How does transit-oriented development affect a neighborhood?: A look into gentrification and displacement

by

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B.S., Kwame Nkrumah University of Science and Technology, 2015

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF REGIONAL AND COMMUNITY PLANNING

Department of Landscape Architecture, Regional and Community Planning
College of Architecture, Planning and Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2021

Approved by:

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Abstract

The construction of light rail transit lines accompanied by transit-oriented developments improves neighborhoods and makes them attractive and desirable. These developments can also cause property values and rents to go up, making it difficult for low-income residents to stay, which can cause transit-oriented gentrification, as identified by some studies. Historically, low-income households have benefited from living close to station areas since they get cheap and easy accessibility to places. Hence, the vulnerable, including low-income households, adults with lower levels of education, and historically marginalized races, remain at risk of displacement when there is a socio-economic change to a more affluent group around these station areas.

Previous studies have always sort to identify gentrification and displacement in low-income and dominated historically marginalized race neighborhoods. However, there have been a lot of challenges for researchers finding the right data and methods to measure gentrification and displacement. This study using simple local percentage share identifies gentrification and displacement in a moderate-to-high income white dominated neighborhood along the Southwest Light Rail Line in the Denver area. The study also tries to identify if the few vulnerable people in the neighborhood are displaced after a new transit development is introduced.

The study adopts a pretest-posttest analysis to predict if the corridor undergoes gentrification before the construction of the LRT or after it is built. The study spans from 1990 to 2018 with analysis on changes in 1990-2000, 2000-2010, and 2010-2016. Two methods using simple quantitative analyses like percentage change, local percentage share, absolute figures, and location quotient are employed in this study. The first method uses the conventional method to identify gentrification, which scholars like Freeman (2005) and Chapple et al. (2017) have also used. The conventional method showed that the corridor was susceptible to gentrification

through the study period but did not find the area to be gentrifying though there were signs of it. The flaw of the method ignoring the local shift from previous years influenced the adoption of the local share method.

The local share method rather showed that the corridor gentrified in the 2010-2016 decennial period. The local share method identified gentrification by showing that the there is a five percentage point changes in the share of low-income households; share of adults with high school certificates or lower; the share of multi-family units; and the percentage increase of rent from the previous period. The study shows the share of adults with high school certificates or lower continuously reduced from 50% to 27% by the end of the study. Also, it was observed that before the construction of the LRT line in 2000, rents reduced to $785 but increased exponentially after the line was built to $1332. The study observed that, the share of new houses and multi-family units begun to increase after the opening of the line. The share of low-income households at the end of the study remained the same as the beginning, whiles the share of high-income households increased by 7 percentage points at the end of the study. No evidence of displacement was observed among non-white race and low-income households along the corridor. However, the reduction in the share of adults with high school certificates or lower and low-income households, whiles those with some college education and middle-income households remained the same, shows that there were some forms of displacement.

This study also shows that in unique places like Denver, the conventional method of identifying gentrification and displacement does not show the true characteristics of transit induced gentrification as the local share method does. Also, the study shows that the construction of a new transit infrastructure may not be so hostile to historically marginalized races and sometimes bring about racial diversity as observed along the LRT corridor.

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Acknowledgments

I want to thank the Almighty God for His abundant grace and for granting me the wisdom and strength to write this thesis. I also like to thank my siblings, especially my brother Emmanuel Ofori, for all the support they have given me through my entire educational career. I thank my colleague Julie Baniqued for all the support and great project collaborations we did in the classroom and on our community engagement roles. I also like to thank Grace Benedick and Carol Russell for helping me edit my thesis. I thank Jody Hodges, Anne Beamish, Ph.D., and Stephanie Rolley, Ph.D., for their outstanding departmental support and assistance. I also like to express my sincere gratitude to Debra Bolton, Ph.D., for her big heart and for always opening her doors for me. I thank Gregory Newmark, Ph.D., for his unending support and guidance throughout my graduate program, especially preparing my final dissertation. Again, a big thank you goes to my committee members Susmita Rishi, Ph.D., and MD Shakil Kashem, Ph.D., for their tireless effort in making this dissertation a success. Lastly, I like to thank the African Students Family here at K-State for creating a friendly environment that enabled me to have an enjoyable educational journey.

God bless you all!

Dedication

I dedicate this thesis to my mother, Agnes Abena Serwaa, and my lovely wife, Margaret Safoah, for their prayers, love, and encouragement throughout my graduate program.

Chapter 1 - Introduction

The aim of my research is to explore whether the construction of a light rail line in neighborhoods southwest of Denver to gentrify and, if so, how and when it happened. Additionally, this research seeks to identify what happens to the socio-economic characteristics of a neighborhood when a new transit infrastructure is introduced. This study specifically adds to the literature on gentrification, how to use simple statistical tools to determine if low-income households and historically marginalized races along transit stations are displaced and how the neighborhood changes.

Gentrification is a term first defined by Ruth Glass as the process of class succession and displacement in areas broadly characterized by the working class. It has evolved to now include the displacement of people in transit infrastructure neighborhoods, which has been given the term transit-induced gentrification (Yunlei, 2020). For this study, gentrification is studied in transit-oriented developments (TOD) neighborhoods along the Southwest Light Rail Transit line in Denver (LRT). Transit-Oriented Developments are developments in a half-mile radius or high density and mixed-use buildings around rail transit stations that are pedestrian and bicycle-friendly (Chatman, 2013). They have strong potential to improve urban development, improve air quality, preserve open spaces, provide affordable houses, and improve the living conditions of low-income households (Cervero, 2004; Debrezion et al., 2006; Haas et al., 2016; The Center for Transit-Oriented Development, 2009; Transportation Research Board & National Academies of Sciences, Engineering, and Medicine, 2004). However, numerous studies have found TODs causing increased rents and homes prices and other going to the extent causing gentrification and displacement (Baker & Lee, 2019; Bates, 2013; Cao & Lou, 2018; Chapple et al., 2017; Chapple & Loukaitou-Sideris, 2019; Chapple & Thomas, 2020; Diaz, n.d.; Duncan, 2011b; Grube-Cavers

& Patterson, 2015; D. B. Hess & Almeida, 2007). Some gentrification researchers have gone further to classify displacement into direct or indirect (exclusionary). Direct displacement is when an influx of new residents causes rent prices to increase and force the incumbent residents to leave (Atkinson, 2000). Indirect or exclusionary displacement has also been defined as when current neighborhood conditions prevent some residents from moving in or the incumbent resident feels excluded (Burns et al., 2012; Chapple et al., 2017).

The study of gentrification has become popular over the past decades because of the negative connotations like the involuntary residential displacement it causes. Authors like Zuk et al. (2018) and Chapple and Loukaitou-Sideris (2019) hypothesize that gentrification may result from the investment or disinvestment of a neighborhood. Public transit, especially light rail transit over the past two decades, has been one of the leading public investment tools used by the United States government to reduce auto-dependency (Zuk et al., 2018). The LRTs are accompanied with these TODs tend to improve neighborhoods and make them more attractive and desirable, which also causes property values and rents to go up (Baker & Lee, 2019; Bates, 2013; Debrezion et al., 2006; Sanchez et al., 2003). In other cases, neighborhood conditions like housing, neighborhood experience, and commercial activities change to favor only the affluent groups moving in at the expense of the remaining low-income households (Burnett, 2014; Duncan, 2011b; Ellis-Young & Doucet, 2021). The chances of low and moderate-income families living close to transit station areas, which have historically provided cheap and easy access to opportunities, are hindered due to the influx of these affluent groups (Sanchez et al., 2003). The idea of new transit system causing gentrification has caused multiple researchers to investigate how rail development may have caused station areas to gentrify and potentially

displacing the vulnerable (Cao & Lou, 2018; Cervero & Duncan, 2002; Chapple & Loukaitou-Sideris, 2019; Deka, 2017; Jackson & Buckman, 2020). This research seeks to do the same.

However, gentrification studies are challenge with the right way to measure if a neighborhood is gentrifying and displacement due to varied definitions and difficulties in finding the right data, Also, a heavy focus has been made on the changes in low-income neighborhoods after transit investments are introduced. Little attention is given to the socio-economic effects on the few minority groups in moderate- to high-income neighborhoods which also receive transit infrastructure. Also, gentrification and displacement studies have heavily focused on identifying which census tracts are gentrifying or vulnerable to gentrify with little focus on when the gentrification process started and how. Knowing when low-income households or the vulnerable are likely to be displaced due to a transit investment will inform developers, policymakers, planners, and the government on the stages interventions for curbing such situations are needed. This research therefore uses a simple local percentage share method to identify gentrification and displacement over a period before the light rail line was constructed and 18 years after its construction.

This research uses a pretest posttest study of neighborhoods around five-station areas on the Southwest Light Rail Transit line in Denver, Colorado, that opened as an extension in 2000 to investigate if gentrification and displacement have occurred and how. The LRT line lies parallel to the famous Santa Fe Drive in Denver and two rail lines. The Regional Transportation District (RTD) of Denver has proposed to extend the Southwest LRT by adding 2.5 miles of rail and a station at the end of the line by 2040, which makes it important to assess the impact of the existing line after two decades of its construction. This study will therefore inform RTD, the local planners, and the local government on how the announcement and development of the

existing line caused the station areas to become vulnerable to gentrify or even displaced people. This study uses quantitative methods like simple percentage change, location quotient, and local share to determine the neighborhood change and possible displacement before and after the construction of the LRT.

Research Questions

The broad aim of this research is to identify if the construction of the Southwest Light Rail Transit line in the southwestern part of Denver, Englewood, and Littleton caused the station areas to gentrify and if they did, when and how? This research also seeks to propose a simple statistical tool to measure gentrification and displacement.The questions that this research hopes to answer are:

i. Has the construction of the light rail line caused gentrification along the corridor?
ii. Did the change (gentrification) occur before or after the LRT was constructed?
iii. Have low-income and historically marginalized race (non-whites) been displaced from the corridor?

The answers to the questions above will then help us:

i. To understand if the construction of a light rail transit line gentrifies a neighborhood
ii. To know when changes (gentrification) take place
iii. To identify if low-income, historically marginalized races are displaced
iv. To determine which variables easily can be used to predict gentrification

Definitions of Gentrification

Hamnett (1991) iterates that before one can assess and evaluate gentrification, it must first be defined, and the criteria for detailed explanation established. Ruth Glass, a British sociologist, first used gentrification when she saw that a group of affluent men in a working-class neighborhood in central London was becoming dominant in 1964. Gentrification has since then been defined in so many ways. The definition of gentrification now includes many more potential gentrifiers. Smith (1982, p. 139) described gentrification as "a process by which working-class residential neighborhoods are rehabilitated by middle-class homebuyers, landlords, and professional developers." Two types of gentrification ideologists were observed in the 1980s. They are those who saw gentrification to be localized and purely temporary, or those who saw it to be part of an urban and inner-city revitalization after people were returning to the city from the suburbs (Smith, 1982). Smith (1982) concludes that the two positions are only crucial after considering uneven development at the urban scale. His understanding of gentrification was rooted in the capitalist's idea of economic disequilibrium in the urban centers, which allows for home conversion to appease the affluent. Smith's (1982) stance can be related to modern definitions of gentrification, where authors have related it to the influx of middle or upper-income groups to disinvested neighborhoods (Freeman, 2005; Zuk et al., 2015).

Succession ideologist researchers have also identified gentrifiers by investigating various characteristics. The forms of gentrification identified by previous researchers have changed and metamorphosized over time (Burns et al., 2012), causing us to have a range of definitions from pure economics to demography and other hybrids of these ideas (Chapple, 2009). The economic definitions mostly have to do with the changes in income levels, housing investments, or the change in tenure. In addition, the demographic shift could be an influx of white households,

college-educated residents, and families without children (Chapple, 2009). Freeman (2005) emphasizes that education is a better marker of class than income since income fluctuates easily whiles education levels are more stable for adults (persons over 25 years). The use of income alone to measure gentrification also runs into problems when the new residents are recent graduates, current students, or newly married couples (Ding et al., 2016).

The definition of gentrification is essential since it determines the approach you use and the results you get (Yunlei, 2020). Some researchers find gentrification to be beneficial in that it revitalizes the neighborhood, and the residents benefit from that though the negative consequences can outweigh the good ones (Sanchez et al., 2003). There is the need to differentiate between revitalization, which Chapple (2009) defines as the improvement in neighborhood's income resulting from new residents or the changes for existing residents and gentrification. Gentrifying neighborhoods are those with changes in high-income households, college-educated people, families without children, amongst others more than the region (Chapple & Loukaitou-Sideris, 2019; Freeman, 2005).

The use of college education attainment, high-income households, and others help identify neighborhoods that are changing but cannot directly identify displacement. The use of eviction data (Delmelle et al., 2021) and longitudinal data (Ding et al., 2016; Freeman, 2005) are ways involuntary displacement can be traced. The demolition of old buildings to make way for condominiums or high-rise buildings also leads to direct displacement, hence gentrifying neighborhoods (Shin et al., 2016). This trend of gentrification has been witnessed in the Global East (Asia). These changes may not be seen as the class of gentrification Ruth Glass was talking about, but the neighborhood eventually welcomes affluent people and displaces the poor.

Shin et al. (2016) argue that we have moved from the time gentrification was only seen in industrialized Western cities and at particular times. It is now seen as the commodification of space and land-use changes that go with it, displacing existing residents by the more affluent group (Burnett, 2014; Shin et al., 2016). The term redevelopment was used in countries like South China and Korea until the word 'new build' gentrification was coined (Shin et al., 2016). This shows that gentrification may only be identified unless a critical study is done to understand the changing neighborhood.

Gentrification can have so many definitions, but the common questions are: were the low-income residents displaced, by whom, when, and how? The criteria used to identify gentrification have always been to identify places with a median income lower than the metropolitan area or places with most low-income households (Freeman, 2005; Zuk et al., 2015) but have not considered a neighborhood with historically low educated households. This research, therefore, defines gentrification as the one by Chapple (2009, p. 2) as the "process of neighborhood change that encompasses economic change in the form of an increase in both real estate investment and household income, as well as demographic change in the form of an increase in the educational attainment." Gentrification has been seen to be a result of those who move in into a neighborhood (Brown, 2015), so it is equally important to look at the decrease in the share of vulnerable groups and the increase in the share of proxies of gentrification.

Typically, low-income families tend to benefit from living closer to transit stations because of the ease of accessibility. Notwithstanding, transit-oriented gentrification, a term meaning the process of socio-economic change around station areas to a more affluent one, is liable to happen when there are more low-income households are living around these transit station areas (Brown, 2015; Chapple, 2009). The existence of the low-income households along

station areas makes them vulnerable to be displaced to more affluent people who move in to enjoy the diversity and vibrancy that transit stations provide. This research, therefore, seeks to look into changes the construction of the LRT in a moderate-to-high-income white-dominated neighborhood brought to the corridor and if the few low-income households were displaced.

Which Comes First, Gentrification or Displacement?

The different definitions of gentrification across research make it difficult to identify a simple way how gentrification works. Ruth Glass identified gentrification as a complex urban process that included rehabilitating old buildings, increasing property values, changing from renters to owners, and the displacement of the working class by the affluent who move in (Lees et al., 2008). Residential displacement which is the movement of people from their homes can be dated back to the mid-twentieth century when federal urban renewal, local redevelopment, and interstate highway construction were used to clear away black neighborhoods and low-income communities in urban centers (Zuk et al., 2018). This created a lot of concern amongst gentrification researchers and housing advocates about the government activities that cause the direct displacement of people. The nature of displacement changed from the forced removal of people by federal policies to the 'back to the city' trend caused by private actions and individuals preferences in 1970 (Zuk et al., 2018), including condo conversion (Lees et al., 2008).

Zuk et al. (2018, p. 35) argue that gentrification-induced displacement studies treat the issue of displacement lightly by only looking at "last resident displacement." However, gentrification can occur long after "abandonment-induced displacement" (Chapple et al., 2017, p. 27). The abandonment-induced displacement occurs when properties are left to decay when the value of the properties cannot compensate for the maintenance of the property. The authors

note disinvestment displacement, reinvestment displacement, and displacement caused by enhanced market competition are categorized causes of gentrification. They concluded that the types of displacement were seen to be successive of one another when disinvestment displacement resulting from the value of a property not being worthy of investing leads to abandonment and vacancies. Properties were purchased cheaply and then reinvested into, causing reinvestment displacement. The rehabilitated houses then gain high rents to the point residents have to move out to be sold for higher profits. This process shows that displacement can occur before gentrification begins. This is explained further by Freeman (2005) that succession studies can only show that gentrification is happening but cannot demonstrate its impact on displacement without additional information like why the displaced move and the neighborhood dynamics causing the movement. Therefore, it is important to look at the disinvestments in a neighborhood and their resulting opportunities for reinvestment which can cause displacement which makes neighborhoods prone to gentrification (Freeman, 2005; Marcuse, 1985; Zuk et al., 2018).

Though disinvested displacement may not be able to depict any sign of gentrification, reinvestment and enhanced market competition can lead to, what scholars calls, direct displacement (Zuk et al., 2018). The general definition of displacement as the physical movement of people now includes social, cultural, and political dimensions of neighborhoods (Rayle, 2015, p. 539). Current researchers from around the globe have also classified new-build gentrification, which is seen as similar to the US urban renewal, as direct displacement and has termed it as “development-induced displacement” (Chapple & Loukaitou-Sideris, 2019). This form of gentrification has been seen in South Korea and China, where rapid urbanization causes wholesale demolitions and reconstruction of neighborhoods (Shin et al., 2016). In Cambodia and

the Philippines, railway lines' construction has also been seen to have relocated, and force evicted people to places far from their jobs (Chapple & Loukaitou-Sideris, 2019).

Chapple & Loukaitou-Sideris (2019) continue that displacement can occur due to market failure where the market cannot produce enough houses for new residents who want to move in. The inability of households to move into a dwelling unit due to conditions beyond the neighborhood control, especially price increase in housing, is “exclusionary displacement” (Chapple & Loukaitou-Sideris, 2019; Rayle, 2015). Whites, affluent groups, and people with high status have easily moved into gentrifying neighborhoods while low-income people cannot, which confirms exclusionary displacement (Atkinson, 2000; Chapple & Loukaitou-Sideris, 2019; Ellen & O’Regan, 2011; Freeman, 2005).

However, some authors have also found it very difficult to identify displacement caused by gentrification (Ellen & O’Regan, 2011). Ellen & O’Regan (2011), using the longitudinal unit/household-level data from the American Housing Survey and census tract data from the decennial census, observed the existing rates of low-income households in neighborhoods that are seen to be gaining economically. The authors identify that new homeowners were 28% more affluent than the old residents. Though it had been argued by other authors that majority renter neighborhoods are more likely to gentrify, Ellen & O’Regan (2011) identified that all raising average income is as a result of higher-income homeowners moving in and not renters. In a quest to see if low-income people move out, the authors also find no evidence of low-income renters exiting neighborhoods that were economically gaining. Instead, they find that renters moving out had slightly higher incomes. Their finding is supported by housing advocates who have found that poor renters are less mobile than those who can afford to move (Goetz, 2018).

Chapter 2 - Literature

Common Concerns of Gentrification and Displacement

Gentrification has its own positive benefits but becomes an issue when neighborhoods attract more affluent residents and increases rents, and make property values unbearable (Bates, 2013). As rents and property values go up, low-income residents often become incapable of paying their rents in that neighborhood and must leave to place they can afford to live there. In some cases, they are pushed out by people who can afford the higher rents (Burns et al., 2012; Chapple & Loukaitou-Sideris, 2019; Shin et al., 2016). Chapple & Loukaitou-Sideris (2019) and Burns et al. (2012) identify displacement as a result of eviction and an indirect result of exclusionary action. Someone immersed so much in a neighborhood where they have grown up would feel different when the area suddenly changes. Studies have shown that residents who remain in a gentrifying community who have strong connections with where they live are affected psychologically (Burns et al., 2012).

Hamnett (2003) argues that a reduction in the working-class population over time is not necessarily displacement but rather a replacement. He, therefore, justifies his argument by saying:

> "If it is assumed that the average working life of an individual is 40 years (from age 20 to age 60), the entire labor force will turn over and be replaced during a 40-year period, and a quarter will be replaced every 10 years. Consequently, a high proportion of the manufacturing labor force in 1961 will have disappeared by 1991 or 2001. They will have either retired, moved out or died. This change will have taken place as a result of long-term industrial and occupational change, not necessarily as a result of gentrification *per se."* (Hamnett, 2003, p. 2421)

This statement is evident in most studies where no or little correlation is found between gentrification and displaced residents (Chapple et al., 2017; Chapple & Loukaitou-Sideris, 2019), which most authors have blamed on a lack of data regarding displaced people. However, when

the shift is coupled with increasing rents and change in taste of the neighborhood, it does not only remain replacement but gentrification.

Other studies have also found that gentrification has a more significant impact on closer commercial properties than residential homes (Debrezion et al., 2006). In some cases, only commercial properties gentrify even amid poor residents (Burnett, 2014). For reasons like these, (Bates, 2013) suggests that today's approaches to gentrification should not be so limited and must include racial /ethnic equity, effects of public investment, and the public sector's interference in the change process. These fundamental questions, amongst others, are what triggers scholars to look into gentrification and displacement. There have also been many concerns about how transit lines, stations, and systems increase land premiums in surrounding neighborhoods, further discussed in the following sections.

Gentrification and Transit

Prospects of TODs

Accessibility - the capability to reach opportunities – forms a great part of humans well-being in modern society (Gorham, 2002). This has called for planners to continuously finding ways and policies that would allow for walkable and transit-rich neighborhoods. This has resulted in the increased development of location-efficient neighborhoods (Haas et al., 2016).

Location-efficient neighborhoods are those that have good access to transit opportunities and easy mobility. Haas et al. (2016) define them as "places associated with lowest transportation cost characterized by high levels of accessibility to jobs and services that enable residents to drive less either by making shorter trips or shifting trips to transit, walking and bicycling." Until about a decade ago, low-income households mostly lived closer to transit stations since they normally cannot afford to travel long distances to transit stations. Newmark & Haas (2015) have also

identified that poor-income groups make better use of these location-efficient spaces since there are various cheap mobility means. Some good examples of location-efficient neighborhoods are buildings in a half-mile radius or high density and mixed-use buildings around rail transit stations that are pedestrian and bicycle-friendly, which Chatman (2013) terms as Transit-Oriented Developments (TODs), can be good examples of location-efficient neighborhoods.

TODs make neighborhoods attractive, provide affordable housing, varied mobility choices, and improve environmental performances (The Center for Transit-Oriented Development, 2009). They have also been seen as a means to curb sprawling, promote smart growth and a means to bring some vitality to struggling inner-cities (Transportation Research Board & National Academies of Sciences, Engineering, and Medicine, 2004). The attractiveness of a neighborhood is seen to be enhanced when it provides residents with a greater means of accessibility, walkable streets, and other attractive places (Debrezion et al., 2006; Haas et al., 2016). And this is seen as the true definition of a place - Duncan (2011b) observed in Atlanta. Throughout history, human beings have sought residence near entertainment centers and cultural facilities (Hamnett, 1991), which most TODs provide. Also, it is identified that neighborhoods with TOD features like walkable streets, transit access, and a mix of housing, jobs and shops spend 9% of their household budgets on transportation while an average household spends 19% and auto-dependent household use 25% of their income (The Center for Transit-Oriented Development, 2009).

However, living close to rail lines can be despised because of the ‘negative externalities’ or ‘nuisance effects’ like noise and pollution associated with them (Wardrip, 2011). Despite these reasons, houses, properties, and lands near rail stations usually have higher values (Diaz, n.d.; Duncan, 2011a; Hess & Almeida, 2007), which can benefit the neighborhoods, economy,

and development (Sanchez et al., 2003). These upgrades can be detrimental to low-income households when more affluent families are attracted to such TOD neighborhoods (Chapple & Loukaitou-Sideris, 2019). Most gentrification studies have only looked for evidence of neighborhood change and the socioeconomic effects of rail lines after they are constructed (Deka, 2017). Yet, very few have found empirical evidence of low-income households been displaced as a result of the construction of a LRT. Also, not so many studies have looked at what changes occurred before the infrastructure was built or after the announcement of the project.

Commonly, low-income groups, Blacks and Hispanics, have lived closer to transit stations, making them more susceptible to gentrification (Burns et al., 2012; Chapple, 2009; Rayle, 2015). Living close to transit stations helps low-income households with limited travel options to travel to places using transit and, therefore, they should be given the opportunity to remain in their neighborhoods. It is estimated that the demand for housing near transit will increase from 6 million to 15 million households by 2030 (Fogarty & Austin, 2011), leading to high demand for TODs. The question then is, who are the households who will move to the TOD areas? Affordable housing has been seen as a measure to safeguard low-income households living in TODs (The Center for Transit-Oriented Development, 2009), and they should be increased. CTOD (2009) further concurs that affordable mixed-income houses near TODs save households 16% of their household budget, making it a necessity for low-income earners.

TODs, Gentrification, and Displacement

The process of gentrification may begin along TODs when a neighborhood positions itself in response to the construction or improvement of a transit project. They have a high possibility of increasing rents and property even before completing the projects depending on the neighborhood's policies and local dynamics (Chapple et al., 2017; Zuk et al., 2018). Though it

has been challenging for researchers to relate TODs to the direct displacement of poor households, neighborhoods do change even in response to the announcement of rail line construction resulting in increased rents, land premiums and financial viability of some places (Bates, 2013; Cao & Lou, 2018). Cao & Lou (2018) observed that the mere announcement of the construction of the Green Line LRT in St. Paul, Minnesota increased housing values by $9.2/sqft. Gentrification can therefore be triggered even if a physical change has not occurred.

Hess & Almeida (2007) identifies in Buffalo, New York that the value of homes located within a quarter-mile radius of light rail lines was two to five percent more than the median home values of the city. Similarly, Duncan (2011a) observes that condos with a good pedestrian environment near stations (TOD) had a higher value than those outside a TOD neighborhood. However, Chatman et al. (2012) identify that the overall economic effects on housing units in a five-mile radius around River Line stations in New Jersey were slightly negative or neutral, with positive effects on only smaller houses and low-income census tracts. These studies show that places further away from stations may not be susceptible to gentrification as compared to those within walking distances. However, the few reliable literature do not provide enough evidence for solid conclusions (Padeiro et al., 2019).

There have been several pieces of research on the impact of TODs on the residential displacement of low-income neighborhoods. Yet, there has not been any empirical evidence of TODs displacing people even though the construction of TODs can gentrify a neighborhood and subsequently displace the vulnerable (Padeiro et al., 2019). Padeiro et al. (2019), in a systematic review of transit-induced gentrification literature, find that six out of seven studies done on single rail lines identified gentrification. Among the 16 studies done on several lines in a specific city, the authors identified seven studies that supported transit-induced gentrification, four not

seeing any evidence of it, and four indicating variable results across space. Only 2 of the remaining 12 studies done for multiple lines in multiple cities identified gentrification, with nine studies suggesting high viability of outcomes. The predetermined criteria that were used by the authors were that the study i. was published in English from 2000 to 2018; ii. used neighborhood social upgrading and/displacement of low-income groups and minorities as outcomes measures of interest; iii. used any people-related variables as a measure of neighborhood change. Studies that were based solely on property and land values were not considered eligible for investigation. The authors therefore conclude that it is important to consider local factors since gentrification can be closely related to built environment attributes and policies. Their study seems to be flawed and biased since almost all the papers they investigated were quantitative studies that sidelined equally important qualitative gentrification studies.

In a study of the three the largest Canadian cities, Grube-Cavers and Patterson (2015) identify a positive relation and statistical significance of exposure to urban rail lines and census tracts that show the likelihood to undergo gentrification in Toronto and Montreal but not in Vancouver. The authors observe gentrification as an event and not as a continuous process. They used a survival analysis which they believe is best for variables that change over time. The authors define survival analysis as "a collection of statistical procedures for analyzing data where the outcome variable is time until an event (construction of light rail line) occurs" (Grube-Cavers & Patterson, 2015, p. 185). Using gentrification as the event and proximity to station of rapid rail transit, the authors surmised that the result of their survival analysis was to make inferences to how their "independent variable affects the probability of the event occurring over a given time" (Grube-Cavers & Patterson, 2015, p. 185). The authors observe that the chances of gentrification are greatest immediately after implementing rail transit. Also, they concur that cities are variable

and may have been the cause of different results for Vancouver. The authors did not go further to look at any local dynamics and policies which could have resulted in the discrepancies among the cities.

Dong (2017), using a longitudinal quasi-experimental design in a quest to identify gentrification in suburban Portland, looked at the reduction of affordable homes. Making a pretest-posttest comparison between TOD neighborhoods and their control neighborhoods, the author found no consistent evidence of gentrification or the reduction of affordability in houses in the suburbs. Similarly, Hess (2020) observed that the Black race in neighborhoods near the Link LRT in the suburbs of Seattle instead increased after inauguration, and the Asian and Hispanic Race increased after opening. The two studies in this paragraph show how the introduction of rail lines does not necessarily disadvantage a community. The two studies also support the idea that gentrification is an urban phenomenon (Freeman, 2005; Marcuse, 1985), yet more research will have to be done to prove this.

Similarly, Kahn (2007) obtained varied results of gentrification along rail transit lines constructed between 1970 and 2000 in 14 cities in the United States. Kahn (2007), unlike most gentrification studies, observes an increase in poverty along 'Park and Ride' stations in the cities he studied. However, the author observed a significant increase in the share of adult college graduates in nine of the cities in communities treated with "Walk and Ride" access which he confirmed to be a key indicator of gentrification. Similarly, Delmelle and Nilsson (2020) also found no significant evidence of low-income displacement out of transit neighborhoods across the U.S. The authors employed the Panel Study on Income Dynamics (PSID) to model out-migration as proxied by census tracts in U.S. major cities from 1970 to 2014. The PSID allowed the authors to trace the movements of individuals in or out of a neighborhood for decades. The

authors identify that, notwithstanding the income of individuals, there was no difference in the odds that residents leave a TOD neighborhood as compared to any other neighborhood, which causes them to "reject the wholesale notion that investment in transit will automatically lead to the exodus of low-income residents and possibly the most transit-dependent population" (Delmelle & Nilsson, 2020, p. 147).

Transit Induced Gentrification in Denver

Currently, in Denver, almost every current and proposed station has a TOD zone or has a planned for one to help consolidate urban land use around rail transit lines (Bhattacharjee & Goetz, 2016). The Regional Transportation District (RTD Denver) which is the principal transit agency for Denver, defines TOD as creating a neighborhood that maintains synergies that enhance new high-density constructions and transit values (Regional Transportation District, 2021). The RTD's FasTracks program approved in 2004 prioritizes developments at and around transit stations and have provided numerous TOD programs in the Denver metro. If not planned well, the intentional development of TODs along the planned 122 miles rail in Denver can put low-income households and vulnerable residents in Denver at risk of losing their homes – something this research will try to identify.

Bardaka et al. (2018) use a quasi-experimental spatial econometric approach to capture the direct and indirect socioeconomics effects on TOD neighborhoods and the spillover effect on other neighborhoods in Denver. The authors use the urban part of the MSA as their primary study area. The authors argue that it was essential to look at other surrounding communities which have not been treated with a light rail line because once transit investment is made to a neighborhood, the gentrification process can be triggered in nearby neighborhoods. They further explain that this can also start a cycle of socioeconomic adjustment like the displaced moving to

nearby communities and impacting the neighborhoods' socioeconomic status. The authors find that neighborhoods within a mile of light rail line had a 14.6% increase in median household income between 1990 and 2000. The authors also find no evidence of the light rail having an impact on educational attainment. Lastly, Bardaka et al. (2018) observe that houses in low-income neighborhoods within a mile of the rail station areas in Denver were 22.42% higher from 1990 but no significant spillover effect. A flaw of the study is that it had only been six years since the opening of the line, which the authors could had more analysis to see if neighborhoods gentrified in the subsequent years.

Jackson and Buckman (2020) also studies how TODs shape the neighborhood perception and attachment to the Evans station area, which is an area included in this study. The authors describe the station area as a ‘grey zone of gentrification,’ meaning the neighborhood does not have characteristics of the usual displacement of low-income earners by the middle-high-class-income households (Chapple & Thomas, 2020). They continue that if because TOD neighborhoods are planned for connectivity, social mixing, and benefit of all residents, then there is the need to look at the perception of place when evaluating gentrification. The authors, therefore, use a household survey to gather the perception of residents in the neighborhood. The authors use this approach to be able to identify how connected people are to their neighborhoods. Their approach is in line with identifying the exclusionary perception of gentrification and displacement. The authors further iterate that North American LRT studies find little success identifying displacement when the census data is used. The authors' responses influence them to conclude that the Evan Station shows signs associated with gentrification, yet they are not catalysts for gentrification. A flaw in their study is that little emphasis was given to the quantitative findings that was observe. The author based all their conclusion on the survey

responses they got and sidelined the statistical analysis like the increasing rents and adults with higher education levels in the neighborhood.

Furthermore, a study by the Urban Displacement Project in Denver also finds that about 45% of the metro's moderate-to-high-income neighborhoods demonstrated risk or ongoing exclusion of low-income households. They further explain that 21% of Denver's low-income households live in potential or currently excluded neighborhoods (Chapple & Thomas, 2020). Though the authors do a good job of identifying the level of every Census tract in the gentrification process, they rely strongly on a neighborhood with a low median income and consider lightly other variables like education attainment and the connectivity of people to their neighborhood.

How Gentrification and Displacement Is Measured

Methods

Many researchers measure gentrification and displacement in varied ways, depending on how they explain them. Previously, researchers begin by defining a gentrifying neighborhood. A gentrifying neighborhood is one that has changes in high-income households, college-educated people, and families without children, amongst others more than the region (Chapple & Loukaitou-Sideris, 2019; Freeman, 2005). However, Ellen & O'Regan (2011), identified gentrifying neighborhoods by creating the quintiles of neighborhoods based on their relative income ratio in 1990. The authors used the lowest two quintiles as their sample low-income tracts, which had a mean household income that was 85% of the metro. The authors linked housing units across survey from 1991 to 1999 that allowed them to investigate the occupancy changes over the decade. They identified changing communities by classifying them into those that had no shift in economic status (non-gain), significant gain (5 percentage point change), and

substantial gain (10 percent point change). The authors also employed the exit/turnover rates of the American Housing Survey to investigate the share of households who leave their homes over a survey window as proxy for displacement among "those with fewest resources, renters and the poor" (Ellen & O'Regan, 2011, p. 89). The authors find no evidence of displacement even amongst the most vulnerable residents.

People move out of neighborhoods for different reasons and purposes, making it challenging to understand whether they are displaced or moved willingly. Numerous gentrification studies are limited by data availability and have to stick to a short time frame of analyses that sometimes are not able to depict gentrification results (Chapple & Loukaitou-Sideris, 2019). Others have also used more complex variables like credit scores, mortgage, and payment delinquencies (Ding et al., 2016), while others use simple factors to determine gentrification and displacement. Chapple et al. (2017) used a model called PECAS Land Use Model in identifying displacement in TOD neighborhoods. The SCAG PECAS is a land-use forecasting and policy analysis software used for transportation and comprehensive planning. It is designed to understand how spatial economic and social-economic systems react to policies - an aspect of determining displacement which former researchers may not have considered. The authors used the PECAS model to answer questions like how does the region look when TOD is implemented, and what are the characteristics of residents that move into or out of TOD areas. The model calculated changes by comparing two stages at different times. Their findings were similar to others where the proximity to a rail station causes a neighborhood to change to a pattern associated with gentrification and displacement.

Chapple (2009, p. 6), in a study of Bay Area, California, use multivariate regression to identify areas that are susceptible to gentrification by looking at the demographic factors (such as

families in the neighborhood), income, transportation factors (reliance on transit for commute), housing factors (large share of rental houses), location of the neighborhood, and availability of amenities like parks and community facilities. Although the availability of amenities and public transportation came up on top of the author's list, she finds tracts in or near the downtowns of Oakland and San Francisco to be more susceptible to gentrification. Her finding supports Freeman's (2005) urban/city center phenomena of gentrification. Chapple (2009) finds that a neighborhood with a high share of renters who pay more than 35% (Bay Area context due to high housing cost) of their income for rent are more likely to gentrify, while those that have a high share of overburdened homeowners do not since they are more affluent. The author continues that a neighborhood with more non-family-related households was more likely to become gentrified. Yet, it is more likely to happen in dominant non-white communities than non-Hispanic white ones. For housing variables, the author states that "the higher share of multi-unit buildings and share of renter-occupied housing, the more likely the area is to gentrify, perhaps because the change can occur more rapidly through turnover of rental units" (Chapple, 2009, p. 7). The author clarifies that multi-unit buildings alone do not cause a neighborhood to be more susceptible to gentrification; it can when coupled with high renter occupancies and a share of amenities. The author, though, was unable to measure how much displacement was occurring in the neighborhoods. She reiterated that renter occupancies and high rent burdens were the most strongly related to displacement, and the existence of anti-displacement policies can help avoid them (Chapple, 2009; Zuk et al., 2018).

Criteria

In case studies done by the Urban Displacement Project, the author's categorized neighborhoods as susceptible to gentrify or gentrifying using low-income tracts and as exclusion

when census tract levels were moderate to high. These typologies were classified as: not losing low-income households (low-income), at risk of gentrification (low-income), displacement of low-income households/ ongoing gentrification (low-income), advanced gentrification (moderate to high-income), not losing low-income families (moderate to high-income), at risk of exclusion (moderate to high-income), displacement of low-income households/ongoing exclusion (moderate to high-income) and advance exclusion (moderate to high-income) (Chapple & Thomas, 2020).

The term gentrification was not used for the moderate to high-income tracts in the Urban Displacement Project, but rather all advanced gentrification or some form of exclusion was used for all census tracts that qualified for the criteria shown in Appendix B. Some initial criteria had to be met for a census tract to be classified as gentrifying or any advanced form of gentrification. For example, for a low-income tract in a TOD to be considered at risk of gentrifying, the authors considered that the neighborhood must have the following:

- Pop in 2000 > 500
- Low Income Tract in 2015
- Vulnerable in 2000
    a. % low-income households > regional median
    b. % college educated < regional median
    c. % renters > regional median
    d. % nonwhite > regional median
- 2 out of the 4 of the following is true in 2015:
    a. Has rail station in tract
    b. % of units in pre-1950 buildings > regional median
    c. Employment density (2014)> regional median
    d. “Hot market” (options defined below table)
- Not currently undergoing displacement or ongoing gentrification

Table 2.1 and Appendix B have more of the how the typologies were formulated by the (Chapple & Thomas, 2020) . The use of different variables at different stages of the gentrification process may be a good way to understand the gradual process of gentrification.

Also, Freeman (2005) created a criteria for measuring gentrifying neighborhoods in the U.S. In his approach, he first considers the neighborhoods with the potential to gentrify by looking for proxies of disinvestment. The author uses vintage housing stock for disinvested communities since disinvestment is a “more difficult concept to measure using census data" (Freeman, 2005, p. 470). Also, he uses low-income tracts with median income at or lower than the respective metro to show neighborhoods that have previously experienced disinvestment. Secondly, Freeman (2005) looks at the process of gentrification and chooses to use educational attainment rather than income. He justifies the use of education attainment as being more stable, and its unlikeliness to miss the influx of highly educated but poorly paid professionals. He also echoed that using education would help differentiate between incumbent ‘upgrading’ of current residents outside gentrifiers coming in. He classified a neighborhood to be gentrifying when the percentage increase in the number of people in the neighborhood having higher education attainment (at least four years of college) is more than the metro. Freeman (2005) finally distinguishes a gentrifying neighborhood from others by looking at the reinvestment in the neighborhood using housing prices. The criterion he uses is shown in Table 2.1. The author classified neighborhoods that met only his first three criteria as non-gentrifying, and those that met all five were seen as gentrifying. Freeman’s (2005) study overlooks the gradual process of gentrification by not looking at what can happen before it occurs. He refused to look at a neighborhood that could be susceptible to gentrification by creating a criterion which only looked in low-income areas that were likely to gentrify.

Freeman (2005) furthers his research to discern the displacement/ mobility amongst household heads in gentrifying and non-gentrifying neighborhoods using a set of criteria that can be found in Table 2.1. He hypothesized that:

> "1) Pre-existing residents of gentrifying neighborhoods are more likely to move/be displaced when residing in gentrifying neighborhoods, all things being equal.
> 2) Poor renters residing in gentrifying neighborhoods are more likely to move/be displaced when residing in gentrifying neighborhoods, all things being equal."
> (Freeman, 2005, p. 476).

Using bivariate and multivariate relationships, the author finds no significant interaction to support his second hypothesis that renters were more susceptible to be displaced. The author rather finds a modest link (0.5%) between gentrification and displacement after using multivariate analysis.

In a study by Chapple et al. (2017), the authors classified a neighborhood to be vulnerable to gentrification or eligible to gentrify in Los Angeles if it met all of the criteria given. The first criteria were for the census tracts to have at least 500 residents in year 1, and the second was the percentages of three of their four indicators were greater or less than the county median. The percentage of low-income households, renters, and non-whites all had to be greater than the county median, while the percentage of college-educated had to be lower than the county median. The authors considered households with income 80% or less of the county median as low-income households. Also, for a tract to be gentrified or gentrifying, two criteria were to be met. First was for all demographic changes between year 1 and year 2: college-educated, non-Hispanic whites, and household income to be greater than the county. The second, was also for a change in the Median Gross Rent of the tract to be greater than the county.

One similarity among all the criteria used above shows some demographic characteristics and economic components in predicting gentrification and displacement. Also, the studies compared local results to the region or a neighborhood not gentrifying. This is because gentrification is seen as a phenomenon where a neighborhood should be experiencing local

changes that are different from the region. In a place like the Denver metro, income levels, higher educational attainment, rents, and home price are increasing regionally, and the traditional regional comparison will not be able to depict what is happening locally. It therefore becomes important to look at the local dynamics of the process of gentrification by looking at the share of variables in neighborhood as compared to the previous period.

Study Area

Gentrification and displacement studies have been researched many times in areas where there are historically low-income households, and marginalized races but recently it is studied around rail transit stations. Unique to other gentrification studies, the Southwest Light Rail Transit lines (C & D) under study lie along a medium-to-high-income white dominated neighborhood. Also, the lines lie between two major rail lines and a highway serving the Mountain States.

In 1993 Regional Transportation District (RTD) purchased the 10.4-mile strip of the railway from the Southern Pacific/Denver Rio Grande Railroad to prevent the old industrial rail corridor from being sold for real estate purposes (Regional Transportation Department et al., 1995). The railroad served numerous industries, which cause its work force along the corridor to be majority less-educated skilled workers (Regional Transportation Department et al., 1995).

The tracks were opened as an 8.7mile rail lines in July 2000. The lines lie parallel to the east to the famous Santa Fe Drive and two heavy rails operated by Burlington Northern South Santa Fe (BNSF) and Union Pacific (UP) (Mills, 2018). The lines are an extension of the LRT from Broadway/L25 to Littleton Minerals. The RTD has also proposed to extend the LRT by a 2.7mile rail to Highlands Ranch.

Authors		Freeman (2005)	Chapple (2009)	Baker & Lee (2019)
Location		U.S.	San Francisco Bay Area	14 major U.S. cities
Timeframe		1980-1990 and 1990-2000	1990-2000	Beginning decade year LRT was opened to 2010
Criteria		Nongentrifying or Gentrifying	Susceptibility to Gentrify	Gentrified or Not gentrified
Neighborhood Types		Gentrifying Nongentrifying	No Susceptibility Low Susceptibility Moderate Susceptibility High Susceptibility	Gentrification and TOD (low-income and minority households priced out, new development with increased transit access) Countergentrification and TOD (attracted low-income and minority households) Gentrification and counter or no TOD (triggered new development and attracted high-income households who do not use transit) Neighborhood decline (census tract experiencing greater negative change indicators)
Variables	Types	Measures	Measures	Measures
	Location	Proximity to city center	Distance to urban center	Distance from centroid to CBD Census tract in core central city
	Socio-economic	Educational attainment Median income	% non-family households % married couples with children % non-Hispanic white % of renters paying > 35% of income % of owners paying > 35% of income Income diversity	Population density Median Income % of non-Hispanic white % of population 25+ with college degree % of poverty rate % of employed age 16+ with professional occupation
Variables	Housing	Houses built within the past 20years Real housing prices	% of dwelling units in buildings with 3-4 units and 5+ units % renter-occupied units Public housing units Median gross rent	% of renter occupied units % of units 30yrs & older Median rent and median home price Rent gap

	Transportation		% of workers taking transit % of dwelling units with three or more cars available	% of all commuters who use public transit % of all commuters who use other modes of transit than privately owned vehicles (POVs)
	Amenities		Youth facilities per 1,000 Public space per 1,000 Small parks per 1,000 Recreational facilities per 1,000	

The extension makes this study very important to help understand how the extension may affect the low-income households, housing, and the vulnerable at C-470 and Lucent Boulevard (proposed station area). The line currently has five stations that passes through Englewood and Littleton, connecting to other lines that lead to Denver Union Station and Downtown Denver. All five stations serve as bus transfer facilities, with four of them providing park-n-ride services. The LRT serves Arapahoe County, and the southmost part of the city of Denver in Denver County. A half-mile radius around the station areas put them all – the study area - in an urban setting except for the area around Littleton-Mineral Station, which is considered suburbia by the Denver Regional Council of Governance (DRCOG). Since all the station areas are all studied as one neighborhood, this research uniquely adds to the literature on how the construction of a light rail transit line affects a neighborhood with both urban and suburbia characteristics. No known research has tried to identify gentrification and displacement in a neighborhood with both characteristics.

The Denver FasTracks Program, after it got accepted by regional voting in 2004, is adding more transit options to the region. The program, since its existence, has added 25.1miles of light rail tracks and 53 miles of commuter rail tracks (Denver Regional Transportation District, assessed 2021). TOD has become a significant focus in Denver after the inception of the FasTracks program since it has an interest in regional land use development (Ratner & Goetz, 2013). The RTD concurs that, since 2005, 68% of all new offices and 44% of all new housing in Metro Denver are located in one half-mile of RTD stations (Regional Transportation Department et al., 1995) which makes it crucial for planner and community developers to understand which group of people are in moving into these TOD areas.

The Economy and Housing

The Denver area is a fast-growing economy that attracts people from all around and across the United States. Denver has become a role model for other cities due to its booming economy because of its smart investment and visionary leaders. The booming economy coupled with the LRT construction may have caused the increased in the number of people along the LRT corridor in 2000. The Denver's Office of Economic Development (2016) indicates that Denver is now a hotspot for the West Coast and other investment-making cities. It has a healthy economy coupled with a competitive cost of living in the metro, making it one of the States' leading economic forces. Thus, the metro has become a preferred destination for the young and highly educated which is reflected in the metro's censuses.

The economy of Denver began to improve significantly from 1990, while at the same time, the country's economy was getting sluggish. Denver was a hub for many trade and commerce businesses because the city constructed many new offices, apartments, single-family homes and created more jobs and fun places (Blake, 2019). Blake (2019) explains that housing prices from 1990 to 2000 increased to about 150%. Denver's economy became dependent on the "Dot.Com" industry, which was built on the growth of technology and computer development companies. The economy suffered a lot after the 2001 "Dot.Com" crisis, which prepared Denver for the "Great Recession" (Blake, 2019). Before the housing crisis in 2007, many cities were doing well until the burst, which left the nation's unemployment rate at 10% and home values below 30% (Silva, 2019). Denver stood amongst the cities with higher unemployment rates (11.9%) during that time (Silva, 2019) and may have caused the reduction of the income level of households in the study area between 2008 and 2012. Denver in 2009, when Median Household Income (inflated) started to depreciate, was $70,483, whiles the U.S. and Colorado were $59,988

and $66,210 respectively. The average price of a house in the Denver Metro was $291,000 in 2007 but dropped to $263,000 in 2009 (Silva, 2019). Unlike other cities, Denver quickly emerged as the first city to eclipse the pre-recession average housing values in 2013 (Silva, 2019). By 2016 the average median price of a house in Littleton cost $370,000, and the average median rent was $1,500 in 2015 (City of Littleton, 2017).

Due to the mortgage and foreclosure crisis, homeownership dropped, causing many householders to rent between 2009 to 2011 (The Denver Post, 2013). The increase in home rentals may have gradually reduced the vacancy levels in the nation and in Denver. Though there was a decrease in rent in other major cities, Denver's median gross rent in 2011 surpassed the national median gross rent by $920 to $871 (National Low Income Housing Coalition, 2013).

The increase in prices puts low-income and vulnerable populations at risk of displacement as homes become unaffordable. The Denver OED indicates that Denver’s average median income, which is up by 21.9%, does not pace up with rents, which have gone up by 50% since 2012 (Denver Office of Economic Development, 2016). The office states that "a single food preparation and serving worker" must work 62 hours/week to be able to live in Denver. Single parents in the same job would have to work 114 hours/week to live in median-priced housing, which is an indication that one must have a well-paying job to survive in the metro. Hence, a significant number of people who have only high school diplomas in low-skilled jobs are not capable of living there (Denver Office of Economic Development, 2016) and are at risk of being displaced. The National Community Reinvestment Coalition, in a recent study, identifies that from 2012-2017, Denver was the second most gentrifying city (27.5% of eligible tracts) in the U.S. after San Francisco-Oakland (Richardson et al., 2020). The authors defined

gentrifying neighborhoods as having increased median home values, household income, educational levels, rents, and decrease in owner occupancy.

Chapter 3 - Methodology

This chapter introduces the research methods used in this research which is a simple pretest-posttest analysis of neighborhoods in a half-mile radius of the Southwest Light Rail Transit Line stations. Two different methods are used to identify gentrification in two different ways. The first method would follow the conventional way of identifying gentrification and displacement where a group of gentrification proxies must all be changing at the same time with reference to the metropolitan region (Baker & Lee, 2019; Bates, 2013; Chapple, 2009; Ellen & O'Regan, 2011; Freeman, 2005). The first method has two steps. The first step identifies which period the corridor became vulnerable to gentrification, and the second step determines whether the corridor gentrifies or not. For the first method, six criteria are created and four of them must be met in a specific census period, for it to be described as when the corridor becomes susceptible to gentrification. The second step would have to qualify for all the criteria given for the neighborhood to be considered gentrified or gentrifying. The second method identifies gentrification locally by looking at the increase in the percentage share of variables along the corridor. For the conventional method, the author employs simple absolute change, location quotient, and percentage change for the analysis and uses local percentage share for the second method.

Gentrification has always been seen as a regional/urban phenomenon, and with Denver having been observed as the second most gentrifying city in the US (Richardson et al., 2020), it is vital to observe the changes that are slightly different from what have previously been done. A simple method is therefore needed to focus on the local dynamics of how the neighborhood changed over the period the LRT was constructed. Also, the majority of researchers have analyzed gentrification and displacement on a neighborhood (census tracts) basis, unlike this

research which is done using aggregated census block groups within a half-mile radius along the light rail transit line. For the first method, the criteria for predicting whether the LRT corridor gentrifies or not is adopted from Freeman's (2005, p. 470) idea of "dimensions in operationalizing gentrification." The concepts look for proxies of disinvestment, the process of gentrification (eg. educational attainment) and reinvestment (eg. home prices). Also, as Chapple & Thomas (2020) identifies, in the Urban Displacement Project, the process of a neighborhood being at risk of gentrifying or experiencing gentrification can be at different times, depending on how often or fast neighborhood conditions change. This makes it essential to understand the changes at different intercensal periods as done in this research to get a clear sense of which decennial period the corridor becomes vulnerable to gentrification or even undergoes gentrification.

For the first method, we identify which period(s) the corridor becomes susceptible to gentrification by qualifying for four of the criteria listed below:

1) Neighborhood within a half-mile radius of a transit station
2) Location quotient of low-income households (less than 100% of the poverty line) > 1
3) Location quotient of high school educational level or lower > 1
4) Location quotient of new buildings < 1 (Built after 1960)
5) Location quotient of non-whites > 1
6) Location quotient of renters > 1

In the second step, we identify the period the transit corridor gentrified or not. For the corridor to be identified as gentrified all the criteria below must be met:

1) Demographic change between census years
    - ➢ % change in college-educated > MSA
    - ➢ % change in non-Hispanic white > MSA (percentage points)

➢ Change in median income > MSA (absolute change)

2) Change in median gross rent > MSA (absolute change)

A major struggle that conventional gentrification and displacement researchers face is getting adequate data to show how people of the historically marginalized groups and low-income people race are actually displaced. The second approach adds to the literature by proposing a straightforward methodology in identifying gentrification and displacement in specific time periods by looking at the changes in local share for: adults with low education levels, high-income level, multi-family units, and rents. For the second approach variables must obtain a five-percentage point greater or lower than the previous decennial period to qualify as gentrifying. All the variables must qualify the criteria for the period to be seen as gentrifying/ gentrified. The local share used in this study shows which percentage of the variable is within the neighborhoods, and the decennial trend helps to monitor how those variables change over time. The local share is the percentage of a single variable type over the sum of variables in the same cohort. For the second method, an increase in the local share of housing variables can mean that the neighborhood is gentrifying, and a decrease in the share of the demographic variables above can mean that people have been displaced.

The percentage change used in the conventional method is calculated by subtracting a variable of the current year from the base year and dividing that by the figure for the base year. Results can be negative or positive depending on how a variable is decreasing or increasing relative to others. As defined by Newmark (N.D), the location quotient is when variables of a neighborhood are compared with the same variables of a reference neighborhood (MSA) by taking the ratio of the former to the latter. When a result is more than 1, the local has more of that variable than the reference(region/metro), but when result is less than 1, the metropolitan

region has more of that variable. Neighborhood changes using the conventional method must be unique to the corridor to be considered gentrifying or gentrified and this can be identified using the location quotient.

Data Collection

Demographic data, housing data, and shapefiles were collected from the IPUMS National Historic GIS platform developed by the University of Minnesota. Decennial years 1990, 2000, ACS 2008 – 2012 and, ACS 2014 – 2018 were used. Mid-years were used in describing the five-year ACS data for the sake of brevity. This, therefore, makes the comparable years 1990, 2000, 2010 and, 2016. Analysis was done at block group levels to get a much accurate representation of the neighborhood. The selected block groups were aggregated into a single study area. NHGIS provided all the shapefiles and census data for both the county and block group levels. Residential parcel data was also acquired for Arapahoe and Denver counties from ESRI. The following variables are what was extracted from the census data for the study:

i. Demographic-based
- Total population
- White alone
- Non-white (Hispanic, Black, Asian/ Pacific Islander, American Indian/ Eskimo/ Aleut) NB. Classification based on 1990 Census
- Income
- Education level of persons more than 25 years
- Income level

ii. Housing based
- Tenure
- Median Gross Rent
- Median Value

ESRI ArcMap was used to generate maps for the study area and metropolitan area. IPUMS NHGIS provides census block group shapefiles, Census and ACS data that allowed the author to create the data for analysis in R. The study area was mapped by creating a half-mile radius

around all the five stations obtained from Denver Open Data (RTD). The census block groups that intersected the station areas' half-mile radius were selected. The selected block groups for the 2008-2012 shapefile are shown in Figure 3.2. The 1990 aggregated block groups shapefile was used as the standard shapefile for the analysis. Block groups that were not in conformity with those in the other years were removed from the analysis. For the decennial year 1990, 34 block groups were initially selected to be in a half-mile radius, but 18 of them are used for the analysis. Figure 3.3 shows the process of selecting block groups to align with various decennial years to be used for the study. Another block group showing as 'Area Added after 1990' in Figure 3.4 was added to the analysis to ensure conformity with other periods that had that potion added. Using historical maps from Google Earth, we noticed that that the "Area added after 1990' was added when development started occurring in the area 2000. Block group changes in 2000 did not affect the study area, so there were no changes for 2010 and 2018. The final selected block groups were merged into a single study area for each decennial year. A limitation of this research is that some of the selected block groups in a half mile radius were dropped, limiting the true representation of the half-mile study. For the MSA, county shapefiles and census data for Denver-Aurora-Lakewood were used. County lines stayed relatively the same except after 2000, where the portion labeled 'MSA Area Added after 2000' (shown in Figure 3.1) was added to Denver County. It was essential to add this portion because it could have been a population or developmental increase in the area that extended outside the county lines.

All data were first visualized and refined to the study area using ESRI ArcMap. A detailed analysis was done in R Studio to determine the relative local share, LQ, and percentage changes to be used for the criteria.

Aggregation of Median Income, Home Values, and Rents

The census data especially the first 5-year ACS data allows users to aggregate small geography levels into larger areas rather than looking at areas individually. Data used to calculate for average median income, average median gross rent, and the average median value of various block groups had to be aggregated and recalculated for the study area and the MSA. A formula adopted from the Census Bureau was used to recalculate the median values. How the formular is applied is shown in Appendix A.

The Denver metropolitan area has seen a lot of economic growth over the last 20 years. Due the fact that national inflation is based on so many factors, a regional Consumer Price Index (CPI) was used which reflects local inflation over the decennial years in the study area. Rents and value of homes collected for 2014 – 2018 ACS were adjusted to the 2018 inflation rate by the Census Bureau. Therefore, the author calculated all the inflation rates based on the 2018 consumer price index. The U.S. Census Bureau clarifies that the accurate way to calculate the median income in the previous years is to multiply the income by the base year's CPI divided by the former CPI. For the Denver-Aurora-Lakewood metropolitan area, the CPIs obtained from the U.S. Bureau of Labor Statistics are 120.9, 173.2, 212.447, and 261.985 for value years 1990, 2000, 2010, and 2018 respectively.

Calculating for the average median gross rents, they were inflated with 2018 as the base year by multiplying it to the CPI obtained each year. This enables the author to get the 'real rent,' making it possible for past rents to be comparable to current ones. In determining the change in average rent between 1990 and 2000, the figure for 2000 was subtracted from that of 1990 and then divided by the figure for 1990. Similar calculations were done to determine the changes for the other years.

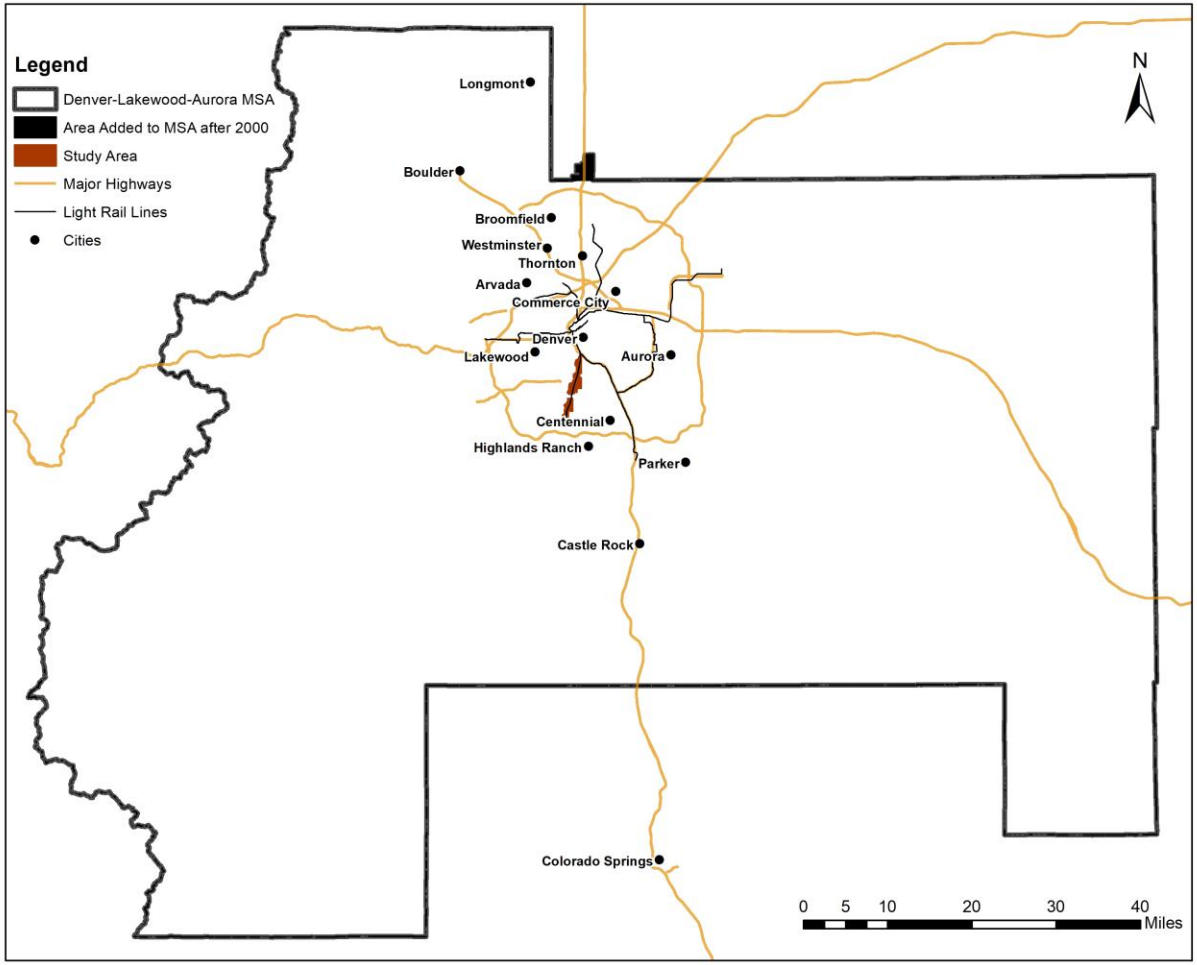

Figure 3.1 Denver-Aurora-Lakewood Metropolitan Statistical Area

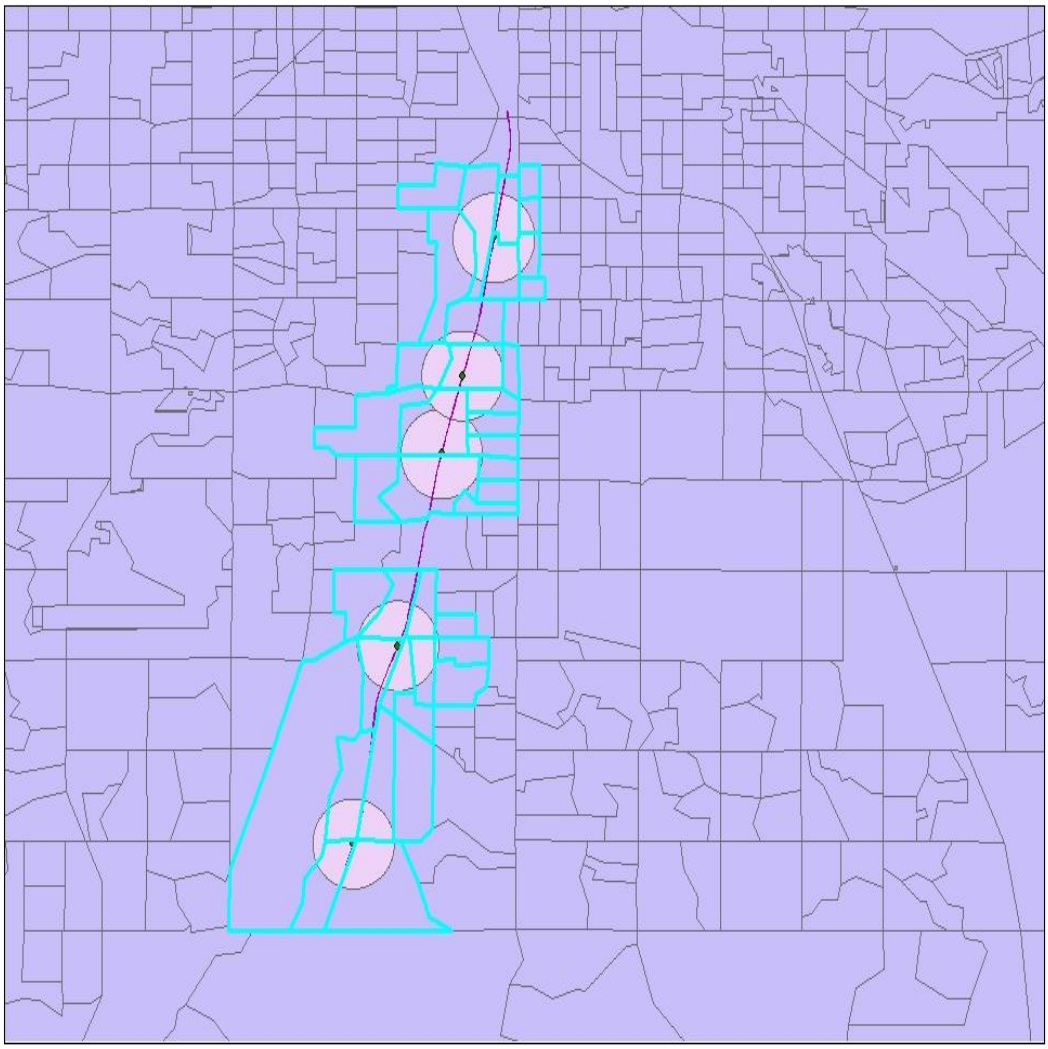

Figure 3.2 Half-Mile Radius and Initial Selected Block Groups

Figure 3.3 Determining the Census Block Groups that Conformed to Other Decennial Years for Analysis

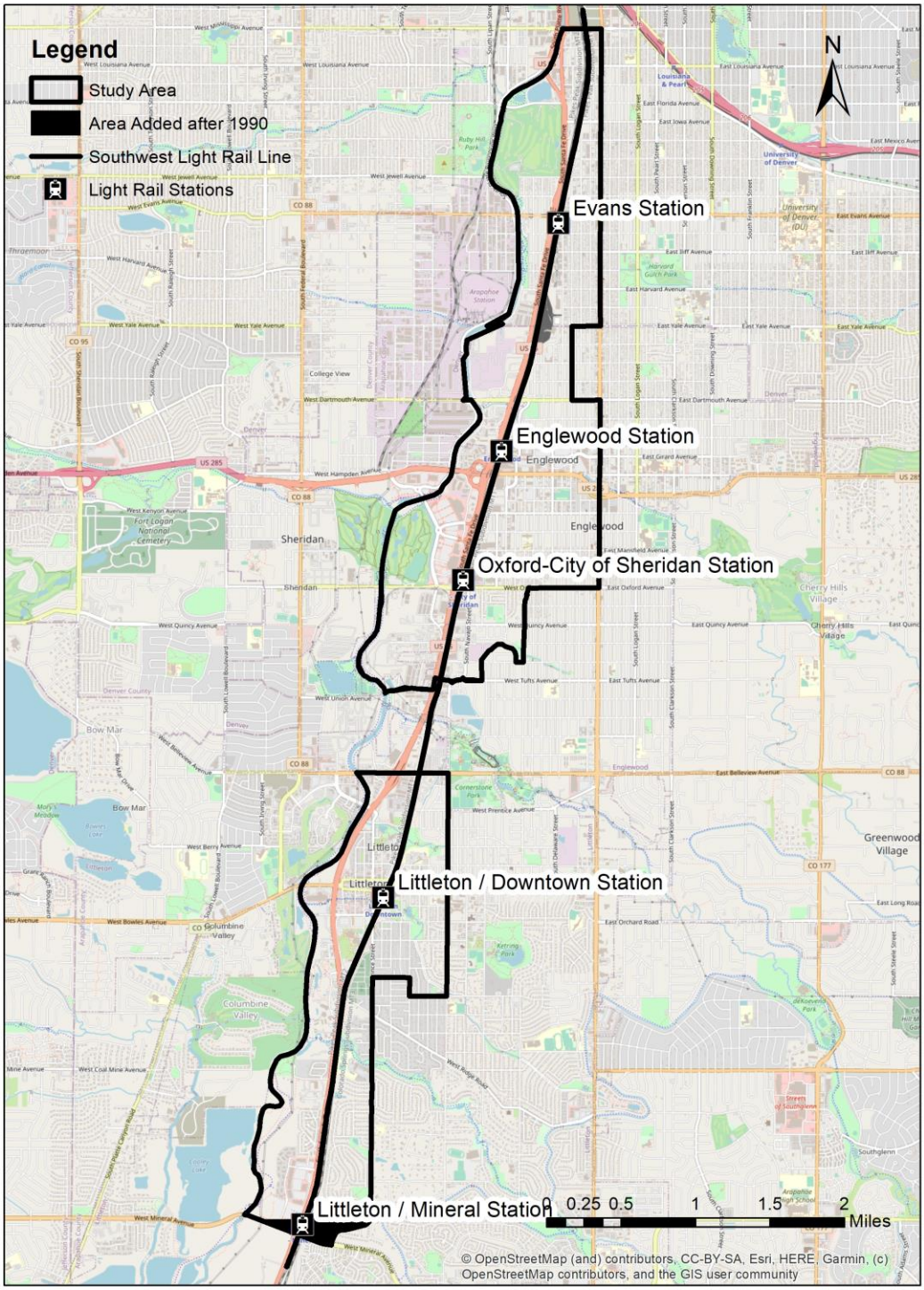

Figure 3.4 Study Area

Equation for Determining the average median value of houses for aggregated block groups

1) Aggregate the number of home values in each range for the selected areas. Calculate a cumulative total and a cumulative percent.

2) Total Number of households ÷ 2 = 2931 ÷ 2 = 1465.5

3) Here the mid-range based on the mid-point falls in the $125,000 to $149,999 range

4) (Mid-point) - (total HH in the previous smaller range, $100,000 to $ 124,999)

1466 – 774 = 692

5) (Result from Step 4) ÷ (number of HH in mid-range)

692 ÷ 1466 = 0.472

6) The width of $125,000 to $ 149,999 is $25,000

The proportion * the width = 0.472 * $25,000 = $11,800

7) Beginning of the mid-range + results from step 6

$125,000 + 11,800 = $136,800

8) Weight results to 2018 inflation value

Weighting results to 2016 inflation value

2000 CPI = 173.2

2016 CPI = 246.643

Weighted Value = $136,800*(246.643/173.2) = $194,808

NB: 2016 CPI was used because the ACS home values was taken for up to 2016 and not 2018. Detailed analysis is shown in Appendix A

Chapter 4 - Analysis And Discussion

This chapter talks about the results obtained after performing the analysis and the discussions that go with them. There is no systematic flow of the results, but the first method's results would be discussed, and it would be followed by the results of the simple non-conventional approach.

Step 1

Table 4.1 shows that the corridor was susceptible to gentrify throughout the study period from 1990-2016. The table summarizes the variables and the census periods that the corridor becomes vulnerable to gentrification. The corridor at that time qualified for five of the criteria used. The non-white race had a LQ of 0.74 and 0.66 in the period before 1990 and 1990-2000, respectively, which disqualified it from showing susceptibility to gentrify. This is so because the white race along the corridor is dominant locally than the regional, as depicted in Figure 4.1. The non-white households along the corridor increased from 1911 to 2557 before the rail line was opened (1990-2000), and after it was opened (2000-2010), it grew from 2557 to 4432, which showed no sign of displacement, as seen in Figure 4.1.

Table 4.1 Susceptibility Analysis

Year/Topic	Low Income Level	High School Certificate or Below	New Housing Structure	Non-white Race	Renters
Before 1991	1.28	1.13	0.99	0.74	1.31
1990-2000	1.22	1.34	1	0.66	1.35
2000-2010	1.55	1.26	1	0.89	1.58
2010-2016	1.33	0.96	1.01	0.64	1.65

Source: Census Data, IPUMS NHGIS,2020

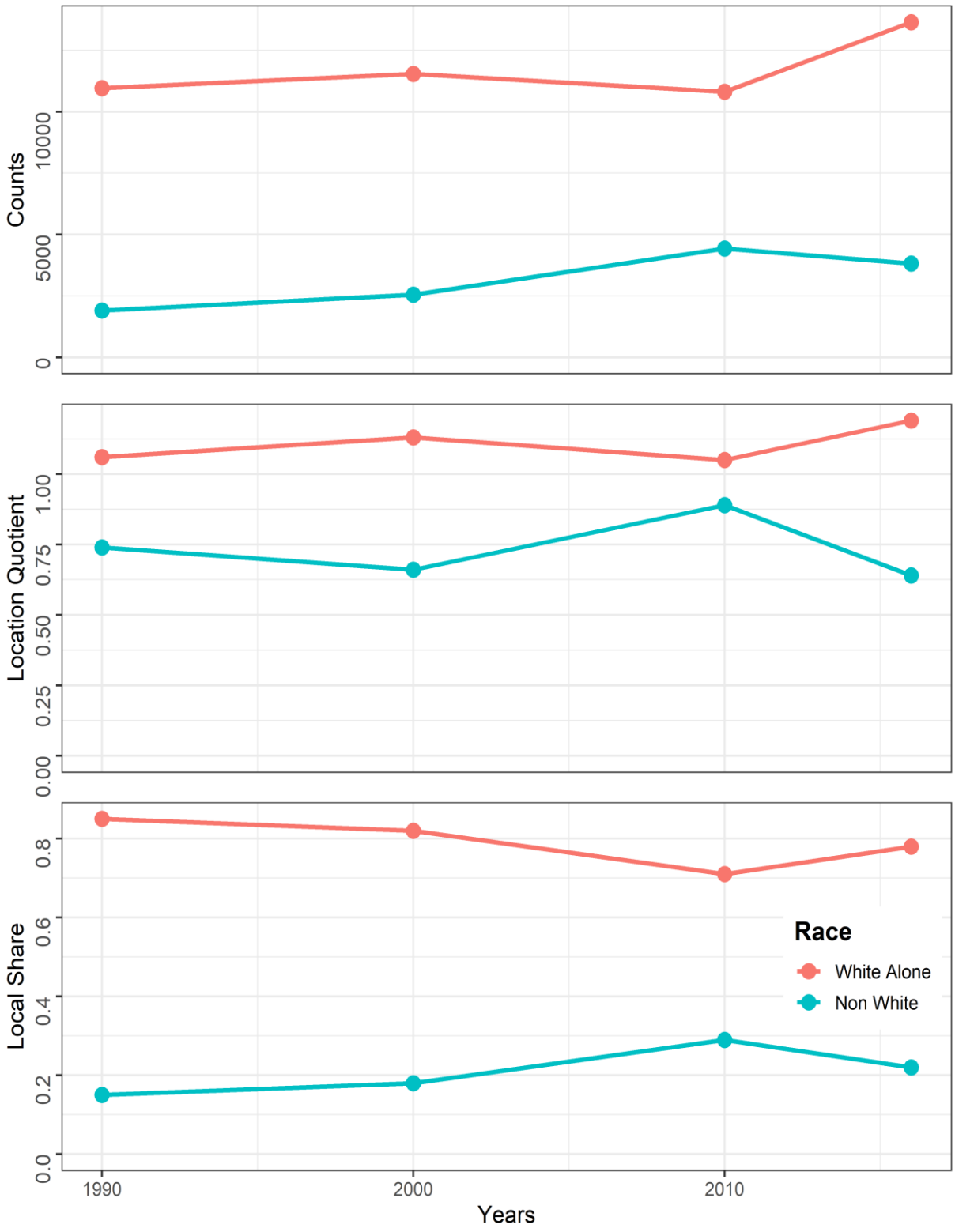

Figure 4.1 Race

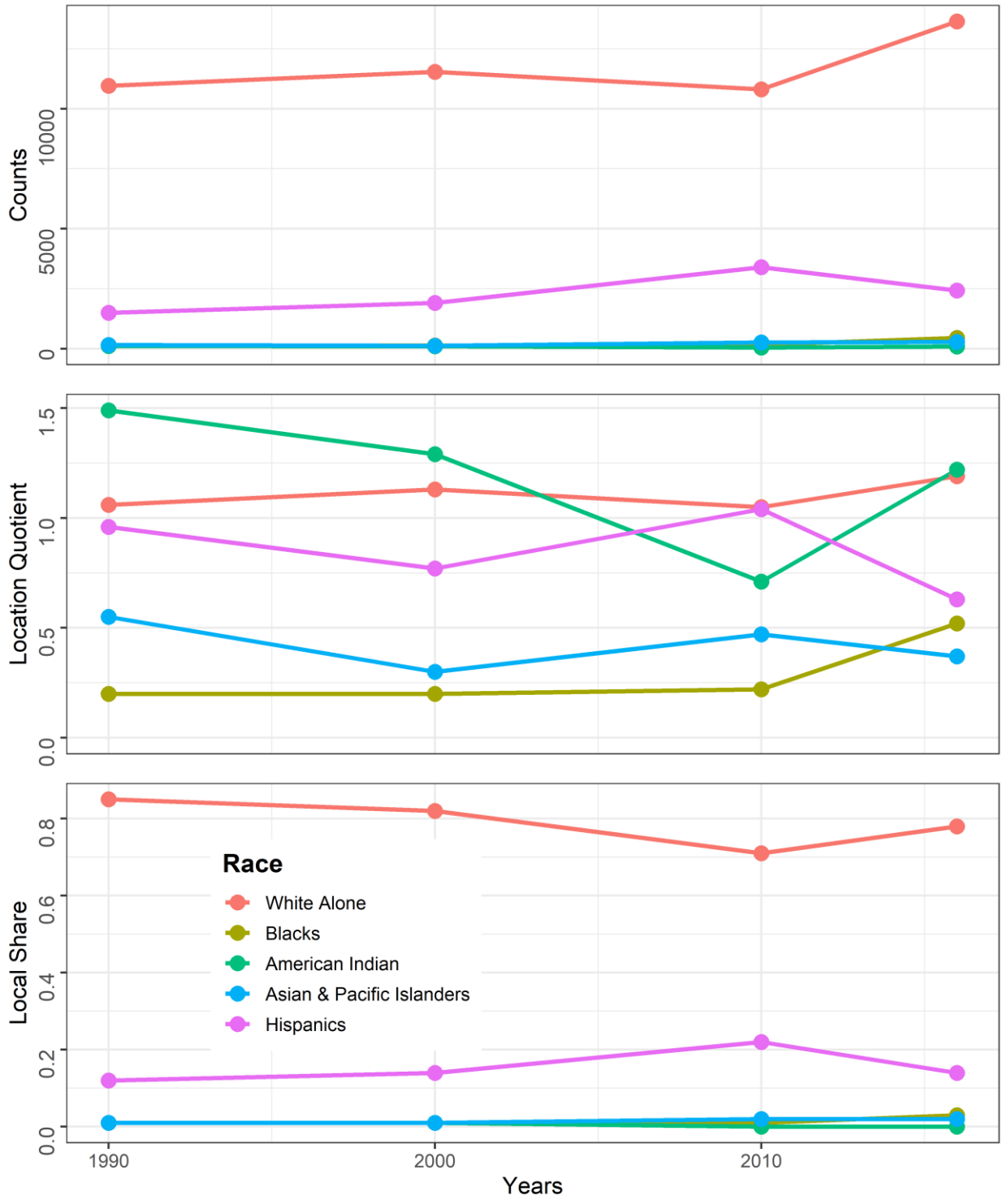

Figure 4.2 Ethnicity

The non-white population dropped from 29% in the period the LRT was opened to 22% in 2010-2016. To understand the dynamics of race along the corridor, the specific ethnic groups along the corridor were examined. It was observed that all other ethnics groups, except the white alone and Hispanics, along the corridor remained the same throughout the study period. The major changes in Hispanics after construction between 2000-2016 greatly impacted the non-white race results along the corridor. Comparing to the region, the corridor lost a lot more of the Hispanic ethnic group whiles the other ethnic races increased along the corridor during that period. The study did not identify what causes the change but the drop in the number of Hispanics in 2010-2016 shows that there was a shift in the number of ethnic races from one to another. Figure 4.2 shows the graph of the ethnicity and the changes that occurred between them.

The susceptibility analysis shows that the corridor was vulnerable to economic gentrification and not racial gentrification in the 1990-2000 and 2000-2010 decennial periods. Both periods before the construction of the LRT and immediately after its construction had four of the criteria qualifying for the susceptibility analysis used. Low-income households, people with high school certificates or lower education levels, and renters were the variables that showed potential to gentrify during the periods. The number of low-income households along the corridor remained higher than the metropolitan throughout the study. This made the few low-income households vulnerable to be displaced by the majority middle and high-income households in both the local neighborhood and the region. Table 4.1 also shows that the LQ of the low-income households (1.55) and adults with high school certificate or lower (1.26) were the highest for the 2000-2010 decennial period. This means that low-income households and the lower educated people along the corridor became more vulnerable to be displaced immediately

after the rail line was opened, that is between 2000 and 2010. The local and regional income changes are shown in Figure 4.3 below.

Adults with high school certificate or lower remained the most vulnerable to be displaced because they maintained a LQ greater than 1 until the 2010-2016 period. Before the construction of the LRT (before 1991), the corridor had 50% of people with only high school certificates and lower education which was twice as much as the person with college degrees and higher qualifications (19%). Even comparing to the region, the corridor lower educated adults were more which could be due to skilled workers with lack of education who might have been working in the industries that were along the rail line. Figure 4.4 shows that the number of persons with a degree and above education increased gradually from the time the line was announced and exponentially in the period after the Great Recess (2010-2016).

The period of 2010-2016 saw the most exponential changes in variables like persons with advanced degrees, high-income households, white alone race, and rents but we cannot say the period was susceptible to gentrification according to our criteria. During the 2010-2016 period, it was low-income households, renters, and nearness to a rail station that met the criteria, which made the period not susceptible to gentrification. Perhaps, something more than just the corridor been vulnerable was happening. The second step used to identify gentrification takes a closer look at what happened within that period.

The use of new housing structures as a criterion is essential because prior research suggest that some communities position themselves to allow more high-density and multi-family units once new transit projects are proposed. The study identified that 85% of houses were built before 1991. This put several homes in potential historic areas. For this research, houses built before 1960 were classified as historic buildings. The existence of more historic houses along the corridor would also mean disinvestment, which contributes to making a neighborhood susceptible to gentrify

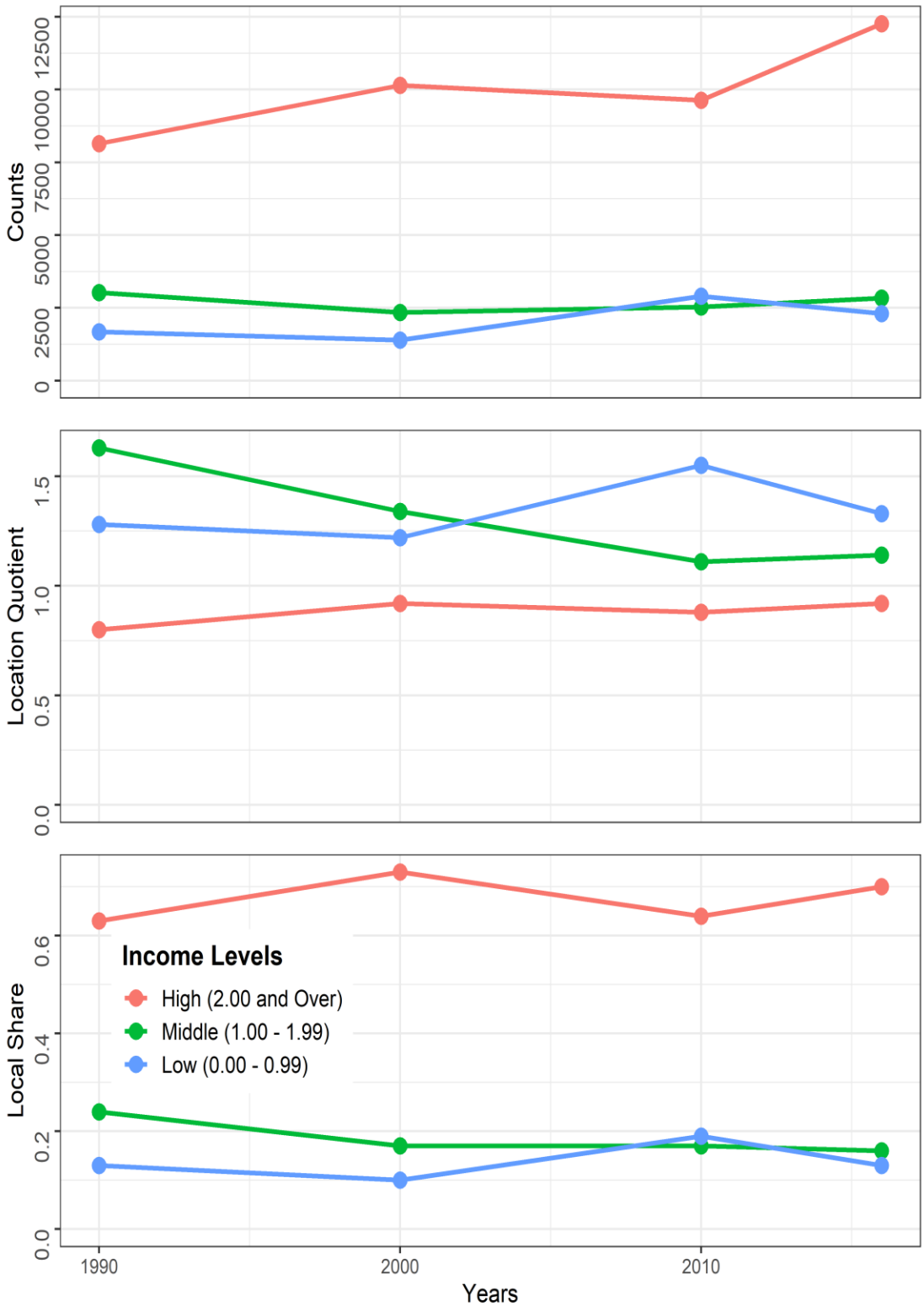

Figure 4.3 Income Levels

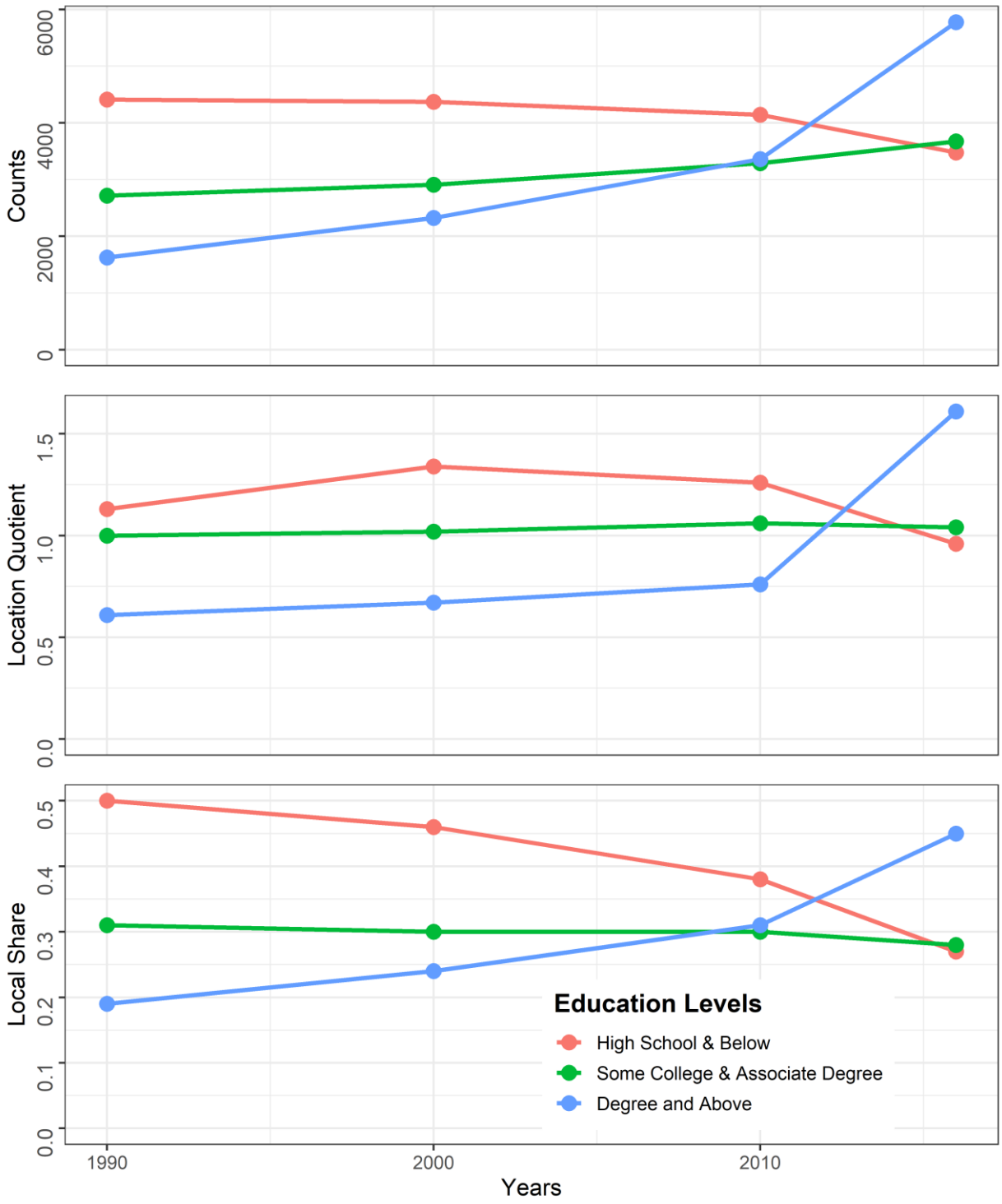

Figure 4.4 Education Level Attainment of Persons Older Than 25years

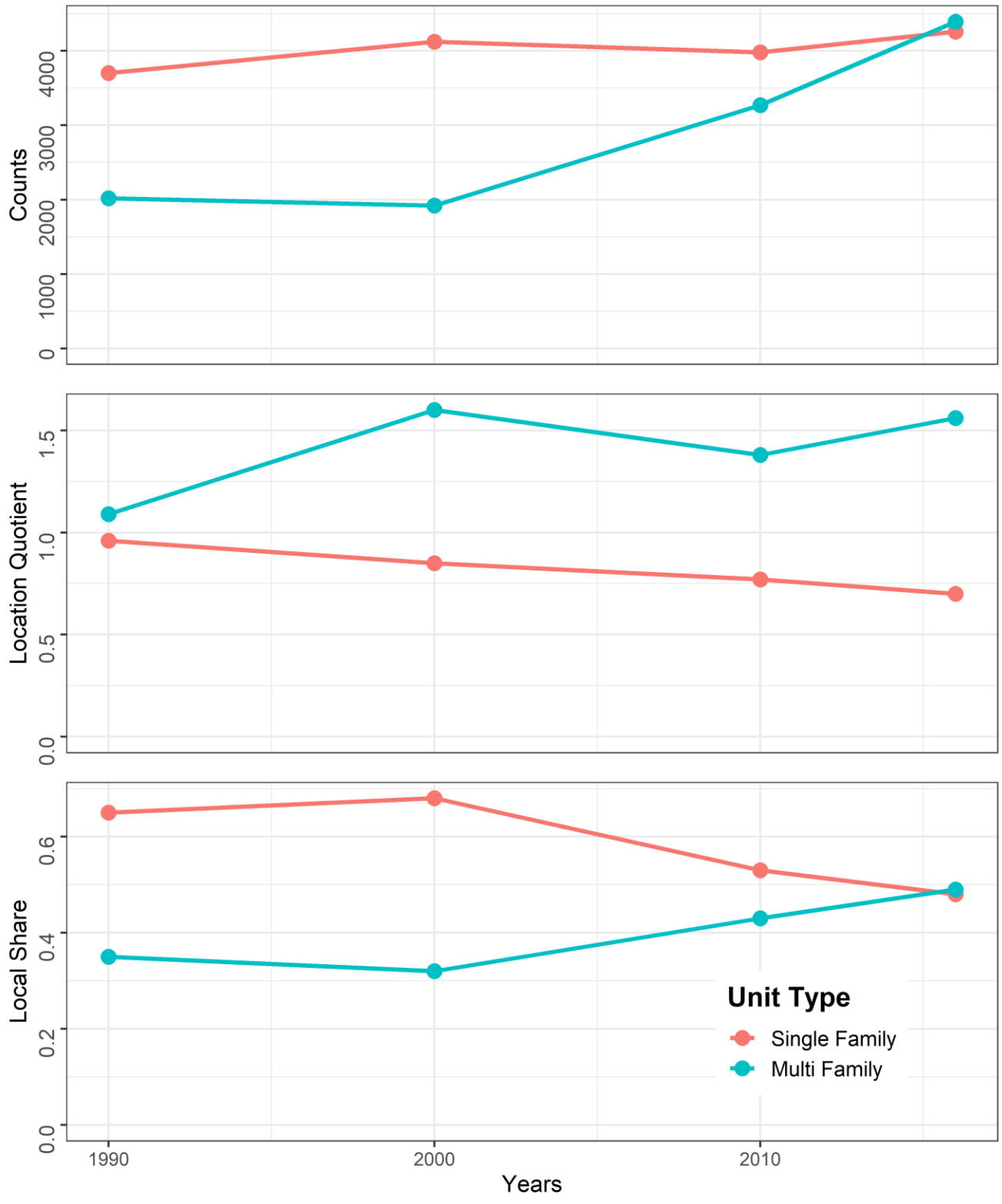

Figure 4.5 Occupied Residential Housing Units

(Freeman, 2005). In the period before 1991, the corridor had slightly lesser new houses than the metro region which made it the only period it contributed to the area's vulnerability to gentrify. Table 4.1 shows that the corridor produced as many new houses as the metro region in the 1990-2000, 2000-2010, and 2010-2016 periods. Further studies were made to understand the types of residential housing units that were produced during the study period. Though this analysis was not included in the first method, it is important to understand how the housing types along the corridor changed. Before the construction of the LRT, the corridor had almost twice as many single-family units (65%) as multi-family units, as shown in Figure 4.5 above. At the end of the study period, the share of single-family units had trailed to multi-family units. Though there has not been any empirical evidence confirming the relationship between the increase in multi-family units to gentrification, it has been established that proximity to TODs has a high chance of increasing multi-family housing production (Delmelle & Nilsson, 2020; Dong, 2017). Chapple (2009) also concurs that a higher share of multi-family buildings shows a higher chance of gentrification happening.

Lastly, the criteria for determining the corridor's susceptibility were the station areas having more renters than the metro region. Table 4.1 shows that the corridor had more renters than the metro which contributed to making the corridor susceptible to gentrify throughout the study period. It was observed that the number of renters declined in the periods before the construction of the LRT from 2773 in 1990 to 2743 in 1990-2000. Yet after the construction of the LRT line, we observed the percentage of renters increase to about 80% by 2016, which is typical of a neighborhood that is susceptible to gentrify (Delmelle & Nilsson, 2020).

Step 2

The second step used the simple percentage and absolute changes in variables to determine if the corridor gentrified. For this step, all the two criteria and sub criteria used must be met before the corridor could be seen as gentrifying or gentrified. According to the

conventional method of predicting gentrification, the percentage changes of the local variables all have to be more than the percentage changes of the metro region within a specific period. Table 4.3 shows the percentage changes of non-Hispanic white and adults with college degrees and advanced education, absolute changes of median income and median rent including the decennial periods the changes happen. The table shows that none of the periods witness an overall increase in the local proxies to be more than the metro. Therefore, the corridor cannot be said to have gentrified either before or after the construction of the LRT.

Table 4.2 Percentage And Absolute Changes of Variables for Identifying Gentrification

Topic	Non-Hispanic White		College Degree Or Advanced		Median Income $		Rent $	
Measure	Local	Regional	Local	Regional	Local	Regional	Local	Regional
1990 - 2000	0.05	0.18	0.43	0.56	15091	26549	-68	100
2000 - 2010	-0.06	0.08	0.44	0.33	-6328	4811	216	-46
2010-2016	0.26	0.08	0.72	-0.22	7850	3812	263	353
1990-2016	0.24	0.39	2.55	0.63	16615	35172	547	520

Source: Census Data, IPUMS NHGIS, 2020

It was observed that the corridor did not gentrify in any period even though the susceptibility analysis showed that it was vulnerable to gentrify even before and after the LRT was built when the conventional method was used. It must be noted that the Denver metropolitan region is gentrifying (Chapple & Thomas, 2020; Richardson et al., 2020), and the proxies of gentrification are already high. For instance, in 2010-2016, rents along the LRT corridor went up by $263, but that of the region went up by $353, which led to the period not qualified to be

gentrifying. The conventional method does not capture prior local rents and how they have increased regardless of what is happening regionally. Figure 4.6 shows that before or during the time of the construction of the LRT, rents along the corridor were around $785 while the metro region was around $1,000, and by 2016 rents have increased to $1,332 whiles the region remains around $1,300 which shows signs of gentrification, but it is not capture when using the conventional method. Though the median income of households along the corridor increased from $44,110 in 1990 to $59,201 in 2000, the Denver metro again increased from $65,778 to $92,327, whiles the national median average was at $60,020 (inflated). This unique nature of Denver's economy makes using the metropolitan area as a benchmark for determining gentrification very challenging and makes it hard to depict if gentrification is occurring in the study area.

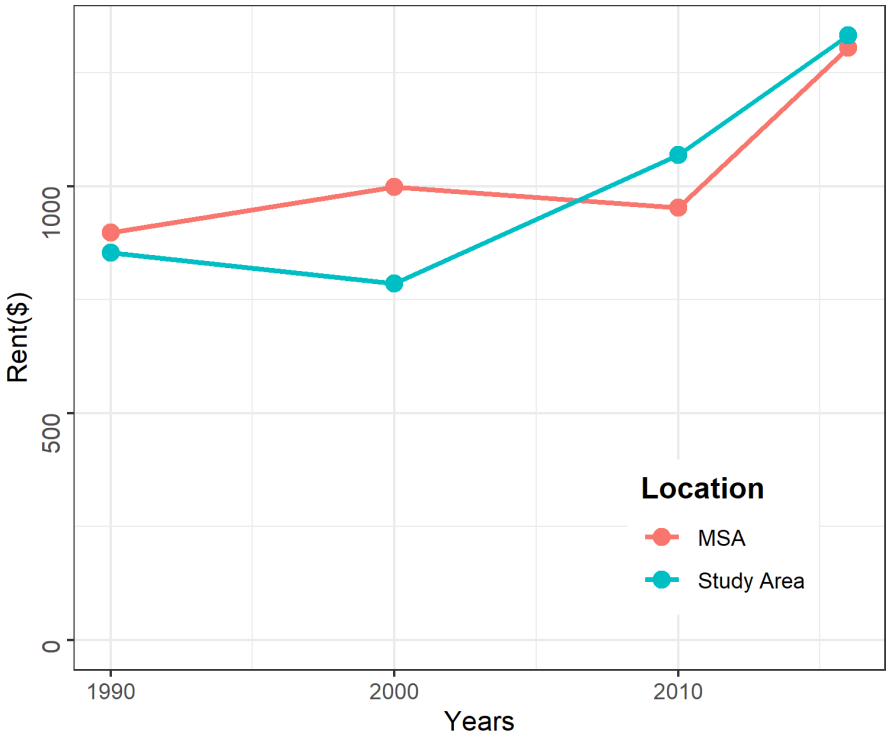

Figure 4.6 Median Rent

Method II

Gentrification and displacement research has shown that gentrification is variable across space. This makes it important to observe if the share of variables that caused the corridor to be vulnerable to gentrification did actually gentrify and also displaced people. A five-percentage point drop or increase from the previous period shares of variable that showed variability to gentrify in Step I will be used to depict if the corridor gentrified or not. Also rents that get more than five percent increase from the previous period qualifies the period as gentrifying. This simple method can also give us a sense of whether residents were displaced or not.

For this method, the percentage point decrease in the share of the low-income households, adults with high school certificates or lower, percent increase in rents would be used as the criteria for depicting gentrification and displacement along the corridor within a given period. A percentage point increase of the share of multi-family homes is used in place of the share of new buildings for this analysis. As seen in Table 4.3, the period between 2010-2016 was the only period the corridor was seen to be gentrifying. During this period, the number of low-income households decreased by six percentage points, adults with high school certificate or lower by 11 percentage points and multi-family units increased by 6 percentage points from the previous decennial period. Rents also contributed to the gentrification of the neighborhood by having a 20 percent increase in the period 2010-2016. The period before the light rail line was opened demographically showed some signs of gentrification but cannot be said so because the changes did not meet the five-percentage point mark and even rent and multi-family units decreased.

Table 4.3 Share of Variables for Depicting Gentrification

Years/Topic	Low-Income Households		High School Certificate or Lower		Multi-family Units		Rent (% Change)		Gentrified Or Not Gentrified
	Share	%	Share	%	Share	%	($)	%	
1990	0.13	N/A	0.5	N/A	0.35	N/A	853	N/A	N/A
1990-2000	0.1	-0.03	0.46	-0.04	0.32	-0.03	785	-0.09	Not Gentrified
2000-2010	0.19	0.06	0.38	-0.08	0.43	0.11	1069	0.27	Not Gentrified
2010-2016	0.13	-0.06	0.27	-0.11	0.49	0.06	1332	0.2	Gentrified

The period after the light rail line was opened also showed some strong signs of gentrification but cannot be concluded as such since the share of low-income households rather increased during that period. The increase in the share of low-income households can be attributed to the Great Recession in 2007 which caused many people to lose their jobs. In the study area, the share of high-income households reduced from 73% to 64%. Though the study was not able to identify what caused the reduction in the share of adults with high school certificate or lower, but the constant share in adults with some college education throughout the study can be attributed to likely displacement of the former.

It can also be said that, apart from the corridor been gentrified in 2010-2016 period, the corridor also gentrified from 1990 to 2016. This statement may be argued since the share of low-income households remained the same in 2016 just as the beginning of the study in 1990. However, the share of high-income households increased from 67% in the first year to 70% in 2016. And having understood that gentrification can also be viewed as the number of people coming in, the corridor can be concluded as been gentrified yet there is no displacement of low-income households.

Chapter 5 - Conclusion

Gentrification and displacement are words that have become popular amongst city planners, developers, and residents in neighborhoods that are about to or received new projects. The impact of gentrification may never be realized since it can be a gradual process. In some instances, transit infrastructure can cause direct displacement without gentrification (Chapple & Loukaitou-Sideris, 2019). Understanding the effects transit systems have on a community, and the low-income population is significant, especially when RTD is planning on opening a new station south of this study area. Gentrification has historically been examined in low-income neighborhoods, but Freeman (2005) states that gentrification is when communities are no more affordable to low-income households and historically marginalized races, and should be studied in places where these groups may be vulnerable. Studies have also identified that the construction of rail transits has the potential to gentrify TOD neighborhoods and sometimes displace the vulnerable. Denver which is enthused about building about 122 miles of light and commuter rail to the already existing 78.1 miles to continue to remain a hub for young graduates and professionals. Yet has the city has been identified as the second most gentrifying in the United States, with skyrocketing rents, putting low-income households at risk. Gentrification scholars struggle with identifying a simple uniform way of measuring gentrification and displacement due to unavailability of data and also varied definitions being used. It becomes more complex when the TOD neighborhood studied is within a gentrifying metro region.

This study therefore employs a simple local share method and the conventional method to test if gentrification and displacement occurred along the corridor and the periods in which they did. The study observes that the corridor was susceptible to gentrify from 1990 to 2016. It also noticed that low-income households, adults with high school certificate or below, renters and

new housing structures contributed to the susceptibility of the neighborhood to gentrify from 1990-2016. For the conventional method, all local changes had to be more than the Denver metro for the corridor to be considered as gentrifying. Using this method, the corridor was observed not to be gentrifying since all the two criteria set were not met. Applying the conventional method in a city like Denver, where the metro is gentrifying, it can be very challenging to identify gentrification. The weakness in the conventional method led to the use of the second method, which examined gentrification using the percentage share of the variables that showed susceptibility to gentrification.

The simple local share method unlike the conventional one observed that the corridor gentrified during the period between 2010-2016. It used a five percentage point change in the share of the variables from the previous period to determine if the corridor witnessed gentrification and displacement. It was observed that adults with high school certificate or lower lost 11 percentage points; low-income households lost 6 percentage points; multi-family units gained 6 percentage points and rents went up by 20% from the previous period. The study also finds that the construction of the light rail transit line has caused the LRT corridor to gentrify though it did not displace low-income households and non-white race. What the LRT corridor witness can be called racial diversity in a gentrifying neighborhood. However, the trend observed in this study shows that there is still high potential of continuous gentrification along the corridor.

The study finds that variables like education attainment, housing unit types, age of houses, and rents can be more easily used to predict gentrification than household income levels. Variables like income levels need more information like the number of people in household, occupation, and distance to workplace to conclude if they contribute to gentrification and

displacement or not. This research shows that the construction of the Southwest Light Rail Transit line led to the gentrification of the corridor after it was built. The corridor also remained vulnerable to gentrify throughout the study. Despite the corridor gentrifying, the author observed an increase in the diversity of race at the end of the study period – something that housing advocates and community developers both adjudicate for (Goetz, 2018).

Implication for Planning

No one can predict when gentrification would occur, but before a light rail line is constructed, thorough research must be done on the neighborhoods' housing stock, economy, and demographic characteristics to identify the shock it may cause. Studies should include previous changing trends and the projected or expected change. Also, a neighborhood survey should be done to understand the policies and needs of current residents that would enable them to continue to live in TOD neighborhoods. Gentrification is variable in space, and it must be noted that not all policies work for places. Hence, examining studies from places with similar populations and sizes may not be able to give accurate expectation, especially in Denver, where the metro region has unique characteristics like higher rents, highly educated adults, and increasing young professionals. Policies must be specific and be reviewed frequently to identify gentrification when it emerges. Gentrification cannot be controlled or prevented, but local examination of a LRT corridor’s housing stock and investments can depict if a new mega project will cause a neighborhood to gentrify or not. It is also important to find out from community members what would make them stay when such infrastructure are put in place.

The result of the research mainly contribute to the way planners, researchers, and local governments can address or even view gentrification. The ultimate implication of this case study shows that gentrification can also be viewed as the sudden shift in the local share of proxies of

gentrification with increasing rents along station areas in cities which are already seen as gentrifying. For a city like Denver, gentrification would have to be extremely worse in a neighborhood before it can be identified, making local changes more important to be looked at. The use of the local share method is a better way of identifying gentrification in an already gentrifying region where other methods may miss the changes that are occurring. It is also necessary that before a reference is selected for gentrification analysis, no similar transit investment or external control be observed since that may alter the outcome of the study. This will help get unique results for the TOD neighborhood under study.

This study also establishes that gentrification is a gradual process that cannot be observed in one period. Gentrification is shown in this study as an event that can occur at different periods with different characteristics. Understanding what neighborhood characteristics are before and after a LRT line is constructed gives a clearer idea of whether the neighborhood will gentrify or not. This study therefore seeks to propose that the notion of only seeing gentrification as the reduction of historically marginalized races and low-income households be changed to include a the sudden shift in the share of proxies for gentrification like the reduction of adults with low education levels.

Lastly, residents should also not be so quick to tag new transit infrastructure or TOD as bad but rather be ready to embrace the positives it brings. In this study, it was observed that the number of non-whites increased after the construction of the LRT line. Equitable Transit-Oriented Development (ETODs) can be introduced to every new transit hub in the Denver area to ensure that the dense, pedestrian-oriented, and mixed-used development benefits everyone regardless of income levels, race, age, etc. Undertaking TODs with equity in mind will then help close the gap between historically marginalized races and low-income households by providing

affordable housing, strong local businesses, public health, and environmental sustainability. (The City of Chicago, 2021).

Limitations

This research is faced with some data limitations. The best way the author wanted to identify gentrification was using panel data. This data is difficult to come by and resulted in the use of decennial census and ACS data. This research is also limited because some block groups in a half-mile radius were not added because they were not in conformity with other decennial periods' shapefiles. Future studies may avoid the removal of block groups within half mile radius due to non-conformity by performing spatial interpolation in ESRI ArcMap to capture all the information from the overlapping block groups. Also, since the study area consisted of different block groups of different cities and counties, the results may not give a true representation of what is happening in various cities since data was aggregated. Also, this research is limited with qualitative information that could help identify policies that were put in place before or after the construction of the LRT and how the residents feel about the neighborhood.

Future research will look at some of the policies or neighborhood dynamics that are made before and after light rail line is built using more robust analysis including community surveys. Such qualitative data would be needed to understand what caused the decrease in rents and the number of renters in the period before the LRT was constructed. Also, to ensure that no data is lost, future studies can use spatial interpolation to capture all the data that are within the half-mile radius of the station areas. More studies would also be needed to understand if the construction of the light rail transit line caused the displacement of skilled adults with low educational level along the corridor.

Chapter 6 - References

Atkinson, R. (2000). Measuring Gentrification and Displacement in Greater London. *Urban Studies, 37*(1), 149–165. https://doi.org/10.1080/0042098002339

Baker, D. M., & Lee, B. (2019). How Does Light Rail Transit (LRT) Impact Gentrification? Evidence from Fourteen US Urbanized Areas. *Journal of Planning Education and Research*, *39*(1), 35–49. https://doi.org/10.1177/0739456X17713619

Bardaka, E., Delgado, M. S., & Florax, R. J. G. M. (2018). Causal identification of transit-induced gentrification and spatial spillover effects: The case of the Denver light rail. *Journal of Transport Geography*, *71*, 15–31. https://doi.org/10.1016/j.jtrangeo.2018.06.025

Bates, L. K. (2013). *Gentrification and Displacement Study: Implementing an Equitable Inclusive Development Strategy in the Context of Gentrification* (pp. 1–95). City of Portland. https://doi.org/10.15760/report-01

Bhattacharjee, S., & Goetz, A. R. (2016). The rail transit system and land use change in the Denver metro region. *Journal of Transport Geography*, *54*, 440–450. https://doi.org/10.1016/j.jtrangeo.2016.02.004

Blake, S. (2019, September 12). Cocktail chattables: The Denver housing market, strong and growing, is at no risk of being in a bubble that could burst. *The Denver Post*. https://www.denverpost.com/2019/09/12/real-estate-voices-cocktail-chattables-the-denver-housing-market-strong-and-growing-is-at-no-risk-of-being-in-a-bubble-that-could-burst/

Brown, A. E. (2015). Uneven Effects: The Mixed Story of Transit-Oriented Gentrification in Los Angeles. *Critical Planning*, *22*(1). https://escholarship.org/uc/item/83k795fc

Burnett, K. (2014). Commodifying poverty: Gentrification and consumption in Vancouver's Downtown Eastside. *Urban Geography*, *35*(2), 157–176. https://doi.org/10.1080/02723638.2013.867669

Burns, V. F., Lavoie, J.-P., & Rose, D. (2012). *Revisiting the Role of Neighbourhood Change in Social Exclusion and Inclusion of Older People* [Research article]. Journal of Aging Research. https://doi.org/10.1155/2012/148287

Cao, X. (Jason), & Lou, S. (2018). When and How Much Did the Green Line LRT Increase Single-Family Housing Values in St. Paul, Minnesota? *Journal of Planning Education and Research*, *38*(4), 427–436. https://doi.org/10.1177/0739456X17707811

Cervero, R. (2004). *Transit-oriented Development in the United States: Experiences, Challenges, and Prospects*. Transportation Research Board.

Cervero, R., & Duncan, M. (2002). *Land Value Impacts of Rail Transit Services in Los Angeles County*. 37.

Chapple, K. (2009). Mapping Susceptibility to Getrification: The Early Warning Toolkit. *Center for Community Innovation, University of Califonia*.

Chapple, K., & Loukaitou-Sideris, A. (2019). *Transit-Oriented Displacement or Community Dividends?: Understanding the Effects of Smarter Growth on Communities*. MIT Press.

Chapple, K., & Thomas, T. (2020). *Berkeley, CA: Urban Displacement Project.* https://www.urbandisplacement.org/

Chapple, K., Waddell, P., Chatman, D. G., & et, al. (2017). *Developing a New Methodology for Analyzing Potential Displacement*. https://escholarship.org/uc/item/6xb465cq

Chatman, D. G. (2013). Does TOD Need the T?: On the Importance of Factors Other Than Rail Access. *Journal of the American Planning Association*, *79*(1), 17–31. https://doi.org/10.1080/01944363.2013.791008

Chatman, D. G., Tulach, N. K., & Kim, K. (2012). Evaluating the Economic Impacts of Light Rail by Measuring Home Appreciation: A First Look at New Jersey's River Line. *Urban Studies*, *49*(3), 467–487. https://doi.org/10.1177/0042098011404933

City of Littleton. (2017). *Littleton Housing Study*.

Debrezion, G., Pels, E., & Rietveld, P. (2006). The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-analysis. *The Journal of Real Estate Finance and Economics*, *35*(2), 161–180. https://doi.org/10.1007/s11146-007-9032-z

Deka, D. (2017). Benchmarking gentrification near commuter rail stations in New Jersey. *Urban Studies*, *54*(13), 2955–2972. https://doi.org/10.1177/0042098016664830

Delmelle, E., & Nilsson, I. (2020). New rail transit stations and the out-migration of low-income residents. *Urban Studies*, *57*(1), 134–151. https://doi.org/10.1177/0042098019836631

Delmelle, E., Nilsson, I., & Bryant, A. (2021). Investigating Transit-Induced Displacement Using Eviction Data. *Housing Policy Debate*, *31*(2), 326–341. https://doi.org/10.1080/10511482.2020.1815071

Denver Office of Economic Development. (2016). *Jump Start 2016*.

Diaz, R. (n.d.). *Impacts of Rail Transit on Property Values*. 8.

Ding, L., Hwang, J., & Divringi, E. (2016). Gentrification and residential mobility in Philadelphia. *Regional Science and Urban Economics*, *61*, 38–51. https://doi.org/10.1016/j.regsciurbeco.2016.09.004

Dong, H. (2017). Rail-transit-induced gentrification and the affordability paradox of TOD. *Journal of Transport Geography*, *63*, 1–10. https://doi.org/10.1016/j.jtrangeo.2017.07.001

Duncan, M. (2011a). The Impact of Transit-oriented Development on Housing Prices in San Diego, CA. *Urban Studies*, *48*(1), 101–127. https://doi.org/10.1177/0042098009359958

Duncan, M. (2011b). The Impact of Transit-oriented Development on Housing Prices in San Diego, CA. *Urban Studies*, *48*(1), 101–127. https://doi.org/10.1177/0042098009359958

Ellen, I. G., & O'Regan, K. M. (2011). How low income neighborhoods change: Entry, exit, and enhancement. *Regional Science and Urban Economics*, *41*(2), 89–97. https://doi.org/10.1016/j.regsciurbeco.2010.12.005

Ellis-Young, M., & Doucet, B. (2021). From "Big Small Town" to "Small Big City": Resident Experiences of Gentrification along Waterloo Region's LRT Corridor. *Journal of Planning Education and Research*, 0739456X21993914. https://doi.org/10.1177/0739456X21993914

Freeman, L. (2005). Displacement or Succession?: Residential Mobility in Gentrifying Neighborhoods. *Urban Affairs Review*, *40*(4), 463–491. https://doi.org/10.1177/1078087404273341

Goetz, E. G. (2018). *The One-Way Street of Integration: Fair Housing and the Pursuit of Racial Justice in American Cities*. Cornell University Press,. https://doi.org/10.1515/9781501716706

Gorham, R. (2002). *Air Pollution From Groud Transportation*. 87.

Grube-Cavers, A., & Patterson, Z. (2015). Urban rapid rail transit and gentrification in Canadian urban centres: A survival analysis approach. *Urban Studies*, *52*(1), 178–194. https://doi.org/10.1177/0042098014524287

Haas, P. M., Newmark, G. L., & Morrison, T. R. (2016). Untangling Housing Cost and Transportation Interactions: The Location Affordability Index Model—Version 2 (LAIM2). *Housing Policy Debate*, *26*(4–5), 568–582. https://doi.org/10.1080/10511482.2016.1158199

Hamnett, C. (1991). The Blind Men and the Elephant: The Explanation of Gentrification. *Transactions of the Institute of British Geographers*, *16*(2), 173–189. JSTOR. https://doi.org/10.2307/622612

Hamnett, C. (2003). Gentrification and the Middle-class Remaking of Inner London, 1961-2001. *Urban Studies*, *40*(12), 2401–2426. https://doi.org/10.1080/0042098032000136138

Hess, C. L. (2020). Light-Rail Investment in Seattle: Gentrification Pressures and Trends in Neighborhood Ethnoracial Composition. *Urban Affairs Review*, *56*(1), 154–187. https://doi.org/10.1177/1078087418758959

Hess, D. B., & Almeida, T. M. (2007). Impact of Proximity to Light Rail Rapid Transit on Station-area Property Values in Buffalo, New York. *Urban Studies*, *44*(5–6), 1041–1068. https://doi.org/10.1080/00420980701256005

Jackson, S. L., & Buckman, J. (2020). Light rail development with or without gentrification?: Neighborhood perspectives on changing sense of place in Denver, Colorado. *Journal of Transport Geography*, *84*, 102678. https://doi.org/10.1016/j.jtrangeo.2020.102678

Kahn, M. E. (2007). Gentrification Trends in New Transit-Oriented Communities: Evidence from 14 Cities That Expanded and Built Rail Transit Systems. *Real Estate Economics*, *35*(2), 155–182. https://doi.org/10.1111/j.1540-6229.2007.00186.x

Lees, L., Slater, T., & Wyly, E. K. (2008). *Gentrification*. Routledge.

Marcuse, P. (1985). Gentrification, abandonment, and displacement; connections, causes, and policy responses in New York City. *Washington University Journal of Urban and Contemporary Law*, *28*, 195–248.

National Low Income Housing Coalition. (2013, April 19). *New Brief Provides Examination of Changes in U.S. Rental Market, 2009 to 2011*. National Low Income Housing Coalition. https://nlihc.org/resource/new-brief-provides-examination-changes-us-rental-market-2009-2011

Newmark, G. L., & Haas, P. M. (2015). *Income, Location Efficiency, and VMT: Affordable Housing as a Climate Strategy*.

Padeiro, M., Louro, A., & da Costa, N. M. (2019). Transit-oriented development and gentrification: A systematic review. *Transport Reviews*, *39*(6), 733–754. https://doi.org/10.1080/01441647.2019.1649316

Ratner, K. A., & Goetz, A. R. (2013). The reshaping of land use and urban form in Denver through transit-oriented development. *Cities*, *30*, 31–46. https://doi.org/10.1016/j.cities.2012.08.007

Rayle, L. (2015). Investigating the Connection Between Transit-Oriented Development and Displacement: Four Hypotheses. *Housing Policy Debate*, *25*(3), 531–548. https://doi.org/10.1080/10511482.2014.951674

Regional Transportation Department, U.S. Department of Transportation, & Federal Transit Administration. (1995). *Transportation*. https://play.google.com/books/reader?id=4CU3AQAAMAAJ&hl=en_GB&pg=GBS.PR5

Regional Transportation District. (2021, Accessed //13). *Transit Oriented Development Projects*. RTD - Denver. https://www.rtd-denver.com/projects/transit-oriented-development-projects

Richardson, J., Mitchell, B., & Eblebi, J. (2020). Gentrification and Disinvestment 2020; Do Opportunity Zones benefit or Gentrify low-income neighborhoods? *National Community Reinvestment Coalition*, 32.

Sanchez, T. W., Stolz, R., & Ma, Jacinta S. (2003). *Moving to Equity: Addressing Inequitable Effects of Transportation Policies on Minorities*. Center for Community Change and Havard University.

Shin, H. B., Lees, L., & López-Morales, E. (2016). Introduction: Locating gentrification in the Global East. *Urban Studies*, *53*(3), 455–470. https://doi.org/10.1177/0042098015620337

Silva, D. (2019, July 23). *Cities That Have Recovered Most Since the Recession*. SmartAsset. https://smartasset.com/mortgage/cities-that-have-recovered-most-since-the-recession

Smith, N. (1982). Gentrification and Uneven Development. *Economic Geography*, *58*(2), 139. https://doi.org/10.2307/143793

The Center for Transit-Oriented Development. (2009). *Mixed-Income Housing: Increasing Affordability Using Transit*.

The City of Chicago. (2021). *The City of Chicago Equitable Transit-Oriented Development (ETOD) Policy Plan* (p. 67) [Policy Plan].

The Denver Post. (2013, April 25). Denver Renters: More Than 35 Percent of Income Pays the Rent. *The Denver Post*. https://www.denverpost.com/2013/04/25/denver-renters-more-than-35-percent-of-income-pays-the-rent/

Transportation Research Board & National Academies of Sciences, Engineering, and Medicine. (2004). *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects*. Transportation Research Board. https://doi.org/10.17226/23360

Wardrip, K. (2011). *Public Transit's Impact on Housing Costs: A Review of the Literature*.

Yunlei, Q. (2020). *Transit-Induced Gentrification in U.S. Metropolitan Areas*. University of Minnesota.

Zuk, M., Bierbaum, A. H., Chapple, K., Gorska, K., Loukaitou, A., Ong, P., & Thomas, T. (2015). *Gentrification, Displacement and the Role of Public Investment: A Literature Review*. 76.

Zuk, M., Bierbaum, A. H., Chapple, K., Gorska, K., & Loukaitou-Sideris, A. (2018). Gentrification, Displacement, and the Role of Public Investment. *Journal of Planning Literature*, *33*(1), 31–44. https://doi.org/10.1177/0885412217716439

Appendix A -

How to calculate 2000 average median value of houses from aggregated census block groups

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	Aggregated_Value_00	Commulative	Cum_Percentage
Less than $15,000	0	0	0	5	0	0	0	0	0	0	5	0	0	10	10	0.3
$15,000 to $19,999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.3
$20,000 to $24,999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.3
$25,000 to $24,999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.3
$30,000 to $34,999	0	0	0	0	0	0	0	0	0	0	0	11	6	17	27	0.9
$35,000 to $39,999	0	0	0	0	0	0	0	0	0	0	0	5	0	5	32	1.1
$40,000 to $49,999	0	0	0	0	0	0	0	0	0	0	0	0	5	5	37	1.3
$50,000 to $59,999	0	0	0	0	0	0	6	0	0	0	0	0	16	22	59	2
$60,000 to $69,999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	2
$70,000 to $79,999	0	0	0	0	0	0	0	6	0	0	0	0	0	6	65	2.2
$80,000 to $89,999	0	0	6	0	7	9	14	0	0	0	0	20	40	96	161	5.5
$90,000 to $99,999	0	0	0	10	0	5	0	0	8	7	12	17	17	76	237	8.1
$100,000 to $124,999	0	92	43	54	36	49	20	17	0	28	38	61	99	537	774	26.4
$125,000 to $149,999	0	88	83	34	28	61	103	76	8	56	60	28	119	744	1518	51.8
$150,000 to $174,999	0	55	62	43	6	66	100	51	6	54	100	13	34	590	2108	71.9
$175,000 to $199,999	0	92	23	0	0	46	48	39	0	23	38	0	5	314	2422	82.6
$200,000 to $249,999	0	209	0	0	0	0	20	6	0	0	38	0	0	273	2695	91.9
$250,000 to $299,999	0	53	0	5	0	0	6	0	0	11	20	0	0	95	2790	95.2
$300,000 to $399,999	0	52	0	0	0	0	0	10	0	0	26	0	0	88	2878	98.2
$400,000 to $499,000	0	35	0	0	0	0	0	0	0	0	5	0	0	40	2918	99.6
$500,000 or more	0	7	0	0	0	0	6	0	0	0	0	0	0	13	2931	100

(1) Aggregate the number of home values in each range for the selected areas. Calculate a cumulative total and a cumulative percent.

(2) Determine the mid-point:

Total Number of households ÷ 2 = 2931 ÷ 2 = 1465.5

The 1466^{th} number is the mid-point

3) Determine the range holding the mid-point:
Here the mid-range based on the mid-point falls in the $125,000 to $149,999 range

(4) How many of the households (HH) in the mid-range are needed to reach the mid-point?
(Mid-point) - (total HH in the previous smaller range, $100,000 to $ 124,999)
1466 – 774 = 692
Now we need 692 more households to reach the mid-point

(5) What is the proportion of the number of households in the $125,000 to $149,999 range that would be needed to get to the mid-point?
(Result from Step 4) ÷ (number of HH in mid-range)
692 ÷ 1466 = 0.472

(6) Multiply this proportion to width of the mid-range dollar figure:
The width of $125,000 to $ 149,999 is $25,000
The proportion * the width = 0.472 * $25,000 = $11,800

(7) Calculate the new median:
Beginning of the mid-range + results from step 6
$125,000 + 11,800 = $136,800

Therefore, the average median value of homes along the corridor in 2000 was $136, 800

$136, 800 *CPI = $194,808

Appendix B -

Typology	Typology Criteria
Displacement of Low-Income Households/Ongoing Gentrification (Low Income)	• Pop in 2000 > 500 • Low Income Tract in 2015 • Vulnerable in 2000 (Defined in Appendix) • Population stable or growing 2000-2015 • Loss of LI households 2000-2015 (absolute loss) • Either: o "Hot market" (Defined in Appendix) o LI migration rate (percent of all migration to tracts that was LI) in 2015 < in 2009 *– Or –* • Low Income Tract in 2015 • Gentrified in 1990-2000 or 2000-2015 (Defined in Appendix)
Advanced Gentrification (Moderate to High Income)	• Pop in 2000 > 500 • Moderate to High Income Tract in 2015 • Gentrified in in 1990-2000 or 2000-2015 (Defined in Appendix)
Not Losing Low-Income Households (Moderate to High Income)	• Pop in 2000>500 • Moderate to High Income Tract in 2015 • Not classified as At Risk of, Ongoing, or Advanced Exclusion

At Risk of Exclusion (Moderate to High Income)	• Pop in 2000 > 500 • Moderate to High Income Tract in 2015 • 2 out of the 4 of the following is true in 2015: o Has rail station in tract o % of units in prewar buildings (1950) > regional median o Employment density> regional median o "Hot market" (options defined below table) • Not currently undergoing exclusion – none of the below classifications are met
Displacement of Low-Income Households - **Ongoing Exclusion** (Moderate to High Income)	• Pop in 2000 > 500 Moderate to High Income Tract in 2015 Population stable or growing 2000-2015 Loss of LI households 2000-2015 (absolute loss) • Either: o "Hot market" (options defined below table) o LI migration rate (percent of all migration to tracts that was LI) in 2015 < in 2009
Advanced Exclusion (Moderate to High Income)	• Pop in 2000 > 500 Moderate to High Income Tract in 2015 • <20% LI in 2000 and % LI in 2015 < % LI in 2000 • LI migration < regional median in 2015

Source: Chapple and Thomas (2020)