

Displacement and the Consequences of Gentrification^{*}

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Abstract

Over the past several decades, cities across the U.S. have experienced gentrification and the associated socio-demographic shifts. As this phenomenon has accelerated, concerns about gentrification-induced displacement and its impacts on incumbent residents have grown. This paper studies the link between gentrification and displacement, identifying the social groups most likely to be displaced and the impacts on those displaced groups. The results provide evidence of displacement, showing that lower-income renters are significantly more likely to exit from gentrifying neighborhoods. Moreover, they tend to move to neighborhoods with significantly lower school quality and higher crime rates and have a higher probability of changing jobs and receiving lower incomes. Owners, however, are more likely to remain in gentrifying neighborhoods, benefiting from the increased amenities and rising home values. In stark contrast to renters, when these owners do move, they convert those capital gains into improved living conditions. These results provide direct evidence of how housing tenure defines the welfare consequences of environmental improvements.

Keywords:

Environmental Gentrification, Displacement, Housing Appreciation

JEL Classification: Q53, R21

1. Introduction

Gentrification, generally defined as a process in which an influx of upper- or middle-income households transforms lower-income neighborhoods, has accelerated across U.S. cities over the past several decades. While this phenomenon began in the early part of the 20th century, it accelerated in the 1970s when, during a period of experimentation and grassroots activism, middle-class “pioneers” moved from the suburbs into poorer areas of cities. They rehabili-

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tated houses and brought drastic changes to these neighborhoods, providing a countertrend to the “white flight” phenomenon that defined the period from the 1950s to 1970s (Osman, 2016). Since then, most major cities have experienced gentrification in some of their neighborhoods. Between 2014 and 2015, the U.S. Census Bureau found that all but one (Chicago) of the country’s 20 largest cities experienced population growth, and the overall rate was double what it was from 2000 to 2010 (Madhani, 2016). As cities grow, their demographics also change. Since the 1990s, the downtown areas of these cities have seen significantly higher numbers of younger, higher-income, and more educated residents, a telltale sign of gentrification (Juday, 2015).

By attracting upper- and middle-class residents, gentrification brings housing investment to areas and stimulates better public services. Rising property values, falling crime rates, and better public amenities (e.g., street repair, sanitation) generally coincide with gentrification (Atkinson, 2002). Despite these potential benefits, a primary concern about gentrification is its effect on displacement. The influx of middle-class residents bids up housing prices, which leads to the conversion of rental units to owner-occupied dwellings. Lower-income incumbent residents (particularly renters) may find that they are no longer able to afford to maintain their residences. In the aggregate, displacement is blamed for breaking up tight-knit communities and destroying social capital. At the micro-level, it may force individuals to re-optimize their housing choices, leading to worse overall living conditions (Atkinson, 2002). At the same time, neighborhood economic upgrading brings in new businesses, creating more high-wage positions while inducing job losses in low- and moderate-wage positions, especially for localized service and goods-producing sectors (Meltzer & Ghorbani, 2017). Changes in residential locations also lead to changes in commuting zones and force movers to re-optimize their job choices. Lower-skilled residents and workers may find that they experience job losses due to local labor market changes or displacement and are not as competitively positioned for the new high-wage positions or the other labor markets. Employment effects from gentrification change job access for incumbent residents and can lead to unemployment and income reduction for low-skilled residents.

The impacts of gentrification have been discussed for decades, and apprehensions about displacement have grown as gentrification proceeds. In fact, many organizations, such as the Brooklyn-based group Right to the City, claim that gentrification-induced displacement is a human-rights violation (Knafo, 2015). This is because displacement from gentrifying neighborhoods may increase economic segregation and exacerbate inequality. Over the last 30 years, economic inequality has increased substantially in the United States, with average income after transfers and taxes quadrupling for the top 1 percent of households and increasing by only 50% for the bottom 20 percent (Stone et al., 2015).¹ This rising economic inequality can be explained by many factors, including shifts in industrial structure, technological changes and globalization (Swanstrom et al. 2002; Baum-Snow et al. 2014). In addition to these factors, the sorting of economic classes across space and its accompanying residential segregation can play a pivotal role in entrenching and widening inequality (Swanstrom et al., 2002). Neighborhood conditions have important impacts on one’s earning potential, school performance, and access to opportunities over and above individual characteristics and family background. Using 7 million families who move across commuting zones and counties in the United States, Chetty & Hendren (2018) found that neighborhoods have significant childhood exposure effects — “the outcomes of children whose families move to a better neighborhood — as measured by the outcomes of children already living there — improve linearly in proportion to the amount of time they spend growing up in that area, at a rate of approximately 4% per year of exposure” (p.1107). Even though one might justify economic segregation on the grounds of rational market choices (i.e., people with similar tastes and similar abilities to pay for public goods will naturally move to similar neighborhoods and get what they pay for (Rockwell 1994; Husock 1991)), increases in social costs and social disadvantages that accompany economic inequality provide ample motivation to learn about these causes and address it with policy.²

The principal government responses to concerns about gentrification-induced displacement, and thus economic segregation and economic inequality, have included preserving, improving

¹ Source: Congressional Budget Office

² Pack (1998) found that cities spent \$27.75 more per capita on nonpoverty-related services for every one point increase in the poverty rate.

and creating affordable housing in gentrifying neighborhoods; establishing and implementing service programs and stringent landlord-tenant laws to protect tenants; and dedicating tax revenue to subsidize low-income residents (Kennedy & Leonard, 2001). However, whether these policies target the right populations or are even necessary is still up for debate. Central to that debate is the question around the link between gentrification and displacement, the differential impacts of gentrification on indigenous residents, and who bears the burden and who reaps the benefits of these changes. This paper seeks to provide answers to these questions and provide quantitative evidence describing who is most likely to be displaced, what these people do in response to displacement, and what the practical implications are for their lives.

Previous studies on the link between gentrification and displacement have found mixed results. Several studies offer evidence that gentrification results in significant displacement (Atkinson 2000; Newman & Wyly 2006; Wyly et al. 2010), but some studies have found small or even nonexistent links between the two (Vigdor et al. 2002; Freeman & Braconi 2004; McKinnish et al. 2010). The lack of consensus across these previous studies arises partly from inconsistencies in how gentrification and displacement are defined in different studies. The time-scales of analysis also differ across studies and may not always capture the full process of gentrification. The aerial unit may also be different, and studies using spatially aggregated data may mask local heterogeneity. There is some literature investigating industrial revitalization, industrial displacement, and employment effects in gentrifying areas (Curran 2004; Hartley et al. 2013; Baum & Snow 2017). One key question left unaddressed is how gentrification impacts the incomes and earnings of incumbent residents with local labor market changes and gentrification induced displacement. Most of these limitations are ultimately data-driven. One challenge is that most data sources do not track the movements and employment of households and fail to identify movers' former and latter residences and employment conditions. Consequently, it is usually not possible to determine who was displaced because of gentrification, and it is difficult to understand the extent and implications of displacement. This paper will utilize longitudinal microdata to answer these questions.

The Los Angeles Family and Neighborhood Survey (L.A. FANS) data is used in this paper to examine whether gentrification is associated with displacement and job changes and to analyze gentrification’s impact on displaced residents. To investigate if there is a displacement effect, we focus on the movements and employment of lower-income residents over a period of ten years, analyzing residents’ housing decisions and job choices, and comparing the differences by race and tenure. We identify gentrifying neighborhoods using changes in housing prices and measure displacement as the exit rate of low-income residents. We examine how residents trade off housing expenditures against other amenities and look at whether those who are displaced end up in worse neighborhoods, measured in terms of education quality, crime rates, and air toxicity. We then investigate changes in residents’ socioeconomic conditions, including annual income and hourly salaries, in gentrifying neighborhoods for movers and residents who changed their jobs. We find a positive and significant link between gentrification, displacement, and job changes. Minorities, renters, and households with kids have an increased probability of displacement. Additionally, those who are displaced are significantly more likely to move to more polluted neighborhoods with lower school quality and higher crime rates and have a higher probability of changing jobs and receiving lower earnings.

This paper proceeds as follows. Section 2 reviews the current literature on gentrification and displacement. Section 3 discusses gentrification in Los Angeles, which is our study area. Section 4 describes the data, and Section 5 presents our empirical specification. Section 6 examines our results. Section 7 discusses some of the policy implications of our findings, and Section 8 concludes.

2. Literature Review

Before reviewing the relevant literature, we discuss the definitions of gentrification that have been used in the literature. The term “gentrification” was first coined in [Glass \(1964\)](#) as a reference to the process of class invasion and takeover that facilitated the displacement of the original working-class inhabitants. Further literature about gentrification and its effects expanded upon this definition. [Banzhaf & McCormick \(2006\)](#) note that there are three main hallmarks of gentrification: (1) rising property values and rental costs; (2) renewal or creation of new housing stock; and (3) changes in demographic composition, particularly income

levels. Most studies, however, do not incorporate such complex definitions when measuring and identifying gentrification. Rather, they use a variety of proxies for gentrification, such as increases in the percentage of professionals or higher-income residents in a neighborhood (Atkinson 2000; Vigdor et al. 2002) and neighborhood investment (Charles, 2003). Most research has found consistent evidence of demographic changes in gentrifying neighborhoods: incumbent, low-income minorities are typically replaced by high-income, white in-movers. While each gentrification indicator has its own advantages and disadvantages, all share the same feature in this process of demographic change – property market appreciation.

Several papers have used housing prices to measure gentrification. Bates (2013) developed the approach of using neighborhood typologies to predict gentrification and defined “early gentrified”, “dynamic gentrified”, and “late gentrified” tracts using housing appreciation rates and housing values. Our indicator and proxy for gentrification will thus build on the existing gentrification literature and will utilize housing appreciation rates and increases in housing values while incorporating income and demographic constraints.

The definition of displacement, like that of gentrification, varies throughout the literature. Most papers choose to use the definition from Grier & Grier (1980) who argued that “displacement occurs when any household is ‘forced’ to move from its residence by conditions which affect the dwelling or its immediate surroundings, and which are beyond the household’s reasonable ability to control or prevent” (Newman & Owen, 1982, p. 137). Proxies to measure displacement include the rate of exit due to high rents, eviction, or housing being sold; decreases in the number of residents from vulnerable groups; and the rates of lower-income out-movers (Schill et al. 1983; Atkinson 2000; Freeman & Braconi 2004). In this paper, we use the exit rates of lower-income out-movers as our definition of displacement.

Several studies have looked at the relationship between gentrification and displacement. Atkinson (2000) examined gentrification’s impact on displacement by comparing decreases in the number of residents from vulnerable groups (e.g. the working class) in four areas in London, U.K. Using cross-sectional longitudinal census data and measuring gentrification as an increase in the number of professionals, he found a significant link between gentrification and displacement. Vigdor, Massey & Rivlin (2002) compared exit probabilities of vulnerable

low-status households in gentrifying neighborhoods to other areas in Boston. Using aggregate census data and the American Housing Survey (AHS), they measured gentrification as increases in educational attainment and owner-occupied housing values. Their results showed that poor households in gentrifying neighborhoods were not significantly more likely to be displaced. One possible explanation for these contradictory results is that the two studies used different measures of gentrification and both relied on aggregate data. In particular, while both studies attempted to isolate social groups that are most susceptible to displacement, they used different indicators for disadvantaged status — income in [Atkinson \(2000\)](#) and education in [Vigdor, Massey & Rivlin \(2002\)](#).

[Freeman & Braconi \(2004\)](#) used disaggregate data from the New York City Housing and Vacancy Survey (NYCHVS) and applied methods analogous to those used in [Vigdor, Massey & Rivlin \(2002\)](#). Using growth rates of the white population, rent, educational attainment and median income as measures of gentrification and the exit rate of poor households as their measure of displacement, they found that poor households in gentrifying neighborhoods were less likely to move than those in other neighborhoods. However, their analysis also showed demographic changes in gentrifying neighborhoods and higher socio-economic statuses of in-movers than out-movers. For further analysis, [Freeman \(2005\)](#) used the number of moves due to residents' willingness to pay for cheaper housing, a smaller space, or less rent and moving because of housing eviction as a measure of displacement and considered census tracts shifting from disinvested with low-income residents to reinvested with better-educated residents as gentrifying neighborhoods. He found more moves that resulted in improvements in socioeconomic conditions in gentrifying tracts than the other areas. Additionally, even though the displacement rate in [Freeman \(2005\)](#) was relatively low (1.3%), given the fact that he used national aggregate data, the results might be underestimated.

Another study that quantified the extent of displacement in gentrifying neighborhoods is [Wyly, Newman, Schafran & Lee \(2010\)](#). Using New York City Housing and Vacancy Survey (NYCHVS) data from 2002 to 2008, the authors measured displacement using the number of in-movers and out-movers. They found that about 10,000-20,000 households were displaced per year and that poor households, especially renters, were twice as likely to be displaced as

residents from other groups. [Wyly, Newman, Schafran & Lee \(2010\)](#) also raised the concern of endogeneity in previous studies of gentrification and displacement. Subsequent studies further examined who is more likely to be displaced by gentrification. [Wyly, Newman, Schafran & Lee \(2010\)](#) found that those most susceptible to gentrification-induced displacement were families with high housing cost burdens (as a percentage of income), short durations of occupancy, and homes closer to the central city while [Ellen & O'Regan \(2011\)](#) found that age, minority status, and renter status were the major determinants.

Most previous studies have been devoted to measuring the link between gentrification and displacement or identifying the vulnerable groups that have been displaced, but limited studies examined how gentrification affects indigenous residents' housing decisions, socioeconomic conditions, and where the displaced ultimately end up. [Schill, Nathan & Persaud \(1983\)](#) found that displaced residents do not live in worse conditions after they move, but [Newman & Wyly \(2006\)](#) found that displacement resulted in crowding and homelessness. However, these studies primarily relied on data collected from interviews or surveys of out-movers and used door-to-door canvassing to identify these movers, meaning the most vulnerable and transient households were less likely to be detected, leading to under-sampling and bias ([Zuk et al., 2015](#)). Recent papers by [Brummet & Reed \(2019\)](#) and [Dragan, Ellen & Glied \(2019\)](#) approached the problem of gentrification's impacts using longitudinal microdata tracking residents' movements. Both papers found that gentrification does not make incumbent renters worse-off as gentrification can benefit incumbent stayers and children through declining poverty exposure. However, [Brummet & Reed \(2019\)](#) also found that less-educated renters are differentially more likely to leave the housing and labor market when their neighborhood gentrifies and move to worse neighborhoods while [Dragan, Ellen & Glied \(2019\)](#) found no significant differences in mobility patterns between gentrifying neighborhoods and not gentrifying neighborhoods. The incongruent intuitions in housing decisions could be explained by their measure of gentrification (changes in the percentage of highly-educated residents) and the use of restricted samples.³

³ [Brummet & Reed \(2019\)](#) use national data from the 2000 Census and the 2010 - 2014 ACS 5-year estimates, which cannot capture short-term changes in housing markets. [Dragan, Ellen & Glied \(2019\)](#) use a sample of families with children continuously enrolled in Medicaid from 2009-2015 living in multi-

The methodological limitations of previous studies and the lack of analysis of the displaced are ultimately data problems. Cross-sectional data, aggregate data, and longitudinal data with limited movement and employment information may misrepresent households’ residential decisions and employment changes, and underestimate the displacement impacts of gentrification. With limited information about households’ full path of movement and employment, previous studies have not been able to capture low-income households’ housing decisions and changes in their socio-economic conditions. In our paper, we will build on the existing literature and solve these problems by utilizing a new longitudinal dataset that tracks individual movement and employment in a detailed manner to capture the link between gentrification and displacement, identify the groups vulnerable to displacement, and measure the effects of displacement on the displaced.

3. Environmental Gentrification in Los Angeles

In this paper, we consider gentrification in Los Angeles County. In 2000, an environmental shock significantly and permanently decreased pollution levels in a collection of neighborhoods there. The reason for the shock was that all power plants in L.A. were forced to install the cleanest abatement facilities to justify their incompliance with the RECLAIM cap-and-trade program during the California Electricity Crisis, when there was a spike in permit prices. We exploit the resulting gentrification.

In 1994, the South Coast Air Quality Management District (SCAQMD) implemented a “cap and trade” system—the Regional Clean Air Incentives Market (RECLAIM) — to control emissions of NO_X and SO_X in California. This program aimed to reduce NO_X and SO_X emissions by issuing permits to 392 facilities in Southern California. A tradable but non-bankable permit was required to cover each unit of NO_X and SO_X emitted. The total number of permits issued decreased annually to force firms to either reduce production or increase pollution abatement. The program expected to get to the “cross-point” (i.e. when

family rental buildings in 2009, for whom the decision of staying can be correlated to their choice of schools, their preferences for stability, and their needs for medical care.

the amount of emissions equals the number of permits issued) in 2000.⁴ Firms' options to remain in compliance included reducing production, increasing operating efficiency, installing abatement technology or purchasing more permits. Failure to comply meant incurring a heavy penalty.

Since the market price for permits was low and the number of available permits exceeded the amount of emissions for a long period of time after the implementation of RECLAIM, most firms were not constrained by RECLAIM until 2000. However, in 2000, because of the California Electricity Crisis,⁵ demand for permits increased as gas-fired generators had to increase production in response to a drop in electricity supply. Permit prices increased from \$30/ Mwh to \$240/ Mwh. This increased the marginal supply costs for a peaking turbine from \$100 to \$120/ Mwh. To avoid a crisis, SCAQMD negotiated with gas-fired generators, suspending their involvement in the permit market and allowing them to emit more in exchange for installing the available abatement equipment.

The California Electricity Crisis therefore unexpectedly forced most of the gas-fired power plants to install abatement facilities in a short amount of time, significantly improving the environmental quality of some neighborhoods. As shown in Figure 1, many neighborhoods realized reduced toxicity levels.⁶ This positive shock to environmental conditions triggered a

⁴ According to Moore (2004), before 2000, the market price of permits, or RTCs, remained low, and firms spent little effort on controlling emissions. This was because far more permits were allocated than firms' emissions.

⁵ In 1996, the California State government made a decision to restructure its electricity market. In the restructuring process, three major utility companies such as PG& E were required to sell their fossil-fuel capacity to form a more competitive electricity transmission market. Government officers thought that this new market would lower electricity prices. However, in 2000 a serious drought happened in the Northwest, and because of seasonal unbalance and uncertainty about electricity generating, there was no import of electricity. California faced a lack of electricity supply and consequently got widely blacked out. Local power plants were forced to use all their facilities to produce more electricity. However, reusing of old facilities and generators meant higher costs and more pollution when producing. Additionally, with manipulations of the market and the increase in permit prices, electricity prices skyrocketed. At the same time, the government had set a cap on utility companies' retail prices, which caused these companies to go into ten billion dollars of debt and eventually go bankrupt. This crisis did not end until 2002 when there was a decrease of demand and increase of electricity imports.

⁶ Measurement of toxicity concentration is imputed from Risk Screening Environmental Index (RSEI) data by summing up grid-cell level toxicity concentrations into tract-level concentrations using geographic weights. The measure of pollution used is toxicity concentration, which is a co-pollutant measure calculated as the sum of "Toxicity Weight \times Pounds of the Chemical" to capture the relative releases and transfers of chemicals. RSEI toxicity concentration is directly related to facilities instead of other

gentrification process in Los Angeles neighborhoods.

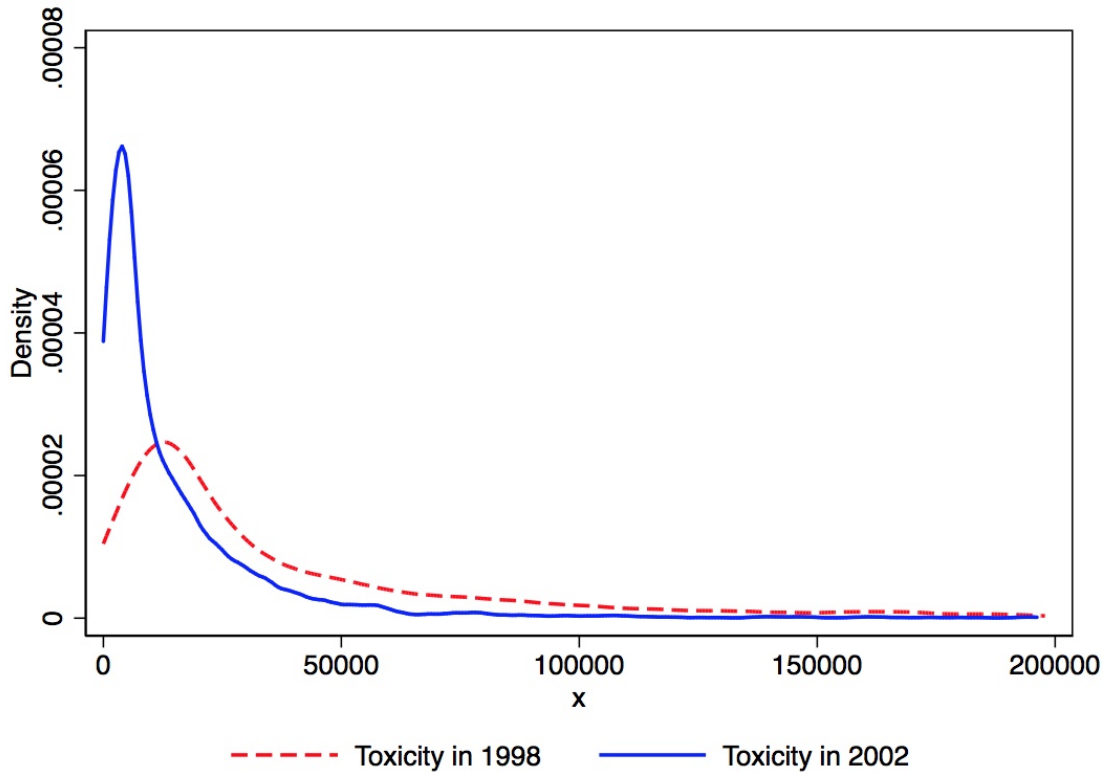


Figure 1: Toxicity Concentration of Los Angeles Before and After the Electricity Crisis

4. Data

The data for this study come predominantly from the Los Angeles Family and Neighborhood Survey (L.A. FANS). This survey was conducted in two waves: Wave 1 lasted from 2000-2001 and Wave 2 was fielded from 2006-2008. The data consist of a sample that was representative of all neighborhoods and households in Los Angeles County but oversampled poor neighborhoods and families with children.⁷ Detailed information on the housing status (tract-level location, tenure choice, neighborhood conditions), employment conditions (tract-level workplace, hourly salary, commuting distance), family characteristics (income, wealth, and assets), and family members' socioeconomic characteristics were collected from

sources and combines the impacts of emissions from multiple facilities that may be located on the same area.

⁷ Even though it oversamples poor families and families with children, L.A. FANS data still include a sample of neighborhoods across the entire income range.

both adults and children in households. The final sample used for analysis contains 1,618 records: 996 of these households moved to a new neighborhood after 2000, 880 households changed jobs at least one time from 2000 to 2007, and 1,096 households in the sample were renters. The main strength of this dataset is that it follows households over time and records residents' movements and employments by time, location, housing prices (rent) and salaries. This unique feature allows us to fill in the gaps of previous studies and add more insight into the mixed displacement findings.⁸

We supplement the L.A. FANS data with CoreLogic data to get information about housing transactions. We use the average housing prices from 2000 to 2008 to calculate both the housing appreciation rate and the changes in housing price value for each census tract. In our regression analysis, the average housing price is considered to be an important neighborhood attribute. While the CoreLogic dataset does not include rental prices, it should be predictive of changes in rents. To verify this, we examine the correlation between housing and rental appreciation rates using CoreLogic data and Census data, and find the correlation to be very high at 0.6.⁹ The median rent, median income, and population of each census tract come from 2000 and 2010 U.S. Census data and the American Community Survey 5-year estimates from 2005 - 2009.

We use three other amenities in our analysis of housing decisions: environmental conditions, crime rate, and school quality. Toxicity concentration is measured by the Risk-Screening Environmental Indicators (RSEI) data,¹⁰ which provide information about the potential health-related impacts of toxic releases from facilities in a community. Tract level crime rate and school quality data come from RAND's crime rate and academic performance data, which take the weighted average of the three nearest cities' and schools' recordings.

⁸ Most prior studies tend to use data from the American Housing Survey (AHS) or New York Housing and Vacancy Survey (NYCHVS). The AHS, however, only focuses on changes occurring within households (e.g. changes in rent and in the people living in the homes), while the NYCHVS only measures changes in vacancy rates. Because they do not track those that have moved, these datasets cannot precisely measure displacement or even verify that households moved in the first place.

⁹ See Appendix B

¹⁰ RSEI data are available on the EPA's website: <https://www.epa.gov/rsei>

Table 1 presents descriptive statistics for the variables of interest in our sample. The majority of people in our sample are renters (68%), Latino (66%) and have kids under 18 (86%). On average, renters in our sample paid an annual rent of about \$7,500 in Wave 1 (i.e., year 2000), and an annual rent of about \$11,000 in Wave 2 (i.e., year 2006). The average income for households in Los Angeles in our sample is about \$40,000, and the average education level is about grade 11, which is not surprising given that there is an oversampling of poor tracts. Sixty percent of the households moved to other locations after the Wave 1 survey.

Measures of amenity changes are defined as the differences in amenity values between the original and new census tracts in the year of moving. As shown in Table 2, on average those who moved between Waves 1 and 2, which includes renters and owners, moved to neighborhoods with better education quality, lower crime rates but more pollution. Later, we explore if this result differs between renters and owners and examine how they make trade-offs.

5. Empirical Specification

5.1. Define Gentrification

Our analysis is comprised of five different parts. The first step involves creating three measures of gentrification. The first measure, adopted from one of the hallmarks of gentrification in [Banzhaf & McCormick \(2006\)](#) and adjusted by the neighborhood market topologies in [Bates \(2013\)](#), is calculated using tract level housing appreciation rates, median income, and population. Housing appreciation rates are calculated from housing transactions records taken from CoreLogic.¹¹ We use housing appreciation rates from 2000 to 2005, $(P_{2005}/P_{2000}) - 1$. We generate a dummy variable indicating whether a census tract is gentrified; if the housing appreciation rate from 2000 to 2005 was larger than 100% and the increase in the average housing value was larger than \$200,000, or if the housing appreciation rate from 2000 to 2005 was larger than 50% and the increase in the average housing value

¹¹ CoreLogic data that support the findings of this study are available from CoreLogic but restrictions apply to the availability of these data. We have obtained the rights to use this restricted access dataset by securing an agreement between RAND and Duke University.

was larger than \$220,000, a tract is considered gentrified.¹² We then constrain gentrifying tracts to tracts with populations larger than 3,000 and with median household incomes in the bottom 50% in 2000 to rule out rich areas and forested areas on the outskirts of Los Angeles.¹³

The second measure of gentrification is adopted from the Urban Displacement Project (UDP) of UC Berkeley and UCLA, which explored the relationship between residential mobility patterns and the local rental housing market dynamics in Los Angeles. They used rent burden,¹⁴ changes in income and changes in population to form an indicator of gentrification. We use a similar measure, defining a tract as gentrifying if its rent burden was less than 40% in 2000 and higher than 50% in 2010 or if, between 2000 and 2010, a tract experienced an increase in rent burden larger than 30%.¹⁵ Gentrifying tracts are again constrained to tracts with populations larger than 3,000 and median household incomes in the bottom 50% in 2000.

The third measure of gentrification is similar to that in [Brummet & Reed \(2019\)](#).¹⁶ We define a tract as gentrifying if the percentage of individuals aged 25+ with a bachelor's degree living in tract j increased by more than 10 percent from 2000 to 2010. Gentrification is measured using a dummy variable, and gentrifying tracts are still constrained to tracts

¹² We use both the housing appreciation rate and the average housing value increase in this measure to rule out tracts that have high appreciation rates but are not gentrifying compared to other neighborhoods. To be more specific, consider a tract that has experienced high housing appreciation rates, but the housing prices are still much lower than those of other neighborhoods since the 2000 housing market boom inflated housing prices all over the Los Angeles area. If only the housing appreciation rate is used, tracts like Tract 1 that have low initial housing prices are much more likely to be defined as gentrifying neighborhoods, even though their prices are still low relative to other neighborhoods. To increase the chance that upscaling tracts with rising housing values are included in our measure as gentrifying tracts, we use both the housing appreciation rate and the average housing value increase. These two rules in defining gentrification aim to include both tracts with low initial housing values, high appreciation rates, and high value increases and tracts with high initial values, high appreciation rates, and high value increases.

¹³ For such neighborhoods, there are likely other reasons, unrelated to gentrification, for why they experienced large increases in housing price.

¹⁴ Rent burden is defined as the ratio of median rent to median income of a tract.

¹⁵ This measure is comparable to the measure done by UDP. They defined a tract as gentrifying if the rent burden was higher than 30%.

¹⁶ They measure gentrification as the change from 2000 to 2010 - 2014 in the number of individuals aged 25+ with a bachelor's degree or more living in tract j in the city c , divided by the total population aged 25+ living in tract j and city c in 2000.

with populations larger than 3,000 in the year 2000 and the year 2010.

In the other four parts of empirical analyses, we use the first measure of gentrification — the one defined by housing appreciation rates — to estimate residents’ choices and their socioeconomic changes. The other two measures of gentrification will be used to give robustness checks to our results.

5.2. *Neighborhood Changes — Difference-in-Difference Approach*

After calculating the measures of gentrification, in the second part of the analysis, we use census data and amenity data to examine demographic and public amenity changes in gentrifying tracts. We use a difference-in-difference approach to compare public amenity changes in gentrifying tracts to those in non-gentrifying neighborhoods. The standard difference-in-difference regression is:

$$X_{j,t} = \alpha_1 \text{Gentrification}_j + \alpha_2 \text{Post}_t + \alpha_3 \text{Gentrification}_j \times \text{Post}_t + \xi_j + \varepsilon_{j,t}$$

where $X_{j,t}$ is the value of public amenities including pollution level, safety conditions, and school quality in tract j at time t . Subscript j indicates tract and subscript t indicates the time. ξ_j is the location fixed effect which captures all time-invariant characteristics of the tracts. α_3 is the change in public amenity levels in gentrifying neighborhoods after the shock, which is the treatment effect of gentrification on public amenities.

To investigate demographic changes in gentrifying tracts, we use matching methods to construct a comparison group by matching tracts based on their populations, median incomes, and average housing prices before the shock. Two matching methods — Propensity Score Matching (PSMatch) and Nearest Neighborhood Matching (NNMatch)— are used to evaluate the effects of gentrification on demographic changes by comparing gentrifying tracts to matched tracts that do not gentrify. The gentrifying tracts and non-gentrifying tracts are compared with respect to changes in median income, percentage of minorities, percentage of individuals aged 25+ with a bachelor’s degree, rent burden, percentage of renters and median rent between 2000 and 2010.

5.3. Moves — Probit Regression Model

After examining the impacts of gentrification on households' housing choices, we use the moving histories in the L.A. FANS data to examine whether gentrification is associated with displacement and to identify the groups vulnerable to displacement. We use a probit model to regress households' moving decisions on the gentrification measure (i.e., housing appreciation rate, rent burden, or educated percentage), tenure, the interaction of tenure and gentrification, and other control variables. The general form of the specification is shown in the following equation:

$$\begin{aligned} Moved_i = & \beta_0 + \beta_1 Gentrification_i + \beta_2 Gentrification_i \times renter_i + \\ & \beta_3 Renter_i + \beta_4 control_1 + \beta_5 control_2 + \dots \end{aligned}$$

where $Moved_i = 1$ if household i moved to another tract after the Crisis; $Gentrification_i = 1$ if household i lived in a gentrifying tract before the Crisis happened ; $Renter_i = 1$ if household i was a renter in the first place; and the controls include age, race, education, income and whether the household has kids.

To examine the impacts of gentrification on households' career choices, we use the employment histories in the L.A. FANS data to examine whether gentrification is associated with career moves. We use a similar probit model to regress households' decisions of whether to change job on the gentrification measure (i.e., housing appreciation rate, rent burden, or educated percentage), tenure, the interaction of tenure and gentrification, and other control variables. The general form of the specification is shown in the following equation:

$$\begin{aligned} ChangeJobs_i = & \beta_0 + \beta_1 Gentrification_i + \beta_2 Gentrification_i \times renter_i + \\ & \beta_3 Renter_i + \beta_4 control_1 + \beta_5 control_2 + \dots \end{aligned}$$

where $ChangeJobs_i = 1$ if household i changed its jobs after the Crisis.

The interaction term in each of these models is critical and is our main variable of interest because it tells us whether renters, as opposed to owners, are more likely to move from gentrifying neighborhoods or change jobs. If renters are more likely to move out of a gentrifying

neighborhood, then gentrification is likely associated with displacement. However, if there is no difference between renters and owners in moving decisions, there is probably little link between gentrification and displacement. Renters will be more negatively impacted by housing appreciation as a result of gentrification; owners, on the other hand, will likely benefit from higher housing prices, especially because of California’s property tax limit, so there is less incentive for owners to move from their current homes.¹⁷ Similarly, if renters initially living in the gentrifying neighborhood are more likely to change their jobs, then gentrification likely impacts their socioeconomic outcomes and affects their financial conditions.

In this part of the analysis, we use an income/asset threshold to better identify households susceptible to displacement or career changes. This idea builds off the previous literature, which measures displacement as exit rates amongst lower-income populations. By limiting our dataset to susceptible populations, we exclude those who are likely to move for reasons outside of displacement. [Gould, Cooke & Kimball \(2015\)](#) calculated that for a “two-parent two-child” family to live a “modest but adequate” life in Los Angeles, the required annual family earnings must be higher than \$74,000. Based on their calculations and the family structures (number of children and adults) in our data, we eliminated observations with high enough budgets to live in Los Angeles and only kept those who may struggle to make ends meet and are thus susceptible to displacement.¹⁸ We also drop households with non-housing assets higher than \$300,000, which eliminates those who may not make much income, but have a lot of wealth and thus are not likely to be displaced.

¹⁷ Owners typically need to pay 6% of their housing price to realtors when selling their houses, which is a large chunk of their wealth. This further makes owners less likely to move.

¹⁸ We eliminate observations of families with fewer than two adults or fewer than two children but with annual total earnings higher than \$74,000, families with fewer than five adults or fewer than four children but with annual total earnings higher than \$150,000, and families with more than five adults or more than four children but with annual total earnings higher than \$200,000. Using thresholds from [Gould, Cooke & Kimball \(2015\)](#) is more appropriate in this paper as the calculations are specific to Los Angeles. While we also considered using income cutoffs for state social safety net programs (e.g. Medicaid) as our thresholds, these numbers do not consider economic security and tend to be state-wide cutoffs, failing to consider the fact that Los Angeles has a higher standard of living than other parts of California. Federal poverty guidelines are also an inadequate threshold for this reason. Although we use a relatively high threshold, it is appropriate given the fact that Los Angeles is among the top 3 largest family budget areas.

5.4. Outcomes — OLS Regression Model

After establishing the link between gentrification and displacement and examining the characteristics of those likely to be displaced, we look at what happens to residents after displacement. The L.A. FANS data record households' movement histories with both their former and latter residences. In the previous analysis, we formed a sample of low-status households. Some of these households stayed in the same location during the entire survey (2000-2008) while others moved.¹⁹ In this part of the analysis, we use a sample of only movers and apply seemingly unrelated regressions to examine how residents make housing decisions after moving out, whether renters who were previously living in gentrifying neighborhoods will take up residence in neighborhoods with fewer amenities, and how residents make trade-offs among different amenities.

Seemingly unrelated regression is used here since choices of amenities are correlated with each other. Residents will be constrained by their financial conditions, which makes moving to a neighborhood with all improved amenities not feasible or affordable for them, particularly if they do not enjoy a large capital gain on a previously owned house. With a limited budget, a resident's decision to move to a neighborhood with better schools could only be realized by sacrificing other amenities.²⁰ Their decisions about different amenities reveal something about their preferences and their willingness to make trade-offs. Our dependent variables are changes in four amenities (housing price, pollution level, school quality and crime rate) between the original residence and the new residence measured in the year of the move. As in our previous analysis, we regress these on the gentrification measure, whether a person is a renter, and the interaction of the two. The interaction term is again our main variable of interest because it tells us what happens to renters who moved from gentrifying neighborhoods (i.e. the displaced). We include households' demographic and socioeconomic characteristics as controls because some amenities, such as education quality and crime rate of a neighborhood, will likely matter more to households with kids. The equations for this

¹⁹ In the sample, most movers only moved once. Fewer than 100 observations moved twice or more. We include all movement within the span of more than three years.

²⁰ See more explanations to this part in [Appendix A](#)

regression are shown below:

$$\begin{cases} C_H = \theta_{1,0} + \alpha_1 G_i + \beta_1 R_i + \gamma_1 G_i \times R_i + X'I_i \theta_{1,0} + \epsilon_{1,i} \\ C_P = \theta_{2,0} + \alpha_2 G_i + \beta_2 R_i + \gamma_2 G_i \times R_i + X'I_i \theta_{2,0} + \epsilon_{1,i} \\ C_S = \theta_{3,0} + \alpha_3 G_i + \beta_3 R_i + \gamma_3 G_i \times R_i + X'I_i \theta_{3,0} + \epsilon_{3,i} \\ C_C = \theta_{4,0} + \alpha_4 G_i + \beta_4 R_i + \gamma_4 G_i \times R_i + X'I_i \theta_{4,0} + \epsilon_{4,i} \end{cases}$$

$$E[\epsilon_{m,i}, \epsilon_{n,i} | X] = \sigma_{mn}$$

where C_H, C_P, C_S, C_C are changes in housing price, toxicity concentration, school quality and crime rate after moving respectively,²¹ G is the indicator of whether the resident previously lived in a gentrifying neighborhood, and R is the indicator of tenure (i.e. being a renter).

As mentioned in [Wyly, Newman, Schafran & Lee \(2010\)](#), endogeneity is a problem in the analysis of gentrification and displacement. Neighborhood changes affect residents' housing decisions. With an influx of middle-class residents and housing investment in a neighborhood, housing prices and peer-based public amenities increase. This creates an endogeneity problem. To solve that problem, we employ an instrumental variable. As mentioned before, gentrification in Los Angeles was triggered by an environmental shock that happened within a narrow window. The only channel for toxicity reduction to push current residents out is through housing appreciation.²² Toxicity reduction in Los Angeles from 2000 to 2002 can thus be used as an instrument for gentrification. A neighborhood with significant environmental improvement will attract households to move in, which will result in housing appreciation and displacement of some previous residents.

[Brummet & Reed \(2019\)](#) found that gentrification increases rent for more educated renters but not for less-educated renters, suggesting gentrification has small effects on original renters

²¹ C denotes the change in amenities, for which we use the differences in the average tract level amenity between the tract a resident moved from and the tract he moved to in the year of the move. To be more specific, if resident i moved in 2002 from tract A to tract B , C_H is calculated as “the average housing price of tract B in 2002 – the average housing price of tract A in 2002.”

²² We only include movers in our sample. For movers who previously lived in a gentrifying area, toxicity reduction raised housing prices and pushed these residents out, but toxicity reduction in 2001 is less likely to be correlated with residents' amenity choices in the future. We calculate the instrumental variable using $\text{Toxicity Concentration}_{2001} / \text{Toxicity Concentration}_{1998}$.

who are less-educated.²³ To explore the differential impacts of gentrification on more-educated renters and less-educated renters, we repeat the probit regressions on more-educated residents and less-educated residents, and then estimate changes in annual rent using the following OLS model:

$$RentChange_i = \gamma_0 + \gamma_1 Gentrification_i + \gamma_2 Gentrification_i \times Education_i + \gamma_3 Education + \gamma_4 control_1 + \gamma_5 control_2 + \dots$$

The dependent variable $RentChange_i$ is the change in rent between year 2000 and year 2005. Both $Gentrification_i$ and $Education_i$ are dummy variables. $Gentrification_i = 1$ if household i lived in a gentrifying tract at the beginning of 2000. $Education_i = 1$ if the head of household i had a bachelor degree. Controls includes age, income and whether the household has kids.

To determine the effect of gentrification on original residents' socioeconomic conditions, we first compare the changes in incomes among renters and owners living in gentrifying tracts or non-gentrifying tracts using the following OLS model:

$$IncomeChange_i = \theta_0 + \theta_1 Gentrification_i + \theta_2 Gentrification_i \times Renter_i + \theta Renter_i + \theta_4 control_1 + \theta_5 control_2 + \dots$$

The dependent variable $IncomeChange_i$ is the change in annual income between the year 2000 and the year 2005. Residents living in gentrifying neighborhoods can earn more income as gentrification brings investment and creates jobs. However, residents' decisions to move as a result of gentrification-induced property market changes can also affect their choices of employment by changing commuting distances and can reduce their incomes. To assess the changes in employment for residents living in gentrifying tracts, we compare changes in hourly salaries for households who changed their jobs and did not change their jobs after

²³ [Brummet & Reed \(2019\)](#) found that in gentrifying neighborhoods, on average, rents increased for less-educated renters by \$126/month while they increased \$171/month for more educated renters. In other words, gentrification increased monthly rent for more educated renters by \$50/month more than low educated renters. This was mostly driven by more educated stayers.

2000 using the following equation:²⁴

$$\begin{aligned} \text{SalaryChange}_i = & \theta_0 + \theta_1 \text{Gentrification}_i + \theta_2 \text{Gentrification}_i \times \text{ChangeJobs}_i + \\ & \theta \text{Education} + \theta_4 \text{control}_1 + \theta_5 \text{control}_2 + \dots \end{aligned}$$

The dependent variable SalaryChange_i is the change in hourly salaries between year 2000 and year 2005.

6. Results

We define three measures of gentrification using changes in housing appreciation rate, rent burden, or percentage of the population that is highly educated in the first part of the empirical specification. Table 3 presents descriptive statistics for our three measures of gentrification. As shown in Table 3, housing prices increased by 80% on average from 2000 to 2005, rent burden increased by 12% from 2000 to 2010, and the percentage of adults with bachelor's degrees increased by 5% from 2000 to 2010. Using the definitions in 5.1, we define 15% - 20% of the tracts in Los Angeles County as gentrifying tracts. We mainly use the first measure (i.e., housing appreciation rate) to conduct the empirical analysis. Most of these gentrifying tracts were in the downtown areas that experienced air quality improvements during the California Electricity Crisis. Figure 2 shows trends of housing prices in gentrifying tracts and non-gentrifying tracts from 1996 to 2006. Housing prices in gentrifying tracts are persistently lower than those in non-gentrifying tracts and increased at a similar rate before 2000. After 2000, housing prices in gentrifying tracts appreciate more than those in the non-gentrifying tracts and become higher than those in the non-gentrifying tracts after 2002.

²⁴ We use hourly salary instead of income as the dependent variable to investigate the effects of gentrification on employment as low-income households and renters may choose part-time jobs after displacement. Income could reflect changes in their financial conditions, which have been investigated in the previous analysis. Changes in hourly salary could reflect changes in labor markets.

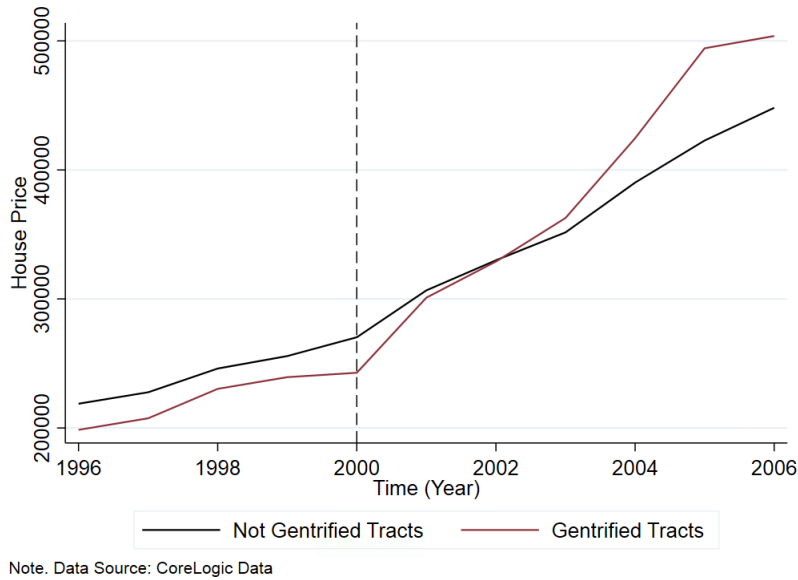


Figure 2: Trends in Housing Prices in Los Angeles County (Gentrified vs. Non-Gentrified)

6.1. Neighborhood Changes

The estimates of gentrification’s impacts on public amenity changes using a difference-in-difference approach are summarized in Table 4. Column (1) and Column (2) show models that include only basic controls (i.e., population and median income in each census tract) and models that include both basic controls and location fixed effects. We estimate gentrification’s impacts on three public amenities: pollution level, crime rate, and school quality. Results show that the gentrifying tracts experienced significant improvements in all three amenities after 2000. Estimates of gentrification’s impacts on demographic characteristics are shown in Table 5. Employing two matching methods — Propensity Score Matching (PSMatch) and Nearest Neighborhood Matching (NNMatch), we explore gentrification’s impacts on median income, percentage of minorities, percentage of college graduates, percentage of renters, median rent, and rent burden. Results from both matching methods show that gentrified areas experienced greater increases in median income, rent, and in the percentage of highly educated residents compared to the similar, non-gentrified areas. However, the percentage of minorities and renters in these tracts significantly decreased in gentrified areas, suggesting that renters and people of color flee in response to neighborhood and property market changes. In other words, the neighborhood improvements and property market appreciation in gentrifying tracts attracted new residents and made incumbent residents re-optimize their

housing choices.

6.2. Displacement

After calculating our measures of gentrification and observing the demographic changes in gentrified areas, we proceed to the probit model from the third part of our specification to investigate residents' moving decisions. The results of this analysis are shown in Table 6. Results from the regression that uses housing appreciation rates as the gentrification measure are in Column 1, the results using changes in the rent burden are in Column 2, and the results using changes in the percentage of adults with bachelor's degrees are in Column 3.

These results show a significant link between gentrification and displacement for all three measures of gentrification. In other words, lower-income renters are significantly more likely than lower-income owners to leave gentrifying neighborhoods, which is a sign of displacement. Lower-income young people and people with kids are also more likely to be displaced in all three specifications. As shown in Table 6, we also find that African Americans are more likely to move after gentrification has occurred, but that owners who live in gentrifying neighborhoods are on average less likely to move. This is intuitive considering the impacts of gentrification as a whole. Improvements in environmental quality attract a wealthier population to impacted neighborhoods, bidding up housing prices and increasing rent burdens. Households renting properties in these neighborhoods benefit from the cleaner environment but also have to face higher rents. Households owning properties, however, benefit from both the cleaner environment and higher property values. As property values grow, homeowners can stay in the gentrified neighborhoods and benefit from the increased amenities, but they can also realize increased asset value. Should they then decide to move, they can use that capital gain to increase consumption in the new neighborhood. Home renters, however, have to make trade-offs between the cleaner environment and increased rent. As the rent burden increases, renters may not be able to afford the higher cost and may choose to move out. Conditional on the low property tax rates and high moving costs, owners may have less incentive to move.²⁵

²⁵ Property taxes are relatively low in Los Angeles. The average effective property tax rate in California is 0.79%, compared with a national average of 1.19%. Under Prop. 13, a property is assessed for tax

Some previous studies have found evidence of displacement of low-income, less-educated renters, but no significant increase in their rent in gentrifying areas. Some studies have found significant increases in rent for this population in gentrifying areas, but no evidence of significant displacement. With more detailed data on renters' movements and annual rents, we repeat the probit regressions of moving decisions for highly-educated and less-educated renters and estimate changes in annual rent.²⁶ From the results of the probit regressions in Table 7, we find that low-income, high-education renters are more likely to move out of gentrified areas whereas there is no significant result for low-income, less-educated renters. The results of rent changes in Panel A of Table 8 reveal that low-education renters are poorer and initially pay much lower annual rents than do highly-educated renters. However, they experience greater increases in annual rent when moving out than staying. The results in Panel B of Table 8 show that highly-educated renters living in gentrifying neighborhoods experience smaller rent increases than low-education renters do. We get similar results when using a sample of all renters and renters who chose to stay in gentrifying areas. The descriptive results and the regression estimation give another explanation for renters' decisions to stay in gentrified neighborhoods — fewer affordable choices outside of gentrified areas. Annual rents paid by low-income, less-educated renters before gentrification are much lower than rents for low-income, highly-educated renters and renters in other areas. Even though annual rents in gentrified areas increase significantly as a result of gentrification, gentrified areas are still more affordable than other areas for low-income, less-educated renters after taking moving costs into account. However, low-income, highly-educated renters have more affordable choices outside of gentrified areas and are more likely to move out. The decisions for low-income, less-educated renters to stay is mostly due to their budget constraints instead of their preferences for public amenity improvements, suggesting a loss of welfare for them.

purposes only when it changes ownership. As long as the property is not sold, future increases in assessed value are limited to an annual inflation factor of no more than 2%. If the household own and live in the place for two of the five years before the sale, then up to \$250,000 of profit is tax-free. If the household is married and files a joint return, the tax-free amount doubles to \$500,000.

²⁶ Highly-educated renters are defined as renters with a bachelor's degree while low-educated renters are defined as renters did not go to or graduate from college.

6.3. Trade-offs in Amenity Choices

Based on our previous analysis, renters in gentrifying neighborhoods are more likely to be displaced, while owners are more likely to stay and benefit from the higher property values that result from gentrification. Both renters and owners could move out of their original neighborhoods after gentrification. However, when making housing decisions, owners are more likely to choose a better location than renters of the same type based on their realized capital gains, while renters only experience higher rent burdens, leading them to take up residence in another less-preferred, even worse neighborhood. This implies a gentrification-induced welfare loss for them due to displacement. To know more about displacement's impacts on the displaced and the trade-offs in amenity choices that the displaced make, we use seemingly unrelated regressions to examine the consequences of low-income movers' decisions on four amenities that are most important in housing decisions — living cost (expenditure), pollution, education, and safety.

Cost of living, which plays a vital role in housing decisions, is measured using housing prices in each neighborhood. As mentioned before, renters are more likely to be displaced from gentrifying areas as a result of an increased rent burden. After moving out of a gentrifying neighborhood, renters' budgets will only be reduced by moving costs while owners might receive extra flexibility from capital gains accrued from the sale of their houses. Ownership cost and rent can be used to characterize living costs. For the other amenities, we use the RSEI toxicity concentration to measure pollution levels, the Academic Performance Index (API) of the three nearest elementary schools to measure education levels, and the RAND crime rate of the three nearest cities²⁷ to measure the safety of each census tract. The dependent variables are the differences of these four amenities between the original neighborhood and the neighborhood a household moved to in the year of moving.

The effects of gentrification on the displaced are shown in Table 10 and Table 11. We find that renters are significantly more likely than owners to end up in neighborhoods with worse quality schools, higher crime rates, and lower housing prices (rent). Additionally, renters who

²⁷ There are 88 cities in Los Angeles County. More details could be found on https://en.wikipedia.org/wiki/List_of_cities_in_Los_Angeles_County,_California

move out of gentrifying neighborhoods tend to end up in worse neighborhoods, while owners who move from gentrifying neighborhoods choose neighborhoods with less pollution, better schools, and lower crime rates, most likely due to the capital gains benefits they accrued as a result of gentrification. In other words, owners benefit from the higher property values and higher amenities that result from gentrification; even if they choose to move and sell their houses, they have more money to relocate to a nicer neighborhood.

The correlation matrix in Table 11 describes how households make trade-offs among the four amenities. In general, households who leave gentrifying areas trade off expenditures on housing price against school quality, pollution and crime. In other words, to decrease living costs, households tend to move to neighborhoods with more pollution and higher crime rates and they are willing to pay more for better schools. To get safer and cleaner living conditions, they are required to pay more to purchase or rent a house.

6.4. Changes in Incomes and Employment

Gentrification brings investments to gentrifying tracts, stimulates the development of the local economy, and creates more job opportunities, which suggests an increase in incomes. Previous literature has found that gentrification leads to an increase in high-wage positions but induces job loss in low- and moderate-wage positions, especially for localized service and goods-producing sectors. The impacts of gentrification on labor markets change job access for incumbent residents, facilitating local hires and attracting in-migration of highly-educated workers while shedding job opportunities for less-educated workers. In addition, based on our previous analysis, incumbent renters and low-income residents are more likely to move out of gentrifying neighborhoods. Changes in residential locations can affect movers' job access and choices in the labor market through changing commuting distances and employment opportunities, which can then affect their incomes.

In Table 12, we investigate residents' decisions to change jobs. The results show that owners living in gentrifying areas are less likely to change their jobs, but that renters are more likely to change their jobs, mostly due to the fact that renters are more likely to be movers and low-income residents. This is intuitive considering the impacts of gentrification as a whole. The increase in economic investment and economic activities increase overall job opportunities

and imply income growth. Households earn higher incomes from retaining their jobs and are less likely to change jobs taking into account search costs. Low-income, less-educated owners and renters, however, may not benefit from local labor market improvements as gentrification induces displacement of renters and gentrifying neighborhoods experience job loss in low- and moderate-wage positions for renters and owners, even while jobs overall increase. This implies a gentrification-induced welfare loss for these residents due to employment changes. To know more about gentrification's impacts on residents' job decisions, especially for displaced residents, we then use OLS regressions to examine residents' changes in income in gentrifying tracts and how their earnings change after changing jobs.

Changes in incomes for residents living in gentrifying tracts are shown in Table 13. Panel A of Table 13 compares income and income changes over five years for renters and owners originally living in gentrifying areas and in non-gentrifying areas. Renters originally living in gentrifying tracts experience an average income increase of \$13,290 over five years, while owners living in gentrified areas experience an increase of \$24,570, which is much higher than renters and owners living in non-gentrifying tracts. The OLS regressions in Panel B further prove this with a significant negative coefficient for the interaction of living in gentrifying tracts and being a renter. These results are robust to different gentrification measures, proving that renters, on average, have smaller income increase than owners do. The fact that renters are significantly more likely than owners to move, change jobs, and receive smaller income increases demonstrates their vulnerability to gentrification in both housing markets and labor markets. To know more about their income changes, we use OLS regressions to investigate how residents' hourly salaries change after changing jobs.

We use hourly salary to examine changes in labor markets as income could be composed of many earning sources, and changes in working hours and full-time status can affect residents' incomes in many ways. Panel A of Table 14 shows that the hourly salaries of new jobs are lower on average than the hourly salary of the last job for low-income, less-educated renters. This is intuitive considering the data oversample poor neighborhoods and families with children whose employment changes are likely passive choices due to market changes instead of active choices for promotions and upgrading. The results in Panel B show that

there are no significant salary changes for stayers in gentrifying neighborhoods who changed their jobs. However, residents who moved out of gentrifying areas and changed their jobs experienced a significant decrease in their hourly salaries even though hourly salaries in gentrified areas significantly increased, which implies that displaced residents were harmed in labor markets.

7. Policy Implications

Development is necessary for a neighborhood to thrive, and gentrification brings opportunities for reinvestment and revitalization. However, policymakers must consider the negative impacts that accompany gentrification, specifically displacement and job availability. Low-income renters re-optimize their housing choices corresponding to rent burden increases. The loss of low- and moderate-wage positions in service and manufacturing sectors in gentrifying neighborhoods leads to unemployment and income reduction ([Meltzer & Ghorbani 2017](#); [Hartley et al. 2013](#)). These negative impacts worsen living and socioeconomic conditions of some incumbent residents and increase economic inequality. The challenge governments face is how to manage gentrification in a way that ensures the existing residents, especially the vulnerable groups such as renters and the poor, enjoy the benefits of gentrification.

Some policymakers have proposed policies aimed at preventing gentrification induced displacement including preserving and creating affordable housing in gentrifying neighborhoods, subsidizing low-income residents' housing, setting caps on rent or mortgage payments, issuing laws to provide protection and financial support to tenants, and giving lower-income people the means to keep up with rising rent (e.g. a higher minimum wage, stronger social protection programs). Government policies may require local hiring for new businesses or unemployment compensation and assistance to mitigate gentrification-induced job losses. If governments adopt these policies, they must do so with intent and in a way that ensures that the right groups are the beneficiaries. In this paper, we use a unique dataset to identify the groups most vulnerable to displacement and examine how gentrification-induced displacement affects displaced residents' housing decisions. We find that lower-income renters, younger residents, African Americans, and households with kids are particularly vulnerable to displacement and job changes, which also means that they should be the target groups for

these policies. Based on these results, these proposed policies seem to target the right population and may be the most effective strategies in curbing gentrification-induced displacement and unemployment in the short term. However, further analysis of renters' choices and welfare as well as the impacts of these policies should be done in the future.

Even though we did not discuss the supply side of the housing market, it can play an important role in this discussion. Increasing the supply of affordable housing, for example, by subsidizing the costs of construction (as is done with the Low-Income Housing Tax Credit) or implementing inclusionary zoning ordinances, which require that a certain percentage of new property developments be made affordable to lower-income residents, could be good long-term solutions; however, implementing these policies is a long process that does not easily keep pace with increasing demand. Housing is generally considered to be affordable if housing costs (i.e. rent/mortgage, tax, and maintenance costs) are less than 30% of a household's income. In a gentrifying neighborhood, the rent burden could be much higher than 30% and there may be limited space for extra supply of affordable housing. One way to preserve affordable rental housing in an appreciating housing market is to provide renters with an ownership interest, which has already been applied in the case of Pittsburgh's Hill District. By giving tenants the right to purchase the house that they currently live in for a set buy-out price after a set amount of time, renters could benefit from gentrification as do owners without increasing the affordable housing supply.

Other suggestions include adopting policies that seek to mitigate the negative effects of displacement on the displaced. For instance, if policymakers considered investing more in low-performing public schools and pursued policies that allow displaced children to attend higher performing schools with ease, it may also help alleviate the negative outcomes of displacement.

8. Conclusion

This paper studies the link between gentrification and displacement, and the effects of gentrification on lower-income residents' housing choices and employment choices. Our research expands on the previous gentrification and displacement literature by utilizing a more

appropriate dataset to measure gentrification, and it expands on the existing literature by examining the impact of gentrification-induced displacement on the displaced and gentrification's impact on residents' employment and socioeconomic conditions. We find that there is a positive and significant link between gentrification and the displacement of lower-income renters. Those who are displaced tend to trade housing expenditures with neighborhood amenities and are significantly more likely to move to worse neighborhoods with lower education quality, higher crime rates, and higher pollution concentration. Additionally, the negative effects of displacement tend to be concentrated among poor renters and minorities. The changes in labor markets and residents' housing choices then impact residents' job choices and affect their incomes. Low-income renters living in gentrifying neighborhoods are more likely to change jobs and earn less money from their new jobs.

There are some limitations to our findings. Extending our results to other settings may be limited because our analysis is based on a unique sample from Los Angeles County. Los Angeles might differ in important ways from other areas. Further, because our measures of gentrification and displacement are proxies, they may not have captured each phenomenon as precisely as possible. For example, because our definition of displacement includes all lower-income renters who moved out of gentrifying neighborhoods, it is possible that some of the movers we included in our analysis moved for reasons other than displacement. This would make the link between gentrification and displacement imprecise. Future studies will hopefully build on our analysis and compare impacts of different policies on gentrification and displacement, which could provide policymakers with better ideas about how different policies, such as subsidizing affordable housing, implementing rent controls, or providing more benefits to lower-income residents, will affect vulnerable groups and find the appropriate policy to mitigate gentrification's negative impacts.

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Table 1: Descriptive Statistics of Low-Income Residents in the L.A. FANS Data

Variable	Mean	Std.Dev	Min	Max
Race: White	0.1712	0.3768	0	1
Race: Hispanic	0.6588	0.4742	0	1
Race: Black	0.1199	0.3249	0	1
Race: Asian	0.0525	0.2232	0	1
Age	39.8338	12.0217	14	85
Has Kids	0.8585	0.3487	0	1
Total Number of Adults	3.6885	2.0272	0	1
Total Number of Children	1.9530	1.0176	0	1
Education	11.3653	4.2950	0	19
Income ($\times 10,000/year$)	3.2522	2.8847	0	17.8143
Assets ($\times 10,000/year$)	22.8580	47.4748	0	298.3
Renter	0.6774	0.4676	0	1
Rent Wave1 ($\times 1000/year$)	7.5402	2.8511	0.564	25.6230
Rent Wave2 ($\times 1000/year$)	10.9944	4.7223	0.504	24.6000
Moved	0.6156	0.4866	0	1
Changed Jobs	0.5439	0.4392	0	1
N	1618			

¹ Race, age, and education are values for the head of household in the year they moved.

² Income and asset are values from the Wave 1 survey.

Table 2: Changes in Amenities for Low-Income Movers

Variable	Mean	Std.Dev	Min	Max
Change in Toxicity ($\times 10,000$)	0.4625	7.9306	-74.7339	112.275
Change in School Quality ($\times 100$)	0.1051	0.7341	-2.886	3.6996
Change in Crime Rate ($\times 1000$)	-0.0235	0.5643	-2.3583	2.0793
Change in Housing Price ($\times 10,000$)	0.4569	8.6405	-56.2434	36.1242
Renter	0.7562	0.4295	0	1
N	996			

¹ Change in Amenity= (Amenity of Tract Moved to - Amenity of Tract Moved from) $_{MoveYear}$

Table 3: Measures of Gentrification in Los Angeles County

Measure	Mean	Std.Dev	Min	Max
Housing Appreciation (2000- 2005)	0.8479	0.5035	-0.5180	10.2398
Rent Burden Increase (2000-2010)	0.1185	0.1398	-0.6000	0.8448
Increase in Bachelor% (2000-2010)	0.0515	0.0720	-0.7959	0.5407
Gentrified (Housing Price Appreciation)	0.1965	0.3975	0	1
Gentrified (Rent Burden)	0.1619	0.3685	0	1
Gentrified (Education)	0.1837	0.3874	0	1
N	1649			

¹ Housing appreciation is defined as $P_{2005}/P_{2000} - 1$. The rent burden increase is defined as $RB_{2010} - RB_{2000}$. Rent burden is the ratio of median rent to median income.

Table 4: Impacts of Gentrification on Public Amenities

Amenities	Pollution		Crime		School	
	(1)	(2)	(1)	(2)	(1)	(2)
Gentrification× Post	-2.206*** (0.655)	-2.206*** (0.599)	0.052* (0.027)	0.052*** (0.010)	-0.101* (0.053)	-0.101*** (0.026)
Gentrification	2.297*** (0.535)	2.264 (5.984)	-0.179*** (0.022)	-0.047 (0.105)	0.266*** (0.047)	0.762** (0.223)
Post	-2.272*** (0.264)	-2.272*** (0.241)	-0.298*** (0.011)	-0.298*** (0.004)	1.315*** (0.021)	1.315*** (0.011)
Cons	4.757*** (0.216)	5.313* (4.225)	2.254*** (0.009)	1.723*** (0.074)	5.955*** (0.019)	5.882*** (0.158)
Baseline Control	Y	Y	Y	Y	Y	Y
Location Fixed Effect		Y		Y		Y
N	19,764	19,764	19,764	19,764	19,764	19,764

¹ Pollution is measured using tract-level toxicity concentrations; Safety conditions are measured using the tract-level violent crime rate; School quality is measured using the tract-level academic performance index.

² Post is a dummy variable which equals to 1 after 2000.

³ Gentrification is defined using housing appreciation rates. A tract is defined as “gentrified” if its housing appreciation rate from 2000 to 2005 is more than 1 and it has a population of more than 3,000 and its median income was in the bottom 30 percentile in 2000.

Table 5: Treatment Effects of Gentrification on Aggregate Neighborhood Demographics

	(1)	(2)
Gentrification’s Effects on Gentrified Areas		
△ Median Income	2,095.92** (950.77)	692.16 (816.80)
△ Percentage of Minorities	-1.67*** (0.59)	-1.73*** (0.60)
△ Percentage of College Graduates	2.00*** (0.49)	2.46*** (0.60)
△ Rent Burden	0.29 (1.08)	0.20 (0.944)
△ Percentage of Renters	-1.79*** (0.62)	-1.10 (0.75)
△ Median Rent	31.48* (18.01)	5.71 (17.95)
Matching	PSMatch	NNMatch
N	1,649	1,649

¹ Treatment and control groups are assigned using propensity score matching (PSMatch) in the first column and using nearest neighborhood matching (NNMatch) in the second column.

² △ stands for changes in neighborhood demographics. We calculated changes in neighborhood demographics between 2000 and 2010 using census data.

³ The tract level population, average income, and average housing price in year 2000 price are used to match treatment tracts and control tracts.

³ denotes $p < 0.1$; ** denotes $p < 0.05$; *** denotes $p < 0.01$

Table 6: Probability of Moving among Lower-Income Households

Move	(1) Housing Price	(2) Rent Burden	(3) High Educated%
Gentrification	-0.337** (0.161)	-0.239* (0.143)	-0.429* (0.220)
Gentrification × Renter	0.500*** (0.190)	0.703*** (0.228)	0.729*** (0.285)
Renter	0.340*** (0.083)	0.3340*** (0.082)	0.371*** (0.080)
Hispanic	0.009 (0.102)	0.006 (0.103)	0.026 (0.102)
Black	0.356*** (0.130)	0.357*** (0.130)	0.361*** (0.130)
Asian	-0.130 (0.161)	-0.177 (0.160)	-0.159 (0.161)
Kids	0.277*** (0.099)	0.265*** (0.099)	0.270** (0.099)
Age	-0.016*** (0.013)	-0.016*** (0.003)	-0.016*** (0.003)
Education	0.014 (0.009)	0.014 (0.009)	0.015* (0.009)
Income	-0.016 (0.013)	-0.019 (0.013)	-0.016 (0.013)
constant	0.294 (0.256)	0.334 (0.257)	0.277 (0.256)
N	1618	1618	1618
R^2	0.0725	0.0738	0.0723

¹ The first gentrification measure is a dummy variable, defined as 1 if the housing appreciation rate of a census tract between 2000 and 2005 ($P_{2005}/P_{2000} - 1$) is higher than 100% and the average housing price increase between 2000 and 2005 ($P_{2005} - P_{2000}$) is higher than \$200,000. Tracts with average housing price increases higher than \$220,000 and with housing appreciation rates higher than 50% are also considered gentrifying to capture tracts that are upscale but have higher initial housing prices. Tracts with populations less than 3,000 and tracts in the top 50 percent of median income are removed from the gentrifying group.

² The second measure of gentrification uses a similar methodology to UCLA's displacement project. A tract is defined as gentrifying if the rent burden is higher than 40% and if it increased by more than 10% between 2000 and 2010 or if the rent burden increased by more than 30% between 2000 and 2010.

³ The third measure of gentrification uses a similar methodology to that in [Brummet & Reed \(2019\)](#). A tract is defined as gentrifying if the increase in college-educated residents is higher than 10% from 2000 to 2010 and the tract is initially low-income with populations larger than 3,000.

⁴ denotes $p < 0.1$; ** denotes $p < 0.05$; *** denotes $p < 0.01$

Table 7: Probability of Moving (highly-educated vs. Low Educated)

Move	highly educated	Low Educated
Gentrification	-0.443*** (0.229)	0.201 (0.888)
Gentrification × Renter	0.676*** (0.307)	0.343 (0.991)
Renter	0.365*** (0.103)	0.434*** (0.128)
Hispanic	0.029 (0.109)	-0.34 (0.260)
Black	0.387*** (0.140)	-0.169 (0.369)
Has Kids	0.215* (0.121)	0.381* (0.174)
Age	-0.015*** (0.004)	0.019 (0.005)
Income	-0.021 (0.015)	0.018 (0.030)
constant	0.522** (0.261)	0.611 (0.425)
N	927	691
R^2	0.088	0.058

¹ The gentrification measure is a dummy variable, defined using the housing appreciation rate, population and income of a tract.

² denotes $p < 0.1$; ** denotes $p < 0.05$; *** denotes $p < 0.01$

Table 8: Highly-educated Renters vs. Low-educated Renters

A: Socio-demographic Changes				
	Highly-educated Renters		Low-educated Renters	
	All	Stayer	All	Stayer
Income (\$10,000)	2.982 (2.273)	3.031 (2.704)	1.800 (1.264)	1.823 (1.301)
Rent ₂₀₀₀ (\$1000)	7.959 (2.993)	7.879 (3.356)	6.664 (2.223)	6.362 (2.149)
Rent ₂₀₀₅ (\$1000)	11.469 (4.872)	10.450 (4.623)	10.175 (4.142)	9.161 (3.154)
Rent _{change} (\$1000)	3.511 (4.715)	2.620 (3.791)	3.510 (4.116)	2.798 (2.734)
Pollution _{change}	0.006 (5.01)		0.503 (6.970)	
Crime _{change}	-0.029 (0.560)		-0.0017 (0.437)	
School _{change}	0.108 (0.651)		0.320 (0.484)	
N	395	132	406	159

B: Changes in Annual Rent for Renters		
Rent _{change}	All Renters	Stayers
Gentrification	0.683 (0.537)	1.054 (0.667)
Gentrification × Education	-1.808** (0.757)	-2.371** (0.992)
Education	-0.087 (0.403)	-0.121 (0.486)
Has Kids	0.566 (0.485)	0.572 (0.572)
Age	-0.034** (0.015)	-0.014 (0.018)
Income	0.089 (0.087)	0.088 (0.094)
Cons	5.159*** (1.031)	3.507* (1.268)
N	801	291

¹ In Panel A, Rent_{change} is defined as changes in annual rent between year 2000 and year 2005 for renters living in Los Angeles County. The sample only includes households who remains renters. If the renter moved after 2000, Rent₂₀₀₅ is the annual rent of the house the renter moved to.

² In Panel A, Pollution_{change}, Crime_{change}, and School_{change} are calculated as $X_{j,moveyear} - X_{k,moveyear}$, where j is the destination, k is the origin, and move year is the year they moved. Hence, for renters who did not move, all of these measures are 0. Pollution_{change}, Crime_{change}, and School_{change} are changes in public amenities for renters who move in the year they moved. Income and income changes are measured in thousands. Pollution changes are measured in 100,000 ug/m³. Crime rate changes are measured per 1000 cases. School quality is measured per 100 API points.

³ In Panel B, the gentrification measure is a dummy variable, defined using the housing appreciation rate, population, and income of a tract. The education measure is a dummy variable with *Education* = 1 if the resident graduated from high school.

Table 10: SUR Results for Amenity Choices among Movers

Dependent Variable	Increase in Housing Price	Increase in Pollution	Increase in School Quality	Increase in Crime Rate
Gentrification	28.246 (19.408)	-16.219 (16.471)	2.905 (1.905)	-1.384 (1.628)
Gentrification \times Renter	-33.845* (20.275)	17.316 (17.207)	-4.228** (1.991)	3.156* (1.700)
Renter	4.603* (2.734)	-2.267 (2.320)	0.542** (0.268)	-0.488** (0.229)
Hispanic	-1.475 (1.152)	0.678 (0.977)	-0.027 (0.113)	-0.038 (0.097)
Black	-1.335 (1.573)	0.827 (1.335)	-0.192 (0.154)	0.001 (0.132)
Asian	0.856 (2.119)	1.903 (1.798)	0.116 (0.208)	-0.065 (0.178)
Age	-0.004 (0.034)	0.027 (0.028)	-0.004 (0.003)	0.005* (0.002)
Has Kids	-1.199 (1.200)	0.340 (1.018)	-0.144 (0.117)	0.197** (0.101)
Education	0.021 (0.092)	-0.046 (0.078)	0.013 (0.009)	-0.009 (0.008)
Income	0.019 (0.141)	0.139 (0.120)	-0.013 (0.014)	0.007 (0.012)
constant	-0.825 (3.283)	0.567 (2.786)	0.05 (0.322)	-0.174 (0.275)
N	997			

¹ The gentrification measure is a dummy variable, defined using the housing appreciation rate, population, and income of a tract.

² "Increase in Amenity" is the difference between the amenity level of the tract where a household moved to and the amenity level of the tract where a household moved from. We use the amenity level in the year the household moved to capture residents' trade-offs when making moving decisions.

³ * denotes $p < 0.1$; ** denotes $p < 0.05$; *** denotes $p < 0.01$

Table 11: Variance-Covariance Matrix of Residuals

	Increase in Housing Price	Increase in Pollution	Increase in School Quality	Increase in Crime Rate
Increase in Housing Price	94.6948			
Increase in Pollution	-10.2894	68.2050		
Increase in School Quality	4.6382	-0.8478	0.9127	
Increase in Crime Rate	-2.0148	0.3298	-0.4523	0.6664

¹ Increase in Housing Price, Pollution, Crime Rate, and School Quality are calculated as $X_{j,moveyear} - X_{k,moveyear}$, where j is the destination, k is the origin, move year is the year they. House prices are measured in thousands. Pollution changes are measured in 100,000 ug/m³. Crime rate changes are measured per 1000 cases. School quality is measured per 100 API points.

Table 12: Probability of Changing Jobs among Lower-Income Households

Change Job	Coef.	Std. Err.
Gentrification	-0.329***	(0.123)
Gentrification×Renter	0.350**	(0.165)
Renter	0.037	(0.086)
Hispanic	-0.067	(0.095)
Black	-0.025	(0.124)
Asian	0.024	(0.141)
Age	0.008**	(0.0033)
Education	-0.008	(0.01)
Income	-0.009*	(0.006)
constant	0.537**	(0.241)
N	1618	

¹ The gentrification measure is a dummy variable, defined using the housing appreciation rate, population, and income of a tract.

² denotes $p < 0.1$; ** denotes $p < 0.05$; *** denotes $p < 0.01$

Table 13: Regression for Income Changes after Changing Jobs

A: Summary Statistics				
		Income ₂₀₀₀	Income ₂₀₀₅	Income Changes
Gentrified Areas	Renter	27.07 (23.93)	40.36 (29.37)	13.29 (27.85)
	Owner	81.50 (56.75)	106.07 (63.40)	24.57 (38.64)
Not Gentrified Areas	Renter	32.02 (28.04)	45.96 (32.14)	13.94 (25.30)
	Owner	81.94 (84.04)	97.58 (79.31)	15.64 (36.08)

B: Income Changes			
Income Changes	(1) Housing Price	(2) Rent Burden	(3) High Educated%
Gentrification	9.40*** (3.12)	6.42** (2.99)	9.08** (4.35)
Gentrification × Renter	-9.97** (4.01)	-7.00 (5.01)	-14.92** (6.35)
Renter	-2.88 (1.93)	-3.26* (1.93)	-3.61** (1.85)
Hispanic	3.29 (2.27)	3.88 (2.28)	3.52 (2.27)
Black	-0.48 (2.94)	-0.46 (2.95)	-0.01 (2.94)
Asian	-2.80 (3.73)	-1.80 (3.71)	-1.29 (3.71)
Age	-0.15* (0.08)	-0.14* (0.07)	-0.14* (0.08)
Education	0.28 (0.23)	0.32 (0.23)	0.31 (0.23)
constant	17.06*** (5.69)	16.31** (5.73)	16.87*** (5.70)
N	1,521	1,521	1,521

¹ In Panel A, income and income changes are measured in thousands.

² In Panel A and Panel B, income changes are defined as changes in annual family earnings between year 2000 and year 2005 for residents living in Los Angeles County. The sample only includes observations whose income changed by less than \$100,000 over five years.

³ In Panel B, the first gentrification measure is a dummy variable, defined using the housing appreciation rate, population, and income of a tract. The second gentrification measure is a dummy variable, defined using rent burden in UCLA's displacement project. The third measure of gentrification uses a similar methodology to that in [Brummet & Reed \(2019\)](#).

Table 14: Regression for Salary Changes after Changing Jobs

A: Salary Changes			
	Coef.	Std.Err.	
Change Jobs	-2.185***	(0.46)	
Age	-0.008	(0.02)	
Education	0.095*	(0.05)	
Financial Condition	-0.068**	(0.03)	
Cons	1.961*	(1.05)	

B: Changes in Salaries after Changing Jobs			
Salary _{change}	All Residents	Movers	Stayers
Gentrification	-0.471 (-.97)	6.006*** (1.45)	-1.489 (1.18)
Gentrification × Change Jobs	0.243 (1.13)	-6.690*** (1.54)	1.436 (1.45)
Change Jobs	-2.197*** (0.52)	-0.970 (0.79)	-2.553*** (0.65)
Hispanic	0.351 (0.57)	-0.76 (0.57)	0.733 (0.76)
Black	0.468 (0.74)	-1.12 (0.71)	0.975 (1.01)
Asian	0.159 (0.87)	-1.680* (0.90)	0.731 (1.14)
Age	-0.012 (0.02)	-0.022 (0.02)	-0.005 (0.03)
Education	0.064 (0.06)	0.063 (0.06)	0.075 (0.08)
Cons	1.912 (1.38)	2.608* (1.51)	1.250 (1.82)
N	1,663	472	1,191

¹ In Panel A, Salary_{change} is defined as changes in hourly salaries in the year before and after changing jobs. The sample only includes households whose hourly salaries are higher than \$5/hour and less than \$300/hour.

² Change jobs= 1 if the heads of the households changed their jobs between 2000 and 2007.

³ In Panel B, the gentrification measure is a dummy variable, defined using the housing appreciation rate, population, and income of a tract.

Appendix A. Theoretical Framework

To find groups vulnerable to displacement, we need to understand residents' housing decisions. The most relevant model for this purpose is from Tiebout (1956), who recognized that households “vote with their feet” and that heterogeneous households sort themselves across differentiated communities. The amount and character of housing and public goods vary across the urban landscape, and each household selects its preferred bundle of public and private goods given prices and income. Households who have similar preferences and face similar constraints (e.g. income and endowment) are believed to make similar choices. As noted in Banzhaf & McCormick (2006), this model is particularly useful in forecasting community impacts following changes in neighborhoods, such as those that accompany gentrification, and in investigating how residents make trade-offs in housing decisions.

Households' differential incomes and tastes for neighborhood public goods lead them to choose different bundles of goods when making housing decisions. Households choose to live in the neighborhood yielding the greatest utility; and conditional on housing price and amenities of the neighborhood, choose the optimal level of housing. We write the indirect utility function of households choosing neighborhood j as $V_j(y, P, G)$, where y is income of the household and P and G represent property market price and local amenities. $V_j(y, P, G)$ is assumed to have continuous first derivatives such that $V_y > 0$, $V_G > 0$, and $V_P < 0$. The housing demand function is defined as $D_j(P, y)$ with the first derivative $D_P < 0$, $D_y > 0$. The housing supply is defined as $S_j(P)$.

The household's preferences are assumed to satisfy the “single crossing” property, which means that the slope of the indirect indifference curve in the (G, P) space increases in y . Households who are indifferent between two neighborhoods are defined as boundary households and could be identified by income and tenure. Renters whose incomes are below \bar{Y}_R will re-optimize their housing choices based on their income and preferences, and choose the lower-order communities. Equilibrium rental price P_j and boundary incomes $\tilde{Y}_{R,j,j+1}$ are

derived from the equilibrium conditions:

$$V(\tilde{Y}_{R,j,j+1}, P_{R,j}, G_j) = V(\tilde{Y}_{R,j,j+1}, P_{R,j+1}, G_{j+1})$$

where Y_j^R are sets of income for renters in neighborhood j and $P_{R,j}$ is rental price in neighborhood j .

Renters are assumed to have the same preferences on public amenities. Housing demands are highest in the most desirable communities, and consequently, housing costs in these areas are higher as well. Holding tastes constant, wealthier renters will be in the nicer communities and poorer households will be in the less desirable ones.

Considering the case of three neighborhoods, we can get some simple illustrations of how renters make housing decisions from [Banzhaf & McCormick \(2006\)](#). Figure A.3, taken from that paper, illustrates how changes happen in two communities when Community 1 improves. Figure A.3 shows that there are three demographic types with three different income distributions. Their respective density functions are shown by the three curves. Type 2 on average is wealthier than Type 1 while Type 3 on average is poorer than Type 1. Holding tastes constant, there are income thresholds $Y_{(1,2)}$ and $Y_{(1,3)}$ that separate these three groups into three different communities; those with the incomes above $Y_{(1,2)}$ are in the nicer Community 2 while those with incomes below $Y_{(1,3)}$ are in the less desirable Community 3.

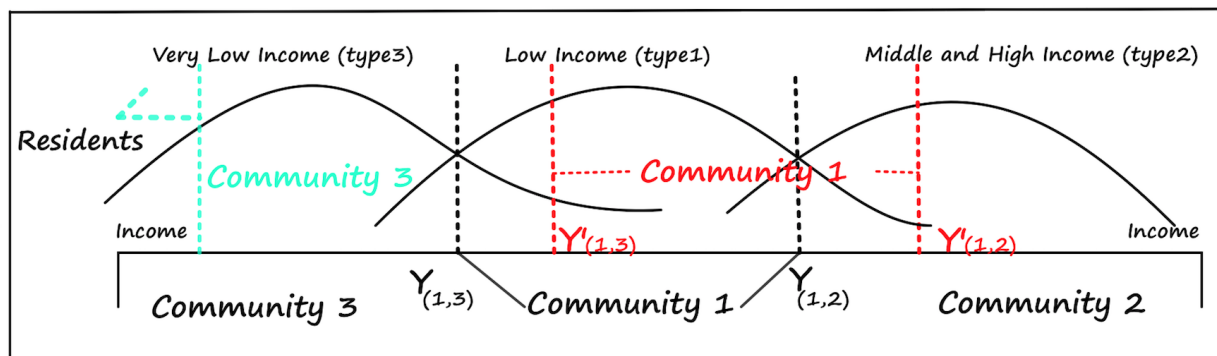


Figure A.3: Shift in Community Income Threshold After a Change in Community 1

As Community 1 begins to improve, the income thresholds $Y_{(1,2)}$ and $Y_{(1,3)}$ change as well. The newly gentrified neighborhood (i.e. Community 1) becomes more appealing to higher-income renters. Households that were previously indifferent between Community 1 and Community 2 will now prefer Community 1.²⁸ $Y_{(1,2)}$ will then shift to the right $Y'_{(1,2)}$. All those who originally preferred Community 1 will still prefer it, but now additional people will also want to live in Community 1, which is represented by the area between the two boundary incomes $Y_{(1,2)}$ and $Y'_{(1,2)}$.

The demand for housing in Community 1 will thus increase, which will raise rents. If no new housing is created in these neighborhoods and the vacancy rates are low, current residents will be pushed out by these higher rental prices and displaced by new ones. As rent increase, renters that were previously indifferent between Community 1 and Community 3 will now prefer Community 3. In other words, renters who have boundary incomes between $Y_{(1,3)}$ and $Y'_{(1,3)}$ are displaced and move from Community 1 to Community 3.

Property market appreciation induced by gentrification affects renters and owners differently. For owners living in gentrifying neighborhood, the negative outcomes of housing appreciation come from higher property taxes and increased living costs, which would be relatively low compared to the capital gains from housing appreciation. As property values grow, homeowners could stay in the impacted neighborhood, benefiting from the increased amenities and realizing capital gains. Renters living in gentrifying neighborhoods, on the other hand, face negative outcomes including rent increases and higher living costs. Renters need to make trade-offs between better amenities and increased rent. As the rent burden increases, renters may not be able to afford the new rent or may be less likely to pay more for amenities. As a result, renters are more likely to move out and take up residence in another neighborhood and we would expect different boundary incomes for renters and owners. As shown in Figure A.4, renters and owners could have different boundary incomes, $Y_{R,(1,2)}, Y_{R,(1,3)}$ and $Y_{O,(1,2)}, Y_{O,(1,3)}$, from the outset. In equilibrium, since gentrification induced property market appreciation will benefit indigenous owners by expected capital gain,

²⁸ The housing price of Community 1 is still lower than that of Community 2 at the beginning of the gentrification process. The influx of residents from Community 2 will raise the housing price of Community 1 and move the income threshold to a new equilibrium level.

more low-income owners can choose to stay.

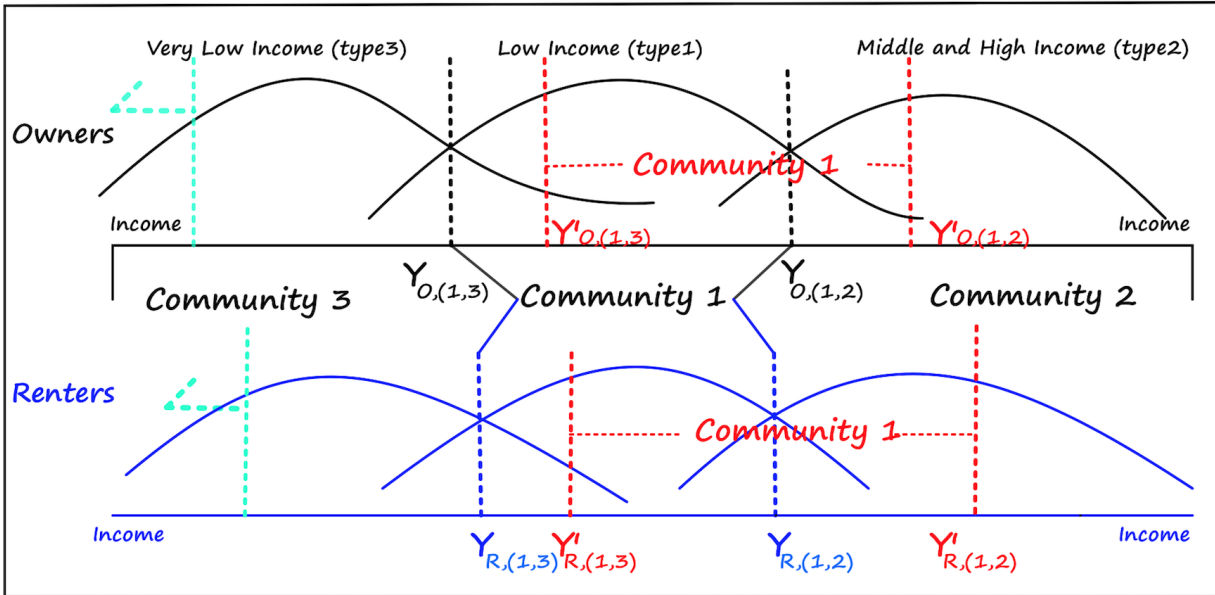


Figure A.4: Shifts in Community Income Thresholds of Renters and Owners

Appendix B. Correlation Between Housing Prices and Rent

We use data on contract rent and occupied housing values for each census block group from the 2000 U.S. Census and the American Community Survey (ACS) five-year estimates in 2013, 2014, and 2015 to calculate the correlation between rent and housing prices in Los Angeles.

From Table B.16, we see that housing prices and rent in L.A. are positively correlated, with a correlation larger than 0.5 for most years between 2000 and 2010. Figure B.5 further proves that the distribution of rent and housing prices in Los Angeles is positively correlated. For example, the San Fernando Valley and central L.A. continue to be the areas with the highest housing prices and rent. Both housing prices and rent in the coastal areas around the Santa Monica Mountains, Westside, and South Bay decreased in the period from 2000 to 2010. Additionally, from 2000 to 2010, Verdugo and the Pomona Valley experienced increases in both housing prices and rent.

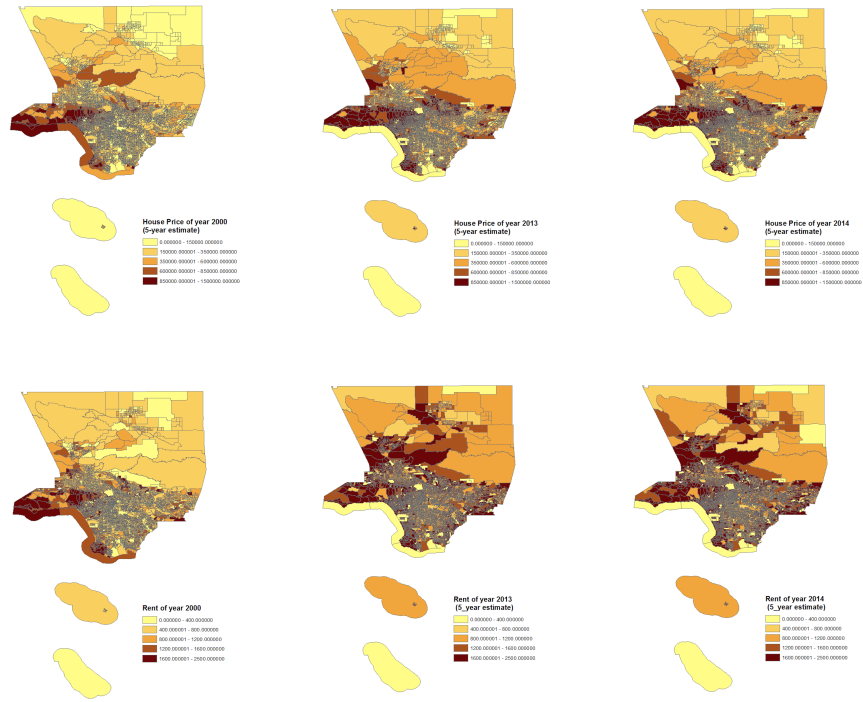


Figure B.5: Distribution of Housing Price and Rent in Los Angeles County (Block Group)

Table B.16: Correlation of Housing Price and Rent in LA

Block Group	Housing Price ₂₀₀₀	Housing Price ₂₀₁₃	Housing Price ₂₀₁₄
Rent ₂₀₀₀	0.6187		
Rent ₂₀₁₃		0.5143	
Rent ₂₀₁₄			0.5199
Tract	Housing Price ₂₀₀₀	Housing Price ₂₀₀₉	Housing Price ₂₀₁₀
Rent ₂₀₀₀	0.7186		
Rent ₂₀₀₉		0.6057	
Rent ₂₀₁₀			0.5882

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