7-24-2018

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C. J. Gabbe
Santa Clara University, cgabbe@scu.edu

Recommended Citation
Gabbe, C. J. (2018). Residential zoning and near-roadway air pollution: An analysis of Los Angeles. Sustainable Cities and Society, 42, 611–621. https://doi.org/10.1016/j.scs.2018.07.020

Residential Zoning and Near-Roadway Air Pollution:

An Analysis of Los Angeles

C.J. Gabbe
Department of Environmental Studies and Sciences
Santa Clara University
500 El Camino Real
Santa Clara, CA
408-551-3618
cgabbe@scu.edu

Introduction

Air pollution harms human health, and evidence suggests good reason to be concerned for people who live, work, and attend school next to freeways and other major roads. While land use policies that separate people from pollution sources make intuitive sense, there has been limited implementation of this approach. One exception is California, which bans new school construction within 500 feet of a freeway, and discourages other "sensitive uses," including housing, in these locations (California Air Resources Board, 2005, 2010). Local governments can ban, discourage, or impose conditions on residential uses near freeways, but few studies have provided insights into how zoning regulates sensitive land uses near high-traffic roadways. I answer two questions. First, how is residential development near major roadways regulated? Second, how common are zoning changes near major roadways, and what factors explain these changes?

Much of metropolitan California is experiencing a housing affordability crisis and there are calls to increase housing production in response (California Department of Housing and Community Development, 2017). Cities are approving more housing units, and some of this new housing is being built near freeways. Los Angeles, for instance, has permitted several thousand new housing units per year near freeways (Barboza & Schleuss, 2017). Municipalities use local zoning codes to shape allowable land uses, densities, height, and other building characteristics (Meck, Wack, & Zimet, 2000). Policymakers should also carefully consider the environmental quality of new housing locations – and ensure adequate mitigation measures – as they enable residential growth.

This special issue of the journal is focused on "The future of urban sustainability: Smart, efficient, green or just?" I imagine that residents of a smart, efficient, green, and just city would have limited exposure to health-harming pollution. A *smart* city would use technology to reduce and mitigate transportation-related air pollution (California Air Resources Board, 2017; U.S. Environmental Protection Agency, 2016). An *efficient* city would price transportation to manage negative externalities like air pollution and congestion (Taylor, 2006). It would also have adequate zoning capacity for new housing in a variety of locations. A *green* city would protect the natural environment, and use vegetation to help mitigate urban air pollution (Beatley, 2011). A *just* city would have democratic processes, equitable outcomes, and diversity (Fainstein, 2010); people of lower incomes and communities of color would not experience disproportionate exposure to pollution. This paper focuses on the justice dimension, specifically inequities related to land use planning near high-traffic roadways.

This paper builds on two threads of past research. First, we know that living near a freeway is dangerous to human health. Despite this knowledge, we have little understanding of how residential development is regulated near freeways and other major roadways. Second, the planning literature suggests that compact city strategies could reduce regional air pollution while increasing some households' exposure to local air pollution. We do not have much evidence about municipal regulatory changes near major roadways. "Upzoning" is the colloquial term for municipal zoning changes to allow higher density development, and it is unclear the degree to which cities are enabling more housing near major roadways.

To examine these questions, I create a dataset with zoning characteristics of every Los Angeles parcel in 2002 and 2014. I specify two sets of regression models. In the first set, I use multinomial logistic regression to identify factors associated with the likelihood that a parcel is zoned for commercial/multifamily uses rather than single-family or non-residential uses. In the second set, I use logistic regression to explain the characteristics associated with a parcel being upzoned for more housing.

My analysis shows that zoning allows residential development on most parcels near major roadways in Los Angeles; for example, housing is permitted on 92% of parcels that are within 500 feet of a freeway. A major explanation is that Los Angeles's hierarchical zoning structure permits residential development in most commercial zones. Although near-roadway parcels include a considerable amount of single-family zoning, the majority of these parcels are zoned – through multifamily or commercial zoning designations – to allow multifamily housing. This is concerning because multifamily housing is more likely to be occupied by renters with lower incomes, and is denser, exposing more residents. While many of these parcels are currently developed for commercial uses, the sites could be redeveloped for housing in the future. Descriptive statistics show that near-roadway parcels are more likely to be upzoned for higher residential densities, but the regression model results indicate no significant differences in odds of upzoning after holding other site and neighborhood factors constant. These results have implications for land use planning and policy decisions near high-traffic roadways.

Roadways, air pollution, and health

The transportation sector – including passenger cars, trucks, and buses – is a major source of health-harming air pollutants. Transportation-related air pollution may come in the form of ultrafine particulates (UFPs), fine particulates (PM 2.5), course particulates (PM 10), ozone, nitrogen oxides, carbon monoxide, and other air toxics (Brugge, Durant, & Rioux, 2007; Houston, Wu, Ong, & Winer, 2004; Karner, Eisinger, & Niemeier, 2010; Zhou & Levy, 2007). Some pollutants spike more sharply along roadways (e.g., ultrafine particulates, carbon monoxide, benzene, nitrogen oxides), while others are more evenly dispersed over an urbanized area (e.g., ozone, fine particulates) (Houston et al., 2004; Hu et al., 2012).

The levels of pollutants near roadways depends on the specific pollutant, regional background pollution levels, mix of vehicles on the road, topography, wind direction, and meteorological factors (Brugge et al., 2007; Zhou & Levy, 2007). For particulate emissions from vehicles, the first 500 feet (152 meters) from the roadway tend to have the highest levels, and particulates seem to drop off to background levels within 984-1,640 feet (300-500 meters) downwind from the roadway (Karner et al., 2010; Zhou & Levy, 2007; Zhu, Hinds, Kim, Shen, & Sioutas, 2002). In many scenarios, however, a 500-foot buffer is insufficiently protective; for example, Hu et al. (2012) studied Los Angeles and found considerable variation for ultrafine particles, black carbon, and oxides of nitrogen by season, day, and time-of-day. Zhou and Levy (2007) conclude that from "a policy perspective […] a 500 meter [1,640 foot] buffer around a roadway would be appropriately protective under most circumstances" (p. 8).

Urban planning and public health researchers have studied near-roadway air pollution (Houston, Li, & Wu, 2013; Karner et al., 2010; Perez et al., 2012; Rowangould, 2013). A large share of Americans live near major roads and are exposed to these pollutants. About 19% of the U.S. population lives within 1/3 of a mile (500 meters) of a high-volume roadway, while 40% of Californians live near such roadways (Rowangould, 2013). Residents of minority and low-income neighborhoods are often more exposed to air pollution (Houston et al., 2004; Pastor, Morello-Frosch, & Sadd, 2005; Pastor, Sadd, & Morello-Frosch, 2004; Sider, Hatzopoulou, Eluru, Goulet-Langlois, & Manaugh, 2015; Stewart, Bacon, & Burke, 2014), and this leads to cumulative impacts from exposure to multiple pollutants (Pastor et al., 2005; Su et al., 2009).

People who live, work, or attend school near major roadways face heightened exposure to toxic pollutants. Connecting pollution exposure with health outcomes is complicated because health effects may vary due to the dose and timing of the exposure, and because individuals are often exposed to more than one pollutant (Kampa & Castanas, 2008). Given these limitations, many scholars have focused on understanding the health effects of particulates. Particulates have been tied with coronary heart disease, respiratory problems, greater use of health care, and increased mortality (Anderson, Thundiyil, & Stolbach, 2011; Ghosh et al., 2016). Particulates cause an estimated 160,000 to 200,000 premature deaths in the U.S. annually and ground-level ozone causes an estimated 4,300 to 10,000 premature deaths annually (Caiazzo, Ashok, Waitz, Yim, & Barrett, 2013; US EPA, 2011). California leads the nation in premature deaths from particulates, with an estimated 21,000 per year (Caiazzo et al., 2013).

Planning, zoning, and exposure to air pollutants

There are four main strategies to reduce overall air pollution from transportation: (1) improve vehicle technology, (2) encourage cleaner fuels, (3) improve transportation system efficiency, and (4) reduce the number and length of trips (US Department of Transportation, 2015). Urban planners increasingly aim to reduce vehicle travel by encouraging compact development near public transportation (Barbour & Deakin, 2012; US EPA, 2016). For example, California's Sustainable Communities and Climate Protection Act of 2008 encourages new development near frequent-service public transit to reduce driving and achieve greenhouse gas reduction targets (Barbour & Deakin, 2012).

Compact development strategies are not a panacea for urban air pollution. Compact development can lead to unintended consequences if more households are exposed to air pollutants because of new housing development near major roadways (Bae, Sandlin, Bassok, & Kim, 2007; Frank & Engelke, 2005; Kaza, Knaap, Knaap, & Lewis, 2011; Marshall, McKone, Deakin, & Nazaroff, 2005). Schweitzer and Zhou (2010) explain that:

> “[…] more compact development leads to less driving, which produces fewer emissions and, in turn, lower concentrations of air pollutants. But more compactness also increases density and infill, which increase the number of people exposed, and with more walking and street life, potentially their inhalation, or *dose* of air pollutants” (p. 365).

An additional related issue is that multifamily housing and older buildings may allow a greater intake of outdoor air pollution (Adamkiewicz et al., 2011; Houston et al., 2013).

Bae et al. (2007) warn that as “the urban-planning profession pays more attention to efforts to reduce urban sprawl via compact-city policies (for example, urban growth boundaries, smart growth), there is the threat of human-health costs to those living near freeways” (p. 155). As a result of these concerns, some public health scholars argue that air quality should have greater consideration in land use decision-making and that there should be formal strategies for “separating people from pollution” (Giles et al., 2010, p. 29).

Zoning that enables housing growth near freeways and other major roadways is a mechanism connecting people to near-roadway pollution. Several papers have touched on zoning, roadway proximity, and air quality issues. Industrial zoning was associated with higher levels of ultrafine particles and airborne black carbon while residential zoning was associated with lower levels in Montreal, Canada (Weichenthal, Farrell, Goldberg, Joseph, & Hatzopoulou, 2014). Commercial and industrial zoning was associated with emissions from stationary sources in Ventura, California (Willis & Keller, 2007). In terms of near-roadway zoning changes, Gabbe (2017) found no significant association between proximity to a freeway ramp and the odds of a parcel being upzoned, while Been et al. (2014) found that parcels on wide streets were more likely to be upzoned and less likely to be downzoned, which refers to zoning changes that decrease allowable density. But, residential zoning near major roadways remains an important and understudied topic. As such, this paper fills a gap in existing scholarship by analyzing zoning designations – and zoning changes – near major roadways.

Los Angeles and near-roadway air pollution

Los Angeles is the second largest American city with 3.9 million residents (United States Census Bureau, 2015). Within its 469 square mile land area (United States Census Bureau, 2010), the city ranges from low-density single-family neighborhoods to an urban downtown, and it is home to some of the nation's poorest and wealthiest neighborhoods. Metropolitan Los Angeles is often viewed as the epitome of car culture, but the reality is more complex; for example, while Los Angeles has the nation's second most total freeway lanes miles, it is in the bottom quartile in terms of freeway lane miles per capita (U.S. Federal Highway Administration, 2009).

City plans and policies indicate that Los Angeles aspires to be smart, efficient, green, *and* just (City of Los Angeles, 2015d, 2015c). At the time of writing, Los Angeles is in the process of several major initiatives that illustrate a balancing act between these aspirations. The city is developing a new zoning code, and intends to update its 35 community plans[1] by 2026 (T. Logan, 2014; Zahniser, 2017). As the city updates its plans and local zoning designations in each plan area, the common practice of approving new residential development near freeways is under increased scrutiny (Barboza & Schleuss, 2017).

[1] California cities are required to adopt and periodically update a citywide comprehensive plan (called a "general plan"). Los Angeles uses more detailed community plans to implement its general plan.

Changes to zoning designations may be initiated by individual property owners or the municipality. If a property owner seeks to build more intensively than currently allowed, they typically apply for a change in zoning designation or height district, along with a general plan amendment (Abundant Housing LA, 2016). The city may initiate larger-scale rezonings as it updates its 35 community plans (City of Los Angeles, 2014b). California cities – including Los Angeles – also commonly adopt specific plans, which are small area plans containing regulatory provisions that supersede the underlying zoning requirements (Governor's Office of Planning and Research, 2001).

The state's California Air Resources Board has released two reports guiding municipalities to reduce exposure to, and mitigate, near-roadway pollution (California Air Resources Board, 2005, 2017). Los Angeles has adopted several measures intended to mitigate residents' exposure to air pollution. The city amended the green building section of its building code to require air filtration systems in new mechanically-ventilated residential developments within 1,000 feet of a freeway (City of Los Angeles, 2016a). But, these air filters only remove some pollutants and must be replaced regularly by property owners, and residents must constantly run their heating and cooling systems (Barboza, 2017). The city also adopted a "Clean Up Green Up" ordinance for three pilot areas including additional design and mitigation requirements within 500 feet of a freeway and 1,000 feet of a polluting industrial source (City of Los Angeles, 2016c). Developers in these pilot areas must incorporate landscape buffers and other types of mitigation, and provide informational signage[2] (City of Los Angeles, 2016b).

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[2] The law stipulates two types of informational signage. First, industrial/manufacturing uses adjacent to residential uses must post signs prohibiting diesel truck idling. Second, informational signage is required for new municipal projects, but not new residential developments, located within 1,000 feet of a freeway: "NOTICE: Air pollution studies show a strong link between the chronic exposure of populations to vehicle exhaust and particulate matter from major roads and freeways and elevated risk of adverse health impacts, particularly in sensitive populations such as young children and older adults. Areas located within 500 feet of the freeway are known to experience the

Data

For this parcel-scale analysis, I begin by using ArcGIS software to assign each of the city's approximately 788,000 parcels with its municipal zoning designation in 2002 and 2014 (City of Los Angeles, 2002, 2014a; Esri, n.d.; Los Angeles County Assessor, 2012). These years represent the oldest and most recent digital zoning files available at the time of data collection. I interpret the zoning code to create additional variables including whether single-family housing is allowed, whether multifamily housing is allowed, and the maximum allowable residential density (City of Los Angeles, 2015b). I compare the maximum allowable residential density of each parcel in 2002 and 2014 to create a new indicator variable representing whether a parcel was upzoned for more residential development during this time period.

Roadway proximity calculations are based on Los Angeles County road network data (Los Angeles County, 2016). The county classifies every road segment by type. I calculate the Euclidean distance from the edge of every parcel to the nearest road. I then create indicator variables for parcels within 500 and 1,500 feet of an interstate freeway or freeway ramp ("freeway"), and within 500 feet of a state highway or arterial ("major roadway"). I only include the 500-foot buffer for major roadways because their traffic volumes are generally lower.

I also incorporate California Environmental Protection Agency estimates of traffic density. CalEPA estimates a census tract's traffic density to be the sum of traffic volumes "adjusted by road segment length (vehicle-kilometers per hour) divided by total road length (kilometers) within 150 meters of the census tract boundary" using 2004 Caltrans data (California Environmental Protection Agency, 2014, p. 52). CalEPA assigns each tract with its

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greatest concentration of ultrafine particulate matter and other pollutants implicated in asthma and other health conditions."

traffic density percentile on a statewide basis, and I use this percentile metric because it illustrates variation between and within metropolitan areas.

In the regression models, I incorporate additional data related to local amenities, accessibility, land use regulations, natural features, homeownership rates, and/or demographic and socioeconomic factors. These data sources are described in Table 1 and summarized in Table 2 below.

[Insert tables 1 and 2 about here.]

Methods

The methods are organized in terms of this paper's two research questions: First, how is residential development near major roadways regulated? Second, how common are zoning changes near major roadways, and what factors explain these changes?

I begin with three definitional notes. First, zoning designations are aggregated into the categories of detached single-family only zones ("single-family only"); attached residential and commercial zones ("commercial/multifamily"); and industrial and other non-residential zones ("non-residential"). It may seem counterintuitive to aggregate attached residential and commercial zoning, but I do so because housing is a permitted use in Los Angeles's commercial zones. For example, in the city's C2 (commercial) zone, developers may build the same types of housing as permitted in the R4 (multifamily residential) zone, equivalent to 109 units per acre. Second, upzoning refers to a zoning change that allows higher density residential development. Third, for roadway proximity, *very near* is within 500 feet and *near* is within 1,500 feet. I examine the zoning of parcels *near* and *very near* freeways and *very near* major roadways.

Descriptive analysis

Summary tables of parcel zoning designations within each buffered distance from roadways (i.e., near freeways, very near freeways, and very near arterials) are presented first. I next compare the composition of parcels within each roadway buffer with citywide averages (Table 3). I also compare the mean CalEnviroScreen traffic density measure for each zoning category with the overall city average. Lastly, I calculate the share of parcels within each type of roadway buffer that were upzoned.

Regression analysis of near-roadway zoning

The descriptive analysis is followed with multinomial logistic regression models to examine associations between zoning category, roadways, and other locational characteristics of parcels. Multinomial logistic regression is a form of logistic regression where the outcome variables have more than two levels (Hosmer, Lemeshow, & Sturdivant, 2013). In this paper's multinomial logistic regression models, the outcome variable has three levels: single-family, commercial/multifamily, and non-residential zoning.

The independent variables reflect locational characteristics that may explain differences in these zoning designations. The main predictor of interest in each model is an indicator variable related to roadway proximity or the traffic density measure. Four models are specified, one each with indicator variables of *very near* freeway proximity, *near* freeway proximity, *very near* major roadway proximity, and traffic density percentile. Other predictors in the model relate to regional location, transportation accessibility, local amenities, and socio-demographic factors. More specifically, the models include distance to the Los Angeles central business district (CBD), a location within a half-mile of a rail transit or bus rapid transit station, Census tract population density in 2011, distance to the beach, elevation, Census tract black population share, Hispanic population share, and share of families in poverty in 2011.

To account for the dependence of parcels that are near each other, standard errors are clustered by Census tract. I also include City Council district fixed effects to account for unobserved variation due to political and geographic factors within Los Angeles. The results are reported as relative risk ratios. The models take the form of Equation 1.

Equation 1. Multinomial logistic regression model of residential zoning

$$\begin{aligned} ZoningCategory_i &= \alpha + \beta_1 RoadwayProximity_i + \beta_2 DistanceCBD_i + \beta_3 RailStationArea_i \\ &+ \beta_4 PopDensity_i + \beta_4 Natural_i + \beta_5 SocioDemographic_i + \beta_6 CityCouncil_i + \varepsilon_i \end{aligned}$$

Regression analysis of zoning changes

My conceptual model is that the likelihood of a parcel being upzoned is based on local amenities and disamenities, accessibility, land use regulations, natural features, homeownership rates, and demographic and socioeconomic factors. This conceptual model is rooted in Gabbe's (2017) analysis of upzoning in Los Angeles. In that research, freeway ramp proximity was included as an accessibility variable, but no other measures of roadway proximity were considered. This paper considers major roadway proximity as a potential disamenity that could deter upzoning or as an accessibility measure that could act as a magnet for upzoning.

Following the methods in Gabbe (2017), I specify logistic regression models to estimate the odds of parcel upzoning based on these factors, adding in roadway proximity and traffic density measures. That previous analysis found upzoning to be more likely on parcels zoned for low-intensity uses (e.g., manufacturing, parking) and less likely in neighborhoods with amenities like higher standardized test scores and beach proximity.

Logistic regression models are the most commonly used type of models with a binary outcome variable (Hosmer et al., 2013). The dependent variable is a binary outcome variable representing whether a parcel was upzoned between 2002 and 2014. Single-family (SF) and non-single family (non-SF) parcels are modeled separately, since research suggests different processes may be at play in related zoning changes. Four logistic regression models are specified each for single-family and non-single-family zoned parcels. Each set includes three models for roadway independent variables (*very near* freeway, *near* freeway, and *very near* major roadway) and a fourth for traffic density percentile.

The predictors in each of the four models include accessibility (distance to the nearest freeway ramp, regional employment accessibility, and location within a half-mile of a rail or BRT station); amenities (distance to the beach, local elementary school test scores, and distance to the nearest park of at least one-quarter acre); natural features (elevation and steep slopes); regulations and human-created constraints (lot size, historic preservation overlay, whether residential was allowed in 2002, whether high-density residential was allowed in 2002, location in an Adaptive Reuse Ordinance Area, and years since the local Community Plan was last updated); population and employment density; category of homeownership rates; demographics (median household income, quartile of black population share, quartile of Hispanic population share, and percent poverty); and indicators of neighborhood change such as housing unit growth between 1990 and 2000, and change in median rent between 1990 and 2000. These models also include City Council district fixed effects and clustered standard errors by Census tract. The results are reported as odds ratios. The equations take the form of Equation 2.

Equation 2. Logistic regression model of parcel upzoning

$$
\begin{aligned}
Upzoning_i = \; & \alpha + \beta_1 RoadwayProximity_i + \beta_2 Accessibility_i + \beta_3 Amenities_i + \beta_4 Natural_i \\
& + \beta_5 Regulations_i + \beta_6 Municipal_i + \beta_7 Homeowner_i + \beta_8 Demographics_i \\
& + \beta_9 NeighborhoodChange_i + \beta_{10} CityCouncil_i + \varepsilon_i
\end{aligned}
$$

Results and discussion

Los Angeles is commonly perceived as a city filled with major roads and freeways. A sizable share of parcels is near a freeway or major roadway. About 6% of L.A.'s parcels are very near a freeway, 21% are near a freeway, and 46% of parcels are very near a major roadway. This roadway proximity has benefits in terms of regional transportation accessibility, but costs related to emissions and noise.

Zoning allows housing on most near-roadway parcels

Los Angeles permits single-family housing on 55% of its parcels, multifamily housing on 41% of parcels (including commercial zoned parcels that permit residential), and prohibits residential development altogether on 4% of parcels. Table 3 shows the composition of parcels within each type of roadway buffer area.

Los Angeles commonly permits multifamily housing on parcels closest to high-traffic roads. Of parcels that are very near a freeway, 37% are zoned for single-family and 55% for commercial/multifamily. Of parcels near a freeway, about 44% are zoned for single-family and 51% for commercial/multifamily. Of parcels very near a major roadway, 38% are zoned for single-family and 55% for commercial/multifamily. Table 3 shows that all differences of the means between near-roadway and other parcels are statistically significant.

The typical parcel where multifamily can be built is in a higher traffic area than the typical single-family parcel. The average parcel in Los Angeles is in California's 57th percentile in terms of traffic density. Higher density zoning is associated with higher neighborhood traffic densities. The average single-family parcel is in the 54th percentile tract, the average two-family parcel is the 57th percentile tract, and the average multifamily parcel is in the 62nd percentile tract.

Parcels near major roadways are disproportionately more likely to be zoned to allow multifamily housing compared with the citywide average. This is partly because Los Angeles has a hierarchical zoning structure, where residential uses are generally allowed in commercial zones, but not vice versa. Although housing is allowed on most commercial parcels, that does not mean they have been developed for residential uses. For example, on a freeway-adjacent parcel that is currently a big box retailer, zoning permits the property owner to build a mixed-use apartment building in the future.

[Insert Table 3 about here]

The regression models account for other factors that might explain differences in zoning designation near major roadways. This includes proximity to downtown Los Angeles, location within a half-mile of a rail or bus rapid transit station, distance from the beach, population density, elevation, and socio-demographic factors. The model results show the odds of a parcel being zoned for commercial/multifamily compared with single-family, and zoned for non-residential compared with single-family. The McFadden's pseudo R-squared statistics indicate that the model explaining zoning near major arterials fits slightly better; this is probably due to common city practices applying multifamily or commercial zoning along major streets.

Near-freeway and near-arterial parcels are much more likely to be zoned for commercial/multifamily compared with single-family. All else equal, a parcel *very near* a freeway is 2.6 times more likely to be zoned for commercial/multifamily than single-family (Model 1 in Table 4), a parcel near a freeway is 1.8 times more likely to be zoned for commercial/multifamily (Model 2 in Table 4), and a parcel *very near* a major roadway is 3.6 times likelier to be zoned for commercial/multifamily (Model 3 in Table 4). In terms of traffic density, for every 1 percent increase in a parcel's traffic density percentile, the relative risk of the parcel being zoned for commercial/multifamily increase by 1.2 percent (Model 4 in Table 4).

In neighborhoods with higher shares of black and Hispanic residents, parcels near major roadways are more likely to be zoned for single-family rather than commercial/multifamily uses (models 1-4 in Table 4). One way to ground-truth these results is by visually assessing freeway-adjacent land uses in South Los Angeles and West Los Angeles. In South Los Angeles, which is majority black and Hispanic, single-family housing is the dominant land use along the 110 freeway. Meanwhile, in West Los Angeles, which is majority white, much of the land along the 405 freeway is developed with commercial and multifamily uses.[3] Meanwhile, all else equal, near-roadway parcels are more likely to be zoned for commercial/multifamily uses compared to single-family in neighborhoods with higher shares of residents at 200% of the poverty line.

Los Angeles zoning allows housing near freeways in most areas, particularly multifamily housing, which raises two main concerns. Most alarming are the high shares of residential parcels within 500 feet of freeways. Additionally, medium- and high-density multifamily housing are the housing types most likely to be permitted near freeways. In a region where the majority of new housing development is multifamily and available land supply is limited, there

[3] In a set of models (not shown) without demographic or poverty variables, parcels farther from the beach were more likely to be zoned for non-residential uses (e.g., industrial) than those closer to the beach. In the models that include variables for black population share, Hispanic population share, and poverty, proximity to the beach is no longer associated with any zoning differences. Distance to the beach may act as a proxy for some neighborhood characteristics, as neighborhoods closer to the beach tend to be whiter and wealthier than Los Angeles neighborhoods farther away.

will be future development pressure on these near-roadway parcels. This is already in progress; Los Angeles permitted 7,300 new housing units within 1,000 feet of a freeway in 2015 and 2016, (Barboza & Schleuss, 2017), though the authors do not specify the shares of new single-family and multifamily units in these areas.

This creates a conundrum for urban planners and policymakers. On one hand, the need for new housing is dire, and reducing the land available for residential development will lead to less housing production and higher housing prices. Some of the areas where the city wants to direct growth – including parts of downtown Los Angeles and many rail station areas – are adjacent to freeways. But, on the other hand, there are serious evidence-based health concerns about locating housing on the parcels nearest to freeways and other high-traffic roads. Some of the impacts may be mitigated through roadway design, site design, and indoor air filtration, but evidence is not clear on the effectiveness of mitigation techniques. The best hope comes over the long term as new technologies enable reductions in fleet emissions and concentrations of air pollutants near roadways.

[Insert Table 4 about here]

Few significant relationships between roadway proximity and upzoning

Upzoning was rare, and roadway proximity is a minor or insignificant factor relative to other determinants of upzoning. The descriptive statistics show that about 1% of parcels citywide were upzoned (Table 2). The shares of upzoned near-roadway parcels were higher. The city upzoned 1.7% of parcels that were *very near* freeways, 1.2% of parcels *near* freeways, and 1.4% of parcels *very near* major arterials.

For non-single family parcels, in three of the four models, there are no significant relationships between roadway variables and the likelihood of a parcel being upzoned. The only significant association is that a non-single-family parcel *near* a freeway is about 60% less likely to be upzoned than one farther away (Model 3 in Table 5). This is most likely because a large share of centrally-located upzoned parcels – particularly in the Wilshire neighborhood and downtown Los Angeles – were somewhat beyond 1,500 feet from a freeway.

The non-single family parcels that were more likely to be upzoned were in inland neighborhoods with higher population densities, faster rising rents, and newer city-adopted plans. These upzoned parcels tended to be in neighborhoods where there would be less opposition from homeowners: neighborhoods with lower homeownership rates and elementary school standardized test scores. In terms of zoning, these parcels were moderately zoned at the analysis outset in 2002; that is, parcels were neither zoned too restrictively (e.g., with a historic preservation overlay) or too permissively (e.g., with a permitted density of over 100 units per acre).

For single-family parcels, there are no significant relationships between roadway proximity and the likelihood of upzoning in three of the four models. There is a positive relationship between a parcel being *very near* a major roadway and its odds of upzoning; single-family parcels within 500 feet of a major roadway are about 2.6 times more likely to be upzoned than other single-family parcels (Model 6 in Table 5). This may be explained by a combination of the accessibility benefit of a location near a major roadway (e.g., parcels that were previously used for agriculture), and the political and financial feasibility of upzoning a single-family parcel close to an arterial. The few single-family parcels that were upzoned were more likely to be in agricultural or low-density areas, on larger lots, and having steeper slopes. Conversely, urban single-family parcels in neighborhoods with high homeownership rates were rarely upzoned.

[Insert Table 5 about here]

The descriptive statistics show that near-roadway parcels are more likely than the average parcel to be upzoned, but the regression results explain roadway proximity to be a minor or insignificant factor relative to other determinants of upzoning. The McFadden's pseudo R-squared statistics show that the models better predict non-single-family upzonings and that the inclusion of the roadway indicators has a small impact on model fit. Additionally, other factors that might be expected to be associated with higher odds of upzoning (e.g., employment or transit proximity, income, and race and ethnicity) have no significant relationships with upzoning. We need further research to understand whether these factors matter differently for upzonings initiated by property owners versus the municipality.

Conclusions and policy implications

Planners and policymakers face tensions between competing priorities when deciding how to address residential zoning and housing development near high-traffic roadways. There are serious equity issues at play, as housing affordability and health arguments are pitted against each other. One set of arguments is focused on housing supply and affordability. Housing development is already restricted too much in cities like Los Angeles and further restrictions will make housing more expensive. High housing prices squeeze the poor the most, so cities should enable as much housing as possible, even near major roadways. Others argue that environmental quality and health should be leading criteria for zoning and housing decisions. Since people of color and those with lower incomes already face disproportionate environmental burdens, enabling more housing near freeways will add to the cumulative impacts of these burdens. A third set of arguments focuses on the regional benefits of building more housing near major transit, even in locations that are near major roadways.

Further research is sorely needed to inform policymaking. We need more research on the health effects of near-roadway pollution exposure, disparities in the characteristics of near-roadway residents, and the efficacy of pollution mitigation strategies. First, we need more evidence about the long-term health risks of living near major roadways. We need to know how health effects vary for different demographic groups, and by type, degree, and length of pollution exposure. Second, we need a better understanding of disparities by race, ethnicity, and income in terms of exposure to health-harming pollution. Zoning may act as a mechanism connecting low-income households and people of color to near-roadway pollution exposure and we need to understand how and why. Third, if near-roadway development remains widely permitted, we need to know about the efficacy of mitigation strategies; that is, the circumstances under which mitigation measures reduce exposure to specific pollutants.

Policymakers should restrict or prohibit residential development in places with the worst air and noise pollution (e.g., adjacent to freeways). Cities could adopt overlay zoning that permits housing under specific overriding conditions, like proximity to rail transit and/or with strict mitigation measures. Municipalities should also allow more infill housing in neighborhoods with better air quality, which would ease some of the development pressure to build housing next to freeways. Evidence shows that even an additional 500 to 1,000 feet of separation from a freeway significantly reduces air pollution concentrations.

Planning and zoning near major roadways should be subject to evidence-based mitigation measures and these measures should be enforced over the long-term. We need to apply the best available evidence about various mitigation measures, including placing housing farther from emissions sources, planting vegetation along roadways, constructing soundwall barriers along roadways, installing electrostatic filters in buildings, reducing vehicular speeds, and improving traffic flow (California Air Resources Board, 2012; CAPCOA, 2009). Enforcement matters too; for example, if cities require high-efficiency air filtration systems, they should also enforce the ongoing maintenance of these systems.

Urban planners can take a leadership role in community conversations about reducing residents' health risks from air pollution. Here, planners can exemplify a pragmatic approach for creating a smart, efficient, green, and just city. While there are no easy answers, the best approach is to speak to the problem directly, and include residential exposure to air pollution as a criterion in land use decisions.

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Tables

Table 1: Data sources and calculations

Variable	Data source
Residential allowed by zoning (2014, indicator)	Calculated by author based on City of Los Angeles (2014a)
Single-family zoning (2014, indicator)	Calculated by author based on City of Los Angeles (2014a)
Two-family zoning (2014, indicator)	Calculated by author based on City of Los Angeles (2014a)
Multifamily allowed (2014, indicator)	Calculated by author based on City of Los Angeles (2014a)
Parcel upzoned (2002-2014, indicator)	Calculated by author based on City of Los Angeles (City of Los Angeles, 2002, 2014a)
Distance to freeway ramp (miles)	Euclidean distance of each Los Angeles County (2012) parcel centroid to the nearest freeway ramp (Caltrans, 2015)
Distance to CBD (miles)	Euclidean distance of each parcel centroid to the downtown Los Angeles intersection of 7th and Broadway.
Employment accessibility measure (2000)	Measure calculated by Lens (2014)
Within a half mile of a rail or BRT station (indicator)	Based on Euclidean distance of each parcel centroid to the nearest rail or BRT station (Center for Transit-Oriented Development, 2011)
Distance to beach (miles)	Euclidean distance from each parcel centroid to the coastline (Hapke, Reid, & Borrelli, 2008)
Neighborhood API score	Inverse distance weighted surface based on state elementary school standardized test results (California Department of Education, 2015)
Distance to quarter-acre park (miles)	Euclidean distance to the nearest park based on Los Angeles City Planning Department (2014) data.
Elevation (in 100s of feet)	Elevation of each parcel centroid calculated using USGS digital elevation model (United States Geological Survey, 2006)
Slope above 25% (indicator)	Slope calculated using USGS DEM data and ArcGIS slope tool (Esri, 2011; United States Geological Survey, 2006)
Lot size (acres)	Lot size based on Los Angeles County Assessor (2012) data.
Historic Preservation Overlay Zone (2002, indicator)	City of Los Angeles (2002)
Residential development allowed (2002, indicator)	Calculated by author based on City of Los Angeles (2002, 2015b)
Over 100 units/acre allowed (2002, indicator)	Calculated by author based on City of Los Angeles (2002, 2015b)
Adaptive Reuse Ordinance area (2002)	City of Los Angeles (n.d.)
Years since last Community Plan update (based on 2014)	Calculated by author based on City of Los Angeles (2015a)
Population density (2000, in 1000s of persons/sq. mi.)	United States Census Bureau (2000)
Employment density (2000, in	United States Department of Transportation (2000)

1000s of jobs/sq. mi.)	
Share owner-occupied housing units (2000)	United States Census Bureau (2000)
Median household income (2000, in 1000s of $US)	United States Census Bureau (2000)
Share black (2000)	United States Census Bureau (2000)
Share black (2011)	United States Census Bureau American Community Survey (2009-2013)
Share Hispanic (2000)	United States Census Bureau (2000)
Share Hispanic (2011)	United States Census Bureau American Community Survey (2009-2013)
Share at 200% poverty (2012)	CalEnviroScreen 2.0 based on United States Census American Community Survey (California Environmental Protection Agency, 2014)
Change in tract housing units (1990-2000, in units)	Calculated by author using U.S. Census (United States Census Bureau, 1990, 2000) data; boundary changes were reconciled using the Longitudinal Tract Database (J. R. Logan, Xu, & Stults, 2014)
Change in tract median gross rent (1990-2000, in nominal $)	Calculated by author using U.S. Census 1990 and 2000 data; boundary changes were reconciled using the Longitudinal Tract Database

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Residential allowed by zoning (2014, indicator)	788,338	0.96	0.20	0.00	1.00
Single-family zoning (2014, indicator)	788,338	0.55	0.50	0.00	1.00
Two-family zoning (2014, indicator)	788,338	0.07	0.25	0.00	1.00
Multifamily allowed (2014, indicator)	788,338	0.34	0.47	0.00	1.00
Parcel upzoned (2002-2014, indicator)	788,338	0.01	0.10	0.00	1.00
Distance to freeway ramp (miles)	788,338	0.99	0.80	0.00	5.63
Distance to CBD (miles)	788,338	12.12	6.86	0.01	26.65
Employment accessibility measure (2000)	788,338	537.38	196.90	135.72	880.96
Within a half mile of a rail or BRT station (indicator)	788,338	0.11	0.32	0.00	1.00
Distance to beach (miles)	788,338	10.86	4.77	0.00	22.41
Neighborhood API score	788,338	82.06	5.62	64.44	95.19
Distance to quarter-acre park (miles)	788,338	0.30	0.23	0.00	2.68
Elevation (in 100s of feet)	788,338	5.52	3.97	-0.04	43.31
Slope above 25% (indicator)	788,338	0.18	0.39	0.00	1.00
Lot size (acres)	788,338	0.72	5.22	0.02	1762.43
Historic Preservation Overlay Zone (2002, indicator)	788,338	0.01	0.10	0.00	1.00
Residential development allowed (2002, indicator)	788,338	0.96	0.20	0.00	1.00
Over 100 units/acre allowed (2002, indicator)	788,338	0.09	0.28	0.00	1.00
Adaptive Reuse Ordinance area (2002)	788,338	1.03	0.16	1.00	2.00
Years since last Community Plan update (based on 2014)	788,336	15.68	3.17	1.00	26.00
Population density (2000, in 1000s of persons/sq. mi.)	786,532	9.87	8.31	0.01	92.16
Population density (2011, in 1000s of persons/sq. mi.)	786,535	12.18	9.27	0.00	102.58
Employment density (2000, in 1000s of jobs/sq. mi.)	788,338	4.53	10.48	0.01	121.95
Share owner-occupied housing units (2000)	786,532	0.50	0.26	0.00	0.97
Median household income (2000, in 1000s of $US)	786,532	50.51	28.92	4.77	200.00
Share black (2000)	786,532	0.10	0.17	0.00	0.91
Share black (2011)	787,529	0.09	0.15	0.00	0.87

Share Hispanic (2000)	786,532	0.37	0.28	0.03	0.98
Share Hispanic (2011)	787,529	0.39	0.28	0.00	1.00
Share at 200% poverty (2012)	784,629	0.36	0.21	0.00	0.97
Change in tract housing units (1990-2000, in units)	786,532	0.38	2.13	-17.11	14.36
Change in tract median gross rent (1990-2000, in nominal $)	786,532	1.72	2.28	-3.56	11.99

Table 3: Comparison between parcels within each near-roadway category with all other parcels in Los Angeles

Comparing zoning of parcels near major roadways with those farther away

	Share of all parcels within 500 feet of a freeway	**Share of all parcels more than 500 feet from a freeway**	***Difference***	***t***	***df***	***P***
Single-family only	37.4%	56.5%	*-19.1%*	83.7	786533	.000
Commercial/multifamily	54.6%	39.4%	*15.2%*	-66.8	786533	.000
Non-residential	7.4%	4.0%	*3.4%*	-36.9	786533	.000

	Share of all parcels within 1,500 feet of a freeway	**Share of all parcels more than 1,500 feet from a freeway**	***Difference***	***t***	***df***	***P***
Single-family only	43.7%	58.4%	*-14.7%*	107.2	786533	.000
Commercial/multifamily	50.5%	37.7%	*12.8%*	-94.3	786533	.000
Non-residential	5.4%	3.9%	*1.6%*	-28.1	786533	.000

	Share of all parcels within 500 feet of a major arterial	**Share of all parcels more than 500 feet from a major arterial**	***Difference***	***t***	***df***	***P***
Single-family only	38.3%	69.9%	*-31.6%*	296.6	786533	.000
Commercial/multifamily	55.3%	27.7%	*27.6%*	-262.0	786533	.000
Non-residential	6.3%	2.4%	*3.9%*	-86.1	786533	.000

Traffic density measure by parcel zoning (Cal EnviroScreen percentile)

	Traffic density percentile by parcel zoning designation	**Traffic density percentile for all other parcel zoning designations**	***Difference***	***t***	***df***	***P***
Single-family only	54.0	61.7	*-7.7*	125.7	786533	.000
Commercial/multifamily	61.4	54.7	*-0.3*	-110.0	786533	.000
Non-residential	63.8	57.1	*2.2*	-43.9	786533	.000

Table 4: Multinomial logistic regression results for parcel zoning designations (reported as relative risk ratios)

	Model 1		Model 2		Model 3		Model 4	
	C/MF vs. SF	Non-Res vs. SF	C/MF vs. SF	Non-Res vs. SF	C/MF vs. SF	Non-Res vs. SF	C/MF vs. SF	Non-Res vs. SF
Within 500 feet of freeway (indicator)	2.561***	1.830***						
	(0.355)	(0.286)						
Within 1,500 feet of freeway (indicator)			1.836***	1.109				
			(0.195)	(0.172)				
Within 500 feet of major road (indicator)					3.589***	3.410***		
					(0.234)	(0.273)		
Traffic density percentile							1.012***	1.008**
							(0.00212)	(0.00275)
Distance to CBD (miles)	1.047*	1.088*	1.046*	1.082	1.034	1.080	1.047*	1.093*
	(0.0220)	(0.0457)	(0.0220)	(0.0450)	(0.0221)	(0.0456)	(0.0226)	(0.0477)
Within 1/2 mile of rail or BRT (indicator)	1.890***	2.247**	1.847***	2.264***	1.778***	2.129**	1.798***	2.188**
	(0.260)	(0.556)	(0.253)	(0.554)	(0.244)	(0.532)	(0.250)	(0.538)
Population density (1000s of persons/sq.mi.)	1.159***	0.902***	1.161***	0.900***	1.160***	0.907***	1.167***	0.907***
	(0.0121)	(0.0217)	(0.0123)	(0.0219)	(0.0119)	(0.0219)	(0.0132)	(0.0224)
Distance to beach (miles)	0.967	1.019	0.968	1.018	0.976	1.024	0.973	1.015
	(0.0360)	(0.0855)	(0.0358)	(0.0854)	(0.0376)	(0.0866)	(0.0368)	(0.0859)
Elevation (100s of feet)	0.862**	0.638**	0.863**	0.640**	0.913	0.681*	0.866**	0.642**
	(0.0432)	(0.0966)	(0.0437)	(0.0963)	(0.0461)	(0.103)	(0.0445)	(0.0992)
Percent black (2011)	0.130***	2.321	0.132***	2.289	0.129***	1.928	0.150***	2.346
	(0.0704)	(3.385)	(0.0710)	(3.334)	(0.0702)	(2.808)	(0.0777)	(3.352)
Percent Hispanic (2011)	0.0578***	0.167**	0.0584***	0.180*	0.0676***	0.177*	0.0626***	0.180*
	(0.0228)	(0.114)	(0.0231)	(0.122)	(0.0275)	(0.122)	(0.0247)	(0.124)
Percent at 200% poverty (2011)	1.030***	1.073***	1.029***	1.073***	1.029***	1.072***	1.027***	1.071***
	(0.00529)	(0.0103)	(0.00534)	(0.0102)	(0.00532)	(0.0102)	(0.00532)	(0.0101)

Observations	784,627	784,627	784,627	784,627	784,627	784,627	784,627	784,627
Pseudo R-squared	0.2837		0.2844		0.3164		0.287	

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Note: C/MF denotes parcels with commercial or multifamily zoning designations; these categories are combined because the Los Angeles zoning code permits residential development on parcels zoned for commercial uses.

Table 5: Logistic regression results for parcel upzoning (reported as odds ratios)

	Model 1 Upzoning Non-SF	Model 2 Upzoning SF	Model 3 Upzoning Non-SF	Model 4 Upzoning SF	Model 5 Upzoning Non-SF	Model 6 Upzoning SF	Model 7 Upzoning Non-SF	Model 8 Upzoning SF
Within 500 feet of freeway (indicator)	0.617	1.863						
	(0.248)	(0.800)						
Within 1,500 feet of freeway (indicator)			0.415*	1.554				
			(0.161)	(0.496)				
Within 500 feet of major road (indicator)					1.408	2.645***		
					(0.375)	(0.521)		
Traffic density percentile							1.006	1.008
							(0.00651)	(0.00619)
Distance to freeway ramp (miles)	0.586	1.022	0.436*	1.092	0.677	1.004	0.745	1.130
	(0.189)	(0.149)	(0.165)	(0.166)	(0.197)	(0.150)	(0.218)	(0.188)
Employment accessibility measure (2000)	0.997	0.997	0.997	0.997	0.998	0.998	0.997	0.997
	(0.00462)	(0.00326)	(0.00460)	(0.00324)	(0.00451)	(0.00323)	(0.00462)	(0.00304)
Within a half mile of a rail or BRT station (indicator)	0.685	0.951	0.736	0.966	0.651	0.976	0.638	0.975
	(0.251)	(0.347)	(0.278)	(0.350)	(0.232)	(0.343)	(0.231)	(0.351)
Distance to beach (miles)	1.572***	1.134	1.574***	1.138	1.558***	1.127	1.573***	1.153
	(0.175)	(0.110)	(0.175)	(0.112)	(0.169)	(0.110)	(0.174)	(0.119)
Neighborhood API score	0.886**	1.048	0.882**	1.048	0.888*	1.034	0.888*	1.048
	(0.0413)	(0.0531)	(0.0409)	(0.0524)	(0.0416)	(0.0526)	(0.0412)	(0.0511)
Distance to quarter-acre park (miles)	0.835	0.502	0.791	0.500	0.865	0.543	0.877	0.505
	(0.801)	(0.304)	(0.740)	(0.303)	(0.868)	(0.332)	(0.856)	(0.304)
Elevation (in 100s of feet)	0.676	0.882	0.661	0.887	0.700	0.933	0.676	0.877
	(0.154)	(0.0657)	(0.157)	(0.0655)	(0.147)	(0.0662)	(0.149)	(0.0624)
Slope above 25% (indicator)	1.286	2.898***	1.298	2.866***	1.285	2.959***	1.301	2.910***
	(0.651)	(0.795)	(0.657)	(0.774)	(0.640)	(0.860)	(0.634)	(0.795)

Lot size (acres)	0.991	1.016**	0.990	1.016**	0.988	1.015**	0.990	1.016**
	(0.0127)	(0.00506)	(0.0121)	(0.00518)	(0.0152)	(0.00480)	(0.0133)	(0.00497)
Historic Preservation Overlay Zone (2002, indicator))	0.0372***		0.0416***		0.0373***		0.0382***	
	(0.0263)		(0.0300)		(0.0263)		(0.0261)	
Residential development allowed (2002, indicator)	0.133***		0.132***		0.138***		0.137***	
	(0.0616)		(0.0596)		(0.0647)		(0.0641)	
Over 100 units/acre allowed (2002, indicator)	0.00553***		0.00562***		0.00551***		0.00526***	
	(0.00670)		(0.00667)		(0.00657)		(0.00656)	
Adaptive Reuse Ordinance area (2002)	3.123		3.680		2.913		2.931	
	(2.236)		(2.769)		(2.124)		(2.059)	
Years since last Community Plan update (based on 2014)	0.837***	1.021	0.832***	1.022	0.841***	1.019	0.840***	1.022
	(0.0382)	(0.0561)	(0.0397)	(0.0562)	(0.0381)	(0.0565)	(0.0377)	(0.0559)
Population density (2000, in 1000s of persons/sq. mi.)	1.045*	0.899**	1.042*	0.900**	1.047*	0.904**	1.048*	0.905**
	(0.0202)	(0.0322)	(0.0205)	(0.0320)	(0.0193)	(0.0317)	(0.0199)	(0.0336)
Employment density (2000, in 1000s of jobs/sq. mi.)	0.970	0.983	0.968	0.983	0.971	0.981	0.971	0.978
	(0.0305)	(0.0490)	(0.0304)	(0.0489)	(0.0307)	(0.0481)	(0.0309)	(0.0497)
Medium homeownership vs. low homeownership tract	0.182**	0.180***	0.187**	0.181***	0.185**	0.177***	0.184**	0.182***
	(0.112)	(0.0884)	(0.112)	(0.0894)	(0.115)	(0.0876)	(0.115)	(0.0878)
High homeownership vs. low homeownership tract	0.0417***	0.0668***	0.0415***	0.0672***	0.0427***	0.0660***	0.0437***	0.0668***
	(0.0389)	(0.0381)	(0.0380)	(0.0382)	(0.0405)	(0.0377)	(0.0413)	(0.0375)

Median household income (2000, in 1000s of $US)	1.025	1.008	1.025	1.008	1.025	1.010	1.023	1.008
	(0.0215)	(0.0119)	(0.0217)	(0.0121)	(0.0214)	(0.0118)	(0.0214)	(0.0122)
Medium black share vs. low black share tract	1.526	0.872	1.534	0.856	1.534	0.895	1.510	0.829
	(0.762)	(0.264)	(0.759)	(0.258)	(0.755)	(0.274)	(0.747)	(0.243)
High black share vs. low black share tract	0.185	1.248	0.177	1.188	0.196	1.339	0.180	1.100
	(0.177)	(0.686)	(0.168)	(0.645)	(0.185)	(0.732)	(0.172)	(0.561)
Medium Hispanic share vs. low black share tract	0.919	1.306	0.879	1.280	0.924	1.211	0.911	1.231
	(0.370)	(0.472)	(0.362)	(0.451)	(0.378)	(0.426)	(0.379)	(0.431)
High Hispanic share vs. low black share tract	0.345	1.184	0.346	1.133	0.337	1.029	0.326	1.087
	(0.209)	(0.772)	(0.212)	(0.723)	(0.205)	(0.670)	(0.201)	(0.661)
Change in tract housing units (1990-2000, in 100s of units)	1.033	0.926	1.037	0.927	1.030	0.929	1.032	0.928
	(0.118)	(0.0438)	(0.126)	(0.0429)	(0.113)	(0.0459)	(0.114)	(0.0436)
Change in tract median gross rent (1990-2000, in 100s nominal $)	1.730***	0.730**	1.725***	0.728**	1.754***	0.729**	1.732***	0.726**
	(0.254)	(0.0863)	(0.258)	(0.0865)	(0.253)	(0.0867)	(0.256)	(0.0837)
Observations	350,688	431,198	350,688	431,198	350,688	431,198	350,688	431,198
Pseudo R-squared	0.3861	0.1738	0.391	0.1794	0.3865	0.1878	0.3856	0.1731
City Council District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Note: For the SF models, missing variables predict the results perfectly or were perfectly collinear.