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The impact of local residential land use restrictions on land values across and within single family housing markets☆

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ABSTRACT

We provide estimates of the impact of restrictive residential land use environments on the price of land across major American housing markets. Using micro data on vacant land purchased to develop single family housing, we implement a new empirical strategy for estimating so-called 'zoning taxes' – the amount by which land prices are bid up due to supply side regulations. Our results are broadly consistent with previous findings that zoning taxes are especially burdensome in large coastal markets. However, our more recent data indicates that price impacts in the big west coast markets now are the largest in the nation. In the San Francisco, Los Angeles, and Seattle metropolitan areas, the price of land everywhere within those three markets having been bid up by amounts that at least equal typical household income. Finally, we show that our zoning tax estimates are strongly positively correlated with a new measure of local housing market supply constraint (the Wharton Residential Land Use Regulatory Index of 2018). This relationship is not mechanically driven as the regulatory index is constructed from survey data that do not incorporate land or house price data in any way.

1. 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 $800,000+ average house values reported by the *American Community Survey* (*ACS*) in the San Francisco and San Jose metropolitan areas in 2019, which many highly-skilled and well-remunerated workers cannot afford based on standard lending guidelines that limit price-to-income ratios below four in the absence of substantial down payments.[1]

Previous research has investigated the role of supply-side constraints on the ability to deliver additional housing units to the market in accounting for high prices (e.g., see Glaeser and Gyourko, (2018) for a recent example). In this paper, we present new estimates of the impact of restrictive residential land use regulation on single family housing land prices across major markets in the United States. Conceptually, our

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[1] More generally, affordability conditions across the county have become more salient recently. At the national level, the executive branch headed by Presidents of different parties has addressed the issue. The Trump Administration established a White House Council on Eliminating Regulatory Barriers to Affordable Housing (https://www.whitehouse.gov/presidential-actions/executive-order-establishing-white-house-council-eliminating-regulatory-barriers-affordable-housing/). The Biden Administration announced a program to award grants to localities allowing more and denser housing development as part of its infrastructure plan proposal (https://www.wsj.com/articles/biden-seeks-to-ease-housing-shortage-with-looser-zoning-rules-11617796817?page=1). Political activity at the state and local level also has increased markedly. California saw debate on a bill that would have limited a locality's ability to stop dense development around transit nodes (see the Vox article at https://www.vox.com/cities-and-urbanism/2018/2/23/1701154/sb827-california-housing-crisis for more on this). In late 2018, the Minneapolis City Council voted to eliminate single family zoning as a category and now permits up to three units on those sites (https://nytimes.com/2018/12/13/us/minneapolis-single-family-zoning.html.) Bills to pass or augment actual rent controls or enhance rent regulation in California, New York, and Oregon can also be seen as a response to growing concern with housing affordability. This debate also is related to the broader issue raised by Glaeser (2019) of a mismatch between capabilities of the private versus public sectors in some of our major urban areas that led to dominance by insiders (existing landowners in our context). The most recent academic review of the literature on supply side restrictions in housing markets is Gyourko and Molloy (2015).

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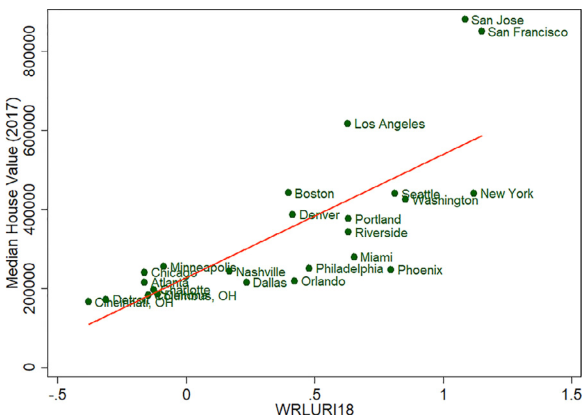

Fig. 1. House Prices vs. Supply Side Regulatory Strictness 24 Major CBSAs. *Notes:* CBSA Median House Value is taken from the 2017 *American Community Survey, 1 Year Estimates*, which can be downloaded at https://data.census.gov/cedsci. The WRLURI18 index value is the average of communities within 30 miles of the relevant CBSA centroid. Those data are available at http://real-faculty.wharton.upenn.edu/gyourko/land-use-survey/.

approach is similar to that used in previous work, in the sense that the impact of regulatory strictness is measured by the gap between the extensive and intensive margin values of land used for single-family home development. The idea is that in a completely unregulated market, there should be no difference in the value that an existing homeowner or homebuilder places on an extra square foot of land. That is, if the value an existing homeowner puts on having a bit more land (i.e., the intensive margin value) is 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. Unless there are regulations preventing that increase in density, there should be no gap between land values on the intensive and extensive margins. This arbitrage condition holds regardless of the forces that might be driving up the prices developers are willing to pay on the extensive margin for vacant land with the right to build single-family product on it. However, if there are binding limits on the ability of existing owners to subdivide and sell to those paying more per square foot on the extensive margin, then there would be a gap between extensive and intensive margin values. In that case, land prices on the extensive margin would be bid up until there were no unexploited profit opportunities left for builders in the more strictly regulated housing markets.[2] This gap between extensive and intensive margin land values has been called the 'zoning tax' in previous research (Glaeser and Gyourko, 2003, 2018).

Our new and updated estimates of zoning taxes rely on proprietary vacant land parcel transactions purchased from CoStar, a well-known data provider to the real estate industry. Its data has been used in other work, so it is known to the urban research community.[3] However, its data have not been used for our specific purpose. This source provides direct observation of prices paid for individual parcels of vacant land purchased with the intention of supplying single family housing units, something that has not been available in previous work on this topic. This provides two important benefits. As we discuss more fully in the next section, not only does this reduce measurement error associated with computing the zoning tax, but the specific location of each parcel is known so that we can investigate spatial variation in price effects within a metropolitan area for the first time. Another benefit is that the data, which are from the 2013 to 2018 time period, provide the most recent picture of the impact on supply constraints on land values in the literature.

We report zoning taxes in 24 major metropolitan areas across the United States. The typical gap between extensive and intensive margin land values of a quarter acre plot of land is about \$400,000 in the San Francisco metro, ranges between \$150,000 and \$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. These amounts are from 1 to 4 times the relatively high typical household incomes in these markets, so the likely impact on housing affordability is meaningful. Smaller gaps between extensive and intensive margin land values 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 Riverside-San Bernardino markets.[4] There is no evidence of an economically meaningful zoning tax for the median observation 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).

Our findings are qualitatively consistent with previous research that also finds the largest gaps between extensive and intensive margin land values in the nation's major coastal markets. Especially big effects in west coast markets are consistent with newly available indexes of regulatory strictness (Gyourko et al, 2019). Later in the paper, we explore this new measure of regulatory restrictiveness 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. That metric, the Wharton Residential Land Use Regulatory Index for 2018 (WRLURI2018), is increasing in the degree of supply side constraint imposed. WRLURI2018 is strongly positively correlated with house prices as documented in Fig. 1's plot of house prices from the 2017 *ACS* for the 24 major markets that we study below against each market's 2018 regulatory index value. The fitted OLS linear regression line implies that a 1.3-unit increase in regulatory index value (which equals a 1.3 standard deviation difference in regulatory strictness in San Francisco versus Atlanta in their data) is associated with just over a \$400,000 gap in prices between San Francisco and Atlanta. Nothing causal is implied by this simple bivariate regression, of course.

However, the basic price theory underlying the gap between extensive and intensive margin prices suggests that the magnitude of our zoning tax estimates should be increasing with the actual degree of regulatory strictness in the market. We document this to be the case by showing that our estimated zoning taxes are strongly positively correlated with WRLURI2018 index values, too (see Fig. 7 below). This relationship is not mechanically driven as the regulatory index is created from

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

[3] Turner et al. (2014) were among the first to exploit this data source. Other relevant papers that also use CoStar data include: Albouy et al. (2018), Davis et al (2021), Fitzgerald et al. (2020), Morris et al. (2020), Munneke and Womack (2020), Nichols et al. (2013) and Nichols (2019). This list illustrates the usefulness with which a growing number of researchers have found for CoStar land transaction data. The Albouy et al. (2018) and Davis et al. (2021) papers use the data to estimate land prices. Ours is the first to estimate zoning taxes using CoStar data.

[4] Large price impacts at the market level are consistent with other research which concludes that binding regulation reduces land value at the micro parcel level (e.g., Brueckner and Sridhar, 2012; Brueckner et al., 2017; Brueckner and Singh, 2020; Turner et. al., 2014). That other work, which tries to compare two otherwise identical land parcels within the same market, finds the more regulated one has a lower price, market prices held constant. That is not at all inconsistent with the conclusions of our paper in which *market-wide* prices themselves are increased if restrictive regulation is widespread and severe enough.

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 Fig. 1, 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.

Our new analysis of the spatial variation within markets helps highlight how different and unique are the three large west coast markets of Los Angeles, San Francisco and Seattle. For this part of the analysis, we divided each CBSA into three zones: (a) near-in, which includes all parcels within 15 miles of the metro urban core; (b) middle, which includes all parcels within 15–30 miles of the metro core; and (c) farther-out, which includes all parcels more than 30 miles out from the metro core. Land is expensive everywhere within these three labor market areas, with there being little difference in the typical zoning tax among 'near-in' versus 'farther-out' parcels. What makes the other two markets of New York City and San Jose that also had very high median zoning taxes of at least $100,000 per quarter acre different is that it is possible to find parcels farther out from their metro cores with zoning tax amounts that are fractions of, not multiples of, typical household income. No other metro area approaches the three large west coast markets in this regard.

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 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.

2. Evidence of binding regulation: land prices on the extensive vs. intensive margins

2.1. 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)].

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

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 Eq. (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 prominent strategy was to start with the price of a given quality house in some year and use that to proxy for *P(H)*. Physical construction costs for a similar quality home would be matched as best as possible using data from engineering consultants in the homebuilding industry. Each represented the metro level average of market price and production cost, respectively, for the typical home in the labor market area. The residual from differencing

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.[5]

In this paper, we use micro observations on the actual 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,

$$P(L) = N * [P(H)\text{-}CC]. \tag{2}$$

Substituting in from (1) yields

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

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. As argued above, profitable arbitrage ensures that the zoning tax (Z) will equal zero if subdivision is unconstrainted on the intensive margin. If for any reason builders are willing to pay more for a unit of land with the right to supply housing on it than existing owners value the same amount of land on the intensive margin, the latter will subdivide and sell land to the builders. This arbitrage continues until intensive margin value is bid up to extensive margin value, so that it does not matter what forces propelled values on the extensive margin to their present heights.[6] However, a binding constraint on the ability to subdivide on the intensive margin will lead to extensive margin value exceeding intensive margin prices (i.e., $Z > 0$). Our interpretation of such a gap between extensive and intensive margin values follows the literature in presuming that it is due to regulatory constraint.

2.2. Computing the zoning tax: data and assumptions

We observe *P(L)* via proprietary vacant land data purchased from CoStar, an industry data provider that has been used in other research, although not for our specific purpose as noted in the Introduction. It is noteworthy that CoStar categorizes land sales by intended use. That is, they are organized by property sector—residential, industrial, retail, etc.[7] 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. This subsample is a better comparison group with the single unit home sale observations used in the hedonic analysis to estimate the intensive margin price (discussed below). It also better suits our research

[5] See Glaeser and Gyourko (2003, 2018) for more detail on this process.

[6] There is a myriad of possibilities for why extensive margin values might be high in absolute terms. Costs of subdividing large plots of vacant land, called plattage in the literature, is one possibility. [This literature dates back at least to Colwell and Sirmans (1978) and includes contributions by Lin and Evans (2000), Thorsnes and McMillen (1998), Colwell and Sirmans (1993), Colwell and Munneke, (1997) and Ecker and Isakson (2005), among others. See Clauretie and Li (2019) for a recent review.] Another factor that could lead to high extensive margin values of land is decreasing returns to scale at the parcel level. This effect arises if the purchaser of vacant land with the right to build on it could sell two small 1800 ft^2 homes for $200,000 a piece, but could only sell a single 3,600 ft^2 home in the same neighborhood for less than $400,000. A rational builder would bid up the value of land on the extensive margin if more density were allowed. Even so, existing land owners still will subdivide until their value of land on the intensive margin is brought into equality with that on the extensive margin. Appendix 5 in our online appendix at https://real-faculty.wharton.upenn.edu/gyourko outlines the math behind the arbitrage problem at the core of this result.

[7] 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 details 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.

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.

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.[8] 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.[9] 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, Seattle, and Washington, D.C. There are 3640 observations on vacant parcels purchased with the intention of building single family housing units across these 24 markets.[10]

Summary statistics on vacant parcel sizes and transactions prices for each metropolitan area are reported in Appendix 2 of our online appendix. 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*) 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 Eq. (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 these nearly one-fifth of vacant parcel observations, both P(L) and N used in determining extensive margin value come directly from the CoStar files on vacant residential land purchases. We impute intensive margin valuation using data from recent single unit housing transactions that are close to the vacant parcel site. As described just below, we presume that the houses to be built on the vacant parcel will be like those in nearby neighborhoods.

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 Fig. 2. This parcel, which is 54.5 acres in size (2,374,020 ft^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 compute P(L)/N, so that the extensive margin value of land per intended housing unit is $67,499 ($6479,937/96).

This is compared to intensive margin value which is computed as follows. We begin by estimating q via hedonic specification using data on 1000 observations of recent sales from 2013 to 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 Fig. 2.[11] More specifically, our estimates of q are based on an underlying hedonic model specified below in Eq. (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,

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

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 depicted with the green dots in Fig. 2.[12] The mean lot size among this subsample of new home was 16,866 square feet, which is nearly 0.4 acres.[13] Multiplying this square

[8] There is no agreed upon answer to what the centroid of a large metropolitan area is. 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 Moscone 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.

[9] In the online appendix, the first appendix 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 to 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.

[10] 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.

[11] 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).

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

[13] 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%

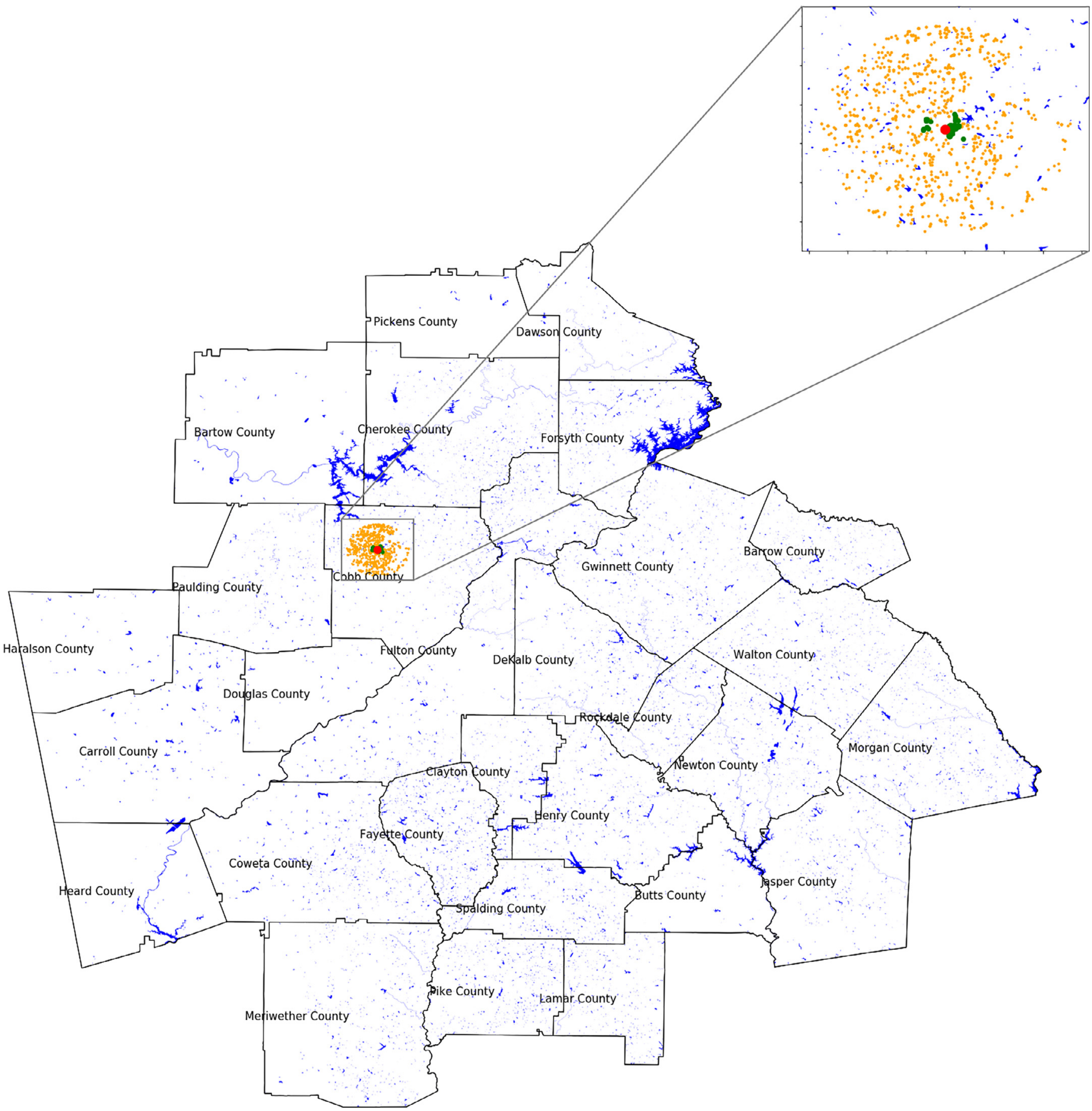

Fig. 2. CoStar and CoreLogic Data Used to Compute the Zoning Tax for a Vacant Land Parcel in Cobb, County, GA. *Notes:* A red dot (•) indicates the location of a recently purchased vacant residential land parcel. Orange dots (•) indicate the locations of the 1000 home sales between 2013 and 2018 that 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 and 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. For Caption: (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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 of land, the zoning tax is $2.28, so that a standardized quarter acre of vacant lot of 10,890 square feet 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

of a large parcel can be used for housing. That guideline fits this case very well, as $0.65 \times 2{,}374{,}020 = 1{,}543{,}113$ 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 16,866 ft^2 that we observe for new homes constructed within the last five years in surrounding neighborhoods.

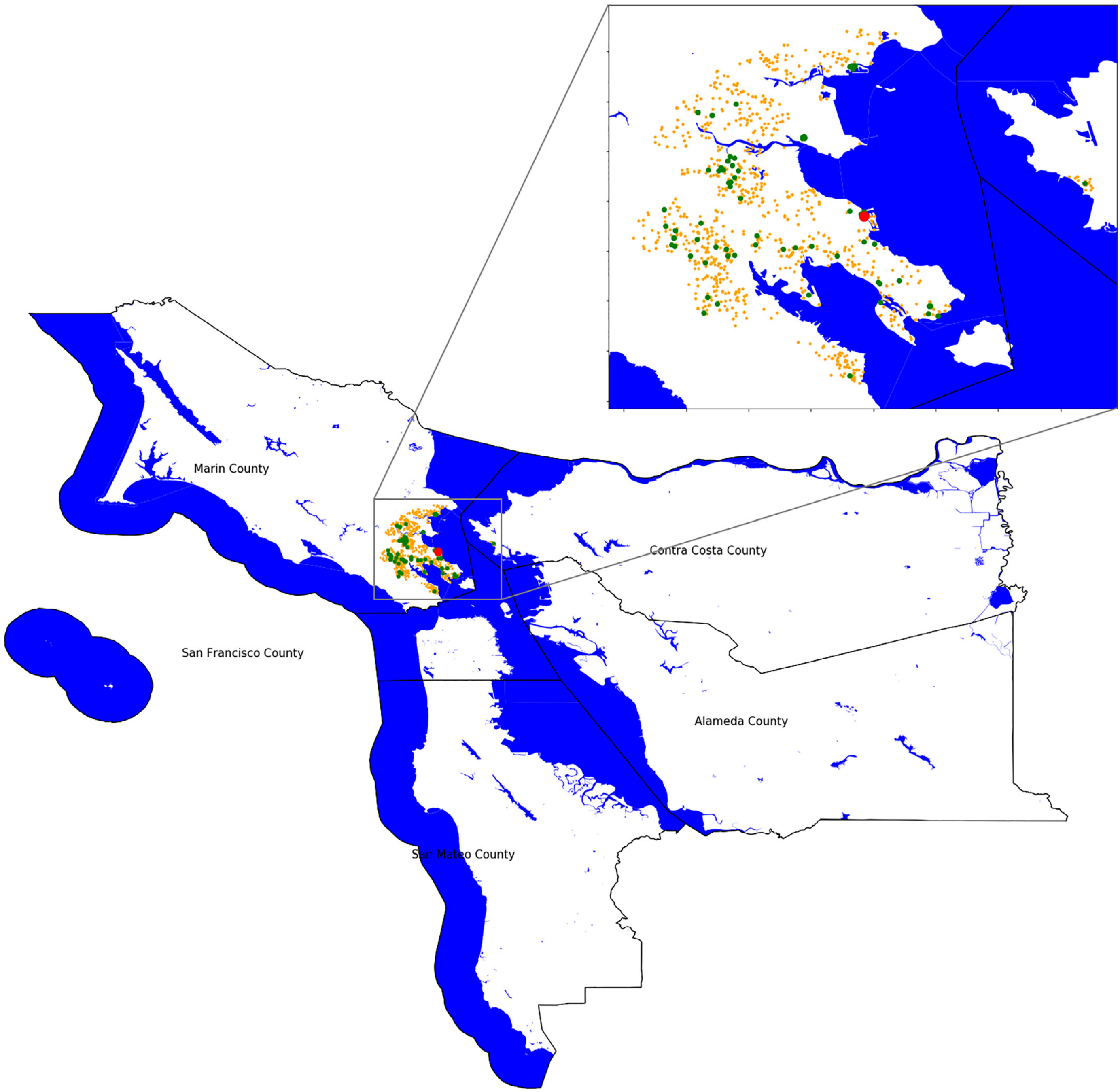

Fig. 3. CoStar and CoreLogic Data Used to Compute the Zoning Tax for a Vacant Land Parcel in Marin County, CA. Notes: A red dot (•) indicates the location of a recently purchased vacant residential land parcel. Orange dots (•) indicate the locations of the 1000 home sales between 2013 and 2018 that are 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 and 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. For Caption: (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.).

San Francisco CBSA. This particular site was 3.93 acres in size (171,388ft^2) and sold for $9701,312 (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 Fig. 3. 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 for this parcel is $808,443. 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 1000 closest homes that sold recently (i.e., from 2013 to 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 regression are plotted in orange in Fig. 3, with the closest 100 newly built houses which have a mean lot size of 13,017 ft^2 depicted by the green dots.[14] Together they

[14] The mean distance of the 1000 recent sales observations from the land parcel is 1.47 miles, with the furthest home sale being 2.33 miles away. The median among the 100 new homes is 10,776 ft^2, so the large mean is not driven by a very few really large properties.

imply an intensive margin value for the typical lot on which one of the dozen homes will sit is equal to \$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 by Emrath and Ford, (2016), *Typical American Subdivisions*, on large land site housing development.[15] 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 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 and 2018. Because there is substantial variation in new home lot size both within and across CBSAs, this can lead to large differences in estimated *N*'s for a given-sized vacant land parcel.

This is readily illustrated using a parcel in Fulton County near the center of the Atlanta CBSA as an example. This site 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 1000 closest transactions between 2013 and 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 × 429,937 ft^2) / 8,521 ft^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 \$3664. Per expected home, the zoning tax is \$12,518; per quarter acre the zoning tax is \$15,998 ((\$12,518 /8,521 ft^2)*10,890 ft^2).[16]

Finally, 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 to the physical unit 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 larger share of land is available for home development, the imputation procedure is the same as just described.

The median number of housing units per acre to be built in each CBSA is reported in Appendix 3 in the online appendix. 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. Data in the online 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 just over 40% 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). In sum, presuming the density of new development on the vacant parcel sites will be similar to that of recent development is nearby neighborhoods helps guard against upwardly biased estimates of Z-values in markets such as San Francisco especially.[17]

2.3. How should the zoning tax be reported?

In the examples above detailing how zoning taxes are computed, we report *Z*-values in multiple forms: at the parcel level, per square foot of land, per quarter acre of land and per expected home to be delivered on the site. In the next section discussing our results, we report the zoning tax per standardized unit of land: per quarter acre, specifically. We also choose to focus on the median, not the mean, value of the zoning tax per quarter acre of lot (along with the interquartile range). We do so for three reasons.

The first is that some standardization is needed to usefully compare results across observations and markets. The zoning tax per parcel values certainly are accurate, but their sizes vary so much within and across markets that the vastly different magnitudes of *Z* at the parcel level are very challenging to interpret.

The second reason is that measuring the amount of the zoning tax per quarter acre of land strikes us as the most useful standardization. That amount of land is a typical lot size for a middle-class household in many markets.[18] Its relevance as a metric is further enhanced because it readily can be compared to other quantities such as typical household income or house value in the underlying market. Being able to gauge the size of the zoning tax per quarter acre relative to income or asset value provides a useful way to interpret our results in terms of housing affordability or the ability to access credit.

These 100 homes are 2.83 miles from the land parcel on average, with the furthest being 4.91 miles away.

[15] This 2016 report is accessible electronically at https://www.nahbclassic.org/generic.aspx?sectionID=734&genericContentID=253886. The NAHB surveyed almost 1500 homebuilders and received data on 254 subdivisions of four or more housing units.

[16] An analogous example from the San Francisco CBSA involves a 442,134 ft^2 parcel in Alameda County that sold for \$20,395,778. We estimate the value of q as \$17.18/ft^2 using the 1000 closest home transactions between 2013 and 2018 and find a mean lot size of the 100 closest new homes (A) of 4,228 ft^2. We then impute N based on these values to be approximately 68 houses ((0.65 × 442,134 ft^2) / 4,228 ft^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 / 4,228 ft^2)*10,890 ft^2).

[17] There also 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 of the online appendix, so the difference should be well understood. 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. The ecologist David Theobold (2005) also has 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 our zoning tax estimates substantially, too.

[18] That does not mean that every household should or actually does desire a one-quarter acre plot, of course. We would expect especially high zoning taxes like those reported below for the San Francisco CBSA to lead to smaller than typical lot sizes (and that is confirmed in the data). The question of how the housing market responds to price distortions from zoning taxes is a separate issue that we hope to address in future work.

We focus on median Z-values and their interquartile range because they are more robust than are means to outliers. It is not feasible to compute standard errors about our reported zoning tax amounts, but it is straightforward to conclude that the median is substantially less sensitive to estimation error arising from any source. The potential for bias in our zoning tax values arises primarily from outlier observations being unduly influential, especially in relatively small samples.

The best example of this involves an observation within the San Francisco CBSA. There is one transaction that we confirmed with a local broker in which a purchaser bought a small parcel of barely more than 5000 square feet with the intention of putting a single housing unit on it for just over $1600 per square foot (which implies an extraordinarily high price per acre of about $70 million or about $17.5 million per quarter acre of lot). 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. Intensive margin values in and around this neighborhood are very high, too, but the zoning tax for this observation still is the largest (by far) across our 24 metropolitan areas.

The potential bias from including this observation does not arise because its information is somehow inaccurate. It is not. The problem is that it is very unlikely to be representative of single-family land development in this metropolitan area. There are only 69 observations in the San Francisco CBSA. In our analysis, we treat them equally, so each has a weight of 1.4% in the sample (1/69~0.014). In the next section, Table 1 reports a median zoning tax of $409,706 based on all 69 observations in the San Francisco metro, but the mean is 85% larger at $759,839. If we drop this observation (i.e., give it a weight of zero), the median falls by 10% to $368,442. The mean falls by a much greater 36% (or nearly $300,000) from $759,839 to $486,539. That the mean is much more sensitive to outliers than the median (as is well known) is why we focus on the median. It is comforting that the impact of an extreme outlier such as this one does not materially change our view of San Francisco being a highly constrained market with very large zoning taxes. There are outliers in every market, but none as extreme as this one.[19]

Ideally, we would have many cross sections over time with which to gauge the proper weight for that extreme outlier (but not just that observation, of course). However, no such data are available, so we cannot actually determine the representativeness of that observation or any other type of parcel (e.g., large versus small; San Francisco County versus Contra Costa or Alameda Counties; in a good school district or not, etc.). Given that there is not an obvious statistical fix,[20] we encourage readers to focus on the second moment of central tendency and the interquartile range of observations because they are not heavily influenced by the magnitudes of even the most extreme outliers. As such, they provide a more accurate representation of the level of zoning tax across markets in particular.

3. Results

3.1. Baseline findings: how big is the zoning tax per unit of land by market?

In this section, we report our zoning tax estimates in three different forms and use the variation to help us gauge their economic importance across markets. Table 1 reports the median zoning tax per quarter acre of land across all parcels in each market covered. Fig. 4 depicts the interquartile range of this same variable in each market, with Fig. 5 charting the share of the median zoning tax in median household income for each underlying 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. In Table 1, 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 on a standard quarter across lot (which contains 10,890 ft^2) in the third column.[21]

Based on this metric, our two dozen markets break naturally into one of three groups. 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 (admittedly somewhat arbitrarily) 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.[22] Land is cheap in general in these markets, as its value on the intensive margin also tends to be economically small.[23]

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 median zoning taxes per standardized quarter acre lot of at least $100,000. 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. Median zoning taxes per quarter acre range from $150,000 to $200,000 in Los Angeles, New York City and Seattle, and are just over $100,000 in the San Jose market.

The seven remaining CBSAs do not have six figure zoning taxes per quarter acre for their median observation, 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), Philadel-

[19] That said, a milder version of this phenomenon exists 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.

[20] The underlying statistical problem actually is more complex than the one we have posed here of bias from non-random (small) samples. There are two parts to our imputation of zoning taxes. One is the estimation of intensive margin values. We know the standard error of the estimated elasticity of lot value with respect to house prices from the underlying hedonic estimation. If that were the only underlying estimation error, that could be used to impute a standard error of Z using standard statistical methods. The problem is that this is the only component of Z that can be directly addressed in such a fashion. Dealing with the likely non-randomness of the underlying CoStar samples is a much more challenging issue as discussed above. Essentially, that is a weighting problem for which there is not sufficient data to solve it using normal methods. Finally, there is the issue of measurement error in N, the expected number of homes to be built on the vacant parcel. This is done by rule, so we do not know the true underlying estimation error. We suspect it is relatively minor because we did experiment with a number of reasonable permutations that made the sites a bit less or a bit more dense, but none of these changes altered our results in a meaningful fashion. Thus, we encourage reliance on measures such as the median and the interquartile range that are not heavily influenced by the magnitudes of the most extreme outliers.

[21] We abstract here from considering the value of the zoning tax per house. 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). Modeling those outcomes is well beyond the scope of this already long paper and is the subject of other research in progress.

[22] 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). At the other end of the distribution for this group, note that the Cincinnati CBSA has a slightly negative median zoning tax 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 at on the intensive margin (q). We interpret this as indicating a market with (roughly) no or zero zoning taxes.

[23] Appendix 4 in the online appendix 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, when we find a high zoning tax market, it is because of very high extensive margin values, not because of abnormally low intensive margin values.

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	$7529
Chicago	70	$5.82	$63,345
Cincinnati, OH	20	-$0.39	-$4276
Columbus, OH	49	$0.21	$2326
Dallas	36	$0.20	$2217
Deltona	37	$0.36	$3911
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	$4379
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

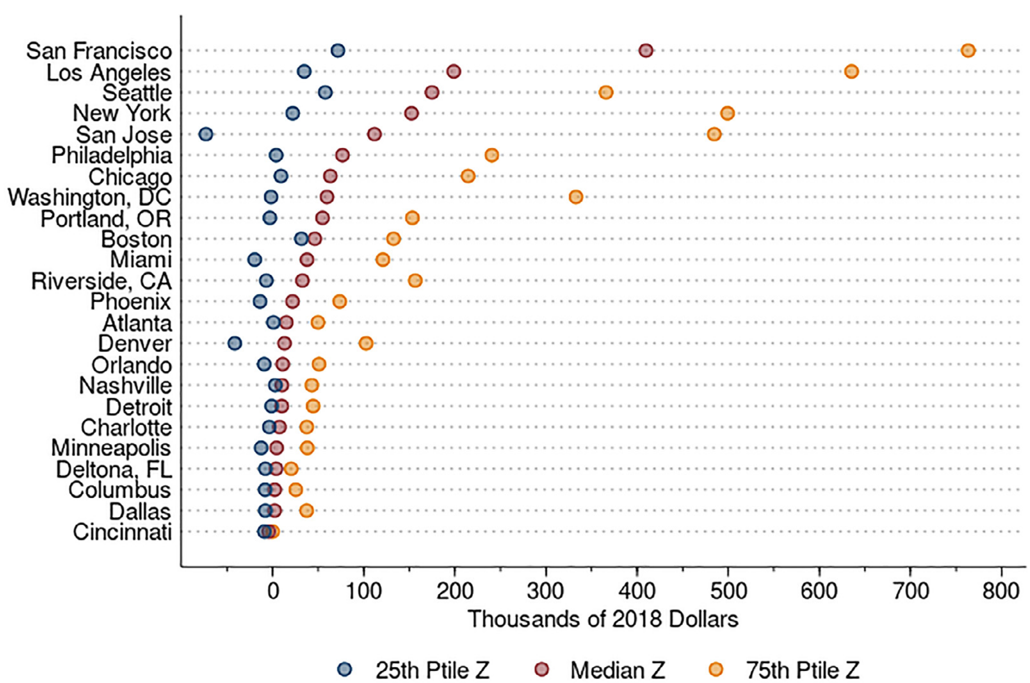

Fig. 4. The Interquartile range of zoning taxes, 24 CBSAs. *Notes:* Zoning taxes are per quarter acre in thousands of 2018 dollars. Statistics are calculated based on observations within 30 miles of CBSA center (same sample as Table 1).

phia, Portland (OR), Riverside-San Bernardino, and Washington, D.C. Median zoning taxes range from $35,000 to $40,000 per quarter acre of land in the Riverside-San Bernardino and Miami (FL) markets, to just over $45,000 in the Boston metro, and peak between $60,000 and $85,000 per quarter acre in the Chicago, Philadelphia, Portland (OR), and Washington, D.C. metropolitan areas.

While the median zoning tax per quarter acre is a much more robust measure than the mean of the difference in price impact of supply-side constraints, it still is only one point on the distribution. Fig. 4's plot of the interquartile range of zoning taxes per quarter acre of land provides added insight into the fraction of parcels in each market for which zoning taxes are relatively small. As above, 'small' is defined as being less than $25,000 per quarter acre.

There are only four markets–San Francisco, Los Angeles, Seattle and Boston—which have 25th percentile zoning tax values above $25,000 per quarter acre, with the New York City metro very close at $22,083. Boston replaces San Jose by this metric, as the latter metro has a very low zoning tax per quarter for its 25th percentile observation. It is quite striking how *de minimis* are zoning taxes for at least one quarter of the observations in every other market covered. In 18 of these areas, the

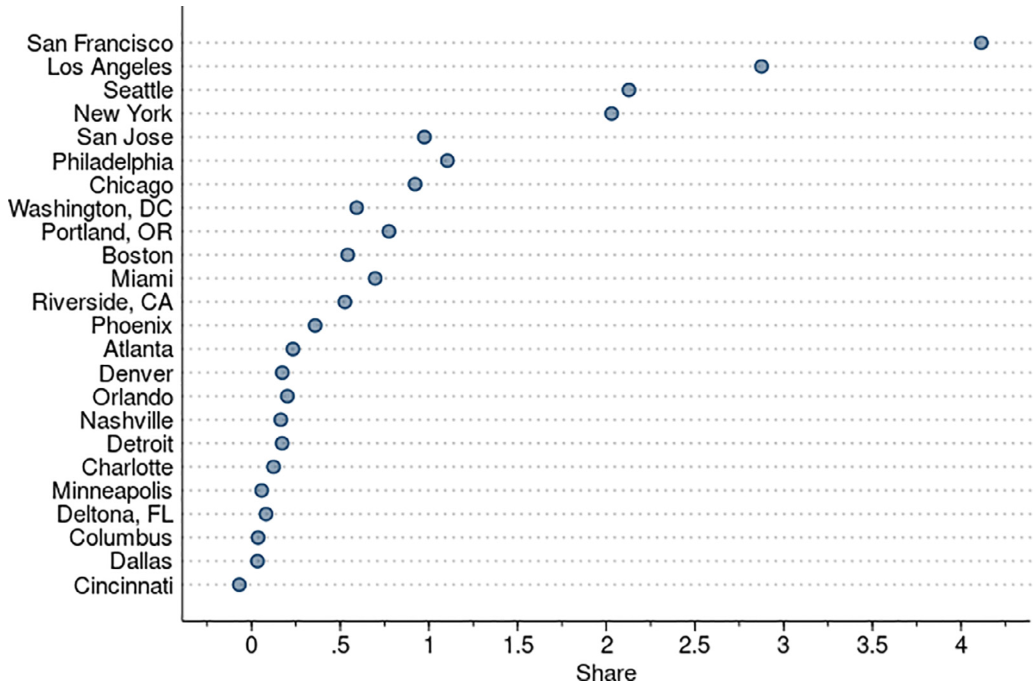

Fig. 5. The zoning tax as a share of median household income. *Notes:* The figure shows CBSA median zoning tax per quarter acre of land as a share of median CBSA household income. Median zoning taxes are calculated based on observations within 30 miles of CBSA center. Median household income is the CBSA-level median based on the 2013–2017 ACS. Both median zoning tax and median income are reported in 2018 dollars.

25th percentile value is less than $10,000.[24] Hence, it is possible to find some new single family development in the bulk of the country that does not appear to be materially affected in terms of higher prices by so-called zoning taxes.

Fig. 5 illustrates how large is the median zoning tax observation relative to median household income in the relevant market. This ratio is interesting in its own right because high shares of typical income are a direct measure of how zoning taxes are influencing affordability. Here we see a pattern somewhat like that in Table 1, where only the median was reported. The typical zoning tax per quarter acre of land in the San Francisco, Los Angeles, Seattle and New York City markets range from 2 to 4 times median household income in those places. For another group of seven markets—San Jose, Philadelphia, Chicago, Washington, DC, Portland (OR), Boston, and Miami (FL)—median zoning tax value is from 50 to 100% of area median household income. In all but one of the remaining 13 markets, the analogous ratio is less than 25%, sometimes much less so. Phoenix is the exception here at 36%.

These different cuts of our data present a consistent picture of the burden of zoning taxes across major U.S. markets. About one-half of our two dozen markets does not appear to have economically large zoning taxes by any metric. These markets tend to be off the coasts and include rapidly growing metros such as Atlanta and Nashville, as well as declining Rust Belt markets such as Cincinnati and Detroit. At the other extreme, there are a handful of large coastal markets, with the three big west coast metros of Los Angeles, San Francisco and Seattle standing out, as being burdened by very large zoning taxes. For those three markets in particular, the absolute value of the tax is least $175,000 per quarter acre of lot at the median, the share of the tax in median household income is at least 200%, and it is very hard to find many recent vacant parcel sales anywhere within these three CBSAs in which the zoning tax is economically small. That leaves a small, but diverse, group of markets including Boston, Chicago, Miami (FL), Philadelphia, Portland (OR), Riverside-San Bernardino, and Washington, D.C. as being somewhere in between. Zoning taxes are not as large as for the other big coastal metros, but they tend to be greater than the much smaller magnitudes consistently found in the other interior markets noted above.

We close this section by documenting that, while high zoning taxes necessarily lead to higher house prices, the converse is not true. That is, high prices do not mechanically lead to higher zoning taxes. This is illustrated in Fig. 6's plot of median zoning tax per quarter acre with median house value in each CBSA. Even within the dozen markets that we classify as having similar economically modest zoning taxes, there are some fairly large differences in typical house value. For example, Denver and Atlanta have median zoning taxes per quarter acre within $2000 of each other (i.e., about $13,000 for Denver and $15,000 for Atlanta). However, Denver's median house value is over $170,000 higher (about $387,000 versus $215,000).

There also are cases of markets with very similarly-priced housing have quite different zoning tax amounts. The Boston, New York City, Seattle and Washington, D.C. CBSAs have far higher than average house values that are within $16,000 of one another.[25] However, their zoning taxes per quarter acre differ by nearly $130,000, ranging from a low of about $46,000 in Boston to a high of about $175,000 in Seattle.

3.2. Heterogeneity—variation in the zoning tax by distance to the metro core

In this subsection, we use the spatial heterogeneity in zoning taxes within a CBSA to help clarify these distinctions across markets. One natural way to investigate this variation is to divide each CBSA into regions defined by their distance from the urban core. We categorized each vacant land parcel as being in one of three regions (defined by concentric circles) based on whether it was: (a) within 0–15 miles of the CBSA center; (b) within 15.01–30 miles of the CBSA center; and (c) more than 30 miles from the CBSA but still within a county that is part

[24] That is so in Atlanta, Charlotte, Chicago, Cincinnati, Columbus, Dallas, Deltona, Denver, Detroit, Miami, Minneapolis, Nashville, Orlando, Philadelphia, Phoenix, Riverside-San Bernardino, and San Jose.

[25] They range from a low of about $425,000 in Washington, D.C. to a high around $440,000 in the other three markets.

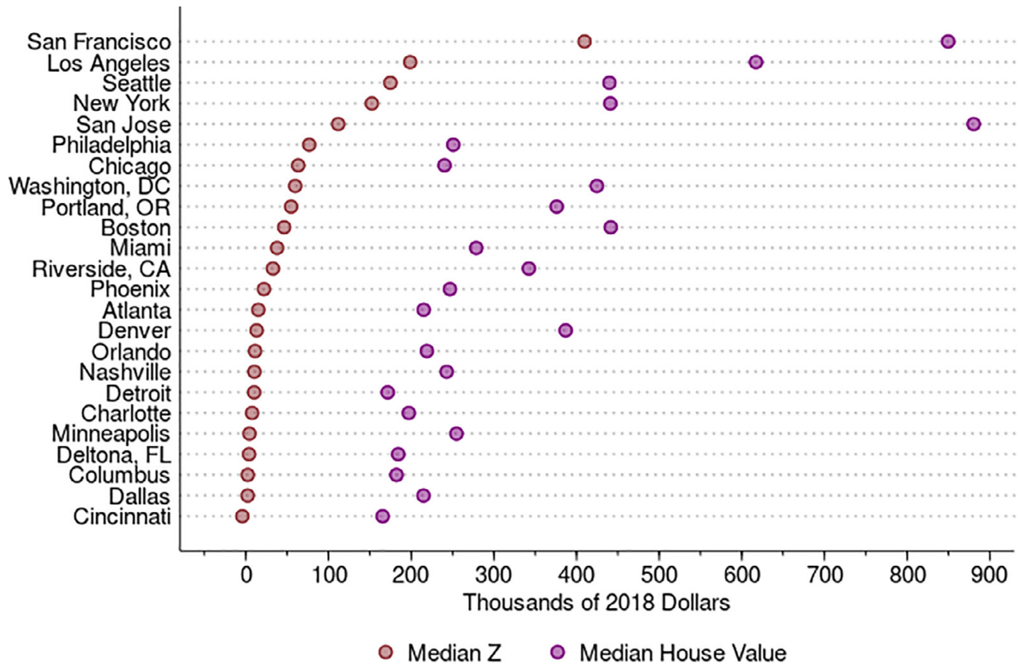

Fig. 6. Median zoning tax per quarter acre and median house value. *Notes:* Figure shows median zoning tax per quarter acre of land and median house value, both reported in thousands of 2018 dollars. The median zoning tax is calculated based on observations within 30 miles of the CBSA center. Median house value is the CBSA-level median according to the 2013–2017 5 year ACS.

Table 2
Zoning tax heterogeneity by distance from the urban core.

CBSA	≤ 15 miles			15–30 miles			30+ miles		
	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	$8523	$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	$2867	$220,755	15	$1980	$140,000
Chicago	15	$402,566	$226,364	55	$24,929	$258,523	169	$4125	$200,000
Cincinnati	4	-$9668	$151,000	16	-$4094	$180,286	4	$1387	$158,374
Columbus	22	$5868	$186,000	27	$2326	$198,680	1	-$14,230	$113,000
Dallas	8	$46,531	$216,651	28	-$2864	$266,503	31	-$7996	$215,786
Deltona	11	$20,269	$179,059	26	$2419	$153,500	3	-$12,245	$228,250
Denver	140	$27,203	$345,257	113	$8299	$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	-$1278	$270,000	13	$8100	$184,384
Nashville	18	$7121	$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	$7009	$243,284
Phoenix	166	$29,115	$216,000	622	$19,705	$274,527	147	$1079	$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	$1039,571	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

of the CBSA; note that data from this third region of the metro area were not included in the analysis reported above.

The results are reported in Table 2, with everything computed as in Table 1. [26] 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 zones within the CBSA sometimes have very small numbers of observations. There are only four relevant CoStar observations within 15 miles of Cincinnati's

[26] This means that the analysis done above for the CBSA is done separately for each of the three regions within the metro area. There are a few cases at the zone boundaries where data from two zones are used to compute the estimated zoning tax. For example, if a vacant parcel sale is (say) 14.8 miles from the CBSA core, it is likely that some of the physically closest new and existing housing come from areas more than 15 miles from the centroid.

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 to 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 that well might interest urban economists. For example, 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. This is consistent with some prominent urban theory such as the monocentric city model. However, given the sometimes very small number of observations involved, we caution against interpreting these findings as evidence for or against any specific theory of urban form. While more data certainly could open up other interesting avenues for research, our purpose here is to use this heterogeneity to provide added insight into our classification of markets into those with large versus medium versus small price impacts from zoning taxes.

First, they confirm how the big three west coast metros of Los Angeles, San Francisco and Seattle stand out in terms of large and widespread zoning taxes. Our more recent and disaggregated data show that Seattle has joined the better-known coastal California markets in this regard. 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. This latter figure is as high as the typical household income for the entire metro. The zoning tax gradient in the Los Angeles market does not slope down much at all, but its zoning taxes are high everywhere throughout its metro area. At the median, they are very close to $200,000 per quarter acre in each geographic region of its market. The zoning tax-distance gradient clearly is negative in the San Francisco CBSA, but the smallest typical 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 to 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.

What makes New York City and San Jose different from those three markets is that land values are not being bid up substantially in places much further out from their urban cores. This was suggested by their lower values of zoning taxes noted above at the 25th percentile of their distributions (Fig. 4). In the New York City market, the median zoning tax within 15 miles of the Wall Street area is very high at over one-half million dollars. The median zoning tax for parcels from 15 to 30 miles out is still economically meaningful at over $50,000 per quarter acre of land, but that is only 10% of the tax for close-in properties. More than 30 miles out, the median zoning tax falls to nearly $27,000 for a standard quarter acre of land with the right to build on it. New York is such a physically large CBSA that land is far less scarce in those collar counties.[27] The importance of geography is evident in the case of San Jose, too. Its median Z-value among close-in parcels is high at just over $160,000 per quarter acre of land. Beyond 15 miles from its centroid, however, there is no evidence of a binding supply constraint.[28]

Analyzing spatial variation in Z-values shows that there also is interesting heterogeneity within the roughly one dozen interior markets that we classified as not being materially impacted by high zoning taxes. For seven of those metropolitan areas, there is no evidence that focusing on the median observation across the entire market was masking important spatial variation. That is, in the Charlotte, Cincinnati, Columbus, Deltona (FL), Detroit, Nashville and Orlando markets, single-family residential land is cheap everywhere in these markets. However, 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.

Finally, we see similar patterns in the remaining CBSAs that had median zoning tax amounts that were clearly above those in (say) Atlanta or Charlotte, but well below those found in the big east and west coast markets. In the Riverside-San Bernardino CBSA, for example, 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, its median tax is very close to $0 for parcels more than 30 miles out. In this sense, Riverside-San Bernardino looks more like Dallas, Miami, Minneapolis and Phoenix than it does like the other CBSAs with modestly high median zoning taxes per quarter acre. Its median Z-value for the overall area reported in Table 1 was being biased up by a relatively large number of close-in parcels with high imputed tax amounts. Something similar is evident for the Chicago and Philadelphia markets. Outside of their urban cores, there is no strong evidence of economically high zoning taxes.[29]

The same cannot be said of the Boston and Miami markets. In those CBSAs, even parcels more than 30 miles out have median zoning tax values in excess of $20,000 for a quarter acre plot. Similar patterns are evident in the Washington, D.C. and Portland (OR) markets. In the nation's capital, 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. In Portland (OR), the typical zoning tax is about $50,000 per quarter acre within 15 miles of the center and actually is slightly higher at about $62,000 for parcels 15–30 miles out. There is only one observation more than 30 miles out, so we cannot say anything meaningful about that region.

In sum, among the seven markets that had median zoning taxes that put them well below the five large coastal markets, but appreciably above the dozen interior markets with economically small zoning taxes, analysis of spatial variation in their zoning taxes suggests that

[27] As the plot in Appendix 1 in the online appendix 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.

[28] This market is bordered to the north by the San Francisco CBSA well before one gets 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.

[29] Deeper scrutiny of their individual observations shows that their 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, too. 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.

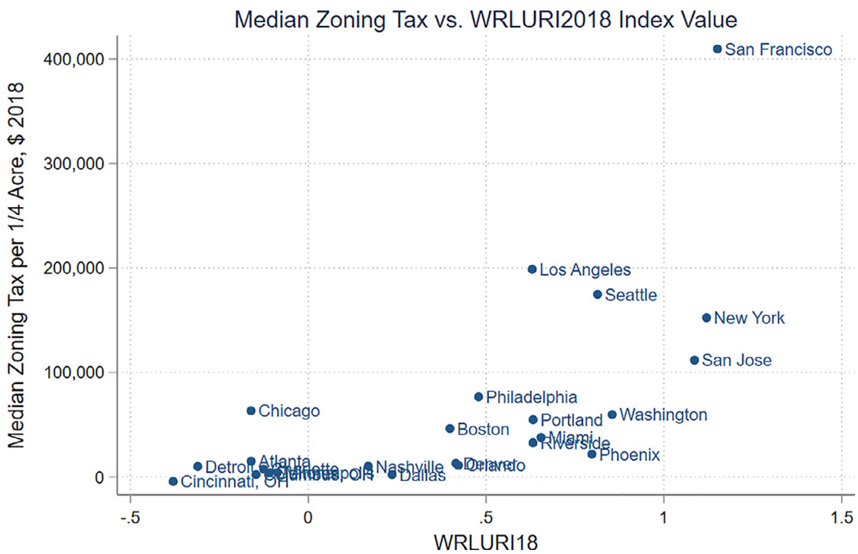

Fig. 7. Median zoning tax vs. a measure of regulatory strictness. *Notes:* The zoning tax figures are taken from Table 1 of the paper. The WRLURI2018 values are from Gyourko et al. (2019).

three (Chicago, Philadelphia and Riverside-San Bernardino) look more like the typical interior market while four (Boston, Miami (FL), Portland (OR) and Washington, D.C.) look more like a big coastal market.

3.3. 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 et al. (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 et al. (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% most highly regulated communities in the country have aggregate index values above 0.64.

Fig. 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.[30] 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.

An additional noteworthy stylized fact from Fig. 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.[31] 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.

4. Conclusions: Implications for housing markets and future research

Utilizing micro data on prices paid for vacant land intended for single family home development allowed us to provide updated estimates of zoning taxes in 24 major metropolitan areas across the United States. While there are many benefits in terms of what we believe is reduced measurement error as well as the ability to see (for the first time) spatial variation in zoning taxes within a market, there are costs to the new estimation strategy we employ with these data. The most important looks to be potential bias from non-randomness in the underlying (sometimes small) samples of observation on extensive margin land values. This leads us to recommend concentrating on the median (not mean) values and the interquartile range of imputed zoning taxes. We believe they provide accurate pictures of the economic importance of zoning taxes across major American housing markets.

It is comforting that our results are qualitatively consistent with previous findings using a different imputation strategy. That is, we find that zoning taxes are appreciably higher in big coastal markets and that they are not economically large in many interior markets. Within that broad

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

[31] 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 et al. (2019) for more detail.

pattern, there are noteworthy new findings. First, Seattle has joined the two big California metros of Los Angeles and San Francisco in having the largest zoning taxes in the nation. Those three markets now look different than the big east coast markets, with a prime reason being that there is virtually nowhere in the three west coast metros, no matter how far from the urban core, where cheap land without a zoning tax at least equal to typical household income is available. Other east coast markets such as Boston, New York, and Washington, D.C. have zoning taxes appreciably higher than those in (say) Atlanta and Charlotte, but the west coast has differentiated itself in this respect. In general, the ability to map the micro data provides new insights into many types of markets, including those that look to be in highly elastic supply on average.

Beyond that, our results will be important inputs into a host of future research on American housing markets. 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 well-known, wide geographic dispersion in house prices. Future research should try to disentangle the influence of this factor from other likely alternative explanations such as differences in construction costs across markets.

One would also expect endogenous local market responses to land price impacts of the magnitude reported in Tables 1 and 2. One possible response would be for builders and homeowners to economize on land in the production of new housing units in markets such as San Francisco. Another might be to put as much structure as possible on any given amount of land. How these different responses translate into house prices will require a model of how developers and households adjust over time in markets ranging from San Francisco to Dallas. The answer seems likely to be a major input into helping us better understand growing affordability concerns in our major coastal markets. A related issue is how this affects who owns, as well as when homeownership becomes financially feasible.

Zoning taxes of the magnitudes reported above in our major coastal markets also look large enough to affect the aggregate distribution of wealth. Previous research has tried to estimate the aggregate value of land in different metropolitan areas (e.g., Davis and Heathcote,2007; Davis and Palumbo, 2008). 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 influence all land in the market. Future work should try to estimate the latter value in this and other markets.

A final issue our results can help investigate is the optimality (or lack thereof) of zoning taxes. Housing 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), so 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 and Moretti (2019) and Duranton and Puga (2019). Our findings can serve as the foundation for the cost side of that analysis.[32]

Credit author statement

Both authors, Joseph Gyourko and Jacob Krimmel, are full coauthors on all aspects of the research including data collection, data and econometric analysis, modeling and writing.

[32] There is a literature on the welfare economics of land use planning more broadly (e.g., see Cheshire and Sheppard, 2002), but no detailed financial calculations comparing costs and benefits of restrictive land use environments.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jue.2021.103374.

CRediT authorship contribution statement

Joe Gyourko: Conceptualization, Data curation, Formal analysis, Software, Validation, Writing – original draft, Writing – review & editing. **Jacob Krimmel:** Conceptualization, Data curation, Formal analysis, Software, Validation, Writing – original draft, Writing – review & editing.

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