Where You Live and Where You Move:
A Cross-City Comparison of the Effects of Gentrification and How these Effects Are Tied to Racial History

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Abstract

This thesis compares the effects of gentrification on school and air quality in ten cities to see whether cities with larger amounts of white flight post-World War II exhibited worse gentrification effects on renters. I find that renters in high white flight cities more consistently experience school quality downgrades—likely attributed to moving from gentrifying neighborhoods to worse neighborhoods. High white flight meant widespread de-investment across neighborhoods which could have lowered the school quality experienced by displaced renters. Gentrification did not consistently affect air quality in any way related to white flight, meaning confounding variables could have influence.

JEL classification: R2, R3, J11

Keywords: Gentrification, Displacement, School Quality, Air Quality, White Flight

Introduction

Gentrification is characterized by a rise in prices and property values, driven by the renovation of a city's infrastructure and housing stock, as well as a high amount of population growth into the city, particularly from college-educated and high-income individuals (Banzhaf and McCormick, 2007). Coveted for its economic stimulation and rebuilding of previously declining metropolitan centers, gentrification often gives rise to better neighborhood amenities, like school quality and air quality (Keels, Burdick-Will, and Keene, 2013). These improved amenities can be attributed to increased investment into the city from businesses and new residents, who now have a higher average income and thus more means to invest into bettering their own neighborhoods.

Unfortunately, alongside this stimulation comes displacement—best described as when households can no longer continue living in their place of residence due to new conditions, most of the time unaffordability, that make it unreasonable to stay. Low-income residents are faced with a higher cost of living in their gentrifying neighborhoods. As a result, they not only move out, but also, frequently move out into neighborhoods that have not experienced as much of the benefits of investment and thus have less improved amenities (Newman and Own, 1982). In many cities, these demographic trends, of high-income people moving into city centers and low-income people being pushed out, are a complete reversal of the movement in and out of urban centers that took place in the mid 20th century.

Numerous metropolitan areas across the United States witnessed a phenomenon of white flight throughout the second half of the 1900s—post-World War II—where high-income, white families moved to the surrounding suburbs, and populations in cities not only changed demographically to be less white, but also decreased tremendously overall (Baum-Snow and

Hartley, 2017). For example, Detroit, Michigan, in a period characterized by race riots and extreme racial segregation, went from being the bustling hub of the United States' auto industry in 1950, with a population that was 83.58% white, to a city with acres of vacant space and a population that was only 55.5% white by 1970 (Sugrue, 2014).

Cities like Detroit that had a relatively high amount of white flight, or migration of high-income, white families out of the city, also commonly experienced a great amount of dis-investment. This lack of investment into the city's upkeep can be primarily attributed to two factors. One, businesses, in order to stay afloat, would often follow the high-income residents out into the suburbs. Two, those who continued to reside in the city had a lower average income and thus fewer resources to invest into what remained of their neighborhoods and houses (Woldoff, 2011). City governments themselves may have also invested less into the neighborhoods of the city, which were now less populous and primarily composed of lower income and minority residents. As a result, cities with a relatively larger amount of white flight would have seen a greater proportion of neighborhoods left abandoned and in decline as compared to cities with relatively less white flight.

Such inter-city discrepancies imply that as gentrification plays out and low-income residents get pushed out of their neighborhoods, those in cities that saw more white flight are also more likely to get pushed out into neighborhoods that have not been kept up. I hypothesize that the displaced, low-income people in high white flight cities would experience a larger drop in quality of amenities when compared to the displaced, low-income people in low white flight cities, where investment across neighborhoods remained more constant. If we compared the effects of gentrification on displaced people across cities, with varying levels of white flight, would there be any differences in these effects? In essence, how do the effects of gentrification

on displaced people differ across metropolitan areas in the United States and are these differences tied to the racial histories of these cities?

As of yet, there has been no research done to compare cities and how the effects of gentrification on displaced people, in regards to quality of amenities experienced, may vary from city to city. So far the existing research regarding gentrification has established two main conclusions. One, gentrifying neighborhoods are characterized by population growth, reduced vacancy rates, demographic shifts towards college-educated, high-income people, and increased prices and property values (Vigdor, Massey, and Rivlin, 2002). Two, the effects of gentrification on displaced people, in their experiences of amenities such as school quality and air quality, are unfavorable when measured at the individual city-level (Timmins, Qiang, and Wang, 2018). These previous studies, however, have only looked at cities individually, for example looking into gentrification in Los Angeles or Durham each by itself, and there is not yet any comparison of these effects and how they might differ, in terms of magnitude and sign, depending on which city is being analyzed (Timmins, Qiang, and Wang, 2018; Ameri, 2019).

In this paper, I introduce city-level variation in an analysis of the effects of gentrification. In particular, I look at the experiences of ten different cities from 2013-2018. To isolate these effects, I run a series of multivariate, panel regressions describing the change in the level of an amenity (both school quality and air quality) experienced by urban residents affected by gentrification as a function of whether the resident lived in a neighborhood that was gentrifying in 2013 and whether the resident was a renter. Data from Info USA enables us to get household-level data on where people have lived from 2013-2018 in order to get accurate estimations.

These regressions first compare people similar on every dimension except whether they lived in a gentrifying neighborhood or not, to reveal the differences in amenities that can be

attributed to gentrification. Second, they compare an individual in 2013 to that same individual in 2018, to identify the time-effects on amenities. Third, they compare all those living in a gentrifying neighborhood along their status as a renter. Doing so shows the effects of gentrification on school quality and air quality for those who are renting their homes, who are most likely being displaced because of higher rent prices, as compared to owners, who most likely remain in their gentrified neighborhood and reap the benefits of improved amenities.

I will then compare cities and identify any trends in how these effects of gentrification compare to the effects experienced in cities with similar levels of white flight and different levels of white flight. To really know if a city's relatively high amount of white flight makes its displaced, low-income residents vulnerable to more significant drops in amenities, several cities with differing racial histories and backgrounds must be analyzed and compared using data from people living in those cities now. In doing so, it will not only be revealed how an individual city's residents experience gentrification, but also how these effects might vary depending on the amount of white flight in that city.

I find that renters in cities with high white flight more consistently experience adverse effects on school quality from gentrification than renters in low white flight cities. In high white flight cities, renters are likely pushed out of their gentrifying neighborhoods and, when they move, live in parts of the city that have had dis-investment and poor upkeep, leading to a downgrade in the renters' experience of school quality. Renters' experiences with air quality, on the other hand, were not affected by gentrification in a way that was related to white flight.

Research Question

How do the effects of gentrification on displaced people differ across metropolitan areas in the United States and are these differences tied to the racial histories of these cities?

Literature Review

Defining and Measuring Gentrification

Gentrification is typically characterized by population growth, but it is how this growth shifts the demographics of a city that best indicates gentrification is taking place. Not only is gentrification often associated with large amounts of migration into a city center, but those making up the largest share of this migrating population are often white, college-educated, high-income individuals and families. This movement inwards is a complete reversal of the decentralization of central neighborhood populations—where that same white, high-income demographic migrated out of the city and into the surrounding suburbs—that took place post-World War II in many cities across the United States (Baum-Snow and Hartley, 2016).

The pattern of migration observed during gentrification has been attributed to the short time period since the housing was built or last renovated of the housing stock in gentrifying cities, coupled with the attraction of high-income people to newer housing. As a city begins to redevelop, from the center and then move outwards, high-income populations follow the newer housing options, resulting in the influx of college-educated, high-income individuals into city centers and then expansion of this population further outwards from the center as additional new housing is developed (Brueckner and Rosenthal, 2009). Though it could be argued that housing development is following the movements of high-income people, instead of the other way around as the literature suggests, what is indisputable is the association of the college-educated, high-income demographic with the newly built or renovated housing.

What ensues is a positive feedback loop. High-income people want to live next to other high-income people and so as new neighborhoods pop up adjacent to one another in city centers, more of this demographic flocks inward. The city's residents, demographically, begin to have a

higher average income and higher educational attainment than previously. Further, the increased demand for city housing, alongside a general increased valuation and investment—now possible due to the higher average income of city residents—into properties, amenities, and services in city centers, results in an increase in housing prices and a higher cost of living in these city neighborhoods (Baum-Snow and Hartley, 2016; Guerrieri, Hartley, and Hurst, 2013; Keels, Burdick-Will, and Keene, 2013).

The higher cost of living in central city neighborhoods can make living in the city unaffordable for minorities and low-income populations, leading to crowd-out, or these populations being forced to move somewhere else (Baum-Snow and Hartley, 2016). If the housing supply in the city is elastic, meaning the quantity of houses supplied is fairly responsive to changes in prices, housing prices should not be expected to rise by much and low-income populations will be minimally affected (Glaeser, Gyourko, and Saks, 2005). Most of the time, however, the housing supply is more inelastic and the quantity of houses supplied is fairly stagnant. Poor households living in gentrified neighborhoods then face two options. First, they can take on the cost to relocate and move somewhere further from the city center, where they would experience decreased utility and happiness. Second, they can continue to live in their gentrifying area and instead take on the higher cost of living by consuming less and accepting a lower standard of living (Vigdor, Massey, and Rivlin, 2002). This unaffordability, faced by low-income people in their original place of residency, is exactly what defines the displacement that often results from gentrification (Newman and Own, 1982).

While this research establishes what happens to populations, demographics, prices, and the housing supply as gentrification occurs, we have yet to find out the effects of this gentrification on displaced populations once they move. The research on these effects does exist,

but it is more scarce and hard to come by for many gentrifying neighborhoods. In this paper I will not only take on this task by analyzing the effects of gentrification on displaced people in several cities and metropolitan areas across the country, but also take it a step further by comparing these effects and how they may differ or be similar to one another.

The Effects of Gentrification on Displaced Populations

A sizable portion of the literature and research indicates that gentrification may not be all that bad for people of lower incomes. Some low-income people may not even be displaced at all. For instance, gentrifying neighborhoods receive a large amount of mortgage capital investment, or loans to help those of lower incomes afford their homes. Moreover, bank policy in formerly redlined areas, where minorities once faced discrimination and other obstacles in buying homes, has actually been to expand home ownership to minorities and lower income individuals by increasing the number of loans made to these populations and by lowering borrowing costs (Wyly and Hammel, 1999).

Further, it was found that, in some cases, those with lower educations were more likely to stay at their original residency, and not move, if they were living in a gentrified neighborhood than if they were living in a non-gentrified neighborhood. This finding suggests that those with lower educations may in some ways actually benefit from gentrification or at least be willing to pay the higher costs associated with it because of the benefits offered in exchange. Such benefits include access to schools with better quality, which would be especially valued by those with low educational attainment (Byrne, 2002).

As an area redevelops, the high-income individuals that then live there will invest their resources and time into the upkeep and quality of the overall neighborhood, which leads to improved amenities and services, like better school quality and air quality, that most of the time

did not exist in the neighborhood before. Some surveys suggest that people living in gentrifying neighborhoods, regardless of the higher cost of living, are satisfied by these benefits and inclined to continue living there due to the better services and amenities that they could not access prior to the gentrification taking place (Vigdor, Massey, and Rivlin, 2002).

How much better these public services are in gentrifying neighborhoods, however, can be debated. For example, though the higher income base would be expected to increase the investment into neighborhood public schools, no such effects have been documented. Academic performance at schools in gentrifying neighborhoods does not seem to increase due to gentrification, which could be due to higher income families choosing to send their kids to private or charter schools or not having kids at all (Keels, Burdick-Will, and Keene, 2013).

Existing research shows gentrification may be beneficial to low-income individuals by building a link from these low-income populations to loans used for home-financing as well as to the benefits associated with gentrification; however, there is also significant evidence to suggest that gentrification does, in fact, displace these people and negatively impact their quality of life. In Los Angeles County, low-income renters were more likely than higher income owners to choose to move from their gentrifying neighborhood. The areas that they moved to had both lower school qualities and higher crime rates, indicating that gentrification not only displaced them, but also, in doing so, gave them a lower quality of life (Timmins, Qiang, and Wang, 2018).

Across the country, in Durham, North Carolina, it was also found that gentrification resulted in adverse effects on displaced people. Low-income renters, having to pay higher prices in their gentrifying neighborhoods, were often pushed out. When these people moved, they were more likely than their high-income counterparts to move into neighborhoods with worse school qualities, more crime, and higher poverty rates (Ameri, 2019).

Like the studies in Los Angeles County and Durham, all research to show the negative effects of gentrification on displaced people has been restricted to the city-level. What remains is a gap in our understanding of how all these cities compare. While city-level research has shown that gentrification in cities does have adverse effects on displaced, lower income people, we have yet to determine if the effects on displaced people in some cities are more adverse than in other cities. For instance, we do not know if displaced, low-income renters in Los Angeles or Durham faced larger decreases in school quality. In this paper, I will tackle this gap by comparing ten cities and the varying effects of gentrification in these cities to see if there are any trends among cities with similar effects and to examine why differences in these effects might arise.

White Flight and Racial Histories in Cities Across the Country

After World War II, many cities, like Detroit, Michigan experienced white flight, where white, high-income families fled to the suburbs. Huge portions of the Detroit white population left many neighborhoods vacant, abandoned, or only occupied by minorities and those of lower incomes (Sugrue, 2014). Cities across the country saw white flight play out in a similar manner, and these movements had several consequences. Many businesses in these cities left to follow the households with higher incomes that had greater capabilities to contribute to their sales. Further, residents that remained in central city areas had, on average, lower incomes and thus less means to invest in their own neighborhoods. These cities, with relatively large amounts of white flight, experienced major declines in the upkeep of amenities, like school quality and air quality; infrastructure; and small businesses (Woldoff, 2011).

Therefore, it was in these cities that had greater amounts of white flight, that displaced people would be expected to suffer more of a downgrade when they are pushed out of their gentrifying neighborhoods. As their neighborhoods begin to gentrify and they become displaced,

the areas that low-income populations then move into are more likely to have seen dis-investment and thus have under-resourced amenities than those in cities that did not experience this across-the-board decline in investment. These discrepancies in white flight and neighborhood investment are likely to play important roles in which cities' low-income populations face more adverse effects from gentrification than other cities' low-income populations. Thus, not only is it worth comparing cities to determine if there are any differences in the effects of gentrification on displaced people, but an interesting basis of comparison would be the degree to which the city had experienced white flight.

More white flight, logistically, means more stratification in which demographic groups live in the city and which in the suburbs surrounding it, and thus which demographic groups will then move into the city center as gentrification occurs. Further, white flight may also impact which cities maintain a certain level of investment throughout their various neighborhoods and which do not. These racial histories and patterns of white migration could very well influence how a city experiences the effects of gentrification. When looking for trends and patterns among the effects of gentrification in various cities, could similarities and differences be attributed to the relative amount of white flight in that city? How do the effects of gentrification on displaced people differ across metropolitan areas in the United States and are these differences tied to the racial histories of these cities?

Synopsis

Previous research on gentrification has been twofold. Firstly, gentrification is characterized by population growth, specifically of college educated and high-income individuals, which in turn increases prices, especially within the housing market. These higher prices tighten the budget constraints of lower income families and individuals, making their new

optimal choice to move out of their neighborhoods as to not spend a larger fraction of their income on housing and more expensive services and amenities. This choice is especially true for renters, who are burdened by the higher rent prices. What results is the displacement of large numbers of poor residents, which leads to the second part of the existing research on how these displaced people are impacted. Most research has been done on a city-by-city basis, but has generally found adverse effects on school quality and air quality for displaced people that are forced to move out of their gentrifying neighborhoods.

Given this research, a gap remains in how these gentrifying metropolitan areas differ in their experiences of gentrification, or whether they even differ at all. The degree to which the adverse effects of gentrification are felt could vary by city and begs the question of whether some city-level characteristic could explain these differences. One characteristic of particular interest, which influenced housing patterns throughout the second half of the 1900s, is white flight. Many cities had especially intense racial histories, characterized by large amounts of white flight that decreased the overall upkeep and investment into city centers as higher income residents moved out and businesses followed them—decisions that currently have major implications for lower income people who are now being displaced from their gentrifying neighborhoods and moving into these other parts of the city. My research question adds to the existing conversation by not only comparing the effects of gentrification in several cities, but also looking to see if differences in effects can be tied to the racial history of each city.

Methodology

Research Design Part One: City-level Analysis

To start out, I first performed a set of two regressions for each of the ten cities. Many of the variables used are binary, which means they take on the value of one if a certain characteristic applies and they take on the value of zero otherwise. It is also worth noting that for the sake of simplicity, I have not reported several control variables on the right sides of the equations listed and instead grouped them together as "Demographic Variables." These variables include the length of time that the family has resided at their current address, a binary variable equal to one if the household has children, the number of children in the household, whether the head of the household is married, the income level of the household, the wealth accumulated by the household, twelve binary variables corresponding to twelve age groups and equal to one if the head of household is a part of that age group, and six binary variables corresponding to ethnicities and equal to one if the head of household is a part of that ethnicity. The dependent variable in these regressions represents different amenities affected by gentrification and is one of two measures: school quality and air quality.

$$\textit{school quality} = \beta_0 + \beta_1(\textit{Gentrification Indicator}) + \beta_2(\textit{Year}) + \beta_3(\textit{Gentrification Indicator*Year}) + \beta_4(\textit{Gentrification Indicator*Renter}) + \beta_5(\textit{Year*Renter}) + \beta_6(\textit{Gentrification Indicator*Year*Renter}) + \beta_7(\textit{Renter}) + \beta_8(\textit{Demographic Variables}) + \varepsilon$$

$$\textit{air quality} = \beta_0 + \beta_1(\textit{Gentrification Indicator}) + \beta_2(\textit{Year}) + \beta_3(\textit{Gentrification Indicator*Year}) + \beta_4(\textit{Gentrification Indicator*Renter}) + \beta_5(\textit{Year*Renter}) + \beta_6(\textit{Gentrification Indicator*Year*Renter}) + \beta_7(\textit{Renter}) + \beta_8(\textit{Demographic Variables}) + \varepsilon$$

Both regressions are multivariate, panel regressions, meaning that they look at the same set of individuals, in this case the same group of households living within a specific city, over multiple points in time, in this case both in 2013 and in 2018, to see how each household's consumption of amenities may be affected by where that household chooses to live, which could

change over time—especially if that household is displaced—or be due to other factors. These other factors are captured in, but not limited to, the independent variables of the regressions.

There are several independent variables of interest in both regressions. "Gentrification Indicator" is a binary variable equal to one if the household lived in a gentrifying neighborhood in 2013. Thus, β_1, controlling for all other variables, is the estimated effect on an amenity if a neighborhood is gentrifying. The coefficient represents the difference in amenities like school quality and air quality from gentrification, for owners. I hypothesized that, for all cities, β_1 in the first equation would be positive, indicating that in period one, or 2013, those living in gentrifying neighborhoods on average experienced a higher school quality—based off of the assumption that gentrification increases the quality of schools in the area. This increase would be due to higher income people now living in the neighborhood and having a greater amount of resources to invest towards bettering their amenities, like public schools; although the amount that property taxes would vary from a gentrifying neighborhood to a non-gentrifying neighborhood is likely not significant enough to influence school quality greatly, higher income families could still have other resources to invest directly or indirectly into their neighborhood public schools. I also hypothesized that, for all cities, β_1 in the second equation would be negative, indicating that in 2013 owners living in gentrifying neighborhoods, on average, experienced a lower air toxicity than those living in non-gentrifying neighborhoods because, again, a higher average income of the area's residents implies more money to be invested in bettering the amenities, like air quality.

The "Year" variable is a binary variable equal to zero if it looks at the individual in 2013 and equal to one if it looks at that same individual in 2018. β_2 is then, controlling for all other variables, the estimated effect on amenities over time, or the time-effects. I hypothesized that, for all cities, β_2 in the first equation would be positive, as school quality would be expected to

develop and improve with more time. I also hypothesized that, for all cities, β_2 in the second equation, would be negative, as air quality would also be expected to improve with time to become less toxic.

Next, there is an interaction variable that multiplies the "Gentrification Indicator" by the "Year" indicator for every household to produce a new binary variable. "Renter" is a binary variable equal to one if the household is renting their home, and thus more burdened by the increases to rent prices seen during gentrification, and equal to zero if the household owns their home. Thus, the coefficient on the variable, β_3, controlling for all other variables, is the additional estimated time-effect on the amenity if the household owns their home and lived in a gentrifying neighborhood in 2013. For all cities, I hypothesize that β_3 in the first equation would be positive, indicating that the positive effects on school quality over time are heightened when the resident is an owner who can either remain in their gentrifying neighborhood—and reap the benefits of greater investment over time into amenities like public schools—or can afford to move to an even nicer neighborhood with even more improved amenities. I also hypothesize that, for all cities, β_3 in the second equation would be negative, indicating that the negative effects on air toxicity over time are even more negative when the household is living in a gentrifying area in 2013 and can afford to stay in a place where residents are capable of investing more into the area's amenities, like air quality.

The next interaction variable is binary and produced from multiplying the "Gentrification Indicator" times the "Renter" indicator. Controlling for all other variables, the coefficient on this interaction term, β_4, is the estimated effect on an amenity if the household is a renter living in a gentrifying neighborhood in 2013. In the first equation, I hypothesize that, for all cities, β_4 would be negative, implying that the positive effect on school quality experienced by households living

in gentrifying neighborhoods in 2013 is dampened for renters because though they may be in a gentrifying neighborhood, as a renter, they may also be living in a neighborhood that generally has worse amenities than those in a neighborhood that an owner could afford to live in. In the second equation, I hypothesize that, for all cities, β_4, would be positive, implying that the negative effect on air toxicity from living in a gentrifying neighborhood in 2013 is not as negative for renters who start off in worse neighborhoods as compared to owners.

The next interaction variable is produced by multiplying "Year" times "Renter." β_5 is thus the estimated additional time-effect on amenities, controlling for all other variables, if the household is a renter who had been living in a non-gentrifying neighborhood in 2013. Renters living in non-gentrifying neighborhoods are most likely not facing much higher rent prices over time and do not have to move. I hypothesize that, for all cities, β_5 in the first equation would be negative because even though renters staying in their neighborhoods may still see improved school quality over time, this increase would be diminished for renters as compared to owners, who can afford to live in neighborhoods with overall better improvement. I also hypothesize that, for all cities, β_5 in the second equation would be positive, as the decrease in air toxicity expected over time is less negative for renters remaining in their neighborhoods that are generally improving less over time as compared to where owners live.

The interaction term created from multiplying "Gentrification Indicator," "Year," and "Renter" is binary as well. β_6 is then the estimated additional time-effect on amenities, controlling for all other variables, from living in a gentrifying neighborhood in 2013, if the household is also a renter. For the first equation, I hypothesized that, for all cities, β_6 would be negative, indicating that the additional positive bump to school quality from both living in a gentrifying neighborhood in 2013 and time is smaller for renters that are being pushed out of the

gentrifying neighborhoods that are experiencing this improvement in schools. For the second equation, I hypothesized that, for all cities, β_6 would be positive, indicating that the decrease in air toxicity from both living in a gentrifying neighborhood in 2013 and time is less negative and maybe even net positive for renters who are facing higher rent prices and thus being displaced and forced to move out from the very neighborhoods benefiting from gentrification and the decrease in air toxicity.

Finally, as mentioned earlier, the "Renter" variable itself is a binary variable equal to one if the household is a renter and most likely feeling the burden of increased rent prices from gentrification. Thus, β_7, controlling for all other variables, is the estimated effect of being a renter on the amenity. I hypothesized that, for all cities, β_7 in the first equation would be negative because, in general, renters would be expected to live in areas that are cheaper to live in and thus have lower quality schools. I also hypothesized that, for all cities, β_7 in the second equation would be positive because, again, renters would be expected to live in areas with a lower cost of living that have higher air toxicities.

Research Design Part Two: Cross-city Analysis

The second layer of my research concerns a city's racial history and whether the amount of white flight that occurred in the city post-World War II, from 1950-1970, can explain the differences in the effects of gentrification on displaced people from city to city. By comparing the magnitudes and signs of the various coefficients in the regressions, I can begin to identify trends and patterns in the effects of gentrification on displaced people in cities with a relatively high amount of white flight versus cities with a relatively low amount of white flight.

Given that cities with a greater amount of white flight also saw a greater amount of dis-investment throughout their neighborhoods, during gentrification, displaced people in these cities

are more likely to be pushed into neighborhoods that had under-resourced amenities. Cities with less white flight, in contrast, would have neighborhoods more similar to one another in investment levels. Thus, a renting household having to move because of gentrification would not experience as much of a downgrade in amenities such as school quality and air quality, because all of the neighborhoods they could potentially move to still have relatively good amenities. As such, I would expect the effects from gentrification exhibited in the city-level regressions, especially for renters, to be greater in magnitude and significance for cities with a relatively high amount of white flight as compared to cities with a relatively low amount of white flight.

There are a few coefficients in the regressions that will be most telling in analyzing how the effects of gentrification on displaced people differ in high white flight cities versus low white flight cities. I do not expect to find any major differences in β_1, the estimated effect of living in a gentrifying neighborhood in 2013 on school quality and air quality, for cities with differing levels of white flight. This is not an effect particular to renters being displaced, but rather describes how gentrification affects amenities, which there is no reason to believe would differ in cities depending on the amount of white flight those cities experienced.

Along a similar vein, I do not expect to observe any striking trends in β_2, the estimated time-effects on school quality and air quality, related to the amount of white flight in a city. Though cities could experience differences in amenities over time, these differences would be regardless of whether or not the city had a large amount of white flight.

β_3, or the estimated additional time-effect on school quality and air quality from living in a gentrifying neighborhood, would also not be expected to reveal much about how displaced populations are affected differently by gentrification depending on whether or not they live in a city with a lot of white flight. It is not related to an individual's status as a renter, and thus not

useful as a basis for comparison when determining whether the effects of gentrification on displaced people vary by city.

Looking at how the value of β_4, or the estimated additional effect from living in a gentrifying neighborhood if the household is a renter, differs in cities with a high amount of white flight versus a low amount of white flight could be more telling. I hypothesize that cities with a relatively larger amount of white flight would have a larger magnitude, or more negative value, for β_4 in the first equation, implying that the effect on school quality from gentrification is not only dampened for renters, but also that this dampening is much more extreme for renters in high white flight cities than renters in low white flight cities. Further, I hypothesize that β_4 in the second equation would also have a larger magnitude, but in this case be more positive, for cities with more white flight. Such a result would imply that decreases in air toxicity attributed to gentrification are not only decreasing by less for renters, but also decreasing by much less if those renters live in cities that experienced a large amount of white flight rather than a small amount of white flight.

Similarly, differences in the value of β_5, or the estimated additional time-effect if the household is a renter, could also be related to a city's racial history. I hypothesize that cities with more white flight would have a larger magnitude, or more negative value, for β_5 in the first equation, meaning that the reduction of the positive time-effect on school quality if the household is a renter is a larger reduction when that renter lives in a city that had experienced more white flight. β_5 in the second equation, I hypothesize, would be larger in magnitude, or more positive, for cities with a greater amount of white flight, implying that the positive bump to the negative time-effect on air toxicity if a household is a renter is a greater positive bump when that renter lives in a city with a high level of white flight.

The best indicator of how the displacement experiences of renters may vary by city will come from looking at β_6, or the estimated additional time-effect from living in a gentrifying neighborhood if the household is a renter. The values of this coefficient reveal the effects of gentrification that are specific to renters and are thus a good place to look and identify whether displaced people feel the effects of gentrification differently depending on a city's level of white flight. I hypothesize that in cities with more white flight, the value of β_6 in the first equation would be greater in magnitude, or more negative. Such a result would imply that while renters see less of the additional time-effect on school quality from living in a gentrifying neighborhood—because they are being pushed out into areas that have received less investment—I expect the reduction in this effect to be larger for renters living in high white flight cities, where the dis-investment across all city neighborhoods was most likely greater. Similarly, I hypothesize that cities with more white flight would have a larger in magnitude, or more positive, value for β_6 in the second equation, meaning not only that the time-effect on air toxicity from living in a gentrifying neighborhood is less negative for renters, but that this positive bump to the negative effect on toxicity is greater for renters living in cities that experienced a high level of white flight.

Less telling, but perhaps still important to observe, are the variances in β_7, the estimated effect of being a renter on the experience of amenities. If cities that had experienced more white flight had also realized greater dis-investment from inner-city neighborhoods, it would be expected not only that renters live in less maintained parts of the city, but also that the discrepancy between where renters live and move to and where owners live and move to is larger in high white flight cities. In other words, I hypothesize that β_7 in the first equation would be greater in magnitude, or more negative, in cities with more white flight, implying that the lower

level of school quality that would be associated with renters is even lower for those renters if they live in a city that had a lot of white flight and thus did not maintain its amenities, like public schools, as well. I also hypothesized that β_7 in the second equation would be greater in magnitude, or more positive, in cities with more white flight, which implies that the higher air toxicity associated with the neighborhoods where renters live would be even higher for those renters if they live in a city that had a high level of white flight versus a low level of white flight.

Analyzing the various regression coefficients, but most specifically β_6, will bring to light any potential trends that could be observed among and between cities with different levels of white flight. Doing so will answer my research question of how these gentrification effects differ by city and if these differences are tied to the racial histories of these cities.

Data Collection and Cleaning

The focus of this thesis is on ten cities across the United States: five that I classified as having a high level of white flight and five that I classified as having a low level of white flight. Cities were chosen based on which had available data for the amenities of interest and were chosen in alternating order of high white flight cities versus low white flight cities. Because white flight occurred in large amounts immediately after World War II, I used Census data to find what percent of each city's population was white in both 1950 and 1970 to determine by how many percentage points the white population of each city had dropped from 1950-1970. The cities that had experienced at least a fifteen percentage point drop in their percent white population were categorized as high white flight cities and those that experienced a drop below that threshold were categorized as low white flight cities. In Table 1: Cities and White Flight Classifications, I detail the cities that were chosen and their categorizations.

Table 1: Cities and White Flight Classifications

City	% White in 1950	% White in 1970	Percentage Point Change	White Flight Level
Detroit, MI	83.58%	55.50%	-28.08	High
Philadelphia, PA	81.70%	65.60%	-16.10	High
Baltimore, MD	76.20%	53.00%	-23.20	High
Cleveland, OH	83.70%	61.00%	-22.70	High
Chicago, IL	85.90%	65.60%	-20.30	High
Seattle, WA	94.20%	87.40%	-6.8	Low
Tampa, FL	78.00%	80.00%	2.00	Low
Houston, TX	78.90%	73.40%	-5.5	Low
Albuquerque, NM	98.00%	95.70%	-2.3	Low
Richmond, VA	68.30%	57.60%	-10.7	Low

Given that I conducted my research at the individual household-level, my biggest source of data was the Info USA dataset purchased by the Duke Economics Department. These data, collected by Infogroup using Census data and IRS tax returns, have household-level information from the years 2006 to 2018 with the variables of interest indicated in Table 2: Info USA Variables and Descriptions.

Table 2: Info USA Variables and Descriptions

Variable Name	Description
familyid	12 digit number assigned to uniquely identify household (HH)
location_type	The kind of physical location associated with address
head_hh_age_code	Age of head of household
length_of_residence	The difference (in months) between arrival date at a residence and current (system) date, converted to number of years. Range is limited to current year minus 1959.
childrenhhcount	Number of HH members determined to be children
children_ind	Indicates children are present in HH
wealth_finder_score	Modeled prediction of household wealth
find_div_1000	A prediction of HH income
owner_renter_status	Score indicating likelihood that HH owns their home or is renting
marital_status	Score indicating likelihood head of HH is married
city	Post office, branch, community or locality name used for last line of a mailing label. May vary within zip code.
state	Standard state abbreviation
zip	Zip code
zip4	Last 4 digits of the ZIP+4 code
vacant	Indicates vacant

ge_latitude_2010	Angular distance north or south from the equator of a point on the earth's surface, measured on the meridian of the point
ge_longitude_2010	Angular distance east or west on the earth's surface, measured by the angle contained between the meridian of a given point and a prime meridian
ge_census_state_2010	State numerical codes assigned by the Bureau of Census for the purpose of collecting and compiling population and housing data
ge_als_county_code_2010	County numerical codes assigned by the Bureau of Census for the purpose of collecting and compiling population and housing data
ge_als_census_tract_2010	Number assigned by Bureau of Census to identify a small geographic area for the purpose of collecting/compiling population/housing data. Census tracts are unique within census county, and census counties are unique only within census state.
ge_als_census_bg_2010	Assigned by the Bureau of Census to identify a small geographic area for the purpose of collecting and compiling population and housing data. BGs are subdivisions of census tracts and unique only within a specific census tract. Census tracts/block groups are assigned to address records via a geocoding process.
ethnicity_code_1	Ethnicity of HH
year	Year

Because the data was divided up into individual files by year and then further by zip code, for each city, I compiled a list of all of the zip codes in that city. This list is detailed in Table A1: Cities and Zip Codes. The process for choosing which zip codes were valid is detailed in Summary A2: Zip Code Selection.

Based off of the code used in a previous undergraduate thesis (Ameri, 2019), I compiled the individual, zip code data files from 2013 and 2018 into one single data file for the city. The 2013-2018 period is of focus, given that some cities have only recently begun to see population growth and price increases from the post-recession economic growth. By looking at where households resided at both the beginning and end of this time frame, any movements in location can be documented. The process of cleaning each city's compiled data file is detailed in Summary A3: Info USA Compiled City Data Cleaning.

My next source of data was the American Community Survey's five-year estimates, which I used to gather information on rental prices and education attainment in every city. I

collected data, at the census block group and census tract level, on the median rent price, average rent price, and percent of people with at least a Bachelor's degree. Data was collected as a five-year moving average from both the 2007-2011 time period as well as the 2012-2016 time period. Using this information, I was able to calculate the percent change in the median and average rent prices, from the 2007-2011 period to the 2012-2016 period, as well as the percentage point changes in people with at least a college degree from the 2007-2011 period to the 2012-2016 period. For the purposes of this thesis, I chose to define a census block group as having been gentrified if it satisfied three criteria:

1. Both the median rent price and average rent price were in the bottom 30% of values, among all census block groups in the city in the 2007-2011 period, to show that prices were not always high in the block group, but instead started low and became high.
2. Both the percent change in median rent price and percent change in average rent price from the 2007-2011 period to the 2012-2016 period were in the top 30% of values, among all census block groups in the city, to show that the price changes in the block group were relatively higher than they were for other block groups in the city.
3. The percentage point increase in percent of people living in the block group with at least a Bachelor's degree was in the top 30% of values, among all census block groups in the city, to show a relatively higher increase in the college educated demographic compared to the other block groups in the city.

Using these criteria, I created a binary variable, "Gentrification Indicator," that equals one if the census block group that the household lived in satisfied all three criteria and equals zero otherwise, essentially defining whether each household was living in a gentrifying area or not. If the household was living in a gentrifying neighborhood in 2013, then in 2018 that same

household is assigned a one for the "Gentrification Indicator" variable to show that they had been previously living in a gentrifying neighborhood. In Summary A4: Creating Interaction Variables, I detail how this "Gentrification Indicator" variable was used to create several interaction variables.

I next assigned each household observation in every city a school quality rating that was found from GreatSchools.org. In Summary A5: School Quality Data, I detail how the school quality ratings were assigned to each household observation based on location information.

Finally, I assigned each household observation in every city an air quality rating, using data collected by the United States Environmental Protection Agency on Risk-Screening Environmental Indicators (RSEI). In Summary A6: Air Quality Data, I detail how I compiled this air quality data and assigned each household observation an air quality rating based on its location information.

Data Analysis

To set up my regressions I sorted the observations within each city by familyid and then year, removing any households that did not have an observation in both 2013 and 2018 as this would not be useful in seeing if the household moved or not in the given time frame. With all variables created at this point, I proceeded with the multivariate, panel regressions to identify the effects of gentrification and time, as well as how these effects vary when a low-income renter is being affected versus a high-income owner. Because of collinearity between the different age group variables, one age group variable was omitted every time the regression was carried out.

After carrying out the regressions on all ten cities, I began to see trends in the effects of gentrification on displaced people living in high white flight cities as compared to the effects of gentrification on displaced people living in low white flight cities.

Results and Analysis

The results below detail the effects of gentrification on both school quality and air quality. I first examine school quality and begin with the five cities classified as having a high amount of white flight, discussing trends among these cities, and then move on to the five cities classified as having a low amount of white flight. I move on to discuss any major differences between both groups of cities. I then repeat this same analysis, but look into air quality. Because there are several variables involved in each regression, I only draw attention to the most important results, especially those that have to do with the effects of gentrification that are specific to renters who are being displaced by high rent prices. It should also be noted that any discussion of air quality is synonymous with air toxicity in that the higher the value of air quality, the more toxic the air is.

School Quality in High White Flight Cities

After running the school quality regressions for the high white flight cities, I got the results showcased in Table 3: High White Flight City-level School Quality Regressions.

Table 3: High White Flight City-level School Quality Regressions

	(1) School Quality Detroit	(2) School Quality Philadelphia	(3) School Quality Baltimore	(4) School Quality Cleveland	(5) School Quality Chicago
Gentrification Indicator	.4466***	-.0891***	-.2503***	.4288***	-0.0141
Year	.1638***	.5628***	.4776***	.6417***	1.1764***
Gentrification Indicator*Year	-.0389*	-.0189	.0769**	.0638***	.0514**
Gentrification Indicator*Renter	-.3425***	-.2981***	-.1745***	-.3286***	.0503**
Year*Renter	.1298***	-.0189***	-.1912***	-0.1097	-.5995***
Gentrification Indicator*Year*Renter	-.1962***	-.1168***	-.0424	-.2254***	-0.0127
Renter	.3484***	.7991***	0.3754	.491***	1.193***
Length of Residence	.0002*	-.0095***	-.0086***	-.0076***	-.0149***
Has Children	-.0217***	-.0867***	-.041***	-.0609***	-.2021***
Number of Children in Household	-.0047**	-.0006	-.009***	-.0044*	.0218***
Married	-.0819***	-.0562***	-.1505***	-.1228***	-.0415***
Income	.0003***	.001***	.0026***	.0019***	-.0033***
Wealth	.0002***	.0009***	.0007***	.0009***	.0018***
Age <25	omitted	.3224***	omitted	omitted	.9404***
Age 25-29	.0436***	.3279***	.0001	.0503***	.8453***
Age 30-34	.0459***	.2792***	-.0482***	.0226**	.6796***
Age 35-39	.0597***	.2396***	-.0884***	0.0087	.6166***
Age 40-44	.0427***	.1376***	-.1605***	-.0982***	.427***
Age 45-49	.0474***	.1333***	-.1672***	-.0918***	.4239***
Age 50-54	.0253***	.0385***	-.2538***	-.1932***	.2233***
Age 55-59	.0173**	.0086	-.2632***	-.2275***	.1754***
Age 60-65	.0114	-.0198***	-.2652***	-.2573***	.0967***
Age 66-70	.0251***	-.0044	-.2197***	-.2542***	.0288***
Age 71-75	.0408***	omitted	-.2185***	-.2537***	omitted
Age >75	.1216***	.1707***	-.1148***	.1793***	.2823***
Black	-.0803***	-.4478***	-.1449***	-.0801***	-1.0916***
White	-.0322***	.3483***	.1516***	.3702***	.332***
Latinx	.0677***	-.256***	.004	.2378***	-.1635***
Middleeastern	.0788***	.0292***	-.0596***	.1831***	.3751***
Asian	.0083	.1378***	-.017	.1767***	.2583***
Native American	-.1123	-.1763***	.0073	.2545***	-0.0759
Constant	2.5579***	1.4808***	1.5307***	1.8285***	1.4766***
Observations	376,118	886,564	316,856	304,376	1,268,158
R2	.0335	.3475	.3164	0.2037	0.404

significant at the *10% level, **5% level, ***1% level

As expected, the coefficients on the gentrification indicator for the Detroit and Cleveland regressions were both positive and statistically significant, indicating that the estimated effect on school quality from living in a gentrifying neighborhood in these two cities was a .4466 and .4288, respectively, higher quality rating. This higher school quality could be attributed to the

higher average income of residents in gentrifying neighborhoods, which implies a greater means to invest in neighborhood amenities such as public schools. This investment could come directly from parents having a greater ability to volunteer their time and resources to help the school or could come indirectly from college-educated parents having kids that tend to do better in school, because they can invest more out-of-school resources towards them, which could have spillover effects on other students at the school and improve the school's average test scores.

In contrast to what I expected, however, the estimated effect on school quality from living in a gentrifying neighborhood in Philadelphia and Baltimore was -.0891 and -.2503, respectively—negative and statistically significant results. Chicago also saw this negative result but it was not statistically significant. These findings could be attributed to what I briefly discussed in my literature review about the demographic moving into neighborhoods that are gentrifying. Because this group of people moving in is most of the time made up of young adults, many households could not have kids of school-going age. Further, if they do have kids going to school, because those moving into a city center are of higher incomes, they could be choosing to send their kids to private schools instead of public schools. Both factors would result in these higher income, new residents to not actually invest more in the public schools in their neighborhoods, and thus could be one explanation for why the coefficients on the gentrification indicator for the regressions in these cities were negative.

Also as hypothesized, the coefficients on the year variable in the regressions for all cities, which represents the time-effects on school quality, were also positive and statistically significant, showing that the estimated effect on school quality solely from improvements over time was a .1638, .5628, .4776, .6417, and 1.1764 higher school quality rating for Detroit, Philadelphia, Baltimore, Cleveland, and Chicago, respectively.

Turning towards the coefficient on the triple interaction term in the regressions, I found that the additional time-effect on school quality from living in a gentrifying neighborhood, if the household was a renter, was -.1962, -.1168, and -.2254 for Detroit, Philadelphia, and Cleveland, respectively. This negative and statistically significant result affirms my hypothesis that the positive effects on school quality from gentrification would be dampened for renters. Though the cause of this effect cannot be known for sure, I speculate that it is due to renters being pushed out of their gentrifying neighborhoods and into areas where amenities like schools have not been kept up and invested in. It is a good example of renters not benefitting from the improvements associated with gentrification because they cannot afford the higher rent prices.

While the coefficients on the triple interaction term were negative for the regressions in Baltimore and Chicago, implying a -.0424 and -.0127, respectively, change in school quality for renters living in gentrifying neighborhoods, these results were not statistically significant. Renters, in this case, were most likely either not being displaced by gentrification and high rent prices or were moving, but into areas that did not have a decreased improvement of schools. In these cases, there were no adverse effects on school quality, from gentrification, for renters.

Besides a few exceptions, like Baltimore and Chicago, in general across the high white flight cities, the estimated effect of gentrification on school quality for displaced renters seems to be, as hypothesized, a dampening of the increase in school quality associated with gentrifying neighborhoods and time. This dampening could be linked to the low-income and renter populations in both cities being pushed out of their gentrifying neighborhoods and into areas with less improvements to amenities. It is likely that these cities did not keep up their amenities in all areas due to white flight and dis-investment. As a result, renters and other displaced low-income populations did not see the same benefits to school quality as other groups.

School Quality in Low White Flight Cities

After running the school quality regressions for the low white flight cities, I got the results showcased in Table 4: Low White Flight City-level School Quality Regressions.

Table 4: Low White Flight City-level School Quality Regressions

	(6) School Quality Seattle	(7) School Quality Tampa	(8) School Quality Houston	(9) School Quality Albuquerque	(10) School Quality Richmond
Gentrification Indicator	-.5635***	-.8026***	-.4156***	-.3911***	-.1196***
Year	.6021***	.9303***	.4776***	.8374***	.7625***
Gentrification Indicator*Year	.152***	.3529***	.0361	.4065***	-.2732***
Gentrification Indicator*Renter	-.0372	.2094***	-.2097***	.1702**	-.6698***
Year*Renter	-.4301***	-.274***	-.0624***	-.2035***	-.1989***
Gentrification Indicator*Year*Renter	.1046	-.237***	-.0812	-.3339**	.3565***
Renter	1.2099***	1.2546***	.8844***	1.6526***	.6777***
Length of Residence	-.0098***	-.0141***	-.0101***	-.0188***	-.0097***
Has Children	-.0805***	-.1656***	-.0887***	-.1074***	-.0887***
Number of Children in Household	.0076	-.0225***	-.0045**	-.0413***	-.0023
Married	-.4336***	-.3591***	-.1884***	-.4304***	-.2471***
Income	.0004***	-.0005***	.0025***	.0061***	-.0011***
Wealth	.001***	.0019***	.0009***	.0014***	.0012***
Age <25	.6423***	omitted	.367***	omitted	omitted
Age 25-29	.5484***	.1306***	.3472***	-.0886***	-.0515*
Age 30-34	.4792***	.0178	.269***	-.2391***	-.2021***
Age 35-39	.3893***	-.0508***	.2151***	-.3179***	-.3138***
Age 40-44	.2366***	-.2618***	.1153***	-.4922***	-.4507***
Age 45-49	.1602***	-.297***	.0969***	-.4695***	-.4504***
Age 50-54	-.0005	-.5243***	.0059	-.608***	-.5766***
Age 55-59	-.02	-.5955***	-.0045	-.6206***	-.5976***
Age 60-65	-.0199	-.6655***	-.0267***	-.63***	-.6158***
Age 66-70	-.0448**	-.6831***	-.003	-.4665***	-.6058***
Age 71-75	omitted	-.677***	omitted	-.3819***	-.6***
Age >75	.0924***	-.3018***	.1372***	-.1405***	-.408***
Black	.0131	-.3211***	-.1486***	.0397***	.4404***
White	.102***	-.0081	.2299***	.0203	.5724***
Latinx	-.2514***	.1888***	.2526***	-.4102***	.5021***
Middleeastern	-.2662***	-.0872***	.2445***	.133***	.5646***
Asian	-.4528***	.0184	.0192***	.0491**	.5564***
Native American	-.015	-.0917	.0888*	-.1831***	.3091*
Constant	2.924***	1.6169***	3.0875***	2.4943***	1.445***
Observations	264,328	313,038	1,287,440	271,538	102,994
R2	.1667	.3965	.3077	.3723	.3175

significant at the *10% level, **5% level, ***1% level

Moving to the cities classified as having low white flight, and thus most likely lower dis-investment across city neighborhoods, in Seattle, Tampa, Houston, Albuquerque, and Richmond, the estimated effects of living in a gentrifying neighborhood on school quality were a -.5635, -.8026, -.4156, -.3911, and -.1196 change, respectively, in the school quality rating. Similar to a

few of the high white flight cities, like Philadelphia and Baltimore, these results could be explained by the demographic composition of those migrating into the city who have less of an incentive to invest in the public schools of the neighborhood.

The time-effect on school quality was positive and statistically significant, as I had hypothesized, across all low white flight cities, with a .6021, .9303, .4776, .8374, and .7625 increase in school quality over time in Seattle, Tampa, Houston, Albuquerque, and Richmond, respectively. It seems that cities with varying levels of white flight all experience the same general effects of gentrification and time, on school quality, which confirms what I had expected in that there are no large discrepancies in how different cities as a whole feel the effects of gentrification, but rather only in how the renters within the cities may feel these effects.

Looking at the coefficients on the triple interaction terms of the regressions, there were no strong trends that seemed to appear across all of the cities. The coefficients on the triple interaction term in the regressions for Seattle and Houston were not statistically significant, indicating that being a renter did not affect the household's experience of the school quality amenity. This result could either be attributed to renter families not moving because of gentrification, or still moving, but being able to move into areas that had been just as kept up in terms of amenities. My hypothesis for these low white flight cities, like Seattle and Houston, is that populations are still being displaced, but that the lack of white flight has not resulted in as much dis-investment across the cities' neighborhoods. Thus, those who are displaced do not experience as much of a downgrade in amenities like schools.

On the other hand, in cities like Tampa and Albuquerque, renters living in gentrifying neighborhoods had a negative and statistically significant additional time-effect of -.237 and -.3339, respectively, which indicates that renters in these two cities experienced a dampening in

the effect of gentrification on school quality as compared to their non-renter counterparts. The magnitudes of these coefficients are around the same size as the coefficients on the triple interaction terms for the high white flight cities. This refutes my hypothesis by suggesting that renters in some low white flight cities may actually experience the same level of a dampening effect on increases in school quality as renters in high white flight cities.

Interestingly, in Richmond, the coefficient on the triple interaction term was positive and statistically significant, implying an additional increase in school quality, on top of the time-effects, for renters living in gentrifying neighborhoods. Renters in Richmond could expect to see a .3565 higher increase in school quality than non-renters, which brings to question what exactly is happening to renters living in gentrifying neighborhoods. It seems that they must be moving out of their neighborhoods because there is a discrepancy in the school quality that they experience versus the school quality others in the same city experience. One potential explanation is that, because it is a low white flight city, the areas that they are moving into have not experienced any sort of downgrade or decline in amenities and have been kept up to the point that being displaced ends up having no adverse effects, or maybe even positive effects, on the displaced population in terms of school quality.

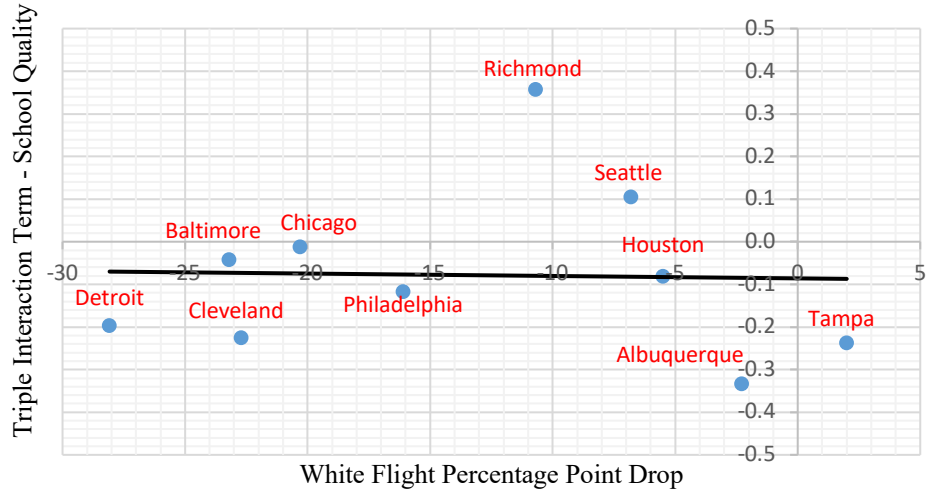
The results across the low white flight cities, with the exception of a few cases, support my hypothesis that renters in low white flight cities do not experience as much of a downgrade in amenities, like school quality, due to gentrification, because amenities across the city's neighborhoods have been fairly kept up as compared to high white flight cities.

Comparing School Quality in High Versus Low White Flight Cities

Given the strong distinction in trends among the high white flight cities versus the low white flight cities, it is important to note any more general or broader trends among all ten cities regarding the effect of gentrification on school quality. Most of the ten cities saw the same general effects of gentrification and time on school quality. High white flight cities, however, more consistently saw renters not benefiting from the increases and benefits to school quality as compared to owners. While there were a few low white flight cities, like Tampa and Albuquerque, whose renters also did experience a drop in amenities like schools, most likely due to moving, for the most part high white flight cities more regularly showed this adverse effect on school quality for renters living in gentrifying neighborhoods.

Below, Figure 5: Scatter of Triple Interaction Terms Over White Flight depicts the overall trend among all ten cities of values for the triple interaction term coefficients and the amount of white flight in that city.

Figure 5: Scatter of Triple Interaction Terms Over White Flight



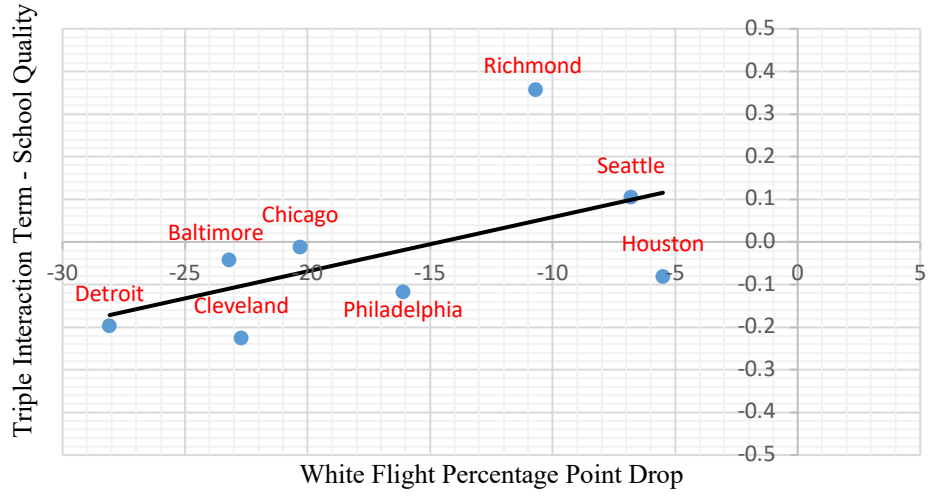
As shown in the figure, high white flight cities, all of which veer towards the left of the scatter plot, have very negative values for the percentage point drop in the white population of

the city and, for the most part, negative values for the triple interaction term coefficient, representing the dampening of the effect of gentrification and time on school quality for renters who are being displaced and forced into parts of the city that have not been kept up.

Low white flight cities, on the other hand, have less of a broader pattern in their placements on the scatter plot, which indicates that in future research there may be other variables and city characteristics to consider besides the amount of white flight. While I had hypothesized that low white flight cities would lean more towards the top right of the scatter plot, having less negative values for percentage point drop in white populations and less negative, if not zero or positive, values for the coefficient on the triple interaction term, because of how the regressions for Tampa and Albuquerque turned out this was not the case. As a result, the trendline showed virtually no positive correlation as I would have expected.

While analyzing more cities would have increased the sample size of data points and enabled these outliers to potentially be cancelled out, the scope of this thesis is limited to just ten cities. The next figure, Figure 6: Scatter without Outliers, depicts what happens to the scatter plot if the outliers of Tampa and Albuquerque are removed.

Figure 6: Scatter without Outliers



Without the outliers, the scatter plot more closely resembles the trend that I would have expected among the ten cities, with a less negative or even positive coefficient on the triple interaction term for cities that had less white flight. These cities experienced less dis-investment in their neighborhoods and thus were able to keep up amenities to the point that even if renters became displaced from their gentrifying neighborhoods, they were able to move into areas that had just as nice of amenities.

One hypothesis for why Tampa and Albuquerque did not match up with the rest of the low white flight cities could be that even though these cities had comparably less white flight, the residential patterns within the cities might have remained stratified based on income or race. If they were to be stratified along the lines of income or race, then certain neighborhoods would be expected to have less investment into amenities over time as compared to other parts of the city and thus less kept up amenities. As such, when displaced renters are forced out of their gentrifying neighborhoods, the places they would be moving into would not have as high quality amenities as would be expected of a low white flight city.

Further, both cities have high Hispanic populations, which could be the force behind some of the residential stratification that I am hypothesizing to have existed. A deeper analysis into the race of the residents that I examined in this study and how demographics could have played a role beyond that of white flight could be an interesting step for future research.

Air Quality in High White Flight Cities

After running the air quality regressions for the high white flight cities, I got the results showcased in Table 7: High White Flight City-level Air Quality Regressions.

Table 7: High White Flight City-level Air Quality Regressions

	(1) Air Quality Detroit	(2) Air Quality Philadelphia	(3) Air Quality Baltimore	(4) Air Quality Cleveland	(5) Air Quality Chicago
Gentrification Indicator	-1851.165***	649.5795***	144.6708***	-4424.89**	-3047.902***
Year	-1087.58***	164.6057***	30.6036***	-23736.35***	-2457.675***
Gentrification Indicator*Year	51.406	-38.8536	57.7221	-4484.043*	129.7325
Gentrification Indicator*Renter	716.7002***	-298.7293***	189.4953***	16546.48***	592.1975**
Year*Renter	491.0281***	-81.5198***	21.5124	5738.345***	1095.981***
Gentrification Indicator*Year*Renter	455.54	-185.2843**	-90.6618	19921.19***	162.5632
Renter	-1874.86***	173.3497***	85.7803***	-3811.463***	-4235.312***
Length of Residence	-3.0640***	-2.3581***	-3.0351***	181.6362***	9.4858***
Has Children	71.7884**	-49.0524***	-68.5893***	1408.129**	384.8339***
Number of Children in Household	42.8718**	-21.1818***	-32.4131***	823.3542***	8.705
Married	876.4659***	-230.2807***	-229.2663***	6272.84***	1620.219***
Income	-21.8829***	-.077	1.8549***	-31.4916***	3.1232***
Wealth	-1.0910***	.1982***	-.0799***	-36.4608***	-3.522***
Age <25	omitted	80.2023	164.3664***	omitted	omitted
Age 25-29	-98.6108	79.8853***	198.8235***	3069.558***	-173.4875
Age 30-34	-129.2608*	77.6526***	321.5155***	6002.299***	162.0973
Age 35-39	-220.3786***	57.87***	223.9252***	8397.737***	196.5578*
Age 40-44	-83.4704	27.6923***	99.7932***	11442.59***	542.499***
Age 45-49	18.0746	5.5605	45.0686**	11943.39***	366.975***
Age 50-54	167.887***	-34.505***	-2.381	16641.17***	611.8742***
Age 55-59	185.0106***	-51.7507***	-16.295	16859.66***	696.759***
Age 60-65	42.712	-55.7187	-25.279	16879.11***	731.2332***
Age 66-70	-268.2958***	-46.127***	-33.7389**	16633.2***	711.1931***
Age 71-75	-476.593***	omitted	omitted	15348.97***	667.1716***
Age >75	-669.0846***	-40.1388***	-67.2722***	8995.405***	-24.1925
Black	1307.566***	268.1254***	-188.5261***	-3927.311***	-1544.915***
White	1477.516***	162.9668***	450.2***	-2560.576***	181.8839***
Latinx	979.2579***	-325.6228***	392.617***	-6220.119***	5782.318***
Middleeastern	629.7248***	87.3531***	-39.7762	-1237.317	-620.0022***
Asian	2492.036***	624.4743***	201.7328***	-3745.32**	-584.4197***
Native American	233.1432	182.5802*	118.5467	-3211.215	2003.15**
Constant	9515.789***	2273.352***	2725.826***	123030.5***	21009.17***
Observations	376,116	860,343	290,630	304,376	1,243,145
R2	.0232	.0227	.0409	.0319	.041

significant at the *10% level, **5% level, ***1% level

For the Detroit, Cleveland, and Chicago regressions, the coefficient on the gentrification indicator was negative and statistically significant, implying that gentrifying neighborhoods had

a -1851.165, -4424.89, and -3047.902, respectively, change in air toxicity. This result confirms my hypothesis that amenities, like air quality, would be better in gentrifying neighborhoods that had newly moved in residents capable of investing in improved amenities.

However, in the Philadelphia and Baltimore regressions, the effects on air quality from living in a gentrifying neighborhood were positive and statistically significant. These results are not as I hypothesized and could indicate some other confounding variables, such as predominant city industries, influencing air quality. One explanation could be that gentrifying areas require significant development, which could release more toxins and counterbalance the investment going into amenity improvement. Further, even if a neighborhood is improving amenities, air toxicity is affected by pollution blowing in from other places. Thus, facilities generating toxins in other parts of the city could be negatively impacting the air quality in gentrifying neighborhoods.

The time-effect on air quality in Detroit, Cleveland, and Chicago was a -1087.58, -23736.35, and -2457.675, respectively, change in air quality, reaffirming my hypothesis that air toxicity would improve over time. Notably, these results were also statistically significant. In contrast, Philadelphia and Baltimore had negative and statistically significant time-effects on air quality, indicating that over time the air in both cities got more toxic, which again could be due to confounding variables not originally considered.

The coefficient on the triple interaction term across the five regressions, however, lacked any sort of trend. In Detroit, Baltimore, and Chicago the coefficients were not statistically significant, showing that renters were not experiencing less of a decrease in air toxicity as compared to the owners. Renters were likely either not being pushed out by gentrification, which seems unlikely given the results from the school quality regressions, or were moving into neighborhoods that did not have lower quality amenities when it came to air toxicity.

In Philadelphia, the coefficient on the triple interaction term, counter to what I had hypothesized, was negative and statistically significant, indicating that the additional time-effect from living in a gentrifying neighborhood for renters was a change in air toxicity by -185.2843. Renters in Philadelphia could again either be not moving from gentrification or could be moving into areas not facing a dis-investment into air quality.

Finally, in Cleveland the coefficient on the triple interaction term was positive and statistically significant, implying a positive bump of 19921.19, to the time-effect's initial decrease in air toxicity, for renters living in gentrifying neighborhoods. Unlike the other four cities, this result supported my hypothesis that though the toxicity of the air was decreasing over time and in gentrifying neighborhoods in Cleveland, this decrease was not as large for renters who were pushed out of their gentrifying neighborhoods and into other parts of the city that had experienced reduced investment after all of the white flight. This reduced investment could have translated into worse amenities, which the displaced populations then face.

The effects of gentrification on air quality for renters and low-income populations in high white flight cities were not particularly striking. There was no strong pattern indicating that renters were not benefiting as much as owners from a reduced air toxicity in the city's neighborhoods. This result could suggest that renters are not being displaced by gentrification, but that seems unlikely given the evidence surrounding effects on school quality. It is more probable that there are some other confounding variables influencing the air quality of the city more so than movements associated with gentrification. For example, the auto manufacturing industry was a predominant source of revenue for Detroit for much of the 1900s and would have resulted in many factories throughout and around the city releasing pollutants, which could impact the distribution of air toxins in the area.

Air Quality in Low White Flight Cities

After running the air quality regressions for the low white flight cities, I got the results showcased in Table 8: Low White Flight City-level Air Quality Regressions.

Table 8: Low White Flight City-level Air Quality Regressions

	(6) Air Quality Seattle	(7) Air Quality Tampa	(8) Air Quality Houston	(9) Air Quality Albuquerque	(10) Air Quality Richmond
Gentrification Indicator	71348.63***	579.8612***	-30380.83***	8.7299***	-418.0084***
Year	-7183.285***	-22.8914***	1482.496	4.2268***	-543.8023***
Gentrification Indicator*Year	-14220.72***	-127.605***	2977.444	2.235***	134.2162***
Gentrification Indicator*Renter	-47081.25***	-811.1002***	28813.52***	-3.1669***	-75.083
Year*Renter	2482.13***	-6.5629	2444.829	.1846	60.7306***
Gentrification Indicator*Year*Renter	-426.1078	128.9009***	-13150.83	-6.3781***	65.3417
Renter	-17135***	80.3135***	-46738.68***	14.4417***	-657.7596***
Length of Residence	81.6309***	1.5122***	-675.1668***	.0447***	5.8396***
Has Children	714.6911**	1.0339	-613.1955	-.9308***	33.9869**
Number of Children in Household	-.6453	-5.6028**	825.4832	-.3372***	-.697
Married	6190.143***	-73.6572***	23156.46***	-2.8274***	197.4131***
Income	-3.2083*	.9001***	-140.0232**	.0048***	2.7143***
Wealth	-14.5986***	-.057***	3.0113***	.0091***	-.8689***
Age <25	-10153.29***	omitted	16437.35***	-1.227***	omitted
Age 25-29	-8242.517***	19.0863**	9719.48***	omitted	65.383**
Age 30-34	-5834.003***	43.6052***	11203.93***	-.7162***	79.5559***
Age 35-39	-4085.664***	51.4648***	12125.98***	-1.1769***	110.7215***
Age 40-44	-2191.309***	61.5118***	13267.42***	-1.9671***	224.5497***
Age 45-49	-1926.296***	64.1238***	13172.91***	-1.7891***	231.8521***
Age 50-54	-57.0203	77.7328***	11020.38***	-2.2542***	344.2961***
Age 55-59	620.634	76.7135***	10943.27***	-2.0964***	334.1402***
Age 60-65	1258.184***	88.6254***	9039.428***	-2.2701***	360.2052***
Age 66-70	997.1152**	100.9315***	4608.516**	-1.749***	364.6013***
Age 71-75	omitted	93.9718***	omitted	-1.409***	402.8875***
Age >75	-779.4839*	72.0192***	-6623.931***	.7708***	235.5924***
Black	-1104.881***	16.117***	-1196.438	.5968***	-115.1416***
White	-1853.951***	12.9026**	13276.49***	.2953**	-12.2221
Latinx	4998.266***	-81.9875***	12759.76***	-5.0203***	190.592***
Middleeastern	1716.505**	-76.7017***	-13158.74***	.985**	-170.7087***
Asian	12697.32***	-104.6669***	76911.63***	1.1015***	-32.2736
Native American	3505.723	-33.09	39722.41**	-2.2419***	215.048
Constant	70384.49***	775.8834***	119810.5***	10.3084***	3048.686***
Observations	255,718	298,382	1,178,997	232,260	102,994
R2	.1276	.0181	.0061	.2172	.1217

significant at the *10% level, **5% level, ***1% level

In Seattle, Tampa, and Albuquerque, the estimated effect of gentrification on air quality was an increase in air toxicity by 71348.63, 579.8612, and 8.7299, respectively, which could have something to do with city development resulting in more air pollutants. On the other hand,

in Houston and Richmond, the estimated effects of gentrification on air quality were a change in air toxicity by -30380.83 and -418.0084, respectively—both negative and statistically significant values. These results reaffirmed my hypothesis that gentrification in neighborhoods would result in improved amenities, like reduced air toxicity.

As I had hypothesized, the time-effects on air quality in Seattle, Tampa, and Richmond were negative and statistically significant, implying a -7183.285, -22.8914, and -543.8023, respectively, change in air toxicity over time in these cities.

Surprisingly, the time-effect of gentrification on air quality in Houston was not statistically significant, which could suggest a lack in overall improvement of air toxicity throughout Houston, unless the neighborhood is gentrifying. Further, in Albuquerque, the time-effect on air quality was 4.2268, indicating that over time the air actually got more toxic. Though this value was statistically significant, it was also noticeably smaller in magnitude than the coefficients for the air quality regressions performed in other cities, making it hard to compare to the other cities. One explanation could be less variation in air quality across the city of Albuquerque, both over time and in the various neighborhoods of the physical city itself. If this were to be the case, then any changes in air quality would be small in size.

As was seen among the high white flight cities, there was no trend or pattern among the coefficients on the triple interaction terms in the air quality regressions for the low white flight cities. In Seattle, Houston, and Richmond, the coefficients were not statically significant. Renters in these cities were either not being displaced by gentrification in their neighborhoods or were having to move, but were able to move into areas that had no significant drop in quality of amenities, like air. Both renters and owners, whether low-income or high-income, in these cities experienced the same effects from gentrification.

The coefficient on the triple interaction term in the Tampa regression was positive and statistically significant, implying that renters in gentrifying neighborhoods experienced less of a reduction in air toxcitiy over time. This result has two major implications. One, renters in Tampa are most likely being displaced and moving into neighborhoods with worse amenities that have not been kept up. Two, this result is surprising given that I had hypothesized that this adverse effect on air quality for renters would only have been noticeable in high white flight cities. Not only did I see no such trend among the high white flight cities, but also Tampa seems to be showing that renters, even in cities with low white flight, can experience downgrades in amenities like air quality.

Meanwhile, in Albuquerque the estimated additional time-effect on air quality for renters living in gentrifying neighborhoods was a decrease in air toxicity by 6.3781, implying that renters were actually better off than owners in experiencing better quality air. Renters in Albuquerque were not only reaping the benefits of gentrification, but also were experiencing higher quality amenities than those of higher incomes. This could potentially be a result of renters being displaced and moving into areas that were not only just as kept up as their gentrifying neighborhoods, but also perhaps better kept up because they were not touched by the polluting effects that go along with development and gentrification.

These findings, similar to those of the air quality regressions performed for high white flight cities, suggest that there is no strong trend in how the renters in low white flight cities experience the effects of gentrification as compared to owners. In many of these cities renters did not experience any significantly different effect from gentrification than owners. Often they were either not being displaced from their original neighborhoods, or were but due to the lack of dis-investment across city neighborhoods did not have to move into an area with worse amenities.

Comparing Air Quality in High Versus Low White Flight Cities

Air quality was not an amenity that followed any patterns in relation to white flight, as I had hypothesized. Results seemed to indicate that there are various other confounding variables that I have not considered that could be impacting the air quality in a city's neighborhoods. The amount of white flight that a city had does not seem to be a determinant of how gentrification will affect the air quality of a city.

One result that was only unique to low white flight cities was that in some of these cities, renters actually had statistically significant improvements to their amenities that gave them a better off experience with school quality or air quality. Such results imply that the lack of dis-investment in low white flight cities was actually so consistent across neighborhoods, that anywhere a renter were to move to would not give them a downgrade in amenities.

Conclusion

Main Findings

My analysis of the ten cities reveals two main conclusions with respect to school quality; with respect to air quality the conclusions do not hold. As revealed, air quality does not seem to be felt differently by those of different incomes, regardless of how much white flight the city experienced.

One conclusion, among cities with a high amount of white flight, is that renters do experience a downgrade in quality when it comes to amenities like schools. I hypothesize that this downgrade occurs because renters and low-income populations are displaced and forced to move into city neighborhoods that have not been kept up as well, which leads to my second main conclusion. I do think there had to have been dis-investment in these high white flight cities post-World War II. This dis-investment would account for why renters experienced less of an increase in school quality when compared to owners who most likely did not have to move out of their neighborhoods because of gentrification and increasing rent prices. On the other hand, some low white flight cities had continued investment throughout the city to such a strong degree that when renters were displaced, their experience of amenities actually went up.

This is not to say, however, that cities that did not experience white flight did not also have adverse effects from gentrification on low-income people. As was shown in a few cities, renters in gentrifying neighborhoods of low white flight cities did at times also experience a downgrade in amenities similar in size to the downgrade in high white flight cities.

Limitations

Firstly, the analysis of this thesis is limited to ten cities. With the inclusion of a larger number of cities, I would have been able to make greater and broader conclusions concerning the

effects of gentrification on renters and displaced people, would have been able to identify more sweeping trends among cities with high and low white flight, and could have balanced out some of the cities that stood out as outliers.

Second, the scope of the thesis was also limited in that it only looked at two amenities, school quality and air quality. With data on other amenities, such as crime rate for example, perhaps even more significant conclusions on the effects of gentrification on displaced people could have been reached.

Third, I used 2013 values of RSEI as a proxy for air quality in 2018 as well. Though not necessarily wrong, doing so does not account for any big air quality changes that could have majorly affected certain neighborhoods within a city. Further, because there was no data on school quality from previous years, 2019 data had to be used as a proxy and thus the school quality measurement was from a later time than when people were moving in the model.

Policy Implications for Cities Undergoing Gentrification

While gentrification is inevitable, as it provides an opportunity to abandoned cities for economic development and growth, certain factors must be considered by governments seeking to ensure the social welfare of all of their citizens. Though gentrification is associated with improvements in amenities, these improvements do come with caveats. Generally, gentrification is associated with increasing school quality, but it could also lower school quality because of the disincentives that people moving into the city have to invest in public schools. Further, air quality itself could also get worse if the development that comes alongside gentrification is releasing harmful pollutants into the air.

That all being said, even if amenities are overall improving in gentrifying neighborhoods, governments must find ways to enable renters to also be able to benefit from these improved

amenities and not get pushed out into areas that have worse amenities because of a lack of upkeep. These groups are often not only low-income, but also more commonly black, Hispanic, or a part of another minority group. Thus it is people of color that are disproportionately bearing the burden of displacement and gentrification.

Some solutions that governments could employ to reduce this burden from gentrification could be to subsidize rent payments for renters living in neighborhoods experiencing significant increases to prices and the cost of living. In this way, renters could remain in their neighborhoods and not be pushed out by gentrification and the higher costs associated with it. Governments could also create or at least preserve, cheap, public housing options as another way for low-income residents to remain in their neighborhoods and not be pushed out by the increasing prices.

Finally, city governments should consider regulating business investment within the city, taking into account community opinions and zoning considerations. This move would not be to stifle investment and growth, but rather ensure that investments are going into the right areas and in a way that will not harm the residents that already live nearby.

Future Research

Because the analysis on air quality was so unique and did not seem to follow any pattern or trend, it could be interesting to analyze what other factors influence the air quality of a city, like the industries in that city. Evidently, gentrification patterns are not the only thing that affect changes in the experience of air quality by residents, which could be something worth learning more about.

One area of research, which I unfortunately did not have the resources to take on, was the effect of gentrification on the crime rate; more simply, whether moving increases the amount of

crime a family or household experiences. Due to the lack of centralized data on crime rates, especially at the block group level, looking at these effects across cities was not possible for me to carry out, but could be an important next step in analyzing the full picture of how gentrification affects the displaced. Additionally, with unlimited time and resources, it would have been interesting to analyze the impact of white flight in a city on how unequal the amenities and the distribution of said amenities are in cities that are beginning to gentrify. Doing so would look into the choices available to city's residents among its various neighborhoods and whether these choices are more equal or unequal, instead of exclusively what the actual experience of the amenity was.

I also believe that further study, with more cities, is necessary to capture a fuller picture of how gentrification is playing out in cities across the country and to identify how much of a role previous white flight in that city is having. Right now this thesis only has a first glance at how the effects of gentrification may vary from city to city. And though it goes into the trends related to the white flight of the ten cities, this is only the beginning of that discussion.

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Appendices

Table A1: Cities and Zip Codes	
City	**Zip Codes**
Detroit, MI	48201, 48202, 48203, 48204, 48205, 48206, 48207, 48208, 48209, 48210, 48211, 48212, 48213, 48214, 48215, 48216, 48217, 48219, 48221, 48223, 48224, 48225, 48226, 48227, 48228, 48234, 48235, 48236, 48238, 48239, 48240, 48243
Philadelphia, PA	19102, 19103, 19104, 19106, 19107, 19110, 19111, 19112, 19114, 19115, 19116, 19118, 19119, 19120, 19121, 19122, 19123, 19124, 19125, 19126, 19127, 19128, 19129, 19130, 19131, 19132, 19133, 19134, 19135, 19136, 19137, 19138, 19139, 19140, 19141, 19142, 19143, 19144, 19145, 19146, 19147, 19148, 19149, 19150, 19151, 19152, 19153, 19154
Baltimore, MD	21201, 21202, 21205, 21206, 21207, 21208, 21209, 21210, 21211, 21212, 21213, 21214, 21215, 21216, 21217, 21218, 21222, 21223, 21224, 21225, 21226, 21227, 21229, 21230, 21231, 21234, 21236, 21237, 21239
Cleveland, OH	44102, 44103, 44104, 44105, 44106, 44107, 44108, 44109, 44110, 44111, 44112, 44113, 44114, 44115, 44117, 44119, 44120, 44121, 44122, 44126, 44127, 44128, 44129, 44134, 44135, 44142, 44144
Chicago, IL	60601, 60602, 60603, 60604, 60605, 60606, 60607, 60608, 60609, 60610, 60611, 60612, 60613, 60614, 60615, 60616, 60617, 60618, 60619, 60620, 60621, 60622, 60623, 60624, 60625, 60626, 60628, 60629, 60630, 60631, 60632, 60633, 60634, 60636, 60637, 60638, 60639, 60640, 60641, 60642, 60643, 60644, 60645, 60646, 60647, 60649, 60651, 60652, 60653, 60654, 60655, 60656, 60657, 60659, 60660, 60661, 60706, 60707, 60803, 60804, 60805, 60827
Seattle, WA	98101, 98102, 98103, 98104, 98105, 98106, 98107, 98108, 98109, 98112, 98115, 98116, 98117, 98118, 98119, 98121, 98122, 98125, 98126, 98133, 98134, 98136, 98144, 98146, 98154, 98161, 98164, 98174, 98177, 98178, 98199
Tampa, FL	33602, 33603, 33604, 33605, 33606, 33607, 33609, 33610, 33611, 33612, 33613, 33614, 33615, 33616, 33617, 33619, 33621, 33629, 33634, 33637, 33647
Houston, TX	77002, 77003, 77004, 77005, 77006, 77007, 77008, 77009, 77010, 77011, 77012, 77013, 77014, 77015, 77016, 77017, 77018, 77019, 77020, 77021, 77022, 77023, 77024, 77025, 77026, 77027, 77028, 77029, 77030, 77031, 77032, 77033, 77034, 77035, 77036, 77037, 77038, 77039, 77040, 77041, 77042, 77043, 77044, 77045, 77046, 77047, 77048, 77049, 77050, 77051, 77053, 77054, 77055, 77056, 77057, 77058, 77059, 77060, 77061, 77062, 77063, 77064, 77065, 77066, 77067, 77068, 77069, 77070, 77071, 77072, 77073, 77074, 77075, 77076, 77077, 77078, 77079, 77080, 77081, 77082, 77083, 77084, 77085, 77086, 77087, 77088, 77089, 77090, 77091, 77092, 77093, 77094, 77095, 77096, 77098, 77099, 77201

Albuquerque, NM	87102, 87104, 87105, 87106, 87107, 87108, 87109, 87110, 87111, 87112, 87113, 87114, 87116, 87120, 87121, 87122, 87123
Richmond, VA	23219, 23220, 23221, 23222, 23223, 23224, 23225, 23226, 23227, 23230, 23231, 23232, 23234, 23235, 23298

Summary A2: Zip Code Selection

I did not include the zip codes designated for P.O. boxes as these would not provide any information on the physical address or location of a resident of the city and thus would also not reveal anything about the amenities and features near the place of residence.

Summary A3: Info USA Compiled City Data Cleaning

I first dropped observations in the city's compiled Info USA data file that did not have a value for latitude or longitude, as these would not be helpful in tracking the movements of individuals. I also dropped observations that were classified as being vacant, that did not have the relevant city name in place for the city variable, or that were of location types "N" (nursing home), "T" (trailer), or "U" (undefined). I also dropped several variables that would not be useful in my analysis; these variables were not included in Table 2: Info USA Variables and Descriptions.

Based off of previous undergraduate thesis work (Ameri, 2019) I created a few new variables based off of the variables that already existed. The owner_renter_status variable was on a scale of zero through nine to represent the likelihood that the household rents or owns their home, with higher numbers meaning a higher likelihood that the household was an owner. To simplify it, I created a binary variable, renter, which equals one and signifies a renter if the owner_renter_status variable is less than five and equals zero otherwise. Similarly, marital_status was on a scale of zero through six, with greater numbers representing a greater likelihood that the head of household was married. I created a binary variable, married, equal to one if marital_status was greater than four and equal to zero otherwise.

Using the given ethnicity_code_1 variable, I also created several binary variables labeled black, white, latinx, middleeastern, asian, and nativeamerican that took on the value of one if the head of household's ethnicity code corresponded to that variable's ethnicity label. I took a similar approach with age of the head of household, creating binary variables to categorize each age group, including less than 25, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-65, 66-70, 71-75, and greater than 75, with the variable taking on the value of one if the head of household's age matched that of the age group.

Finally, I create a binary variable "Year," which equals zero if the year of the observation is 2013 and equals one if the year of the observation is 2018.

Summary A4: Creating Interaction Variables

I first created an interaction variable that multiplied the value of the "Gentrification Indicator" variable with the "Year" variable to create a new binary variable. Second, I created a

variable that multiplied the value of the "Gentrification Indicator" variable with the "Renter" variable to create another new binary variable. Third, I created an interaction variable that multiplied the value of the "Year" variable with the "Renter" variable, thereby creating another binary variable. Finally, I created a triple interaction term, also binary, that multiplied the values of the "Gentrification Indicator" variable, the "Year" variable, and the "Renter" variable.

Summary A5: School Quality Data

To find school quality data, I used GreatSchools.org, which rates schools on a scale of 1-10, to find all of the public and charter elementary schools in a city along with their rating and latitude and longitude coordinates. This information was up to date and had the rating and location of the school as of 2019. An important thing to note about this school quality data is that because I use ratings from 2019 as a proxy for the school quality in 2013 or 2018, it does not account for how these qualities may have changed over time, which is important to consider given that I hypothesize how these qualities may be affected by time and gentrification and could have very well changed greatly from 2013 to 2019. Given the lack of access to ratings from previous years, however, using 2019 values as a proxy is necessary. Using R Studio, I mapped all of the schools in a city as well as the coordinates of all the households I had for a city from Info USA to find the average rating of the three closest schools to each household. By assigning each observation a school quality, creating a variable for school quality, I would be able to see if a family were to move, if their school quality would also change.

Summary A6: Air Quality Data

For air quality, I took data collected by the United States Environmental Protection Agency on Risk-Screening Environmental Indicators (RSEI), which assigns a higher number to a census block group, the more toxic the air quality is. The Duke Economics Department has already scraped these RSEI values up through 2013 across all census block groups in the United States. Because the RSEI value for an area does not change greatly from year to year, I used the 2013 values as a proxy for all years and matched the block group of each observation unit to its corresponding RSEI value to get a measure of air quality. I had two variables called rsei and ln_rsei, the log of the rsei value, to represent these air quality numbers.