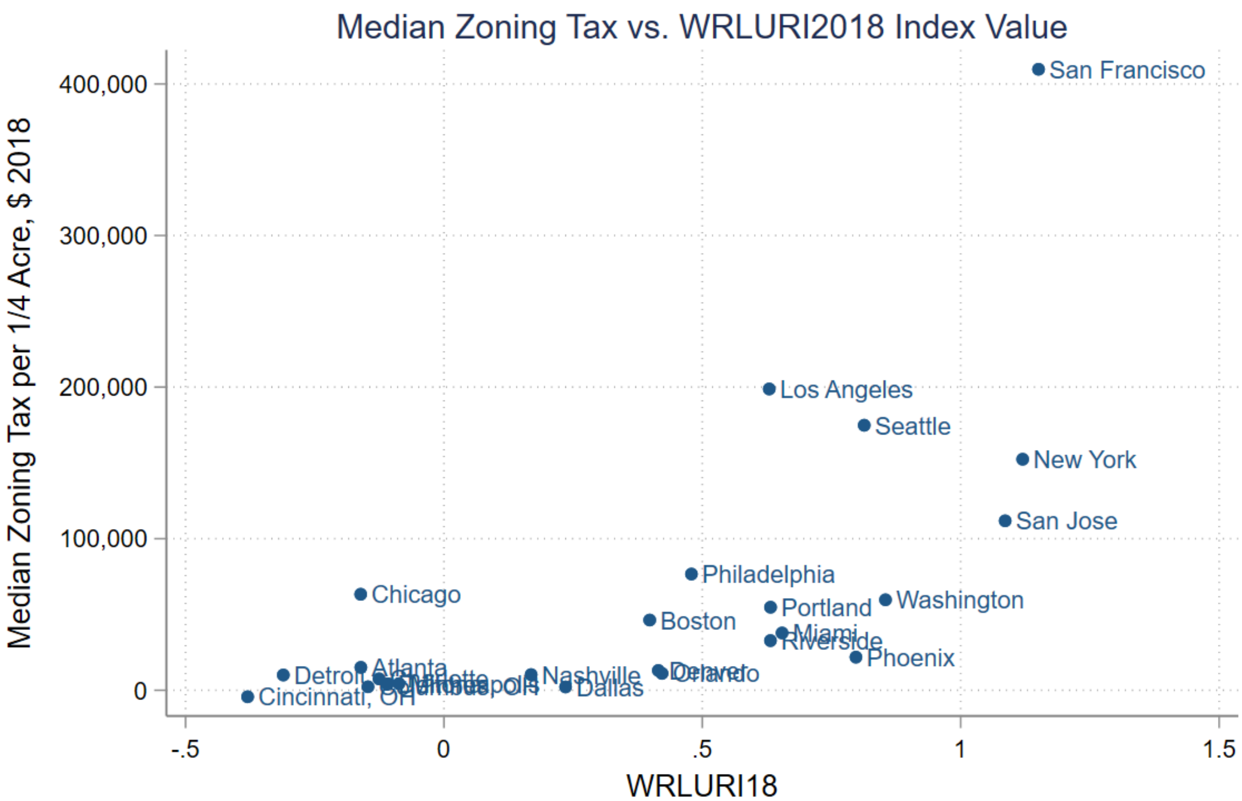


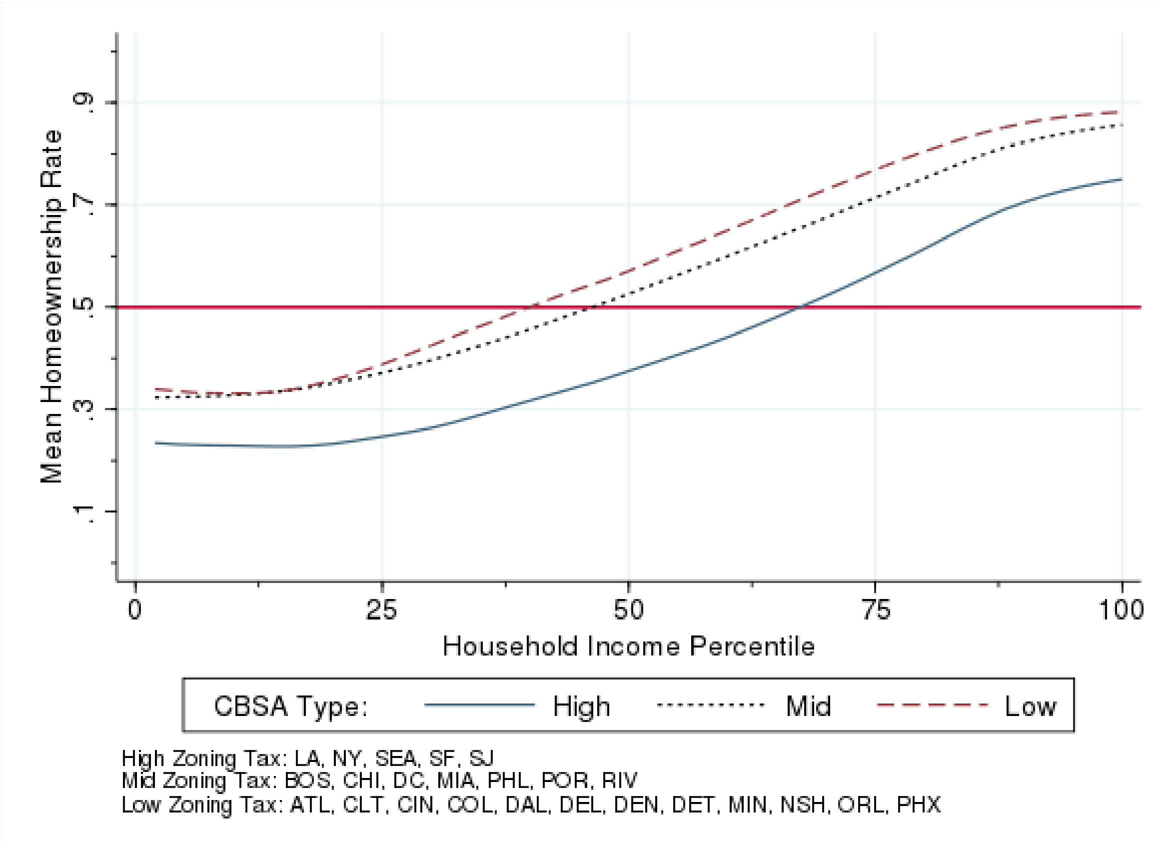
Figure 7: Median Zoning Tax vs. a Measure of Regulatory Strictness



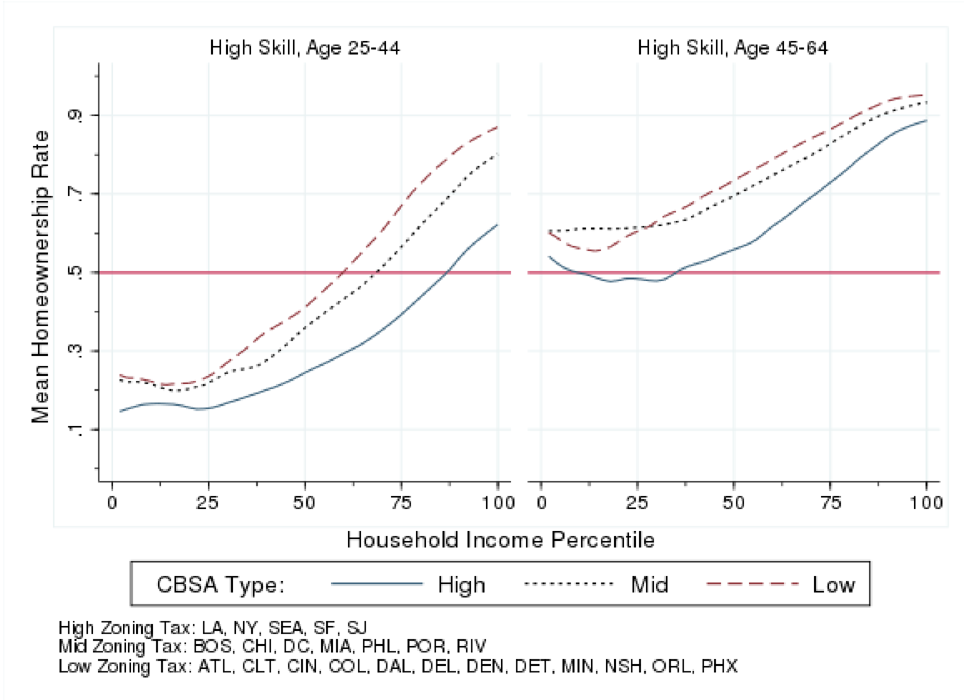
Notes: The zoning tax figures are taken from Table 1 of the paper. The WRLURI2018 values are from Gyourko, Hartley and Krimmel (2019).

Figure 8 – Homeownership Rate by Income Percentile

Panel 1 – Overall, by CBSA Zoning Tax Type



Panel 2 – High Skill Sector, by Age Group



Panel 3- Local Nontradable Sector, by Age Group

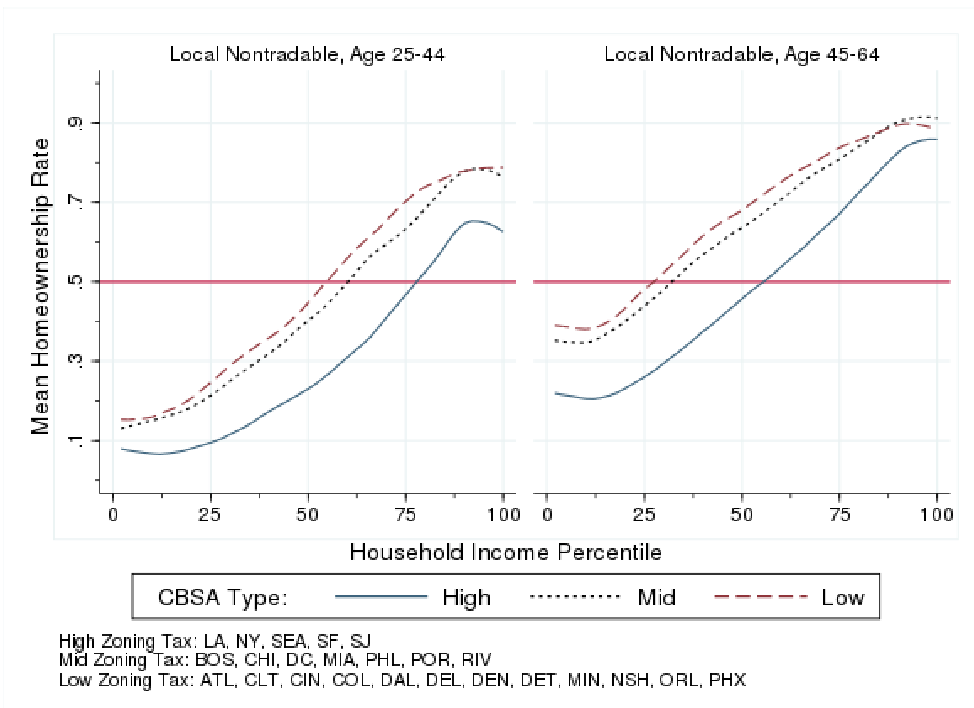


Table 1: Imputing Supply Restrictedness by Comparing Land Prices on the Intensive and Extensive Margins, 2013-2018 Period (within 30 miles of the CBSA Centroid)

CBSA	*Number of Observations*	*Median Zoning Tax per Square Foot (P(L)/N – qA) / A*	*Median Zoning Tax per Quarter Acre ((P(L)/N – qA) / A)*10,890*
Atlanta	301	$1.39	$15,111
Boston	23	$4.26	$46,358
Charlotte	279	$0.69	$7,529
Chicago	70	$5.82	$63,345
Cincinnati, OH	20	-$0.39	-$4,276
Columbus, OH	49	$0.21	$2,326
Dallas	36	$0.20	$2,217
Deltona	37	$0.36	$3,911
Denver	253	$1.20	$13,059
Detroit	43	$0.93	$10,089
Los Angeles	157	$18.25	$198,769
Miami	112	$3.47	$37,799
Minneapolis	41	$0.40	$4,379

Table 1 Continued

CBSA	*Number of Observations*	*Median Zoning Tax per Square Foot (P(L)/N – qA) / A*	*Median Zoning Tax per Quarter Acre ((P(L)/N – qA) / A)*10,890*
Nashville	45	$0.95	$10,325
New York	58	$14.00	$152,417
Orlando	249	$1.02	$11,126
Philadelphia	73	$7.04	$76,672
Phoenix	788	$2.01	$21,872
Portland	256	$5.03	$54,781
Riverside	286	$3.01	$32,771
San Francisco	69	$37.62	$409,706
San Jose	44	$10.27	$111,793
Seattle	232	$16.06	$174,850
Washington	119	$5.48	$59,689

Table 2: Zoning Tax Heterogeneity by Distance from the Urban Core

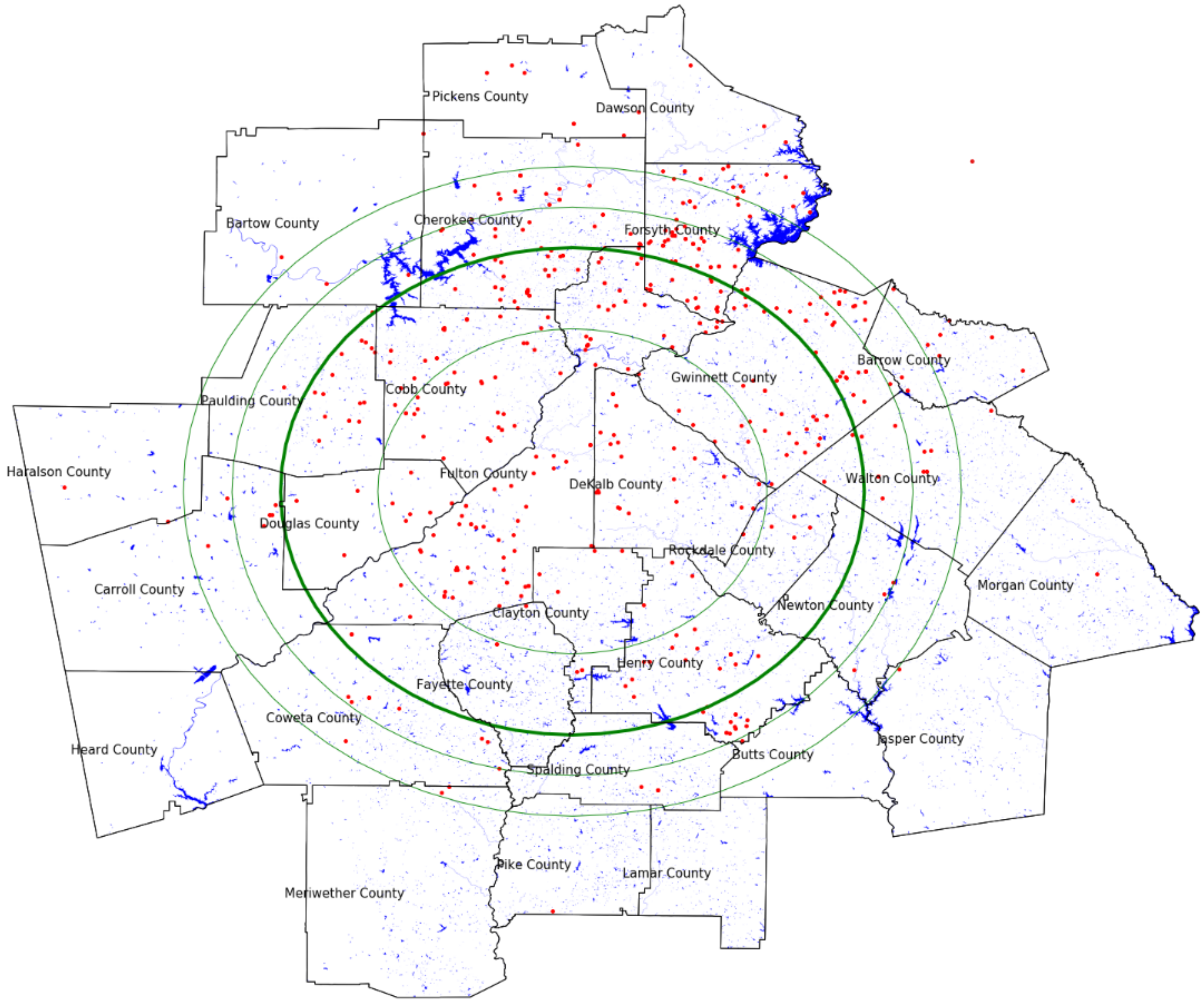
	≤ 15 miles			*15 - 30 miles*			*30+ miles*		
CBSA	*Number of Obs*	*Zoning Tax per 1/4 Acre [((P(L)/N–qA)/A) *10,890]*	*CBSA Median House Price*	*Number of Obs*	*Zoning Tax per 1/4 Acre ((P(L)/N–qA)/A) *10,890*	*CBSA Median House Price*	*Number of Obs*	*Zoning Tax per 1/4 Acre ((P(L)/N–qA)/A) *10,890*	*CBSA Median House Price*
Atlanta	77	$30,120	$207,384	224	$12,755	$214,478	219	$8,523	$187,500
Boston	5	$158,406	$514,060	18	$38,238	$406,630	12	$25,061	$317,987
Charlotte	118	$12,416	$224,618	161	$2,867	$220,755	15	$1,980	$140,000
Chicago	15	$402,566	$226,364	55	$24,929	$258,523	169	$4,125	$200,000
Cincinnati	4	-$9,668	$151,000	16	-$4,094	$180,286	4	$1,387	$158,374
Columbus	22	$5,868	$186,000	27	$2,326	$198,680	1	-$14,230	$113,000
Dallas	8	$46,531	$216,651	28	-$2,864	$266,503	31	-$7,996	$215,786
Deltona	11	$20,269	$179,059	26	$2,419	$153,500	3	-$12,245	$228,250
Denver	140	$27,203	$345,257	113	$8,299	$411,094	2	$29,017	$259,583
Detroit	5	$10,089	$94,161	38	$12,221	$197,071	35	$266	$207,914
Los Angeles	73	$198,769	$515,987	84	$200,210	$547,180	113	$203,423	$598,248
Miami	21	$67,038	$287,714	91	$26,951	$265,197	54	$22,798	$276,576
Minneapolis	7	$48,501	$235,403	34	-$1,278	$270,000	13	$8,100	$184,384

Table 2 Continued

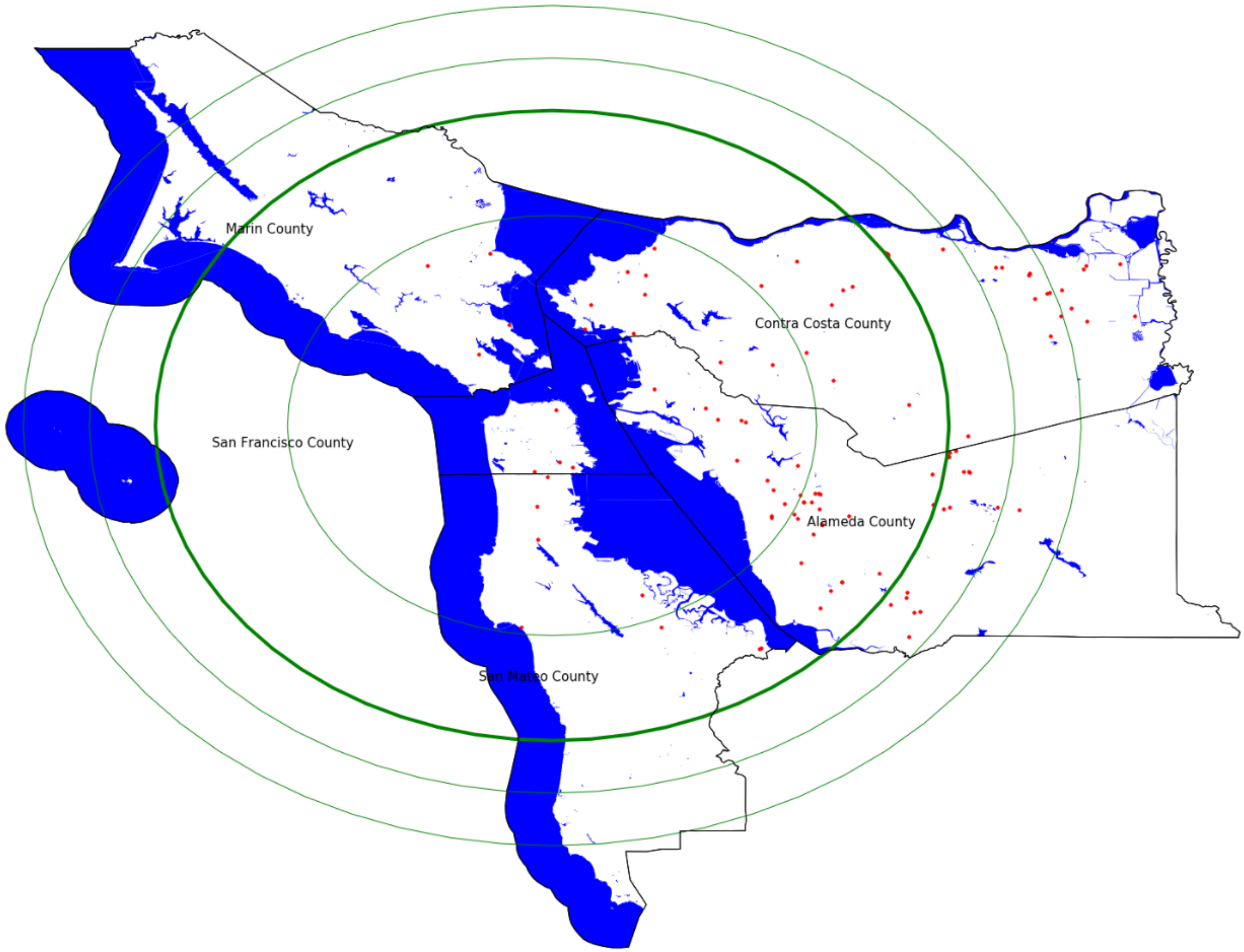
	≤ 15 miles			15 - 30 miles			30+ miles		
CBSA	*Number of Obs*	*Zoning Tax per 1/4 Acre ((P(L)/N–qA)/A) *10,890*	*CBSA Median House Price*	*Number of Obs*	*Zoning Tax per 1/4 Acre ((P(L)/N–qA)/A) *10,890*	*CBSA Median House Price*	*Number of Obs*	*Zoning Tax per 1/4 Acre ((P(L)/N–qA)/A) *10,890*	*CBSA Median House Price*
Nashville	18	$7,121	$244,000	27	$11,259	$236,556	18	$12,131	$158,588
New York	20	$533,703	$316,910	38	$53,566	$451,749	70	$26,851	$312,598
Orlando	146	$12,623	$228,079	103	$10,203	$217,191	14	-$10,132	$168,000
Philadelphia	30	$236,815	$184,384	43	$32,771	$275,159	29	$7,009	$243,284
Phoenix	166	$29,115	$216,000	622	$19,705	$274,527	147	$1,079	$197,900
Portland	195	$52,218	$348,280	61	$61,515	$308,286	1	$27,365	$220,000
Riverside	148	$46,981	$343,159	138	$15,091	$334,156	181	-$396	$292,428
San Francisco	20	$410,290	$863,510	49	$292,264	$822,598	41	$268,231	$496,961
San Jose	29	$163,200	$1,039,571	15	-$30,221	$809,240	4	-$28,076	$541,001
Seattle	77	$306,371	$600,000	155	$134,437	$368,716	73	$106,083	$287,806
Washington	37	$72,402	$486,499	82	$58,754	$416,912	46	$12,834	$324,332

Appendix 1:

Atlanta CBSA: 20, 30, 35 and 40 Mile Radii Boundaries



San Francisco CBSA: 20, 30, 35 and 40 Mile Radii Boundaries



New York CBSA: 20, 30, 35, and 40 Mile Radii Boundaries

Appendix 2: Summary Statistics on Vacant Land Purchases Intended for Single Family Home Development, 2013 - 2018 (within 30 miles)

CoStar Data

		Parcel Size (ft^2)			
CBSA Name	*Number of Observations*	*Median*	*Mean*	*Mean P(L) / ft^2 (Std. Dev.)*	*Total SF Vacant Land Area Transacted (acres)*
Atlanta	301	435,600	1,077,105	\$3.80 (\$6.36)	7,443
Boston	23	653,400	1,120,446	\$8.01 (\$10.70)	592
Charlotte	279	522,720	2,010,451	\$3.73 (\$7.33)	12,877
Chicago	70	139,233	753,787	\$22.08 (\$55.43)	1,211
Cincinnati, OH	20	2,178,000	2,602,309	\$0.83 (\$1.03)	1,195
Columbus, OH	49	594,158	948,952	\$3.18 (\$7.41)	1,067
Dallas	36	612,018	2,001,506	\$3.75 (\$6.16)	1,654
Deltona	37	1,047,618	5,370,782	\$8.70 (\$36.44)	4,562

Appendix 2 Continued

CBSA Name	*Number of Observations*	*Parcel Size (ft²)* *Median*	*Mean*	*Mean P(L) / ft²* *(Std. Dev.)*	*Total SF Vacant Land Area Transacted (acres)*
Denver	253	195,149	1,850,655	\$14.67 (\$45.50)	10,749
Detroit	43	170,280	673,733	\$3.75 (\$7.99)	665
Los Angeles	157	75,489	725,481	\$49.64 (\$87.48)	2,615
Miami	112	266,587	6,467,220	\$15.24 (\$40.78)	16,628
Minneapolis	41	914,760	1,585,248	\$5.90 (\$13.27)	1,492
Nashville	45	1,237,104	2,567,597	\$2.59 (\$4.02)	2,652
New York	58	113,691	718,918	\$56.98 (\$117.92)	957
Orlando	249	187,000	1,122,591	\$5.32 (\$8.26)	6,417
Philadelphia	73	304,920	975,765	\$25.92 (\$51.92)	1,635

Appendix 2 Continued

CBSA Name	*Number of Observations*	*Parcel Size (ft^2)* *Median*	*Parcel Size (ft^2)* *Mean*	*Mean P(L) / ft^2 (Std. Dev.)*	*Total SF Vacant Land Area Transacted (acres)*
Phoenix	788	435,600	1,020,967	$7.78 ($8.03)	18,469
Portland	256	88,032	310,189	$12.01 ($12.69)	1,823
Riverside	286	463,479	1,452,707	$9.09 ($15.33)	9,538
San Francisco	69	119,354	597,764	$61.95 ($192.16)	947
San Jose	44	306,227	1,200,930	$32.69 ($48.66)	1,213
Seattle	232	181,428	455,279	$24.08 ($37.00)	2,425
Washington	119	114,837	2,488,874	$26.65 ($50.57)	6,799

Appendix 3: Median Number of Housing Units (N) per Acre, by CBSA

CBSA	*Median Housing Units Per Acre*
Atlanta	2.89
Boston	0.91
Charlotte	2.12
Chicago	3.56
Cincinnati, OH	1.63
Columbus, OH	2.23
Dallas	3.14
Deltona	3.34
Denver	4.25
Detroit	1.68
Los Angeles	4.79
Miami	4.77
Minneapolis	2.16
Nashville	2.29
New York	2.88
Orlando	4.00
Philadelphia	3.66
Phoenix	3.94
Portland	6.53
Riverside	3.53
San Francisco	4.45
San Jose	5.17
Seattle	4.85
Washington	4.13

Appendix 4: Summary Statistics on Intensive Margin Valuations and their Components: Interquartile Ranges

CBSA	*Panel*	*p25*	*p50*	*p75*
Atlanta	Panel (a) q	$0.10*	$0.54	$1.38
	Panel (b) A	7,363	10,019	13,558
	Panel (c) qA	$1,132	$5,539	$15,822
Boston	Panel (a) q	$0.25	$0.62	$1.32
	Panel (b) A	26,262	35,987	42,315
	Panel (c) qA	$9,739	$27,226	$35,993
Charlotte	Panel (a) q	$0.28	$1.02	$2.79
	Panel (b) A	10,623	15,131	22,498
	Panel (c) qA	$4,377	$18,887	$40,298
Chicago	Panel (a) q	$1.21	$3.74	$5.53
	Panel (b) A	6,326	7,854	10,417
	Panel (c) qA	$11,717	$31,214	$54,989
Cincinnati, OH	Panel (a) q	$0.62	$0.85	$1.57
	Panel (b) A	15,318	17,658	23,328
	Panel (c) qA	$11,444	$18,719	$27,578
Columbus, OH	Panel (a) q	$0.49	$0.94	$2.02
	Panel (b) A	8,370	12,234	19,595
	Panel (c) qA	$6,682	$13,873	$21,072
Dallas	Panel (a) q	$0.88	$1.66	$2.89
	Panel (b) A	7,802	9,161	11,323
	Panel (c) qA	$10,546	$17,628	$27,870

Appendix 4 Continued

CBSA	*Panel*	*p25*	*p50*	*p75*
Deltona	Panel (a) q	$0.77	$1.46	$2.45
	Panel (b) A	7,620	8,690	11,082
	Panel (c) qA	$7,447	$12,528	$24,176
Denver	Panel (a) q	$3.74	$7.43	$10.84
	Panel (b) A	5,683	7,184	8,715
	Panel (c) qA	$28,893	$49,904	$89,026
Detroit	Panel (a) q	$0.10*	$0.31	$1.63
	Panel (b) A	14,493	17,494	21,073
	Panel (c) qA	$1,746	$5,024	$29,497
Los Angeles	Panel (a) q	$7.07	$12.24	$20.13
	Panel (b) A	5,084	6,267	8,439
	Panel (c) qA	$47,896	$84,119	$153,781
Miami	Panel (a) q	$1.80	$4.30	$10.35
	Panel (b) A	4,782	6,513	9,697
	Panel (c) qA	$8,638	$36,477	$81,642
Minneapolis	Panel (a) q	$1.53	$2.11	$3.25
	Panel (b) A	10,356	13,372	15,665
	Panel (c) qA	$20,541	$27,916	$43,818
Nashville	Panel (a) q	$0.10*	$0.28	$0.85
	Panel (b) A	10,010	12,378	17,685
	Panel (c) qA	$1,542	$4,345	$15,416

Appendix 4 Continued

CBSA	*Panel*	*p25*	*p50*	*p75*
New York	Panel (a) q	$2.25	$5.80	$17.92
	Panel (b) A	5,995	11,928	19,715
	Panel (c) qA	$40,330	$65,829	$142,743
Orlando	Panel (a) q	$0.99	$2.77	$5.30
	Panel (b) A	6,632	8,379	10,691
	Panel (c) qA	$7,790	$21,096	$45,313
Philadelphia	Panel (a) q	$0.53	$1.36	$3.47
	Panel (b) A	1,160	7,995	14,118
	Panel (c) qA	$4,609	$12,005	$25,342
Phoenix	Panel (a) q	$3.24	$5.77	$9.74
	Panel (b) A	6,194	7,554	10,208
	Panel (c) qA	$24,070	$46,671	$80,360
Portland	Panel (a) q	$2.98	$5.00	$7.66
	Panel (b) A	4,190	5,369	7,574
	Panel (c) qA	$15,788	$23,900	$39,577
Riverside	Panel (a) q	$1.83	$3.54	$5.90
	Panel (b) A	6,905	8,224	9,548
	Panel (c) qA	$15,843	$31,425	$50,159
San Francisco	Panel (a) q	$4.63	$7.46	$12.05
	Panel (b) A	4,328	7,828	9,573
	Panel (c) qA	$29,846	$53,190	$92,286

Appendix 4 Continued

CBSA	*Panel*	*p25*	*p50*	*p75*
San Jose	Panel (a) q	$7.32	$11.46	$15.37
	Panel (b) A	5,149	6,170	8,352
	Panel (c) qA	$50,142	$62,231	$105,194
Seattle	Panel (a) q	$2.36	$3.98	$6.49
	Panel (b) A	4,845	6,361	8,330
	Panel (c) qA	$15,892	$26,593	$42,783
Washington	Panel (a) q	$1.23	$2.80	$6.66
	Panel (b) A	4,796	8,669	14,444
	Panel (c) qA	$10,064	$28,896	$65,368

Notes:

1. Each row reflects the interquartile range of our estimates or calculations of *q*, *A* or *q*A* for each CBSA. Within CBSA, the underlying observation can and does change across rows.
2. A * indicates an allocated value for *q*, the intensive margin value of a square foot of extra land. This was done in the few cases when we estimated a negative value for this parameter. When this happened, we allocated a value of $0.10 (10 cents) per square foot. While we have no trouble believing an existing owner might not pay much at all for extra land in a market with low land prices in general and large lot sizes, we thought it unlikely that they would actually be willing to pay to reduce their lot size. Hence, this allocation decision. This outcome occurred most frequently in Atlanta. That is the only CBSA for which at least 25% of the cases generated estimated values of $q<0$ (although these cases were not statistically significant in general). Implementing this procedure does not change any result in any meaningful way. The largest absolute impact is in Philadelphia, where if we take the negative *q*'s literally, the median parcel zoning tax increases to $84,857 from $76,672 in Table 1. Other markets change by much smaller amounts ranging from $0 to $6,767 with half of markets experiencing no change. Atlanta is in the middle, as its median parcel would have a zoning tax value of $18,269 (versus $15,111 in Table 1) were we to leave the negative *q*'s unchanged.

Appendix Table 5 - Homeownership Rates by National Income Percentile, Household Age-Sector and CBSA Zoning Tax

		Income Percentile (National Distribution)				
		25th Percentile (≈ $30,000)	50th Percentile (≈ $60,000)	75th Percentile (≈ $108,000)	90th Percentile (≈ $170,000)	Overall
Age-Sector Profile	**CBSA Zoning Tax**					
Total	High	21%	37%	59%	73%	49%
	Mid	32%	53%	72%	83%	62%
	Low	38%	55%	79%	88%	62%
	Overall	31%	49%	70%	81%	58%
High Skill, Age 25-44	High	17%	32%	42%	54%	46%
	Mid	29%	34%	59%	69%	56%
	Low	32%	41%	71%	82%	61%
	Overall	27%	37%	58%	67%	54%
Local Nontradable, Age 25-44	High	8%	22%	49%	65%	28%
	Mid	21%	42%	64%	78%	42%
	Low	26%	45%	72%	81%	41%
	Overall	19%	37%	62%	73%	37%
High Skill, Age 45-64	High	36%	57%	75%	84%	79%
	Mid	44%	71%	81%	91%	86%
	Low	72%	71%	88%	94%	87%
	Overall	52%	67%	82%	90%	84%
Local Nontradable, Age 45-64	High	26%	44%	67%	82%	51%
	Mid	21%	42%	64%	78%	66%
	Low	49%	62%	84%	88%	65%
	Overall	39%	57%	77%	86%	60%
All others	High	25%	38%	59%	74%	51%
	Mid	34%	53%	73%	84%	64%
	Low	38%	56%	79%	89%	64%
	Overall	33%	50%	71%	82%	60%