Mobility for Whom? Transit Equity in the Unaffordable City

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DEDICATION

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To my father, **Joseph Alexander McKane** - tá mo chroí istigh ionat. Is tusa mo chara is fearr.

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Chapter I

Introduction

In May 2018, voters in Nashville, TN, rejected a $5.2-billion transit plan that included five Light Rail Transit (LRT) lines. The plan failed by a 2-to-1 margin. Community leaders and activists who formed an organization called People's Alliance for Transit, Housing, & Employment (PATHE) argued that the plan would intensify the gentrification that is uprooting minority communities across the city. Tamika Douglas, a member of PATHE and the Music City Riders United (MCRU)—Nashville's bus riders union—argued: "We want equitable transit that doesn't displace people, and we want to make sure that we're also focused on housing. If you don't have a place to stay or a home, who cares about a train versus a bus? We've got to get more housing in this city" (Haggard, 2018).

Nashville is just one of many cities across the country that are undergoing massive population growth, gentrification of its urban core, and displacement of low-income residents, often people of color. Rent and housing prices are skyrocketing, and Black hubs are disappearing as suburban whites move back to the inner-city. Developers are building high rise luxury apartments as cities demolish public housing units. Urban renewal projects promoted by "smart growth" and "new urbanism," such as transit-oriented development (TOD), are undertaken with the intention of creating economic growth and sustainable amenities within the city. Thus, it is important to note that urban redevelopment was not coincidental. It was facilitated by supply side forces—such as local governments and corporate actors who followed the advice from urban scholars to lure the creative class, and subsequently wealth and whiteness, into the inner-

city (Florida, 2014; Harvey, 2008).

These widely implemented urban planning practices promote the creation and use of cleaner forms of transportation such as walking, bicycling, LRT, and commuter lines as opposed to the use of private automobiles in the inner-city (Bullard, 2007). Yet, increasing transit ridership through the development of TOD projects can create a transportation access paradox. Even if potential residents may not be persuaded by the potential development of cleaner and more efficient forms of public transportation, areas surrounding TOD offer a variety of cultural, social, and physical amenities to increase the desirability of inner-city living (Florida, 2014; Glaeser & Shapiro 2003). As desirability increases, so does the cost of housing in an unchecked capitalist market. Tamika Douglas' words speak deeply to the intertwined nature of this relationship, one all too familiar to folks across the country fighting for their right to emplacement, accessibility, and social inclusion in the very neighborhoods that they have historically called home.

The mobilizations in Nashville and across other cities in the U.S. are forcing policy makers to confront the fact that not everyone is reaping the benefits of explosive urban growth. Rampant and unchecked development in the inner-city is a threat to the livelihoods of low-income earners and people of color. The urban restructuring that is creating an affordable housing crisis is also inextricably linked to the changing nature of transportation accessibility in cities. The crisis of affordability and the subsequent crisis of accessibility are both connected to a long history of spatial segregation that was facilitated, in part, by changes in the nature of transportation itself (Sheller & Urry 2000). The very same system of racial capitalism that led to the blight of urban areas, white flight, and suburbanization is simply creating a new chapter in the saga of spatialized inequality in cities.

Although researchers have begun exploring the role that public transportation plays in the unequal restructuring of urban areas and how the unaffordability of the inner-city shapes patterns of public transportation accessibility, there is much work to be done. Systematic overviews of transportation accessibility and how transportation influences patterns of residential change are often left to urban development officials who ignore the racialized history of the social creation of space. This disconnect often plays out in local level policy that attempts to redress both transit and housing poverty. City level transit plans that attempt to tackle transportation access without addressing the shifting demographics of urban areas, as well as its link to the affordable housing crisis, are incorrectly defining the changing nature of transit accessibility.

The consequences of this definitional problem are dire. Ineffective and unpopular solutions aimed at increasing access to public transportation can exacerbate the banishment of racial minorities and the poor in the name of urban development and sustainability (Roy, 2017). Transit plans that focus on the construction of new and cleaner forms of transit, such as LRT, without addressing products of gentrification, such as the affordable housing crisis and destruction of homes and businesses historically belonging to Black and Indigenous People of Color (BIPOC), will do little to increase accessibility for those who actually need public transportation the most. These plans have the potential to push transit dependent populations further into suburban areas that are poorly connected to the inner-city by public transit networks since they were historically created to keep inner-city transit riders out (Allen, 2017).

RESEARCH QUESTIONS

Each of the three substantive chapters of this dissertation challenges us to redefine the problem of transportation accessibility in the age of rampant urban redevelopment. By exploring this

linkage, this dissertation speaks to the problem of supply and demand misallocation in urban transportation and housing markets. I pay close attention to racial variations in exploring the causes and consequences of accessibility in order to more fully understand how this problem is linked to a historical system of racialized capitalism (Pulido, 2015). I use insights from urban sociology, mobility studies, and environmental justice to help reframe the changing dimensions of transportation accessibility and its linkage to a long history of urban spatial inequality, segregation, and transportation racism (Bullard, Johnson & Torres, 2004; Bullard & Johnson, 1997; Avila, 2014; Farmer, 2011; Sheller, 2015)

The first substantive chapter of this dissertation links the growing affordable housing crisis to transit accessibility. Studies on transit accessibility, and by extension social exclusion and inclusion, measure accessibility using poverty measures and not affordability (Kramer, 2018). Although research has shown that poverty is still deeply entrenched in the inner-city where there are more frequent and connected transit services (Kneebone & Berube, 2013; Hwang, 2015), there is evidence that racial minorities and the poor face heightened residential mobility, overcrowding, and evictions (Clampet-Lunquist, 2003; Desmond, 2016). Low-income housing is dwindling in urban areas and the majority of new housing units are built for high-income earners. While the poor still live in cities, they are often rent burdened and lack access to affordable units (Joint Center for Housing Studies, 2020). Thus, this chapter reframes the question of transit accessibility as an extension of the affordable housing crisis by asking the following question:

1. *In cities with rampant urban restructuring and TOD developments, what is the current state of transit accessibility and housing affordability?*

The second substantive chapter speaks to the growing literature that quantitatively examines the relationship between LRT and gentrification that has yielded mixed findings. Notably, these studies are typically undertheorized in two major ways. First, existing studies heavily focus on examining changes in property values while ignoring potential demographic patterns of displacement and racial banishment of minority residents (Kahn, 2007; Zuk et al., 2018). As such, I contribute to this literature by understanding gentrification as an inherently intersectional issue by quantitatively examining patterns of potential racial banishment along with traditional measurements of gentrification and neighborhood upgrading. This chapter demonstrates that accessibility, and the patterns of unequal urban redevelopment that are changing the nature of accessibility, are inherently tied to transit objects (Skeggs 2004; Kaufman, Bergman, & Joye 2004). Although transportation accessibility often examines how transit is used to redress inequalities in mobility, this chapter highlights how transportation can be used a tool to create inequity. As such, the second substantive chapter addresses the following research question:

2. *To what extent is gentrification, understood as both a process of growing unaffordability and racial banishment, associated with the presence of light rail stations in cities?*

Whereas the first substantive chapter demonstrates the high cost of housing in transitscapes, the third substantive chapter in this dissertation explores how the growing unaffordability of the inner-city is forcing residents into areas that are not well served by public transportation. Recent work on "transit deserts" explores how transit dependent populations are growing in suburban areas (Allen, 2017; Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013). Yet, this relatively new body of research explores accessibility, or inaccessibility, through supply and demand mismatch

for transit dependent populations. However, the definitions of transit dependent populations reflect the cultural and social privileging of automobility (Lubitow et al. 2017). Thus, these studies do not distinguish between "transit deserts" and areas that are poorly served by public transportation in general. As such, I argue that definitions of inaccessibility should focus on the latter in an effort to minimize the multiscalar effects of transportation usage in the age of climate change (Pellow, 2018). Furthermore, I challenge the way we examine inaccessibility by exploring how the class and racial composition of those living in inaccessible areas has changed over time. Thus, the main research question for the third substantive chapter is:

3. *Has the demographic makeup of public transit deserts changed to reflect the process of minority suburbanization, thus changing the historic demographic makeup of public transit inaccessibility itself?*

BACKGROUND AND THEORY

To situate this research, I bring together literatures in urban sociology and mobility using an environmental justice lens to provide a new perspective on transportation inequity in cities with TOD. Urban sociology provides a framework for conceptualizing theories of urban social organization and spatial mobility that influence patterns of residential segregation in metropolitan areas (Wilson, 1987; Drake & Clayton, 1945; Gottdiener, 1985). Furthermore, this vast body of literature has been instrumental in theorizing the continual structuring and restructuring of cities and in exploring definitions of the process of gentrification (Squires & Kubrin, 2005). Although older studies in this field tended to focus on gentrification in terms of economic restructuring (Smith, 1982; Ley, 1986), new studies in human geography have pointed

to the racialized nature of poverty capitalism and the importance of examining racial banishment as a feature of gentrification (McKittrick, 2011; Roy, 2017).

The transdisciplinary field of mobilities research includes studies of the spatial mobility of both humans and objects, and how control over mobility is a reflection of power and social inclusion (Sheller, 2014; Skeggs, 2004; Urry, 2007). Although both literatures recognize mobility as a social experience with very real implications, only mobilities research has embraced the importance of infrastructure, including transportation, in analyzing spatialized inequality (Kaufmann, 2011; Sheller, 2014). The new mobilities paradigm speaks to transportation exclusion in an age of escalating hypermobility (Urry, 2007; Kenyon, 2003). This perspective explores how certain groups are excluded from or disproportionally impacted by the transportation system and how the system reinforces existing systems of social stratification (Cass et al., 2005; Lucas, 2012).

Although spatial mobility and accessibility of the built environment, including transportation justice, have been severely underexplored in mainstream sociological theory, they have been given significant consideration in environmental justice studies (Bullard & Johnson, 1997; Bullard, Johnson & Torres 2004). The field of environmental justice was not always theoretically well-developed, but scholars are increasingly merging insights from theoretical frameworks such as critical race theory and intersectionality to better understand how various forms of social difference relate to both the built and natural environment (Pellow, 2018; Malin & Ryder, 2018; Mohai, Pellow, & Roberts, 2009). These insights can help us contextualize both the systems of urban inequality explored in urban sociology and the use of transportation objects to facilitate urban restructuring in the field of mobilities as interconnected environmental justice issues.

Segregation, Gentrification, and the Restructuring of U.S. Cities

Developments in urban sociology help us understand the process of neighborhood change in metropolitan areas through succession and renewal. This body of research explores theories of spatial-temporal segregation including white flight to the suburbs and the back-to-the-city movement, as well as the spatial components and social consequences of capital flows and the neoliberalization of the inner-city (Gottdiener, 1985). Early research in this field explored segregation in inner cities as both a function of race and class, and the research attributed segregation to overtly racist and classist policies and practices that dictated where people could live. In the age of gentrification and the rapidly changing social and spatial structures within the city, class mobility has become the defining explanation for contemporary social segregation. However, the contemporary emphasis on class ignores lessons from both intersectionality and critical race theory that validate how class mobility in U.S. cities itself is intrinsically tied to race (Crenshaw, 1989; Collins, 2000; hooks, 2000).

Early work in urban sociology explored spatial segregation through the creation of ethnic enclaves during the height of European immigration. The invasion-succession model was first developed to recognize how racial and ethnic groups replace each other in urban spaces (McKenzie, 1924). Park, Burgess and McKenzie (1925) applied this model to the assimilation of white ethnic European immigrants in American cities, a process by which immigrants who were moving out of city centers were subsequently replaced by poorer immigrants. In the following decades, heavy waves of immigration subsided, and the invasion-succession model was used to explore the relationship between class-based invasions and racial segregation, both contextualized through the lens of power.

The spatial layout of cities changed rapidly after World War II as automobility facilitated a mass migration to suburban areas and created a racialized urban-suburban divide. This created "sprawl cities" with varying levels of urbanization, including urban centers and inner and outer ring suburban areas that were not well-connected by or easily accessible with public transportation. Gillham (2002) defined sprawl as "a form of urbanization distinguished by leapfrog patterns of development, commercial strips, low density, separated land uses, automobile dominance, and a minimum of public open space" (Gillham, 2002, p. 8). As investment flowed into suburbia, the urban core witnessed unemployment, widespread poverty, and what many scholars deemed an "urban crisis." Declining tax revenues associated with the crisis led to major cutbacks for inner-city school systems and infrastructure. The suburbs held a clear advantage over urban centers by declaring themselves independent municipalities and retaining control over their new wealth. Research on racial segregation during and after the creation of suburban America demonstrates how structural racism excluded Blacks from participating in invasion-succession processes in predominantly white suburban areas.

Drake and Cayton's (1945) work on Chicago explores how urban Blacks were deliberately banned from certain spaces through both overt and covert racist real estate practices including redlining. Racial integration in the city was often met with violent opposition. Alba et al. (1999) found that Black homeowners were systematically kept from buying homes in white neighborhoods, and thus restricted to purchasing homes only in majority Black areas. Massey and Denton (1993) found that for both for Hispanics and Asians, segregation actually decreases as income increases; however, this was not true for Black inner-city populations. Similarly, Crowder (1999) found that typical means of increasing social status such as

homeownership or educational attainment improve neither human nor social capital for these Black residents. Thus, although class mobility was beneficial for white European immigrants, in a heavily racialized society, it has not ended urban segregation.

Nonetheless, early studies on spatial assimilation and the urban "underclass" associated the process of racial segregation with differences between racial groups in socioeconomic status, such as class, and in educational attainment (Oliver & Shapiro, 1995). These studies failed to examine how persistent structural racism, and subsequently racial segregation, is what led to racial differences in socioeconomic status in the first place. Massey and Denton (1993) argue that the early racial segregation literature should have focused on the detrimental effects of racial segregation and that these early spatial assimilation theories ultimately "amplif[ied] the harmful social and economic processes they [aimed to] treat" (p. 7).

The effects of segregation were not limited to class mobility. DuBois (1903) explored what he defined as "the color line," or the process of the spatial segregation of Black and white neighborhoods. For DuBois, neighborhoods, as the primary locale for social interaction, are imperative for accepting and promoting diversity. Taeuber and Taeuber (1965) argue that residential segregation "inhibits the development of informal, neighborly relations" (p. 1). Wilson (1987) famously linked social isolation, a state in which "contact between groups of different class and/or racial backgrounds is either lacking or has become increasingly intermittent," to the development of suburbia and the subsequent disinvestment of urban areas during the post-Civil Rights era. Thus, segregation has long been considered detrimental to the social wellbeing of people of color in urban areas. Segregation also prevents mobility, which is imperative for both well-paying employment opportunities and better education (Jargowskey,

1997). This is paradoxical because both adequate access to employment and education have long been considered ways of solving poverty among the urban "underclass."

During the late-twentieth century and early twenty-first century the relationship between racism and urban space shifted from the prior concerns with the effects of spatial segregation to the limitations of the invasion-succession framework for understanding the urban Black experience. Gentrification can be understood as a reversal of the invasion-succession process described by earlier urban scholars (Laska, Seaman, & McSeveney, 1982), but early theoretical insights also viewed the process of gentrification through the lens of consumption and production of middle-class populations rather than its effects on urban Black residents (Smith, 1982; Ley, 1986). Smith (1998) defined gentrification as "the process by which central urban neighborhoods that have undergone disinvestments and economic decline experience a reversal, reinvestment, and the in-migration of a relatively well-off middle- and upper middle-class population" (p. 198). Hamnett (1991) argued that state and corporate actors may influence gentrification by attracting wealthier populations through new developments, but there also must be a demand from potential residents.

Gentrification was not a random process of shifting demographics. It was facilitated by the power of city officials, urban planners, and corporate actors and accompanied by professional reform movements such the smart growth movement and new urbanism (Bullard, 2007). Urban elites also welcomed revitalization and the rise of the new urban "creative class" (Florida, 2002). Insights from political economy demonstrate how capitalistic expansion has been pivotal in the creation of the new age city. Harvey (2008) argued that the built environment is constantly made, destroyed, and remade for the purpose of capital accumulation, leading Logan and Molotch (1987) to refer to cities as "growth machines." Sassen (2006) explored the formation of a world

city system, which positioned cities as products of neoliberalism. Essentially, contemporary cities are run as businesses (Alderson & Beckfield, 2004), including aspects of metropolitan governments such as urban transit systems that can facilitate the process of gentrification.

Theories of gentrification in urban sociology fall back on the class mobility explanation used to explain the spatial and economic mobility of white European immigrants. Class mobility as an answer to redress the spatialized inequality created by gentrification is almost ironic as cities are now destroying the social safety nets that policymakers claim can facilitate the upward mobility of the poor in the first place. For example, Rolnik (2013) argued, "It is through the wholesale intervention of central and local governments that a massive spoliation of the poor has taken place, opening up new frontiers—land hitherto part of the commons (such as public housing or traditional informal settlements) to financial investors" (p. 1064). More importantly, purely economic theories of gentrification in urban sociology ignore decades of rich literature on racial segregation within its own field.

The process of displacement, especially racial displacement, occurring from gentrification has been widely debated in the literature (Freeman, 2005; Pattillo, 2007). Some scholars have pointed out that Black middle-class populations are also moving into inner-city neighborhoods so the process of gentrification may be racially diverse (Moore, 2009). However, other studies have brought displacement back to the forefront of the gentrification debate. Jackson (2015) found evidence of racial displacement in previously Black-occupied neighborhoods in Washington, D.C., and in a study of neighborhood change in New York City, Sutton (2020) argued that even middle-class Black and Latino residents were being kept out of gentrifying neighborhoods.

Roy (2017) noted that "financialization is necessarily constituted through racialization" (p. A9). That is not to say that economic forces are not responsible for gentrification but that poverty is still facilitated by racist practices and policy in the inner-city. For example, Wyly and Ponder (2011) explored racism in predatory practices in the subprime market, which have become so commonplace since the Great Recession that they crafted the term "subprime America." They found that subprime lenders particularly targeted elderly African American women, many of whom were widows, and left them financially devastated. Hiller (2013) provided evidence that rent-paying tenants in racial minority neighborhoods in Chicago were forced out of foreclosed buildings by coercion and by deceptive tactics such as providing tenants with false information. Thus, these recent studies highlight how class-based arguments in the gentrification literature are problematic because they view the destruction of Black and minority neighborhoods as almost coincidental.

Scholars in the field of human geography are calling for a paradigm shift in how we understand the process of gentrification. These scholars suggest the need to include racial banishment as a facilitator of urban redevelopment. On this point, McKittrick (2011) argued, "[The] annihilation of black geographies in the Americas is deeply connected to an economy of race, and thus capitalism, wherein the process of uneven development calcifies the seemingly natural links between blackness, underdevelopment, poverty, and place within differing global contexts" (p. 951). In summary, research on the relationship between gentrification and people of color has increasingly recognized that gentrification represents a continuation of the history of spatial and structural racism that has longed characterized American cities. This conceptualization of gentrification and what it means in the U.S. urban context forms one of the major the underlying theoretical components of this study.

Mobilities, Automobility, and Transit Accessibility

Although urban sociology provides a framework for understanding processes of segregation and neighborhood change, it largely ignores the actual physical structures and objects within urban spaces that can be used as tools to facilitate segregation (Kaufman, 2011). Mainstream sociology has long been concerned with mobility, but often only in the sense of a limiting the definition of social mobility so that it does not include the geographical spaces in which the social world exists. For example, Lipset and Bendix (1959) defined social mobility as " the process by which individuals move from one position to another in society— positions which by general consent have been given specific hierarchical values." (p. 1). As Sheller (2014) notes, with this commonplace understanding of the word "mobility" in sociology, "space is treated as an empty container for social processes, even if geographical movement may effect prospects of social mobility" (p. 791).

Mobilities research examines the somatic travel of people and the physical movement of objects, such as transportation, as well as virtual travel and communicative travel (Urry, 2007). However, this dissertation is only concerned with the former. Although mobilities is a distinct transdisciplinary field, it does have deep connections to the early work from the Chicago School of urban sociology (Sheller, 2014; Kaufman, 2014). In their famous book, *The City*, Park, Burgess, and McKenzie (1925) note, "Society is, to be sure, made up of independent, locomoting individuals. It is this fact of locomotion, as I have said, that defines the very nature of a society" (p. 159). However, much of the urban sociology literature has isolated itself from specialty subfields related to spatial mobility, such as the study of transportation (Kaufman, 2011; Sheller, 2014).

Sheller and Urry (2000) argue that urban sociology has failed to consider "the overwhelming impact of the automobile in transforming the time-space scales of the modern urban/suburban dweller" (p. 738). The cultural shift to automobility is what ultimately facilitated the suburban-urban divide and widespread sprawl. Henderson (2006) argues for greater attention to "secessionist automobility," which pays greater attention to how the automobile was used as an instrument for spatial secession. This definition speaks to how the automobile was used by suburban whites to physically segregate themselves from minorities within urban areas.

Investments and divestment in public transportation infrastructure have been, and continue to be, at the heart of the structuring and restructuring of urban and suburban areas across the U.S. Before the creation of the automobile, streetcar systems were often built to add value to peripheral residential areas, known as "streetcar suburbs." Sam Bass Warner's classic work *Streetcar Suburbs*, a case study of Boston, demonstrates how streetcars represented the beginning of the decentralization of the American city: early independent suburban real estate developers used transportation to create urban sprawl. This suburban growth and subsequent decentralization led to what Warner deems the two-part city: "a city of work separated from a city of homes" (Warner, 1978, p. 25).

Automobiles replaced streetcars as the facilitator of urban sprawl and the creation of suburbia. The automobile is more than just a status symbol and it is not a neutral technology (Sheller & Urry, 2000; Henderson, 2006). The modern highway system was constructed, in part, to accommodate the automobile. The construction of this system was met with massive NIMBY (not-in-my-backyard) protests—collectively known as the "freeway revolts," mostly led by affluent white residents. Minority residents lacked the political and economic power to stop

highway construction through their neighborhoods, which worsened the racialized spatial apartheid in the city. For example, Avila (2014) highlighted how people of color in urban areas protested the development of highways systems through creative opposition. Likewise, Mohl (2014) explained how the creation of I-40 in Nashville demolished Black homes and churches, and effectively separated Black neighborhoods from Black businesses, which is still the case today.

The physical boundaries created by the construction of the interstate highway system highlight the connection between spatial and social mobility. Kaufman, Bergman, and Joye (2004) use the term "motility" to describe the link between spatial and social mobility, and define it as "the capacity of entities (e.g. goods, information or persons) to be mobile in social and geographic space, or as the way in which entities access and appropriate the capacity for socio-spatial mobility according to their circumstances" (p. 750). This definition speaks to the politics of mobility and how access to social mobility is controlled through power over physical spatial mobility (Massey, 1991). Skeggs (2004) argues that "mobility and control over mobility both reflect and reinforce power. Mobility is a resource to which not everyone has an equal relationship" (p. 49).

Equally important to conceptualizing the link between spatial mobility and social mobility is the concept of social inclusion and exclusion. Unfortunately, mainstream sociology often ignores the spatial and mobility related facets in definitions of social inclusion and exclusion (Kenyon, Lyons, & Rafferty, 2002; Levitas, 1998). Church, Frost, and Sullivan (2000) argued that definitions of social exclusion must be distinct from poverty. As such, they defined social exclusion as a concept in which "people or households are not just poor, but that they have additionally lost the ability to both literally and metaphorically connect with many of the jobs,

services and facilities that they need to participate fully in society" (p. 197). In turn, concepts of social exclusion have been applied in the mobilities literature. Kenyon, Rafferty, & Lyons (2003) define transit-related exclusion as a process by which people are prevented from participating in social life "due in whole or part to insufficient mobility in a society and environment built around the assumption of high mobility" (p. 210). Whereas the automobile promoted spatial and social mobility for those able to move to the suburbs, those lacking access to the automobile in places without well-connected public transit faced social and spatial exclusion. Often transit-related exclusion is not studied independently of other measures of deprivation. For instance, a lack of car ownership is used as a proxy for poverty or combined with indices of exclusion and deprivation instead of being examined independently (Church, Frost, & Sullivan, 2000).

Theoretical concepts in mobilities research, including the recent "new mobilities" paradigm, have been picked up by transportation planners (mostly in Europe and Canada) seeking to change the way policy makers define accessibility. Lucas (2012) argued that the social exclusion literature may help policy makers shift from a systems-based approach in transportation planning to a people-focused approach, and Hansen (1959) introduced the concept of accessibility to transportation planners as simply "the potential of opportunities for interaction."

Much of the quantitative work in this field measures accessibility purely in terms of travel duration and/or distance, both of which are highly correlated and often interchangeable (El-Geneidy & Levinson, 2006; Vickerman, 1974). El-Geneidy et al. (2016) argued that understandings of transit accessibility must also include the cost of transit itself. In general, this literature has also raised the issue of redistributive justice and how planners should approach the distribution of transport wealth in the interest of fairness.

Although transportation planning has made much progress by including new theoretical developments from the field of mobilities, there is much work to be done with simply defining and evaluating accessibility itself (Lucas, 2012). The link between income and transportation is often ignored or implied but never fully dissected (Preston, 2001, Boschmann & Kwan, 2008). Even less research has been done to evaluate how affordable housing fits into transit accessibility in gentrifying cities (Kramer, 2018). As gentrification has developed, Black and other minority residents in the city have been forced to relocate away from the neighborhoods that they have historically occupied, a change that has caused the suburbanization of poverty (Lee & Leigh, 2007). This change has pushed people who rely the most on transit accessibility, mostly racial minorities and the poor, to peripheries in inner and outer cores, and away from these new urban benefits. Although developments in mobilities research helps us theoretically to conceptualize the importance of transit objects in facilitating such changes, we need more quantitative research on exactly how to define and measure transit accessibility in the new city that is gentrifying and becoming unaffordable.

Environmental Justice in the Built Environment

The literature on spatial segregation and transportation accessibility in both urban sociology and mobilities research is typically not framed using an environmental justice discourse. I argue that we should conceptualize the city as an arena of environmental justice conflict, and the mismatch between transit and housing accessibility is an instance of environmental injustice. New developments in environmental justice research, such as intersectional environmental justice and critical environmental justice studies, can help us better understand the temporal connection of the link between housing and transit in the city. These developments can also inform quantitative

measurements of accessibility and displacement that pay tribute to the relationship between multiple forms of inequality and power.

Research on environmental justice has long recognized that environmental risks and benefits have an unequal spatial and social distribution. For example, studies have documented that communities near environmental hazards are more likely to be characterized by lower income and a higher percentage of racial and ethnic minority populations in comparison with other areas (United Church of Christ, 1987; U.S. General Accounting Office, 1983). Residents in these locations suffer from higher levels of exposure to hazardous substances, such as lead and asbestos, and higher levels of air, water, and soil pollution. Conversely, middle-class communities often have the resources to mount NIMBY mobilizations to block exposure to environmental hazards, and middle- and upper-class homeowners are able to locate in suburban areas with better air quality, more green spaces, and in general a higher quality of life (Sherman, 2004; Bullard, 1990). Thus, the class and racial structure of American society is connected with spatialized inequalities of access to environmental goods and bads.

Leading environmental justice researchers have encouraged the field to include "transit racism" or "transit justice" as part of the purview of environmental justice studies (Bullard & Johnson, 1997; Bullard, Johnson, & Torres, 2004; Bullard, 2007). As Bullard, Johnson, and Torres (2004) explain, "Transportation equity seeks to address disparate outcomes in planning, operation and maintenance, and unfractured development. Concerned with factors that may create and/or exacerbate inequities, transportation equity focuses on measures to prevent or correct disparities in benefits in costs" (p. 25). Although the city is not always viewed as part of the "environment" in mainstream sociology, environmental justice has long recognized the artificial distinction between the built and natural environment. The built environment

necessarily creates injustice in the natural environment because environmental issues are inherently multiscalar and do not adhere to social rules of human-made borders (Pellow, 2018).

In recent years, environmental justice studies has developed rich theoretical frameworks that include bringing in critical race theory, intersectionality, critical race feminism, and political ecology to expand how we conceptualize environmental inequity. An intersectional perspective in environmental justice scholarship draws attention to the divergence of environmental risk across and within these multiple categories of difference (Pellow, 2016; Taylor, 1997). Although the following study only examines intersectionality through the intersections of ethnicity, race, and class in urban areas, scholars of environmental justice are increasingly paying attention to other forms of social difference. For example, Simpson (2002) explored the devastating impacts of the environmental hazards faced by impoverished Black women in Memphis, Tennessee. Likewise, Lubitow et al. (2017) investigated discrimination, harassment, and violence experienced by gender nonconforming folks who rely on public transportation.

In an integrative statement of intersectionality and environmental justice, Malin and Ryder (2018) defined intersectional environmental justice as "approaches to environmental justice scholarship that explicitly recognize and iteratively analyze the contextual/historical, often mutually reinforcing, inseparable, and multiple oppressive structures that intersect to control and dominate marginalized individuals and communities while simultaneously privileging powerful actors" (p. 4). Thus, the development of an intersectional environmental justice requires special attention to the multitude of power dynamics that influence the process by which environmental inequity transpires. Schlosberg (2004) explained that distributive environmental justice focuses on the unequal distribution of hazards in minority neighborhoods and ignores the underlying processes that created such injustices. Pulido (2000, 2015) argued

that urban development represents an exertion of white privilege and white supremacy, which manifests as both structural, and subsequently spatial, racism. This is parallel with the literature in Black geography that invites us to reconceptualize gentrification as an instance of racial banishment (Roy, 2017; McKittrick, 2011).

Critical environmental justice studies expand on these perspectives by inviting us not only to apply an intersectional lens but also to examine how environmental justice issues are both geographically and temporally multiscalar and linked to institutions of power that must be confronted rather than embraced as arenas for solutions (Pellow, 2018). The historical usage of transportation as a means to separate housing for poor racial minorities from white affluent areas not only demonstrates how transportation injustice is an intersectional issue, but also how it is a multiscalar one. As Henderson (2006) notes, whites created a culture of automobility to geographically distance themselves from the plight of the inner-city, and in more recent years, challenges to automobility via smart growth and new urbanism are simply rearranging segregation by banishing racial minorities and the poor from their historic homes that middle-class white previous did not want. My point here is to say that although the spatial patterns of gentrification in the city are new, the underlying mechanisms creating spatialized apartheid are the exact same.

CONTRIBUTION

This dissertation and its three substantive studies make several contributions to the current literature surrounding transportation accessibility and the restructuring of urban space. I push the current literature on transportation accessibility in the ever expanding neoliberal city by contextualizing it within the racist and classist history of the state's coercive power in dictating patterns of land use (Rolnik, 2013), the predatory practices of agents in the "free market"

capitalizing on racialized impoverishment (Wyly & Ponder 2011; Hiller, 2013), as well as the historical racial hierarchy attached to certain types of public transit (Bullard & Johnson, 1997; Bullard, Johnson & Torres, 2004). It is not by accident that cities have become arenas of spatialized inequality. Active systems of power, namely the state and by extension free markets, have created what Beckett and Herbert (2010) call "spatial ostracism" by using political tools to banish marginalized people from urban spaces, and transportation systems are among the most prominent and effective of the tools (Roy, 2017). Thus, this dissertation speaks to the system of racial capitalism that has dictated patterns of transit accessibility in the city.

Ultimately, this dissertation asks the question "*transportation for whom?"* While this question has been brought up by a number of scholars in mobilities and environmental justice, I push this research forward by reorienting the current definitions and measurements of transportation inaccessibility used by urban planners to account for the link between the growing unaffordability of housing and the destruction of poor and Black culture in urban space in the name of "development." The linkages I explore in the three substantive chapters can better inform policies that address transportation reform and its role in the changing structure of urban space. This work demonstrates how neoliberal transit planning that relies on gaining discretionary riders through urban redevelopment necessarily leads to racial violence, because of the intertwined nature of both capitalism and racism.

URBAN AREA SELECTION

Each chapter in this dissertation examines the relationship between transportation and socio-demographic change in some form. Thus, all of the chapters in this study include cities that have developed TOD, and specifically LRT. In recent years, LRT has been a source of conflict in urban areas (such as those in Nashville, Maryland, Austin, and Phoenix to name a few), and

these mobilizations highlight the connection between transportation and the changing political, economic, and social structure of the city in the age of new urbanism and smart growth. Chapter 2 includes an analysis of gentrification and LRT development for most urban areas that have developed LRT in the United States between 1980 and the early 2000s. Chapters 3 and 4 only include a selection of cities with LRT. These urban areas have rapid population growth, expansive urban networks of multiple cities, and are well known for their rapid neighborhood change and unaffordability. Table 1 provides a list of the major city in all urban areas in this dissertation and the chapters in which they appear.

Table 1. All Urban Areas

Urban Area	*State*	*Chapters*
Cleveland	OH	Chapter 2
San Francisco	CA	Chapter 1, Chapter 2, Chapter 3
San Diego	CA	Chapter 2
Pittsburg	PA	Chapter 2
Buffalo	NY	Chapter 2
Portland	OR	Chapter 1, Chapter 2
Sacramento	CA	Chapter 2
San Jose	CA	Chapter 1, Chapter 2*, Chapter 3*
Los Angeles	CA	Chapter 1, Chapter 2, Chapter 3
St. Louis	MO	Chapter 2
Denver	CO	Chapter 1, Chapter 2, Chapter 3
Dallas	TX	Chapter 1, Chapter 2, Chapter 3
Salt Lake City	UT	Chapter 2
Houston	TX	Chapter 2
Minneapolis	MN	Chapter 2
Seattle	WA	Chapter 1, Chapter 2, Chapter 3

*San-Jose is included in chapters 2 and 3 as part of the San Jose-San Francisco-Oakland CSA

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Chapter II

(Un)affordable Housing and Spatial (Im)mobility

INTRODUCTION

In November of 2019, two mothers, who later formed the activist group Moms 4 Housing, occupied a home in West Oakland to protest the Bay Area's housing affordability crisis. In March 2020, citing concerns over COVID-19, 12 homeless families seized vacant homes in Los Angeles. These occupations of vacant homes highlight the massive housing affordability crisis that is reaching a breaking point in cities across the country. Between 2012 and 2017, the number of housing units renting for $1000 or more rose by 5 million while the number of low-cost units renting for under $600 fell by 3 million. The largest increases in the share of units renting for at least $1000 a month were in Colorado, Oregon and Washington (Joint Center for Housing Studies, 2020). The majority of new housing units being built in growing urban areas are often not intended for low-income earners, such as luxury condos in city centers.

Housing cost is more than just the cost of a physical structure and the materials that go into building it. The location of a housing unit determines access to neighborhood amenities, quality schools, parks and playgrounds, employment, and public transportation. Housing is deeply embedded in conflicts of capitalist urban development. Housing and rent prices are directly tied to the political economy of the city through taxation and zoning. Housing stock is an important commodity for city level governments that rely on property tax increases for revenue. Thus, in the urban arena, there is a reliance on housing as a wealth producing commodity, one that funds public schools, police and firefighters, and other services offered by city.

Stagnant federal funding for affordable housing programs, increased construction costs, and NIMBY opposition to low-income housing have restricted the supply of affordable housing in higher density developments in the inner-city. The lack of affordable housing for low-income earners has dire consequences. Low-income residents are particularly at risk for housing insecurity because their wages have remained stagnant over the last decade (National Low Income Housing Coalition, 2019). Consequently, there is now a larger number of poor households in suburban areas in comparison with urban areas throughout metropolitan regions, even though the concentration of poverty is still higher in the inner-city in comparison to the suburbs (Kneebone & Berube, 2013). This situation is not just dire for those living at or near the poverty level. There is long history of redlining and foreclosures due to racist predatory lending practices impacting Black and Hispanic communities. The inseparable history of white supremacy and capitalism in the culture of the city suggests the BIPOC are disproportionately affected by the affordability crisis.

Rising rents and housing costs are not a reflection of improved housing quality. It is true that luxury units are being built in urban areas, but there is no evidence that the number of rental units with severe housing problems has decreased in the last twenty years (HUD, 2015). However, there is evidence that lack of affordable housing can lead to overcrowding (Clampet-Lunquist, 2003), evictions (Desmond, 2016), and homelessness (Lee, Price-Spratlen & Kanan, 2003; Quigley, Raphael, & Smolensky 2001). Fears of eviction in areas with limited affordable housing options leave renters with little bargaining power with landlords (Burridge & Ormandy, 2007). Such situations have ripple effects on health and well-being. Research has shown that low-income renters are hesitant to report housing conditions that directly impact their health to their landlords (Grineski & Hernandez, 2010), and it also has shown that current forms of

regulation are inadequate to protect renters' health and safety due to these power dynamics (Chisholm et al., 2020).

There is no question that booming urban areas are in dire need of more affordable and safe housing. But at the same time, cities are also facing the direct consequences of climate change after years of encouraging a system of automobility that has increased inner-city air pollution. Access to affordable homes near public transportation and job centers directly impacts the livability of the city for all residents, and not just for public health concerns. For households that lack automobiles, public transit often serves as a conduit to employment, and a lack of quality transportation can lead to cycles of unemployment and poverty. Spatial mobility is key to obtaining social and economic mobility and reducing exclusion (Kenyon, Rafferty, & Lyons, 2003; Lucas, 2012).

Due to the sprawl of cities and the lack of transportation options into and beyond the suburbs, not all residents benefit from similar levels of access to public transportation (Martens, 2012). The culture of secessionist automobility and the development of the suburbs left behind a frayed urban core, but one that was walkable, affordable, and well served by bus transit (Henderson, 2006). Low-income and minority households are more likely to be public transit dependent (Dodson et al., 2006). However, the growing unaffordability of inner-city homes has the potential to increase transit poverty by pricing low-income households out of transitscapes, that is, urban areas that are well served by public transit (Kramer, 2018, Lee & Leigh, 2007). City transportation systems were not designed to move riders into the outer ring suburbs, where residents are able to find the most affordable housing options. Suburban areas were purposely structured to exclude public transportation networks that would link them to the inner-city to

keep out poor communities of color (Bullard & Johnson, 1997). Moreover, mass transportation networks designed for dense urban areas map poorly onto suburban sprawl.

The affordable housing crisis and transportation inaccessibility are threats to the tenants of environmental justice. There is long history of research on how poor people and racial minorities are forced to live in undesirable areas that are toxic to human health and prohibit both physical and social mobility (Bullard, 1990; Brulle & Pellow, 2006). Where people live determines the accessibility of environmental goods as much as it does your proximity to environmental bads. One of the environmental justice goals of the federal Department of Transportation (DOT) is "to prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income population" (DOT, 2020). This goal is unachievable without addressing the growing unaffordability of housing units near transit networks that are imperative for the mobility of low-income and minority residents. The lack of affordable housing in urban areas leads to an affordability dilemma where residents either face increased rent burden or increased transportation costs (Renne et al., 2016). Thus, residents are forced to use the majority of their income on rent, or live in an area outside of the inner-city that require access to an automobile, which often costs more in the long term than public transportation.

This study intends to propel the conversation on transit accessibility forward by using insights from literature on urban housing and critical urban theory to critically analyze the link between the growing affordable housing crisis and transportation accessibility in urban areas. This challenges us to consider how transit justice and housing justice are deeply intertwined environmental justice issues that must be addressed in tandem. Studies on transit accessibility, and the subsequent issue of social inclusion and exclusion, fail to address how accessibility is connected to other material conditions in the inner-city. Instead, studies often only examine

transit accessibility using measures of poverty and income without considering affordability. Although the poor still live in cities with connected transit systems (Kneebone & Berube, 2013; Hwang, 2015), they are often rent burdened and lack access to affordable units (Joint Center for Housing Studies, 2020). As such, this chapter asks: *In cities with rampant urban restructuring and TOD developments, what is the current state of transit accessibility and housing affordability?*

In addition to providing a descriptive and spatial overview of the relationship between transit access and affordability in six urban areas, this article applies Bayesian hierarchal modeling to examine how this relationship varies at different urban levels. The first section of this paper explores the history of housing and segregation and the importance of housing and social mobility using literature in urban sociology. Furthermore, I explore how this literature connects research in mobilities on transportation and spatial mobility. The next section presents the data, descriptive statistics, and analytic strategy, followed by a discussion of the results. I conclude this chapter by discussing how the tensions underlying access and the lack thereof to both transit and housing are multiplicative environmental justice issues, and providing potential directions for future studies.

BACKGROUND AND THEORY

To situate this research, I draw on studies that highlight the history of housing inequality in urban areas and studies that speak to the spatio-temporal relationship between access to affordable housing and the increased mobility provided by public transportation. Specifically, I bring together literature in urban sociology on housing inequality with literature on transit

inequality to demonstrate how the current housing crisis influences spatial mobility in urban areas and as a consequence, impacts the social and economic mobility of residents.

In order to contextualize the present housing crisis through a sociological lens, I draw on research on housing market discrimination (Jackson, 1985; Gotham, 2002; Rugh & Massey, 2010; Immergluck, 2009) and critical urban sociological studies that explore the capitalist construction of cities (Feagin, 1998; Harvey, 1973; Castells, 1977; Gottdiener, 1985). These studies establish that the present housing affordability crisis, at least in part, is facilitated by a long-standing system of racialized capitalism in cities and the commodification of housing.

Although urban sociologists have explored the connection between housing and social mobility, scholars in the field of mobilities have generally noted that urban sociologists often ignore the connection between social mobility and spatial mobility (Sheller, 2014; Kaufman, 2011; Levitas. 1998; Kenyon, Lyons, & Rafferty, 2002; Church, Frost, & Sullivan, 2000). Research in mobilities explores the privilege that comes with control over one's own mobility (Massey, 1991; Kaufman, Bergman & Joye, 2004), and has been influential to scholars of transportation planning who argue for an accessibility-focused approach to land use transportation and policy responses that address the social sustainability of urban transit regimes (Grieco, 2015; Lucas, 2004).

The Political Economy and Cultural importance of Housing in the U.S.

Early sociologists studied housing and the expansion of home ownership programs in urban areas after WWII (Merton, 1951; Park, 1952; Hawley, 1950). The majority of research in urban sociology has focused on residential segregation (Massey & Denton 1993; Jargowsky, 1997; Cutler, Glaeser & Vigdor, 1999; Rugh & Massey, 2010), neighborhood effects (Sampson, Morenoff & Gannon-Rowley, 2002; Sampson, 2012), or housing discrimination (Jackson, 1985;

Castells, 1977; Squires & Kubrin, 2006; Gotham, 2002). There is also quite a bit of research in urban sociology that focuses on gentrification, including cultural attributes of the gentrifier (Brown-Saracino, 2010; Lloyd, 2006; Zukin, 2009) and measuring the extent of gentrification and displacement (Solari, 2012; Hwang, 2015). However, none of these studies truly distinguishes housing itself as an arena for sociological analysis (Desmond, 2018; Pattillo, 2013).

Although gentrification may be a contributing factor, it paints an incomplete picture of the current crisis of housing affordability because the crisis is a city-wide phenomenon regardless of the gentrification status of a particular neighborhood (Desmond, 2012). Moreover, the gentrification argument attributes neighborhood changes to an omnipresent process without exploring the agency that government and corporate actors have in facilitating the process of neighborhood change. In the context of the neoliberal city, the current housing crisis is a product of a long history of zoning policies that maintain segregation (Briggs, 2005; Orfield, 2005), inequality in mortgage and housing finance (Stuart, 2003; Rugh & Massey, 2010; Gotham, 2002), power concentration in the hands of landlords who have the power to evict tenants (Drier, 1982; Burridge & Ormandy, 2007; Desmond, 2016), and, over the last few decades, increases in the financialization of housing in a globalized market (Rolnik, 2013).

Research in urban sociology on housing market discrimination and evictions, as well as neomarxist theories on the construction of the city, can help us contextualize the history of the affordability crisis and its linkages to systems of inequality through a sociological lens. Critical urban theorists argue that cities are sites of capitalist production and reproduction through development (Brenner, 2012; Sassen, 2006; Alderson & Beckfield, 2004). Whereas urban sociologists tend to focus on the demand side of market factors that influence city development, critical urban theorists target the supply side as the architect of inequality (Feagin, 1988; Harvey,

1973; Harvey & Wachsmuth, 2012; Castells, 1977). Gottdiener (1985) argues that, "The new urban approach recognizes the role of supply-side factors that pull and mold growth and that are often manifestations of elite interests. A political economy of metropolitan development is based on the action of supply-side forces. Three pull factors are most important: state intervention and government programs, the real estate industry, and the effects of global capitalism" (p. x). Similarly, Pattillo (2013) reminds us that the treatment of housing as a commodity and not a right inevitably leads to inequality in its attainment.

Numerous studies have demonstrated how social inequality plays out in the housing market through discriminatory practices in housing finance since the creation of the modern mortgage system in response to the Great Depression (Stuart, 2003). The federal government created a rating system for housing appraisal that is plagued with anti-urban and racial biases (Jackson, 1985; Gotham, 2002). In the1990s there was an increase in subprime mortgage lending, especially among racial minorities, that led to a record number of foreclosures in the Great Recession (Been, Ellen, & Madar, 2009; Rugh & Massey, 2010; Immergluck, 2009). Wyly and Ponder (2011) explored racism in predatory practices in the subprime market, which have become so commonplace since the Great Recession that they crafted the term "subprime America." These studies demonstrate how the process of housing financialization is deeply connected to the racialization of space (Roy, 2017).

While the current housing crisis affects both current and potential homeowners, the situation is dire for renters, who possess less security and power over their own housing (Burridge & Ormandy, 2007). Renters face increased residential mobility, and for low-income groups this means moving from one disadvantaged neighborhood to another, with negative social and economic consequences (South & Crowder, 1998; Sampson & Sharkey, 2008; Desmond,

2012). Renters have consistently experienced a cultural disadvantage to homeowners due to the emphasis on private property as a way of achieving the American Dream (Shlay, 2006; Pattillo, 2013; Dreier, 1982). Culturally, homeownership has been touted as a symbol of citizenship and belonging (Perin, 1977) and overall self-worth (Dreier, 1982). Housing policy in the United States has consistently revolved around homeownership and offering protections to homeowners, and tax policies often reduce the cost of homeownership but not renting (Glaeser, 2011).

The unequal and racialized system of housing finance, the defunding and corporatization of state sponsored housing programs, and a culture of secessionist automobility have collectively and ineradicably shaped the spatial layout of cities. The divestment in the inner-city and the subsequent investment of suburbs created inner-city poverty and neighborhood decline. The current housing affordability crisis is a direct result of the reinvestment facilitated by local governments and developers promoting smart growth and new urbanism (Bullard, 2007; Gottdiener, 2019; Pendall et al., 2005). Capitalistic expansion has been a central goal of urban policy makers who are using investment in modern amenities to draw the middle and upper class back to the urban core (Harvey, 2008).

Pattillo (2013) explores the theoretical dimensions of conceptualizing housing as a right as opposed to a commodity, and concludes with a call to sociologists to view the actual house or apartment as an arena of study. This viewpoint is tied to a rich history of tenant activism and organizing, especially among public housing residents who consistently fight for universal entitlement of affordable housing (Pattillo, 2007; Arena, 2012). In the spirt of this call, I argue that in order to situate the housing unit itself as an arena of new sociological analysis, we must also explore the relationship between housing and mobility. Mobility ensures that residents are connected to social networks and economic markets that are imperative for social and physical

well-being. If housing is to be viewed as an inherent right, it must include the right to transportation.

Housing Affordability and Mobility

Research in mobilities helps us understand how mobility and mobility objects, such as modes of transportation, influence agency and power structures in the urban area (Sheller, 2014; Urry, 2007). This field of study invites us to explore how space itself impacts social mobility, instead of only examining the linkage between social mobility and traditional systems of inequality frequent in urban sociology (Kaufman, 2011; Levitas, 1998; Kenyon, Lyons & Rafferty, 2012). Kaufman, Bergman, and Joye (2004) use the term "motility" to describe the link between spatial and social mobility and define it as "the capacity of entities (e.g. goods, information or persons) to be mobile in social and geographic space, or as the way in which entities access and appropriate the capacity for socio-spatial mobility according to their circumstances" (p. 750). This definition speaks to the politics of mobility and how access to social mobility is controlled through power over physical spatial mobility (Massey, 1991). Skeggs (2004) argues that "mobility and control over mobility both reflect and reinforce power. Mobility is a resource to which not everyone has an equal relationship" (p. 49).

Equally important to conceptualizing the link between spatial mobility and social mobility is the concept of social inclusion and exclusion (Kenyon, 2003). Levitas et al., (2007) define social exclusion as, "the lack or denial of resources, rights, goods and services, and the inability to participate in the normal relationships and activities to the majority of people in a society, whether in economic, social, cultural, or political arenas. It affects both the quality of life of individuals and the equity and cohesion of society as a whole" (p. 9). Church, Frost, and Sullivan (2000) argue that definitions of social exclusion must be distinct from poverty. As such,

they define social exclusion as a concept in which "people or households are not just poor", but, "that they have additionally lost the ability to both literally and metaphorically to connect with many of the jobs, services and facilities that they need to participate fully in society" (p. 197). In turn, concepts of social exclusion have been applied in the mobilities literature on accessibility.

Kenyon, Lyons, and Rafferty (2002) define transit-related exclusion as a process by which people are prevented from participating in social life "due in whole or part to insufficient mobility in a society and environment built around the assumption of high mobility" (p. 210). Transportation disadvantage and social disadvantage interact to create transit poverty (Lucas, 2012). Residents may not have access to public transportation but may have the financial means to afford automobiles, and thus these residents do not experience transit poverty. However, access to transportation across all income levels is imperative to influencing ridership, especially in the context of climate change and the importance of reducing automobile dependency.

Research from mobilities that explores the relationship between social exclusion and spatial exclusion have been influential in the literature on transportation planning. Researchers are increasingly taking an environmental justice approach to transportation planning by exploring the social sustainability of urban mobility (Hine, 2008; Lucas, 2004; Martens, Golub, & Robinson 2012). According to Greico (2015), the social sustainability of urban mobility refers to "whether the benefits and costs of transport and travel services (mobility) and the spatial organization of facilities and services (accessibility) are equally and equitably distributed in a society or community" (p. 82). Tackling transportation access from a social sustainability framework demonstrates that new transportation schemes and land use patterns typically do not benefit the poor, who are more likely to rely on public transportation (Bullard, 2007).

Much of the quantitative work in this field measures accessibility in terms of travel

duration and/or distance, both of which are highly correlated and often interchangeable (El-Geneidy & Levinson, 2006; Vickerman, 1974). There is a growing literature in this field that examines the relationship between transit accessibility and gentrification in urban areas (El-Geneidy et al., 2016; Cervero & Kockelman, 1997). These studies primarily examine the link between investment in rail systems and land costs, incomes, and rising rent. However, there are few studies that explore transportation equity by measuring the relationship between transportation accessibility and housing affordability in urban areas regardless of transit type (Kramer, 2018).

Theoretical Synthesis

I draw on each of the above literatures to problematize the current housing crisis through a historic and spatialized lens to bring issues of transportation access into the discussion on housing affordability. I argue that affordable housing without access to systems of mobility does little to improve the material conditions of those living in poverty or protect others from slipping into poverty. Housing in the urban arena must be linked to physical access to employment, education, and other neighborhood amenities. While the current literature surrounding the housing affordability crisis explores how access to housing is imperative to social mobility, it fails to account for how social mobility is also determined by one's spatial mobility. This study attempts to address this gap. I include measures of race, ethnicity, and income in my analyses to account for the long history of racialized capitalism that has influenced the structuring and restructuring of cities across the United States. I explore the relationship between housing affordability and access to all types of transit, not just rail transit, because bus riders make up the majority of transit riders. Lastly, I measure affordability in terms of both housing value and rent to account for the precarious nature of renting.

DATA AND MEASURES

I examine the relationship between housing affordability and access to public transit in six urban areas with the following central cities: San Francisco, Los Angeles, Portland, Denver, Dallas, and Seattle. Information on urban areas, counties, and transportation systems served are included in Table 1. Results are presented at both the combined statistical area (CSA) level and the metropolitan statistical area (MSA) level with the unit of analysis being the block group. CSAs represent a combination of MSAs and micropolitan statistical areas that are connected either economically or socially and have an employment interchange measure (EIM) over 15%. MSAs typically have a central city and surrounding suburbs and counties that are connected through close economic ties.

Aside from having TOD development, the six urban areas included in this study have experienced population growth of over 8% over the last 10 years. All of these cities are relatively well known for having issues related to housing affordability, gentrification, and displacement of low-income and minority residents. These areas have high-cost housing markets in comparison to the rest of the United States and have seen a decline in the availability of low-cost rental units (Joint Center for Housing Studies, 2020). Many of these urban areas are also in states that have seen sharp increases in their unsheltered populations, including California, Colorado, and Oregon (Joint Center for Housing Studies, 2020). A study by the National Community Reinvestment Coalition found that San Francisco, Portland, Los Angeles, and Dallas have among the highest levels of gentrification and Black displacement in the country (Richardson et al., 2019). Given the current state of affordability in these metro areas, they are good candidates for exploring how the housing affordability crisis is also impacting transit accessibility.

Location data on transportation stops in each of these urban areas come from multiple sources and was collected in December of 2019. I primarily use data from the General Transit Feed Specification (GTFS) provided by public transportation operators. However, some smaller transportation systems do not provide GTFS data, so I hand collected information on transit stops directly from system websites. For each urban area, I collected location information on all public transit stations regardless of transit type.[1]

Table 1. Urban Areas

CSA	*CSA Counties*	*MSA*	*MSA Counties*	*State*	*System Names*
San Jose-San Francisco-Oakland, CA	Alameda, Contra Costa, San Francisco, San Mateo, Marin, Santa Clara, San Benito, San Joaquin, Stanislaus, Sonoma, Solano, Merced, Santa Cruz, Napa	San Francisco-Oakland-Berkeley, CA	Alameda, Contra Costa, San Francisco, San Mateo, Marin	CA	AC Transit, Bay Area Rapid Transit, San Francisco Metropolitan Transit Authority, SamTrans, Marin Transit, Santa Clara Valley Transportation Authority, San Joaquin Regional Transit District, Stanislaus Regional Transit, SolTrans, Sonoma County Transit, Merced Transit Authority, Santa Cruz METRO, Napa Valley Transportation Authority
Los Angeles-Long Beach, CA	Los Angeles, Orange, Riverside, San Bernadino, Ventura	Los Angeles-Long Beach-Anaheim, CA	Los Angeles, Orange	CA	Los Angeles County Metropolitan Transportation Authority, Orange County Transportation Authority, Riverside Transit Agency, Palo Verde Valley Transit, SunLine Transit Authority, PASS Transit, Corona Cruiser, OmniTrans, Beaumont Transit Services, Mountain Transit, Victor Valley Transit Authority, MetroLink, Foothill Transit, Gold Coast Transit, Ventura County Transportation Commission, Thousand Oaks Transit, Simi Valley Transit, Camarillo Area Transit
Portland-Vancouver-Salem, OR-WA	Multnomah, Washington, Clark, Clackamas, Yamhill, Columbia, Skamania, Marion, Polk, Cowlitz	Portland-Vancouver-Hillsboro, OR-WA MSA	Multnomah, Washington, Clark, Clackamas, Yamhill, Columbia, Skamania	OR	TriMet, C-Tran, Yamhill County Transit Area, CC Rider, Skamania County Public Transit, Cherriots, River Cities Transit
Denver-Aurora, CO	Denver, Arapahoe, Jefferson, Adams, Douglas, Broomfield, Elbert, Park, Clear Creek, Gilpin, Boulder, Weld	Denver-Aurora-Lakewood, CO	Denver, Arapahoe, Jefferson, Adams, Douglas, Broomfield, Elbert, Park, Clear Creek, Gilpin	CO	Regional Transportation District, Bustang, Greeley-Evans Transit, Park County Commuter

[1] The transit stops used in this study are stops that are on a fixed schedule. In some suburban areas, transit systems offer residents, mostly low-income and elderly, demand response curb-to-curb pick-up and drop-off services. These are impossible to account for and are not included in the present study.

Dallas-Fort Worth, TX-OK	Dallas, Tarrant, Collin, Denton, Ellis, Johnon, Parker, Kaufman, Rockwall, Hunt, Wise, Hood, Somervell, Grayson, Henderson, Navarro, Bryan, Cooke, Fannin, Palo Pinto	Dallas-Fort Worth-Arlington, TX	Dallas, Tarrant, Collin, Denton, Ellis, Johnon, Parker, Kaufman, Rockwall, Hunt, Wise, Hood, Somervell,	TX	Dallas Area Regional Transit, Trinity Metro, Denton County Transportation Authority,
Seattle-Tacoma-Olympia, WA CSA	King, Pierce, Snohomish, Thurston, Kitsap, Skagit, Island, Lewis, Mason	Seattle-Tacoma-Bellevue, WA MSA	King, Pierce, Snohomish	WA	King County Metro Transit, Sound Transit, Pierce Transit, Community Transit, Intercity Transit, Kitsap Transit, Skagit Transit, Island Transit, Mason Transit

CSA= Combined Statistical Area; MSA= Metropolitan Statistical Area

Names and descriptions of the variables used in this study are located in Table 2. The dependent variable, distance to the nearest transit station from the mean center of a block group, was constructed using the transit location information combined with Census Tiger/Line files in Arc Maps. This dependent variable allows me to explore how various measures of housing affordability relate to variation in distance to any form of transportation (El-Geneidy & Levinson, 2006; Vickerman, 1974).

Table 2. Description of Variables

Variable	*Description*	*Data Source*
Distance Variable		
Distance to the Nearest Transit Station (Miles)	Distance from the mean center of a census tract to the nearest transit station	GTFS + Census TIGER/Line Files
Housing Affordability Characteristics		
Median Home Value	Median home value of owner-occupied housing units	ACS
Median Rent	Median gross rent of renter-occupied housing units	ACS
% Rent Burdened	Percent of the population paying greater than 30% of their income on rent	ACS
Socio-Demographic Variables		

% Black	Percent Black/African American	ACS
% Hispanic	Percent Hispanic/Latinx	ACS
% White	Percent White	ACS
Income	Median Income	ACS
Total population	Total population	ACS

ACS = American Community Survey; GTFS = General Transit Specification Feed

The demographic and housing data at the block group level come from the American Community Survey (ACS) 2013-2018 5-year estimates. Variable names and descriptions can be found in Table 2. The three major independent variables in this study represent theoretically tested measures of housing cost and affordability: median home value of owner-occupied homes, median gross rent, and percentage of the population of renters who spend more than 30% of their income on rent. The first two measures are relatively straightforward, and by including both of these measures, I am able to explore how transportation access and housing affordability differs by home value and rent. This speaks to the empirical studies that demonstrate how renters occupy a precarious position both socially and financially in comparison to homeowners (Burridge & Ormandy, 2007; Glaeser, 2011). The final measure which calculates rent as a percentage of income is a measure of housing cost burden. The U.S. Department of Housing and Urban Development (HUD) defines an affordable dwelling as one that costs a household 30% percent or less of its income, so those paying more than that are considered rent burdened (Joint Center for Housing Studies, 2020). Finally, I include measures race/ethnicity, income, and total population as control measures.[23]

[2] This chapter does not explore the racial breakdown of the relationship between housing affordability and access to transit. This relationship is explored in depth in the final chapter on transportation deserts.

[3] I excluded block groups that had populations of less than 50 and all analyses use complete cases analyses.

RESULTS

Descriptive Statistics

I begin by exploring descriptive statistics on all study variables. The means of all study variables are shown in Table 2 for each urban area at both the CSA and MSA level. Mean distance to transit is lowest in Los Angeles (0.23 for CSAs and 0.48 for MSAs), and highest in Dallas (5.68 for CSAs and 3.33 for MSAs). Dallas is an outlier in terms of transit availability, as it does not have a widespread transit network throughout the metropolitan region in comparison to the other urban areas. In general, there is greater accessibility to transit in MSAs compared to CSAs, as MSAs represent a denser urban core. It is clear that there is a massive issue with cost burden across all metro areas at both the CSA and MSA levels. Cost burden is highest in both the Los Angeles CSA and MSA at 53%. Dallas has the lowest housing cost, but the MSA has a much higher average home value than the surrounding CSA. Median home value as well as median gross rent is highest in urban areas in and surrounding San Francisco

Table 3. Means of all Study Variables

Urban Area	*Distance to Transit*		*Median Home Value*		*Median Rent*		*% Paying > 30% of income on Rent*		*Income*		*% Black*		*% Hispanic*		*% White*		*Mean Population for Block Groups*	
	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA	CSA	MSA
San Jose-San Francisco-Oakland, CA	0.89	0.74	750K	859K	1855	1979	45.56	43.79	100K	110K	5.45	7.27	26.33	20.77	43.00	42.62	1642	1618
Los Angeles-Long Beach, CA	0.23	0.48	563K	629K	1613	1650	53.10	52.93	76K	78K	6.37	6.67	44.51	43.42	33.33	31.98	1732	1616
Portland-Vancouver-Salem, OR-WA	1.07	1.03	335K	381K	1220	1253	44.47	45.27	73K	75K	2.37	3.38	12.38	9.65	75.14	76.56	1688	1638
Denver-Aurora, CO	0.96	0.73	371K	362K	1422	1432	44.90	45.04	83K	83K	4.49	5.67	22.4	22.8	66.48	65.08	1603	1594
Dallas-Fort Worth, TX-OK	5.68	3.33	158K	213K	1179	1391	42.2	42.58	73K	74K	14.23	14.77	29.33	30.20	48.35	46.58	1722	1736
Seattle-Tacoma-Olympia, WA CSA	1.32	0.65	414K	445K	1446	1515	42.82	42.63	86K	86K	4.66	5.36	9.41	9.45	68.15	65.78	1540	1538

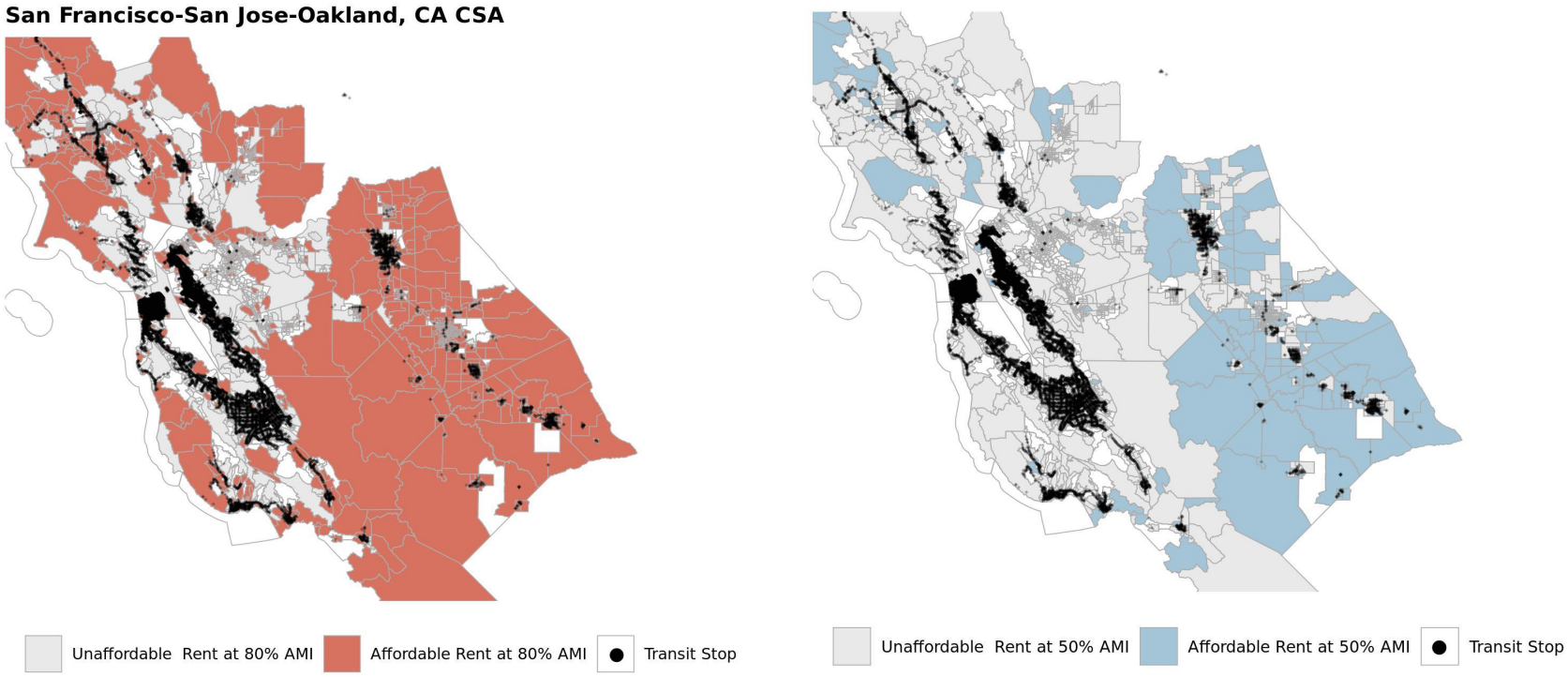
Maps on Housing Affordability and Transit Networks

In order to visually assess the mismatch between affordable housing and access to public transportation, I generated a series of maps for each urban area. The maps below represent affordable median rent for low-income households overlaid with transit stations. A household is considered "low-income" if it makes less than 80% of the area median income (AMI). In this case, the AMI is simply the median income of the entire CSA. I include two sets of maps for each urban area. The first map shows areas in red where the block group median rent would be considered affordable to those making 80% or more of the AMI for that CSA—based on the HUD guidelines that households paying at or below 30% of their income on rent are not cost burdened. The second map shows areas in blue where the block group median rent would be affordable to those making 50% of the AMI.

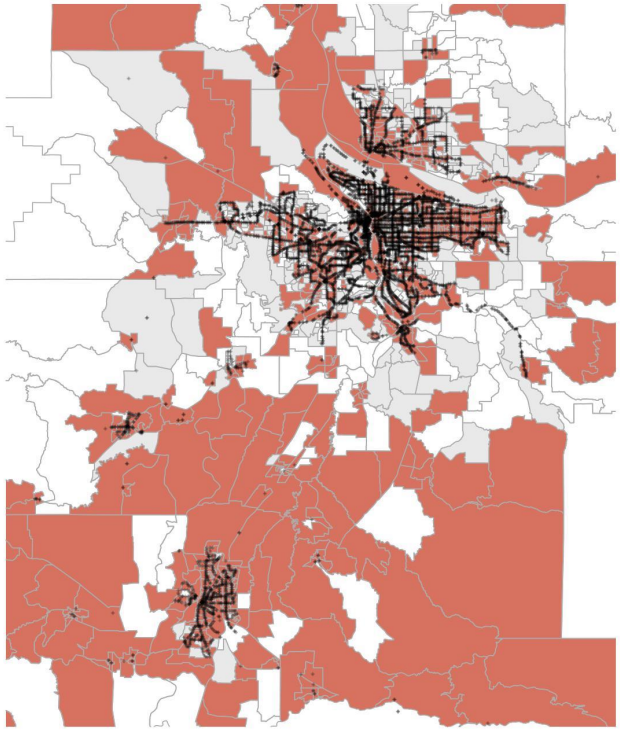
It should be noted that this is a conservative estimate of rent affordability, especially due to high rates of income inequality in cities across the U.S. Take the San Jose-San Francisco-Oakland CSA for example, where the median income is about $92,000. An income of $73,000 (80% of the AMI) is considered low-income in terms of HUD's definitions, but this is well above the AMI for the entire U.S. by about $10,000. Thus, a unit could be considered affordable for a low-income family making 80% of the AMI, but still cost far too much for a family living near the federal poverty line, which for an average family of four is about $24,000. About 9% of the population of this CSA lives below the federal poverty level. With a population of almost 9 million, this means that ~800,000 people have incomes at or below $24,000. Thus, the spatial mismatch between housing and transit is even more dire for a significant portion of the population in this area.

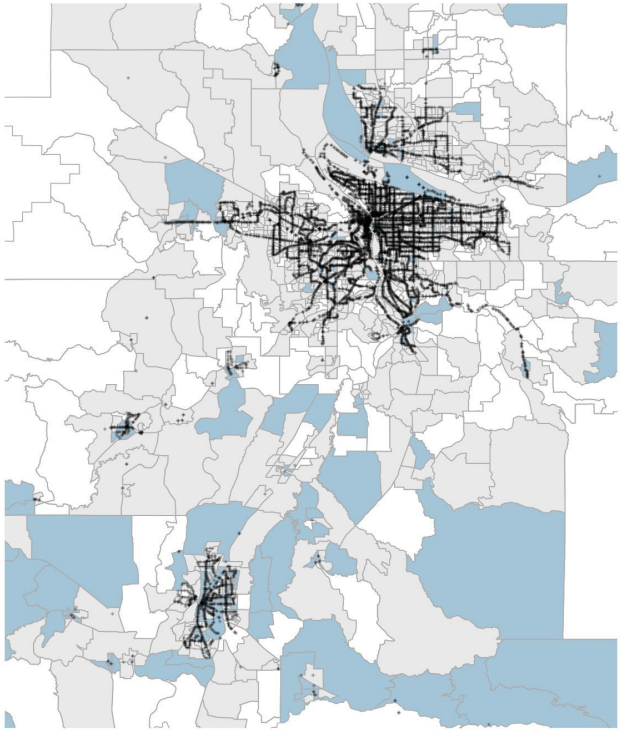
In general, the maps show that there are very few census blocks near transportation where the average median rent would be considered affordable to those making 80% of the AMI, with even fewer options for those making 50% of the AMI. For those making 80% of the AMI in San Francisco-San Jose-Oakland CSA, the affordable options near transit are located well outside of San Francisco county in the cities of Modesto, Stockton and Merced, but even these options are relatively unaffordable for those making 50% of the AMI. For the Portland-Vancouver-Salem CSA there appears to be some affordability near transit in Portland proper for those making 80% AMI, but the limited affordability moves to the outer suburbs and Salem for those making 50% AMI. These outer suburbs are not well connected to transit systems. This pattern generally holds true for the other CSAs as well. Affordability near transit for Seattle-Tacoma-Olympia CSA is more concentrated in Tacoma and Olympia. For Los Angeles-Long Beach CSA it is more concentrated in San Bernardino, and for Denver-Aurora CSA it is more concentrated towards Boulder and Greeley. For those making 50% AMI in Dallas-Fort Worth CSA, there is still some affordability near transit in south Dallas and Fort Worth.

Figures 1-10: Affordable Rent Based on Area Median Income and Transit Stops for each CSA



Portland-Vancouver-Salem, OR-WA CSA

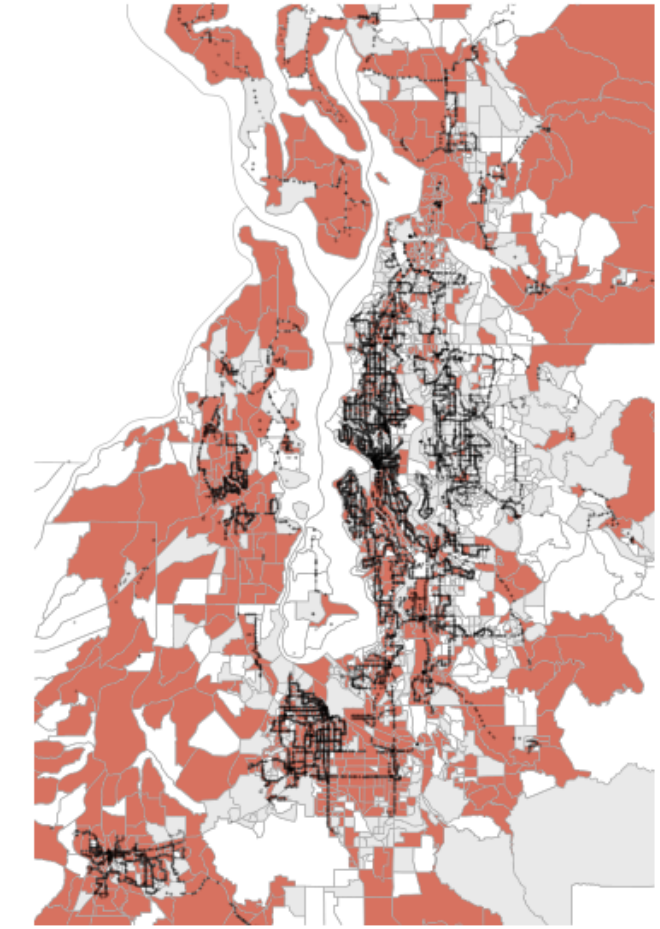




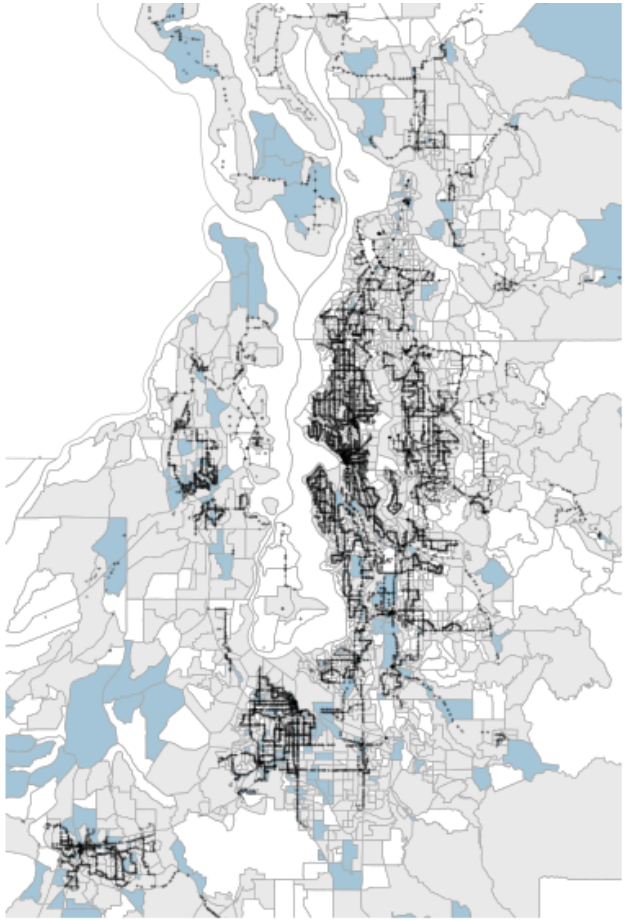
Unaffordable Rent at 80% AMI | Affordable Rent at 80% AMI | Transit Stop

Unaffordable Rent at 50% AMI | Affordable Rent at 50% AMI | Transit Stop

Seattle-Tacoma-Olympia, WA CSA

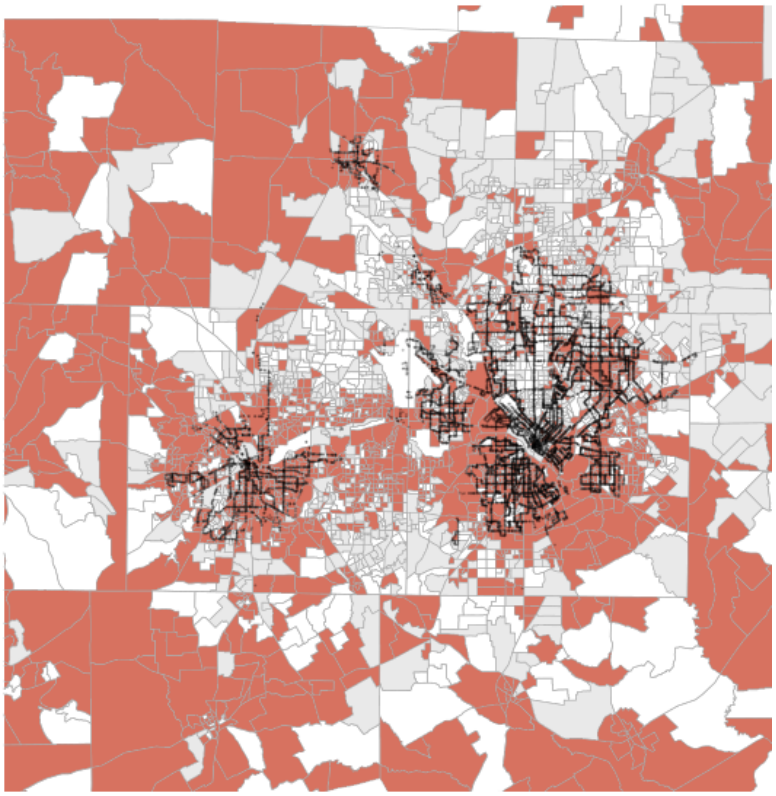


Unaffordable Rent at 80% AMI Affordable Rent at 80% AMI Transit Stop

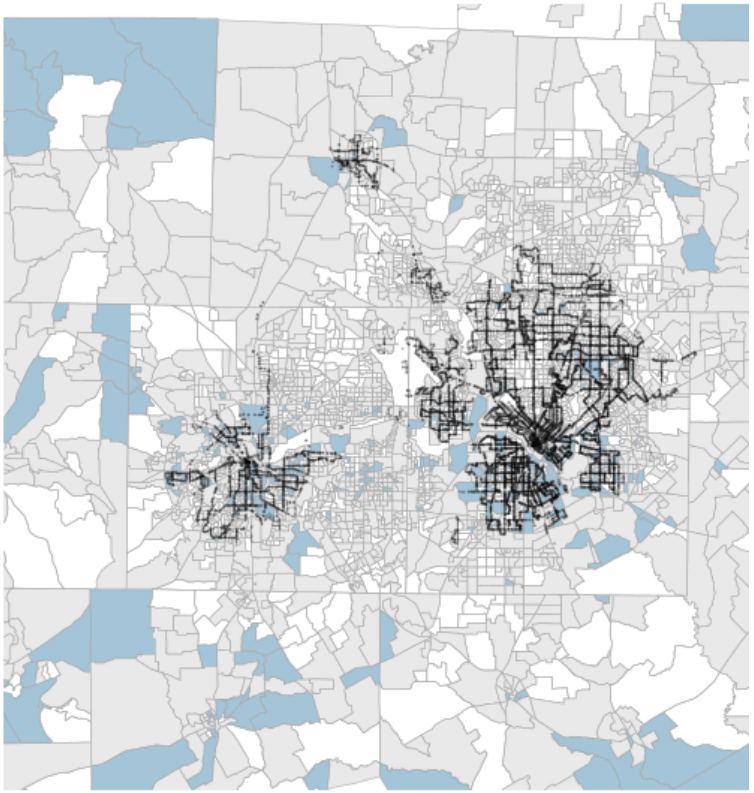


Unaffordable Rent at 50% AMI Affordable Rent at 50% AMI Transit Stop

Dallas-Fort Worth, TX-OK CSA

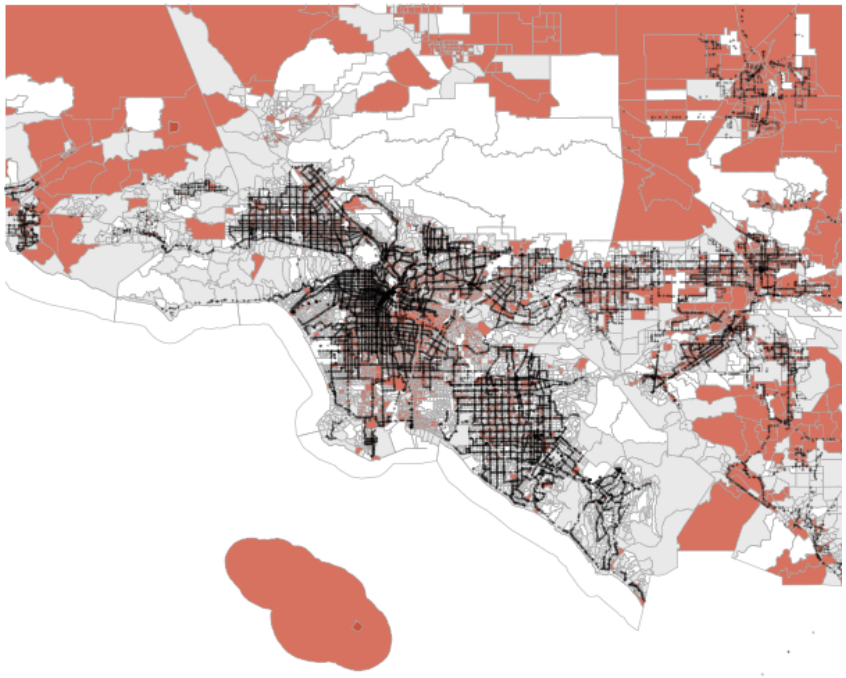


Unaffordable Rent at 80% AMI Affordable Rent at 80% AMI Transit Stop

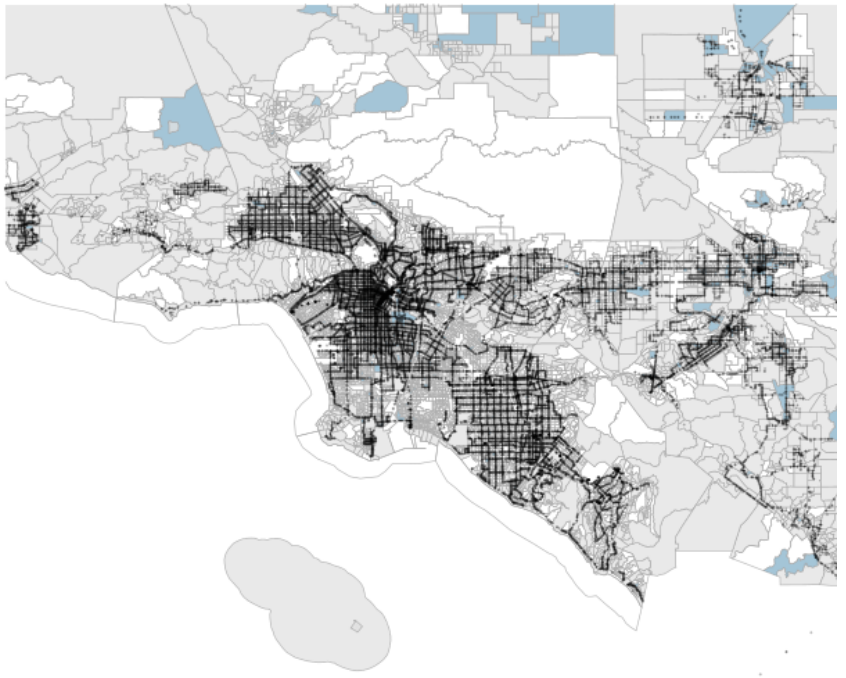


Unaffordable Rent at 50% AMI Affordable Rent at 50% AMI Transit Stop

Los Angeles-Long Beach, CA CSA



Unaffordable Rent at 80% AMI Affordable Rent at 80% AMI Transit Stop



Unaffordable Rent at 50% AMI Affordable Rent at 50% AMI Transit Stop

Regression Analytic Strategy

Next, I use Bayesian hierarchical varying-intercept linear regression[4] to explore the relationship between distance to the nearest transit station and housing affordability characteristics measured as median gross rent, median home value, and percent of the population paying more than 30% on rent, controlling for race/ethnicity and total population at the block group level. The distributions of income, total population, and median home value were skewed across all urban areas, so I use the natural logarithm of these variables as predictors in the regression analysis. I ran two models for each urban area, one for the entire CSA and one for the main MSA, with block groups nested within counties to account for county level variation.[5]

$$(1)\ Y_{ij} \sim \alpha_i + \beta_{ij} X_j + \varepsilon$$

$$Where:$$

$$(2)\alpha_i \sim \alpha_0 + N(0, \delta_\alpha),$$

$$(3)\beta_{ij} \sim \beta_{oj} + N\left(0, \delta_j\right)$$

The general structure of each model is depicted above where Y represents the distance to the nearest transit station for block group j in county i, $\beta_{ij} X_j$ represents the observed explanatory variables, and ε represents the noise term. $N(0, \delta_\alpha)$ represents the county level fixed effect. The regression analysis follows the work of basic textbooks on hierarchical models in a Bayesian

[4] I use Bayesian methods over frequentist approaches throughout this dissertation. Bayesian methodology provides certain advantages. First, Bayesian statistics provide conditional probabilities of parameter values that allow for probabilistic inferences. Second, there has been a lot of discussion across disciplines on how p-values provide limited information about data and are easily misinterpreted.

[5] County level point estimates for the mean of the posterior distribution and the 95% credibility intervals are not presented in this chapter but can be found in the appendix. County-level variation demonstrates that a MLM approach for this chapter is appropriate for the data structure. Furthermore, transportation decision making is typically done at the county or city level so it is to be expected that there might be differences across counties.

setting (Gelman & Hill, 2007; Gelman et al., 2013). I estimate all models using the stan_lmer() function in the rstanarm package in R, which allows applied regression models to be estimated using Markov Chain Monte Carlo (MCMC) methods.

I sampled four Markov chains for 1,000 iterations each, including 1,000 warm-up iterations, for a total of 4,000 samples for each model. All regression coefficients are standardized on a common scale for ease of interpretation (Gelman & Hill, 2007). The means and medians of the posterior distributions were relatively equal and all R-hat values were less than 1.1 indicating an overall good model fit (Gelman & Rubin, 1992). I evaluated each of the models using trace plots that provide information on the sequential draws from the posterior distribution to confirm that the chains in each plot were generally stable and that the chains overlap around the same value. I also examined the posterior predictive checks to evaluate the relationship between the observed data and the simulations from the posterior predictive distribution. [6,7]

Regression Results

The results from the multilevel regression analysis are presented in the following plots for both CSAs and MSAs for each of the six urban areas.[8] The plot points represent the standardized Bayesian point estimate, which in this case is the mean of the posterior distribution (similar to a maximum likelihood estimate from a frequentist approach). The lines on the outside of each estimate represent the 95% uncertainty intervals computed from the posterior draws. Estimates with intervals that do not cross zero indicate a meaningful relationship. Positive point estimates

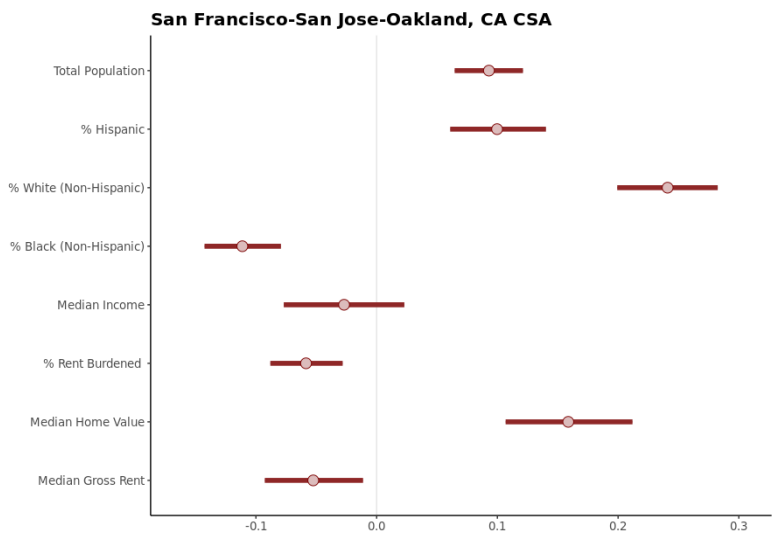
[6] I also estimated each hierarchical model with a frequentist approach using the lme4 package in R. The results were not substantively different from the Bayesian hierarchical models presented here.

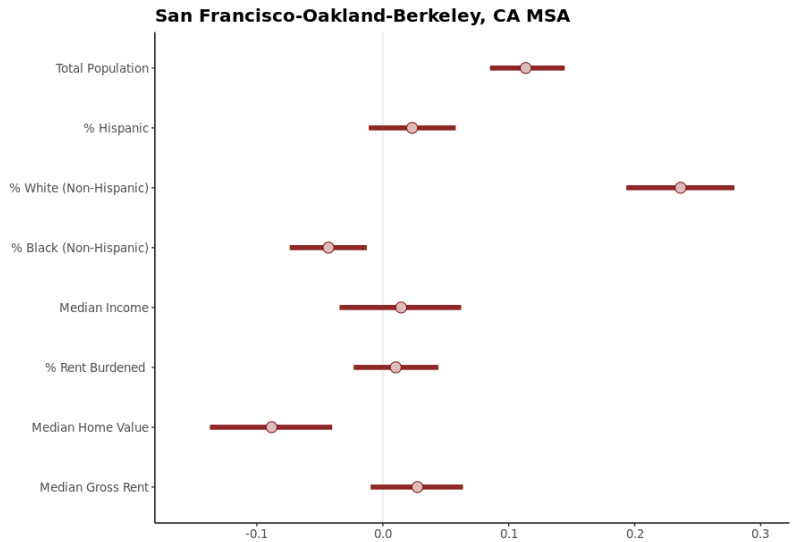
[7] Some of the models did have divergent transitions. However, no model had more than four divergent transitions, with many only having 1-2.

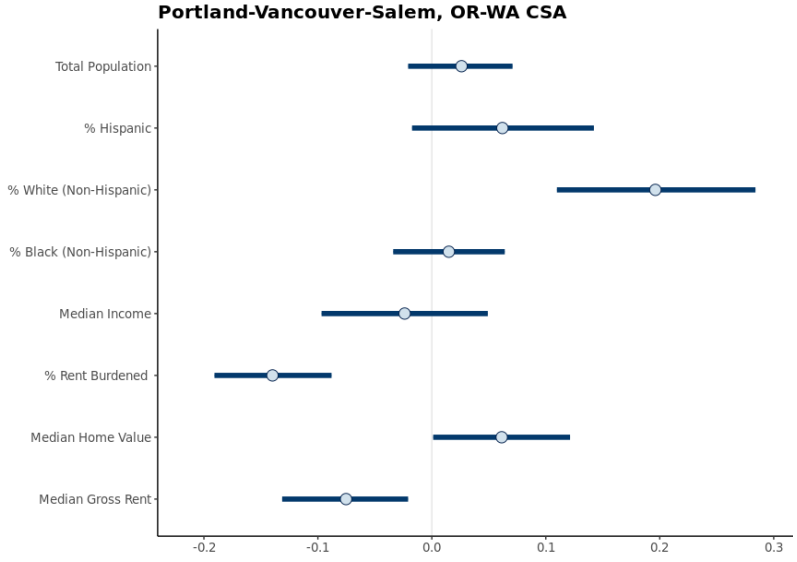
[8] Regression tables are located in the appendix.

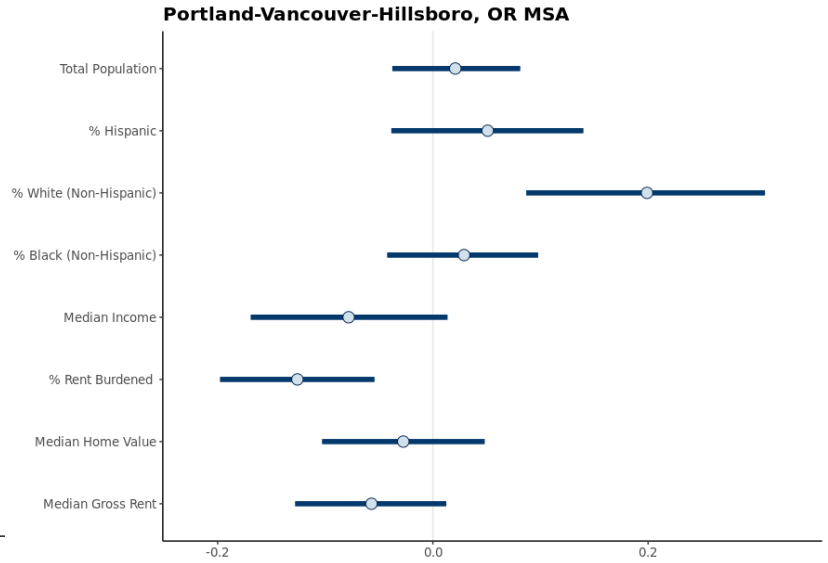
indicate that as distance to the nearest transit increases, the independent variable increases, whereas negative point estimates indicate that as distance to the nearest transit increases, the independent variable decreases. Thus, a positive interval that does not contain zero in the uncertainty interval indicates a meaningful and positive association.

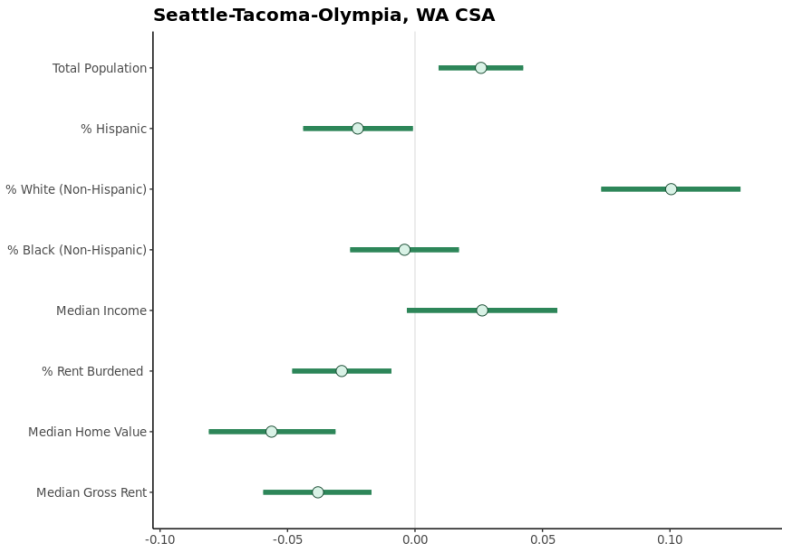
Figures 11-20: Regression Results at the CSA and MSA Level

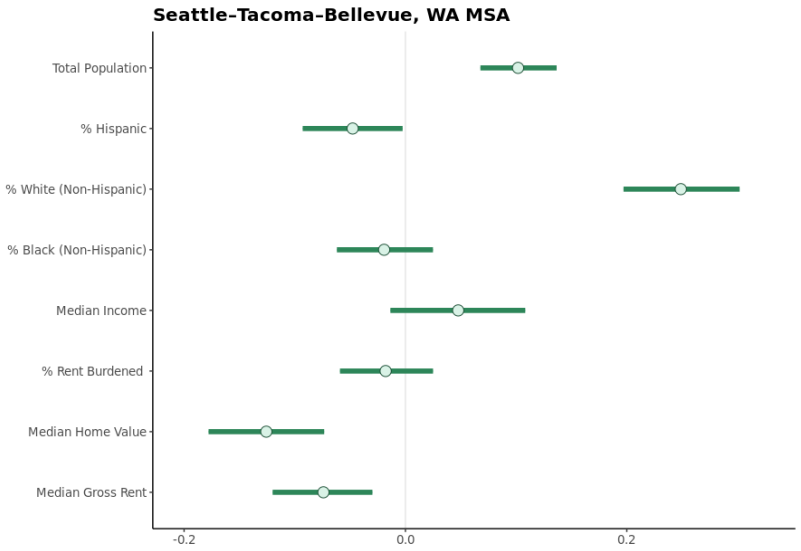


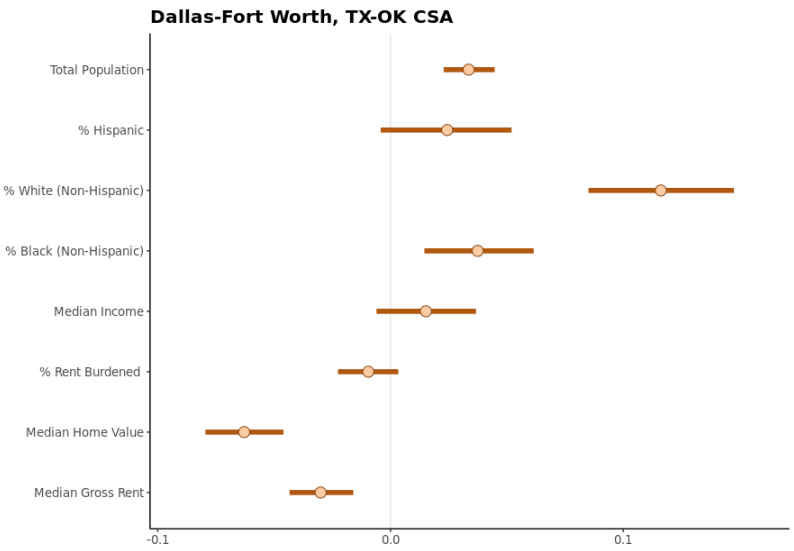


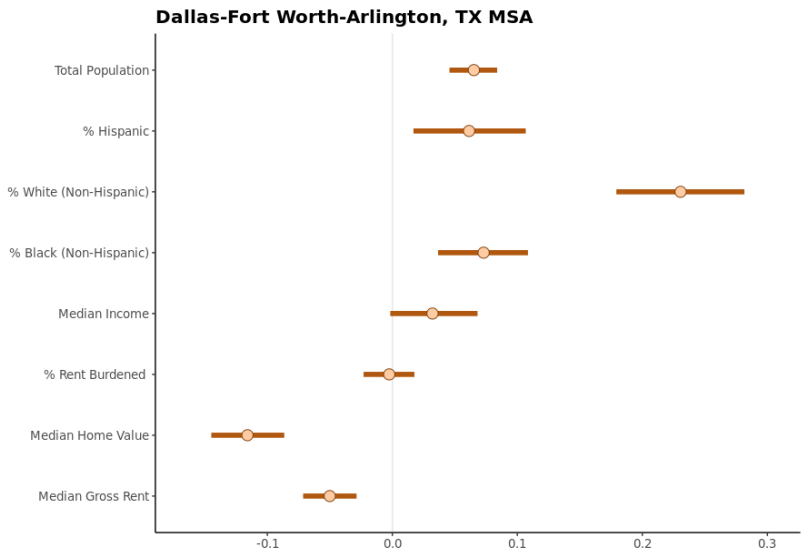


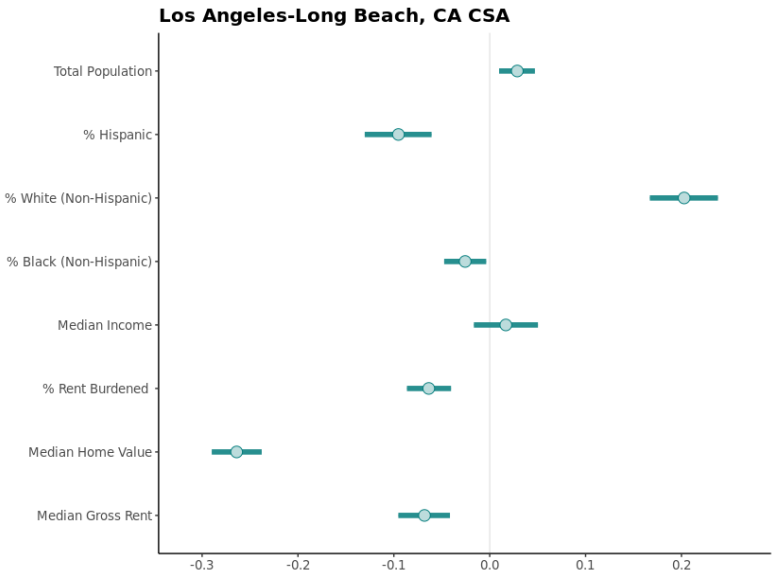


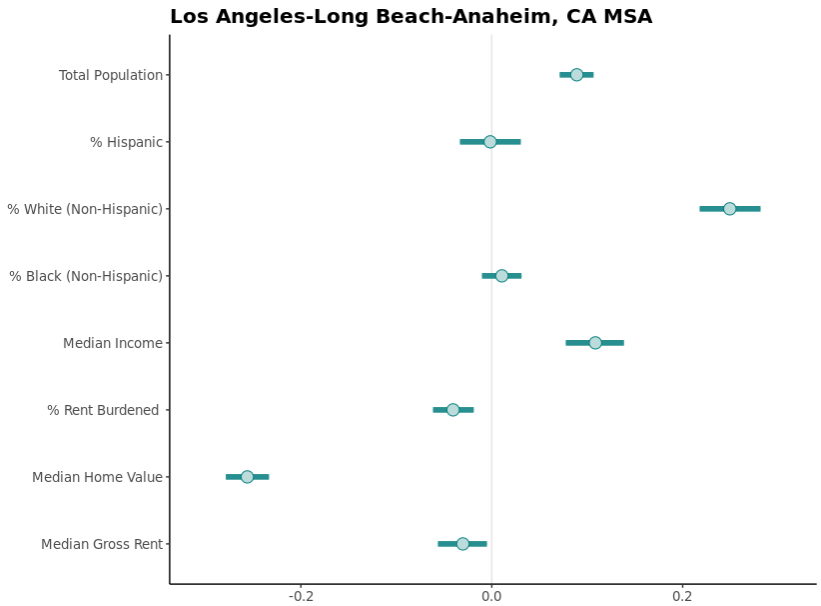

Seattle-Tacoma-Olympia, WA CSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.10
-0.05
0.00
0.05
0.10

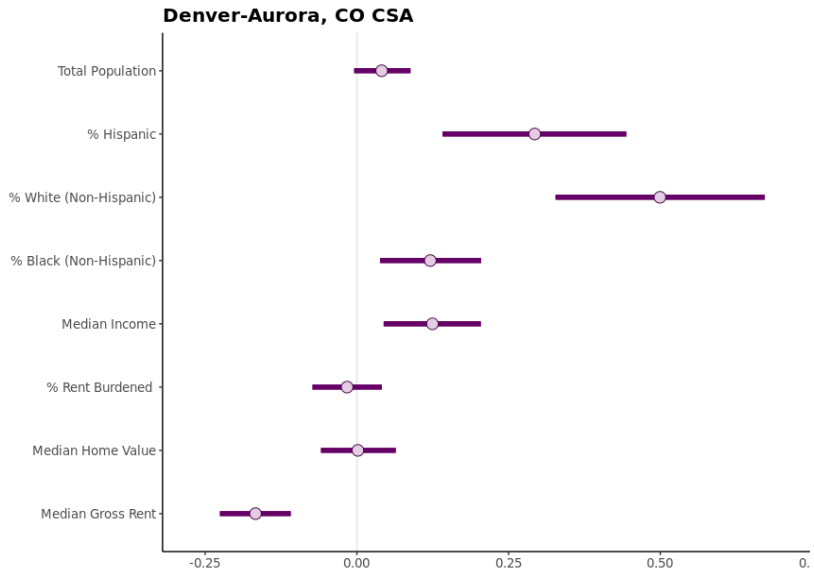

Seattle-Tacoma-Bellevue, WA MSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.2
0.0
0.2

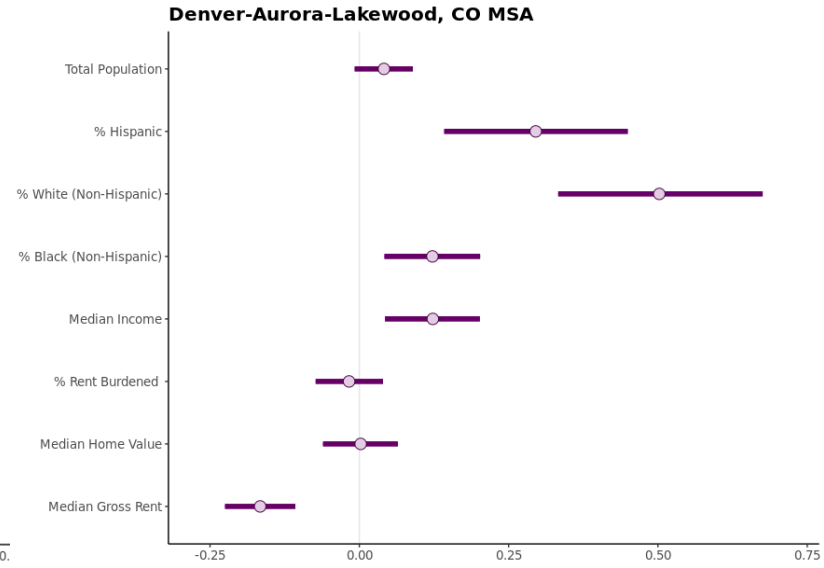

Dallas-Fort Worth, TX-OK CSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.1
0.0
0.1


Dallas-Fort Worth-Arlington, TX MSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.1
0.0
0.1
0.2
0.3


Los Angeles-Long Beach, CA CSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.3
-0.2
-0.1
0.0
0.1
0.2


Los Angeles-Long Beach-Anaheim, CA MSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.2
0.0
0.2


Denver-Aurora, CO CSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.25
0.00
0.25
0.50


Denver-Aurora-Lakewood, CO MSA
Total Population
% Hispanic
% White (Non-Hispanic)
% Black (Non-Hispanic)
Median Income
% Rent Burdened
Median Home Value
Median Gross Rent
-0.25
0.00
0.25
0.50
0.75

Results for both the San-Francisco-San Jose-Oakland CSA and San Francisco-Oakland-Berkeley MSA demonstrate meaningful and positive relationships between percent white non-Hispanic and distance to transit. A one standard deviation increase in percent white non-Hispanic is associated with a .24 increase in distance to transit at the CSA level and a .27 increase at the MSA level. At the CSA level, a one standard deviation increase in percent Hispanic non-white (.10) and median home value (.16) are associated with an increase in distance to transit. A one standard deviation increase in median gross rent, and a one standard deviation increase in percent of the population that is rent burdened, are both associated with around a .05 decrease in distance to transit.

The results for the Portland-Vancouver-Salem CSA and the Portland-Vancouver-Hillsboro MSA are nearly identical. These results show meaningful relationships between distance to transit and percent white and percent rent burdened for both models. A standard deviation increase in percent white non-Hispanic is associated with a .20 standard deviation increase in distance to transit at both the CSA and MSA level. The results also indicate that a standard deviation increase in percent rent burdened is associated with a .13 standard deviation decrease in distance to transit at both levels. At the CSA level, a standard deviation increase in median gross rent is associated with a .07 decrease in distance to transit, but this relationship is not meaningful for the MSA.

Results for the Seattle-Tacoma-Olympia CSA and the Seattle-Tacoma-Bellevue MSA show similar meaningful relationships between distance to the transit and percent white, median home value and median gross rent. A one standard deviation increase in percent white is associated with a .10 standard deviation increase in distance to transit in the CSA and a .25 standard deviation increase in distance to transit at the MSA level. Standard deviation increases

in median home value are associated a .06 standard deviation decrease in distance to transit in the CSA and a .13 standard deviation decrease in distance to transit in the MSA. Standard deviation increases in median gross rent are associated with a .04 standard deviation decrease in distance to transit in the CSA and a .07 standard deviation decrease in the MSA.

The results for the Dallas-Fort Worth CSA and the Dallas-Fort Worth-Arlington MSA show similar meaningful correlations with different effect sizes. The only notable difference is that that a one standard deviation increase in percent Hispanic non-white is associated with a .06 standard deviation increase in distant to transit at the MSA level, but this relationship is not meaningful at the CSA level. Standard deviation increases in home value (.06 at the CSA level and .12 at the MSA level) and median gross rent (.03 at the CSA level and .05 at the MSA level) are associated with standard deviation decreases in distance to transit. A standard deviation increase in percent Black is associated with a .04 increase in distance to transit at the CSA level and this number is .07 for the MSA. The largest effect sizes are shown with percent white, indicating that a one standard deviation increase in percent white non-Hispanic is associated with a .12 standard deviation increase in distance to transit for the CSA and a .27 standard deviation increase for the MSA.

Results for the Los-Angeles- Long Beach, CSA show a meaningful and positive relationships between distance to transit and percent white. Thus, a one standard deviation increase in percent white non-Hispanic is associated with a .20 increase in distance to transit at the CSA level. For the Los Angeles-Long Beach-Anaheim, CA MSA, there are meaningful relationships between distance to transit and percent white (.25) and median income (.11). At the CSA level, a one standard deviation increase in percent Hispanic non-white (.09), median home

value (.26), percent rent burdened (.06), and median gross rent (.07) are associated with standard deviation decreases in distance to transit.

In the Denver-Aurora CSA and the Denver-Aurora-Lakewood MSA, meaningful relationships are shown between distance to transit and percent Hispanic non-white, percent white non-Hispanic, percent Black non-Hispanic, and median rent. A one standard deviation increase in percent white non-Hispanic is associated with a .50 standard deviation increase in distance to transit in the CSA and a .54 standard deviation increase in distance to transit in the MSA. A one standard deviation increase in percent Black is associated with a .12 standard deviation increase in distance to transit in the CSA and .14 standard deviation increase in distance to transit in the MSA. A one standard deviation increase in percent Hispanic non-white is associated with a .29 standard deviation increase in the CSA and this number is .32 for the MSA. At both the MSA and CSA level there is no meaningful relationship between housing value and distance to transit.

DISCUSSION

In general, the results indicate that at both the CSA and MSA level, the cost of housing decreases as distance to transit increases. Simply put, across all urban areas the cost of housing is lower in areas without access to transportation. However, there are notable differences in the results for CSAs versus MSAs in the same general urban area. These results are likely a reflection of the additional counties in CSAs that represent outer-ring suburban areas of the central city. For example, the finding that at the CSA level housing costs actually increase farther from transit in the San Francisco-San Jose-Oakland CSA is not surprising given that homes in these outer counties can cost millions.

Although median rent has a positive relationship with distance to transit across all CSAs, this relationship is not always found with housing value. In the areas surrounding Portland and Denver, at both the CSA and MSA level, the results show that median gross rent correlates meaningfully with distance to transit, but there is no meaningful correlation between median home value and distance to transit. This finding might seem a bit puzzling because one would assume that rent is a direct reflection of housing prices. However, because housing is treated as a commodity, landlords often charge rent that is higher than a monthly mortgage for a home. Homeowners are the ones who determine the cost of rent. Thus, the cost of rent is not always a reflection of the livability or material condition of the home itself, whereas housing prices are determined by market forces and home inspections that are outside the control of the homeowner (Grineski & Hernandez, 2010).

In Portland, Seattle, and Los Angeles, at both the CSA and MSA level, and in San Francisco at the CSA level, the results indicate a meaningful correlation between the proportion of the population that is rent burdened and distance to transportation. Put another way, areas that are closer to transportation see a higher percentage of their population who are paying over 30% of their income on rent. The results highlight the affordability paradox that is plaguing these rapidly redeveloping cities. Residents, and particularly renters, must choose between affordable housing with no transit access or unaffordable housing with transit access. This is particularly troubling given that renters often lack agency over their housing situation and are at a clear disadvantage over homeowners because they rely on the private rental market that offers them little protection (Burridge & Ormandy, 2007; Shlay, 2006; Pattillo, 2013; Dreier, 1982). Furthermore, renters are typically low-income residents who may rely on public transportation for increased mobility (Joint Center for Housing Studies, 2020). Thus, residents who are rent

burdened, and especially poor residents who are rent burdened, can face higher residential mobility and evictions in an effort to maintain their access to public transit (Desmond, 2018; Desmond, 2016).

It is important to note that across many of these models, the coefficient with the largest effect size is percent white. Although it may appear that white populations are the most disadvantaged in terms of public transit access, this finding is likely because there is still a number of wealthy whites who depend on automobiles in the suburbs and choose to live there, even though there is evidence that the suburbs are both becoming poorer (Kneebone, 2017) and more racially diverse (Lichter, 2013). Research has also shown that higher suburbanization rates for whites are associated with higher levels of suburban employment, but for Blacks and Latinos, higher suburbanization rates are related to the availability of affordable housing (Timberlake, 2016).

CONCLUSION

The goal of this research was to explore the link between the affordable housing crisis and spatial (im)mobility in terms of access to public transportation networks in urban areas. The findings from this chapter challenge us to redefine the nature of transit accessibility as an issue of affordability. There is a growing literature that examines how various forms of rail transit influences patterns of gentrification that engages with this paradox of affordability and accessibility (Dong, 2017; Baker & Lee, 2019; Zuk et al., 2018). However, this literature examines transit as a *cause* of gentrification and does not address how the loss of transit access is an *effect* of the affordable housing crisis that is plaguing rapidly gentrifying cities. Furthermore, this study challenges the value of using only traditional measures of social (im)mobility such as poverty and income in a time when the geographic locale of poverty is rapidly changing.

Although the poor still live in the inner-city, an affordability approach to accessibility begs the question: *how long can the poor truly stay in the inner-city if rent continues to increase while wages stay stagnant? Or even the middle or working class?* Snapshots in time may show that the inner-city poor still live in cities (Hwang, 2015), but these residents are doubly burdened by having to use what little resources they have on housing costs to maintain access to public transit while living in poverty. As such, a holistic analysis of transit accessibility requires conceptualizing both housing and transit as sites of environmental inequity.

Using the framework set forth in critical environmental justice theory, transportation access is a multiscalar issue for two reasons (Pellow, 2018). First, solving the transportation accessibility crises has obvious implications for climate change and human health. Reducing the reliance on automobiles by increasing public transportation usage reduces the body burden of pollution that disproportionately impacts the poor and racial minorities. Second, solving this crisis is directly linked to providing safe and affordable housing to residents. Environmental justice studies have long examined the house as a locale of inequity by examining toxins within homes (Bullard, 1996; Grineski & Hernández, 2010), and toxins sited near homes (United Church of Christ, 1987; U.S. General Accounting Office, 1983) but future research should address how access to housing itself is directly linked to the availability of public transportation.

This research has important implications for housing and transit policy at the federal, state, and local levels. Most importantly, this study uniquely reinforces the perspective that transit and housing policies should be created in tandem because transit poverty and housing poverty both impact the economic, political, and social mobility of residents. This study provides further evidence of the extent of the housing affordability crisis in urban areas. A variety of policies are needed to address the crisis, including protections for current residents at risk of

displacement (or banishment), preservation of existing affordable housing supply, and the production of new units. However, current and proposed policies have attempted to address affordable housing production in relation to transit development with little success. Policy centered on TOD that promises the construction of affordable housing near transit stations has clearly fallen short in achieving that goal.

In Seattle, a state statute requires that Sound Transit offer 80% of its surplus property (left over after building stations and tracks) to be used for the development of units affordable to families making 80% or less of the AMI (Sound Transit, n.d.). Yet, this kind of policy is reliant on local and state level zoning laws, which dictates the type of housing that can be built near transportation hubs. Transit agencies have little control over changing single-family zoning that essentially makes the construction of affordable apartment buildings illegal. NIMBY opposition from wealthier residents who do not want higher-density developments in their neighborhoods can make it hard to change zoning and land-use rules. As such, those who lack power, often the poor and racial minorities, are the ones who pay the cost of policies that benefit wealthy, white suburbanites and gentrifiers.

In 2020 the California state legislature failed to pass a bill that would have impacted two of the urban areas in this study. This bill aimed to alter zoning in areas near transit, making it easier to build denser, multi-family housing around public transportation. However, affordable housing advocates opposed the bill, which contained minimal requirements for developers to include affordable housing. (Alliance for Community Transit, 2020). It required developers to make a small share of units affordable, but developers could sidestep building those units by paying a fee to the city, which would diminish the bill's potential to make a real impact on affordable housing supply in areas near transit (Steimle, 2020). The power to dictate affordability

surrounding transit would be left in the hands of developers who aim to keep rental costs high to generate a profit. Since developers have a direct stake in the commodification of housing, how can they be trusted to truly create and maintain affordability near frequent transit networks? Ultimately, creating affordable and well-connected communities in the inner-city will require transferring power and land back to the people.

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Chapter III

Light Rail Transit, Gentrification, and Racial Banishment in the Inner-City

INTRODUCTION

Amidst the growing concern over the consequences of climate change, cities in the U.S. and worldwide are exploring ways to reduce environmental externalities caused by urban transportation and mobility. Consequently, cities are turning to TOD as a critical approach to creating sustainable modal shifts and reducing automobile dependence (Paderio, Louro, & da Costa, 2019). Nearly every major metropolitan area has constructed, or has at least begun planning, new fixed guideway transit (Dittmar & Ohland, 2004). TOD is a central component of new urbanism, or the smart growth movement. New urbanism seeks to bring economic growth back to the city, reduce unsustainable suburban sprawl, and enhance inner-city neighborhood livability (Duncan, 2011). Urban planners note that a neighborhood's livability should not only be measured as favorable economic and social conditions but also as the quality of the physical built environment (Southworth, 2003).

Light rail transit (LRT) has become one of the most popular, and one of the most controversial, types of TOD since it became a central component of development in major urban areas in the 1980s. LRT is a transit mode that operates passenger rail cars on fixed rails, has designated lanes that separate the lines from automobile traffic, and is typically electrically driven (American Public Transportation Association 2018). LRT offers a number of benefits over automobiles and other forms of public transit, such as buses. It is generally cleaner for the surrounding environment, and encouraging commuters to use electric LRT over private vehicles

improves ambient air quality, and thus public health in the city. The fixed nature of light rail often leads to real-estate and property investments around stations and stops, often promoted by city officials to ensure high ridership to offset costs (Higgins, Ferguson, & Kanaroglou, 2014; Cervero & Duncan, 2002).

Investments surrounding LRT stations can drive up property values, subsequently increasing mortgages and rents in the surrounding areas. Consequently, this can force low-income families and racial minorities, groups who have historically relied on public transportation for increased mobility, out of these neighborhoods, or restrict them from affording to move in. Although investments in LRT can create favorable and cleaner living conditions in the inner-city, it is important to ask: *who exactly is reaping the benefit of LRT investments?*

While public transit has long been an equity battleground, conflicts have emerged between activists fighting against the growing unaffordability of inner-city living and urban planners and city level officials pushing for TOD. In a fierce battle over transportation in Nashville, activists referred to LRT as "gentrification trains." Similarly, Maryland's purple line faced opposition from immigrants concerned about rising rent for those who cannot afford to buy homes in the area. In 2014, mass transit plans that included LRT failed in both Austin, TX and St. Petersburg, FL. It is important to note that opposition groups are typically not against the idea of LRT itself, but rather its potential to be used as a tool to reinforce existing patterns of segregation and gentrification by displacing residents through deliberate, and often racially motivated, urban restructuring. There is a growing fear that in the age of the neoliberal city, reinvestment will fail to create a multicultural, multiclass city, and instead maintain a system of geographical apartheid and transportation racism.

Research surrounding TOD and gentrification is imperative for developing a better understanding of public transit's effect on neighborhoods, especially in a time where city governments are in the process of building and planning mass transit systems in an urban landscape that is becoming increasingly precarious for people of color and financially insecure folks. Clagett (2014) argues that gentrification challenges TOD's viability as a tool for sustainable development. This is especially true if we expand our definition of sustainability beyond environmental and economic terms to include an equity component. Boschmann & Kwan (2008) contend that "social" components should be a critical dimension in the conceptualization of sustainability for transportation systems.[9] However, as Jones & Ley (2016) note, TOD often elevates environmental sustainability at the expense of social sustainability, despite the longstanding calls from scholars of environmental justice to examine them both in tandem. Examining the social components of TOD is imperative for ensuring that the city level transitions to environmentally sustainable infrastructure are just.

Scholars have recently begun to empirically examine the connection between TOD, particularly LRT, and its potential to raise housing costs. However, these studies often have mixed results (Kahn, 2007; Pollack, Bluestone, & Billingham, 2010; Dong, 2017). This literature examines various forms of TOD, including bus rapid transit, commuter rail, subway systems, and the primary focus of this paper, LRT.[10] These new studies have helped move the conversation

[9] Research on the social dimensions of sustainable transportation has been fairly limited (Black 2002), with the most notable works being Bullard, Johnson, and Torres (2004) and Bullard and Johnson (1997) that examine transportation racism. Avila (2014)'s work on the freeway revolts also speaks to this issue.

[10] It is important to mention that sometimes this literature has a tendency to lump together all forms of TOD to examine it's to relationship gentrification. While outside the scope of this study, this is a disadvantage because not all forms of TOD carry the same social and historical connotations. For example, Bullard and Johnson (1997) discuss how Blacks are often associated with buses, using the example the racist backronym "Moving Africans Rapidly Through Atlanta." See Guilano (2005) and Taylor and Ong (1995) for a discussion of how poor Black neighborhoods are associated with buses and Babalik-Sutcliffe (2002) and Bowes and Ihlanfeld (2001) on a discussion of rapid transit more generally exists in wealthier neighborhoods. It is unclear how systems like bus rapid transit fit into these distinctions.

forward, but the literature itself suffers from conflicting measurements and definitions of gentrification, mirroring the ongoing debates in urban sociology (Brown-Saracino, 2017). Similarly, the majority of these studies focus exclusively on economic changes in neighborhoods (Barton & Gibbons 2015; Dong 2017; Bardaka, Delgado & Flomax, 2018), while ignoring potential patterns of displacement, especially of racial minorities (Baker & Lee, 2019).

This study intends to propel this conversation forward by applying a sociological lens to critically analyze the relationship between transit and neighborhood change in the neoliberal city. Specifically, I argue that linking theories of neighborhood change in urban sociology to theories of racial banishment in human geography can help us to develop a better framework for studying the relationship between TOD and neighborhood change. Although urban planners have dominated this area of research, a sociological perspective is imperative for appraising the social, political, and economic complexities that underpin this relationship.

The first aim of this research is to explore the proposed relationship between gentrification, displacement, and LRT. Specifically, I ask: *what is the relationship between LRT development and patterns of gentrification and displacement in urban areas?* The second aim of this study is to treat gentrification as an inherently intersectional issue by including measures of racial displacement, perhaps better understood as racial banishment (Roy, 2017; McKittrick, 2011; Kirkland, 2008). Sheller (2015) reminds us that the history of transit development has a sordid history with both overt and covert racist policies.[11] Roy (2017) notes that racial minorities are often kept out of gentrifying neighborhoods, but also systematically removed through racist practices of development agents, forcing us to conceptualize gentrification as not a passive, but

[11] See footnote 1.

an active process. Thus, ignoring potential racial components of neighborhood change paints an incomplete picture of transit-related gentrification.

To answer these questions, I use Bayesian hieratical modeling to longitudinally examine how proximity to LRT stations can lead to change in socioeconomic, housing, and transit use characteristics in 11 urban areas that developed LRT between 1990 and 2004. The first section of this paper explores the definitional and measurement issues of gentrification present in the urban sociology literature, the theoretical development of the linkages between transit and urban neighborhood dynamics, and an overview of the state of the current research on TOD and gentrification, with a particular emphasis on LRT. The next section presents the data and analytic strategy used in the analysis, followed by a discussion of the results. I conclude by discussing potential directions for future quantitative studies and further theoretical developments needed to better address transit equity surrounding LRT.

BACKGROUND AND THEORY

The social and neighborhood effects of TOD have not attracted much attention from quantitative scholars until fairly recently. However, this new area of research is slowly developing a framework for exploring how transit is a mechanism for neighborhood demographic change. Scholars have explored the affordability paradox of TOD, a phenomenon whereby those who would benefit the most from additional accessibility provided by expanding transit are forced out of newly transit rich neighborhoods (Renne et al., 2016; Dong, 2017). Other scholars have explored the potential for TOD to create a "magnet effect," a process whereby updated transportation systems attract impoverished residents (Kahn, Glaeser, & Rappaport, 2008). While the affordability paradox parallels to the fears expressed largely by Black inner-city residents, there is also evidence of NIMBY activism from whiter, wealthier residents who claim to oppose

TOD for fear of "crime," an argument that represents a thinly veiled attempt at hiding racism and maintaining historic segregation. For example, white residents in Anne Arundel county claim that LRT lines are bringing crime from inner-city Baltimore to the suburbs and are fighting to have LRT stops shut down.

Given the growing pressure to restructure mass transportation, and the growing contention surrounding transit in urban spaces, it is imperative that we continue to develop this area of research both theoretically and methodologically. While researchers have continued to tackle the latter issue in the last five years[12], the primary goal of this paper is not to argue for one statistical method over another, but to demonstrate the importance of expanding the current theoretical nexus surrounding transit-related gentrification and pairing that with appropriate methods. The majority of studies only examine the economic changes surrounding TOD areas, ignoring deep histories of racial segregation in both housing and transit in urban spaces. These studies have adopted some of the inadequacies from urban sociology surrounding the relationship between gentrification and displacement. In this section I will provide a compressive overview of gentrification literature in urban sociology and argue for the inclusion of theories on displacement from human geography, with the aim of using these theories to better develop the methodologies used in studies on TOD and neighborhood change.

Defining and Measuring Gentrification

Depending on the time and place, gentrification has been seen as a tool, goal, outcome, or unintended consequence of the revitalization processes in declining urban neighborhoods.

[12] While most studies use some kind of difference in difference design (i.e. comparing tracts that received access to a station versus those who did not) scholars have used various methodologies to explore those differences. Baker & Lee (2019) use spatial autoregressive models, Grube-Cavers & Patterson 2015 use survival analysis, and Dong (2017) uses a propensity score matching method.

Scholars have debated the cause and implications for neighborhood gentrification since Glass (1964) first used the term to describe the "invasion" of the middle class into working class neighborhoods in London. The introduction of new resources and improved conditions associated with gentrification can provide blanket economic benefits to neighborhoods. Thus, the axiomatic assumption in urban sociology has long been that gentrification is primarily an economic, class-based issue and should be defined and measured accordingly. For example, Smith (1998) defines gentrification as "the process by which central urban neighborhoods that have undergone disinvestments and economic decline experience a reversal, reinvestment, and the in-migration of a relatively well-off middle- and upper middle-class population" (p. 198). Kennedy and Leonard (2001) provide another ubiquitous definition of gentrification: "the process of neighborhood change that results in the replacement of lower income residents with higher income ones" (p. 1). These definitions of gentrification are reminiscent of the early urban sociologists who used terms such as "revitalization" and "upgrading" to describe improvements to the physical capital of neighborhoods (McKenzie, 1924; Park, Burgess & McKenzie, 1925).

Although early work on gentrification focused exclusively on exploring the cause as either a product of the neoliberal restructuring of cities or expanding interests in cultural consumption (Zukin, 1987), more recent work highlights a bifurcation in the literature surrounding the actual severity and significance of gentrification itself (Brown-Saracino, 2017). Yet, a quick sweep of news articles on current events shows that gentrification is a very real threat for low-income folks and racial minorities. More recently, scholars have pointed out that while definitions of gentrification usually describe some process of social status upgrading, the concept itself has become too broad, perhaps leading to issues in measuring its significance. Halle and Tiso (2014) argue that the term has been used "very loosely, conflating several issues

that should be considered separately" (p. 16). While gentrification is usually applied to urban areas with entrenched poverty, scholars are examining gentrification in higher income neighborhoods (Lees, 2002), suburban neighborhoods (Charles, 2011), and even in rural areas (Nelson, Oberg & Nelson, 2010). Compounding the geographical expansion of the term "gentrification" is also a longstanding issue with what Wyly et al. (2010) describe as an issue with the "politics of measurement."

Brown-Saracino (2017) highlights how the split in gentrification literature surrounding its severity and significance that mirrors its methodological differences. Qualitative, micro-level scholars often portray gentrification as an inexorable force, while some quantitative macro-level scholars argue that the consequences of gentrification for the poor and racial minorities are marginal. Quantitative scholars challenge the breadth of gentrification by pointing to the persistence of entrenched poverty in the urban core (Hwang, 2015; Solari, 2012). Others provide evidence that cities are not experiencing the displacement of residents, but instead are mirroring national trend towards extreme wealth inequality (Owens, 2012). Moore (2009) notes that the process of gentrification may be more diverse because Black middle-class populations are moving into poorer inner-city neighborhoods. More recent studies have explored the spatio-temporal differences of individual cities, noting that gentrification is unevenly distributed (Dwyer, 2010; Lichter, Parisi & Taquino, 2012).

Some scholars argue that in order to examine the presence of gentrification within neighborhoods, a neighborhood must first have characteristics that make it "gentrifiable," or eligible to experience gentrification at a future date based on certain sociodemographic characteristics (Freeman, 2005; Walks & Maaraen 2008). The concept of gentrifiable has been operationalized in different ways, but typically defines a gentrifiable neighborhood as one that

has a mean or median income below the metropolitan average (Freeman, 2005; Ding, Hwang, & Divringi, 2016; Gibbons & Barton, 2016). Walks and Maaran (2008) include educational attainment in their definition of "gentrifiable" to account for the working-class occupational status of neighborhoods that are eligible to gentrify. Identifying neighborhoods that are eligible to experience gentrification is important when quantitatively examining the effects of gentrification between and within urban areas.

Considering the issues with both defining and measuring gentrification, it is clear as to why these issues have emerged when examining the link between transit and gentrification. The longstanding research in urban sociology truly highlights the historical complexities of neighborhood change. Perhaps the confusion lies less with the diverging results and more with a failure of quantitative scholars to accept that multiple truths can exist at the same time and even within the same geographic space. Given the differences in city level regulations surrounding housing and development, logic follows that gentrification and displacement are not uniform. While the existence of *de jure* segregation during the suburbanization of the U.S. happened across most major metropolitan areas, each city has different legacies and patterns of segregation. Thus, in the same city, gentrification can exist at the same time as entrenched poverty.

Economic definitions of gentrification as a process of investment and upgrading highlight the very active processes taking place in the neoliberal restructuring of the city in recent decades. Thus, maintaining the nature of changing material conditions in the city as a central component to the definition of gentrification is a useful analytic for quantitative scholars of gentrification. However, I argue that quantitative studies of gentrification must take a more holistic approach in

defining and measuring gentrification by exploring the potential for displacement, as economic restructuring of urban areas has long been racially motivated.

Displacement as Racial Banishment

The concept of displacement, and its temporal placement in the process of gentrification, has received some attention from urban sociologists. Atkinson (2000) notes that measuring displacement is akin to "measuring the invisible." Desmond (2016) argues that low-income residents tend to move frequently regardless of gentrification and are consistently precariously housed. Nonetheless, qualitative studies have documented the uprooting of long-standing residents in urban neighborhoods undergoing the process of gentrification (Hyra, 2008; Betancur, 2011; Lloyd, 2006), as well as the physical destruction of their cultural centers (Hyra, 2015). Quantitative scholars, on the other hand, tend to present displacement as a modest consequence of gentrification and often disagree on whether displacement of existing residents is a separate dimension or a prerequisite for gentrification (Lees, Shin, & Lopez-Morales 2005; Freeman, 2005; Freeman, 2011).

Surprisingly, this area of research consistently falls short in exploring the racialized dimensions of gentrification related displacement, despite the fact that urban sociologists have long examined the intersections of race and class in urban areas (Drake & Clayton, 1945; Massey & Denton, 1993; Crowder, 1999). Freeman (2005) primarily examines displacement of the poor through increased costs of rent. Ellen and O'Regan (2011) examine the movement of low-credit score residents in gentrifying neighborhoods. One notable exception is McKinnish, Walsh, and White (2010), who find that while less educated racial minorities were leaving gentrifying neighborhoods, middle class racial minorities were moving in. This finding highlights one of the

larger issues with the literature on displacement, which is that it tends to focus solely on the movement of people and not the destruction of Black culture and businesses in the inner-city (Moskowitz 2017; Betancur, 2011; Lloyd, 2006).

While gentrification and displacement may be two separate but deeply connected processes, we need to develop a better understanding of how they both target and impact racial minorities in urban spaces. The analysis of gentrification in urban sociology relies on postcolonial theories of urban transformations that ignore the connection between racial violence and space (Roy, 2017; McElroy & Werth, 2019). They almost point to both gentrification and displacement as being coincidental, undermining the role that developers and state agencies play in facilitating the process. Logan and Molotch (1987) famously call cities "growth machines," because as Harvey (2008) demonstrates, the urban environment is constantly made, destroyed and remade for the purpose of capital accumulation. But as a white, settler colonial society it is clear that race is a central component to the process of gentrification and displacement, as capitalism itself is inherently racist.

Scholars in the field of human geography are increasingly pointing to the covert and overt ways racism facilitates urban development, suggesting that displacement is better understood as a process of racial banishment. Although gentrification can be understood in terms of social status upgrading, it is important to note that the revitalization taking place in urban areas could have never happened without the continuing exploitation of racial minorities in the U.S. Roy (2017) explains that while gentrification cannot explain all forms of displacement, it is clear that there is a "sheer disappearance of African Americans" in cities (A8). McKittrick (2011) argues, "[The]...the annihilation of black geographies in the Americas is deeply connected to an economy of race, and thus capitalism, wherein the process of uneven development calcifies the

seemingly natural links between blackness, underdevelopment, poverty, and place within differing global contexts" (p. 951).

Studies are increasingly showing the linkages between direct causes of displacement and race through studies on evictions, landlord harassments, eminent domain, and building condemnation. Wyly and Ponder (2011) found that subprime lenders particularly targeted elderly African American women, many of whom were widows, leaving them financially devastated. Foreclosures of Black homes make gaining property for the purpose of neighborhood "revitalization," and potential gentrification, much easier. Hiller (2013) provides evidence that rent paying tenants in racial minority neighborhoods in Chicago were forced out of foreclosed buildings as developers were seeking to "revitalize" by coercion, including providing tenants with false information.

While neo-marxist scholars point to the agency that local governments and developers have in changing the physical and economic terrain of urban spaces, they fall short in examining racial capitalism, or the idea that capitalism and racism are dependent on each other (Pulido, 2017). Thus, in order to retain gentrification and displacement as useful analytics, it is important to find ways to center race, and the racial formation of space, in our conversations and quantitative research. I argue that the new arena examining transportation related-gentrification is an obvious place to merge research on gentrification in urban sociology with work on racial banishment in human geography because the formation of urban space, and racial segregation, have long been linked to mobility through access to transportation. As such, I examine both the change in economic and housing characteristics present in traditional studies on gentrification in urban sociology and the change in the racial and ethnic neighborhoods surrounding LRT stations to explore whether urban transportation systems facilitate racial banishment. Thus, I define racial

banishment related to TOD as the imposed spatial exclusion of racial minorities from cleaner, transit rich areas.

TOD and Gentrification

Studies have examined various types and combinations of TOD including light rail, heavy rail, and bus rapid transit and typically compare the changing demographics in areas well served by a type of transit to those without access. A limited number of researchers examine how bust rapid transit (BRT) relates to neighborhood change. In their study on BRT in Ottawa, Mullins, Washington, and Stokes (1989) found that BRT has a marginal impact on influencing land use patterns. Rodriguez and Targa (2004) explore this relationship in Houston, Pittsburgh, and San Francisco, and found that BRT did not impact residential nor commercial development. However, a study by Brown (2016) revealed that both rent and home value increased in neighborhoods near Los Angeles' Orange BRT line. It is not surprising that evidence of bus rapid transit leading to revitalization is mixed, because as Hess and Almieida (2007) note, "property values near bus routes have only modest gains, if any, from transit proximity, because most bus routes lack the permanence of fixed infrastructure" (p. 1043).

Furthermore, it is well established in literature in environmental justice that urban planning has contributed large-scale transportation projects that often racialize particular forms of transit over others (Bullard & Johnson, 1997). Thus, acknowledging transit type when examining neighborhood change is imperative in order to holistically understand the underlying structural processes contributing to transit injustice. Sandoval (2018) examines mobilizations against TOD in three Latino Barrios (in Oakland, Los Angeles, and San Diego), demonstrating that some of the fiercest battles against TOD specifically involve LRT. City bus systems have

historically been stigmatized as transit for racial minorities and the poor, unlike LRT, which is promoted to middle-class discretionary riders who have the means to use alternative forms of transportation (Bullard, Johnson & Torres 2004; Bullard, 2007). In cities like Los Angeles and New York City, bus rider unions, which are primarily composed of people of color, are fighting for the development of bus rapid transit over LRT to prevent gentrification, even though both are considered aspects of TOD. Thus, differentiating between various forms of TOD is necessary given historical class and racial tensions surrounding rail versus bus systems in US cities.

There are far more quantitative studies on the relationship between rail development and gentrification and displacement in urban areas. Early studies focused almost exclusively on appreciating property values surrounding rail development. Hess and Almeida (2006) examine the impact of proximity to LRT on residential property values in Buffalo, NY and find the increase in property values to be modest in most areas. However, for neighborhoods near three stations, they actually find that property values decrease. Lin (2002) examines this relationship with proximity to subway stations in Chicago between 1975 and 1991. This study finds that properties close to transit significantly increase in value in comparison to those farther away, and that this effect is seen most drastically between 1985 and 1991. This study demonstrates that the effect of LRT on neighborhood temporally varies, with change potentially taking many years after a system begins operations.

More recently scholars have focused on the shifting class dynamics, through both income and poverty indicators, to measure gentrification. Kahn (2007) examines rail-induced gentrification in 14 cities from 1970 to 2000 in the U.S. using census tract level panel data. This study uses increases in college graduates and average household income to measure gentrification. Two cities stood out as having evidence of rail-induced transit, Boston and

Washington D.C., and neighborhoods near "walk and ride" stations were more likely to gentrify in comparison to "park and ride" stations. Similarly, Pollack, Bluestone, and Billingham (2010) find evidence that income and housing costs grew faster in rail-transit served neighborhoods in their study across 12 metropolitan areas between 1990 and 2000. Grube-Cavers and Patterson (2015) examine the effect of rapid rail transit on median rent and family income in three Canadian cities, citing evidence of gentrification in Toronto and Montreal but not in Vancouver.

Using Dallas as a case study, Heilmann (2018) finds that income increases in census tracts that received rail access but does not find that effect in neighborhoods that were promised to receive access. Whereas Kahn (2007) argues that the relationship between income and rail development differs across cities, Heilmann (2018) finds evidence that rail can lead to both gentrification and the "poverty magnet" within the same city. Finally, Dong (2017) uses a propensity score matching method to examine TOD and gentrification in suburban Portland. Unlike other studies, this study did not find that rail transit reduced the home affordability for renters or owners.

Although many of the aforementioned studies include measures of race, they are often used as controls and are not the center of the study. However, there are some notable exceptions. Deka (2016) examines the relationship between commuter rail and gentrification in New Jersey, finding an increase in home values near stations but arguing that there are no notable changes in race and ethnicity. However, this study does not examine changes in the racial makeup surrounding commuter rail stations themselves. Instead, they find evidence that the percent of African Americans is inversely associated with rising housing prices. Thus, it is unclear how the racial demographics were directly impacted by the development of commuter rail.

Baker and Lee (2019) include racial measures as a central component of their study on gentrification and LRT in 14 urban areas in the U.S. The authors note that they do not find evidence of "prevalent gentrification" across all areas but their regression results tell a different story. They actually find that LRT stations in both San Francisco and Denver are in neighborhoods that have seen increases in wealthy educated whites. They find that results vary by city and when tracts are separated into "gentrifiable" and "non-gentrifiable" based on the income levels of the tracts at the beginning of the study year. Hess (2020) examines the changing racial ethnic composition surrounding neighborhoods near one of Seattle's LRT lines. Neighborhoods in the urban core saw an increase in non-Hispanic whites at the start of the project, while neighborhoods in the suburban periphery experienced a growth in racial minorities. This study highlights how the relationship to transportation and displacement

In a systematic review on TOD and gentrification, Paderio, Louro and da Costa (2019) argue that most studies do find some sort of evidence supporting the claim that TOD leads to gentrification but that these studies are often analytically unreliable. Zuk et al. (2018) argue that most of these studies often conflate gentrification and displacement and that this definitional problem is impacting the way scholars are interpreting the results. The authors also highlight the temporal issue in many of these studies. They argue, "Quantitative studies have systematically failed to characterize the various stages of gentrification that a neighborhood may be experiencing, choosing instead to categorize gentrification as a static outcome. The dichotomy also leaves out the potential for gentrification related displacement to precede gentrification, especially when property owners attempt to vacate unites in anticipation of rising rents and neighborhood change" (p. 37).

In summary, scholars have not adequately explored the underlying processes of gentrification and displacement, the relationship of each of these to the racial formation of space, or acknowledged the importance of transportation type. Many of the studies that examine rail-induced transit lump together LRT and commuter rail, and sometimes even subway systems. This could be an important distinction because LRT typically consists of routes with medium capacity with more frequent stops that are closer together, whereas commuter rail typically moves rides from the suburbs to the inner-city. Given the prior discussion on racial banishment and racial capitalism, and the historical racial segregation of the suburbs from the urban core, failing to account for differences in these two types of rail systems may lead to misleading results.

Furthermore, Paderio, Louro, and da Costa (2019) argue that the variability in findings may also be contributed to the importance of local contexts and policies that influence gentrification. Policies on residential and commercial zoning, rent control, public housing development, etc. all impact the conditions that lead to gentrification and usually are all determined by city level decision makers, and sometimes by state level decision makers. Thus, varying results simply speak to the dynamic nature of cities and their ability to encourage or prevent gentrification and displacement. Nonetheless, differing results may still be due to inconsistent study design and varying socioeconomic and housing variables used to measure gentrification.

Theoretical Synthesis

By centering both race and class in future studies on transit related gentrification and displacement, we can develop a better understanding of how public transportation can be used as

a tool to facilitate gentrification and racial displacement. Furthermore, expanding the theoretical nexus in which we position such studies can aid with variable selection, urban area selection, and even the selection of specific transit type in quantitative studies. Scholars often use evidence in one city or another as evidence for or against transit related gentrification, painting a monolithic map of urban areas when results should be discussed only at the city level given each has a unique relationship with racial capitalism and the racial formation of urban spaces. Nonetheless, these recent studies on TOD and gentrification have at least started the conversation on TOD and neighborhood restructuring, and this paper attempts to continue pushing that conversation forward.

I expand the existing theoretical nexus in which transit related gentrification studies are currently situated by moving past the conceptualization of gentrification solely in economic terms and situating the conversation within a spatial and racial intersectional framework. As a scholar of environmental justice, this goal is heavily guided by the first tenant of the critical environmental justice theoretical framework, which views social inequality and oppression as "intersecting axes of domination and control" (Pellow, 2018, p. 19). The literature in human geography reminds us that the unequal distribution of both transportation goods and transit bads across multiple, mutually reinforcing categories of difference must be understood through the historical context of structural inequalities in development and use of transit systems and the racial formation of space. Thus, exploring how TOD can facilitate economic changes and racial banishment in surrounding areas is imperative for the development of more equitable transportation systems.

DATA AND MEASURES

For the present study, I chose to examine the link between transportation and neighborhood change in cities that have developed LRT between the years 1990 and 2004. The American Public Transportation Association (APTA) define LRT as "a mode of transit service (also called, light rail streetcar, tramway trolley) operating passenger rail cars singly (or in short, usually two-car or three-car, trains (on fixed rails in right-of-way that is often separated from other traffic for part of much of the line" (APTA, 2019). It is often hard to distinguish LRT from other systems, such as trams, trolleys, or even light metro, because there is no uniform definition across cities or even across countries on what truly makes a rail system "light." Thus, I followed APTA guidelines for choosing LRT systems.[13]

Table 1 provides information on the urban areas, counties, and their respective LRT lines that are included in this study.[14] Four cities built LRT lines in the late 1980s: Buffalo, Portland, Sacramento, and San Jose. Five cities built LRT lines in the 1990s: Los Angeles, St. Louis, Denver, Dallas, and Salt Lake City. Two cities-built LRT lines in the 2000s: Houston and Minneapolis. All of these LRT systems were planned and constructed prior to 2005 and extend beyond 5 miles. I placed each city into two groups depending on the year the system was first built (see the last column, Table 1). The first group includes lines that were built between 1985

[13] Although the APTA's definition specifies that a true LRT system is "typically" electrically driven, this study excludes non-electric, or hybrid systems. The reason for excluding diesel-based LRT is because diesel-based transit releases more pollutants than electric LRT systems in the areas that they serve. Diesel-based transit is typically considered "dirty" and may not produce the same migration effects of wealthier, whiter populations that cleaner LRT systems do. LRT systems that rely on diesel instead of electric energy include the Camden- Trenton River Line in New Jersey and the Oceanside-Escondido SPRINTER Line in California. These two systems, although labeled as "light rail" by local transit authorities, do not resemble typical LRT systems. For instance, there are no overhead cables on the SPRINTER Line, which resembles more of a commuter rail system. The Camden-Trenton River Line shares rail with local freight lines.

[14] The opening dates generally reflect when the majority of the lines were first built, but some cities added stations in other years as a part of their LRT plans. I only included stations that were created before 2005 to allow for enough time to examine change. Nearly all of the lines that were built by 2005 were already planned. This an important distinction because the knowledge of a planned station or line may facilitate change before it is actually built.

and 1995, and the second includes lines that were built between 1996 and 2004. These groupings reflect the change years examined in the subsequent analysis.[15]

Table 1. LRT System Information

Urban Area	*State*	*Counties*	*First Opening*	*LRT Lines Included*	*LRT System Name*	*Change Years Examined*
Buffalo	NY	Erie	1985	Buffalo Metro Rail	Buffalo Metro Rail	1990-2018
Portland	OR	Multnomah, Washington	1986	Red, Blue, Yellow	MAX Light Rail	1990-2018
Sacramento	CA	Sacramento	1987	Blue, Gold, Green	Sacramento RT Light Rail	1990-2018
San Jose	CA	Santa Clara	1987	Blue, Green, Orange	Santa Clara VTA Light Rail	1990-2018
Los Angeles	CA	Los Angeles	1990	E Line (Expo), A Line (Blue), C Line (Green), L Line (Gold)	Los Angeles Metro Rail	1990-2018
St. Louis	MO	St. Claire, St. Louis, St. Louis City	1993	Red, Blue	MetroLink	1990-2018
Denver	CO	Douglas, Jefferson, Arapahoe, Adams, Denver	1994	C,D,E,F,H,L,R,W	RTD Light Rail	1990-2017
Dallas	TX	Collin, Dallas	1996	Blue, Red, Green, Orange	Dallas Area Rapid Transit (DART)	2000-2017
Salt Lake City	UT	Salt Lake	1999	Blue, Red	TRAX	2000-2017
Houston	TX	Harris	2004	Red	METRORail	2000-2017
Minneapolis	MN	Ramsey, Hennepin	2004	Blue	METRO	2000-2017

[15] For the cities that built systems in the late 1980s that are included in the 1990s category, and for those built in the later 1990s and included in 2000s category, I also conducted an analysis that included them in their respective decades. The results were not substantively different from the ones presented here.

Data

I use data from three sources for the present study. Location data for the LRT stations come from the General Transit Feed Specification (GFTS) system, formerly known as Google Transit Feed Specification. GTFS is a data repository of transit lines provided by transit authorities across the world (General Transit Feed Specification 2018). I collected the GTFS data for all the aforementioned cities to obtain a list of their LRT stations and each station's longitude and latitude coordinates. The demographic data at the census tract level come from two major sources: The GeoLytics Neighborhood Change Database (NCDB) and the American Community Survey (ACS). The NCDB provides historical demographic U.S. Census data using 2010 census tract boundaries, which allows for longitudinal analysis, as the boundaries of census tracts do not remain consistent over time. For this analysis, I use NCBD data from both 1990 and 2000. Demographic data for the year 2018 come from the ACS. The ACS provides pooled 5-year estimates based on a sample of the US population.[16]

Measures

Table 2. Description of Variables

Variable	*Description*	*Data Source*
Socio-Demographic Variables		
Black	Proportion Black/African American	NCDB/ ACS
Hispanic	Proportion Hispanic/Latinx	NCDB/ ACS
White	Proportion White	NCDB/ ACS
Poverty	Proportion below the federal poverty line	NCDB/ ACS
Income (log)	Average family income	NCDB/ACS
Total population (log)	Total population	NCDB/ACS

[16] Census tracts that had a population of 0-10 at the beginning year are excluded from this study. Furthermore, the analysis uses complete cases and a total number of census tracts per city can be found in Table 3.

Housing Characteristics		
Homes after 1970	Proportion of occupied housing units built after 1970	NCDB/ACS
Median Rent	Median gross rent of renter occupied housing units	NCDB/ACS
Transit Characteristics		
Transit Use	Proportion of working population who travel to work on public transportation	NCDB/ACS
Distance Variables		
Distance to the Nearest LRT Station (log)	Distance from the mean center of a census tract to the nearest light rail transit station	GTFS + Census TIGER/Line Files
Distance to the CBD (log)	Distance from the mean center of a census tract to the central business district	Census TIGER/Line Files

Table 2 provides a list of the descriptions and data sources for each variable used in this study. The main outcome variables represent the change in either sociodemographic, housing, or transit characteristics of census tracts between 2018 and either 1990 or 2000. For the first set of outcome variables, sociodemographic, I include change in proportion Black, proportion Hispanic, proportion white, proportion below the poverty level, average family income (logged), and total population (logged). For the second set of outcome variables, housing characteristics, I include proportion of homes built after 1970 and median rent. For the final set of outcome variables, I include both proportion of workers commuting to work using public transit.

These outcome variables speak to both traditional definitions of gentrification that consider it as a process of neighborhood upgrading and class changes (Smith, 1998; Kennedy & Leonard, 2001), while including racial and ethnic variables to explore potential displacement (Roy, 2017). Exploring how proximity to LRT relates to changes in income, housing age, and median rent can show LRT's potential to create material changes in neighborhoods over time and are common variables in studies on TOD and gentrification (Heilmann, 2018; Kahn, 2007; Dong,

2017). I include measures of public transit usage to explore how LRT has impacted transit travel behavior in neighborhoods. While this measures does not speak to gentrification or displacement directly, they do provide information on whether LRT is achieving one of its intended consequences of reducing automobile dependence in the city by increasing public transit ridership.

The main independent variable for this study is distance from the mean center of a census tract to the nearest LRT station. This proximity measure was created by combining data from GTFS on the location of LRT stations with census shape files in ArcMaps. Finally, distance to the central business district (CBD), along with beginning year sociodemographic and housing measures, are included as control variables for all regression analyses. Distance to the CBD speaks to research that explores how proximity to amenities increases the likelihood of gentrification (Hwang & Sampson 2014; Lin, 2002; Timberlake & Johns-Wolf, 2017; Lloyd, 2004).

RESULTS

The methods in this study reflect how I define gentrification, as an economic process related to physical material changes in neighborhoods that is both racially motivated and has the potential to displace racial minorities. Following the work of Baker and Lee (2019), one of the only studies to explicitly consider racial changes in neighborhoods surrounding LRT, I pay particular attention to how proximity to LRT has led to racial changes in each city. The results are presented and discussed at the city level to account for the fact that neighborhood change is reflective of the city level policies and history with spatial segregation and not uniform across all urban areas. Furthermore, research in urban sociology has shown that gentrification manifests differently in relation to both temporal and spatial contexts (Maciag, 2015; Solari, 2012).

I split my analysis into two sets with the first set including all census tracts and the second set only including census tracts that are eligible to gentrify and present results for both sets. I define "gentrifiable" tracts as census tracts that have an average family income below the average of the entire city at the beginning year (Freeman, 2005; Ding, Hwang, & Divringi, 2015; Gibbons & Barton, 2016). Table 3 provides a count of total census tracts and the number of gentrifiable census tracts for each city.

Table 3. Total and Gentrifiable Census Tracts

City	*Total Census Tracts*	*Number of Gentrifiable Census Tracts*
Buffalo	229	116
Portland	265	135
Sacramento	270	141
San Jose	358	135
Los Angeles	1996	1149
St. Louis	355	180
Denver	542	284
Dallas	681	324
Salt Lake City	212	112
Houston	786	452
Minneapolis	436	167

I began the analysis by examining descriptive statistics for all study variables. Table 4 provides some descriptive statistics on the characteristics of proximity to LRT stations including the number of LRT stations, the mean distance to LRT, and the percent of census tracts within a ½ mile and 1-mile radius of an LRT station. These descriptive statistics demonstrate how widespread LRT systems are across the city, which is important for assessing how LRT may

influence neighborhood change. For the study period, Portland, San Jose, and Los Angeles have the highest number of LRT stops at 64, 60, and 55, respectively. Buffalo has the least number of stops (14), followed by Houston (17). San Jose has the highest percentage of census tracts that are within half a mile and one mile of an LRT station, and this percentage almost doubles for gentrifiable tracts. In general, gentrifiable tracts are closer to LRT stations in comparison to all tracts, but there are only marginal increases in Buffalo and St. Louis. The mean distance to LRT is lowest in Portland, followed by San Jose and Salt Lake City. The mean distance to LRT is highest in Houston and Los Angeles.

Table 4. Light Rail Transit Descriptive Statistics

		All Census Tracts			*Gentrifiable Tracts*		
City	*# of LRT Stations*	*Mean Distance to LRT (in Miles)*	*% of census tracts within ½ mile of LRT*	*% of census tracts within 1 mile of LRT*	*Mean Distance to LRT (in Miles)*	*% of census tracts within ½ mile of LRT*	*% of census tracts within 1 mile of LRT*
Buffalo	14	6.22	5.2%	13.8%	4.51	6.1%	19.0%
Portland	64	2.52	11.1%	31.7%	1.78	15.6%	43.7%
Sacramento	46	3.29	11.7%	23.4%	2.57	15.6%	33.3%
San Jose	60	2.81	12.1%	29.1%	2.03	23.7%	59.3%
Los Angeles	55	7.78	3.7%	11.0%	5.12	6.4%	16.8%
St. Louis	38	4.18	5.3%	12.2%	2.44	6.7%	21.1%
Denver	38	5.39	3.9%	12.5%	4.88	6.7%	17.2%
Dallas	35	5.36	3.2%	13..1%	4.58	4.63%	18.8%
Salt Lake City	25	3.32	7.6%	18.9%	2.87	7.1%	16.1%
Houston	17	10.76	1.3%	3.6%	8.87	1.4%	6.1%
Minneapolis	21	6.04	2.76%	8.49%	4.18	1.61%	5.05%

Regression Analysis

Next, I apply Bayesian hierarchical varying-intercept and varying-slope regression to each of the dependent variables to the primary explanatory variable, distance to the nearest LRT station, controlling for beginning year characteristics. The hierarchal structure of the regression model, which nests census tracts into each respective city, reflects the fact that transit related gentrification and displacement is likely to vary across cities. The general formula for the model is as follows:

$$(1)\ Y_{ij} \sim \alpha_i + \beta_{ij}X_j + \varepsilon$$

$$Where:$$

$$(2)\alpha_i \sim \alpha_0 + N(0, \delta_\alpha),$$

$$(3)\beta_{ij} \sim \beta_{oj} + N\left(0, \delta_j\right)$$

Y represents the response variable (represented in change years) for census track j in city i, $\beta_{ij}X_j$ represents the observed explanatory variables, and ε represents the noise term. $N(0, \delta_\alpha)$ represents the city level fixed effect and $\delta_j = 0$ for every explanatory variable aside from miles. The regression analysis follows the work of basic textbooks on hierarchical models in a Bayesian setting (Gelman & Hill 2007; Gelman, Carlin et al., 2013). I estimate all models using the stan_lmer() function in the rstanarm package which allows applied regression models to be estimated using Markov Chain Monte Carlo (MCMC) methods.

I sampled four Markov chains for 1000 iterations each, including 1000 warm-up iterations, for a total of 4,000 samples for each model. All regression coefficients are standardized for ease of interpretation as the variables natural scales vary (Gelman & Hill, 2007). The means and medians of the posterior distributions were relatively equal and all R-hat values were less than 1.1 (Gelman & Rubin, 1992). I evaluated each of the models using trace plots that

provide information on the sequential draws from the posterior distribution to confirm that the chains in each plot were generally stable and that the chains overlap around the same value. I also examined the posterior predictive checks to evaluate the relationship between the observed data and the simulations from the posterior predictive distribution. [17][18]

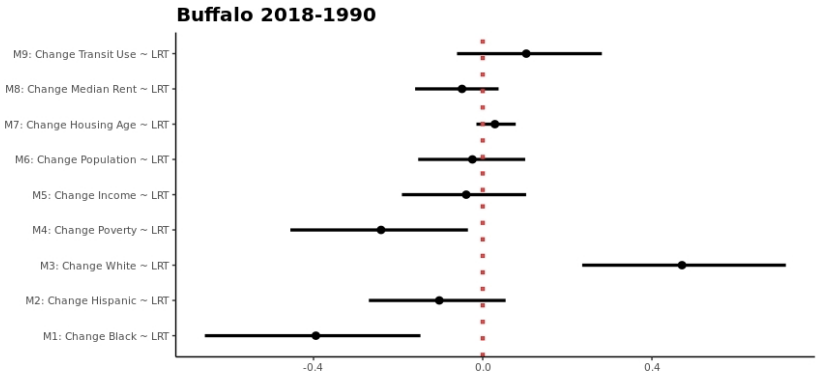
Regression Set 1 Results (All Tracts)

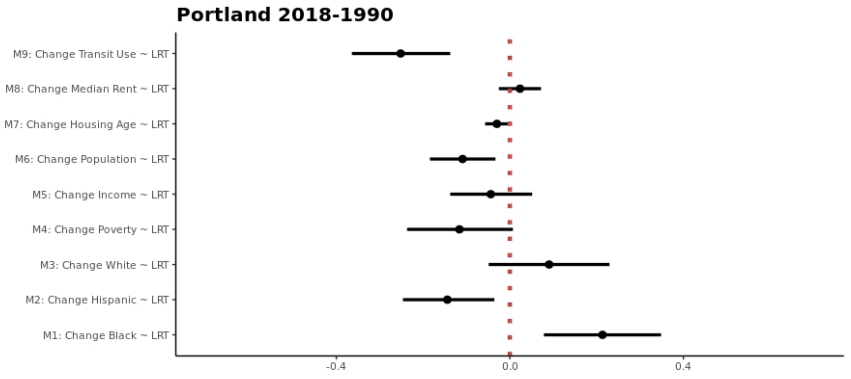
The results from the multilevel varying slope and varying intercept regression analyses are presented in the following plots for all census tracts in each city. The plot points represent the standardized Bayesian point estimate, which in this case is the mean of the posterior distribution (similar to a maximum likelihood estimate from a frequentist approach). The lines on the outside of each estimate represent the 95% uncertainty intervals computed from the posterior draws. Estimates with intervals that do not cross zero indicate a meaningful relationship. Since these are change models, and distance is an increasing measure, the directionality of these models can be difficult to interpret. A positive point estimate indicates that as distance to LRT increases there is an increase in the dependent variable between the two years, whereas negative point estimate indicates that as distance to LRT decreases, the dependent variable between the two years decreases.

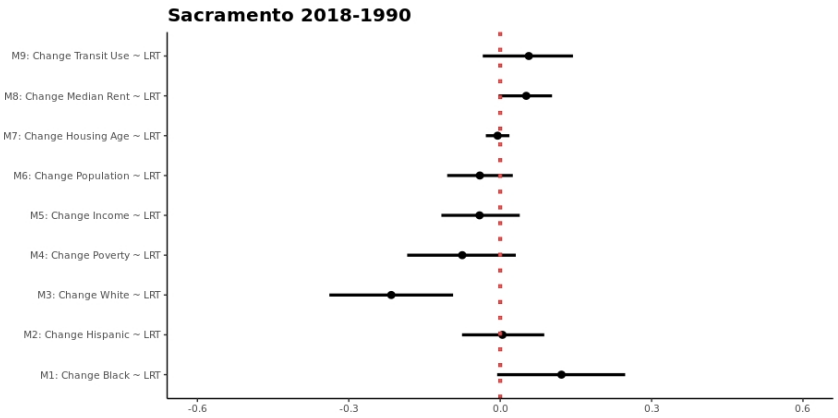
[17] I also estimated each hierarchical model with a frequentist approach using the lme4 package in R. The results were not substantively different from the Bayesian hierarchical models presented here.

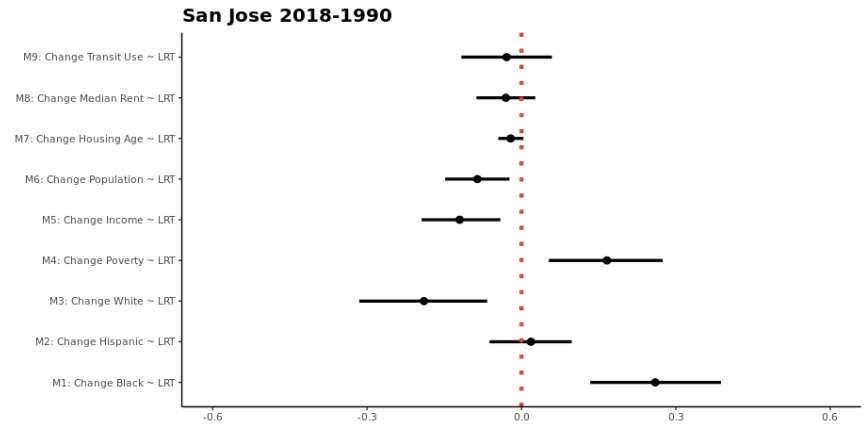
[18] It is important to note that some of the models did have divergent transitions. However, no model had more than four divergent transitions, with many only having 1-2.

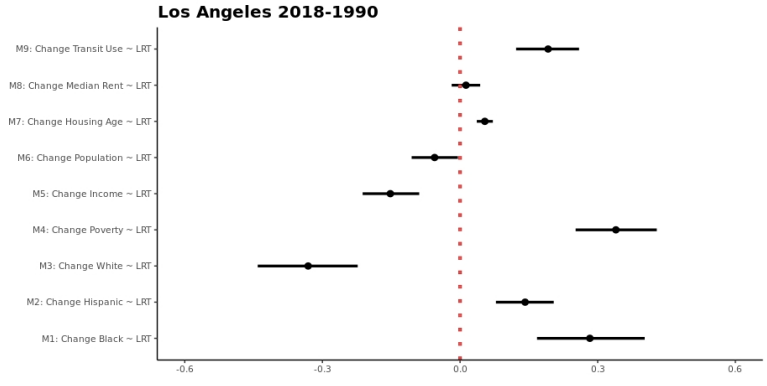
Figures 1-7: Regression Results for the 1990 Set (All Tracts)

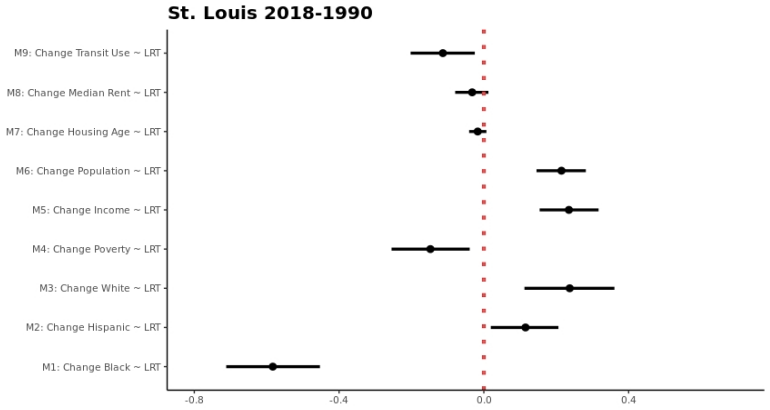


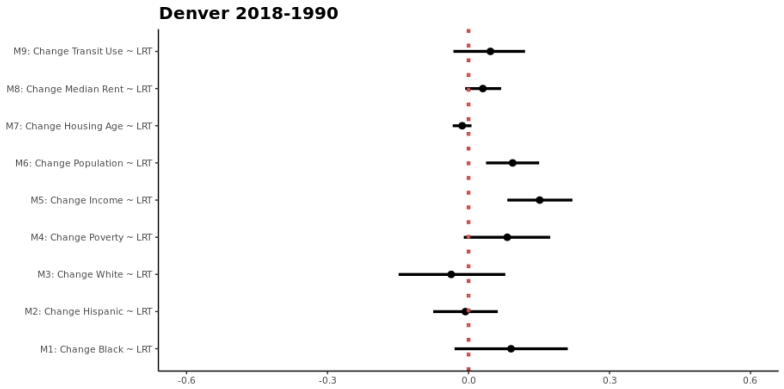







Los Angeles 2018-1990
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.6
-0.3
0.0
0.3
0.6


St. Louis 2018-1990
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.8
-0.4
0.0
0.4


Denver 2018-1990
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.6
-0.3
0.0
0.3
0.6

I will begin by discussing the results for the 1990 set. The results for Buffalo reveal meaningful relationships between distance to light rail and change in white, change in Black, and change in poverty, with only the latter two showing a negative association. A standard deviation increase in distance to LRT corresponds to a .4 standard deviation decrease in change in proportion Black and a .2 standard deviation decrease in change in proportion below the poverty level. A standard deviation increase in distance to LRT corresponds to a .5 standard deviation increase in change in proportion white. Put in a more intuitive way, the results demonstrate that between the year 1990 and 2018, areas closer to LRT in Buffalo see increases in Black and poor populations and a declining white population.

In Portland, the results show meaningful relationships between distance to LRT and the change in transit usage, proportion Black, and proportion Hispanic. A standard deviation increase in distance to LRT is associated with a .2 standard deviation decrease in change in transit usage and a .1 standard deviation decrease in change in proportion Hispanic. However, a standard deviation increase in distance to LRT is associated with a .2 standard deviation increase in the proportion Black. Thus, areas closer to LRT see a decrease in the Black population, an increase in transit ridership and an increase in the Hispanic population over time. Only one meaningful relationship is noted in Sacramento. A one standard deviation increase in distance to LRT is associated with a .2 standard deviation decrease in change in proportion white. Thus, in Sacramento, the proportion white has increased in areas closer to LRT.

The results for San Jose reveal meaningful relationships between distance to LRT, change in proportion below the poverty level, change in proportion white, change in proportion Black, and change in income. A standard deviation increase in distance to LRT is associated with

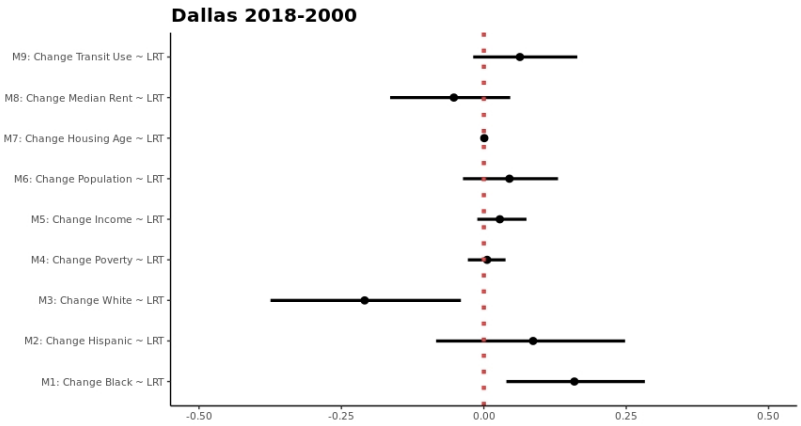
a .2 standard deviation decrease in proportion below the poverty level, a .28 standard deviation decrease in change in proportion Black, and a .2 standard deviation increase in change in proportion white, and a .1 standard deviation increase in change in income. Thus, areas closer to LRT are associated with increases in income and white populations, and diminishing Black and poor populations in San Jose.

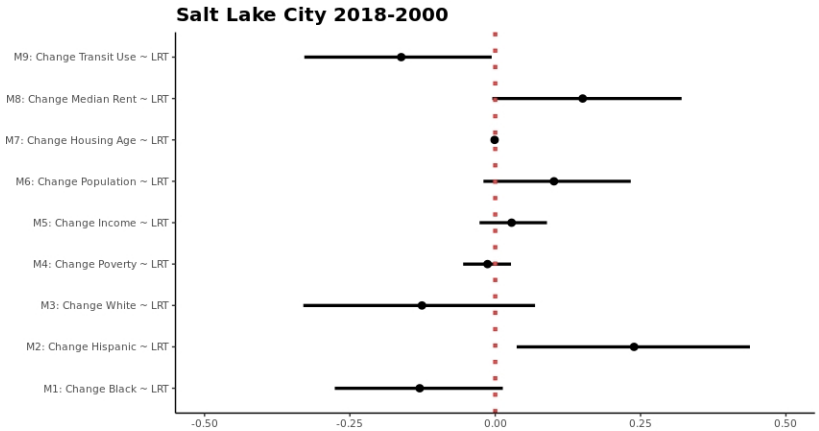
There are meaningful relationships in Los Angeles between distance to LRT and change in transit use, change in proportion below the poverty level, change in income, change in white, change in Hispanic, and change in Black. A standard deviation increase in distance to LRT is associated with a .2 standard deviation decrease in change in transit usage, a .32 standard deviation decrease in change in proportion in poverty, a .2 standard deviation decrease in change in proportion Hispanic, and a .3 standard deviation decrease in change in proportion Black. However, a standard deviation increase in distance to LRT is associated with a .3 standard deviation decrease in change in proportion white and change in income. Thus, in Los Angeles, areas closer to LRT have seen an increase in white populations and income, and subsequently a decrease in impoverished residents, as well as Blacks and Hispanics. Furthermore, increases in transit usage are higher in areas further from LRT.

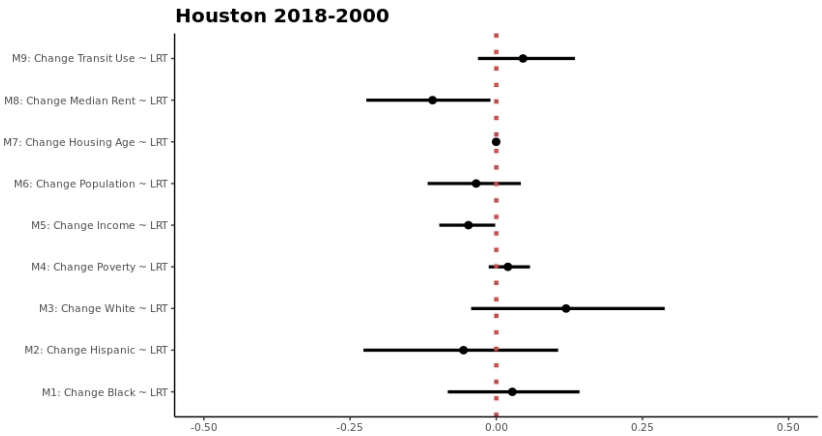
The results from St. Louis include meaningful relationships between distance to LRT and change in income, change in proportion white, change in proportion Black, change in proportion below the poverty level, and change in proportion Hispanic. However, the latter two variables show very small effect sizes that are approaching zero. A standard deviation increase in distance to LRT is associated with a .3 standard deviation decrease in both change in income and change in proportion white, a .12 standard deviation decrease in change in proportion Hispanic, a .1 standard deviation increase in change in poverty, and a .6 standard deviation decrease in change

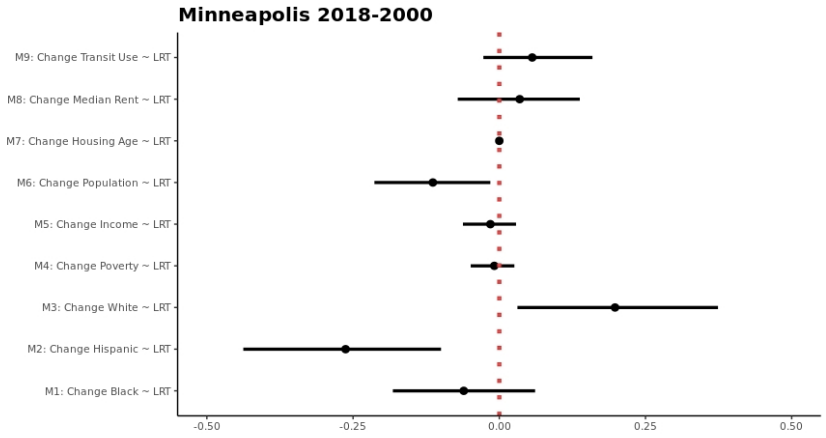
in proportion Black. In St. Louis areas closer to LRT are associated with increasing Black and poor populations. For Denver, the only meaningful relationships are between distance to LRT and change in total population and change in income. A standard deviation increase in distance to LRT is associated with a .1 standard deviation increase in population and a .2 standard deviation increase in income.

Figures 8-12: Regression Results for the 2000 Set (All Tracts)





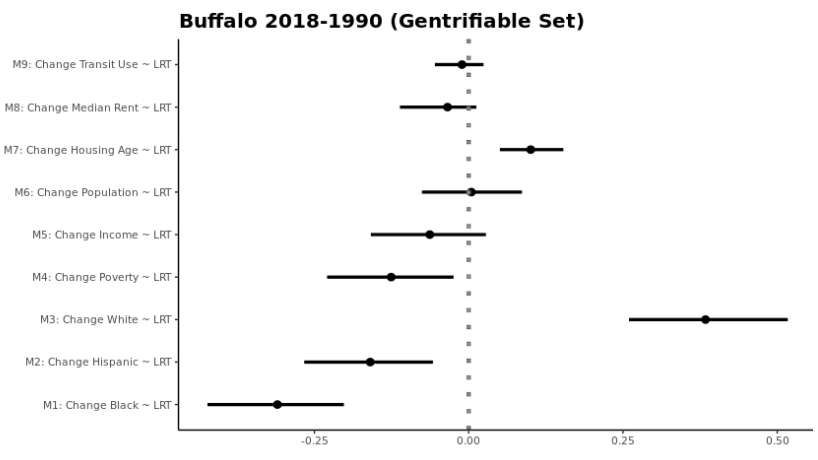


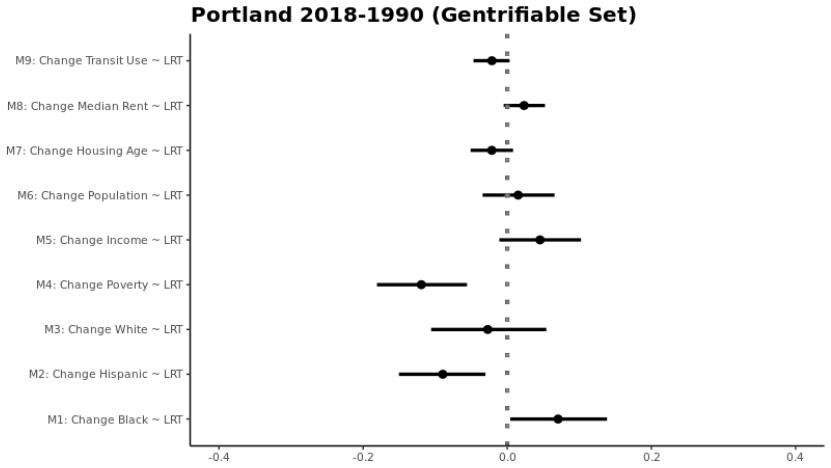


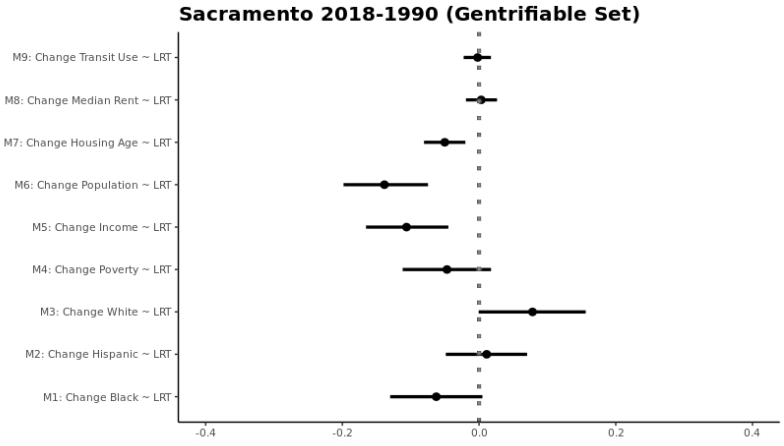
Now I will discuss the results from the cities in the 2000 set. In Dallas, there are only meaningful relationships between distance to LRT and change in proportion white and change in proportion Black. A standard deviation increase in distance to LRT is associated with a .24 standard deviation decrease in change in proportion white and a .15 standard deviation increase in change in proportion Black. Put another way, these results show that areas closer to LRT are associated with a decreasing Black population and an increasing white population. There is only one meaningful relationship found in Salt Lake City: a standard deviation increase in distance to LRT is associated with a .25 standard deviation increase in the change in proportion Hispanic. No meaningful relationships were found in Houston. In Minneapolis, the results indicate that a standard deviation increase in distance to LRT is associated with a .25 standard deviation increase in proportion white and a .25 standard deviation decrease in proportion Hispanic. Areas closer to LRT in Minneapolis are associated with a decreasing white population and an increasing Hispanic population.

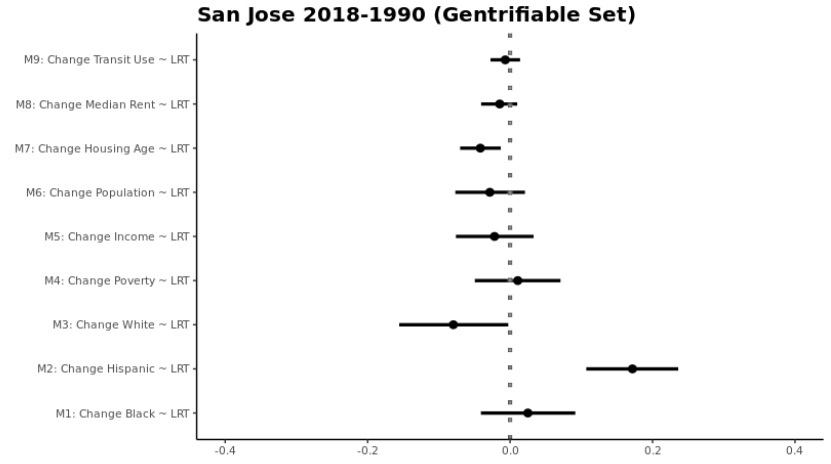
Regression Set 2 Results (Gentrifiable Tracts)

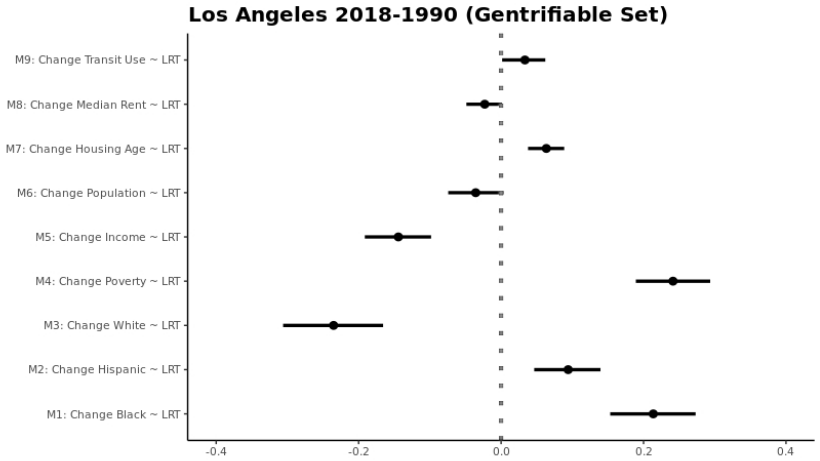
Figures 13-19: Regression Results for the 1990 Set (Gentrifiable Tracts)

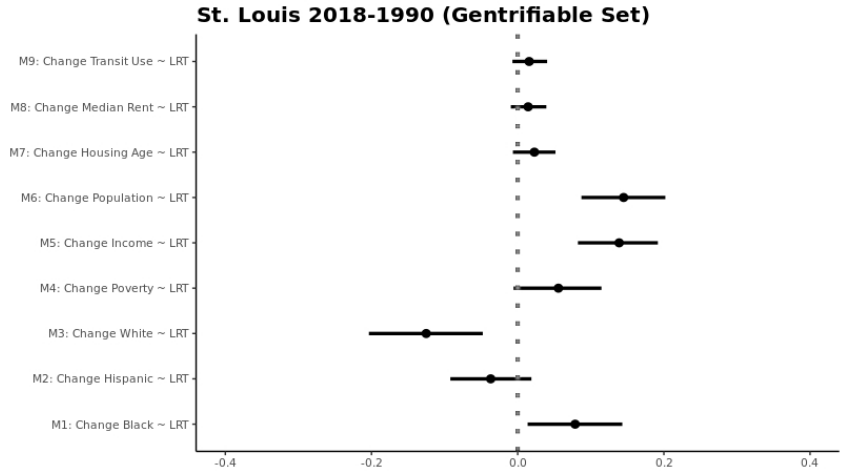


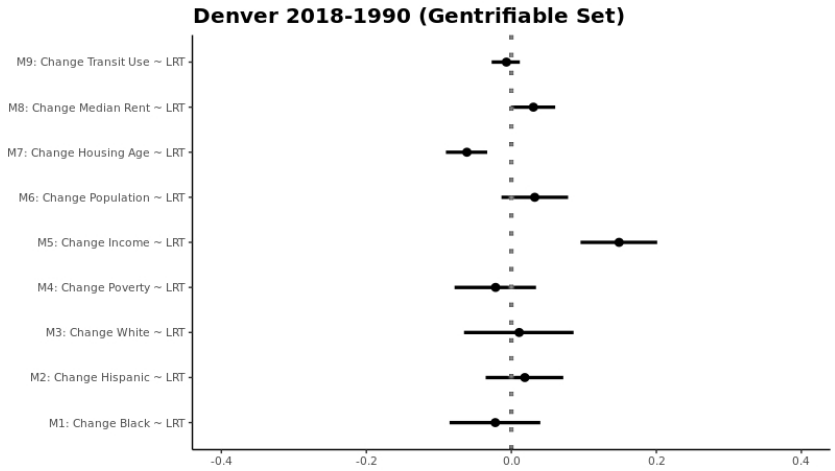







Los Angeles 2018-1990 (Gentrifiable Set)
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.4
-0.2
0.0
0.2
0.4

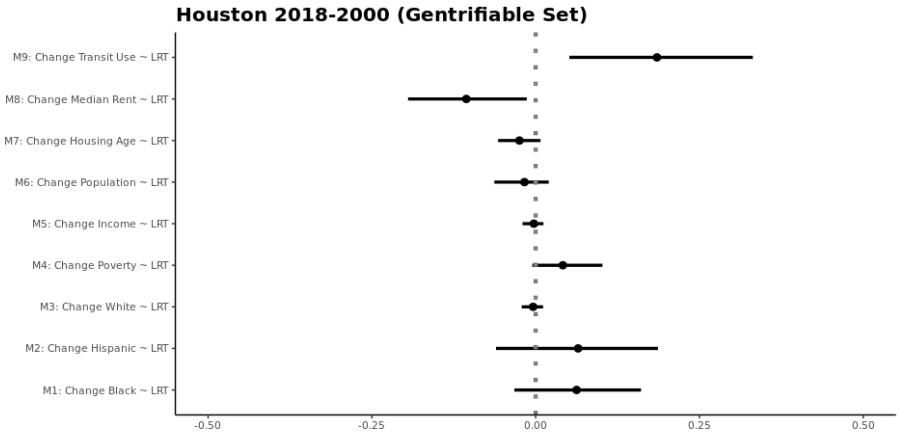

St. Louis 2018-1990 (Gentrifiable Set)
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.4
-0.2
0.0
0.2
0.4

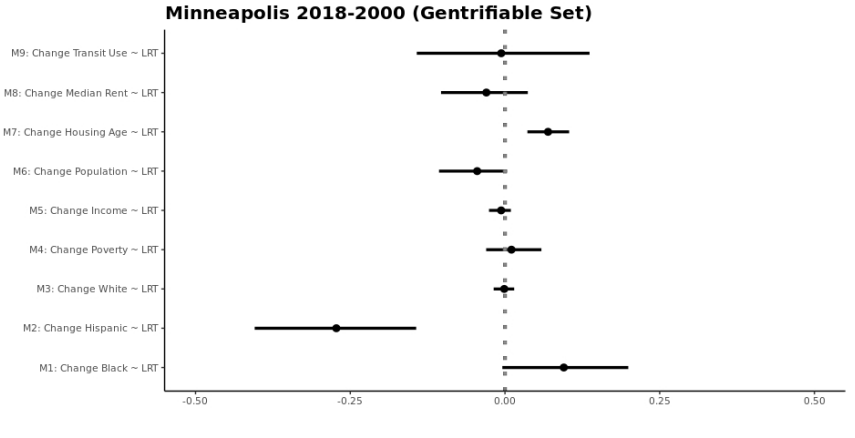

Denver 2018-1990 (Gentrifiable Set)
M9: Change Transit Use ~ LRT
M8: Change Median Rent ~ LRT
M7: Change Housing Age ~ LRT
M6: Change Population ~ LRT
M5: Change Income ~ LRT
M4: Change Poverty ~ LRT
M3: Change White ~ LRT
M2: Change Hispanic ~ LRT
M1: Change Black ~ LRT
-0.4
-0.2
0.0
0.2
0.4

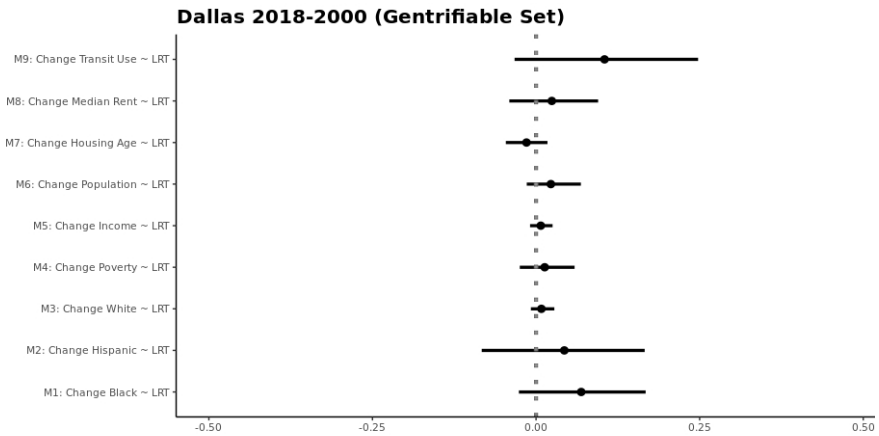
For Portland, the same relationships were found with distance to LRT and change in proportion Hispanic, but the negative relationship between distance and change in proportion Black and the positive relationship between distance and change in transit use is not present in the gentrifiable set. In Sacramento, the relationship between distance to LRT and change in proportion white is not present in the gentrifiable set. However, for census tracts that were below the average income in 1990, a standard deviation increase in distance to LRT is associated with a .18 standard deviation decrease in change in total population and a .17 standard decrease in change in income. For gentrifiable tracts in San Jose, the only meaningful relationship is between distance to LRT and change in proportion Hispanic, with the same directionality as the results in the full set.

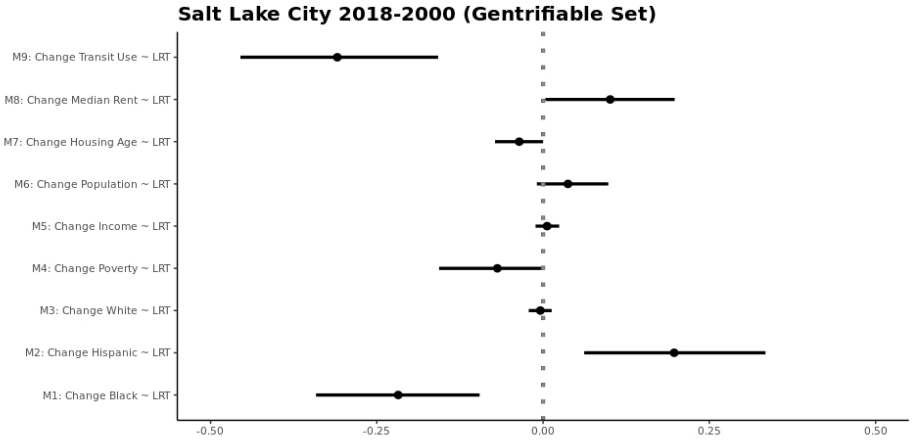
In St. Louis, the results for the gentrifiable set are fairly different from the results in the full set. The results indicate that a standard deviation change in distance to LRT is associated with a .1 standard deviation decrease in change in proportion white, a .1 decrease in change in income, and a .08 decrease in change in proportion Black. When comparing these results to the full set, the directionality switches for both change in proportion Black and change in proportion white. In Denver, the results are similar to the results for the full set, but also indicate that a standard deviation increase in distance to LRT is associated with a .1 standard deviation decrease in the proportion of homes that were built prior to 1970.

Figures 20-23: Regression Results for the 2000 Set (Gentrifiable Tracts)









For the 2000 set of models, there were no meaningful relationships found in Dallas for the gentrifiable set. In the gentrifiable set for Salt Lake City, the same relationship between distance to LRT and change in proportion Hispanic is present, but the results also indicate that a standard deviation increase in distance to LRT is also associated with a .24 standard deviation decrease in change in proportion Black and a .26 standard deviation decrease in change in transit usage. For Houston, the only meaningful relationship indicates that a one standard deviation increase in distance to LRT is associated with a .25 standard deviation increase in transit usage. In Minneapolis, the relationship between distance to LRT and change in proportion Hispanic remains the same as in the full set, but the results from the gentrifiable set indicate that a standard deviation increase in distance to LRT is associated with a .1 standard deviation decrease in the change in proportion of homes that were built prior to 1970.

DISCUSSION

I only find some evidence that the development of LRT changes the economic composition of the surrounding areas. For example, in the full set, the results indicate that income has increased in areas closer to LRT stations in San Jose. Poverty has increased in areas farther from LRT in San Jose for the full set and in Los Angeles for both sets. These finding support other studies that find evidence of rising incomes in areas with access to LRT compared to those without (Kahn, 2007; Heilmann, 2018; Baker and Lee, 2019). Surprisingly, I do not find any evidence that the development of LRT leads to meaningful changes in rent prices is any of the models. However, for Denver and St. Louis, incomes are actually growing faster in areas that are farther from LRT. Similarly, for Buffalo, poverty is growing in areas closer to LRT. This confirms research by Hess and Almeida (2006) who found that in some areas in Buffalo, housing prices actually depreciated

closer to LRT lines. The results for Buffalo also highlight that patterns of decline that have been documented in many rust-belt cities. Buffalo has experienced population decline, entrenched poverty, and increasing housing vacancy for a number of decades (Silverman & Patterson, 2015).

There were very few cities that showed meaningful relationships with housing age and distance to LRT. For Buffalo and Minneapolis, there is evidence that the construction of new homes is growing in areas that are located farther from LRT stations. However, the results for Denver for the gentrifiable tracts do indicate that proximity to LRT is associated with newer housing stock. Thus, the findings in this study on whether LRT station influence new developments in surrounding areas is mixed (Heilmann, 2018; Kahn, 2007; Dong, 2017).

A number of studies have used null results between distance to LRT and economic characteristics of neighborhoods, such as income, to argue that LRT has a marginal impact on neighborhood change (Kahn, 2007; Dong, 2017). However, the majority of these studies have failed to explore the changing racial demographics surrounding LRT. I argue that the most interesting findings in the present research are the connection between declining racial minority populations in neighborhoods with LRT either in combination with, or absent of, changes in income or poverty. For example, in Portland there is evidence that proportion Black has decreased surrounding LRT. I also found this same relationship in San Jose, Los Angeles, and Dallas. In San Jose and Los Angeles, there also evidence that the highest growth in proportion Hispanic is taking place in areas that are farther from LRT.

CONCLUSION

The goal of this study was twofold. First, I sought to explore the relationship between TOD development and traditional measures of economic and material neighborhood change (Kennedy

& Leonard, 2001; Brown-Saracino, 2017). As such, I included change in median income, change in houses build before 1970, and median rent to explore how LRT impacts the physical restructuring of cities and the growth of higher income residents in the inner city. Second, I sought to explore how TOD development impacts the racial and ethnic composition of neighborhoods over time. The purpose of this goal was to explore how LRT can influence patterns of racial banishment in the age of the neoliberal city (Roy, 2017; McElroy & Werth, 2019). To achieve these goals, I used Bayesian hierarchal modeling to assess how neighborhoods with LRT have changed between 2018 and when LRT systems were built, for all census tracts and ones that were deemed "gentrifiable" following the work of quantitative scholars of gentrification in urban sociology (Freeman, 2005; Walks & Maaraen 2008; Gibbons & Barton, 2016).

While the results do provide some evidence that LRT changes the material conditions of neighborhoods in terms of income and housing age, the evidence suggests that LRT has a larger impact on the racial composition of neighborhoods. Thus, it is important that we ask, *why are racial minorities disappearing closer to LRT stations in Portland, San Jose, Los Angeles, and Dallas?* Taken together, these results provide evidence for theories of racial banishment in the inner city (Roy, 2017). Roy (2019) argues that "Banishment is entangled with processes of regulation, segregation and expropriation and it is embedded in the legal geographies of settler-colonialism and racial separation. Banishment shifts our attention from displacement to dispossession, especially the dispossession of personhood which underpins racial capitalism" (p. 227).

The racial changes surrounding LRT stations are better understood through the lens of *dispossession* as opposed to *displacement*. Quantitative studies using census data cannot truly

measure the movement of racial minorities and the poor out of the city. They can only examine larger changes in the composition of these populations in urban areas. The term "displacement" fails to speak to the annihilation of Black geographies and the destruction of the history and culture of these populations in the inner city (McKittrick, 2011; Roy, 2017; Roy, 2019). However, the term "dispossession" speaks to the process by which racial minorities have lost possession of the city and the amenities that come with it. Roy (2019) argues that the necessary counterpart of racial banishment is "the possessive investment in whiteness" (Lipsitz 1998).

In the context of this study, it is clear that racial minorities are losing access to areas with TOD and also to the benefit that LRT provides in the form of cleaner, faster, and more efficient public transportation. In cities where the white population is growing surrounding LRT but the population of racial minorities is declining, investment in better transit is linked to investment in whiteness and disinvestment of communities of racial minorities. Ironically, there is a lack of evidence demonstrating that LRT development has increased transit ridership nationally and the results for Los Angeles and Houston confirm this finding. Public transportation has historically been linked to minority populations and research has shown that minorities still make up a large portion of riders (Pew Research Center 2016; Bullard, 2007; Bullard & Johnson, 1997; Bullard et al. 2004).

However, minority populations have largely felt left out in the development of transportation plans that focus on increasing ridership for non-discretionary riders. Although it is important to convince non-discretionary riders to make the switch to public transportation to fight climate change on a local level, doing so requires not only providing efficient options but also changing the dominant cultural paradigm that links public transportation to poverty and Blackness. White supremacy has permeated the way that we view transit objects, which has

long-lasting consequences for the environment and the public health of the inner-city. Ironically, if the growing number of inner-city white residents continue to promote a culture of automobility instead of using and expanding public transportation, they will face the consequences of poor air quality that minority residents have long faced (McKane et al., 2018). This speaks to the work of Metzel (2019) on how white supremacy is actually detrimental to the health of white populations.

Finally, the racial changes surrounding LRT in urban areas confirm the suspicions of minority populations who challenged large scale transit plans in Nashville and the extension of LRT lines in Maryland. Combined with the crisis of housing affordability that is plaguing urban areas, it is clear as to why minority groups might push for expanded access to bus transportation as opposed to LRT to make the inner-city less appealing for suburban whites. In order to truly construct transit regimes that are equitable, transit plans must address the dispossession that communities of BIPOC and the poor are facing in an urban system that is designed to benefit large scale developers instead of those who rely on the amenities provided by the central city.

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Chapter IV

Losing Mobility: The Inversion of Urban Segregation and Racialized Transit Accessibility

INTRODUCTION

In a global context, the U.S. mass transit system has long been considered a failure. In most urban areas, and especially for wealthier, white residents, public transportation is certainly not the preferred method for mobility. U.S. transit has long been centered around a culture of automobility that prioritizes funding for interstate and highway systems over developing a well-connected mass transit network (Bullard, 2007; Bullard & Johnson, 1997; Bullard et al., 2004). Yet, access to public transportation is imperative for the mobility of minority residents. A 2016 study of public transit ridership in urban areas found that 34% of Blacks and 27% of Hispanics reported daily or weekly use of public transit, compared to 14% for whites (Pew Research Center, 2016). The same study found that 38% percent of immigrants use public transportation on a regular basis compared to 18% of non-immigrants. Likewise, among Americans overall, Black, Hispanic, and foreign-born Americans are less likely to own automobiles and more likely to commute to work on public transportation (DOT, 2010).

Although the culture of secessionist automobility and the development of the suburbs led to stagnant development in mass transit networks, city centers have generally been more walkable, affordable, and served by bus transit (Henderson, 2006). Bus systems have historically been stigmatized, but they still provided an important service for inner-city residents who lack access to private automobiles. Access to frequent transit networks also means control over one's own mobility (Massey, 1991; Kaufman, Berhman & Joye, 2004). Transit-related exclusion

prevents people from participating in social life (Kenyon, Rafferty, & Lyons, 2003; Kenyon, 2003). Without access to frequent transit networks, transit-dependent populations face spatial immobility and cycles of unemployment and poverty (Lucas, 2012; Sanchez et. al, 2004).

However, scholars in the last two decades have noted a shift in the demographics of many suburban populations in major urban areas. Research has shown a massive growth in the number of low-income individuals and families in suburbs, suggesting trends towards the suburbanization of poverty (Berube & Kneebone, 2006; Cooke & Marchant, 2006; Kneebone & Berube, 2013). This trend has been linked to a number of factors including the financial devastation caused by Great Recession for suburban residents, the movement of wealthier whites back to the city, and movement of racial minorities from the inner-city (Kneebone & Berube, 2013).

The suburbanization of poverty has vast implications for transportation accessibility. Poverty programs, such as mass public transportation networks that were built to accommodate dense urban neighborhoods, transplant poorly onto areas with suburban sprawl. There are few cities that have extensive public transit systems that move riders into the inner and outer ring suburbs that were designed to accommodate automobiles. This leads to a spatial mismatch between the supply and demand of public transportation because transit dependent populations lose accessibility when they lose their right to emplacement in the inner-city. More recent research on transit "deserts" explores this spatial mismatch by assessing the gap in the supply and demand of transportation (Allen, 2017; Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013).

Research on transit accessibility and more recent work on transit "deserts" often fails to account for how historic patterns of spatial segregation, and the more recent inversion of these patterns, impact transit accessibility. However, scholars have noted that gentrification and

rampant urban development is leading to the racial banishment of people of color, particularly Black residents, from city centers (Roy, 2017; Roy, 2019; McKittrick, 2011). As such, the present study intends to expand the current literature on public transit inaccessibility by exploring the changing racial demographics in areas that are poorly served by public transportation. Thus, the main research question addressed in this study is: *Has the demographic makeup of public transit deserts changed to reflect the process of minority suburbanization, thus changing the historic demographic makeup of public transit inaccessibility itself?*

In addition to providing a descriptive and spatial overview of transit inaccessibility in five urban areas, this article applies Bayesian logistic regression to examine the current demographic makeup of areas that are poorly served by public transit and how these patterns have changed between 2018 and 2010. The first section of this paper links theories of urban segregation and the changing nature of suburban areas to research on transit accessibility. The next section presents the data and analytic strategy, followed by a discussion of the results. I conclude this chapter by discussing the implications for ignoring the racial dimensions of transit inaccessibility and providing suggestions for future research.

BACKGROUND AND THEORY

To situate this research, I draw on studies that highlight the history of racial segregation and spatial mobility, the suburbanization of poverty, and transportation accessibility in urban space. Research in urban sociology has long examined the racial formation of space and patterns of racial segregation in the city (Massey & Denton 1993; Jargowsky, 1997; Cutler & Glaeser, 1999; Rugh & Massey, 2010). This research documents the discrimination of racial minorities and the poor during the time of suburban development and how these populations were systematically

kept in an economically declining inner-city through racist policies and practices of developers and policy makers (Been, Ellen & Madar, 2009; Squires, Hyra, & Renner, 2009; Rugh & Massey, 2010; Baker, 2014; Jackson, 1985). Research on the suburbanization of poverty demonstrates how the demographics of urban areas are shifting despite the longstanding processes that have kept Black populations and the poor out of the suburbs (Berube & Kneebone, 2006; Cooke & Marchant, 2006; Kneebone & Berube, 2013).

Scholarship on transit accessibility explores the role that transit plays in facilitating mobility and the social and economic benefits that mobility creates for residents (Kenyon, 2003; Levitas et al., 2007). There is also a growing literature on transit "deserts" that highlights the spatial mismatch between transit dependent populations and access to transportation (Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013). This literature links the concept of transit accessibility to the history of automobility and the creation of suburbia (Allen, 2017). In this section, I link draw linkages between the racial formation of space and transit accessibility to demonstrate the importance of redefining inaccessibility as a product of the banishment of racial minorities and the poor from urban areas (Roy, 2017; Roy, 2019).

The Racial Formation of Space and Mobility in the City

Squires and Kubrin (2006 & 2005) identify sprawl, concentrated poverty, and segregation as the predominant social forces shaping the relationship between place and a formative element of urban identity, race. Wilson (1987) famously linked social isolation, a state in which "contact between groups of different class and/or racial backgrounds is either lacking or has become increasingly intermittent," to the development of suburbia and the subsequent disinvestment of urban areas during the post-Civil Rights era. Although the 1960s led to the end of de jure segregation associated with the Jim Crow era in American cities, federal transportation and

housing policies led to de facto segregation by subsidizing the white middle-class exodus to suburbia and the subsequent disinvestment in the majority minority inner-city. Thus, as capital flowed into the suburbs, deindustrializing central city neighborhoods saw a rise in neighborhood poverty and infrastructure decline. Mirroring the process that Drake and Clayton (1945) examined, in which racist policies that kept Blacks out of white ethnic neighborhoods in the 1940s, Blacks were kept out of white suburban areas through discriminatory housing and credit policies such as redlining (Massey & Denton, 1993).

In one of the earliest sociological studies exploring the plight of the Black population in the 7th ward of Philadelphia in 1899, DuBois explicitly details the linkage between affordable housing and social mobility: "Whoever wishes to live in the centre of Negro population, near the great churches and near work, must pay high rent for a decent house… If a number of Negroes settle together, the real estate agents dump undesirable elements among them, which some enthusiastic association has driven from the slums" (1899, p. 194). DuBois was one of the first sociologists to explore the social implications of the commodification of housing in a system of racial capitalism. While many urban sociologists and theorists have studied housing peripherally, there has never truly been a sociology of housing (Pattillo, 2013).

Numerous studies have demonstrated how social inequality plays out in the housing market through discriminatory practices in housing finance since the creation of the modern mortgage system in response to the Great Depression (Stuart, 2003). The federal government created a rating system for housing appraisal that is plagued with anti-urban and racial biases (Jackson, 1985; Gotham, 2002). Jackson's (1985) study on Lincoln Terrace in St. Louis, a neighborhood originally marketed to middle-class whites, demonstrates the overt bias in rating systems. After racial minorities moved into the neighborhood, officials from the Home Owners'

Loan Corporation stated that the neighborhood held "little to no value today, having suffered a tremendous decline in values due to the colored element now controlling the district" (p. 200). Similarly, Massey and Denton (1993) found that working class European immigrants also received discriminatory appraisal of their properties.

Although inner-city minority residents experienced a lack of access to credit for housing during the creation of suburbia, the housing crisis of 2008 demonstrated how predatory lending also reinforced existing systems of social inequality. In the 1990s there was an increase in subprime mortgage lending among racial minorities (Been, Ellen & Madar, 2009; Squires, Hyra, & Renner, 2009; Rugh & Massey, 2010; Baker, 2014). After controlling for a number of socioeconomic factors, Hyra et. al (2013) found that Black/white segregation was a significant predictor of the proportion of subprime loans in metropolitan areas. Discriminatory housing policies, combined with the unaffordability of the inner-city, are leading to shifting patterns of low-income and racial minorities in urban areas.

Shift in the Suburbs

Social scientists and policymakers have long documented the shifting spatial distribution of poverty in the U.S. and explored why increasing numbers of low-income individuals and families live in suburbs (Berube & Kneebone, 2006; Cooke & Marchant, 2006; Kneebone & Berube, 2013). In 2015, there were 16 million poor people in the suburbs, outnumbering those in cities by more than 3 million (Kneebone, 2017). In the suburbs of the largest metro areas, this represented an increase of 57% between 2000 and 2015 (Kneebone, 2017). The suburbanization of poverty is likely caused by a confluence of factors, including the movement of the poor from the inner cities, increasing poverty among suburban residents following the Great Recession, and the relocation of affluent households to the urban core (Kneebone & Berube, 2013).

Most research has focused on factors driving the poor from central cities, and analyses suggest employment decentralization, high rent in the city, and the supply of suburban affordable housing are major forces (Raphael & Stoll, 2010; Howell & Timberlake, 2016). Critical perspectives on the suburbanization of poverty narrative call for examining unique variation among downtown, the inner-city, inner-ring suburbs, and outer-ring suburbs (Lee & Leigh, 2007), and subsequent research has since emphasized that the suburbanization of poverty is driven by distress in the inner-ring suburbs (Cooke & Denton, 2015; Hanlon, 2008).

Importantly, increases in poverty rates in suburban areas are marked by increases in the share of Black, Hispanic, and other racial and ethnic minorities (Holliday & Dwyer, 2009). Although whites are still a greater share of the poor in the suburbs than they are in the cities, poor people of color have suburbanized at a greater rate (Kneebone, 2017), and many suburban locations now have majority-minority populations (Lichter, 2013). To better understand the changing demographics of the suburbs, Howell and Timberlake (2016) examined racial and ethnic trends in the suburbanization of poverty from 2006-2010. For non-Latino whites, higher suburbanization rates were associated with higher levels of suburban employment, while for Blacks and Latinos, change was related to the availability of affordable housing in suburban areas.

As gentrification and its associated forces have pushed Black and other minority residents from the city into the suburbs, continued manifestations of racial segregation create social inequities for low-income people of color. Poor people in the suburbs are farther from important social services that tend to be located in the central city (Allard, 2004; Allard 2008). While racial residential segregation may be declining downtown, studies suggest it is increasing at other levels of geography (Lichter et al., 2015) and be more likely to exist between suburbs than within

them (Jargowsky, Rog, and Henderson, 2014). Finally, areas outside the urban core are typically neighborhoods that lack adequate public transit since mass public transportation was originally created as a poverty program for the inner-city poor (Allen, 2017). Qualitative studies show that low-income families without a car often fear moving from the city to the suburbs due to fear of being unable to accomplish essential travel (Rosenblatt & DeLuca, 2012). Those who do move and continue to lack access to a car face significant challenges (Dawkins, Jeon, & Pendall, 2015; Johnston-Anumonwo, & Sultana, 2006; McLafferty & Preston, 2019).

The history of the racial formation of space and shifting demographics of poverty point to the covert and overt ways that racism has historically shaped and is currently shaping urban development and redevelopment. The current patterns of rampant urban development have vast consequences for people of color and the poor who traditionally made up the demographics of cities. More recent research on the shifting nature of suburbs highlights Roy (2017)'s observation of the "sheer disappearance of African Americans" in cities (A8). Aside from the destruction of minority cultures and businesses, these patterns are also a threat to the physical mobility of residents.

Accessibility and Transit "Deserts"

Increasingly scholars are beginning to examine the spatial mismatch between the presence of amenities and the populations who need those amenities the most. Research on the social sustainability of urban mobility pays attention to the distribution of transit and travel services and whether they are equally distributed across urban areas (Greico, 2015; Lucas, 2004).[19] Much of the quantitative work in this field explores the various ways of measuring accessibility (Handy &

[19] For a more detailed discussion of the literature on transit accessibility and its relationship to social inclusion and exclusion, see chapter 2.

Niemeir, 1997). Foth, Manaugh, and El-Geneidy (2013) explore disparities between job accessibility and transit travel time. Welch (2013) explores the link between the connectivity of transit networks among affordable housing units. This research also addresses the various ways of assessing equity in transportation access. Martens, Golub, and Robinson (2012) note that there is no standard definition of distributional equity in studies of transportation accessibility. However, most studies take a horizontal approach in the measurement of equity using class-based measures such as income and access to employment.

More recent research on transit "deserts" explores equity as the spatial mismatch between transit dependent populations and available transit (Allen, 2017; Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013). This work sprouted out of scholarship on food deserts and the availability of affordable grocery stores (Abel & Faust, 2019; Thomas, 2010; Whelan et al., 2002). Studies on transit "deserts" pay special attention to the gap between transit supply and demand. These studies define transit dependent populations as "all persons who live in a household with no private vehicle available" (The U.S. Federal Transit Administration (FTA), 2013). Using this methodology to identify transit deserts in major Texas cities, Jiao (2017) found that transit-dependent populations were concentrated in inner and outer-ring suburbs and not the inner-city. Jiao and Dillivan (2013) found a similar pattern of transit dependency in Charlotte, NC, and very few transit deserts in Portland, OR, and Chicago, IL, due to well-connected transportation systems throughout the urban area. However, they found that Cincinnati had a much more sporadic pattern of transit dependency, with a concentration of transit deserts in historic neighborhoods near the central business district.

Lubitow et al. (2017) note that federal definitions of transit-dependent populations reflect the cultural and social privileging of automobility. Automobiles have long been associated with

wealth and spatial mobility and public transportation systems are structurally organized in the city to accommodate automobiles (Sheller & Urry, 2000; Henderson, 2006; Sheller, 2004). Federal and state level funding for transportation favors the construction of highways and roads over public transportation networks (Bullard, 2007; Bullard & Johnson, 1997; Bullard et al. 2004). Thus, it follows that defining transit dependency in terms of car ownership deprivation can insinuate that car ownership is preferable to public transportation usage. However, exploring transit accessibility outside of the context of car ownership has important consequences for sustainability.

Theoretical Synthesis

Although research on transit accessibility has done an excellent job in exploring how transportation is imperative for facilitating both spatial and social mobility and inclusion (Kenyon, 2003; Levitas et al., 2007; Kenyon, Lyons, & Rafferty, 2002), more work is needed to account for the historical linkages between accessibility and urban segregation. Research in environmental justice has long argued that transportation disadvantage is historically linked to a system of racial capitalism, whereby public transit and private automobiles have historically been used as racialized tools to facilitate segregation (Bullard, Johnson & Torres, 2004; Bullard & Johnson, 1997). Yet, research on transit accessibility and more recent work on transit "deserts" often fails to explore racial differences in access to transportation. Thus, the present research expands the current literature on public transit inaccessibility by exploring the changing class and racial composition in areas that are poorly served by public transportation.

DATA AND MEASURES

I examine demographic change in areas with poor transit access in five urban areas with the following central cities: San Francisco, Los Angeles, Denver, Dallas, and Seattle. Information on urban areas, counties, and transportation systems served are included in Table 1. Location data on transportation stops in each of these urban areas come from multiple sources and was collected in December of 2019. I primarily use data from the General Transit Feed Specification (GTFS) provided by public transportation operators. However, some smaller transportation systems do not provide GTFS data, so I hand collected information on transit stops directly from system websites. For each urban area, I collected location information on all public transit stations regardless of transit type.[20]

Table 1. Urban Areas

CSA	*CSA Counties*	*System Names*
San Francisco-San Jose-Oakland, CA	Alameda, Contra Costa, San Francisco, San Mateo, Marin, Santa Clara, San Benito, San Joaquin, Stanislaus, Sonoma, Solano, Merced, Santa Cruz, Napa	AC Transit, Bay Area Rapid Transit, San Francisco Metropolitan Transit Authority, SamTrans, Marin Transit, Santa Clara Valley Transportation Authority, San Joaquin Regional Transit District, Stanislaus Regional Transit, SolTrans, Sonoma County Transit, Merced Transit Authority, Santa Cruz METRO, Napa Valley Transportation Authority
Los Angeles-Long Beach, CA	Los Angeles, Orange, Riverside, San Bernadino, Ventura	Los Angeles County Metropolitan Transportation Authority, Orange County Transportation Authority, Riverside Transit Agency, Palo Verde Valley Transit, SunLine Transit Authority, PASS Transit, Corona Cruiser, OmniTrans, Beaumont Transit Services, Mountain Transit, Victor Valley Transit Authority, MetroLink, Foothill Transit, Gold Coast Transit, Ventura County Transportation Commission, Thousand Oaks Transit, Simi Valley Transit, Camarillo Area Transit
Denver-Aurora, CO	Denver, Arapahoe, Jefferson, Adams, Douglas, Broomfield, Elbert, Park, Clear Creek, Gilpin, Boulder, Weld	Regional Transportation District, Bustang, Greeley-Evans Transit, Park County Commuter
Dallas-Fort Worth, TX-OK	Dallas, Tarrant, Collin, Denton, Ellis, Johnson, Parker, Kaufman, Rockwall, Hunt, Wise, Hood, Somervell, Grayson, Henderson, Navarro, Cooke, Fannin, Palo Pinto	Dallas Area Regional Transit, Trinity Metro, Denton County Transportation Authority,

[20] The transit stops used in this study are stops that are on a fixed schedule. In some suburban areas, transit systems offer options for residents, mostly low-income and elderly, pick-up and drop-off services. These are impossible to account for and are not included in the present study.

Seattle-Tacoma-Olympia, WA CSA	King, Pierce, Snohomish, Thurston, Kitsap, Skagit, Island, Lewis, Mason	King County Metro Transit, Sound Transit, Pierce Transit, Community Transit, Intercity Transit, Kitsap Transit, Skagit Transit, Island Transit, Mason Transit

The demographic and housing data at the block group level come from the American Community Survey (ACS) 5-year estimates for 2010 and 2018.[21] Variable names and descriptions can be found in Table 2. The housing affordability characteristics include percentage of renters who spend more than 30% of their income on rent (rent burdened) and the median home value of owner occupied homes. The federal Department of Housing and Urban Development (HUD) defines an affordable dwelling as one that costs a household 30% percent or less of its income. The three variables capturing race/ethnicity are percent Black, percent Hispanic, and percent white. I include two measures to capture the class of residents. First, I constructed the variable "low-income earners" which measures the percent of the population who had income levels 25% or below the median income in the last month. Second, I constructed the variable "high-income earners" which measures the percent of the population who had income levels above the median in the last 12 months. I included both of these measures to capture the potential growing income inequality in suburban areas that are poorly served by public transit. I also include total population as a control measure.

Table 2. Description of Variables

Variable	*Description*	*Data Source*
Distance Variable		
Public Transit Desert (1=yes)	1= block group that does not have a transit stop with headways of 20 minutes of less within a mile of the mean center	GTFS + Census TIGER/Line Files

[21] Block groups with populations of 50 or less were not included in this study and all analyses use complete cases.

Housing Affordability Characteristics		
% Rent Burdened	Percent of the population paying greater than 30% of their income on rent	ACS
Median Home Value	Median home value of owner-occupied housing units	ACS 2010, 2018
Socio-Demographic Variables		
% Black	Percent Black/African American	ACS 2010, 2018
% Hispanic	Percent Hispanic/Latinx	ACS 2010, 2018
% White	Percent White	ACS 2010, 2018
% Low-Income	Percent of the population who had income levels 25% or below the median in the last 12 months.	ACS 2010, 2018
% High-Income	Percent of the population who had income levels above the median in the last 12 months.	ACS 2010, 2018
Total Population	Total population	ACS 2010, 2018
Transit-dependent population	Total population classified as transit dependent	ACS 2010, 2018

I created a measure to capture the transit-dependent population using the work of Jiao & Cai (2020), Jiao (2017), and Jiao & Dillivan (2013). While I argue that this measure has a number of deficiencies, it does demonstrate equity issues for those who lack access to automobiles. The formula for transit-dependent population is as follows:

$$Transit\ dependent\ population = transit\ dependent\ household\ population + population\ aged\ 12-15 + non\ institutionalized\ population\ in\ group\ quarters$$

$$Where$$

$$Transit\ dependent\ househol\ population = household\ drivers - vehicles\ avilable * national\ carpooling\ ratio$$

I then divided the measure for transit dependent population by the total population of each block group. The variable for vehicles available is not available at the block group level but it is

available at the census tract level. I assigned each block group a number for vehicles available based on population density and total area of the block group.

The dependent variable is a binary variable that measures whether or not a block group has high accessibility or low accessibility. I created this measure by first generating a count of all transit stops for the transportation agencies in each CSA that run weekdays and have headways[22] of 20 minutes or less. Shorter headways mean less time restraints for riders and weekday ridership is imperative for those who use public transportation to access employment. Next, identified which block groups were within a 1-mile radius of high frequency transit stops. Thus, I define block groups with high accessibility as those that are within a 1-mile radius of a transit stop that has weekday access and headways of 20 minutes or less.

Table 3. Descriptive Statistics

Core Based Statistical Area	*Total Block Groups*	*% of Block Groups Classified as Poorly Served by Public Transit*
San Francisco-San Jose-Oakland CA CSA	5839	56%
Los Angeles- Long Beach, CA CSA	10800	49%
Denver-Aurora, CO CSA	1819	62%
Dallas-Fort Worth, TX-OK CSA	3661	80%
Seattle-Tacoma-Olympia, WA CSA	3058	64%

Table 3 lists the total number of block groups for each CSA and the percentage of block groups classified as poorly served by public transit. The Dallas-Fort Worth CSA has the highest

[22] A headway is defined as the amount of time between transit vehicle arrivals at a stop.

percentage of block groups that lack access at 80%, followed by the Seattle-Tacoma-Olympia CSA at 64%. Sixty-two percent of block groups in the Denver-Aurora CSA and 56% of block groups in the San Francisco-San Jose-Oakland CSA are classified as lacking access. The Los Angeles-Long Beach CSA has the least number of inaccessible blocks at 49%.

RESULTS

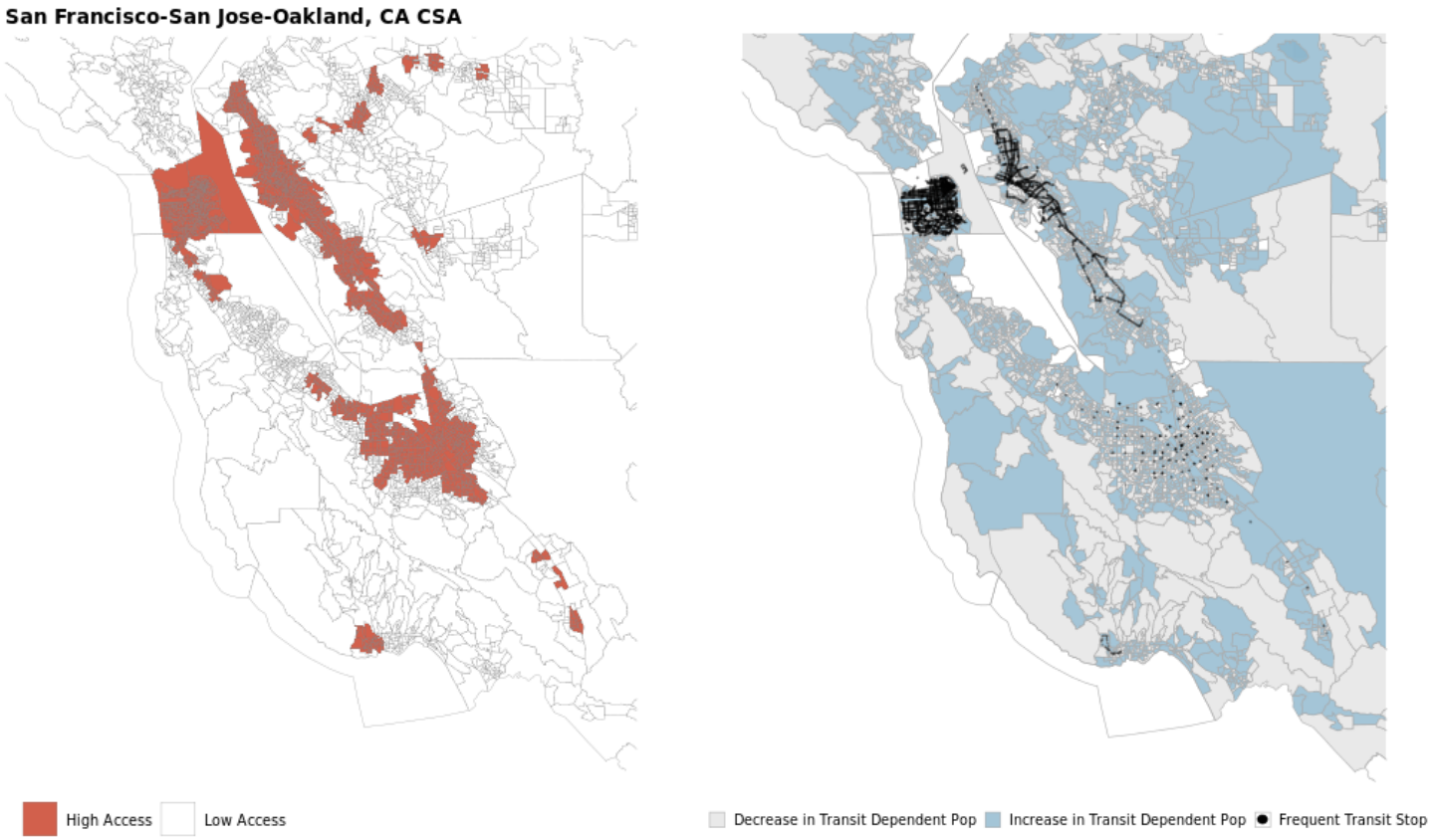
Maps on Transit Dependency and Transit Access

In order to visually assess the mismatch between access to frequent transit networks and change in the transit-dependent population, I generated a series of maps for each urban area. The first map shows areas that are classified as having high access to public transit in red and areas that have low access to public transit in white. The second set of maps represent change in the percent of the population classified as transit-dependent between 2010 and 2018 overlaid with frequent transit stops. The block groups that are highlighted in blue represent areas where the percentage of the population that is transit-dependent has increased and the areas in white represent areas where the percentage of the population that is transit-dependent has decreased.

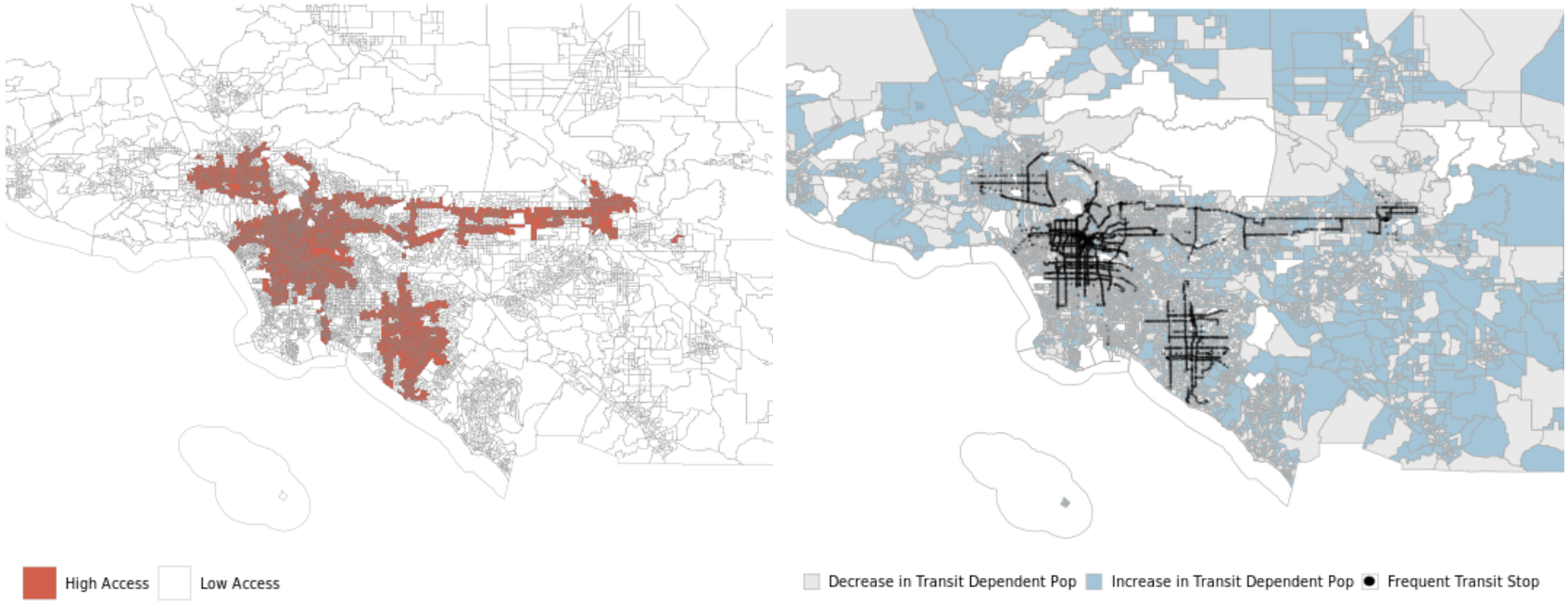
In general, the first set of maps demonstrate that there are very few block groups outside of major urban centers in each CSA that have frequent transit networks. In the San Francisco-San Jose-Oakland CSA, accessibility is more common in San Francisco proper, Oakland, San Jose, with some access in Santa Cruz and cities that are west of Berkeley. In the Los Angeles-Long Beach CSA, access is pretty widespread in the inner-city and down to Santa Ana. There is some access in San Bernardino but access decreases closer to Riverside and Moreno Valley. For the Denver-Aurora CSA, access is primarily located in Denver proper, Boulder, and Longmont. The Dallas-Fort Worth CSA has a pattern of patchwork access in the central cities with almost no access into the suburbs. In the Seattle-Tacoma CSA, access is located in downtown Seattle,

Bellevue, and Tacoma. The second set of maps demonstrate that transit-dependent populations have increased fairly evenly across metro regions over time. However, the increase in transit dependency for inner-ring and outer-ring suburbs demonstrates a growing pattern of spatial mismatch between transit-dependent populations and access to frequent public transit networks.

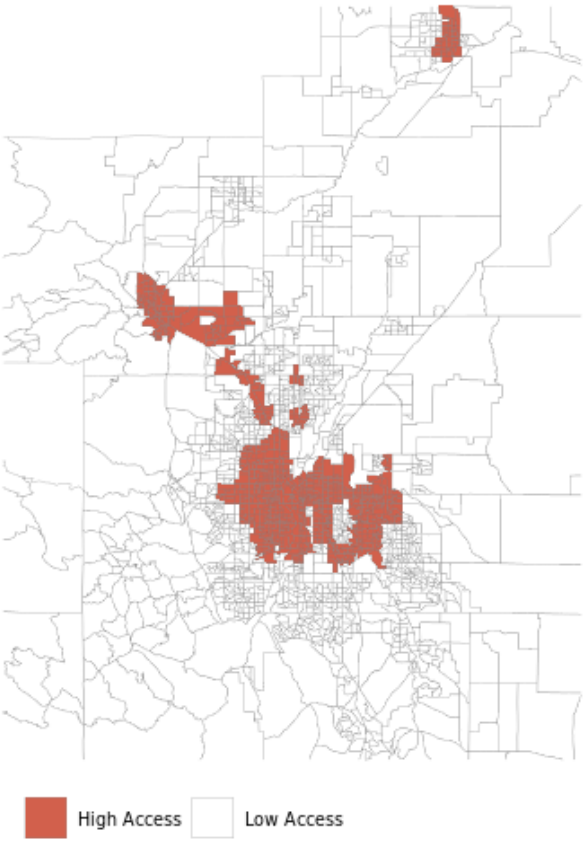
Figures 1-8: Maps on Transit Access and Transit Dependent Population Change for all CSAs

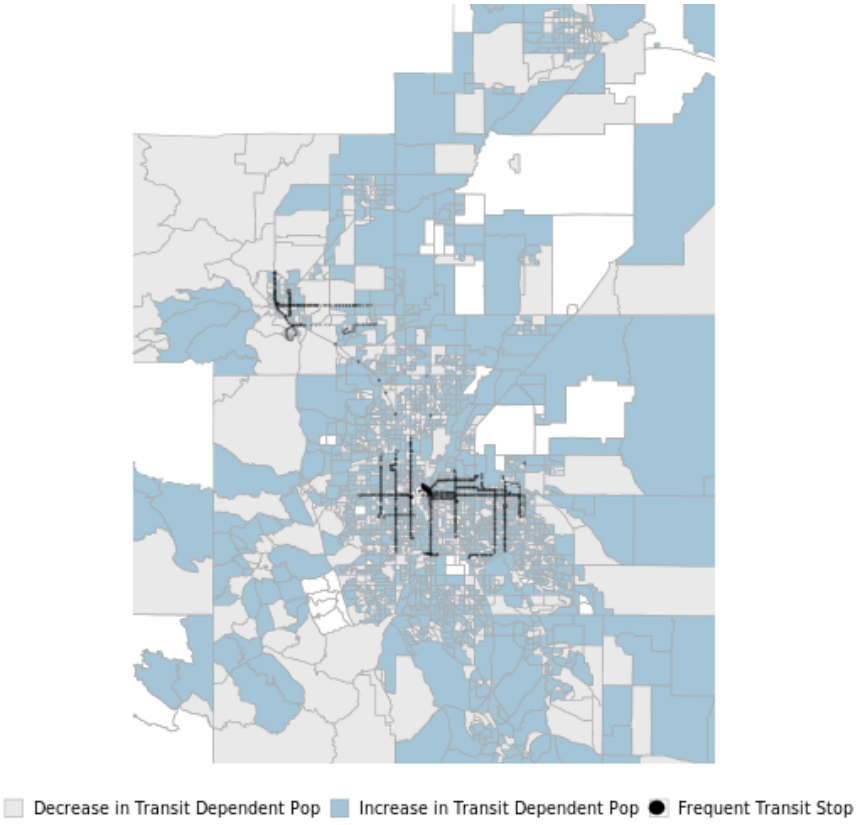


Los Angeles-Long Beach, CA CSA

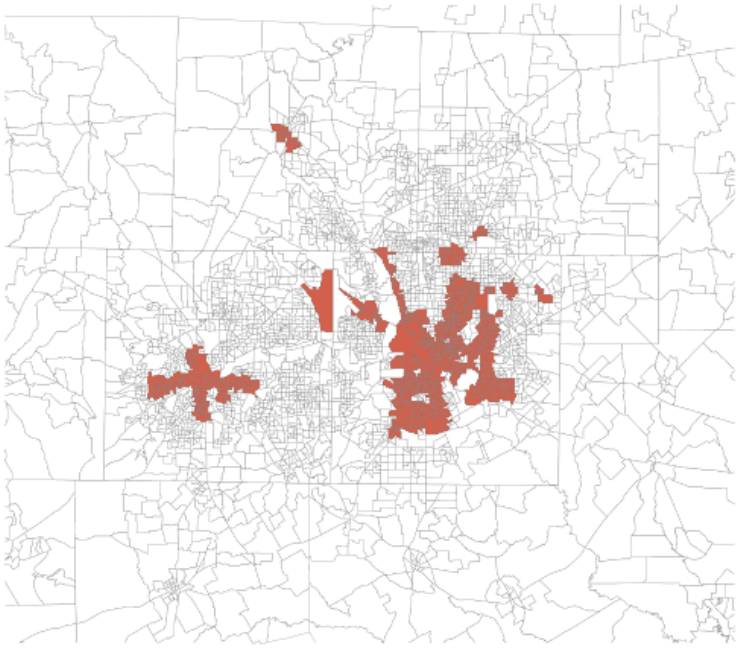


Denver-Aurora, CO CSA

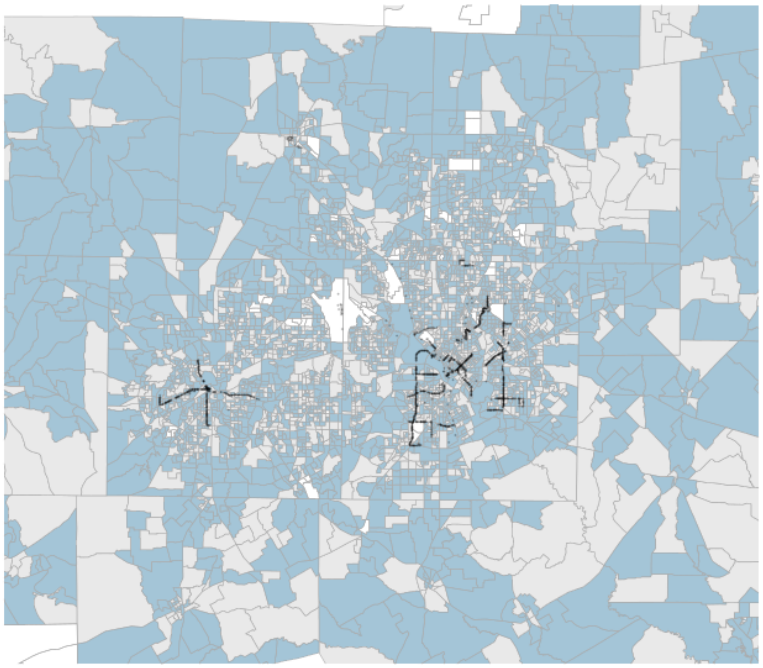




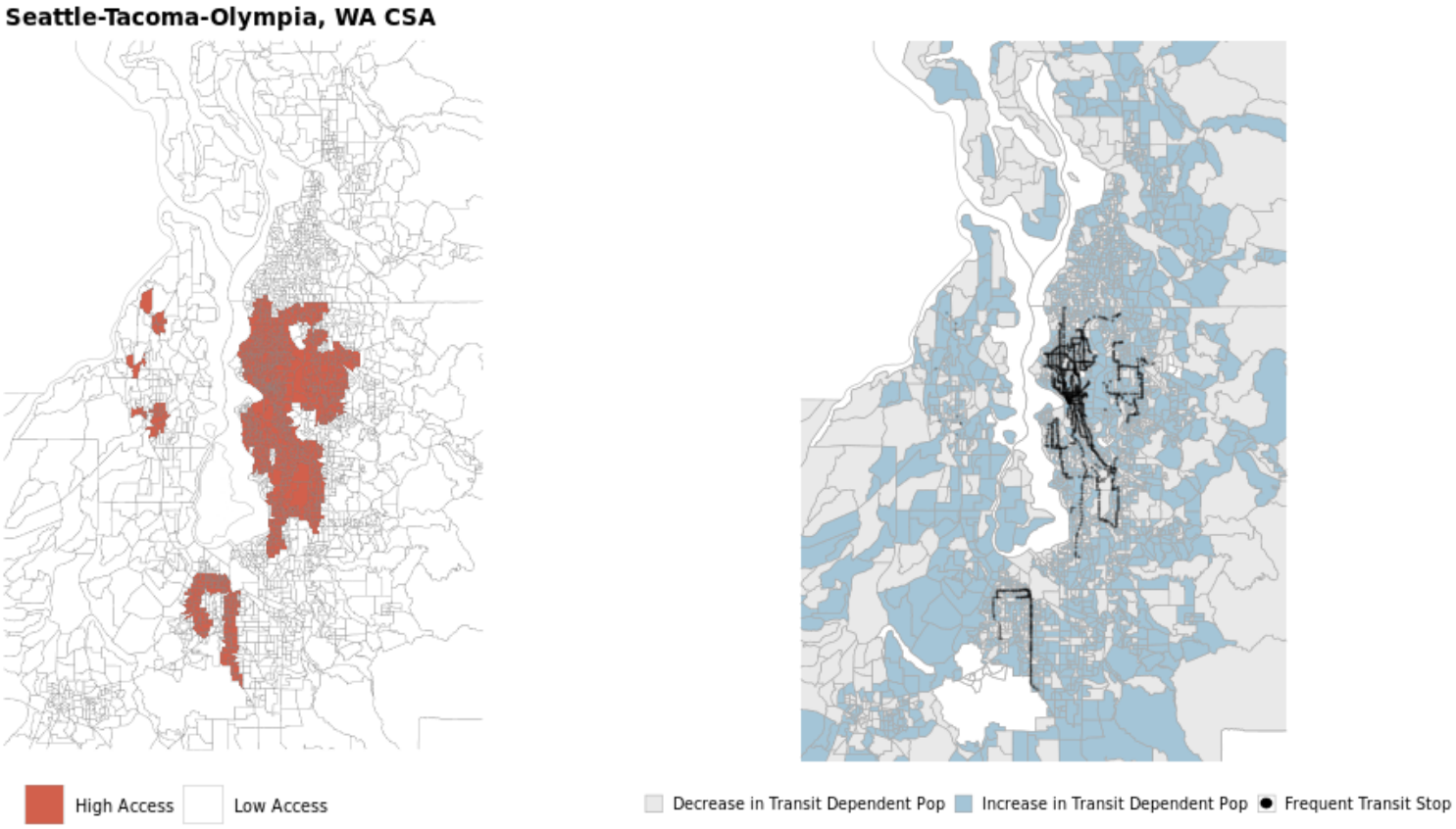
Dallas-Fort Worth, TX-OK CSA



High Access Low Access



Decrease in Transit Dependent Pop Increase in Transit Dependent Pop Frequent Transit Stop


Seattle-Tacoma-Olympia, WA CSA
High Access
Low Access
Decrease in Transit Dependent Pop
Increase in Transit Dependent Pop
Frequent Transit Stop

Regression Analytic Strategy

Next, I use Bayesian logistic regression to explore demographic changes in transit deserts at the block group level. I ran one logistic regression model for each of the 5 CSAs. The distribution of total population was skewed across all urban areas, so I use the natural logarithm of this variable. The general structure of the model is depicted below:

$$\Pr(y_i = 1) = logit^{-1}(B_0 + B_1 X_i)$$

For response variable y, 1 is assigned to areas designated as poorly served by public transit and 0 for areas that are not. $B_1 X_i$ represents the observed explanatory variables. I use a normal distribution to specify the priors for both the intercept and coefficient. However, I also ran each model using Student-t priors that yielded similar results. The regression analysis follows the work of basic textbooks on logistic regression models in a Bayesian setting (Gelman & Hill 2007; Gelman et al., 2013). I estimate all models using the stan_glm() function in the rstanarm package in R, which allows applied regression models to be estimated using Markov Chain Monte Carlo (MCMC) methods. I sampled four Markov chains for 1000 iterations each, including 1000 warm-up iterations, for a total of 4,000 samples for each model. All regression coefficients are standardized on a common scale for ease of interpretation (Gelman & Hill, 2007). The means and medians of the posterior distributions were relatively equal and all R-hat values were less than 1.1 indicating an overall good model fit (Gelman & Rubin, 1992). I evaluated each of the models using trace plots that provide information on the sequential draws from the posterior distribution to confirm that the chains in each plot were generally stable and that the chains overlap around the same value. I also examined the posterior predictive checks to

evaluate the relationship between the observed data and the simulations from the posterior predictive distribution. [2324]

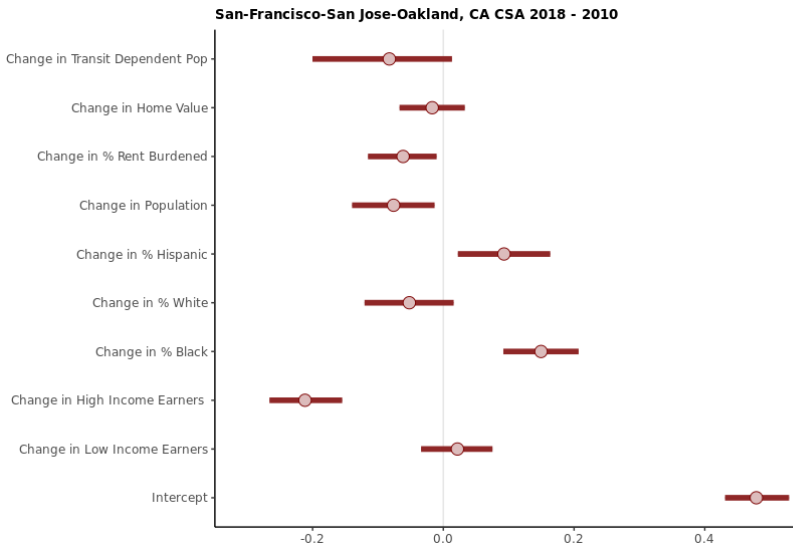
Regression Results

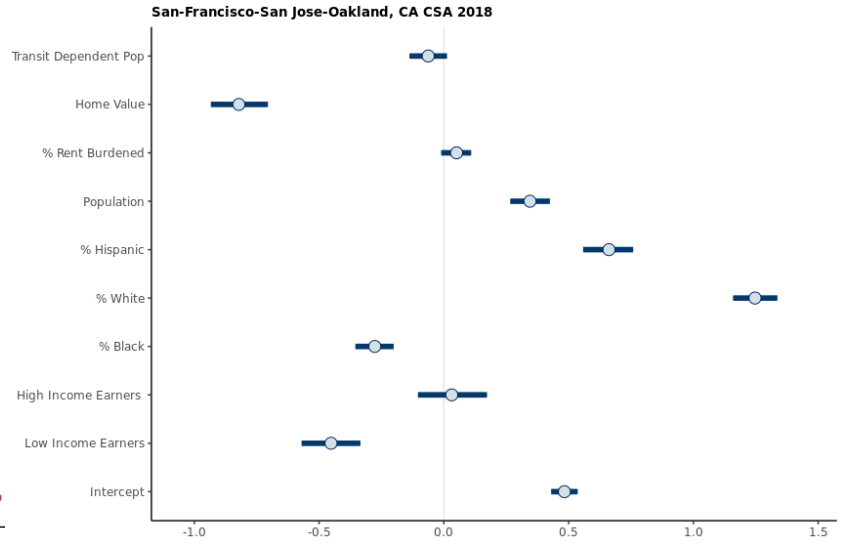
The results from the logistic regression analyses are presented in the following plots.[25] The plot points represent the standardized Bayesian point estimate (log odds). The lines on the outside of each estimate represent the 95% uncertainty intervals computed from the posterior draws. Estimates with intervals that do not cross zero indicate a meaningful relationship. The plots on the left show the regression models examining demographic change in transit deserts between 2010 and 2018 and the models on the right use cross sectional data from 2018.

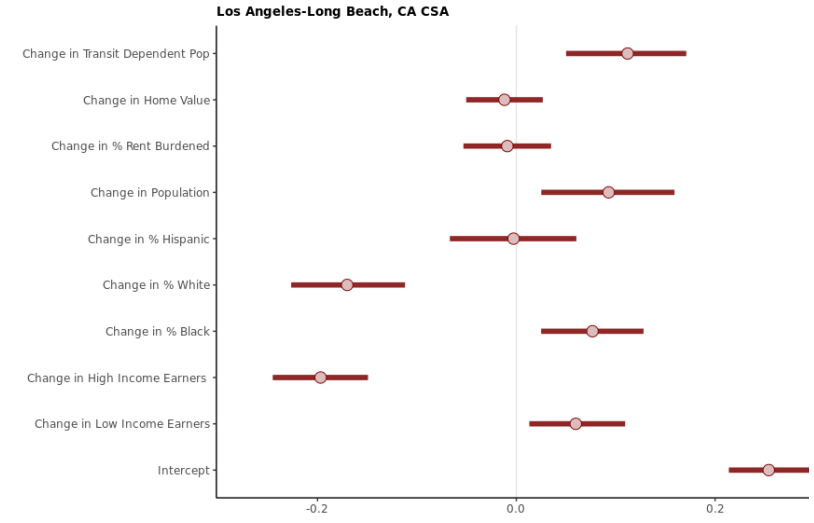
[23] I also estimated each logistic regression using a frequentist approach. The results were not substantively different from the Bayesian hierarchical models presented here. I also estimated these models using Bayesian hierarchal modeling with block groups nested in census tracts. However, there were a number of cases where all the block groups in the county were classified as deserts. As such, there was no within-county variation for these counties. Thus, I decided that regular logistic regression would be a more suitable approach.

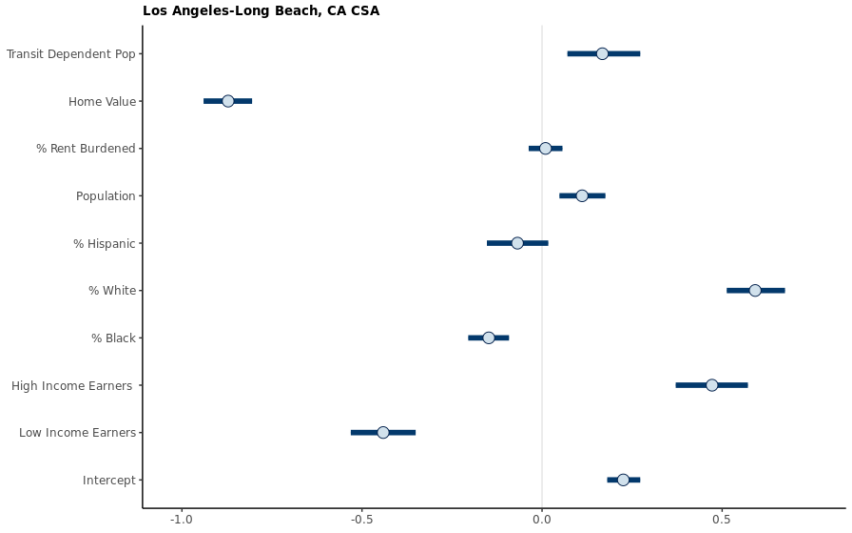
[25] Regression tables are located in the appendix.

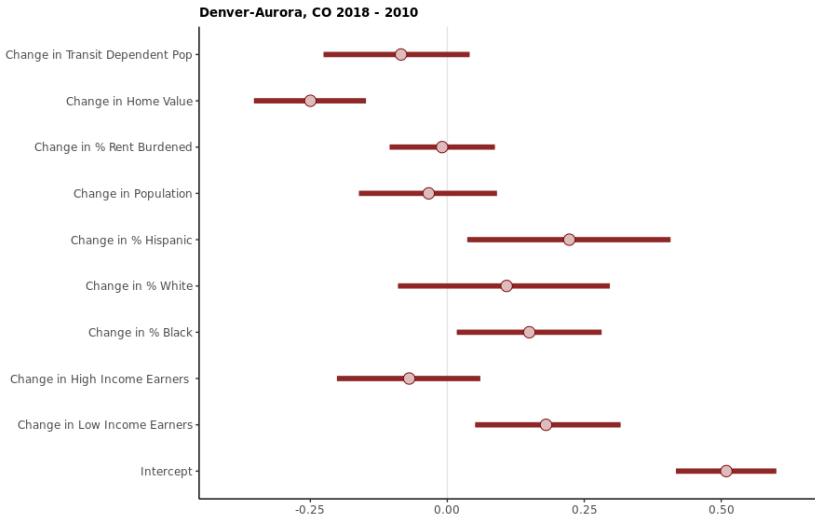
Figures 9-18: Regression Results for all CSAs

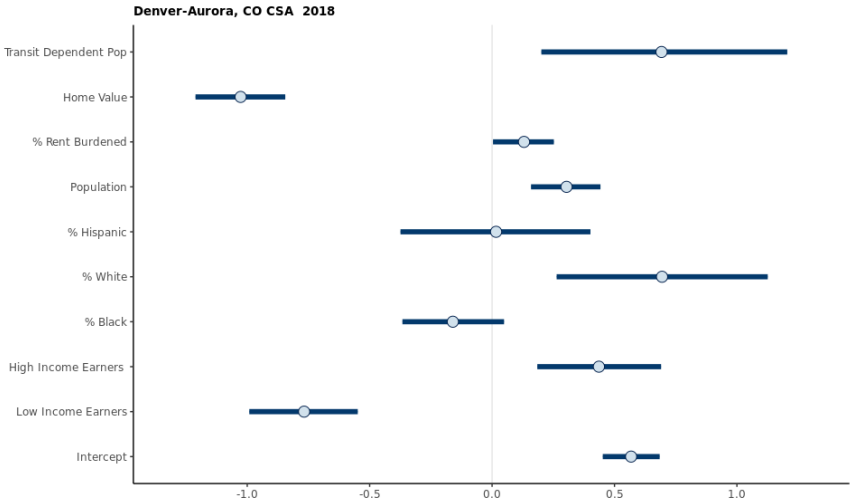


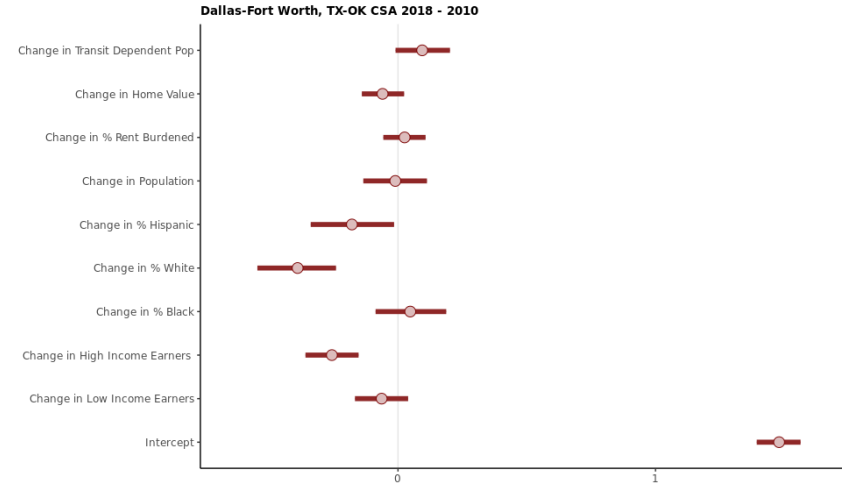


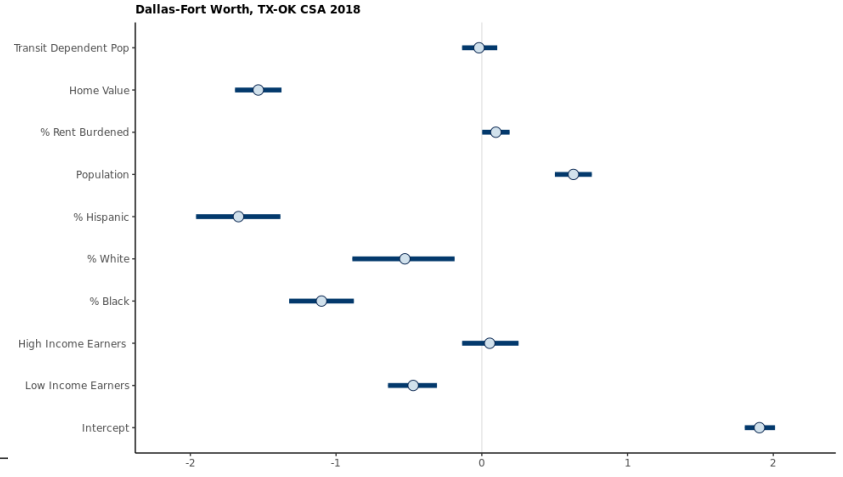


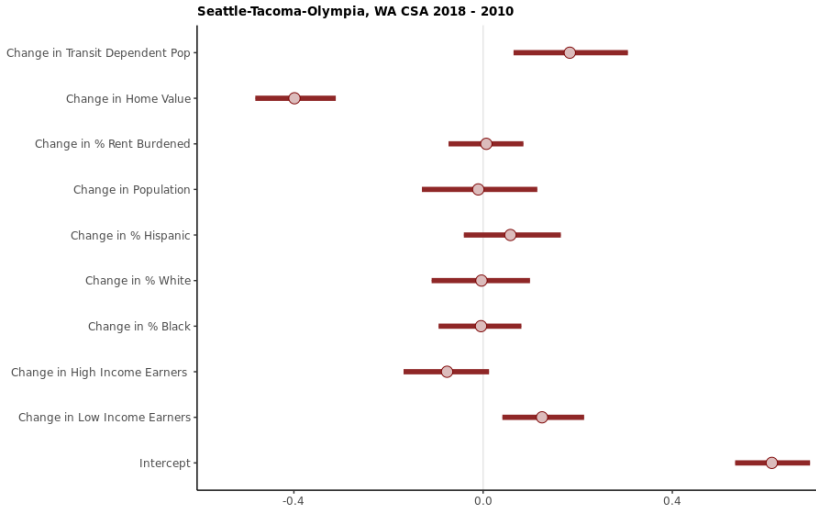


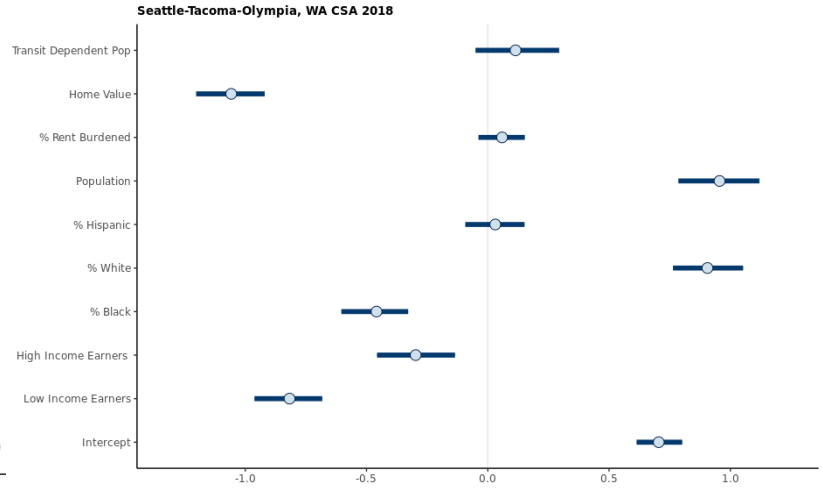

Denver-Aurora, CO 2018 - 2010
Change in Transit Dependent Pop
Change in Home Value
Change in % Rent Burdened
Change in Population
Change in % Hispanic
Change in % White
Change in % Black
Change in High Income Earners
Change in Low Income Earners
Intercept
-0.25
0.00
0.25
0.50


Denver-Aurora, CO CSA 2018
Transit Dependent Pop
Home Value
% Rent Burdened
Population
% Hispanic
% White
% Black
High Income Earners
Low Income Earners
Intercept
-1.0
-0.5
0.0
0.5
1.0


Dallas-Fort Worth, TX-OK CSA 2018 - 2010
Change in Transit Dependent Pop
Change in Home Value
Change in % Rent Burdened
Change in Population
Change in % Hispanic
Change in % White
Change in % Black
Change in High Income Earners
Change in Low Income Earners
Intercept
0
1


Dallas-Fort Worth, TX-OK CSA 2018
Transit Dependent Pop
Home Value
% Rent Burdened
Population
% Hispanic
% White
% Black
High Income Earners
Low Income Earners
Intercept
-2
-1
0
1
2


Seattle-Tacoma-Olympia, WA CSA 2018 - 2010
Change in Transit Dependent Pop
Change in Home Value
Change in % Rent Burdened
Change in Population
Change in % Hispanic
Change in % White
Change in % Black
Change in High Income Earners
Change in Low Income Earners
Intercept
-0.4
0.0
0.4


Seattle-Tacoma-Olympia, WA CSA 2018
Transit Dependent Pop
Home Value
% Rent Burdened
Population
% Hispanic
% White
% Black
High Income Earners
Low Income Earners
Intercept
-1.0
-0.5
0.0
0.5
1.0

Results for the San-Francisco-San Jose-Oakland CSA 2018 – 2010 change model show meaningful relationships with the dependent variable (transit access or not) and change in percent Black (OR = 1.19), change in percent Hispanic (OR = 1.12), and change in high-income earners (OR = .80). There are also potential significant relationships with change in percent rent burdened (OR = .92) and change in population (OR = .91), but the confidence intervals for these variables are very close to the zero line. A standard deviation increase in both percent Black and percent Hispanic is associated with higher odds of lacking transit access. A standard deviation increase in high-income earners is associated with lower odds of lacking transit access. The San-Francisco-San Jose-Oakland CSA model for 2018, which shows the current demographics in public transit deserts, shows positive meaningful relationships with the dependent variable and percent Hispanic (OR = 2.01), percent white (OR = 3.32), and total population (OR = 1.49). Thus, a standard deviation increase in these variables is associated with higher odds of lacking transit access. Standard deviation increases in percent Black (OR = 0.78), percent low-income earners (OR =.61), and home value (OR = .44) are associated with lower odds of lacking transit access.

Results for the Los Angeles-Long Beach CSA 2018-2010 change model show meaningful and positive relationships with the dependent variable and change in percent Black (OR = 1.10), change in transit-dependent population (OR = 1.11), change in total population (OR = 1.10), and change in percent low-income earners (OR = 1.08). A standard deviation increase in these variables is associated with higher odds of lacking transit access. The model shows negative and meaningful relationships between change in percent white (OR = .82) and change in percent high-income earners (OR = .81). Thus, a standard deviation increase in these variables is associated with lower odds of lacking access to transit. Results for the Los Angeles-Long

Beach CSA 2018 model shows meaningful relationships between transit-dependent population (OR = 1.28), percent white (OR = 1.82), percent high-income earners (OR = 1.65), and total population (OR = 1.10), indicating that standard deviation increases in these variables are associated with higher odds of lacking access to transit. Standard deviation increases in percent Black (OR = .90), home value (OR = .44), and percent low-income earners (OR = .67) are associated with lower odds of lacking access to transit.

Results for the Denver-Aurora CSA 2018-2010 change model show positive and meaningful relationships between change in percent Hispanic (OR =1.24), change in percent Black (OR = 1.22), and change in percent low-income earners (OR = 1.23), indicating that standard deviation increases in these variables are associated with higher odds of having access to transit. A standard deviation increase in the change in home value (OR = .77) is associated with lower odds of having access to transit. The results for the Denver-Aurora CSA 2018 model show meaningful and positive relationships between the dependent variable and transit-dependent population (OR = 2.71), total population (OR = 1.49), percent white (OR = 1.82), and percent high-income earners (OR = 1.49). Thus, standard deviation increases in these variables are associated with higher odds of having access to transit. However, standard deviation increases in both percent low-income earners (OR = .49) and home value (OR = .36) are associated with lower odds of having access to transit.

Results for the Dallas-Fort Worth CSA 2018-2010 change model show no positive and meaningful relationships between the dependent variable and the change variables. However, there are two negative and meaningful relationships between change in percent white (OR = .61) and change in percent high-income earners (OR = .67). Thus, standard deviation increases in these variables are associated with lower odds of having access to transit. Results for the Dallas-

Fort Worth CSA 2018 model indicate that a standard deviation increase in total population (OR = 2.01) is associated with higher odds of being in a transit desert. However, standard deviation increases in home value (OR = .22), percent Hispanic (OR = .17), percent white (OR = .61), percent Black (OR = .36), and percent low-income earners (OR = .63) are all associated with lower odds of having access to transit.

Results for the Seattle-Tacoma-Olympia CSA 2018-2010 change model depict meaningful and positive relationships between the dependent variable and change in transit-dependent population (OR = 1.19) and change in percent low-income earners (OR = 1.12). Thus, standard deviation increases in these variables are associated with higher odds of having access to transit. A standard deviation increase in change in home value (OR = .67) is associated with lower odds of having access to transit. Results for the Seattle-Tacoma-Olympia CSA 2018 model show positive and meaningful relationships between the dependent variable and total population (OR = 2.71) and percent white (OR = 2.43), indicating that standard deviation increases in these variables are associated with higher odds of having access to transit. Standard deviation increases in home value (OR = .33), percent Black (OR = .61), percent high-income earners (OR = .67), and percent low-income earners (OR = .44) are associated with lower odds of having access to transit.

DISCUSSION

The results for the 2018 models indicate that the demographic composition of areas that are poorly served by public transit match the demographics of suburban areas since the age of white flight and the development of automobility. These models also confirm that poor, Black, and Brown residents are still present in the inner-city where there are denser and more frequent

transitscapes (Kramer, 2018). In all CSAs, areas with better access to public transportation are associated with a higher percentage of low-income earners, and in every CSA except for Denver-Aurora, better access is also associated with a higher percentage of Black residents. In the Dallas-Fort Worth CSA, increased access is associated with a higher percentage of Hispanics, but this relationship is not present in the other CSAs. Conversely, in every CSA aside from the Dallas-Fort Work CSA, areas with poor access are associated with a higher percentage of whites. In both the Los Angeles-Long Beach CSA and the Denver-Aurora CSA, areas with poor access are associated with a higher percentage of high-income earners.

However, there are some surprising results for the 2018 models that do not match this pattern. For example, in the Seattle-Tacoma-Olympia CSA block groups, more high-income residents and more low-income residents are both associated with an increase in transit access. This could suggest a potential pattern of wealth inequality closer to transportation and more middle class populations living away from transitscapes in Seattle. Also, for the Dallas-Fort Worth CSA, areas with increased access are associated with a higher percentage of whites, Blacks, and Hispanics in comparison to areas with a lack of access, suggesting that transitscapes in this urban area are currently fairly diverse.

However, the results for 2018 only show a snapshot in time, and the longitudinal analysis measuring the change in the demographic characteristics of areas poorly served by transit tell a much different story in each CSA. In the Los Angeles-Long Beach CSA, the Denver-Aurora CSA, and the Seattle-Tacoma-Olympia CSA, there were meaningful increases in low-income earners in areas with poor access to public transportation between the years 2010 and 2018. During the same years, areas with poor transit access saw increases in the Black populations in the San Francisco-San Jose-Oakland CSA, the Los Angeles-Long Beach CSA, and the Denver-

Aurora CSA. This relationship was also found for Hispanics in the San Francisco-San Jose-Oakland CSA and Denver- Aurora CSA. These findings support research that finds that while whites are still a greater share of the poor in the suburbs, people of color, and often poor people, are suburbanizing at a greater rate (Holliday and Dwyer, 2009; Kneebone, 2017). Thus, these results demonstrate how the suburbanization of racial minorities and the poor is creating a situation whereby access to public transportation, and subsequently mobility, is constrained.

The results also indicate that areas that are well served by frequent public transit networks are becoming wealthier and whiter in some urban areas. In the Los Angeles-Long Beach CSA and the Dallas-Fort Worth CSA, areas that are more accessible are associated with increases in white populations. In the San Francisco-San Jose-Oakland CSA, the Los Angeles-Long Beach CSA, and the Dallas-Fort Worth CSA, areas with better transit access have also seen an increase in high-income earners over the eight study years.

The models also reveal interesting patterns in current and changing distribution of transit-dependent populations in urban areas. In the Los Angeles-Long Beach CSA, areas that are currently poorly served by public transit have a higher number of transit-dependent residents, and the change models indicate that this number is growing in comparison to areas that have better access. For the Denver-Aurora CSA, the models show that currently areas poorly served by public transit have a higher number of transit-dependent residents, but this number did not increase meaningfully between 2010 and 2018. However, in the Seattle-Tacoma-Olympia CSA, areas that are poorly served by public transit have seen a meaningful increase in transit-dependent populations. Transit-dependent populations face significant social and economic barriers in comparison to residents who have access to public transit or automobiles. Transit-dependent populations rely on frequent transit networks for social and economic mobility,

including access to jobs, education, and social networks. Thus, these results could signal the potential for increasing cycles of unemployment and poverty in areas with increasing transit dependency but a lack of transit options (Kenyon, Rafferty, & Lyons, 2003; Lucas, 2012; Sanchez et al., 2004).

CONCLUSION

The goal of this research was to explore the current and changing demographic makeup of areas that are poorly served by public transportation using mapping and Bayesian logistic regression for five urban areas. The discrepancies between the cross sectional and change models show that accessibility is a dynamic process that is constantly changing in the face of rampant development and the growing unaffordability of the inner-city. As such, snapshots in time fail to capture the underlying processes driving inaccessibility. Although the growth in low-income earners in suburban areas could be linked to residents who have traditionally lived there growing poorer (Kneebone & Berube, 2013), the racial demographic changes shown in these models suggests that these areas are once again being shaped by a system of racial capitalism.

This chapter challenges us to redefine inaccessibility as a process that is linked to the dispossession of the inner-city for BIPOC and the poor (Roy, 2019). The changing nature of public transportation inaccessibility is a unique form of transportation racism that has multiplicative effects for people of color. Not only are they losing access to urban space, they are also losing access to tools that are vital for social mobility. As such, future research on transit accessibility and transit "deserts" should pay closer attention to race when measuring the spatial mismatch in transit supply and demand. Furthermore, research should also address measuring

accessibility in terms of connectivity to see how changing patterns of transit access are uniquely impacting racial minorities (Welch 2013).

Few studies on transit inaccessibility explore the historical processes of segregation and automobility that created this inaccessibility in the first place (Allen, 2017). Recent work on transit "deserts" has measured transit dependency in terms of access to automobiles (Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013). Thus, these studies unintentionally reflect the privileging of automobiles over public transportation (Lubitow et al. 2017). Although measuring this level of deprivation is important for assessing the overall mobility of residents, it is also important to assess transportation accessibility in terms of access to public transit.

First, automobiles cost money to maintain and poor people and racial minorities are more likely to drive older vehicles that may breakdown and be costly to repair. Thus, automobile ownership does always equate to constant accessibility. Second, prioritizing car ownership is linked to a long history of white supremacy and the racialization of various forms of transportation objects. Public transportation has been linked to poor people and racial minorities white the automobile has been linked to wealthy whites (Bullard & Johnson, 1997). Finally, decreasing the use of automobiles is imperative for creating for sustainable cities seeking to curb emissions.

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Chapter V

Conclusions

In this dissertation I explored the changing nature of transportation accessibility in the age of rampant urban redevelopment in three separate studies. The goal of these studies was to redefine transportation accessibility as both a product and a tool of the inveterate system of racialized capitalism that shapes the social and spatial dimensions of the city. These chapters demonstrate not only how transportation access is diminishing because of unaffordability but also, ironically, how transportation objects can be used a tool to limit accessibility for transit dependent populations. The results from the first and third chapter speak to the former of these two processes while the second speaks to the latter. Results from the first chapter highlight how housing affordability is directly linked to transportation access. Growing unaffordability is forcing people to choose between paying astronomical amounts for housing to live in the city or living in areas that are poorly served by public transit. The third substantive chapter demonstrates how this linkage between accessibility and affordability is linked to suburbanization of both poverty and racial minorities. The second substantive chapter shows how LRT, in the absence of processes that address unaffordability and racialization, can actually achieve the opposite effect of its proposed purpose. The results indicate that in some urban areas, LRT is associated with racial banishment and in some cases decreases in transit ridership.

The process of diminishing accessibility highlights how the prevailing system of white supremacy that continues to define spatial segregation is still very much alive and well today. Changes in accessibility relate to how dominant groups exercise power to develop and enforce both social and spatial boundaries across multiple types of inequality (Pellow 2016; Taylor 1997;

McKane et. al 2018). Thus, transportation, and access to various forms of transit, reflect how transit is a tool used to control the mobility over the poor and racial minorities across urban spaces (Sheller, 2015). The culture of secessionist automobility led to a segregated city where urban residents had access to a frayed and underfunded transportation system that disconnected them to the suburbs (Henderson, 2006). However, the redevelopment of urban space is shrinking access to inner-city spaces, and to the very transportation systems that were originally built as poverty programs to accommodate inner-city residents. As such, the questions this dissertation ask are: *Mobility for whom? Does transit accessibility still benefit transit dependent populations, racial minorities, and the poor? Or is it being used as a tool attract nondiscretionary riders to the inner-city at the expense of those who need it the most?*

IMPLICATIONS FOR SCHOLARS AND FUTURE RESEARCH

This dissertation, and each of the three substantive chapters within it, makes important contributions to research on transportation accessibility and social understandings of space. This dissertation challenges researchers to redefine transportation accessibility by connecting it to other processes of social change in urban areas to understand the changing nature of urban inequity. As such, this dissertation speaks to the call from critical environmental justice studies to pay closer attention to the role of scale when analyzing the production of environmental inequities (Pellow, 2018). Throughout each of these three studies, I pay close attention to the spatial and temporal dimensions of transit objects in urban spaces. The results highlight not only that the nature of transit accessibility is racially exclusionary in some urban areas but also that it is ecologically unstainable. Forcing transit dependent populations into areas that are poorly served by public transit systems does little to address climate change or encourage just transitions at the local level. Gentrification and the move back to the city has failed to increase

transit ridership on a significant scale for non-discretionary riders. Thus, future research should address how racially exclusionary and class exclusionary patterns of transit accessibility are harmful to the sustainability goals of transit-oriented development.

Furthermore, the results from each of the three substantive studies demonstrate how the processes that determine accessibility vary across and within different cities. The first substantive chapter shows how transit accessibility is connected to rising rent but not housing costs, or sometimes both, depending not only on the urban area itself, and the chapter also shows how accessibility is connected to scale through variations between MSAs and CSAs. Results from the second substantive chapter indicate the presence of racial banishment and decreasing transit ridership in areas surrounding LRT in some cities but not others. Finally, the third empirical chapter highlights how the changing demographic patterns in areas of inaccessibility differ across each city. Thus, as a whole, this dissertation highlights the importance of spatially oriented analyses in understanding patterns of segregation (Liévanos, 2015; McKane et. al 2018). The patterns of inequity in the city are deeply tied to city-specific historical processes. Thus, space itself and the tools within that space are used to define the nature of segregation in individual cities. This maps on to criticisms found in mobility studies on how urban sociology often ignores the role of physical space when analyzing patterns of urban inequity (Kaufman, 2011).

Each of the three substantive studies also make individual contributions to the literature. The first substantive chapter asked: *In cities with rampant urban restructuring and TOD developments, what is the current state of transit accessibility and housing affordability?* This chapter challenges us to consider how transit justice is inherently related to the state of other material conditions in the inner-city. In general, the results indicate that housing is cheaper in

areas that are farther from transitscapes in urban areas that are facing rampant population growth and widespread development. Thus, it is important for future research to connect accessibility to the growing unaffordable housing crisis, instead of simply examining how accessibility varies by poverty and income (Kramer, 2018). A holistic analysis of transit accessibility requires redefining accessibility as a mulitscalar issue that is connected to other forms of environmental inequity, such as the insecure access to housing (Pellow, 2018). As such, future research on transportation access and housing unaffordability could unpack how the multiplicative effect of these two instances of environmental injustice impact the health and wellbeing of those experiencing both inequities in tandem.

The second substantive chapter asked: *To what extent is gentrification, understood as both a process of growing unaffordability and racial banishment, associated with the presence of LRT stations?* This chapter quantitatively examines how changing urban demographics are linked to the presence of an LRT station, a particularly polarizing form of TOD. This study contributes to the growing literature that uses urban sociology to examine how LRT can influence patterns of gentrification and subsequently reduce accessibility for transit dependent populations. Whereas previous studies focused almost exclusively on changing property values and income surrounding LRT (Kahn, 2007; Zuk et al., 2018), I argue that gentrification must be understood as an inherently intersectional issue. As such, I include measures that capture the process of racial banishment that is taking place in urban areas (Roy, 2017; Roy, 2019). Although urban sociologists have long studied the idea of "displacement," this term does little to address to how white supremacy permeates the social institutions dominating the redevelopment of urban areas. Statistical models exploring the link between transportation and gentrification must examine racial inequities in accessibility. The unraveling community fabric of minority

cultures in well documented in micro level qualitative studies on gentrification and the local knowledge of community leaders in areas fighting for the right to emplacement. Future studies on transportation and racial banishment should explore why communities of color are disappearing near LRT and how this relationship is linked to the long-documented history of transportation racism (Bullard, Johnson & Torres, 2004; Bullard & Johnson, 1997; Avila, 2014), and the legacy of white supremacy dating to the civil rights movement that that culturally attributes the bus to Black bodies and cleaner forms of transit, such as LRT, to white bodies (Mills, 2001).

Finally, the third substantive chapter asked: *Has the demographic makeup of public transit deserts changed to reflect the process of class and minority suburbanization, thus changing the historic demographic makeup of public transit inaccessibility?* The results for this chapter demonstrate how the growing unaffordability of the inner-city is leading to population changes in areas that are not well served by public transportation. This research builds on more recent work that explore the concept of "transit deserts" (Allen, 2017; Jiao & Cai, 2020; Jiao, 2017; Jiao & Dillivan, 2013). I push this literature forward in two ways. First, I distinguish between "transit deserts" and "public transit deserts." This distinction is imperative for understanding transportation accessibility as a multiscalar issue that connects to urban air pollution caused by the dominant culture of automobility. Just transit is transit that addresses accessibility gaps in public transit for racial minorities. Measuring areas of transit accessibility through the lens of car ownership deemphasizes the importance of public transit as a tool for sustainability (Lubitow et al. 2017). Second, I explore the patterns of racial change in inaccessible suburban areas, something that has been overlooked in quantitative research on "transit deserts." This research speaks to how public transit, an environmental good, is being

taken away from racial minorities and the poor as they are losing their rights to the city and the amenities they have traditionally relied on.

IMPLICATIONS FOR PUBLIC POLICY

Transit ridership has been declining in major cities such as San Francisco, Los Angeles, New York, and most major urban areas across the United States in recent years. Urban planners have asked themselves: *where have transit riders gone and how can cities bring them back?* It is possible that declining transit ridership may be part of larger national trends such as an expanding economy, declining oil prices, and the declining costs of the automobile. However, the empirical research presented in this dissertation suggests that issues with transportation accessibility are playing out on a local level.

The promises of the "creative city" and "new urbanism" have fallen short of creating a multiclass city designed to increase the quality of living of inner-city residents. Instead, what has taken place has been what Rolnik (2013) describes as "a massive spoliation of the assets of the poor" (1064). Financial investors and developers have exacerbated the commodification of housing and amenities of the inner-city through the destruction of the commons. A system of racial capitalism in the city dictates patterns of transportation accessibility, and this dissertation demonstrates how the changing structure of the city has vast implications for racial minorities, primarily those who are transit dependent riders and the poor, who have had their right to the city revoked by local governments who, ironically, push neoliberal policies to address social issues.

As such, the issue of transportation accessibility that is explored in this dissertation speaks deeply to the third pillar of critical environmental justice. Pellow (2018) states, "Social inequalities—from racism to speciesism—are deeply embedded in society (rather than aberrations) and reinforced by state power, and … therefore the current social order stands as a

fundamental obstacle to social and environmental justice" (22). City officials have long taken an austerity approach in funding social programs such as public transportation and housing while favoring pouring money into the budgets of law enforcement agencies to police the very people who rely on public transportation. And to be clear, these patterns of funding are deeply embedded in a system of white supremacy that purposely takes power away from racial minorities and the poor by limiting their access to physical mobility and other tools to ensure social and economic mobility. Transportation plans have long fallen short in their promise to provide equitable accessibility to transit dependent populations. This pattern is depicted in the maps and the statistical models that demonstrate who is losing accessibility in urban areas in the substantive chapters of this dissertation.

In the age of rampant gentrification, large scale transportation plans have been constructed to boost transit ridership for discretionary riders in an effort to bring wealth, and also whiteness, back into urban areas. As Roy (2017) notes, "Financialization is necessarily constituted through racialization" (p. A9). Thus, transit plans crafted to benefit developers and the other financial beneficiaries of rampant urban development inherently lead to deeply racist and classist approaches to urban development in a system of racial capitalism. In turn, these plans have the potential to simply invert the spatial pattern of urban apartheid by pricing minority communities out of the city and pushing them to suburban areas. This is exactly what Tamika Douglas was speaking of when she exclaimed: "If you don't have a place to stay or a home, who cares about a train versus a bus? We've got to get more housing in this city" (Haggard, 2018).

Redirecting local funding to transportation projects without acknowledging the changing patterns of demographics in the city nor addressing the growing crisis of unaffordability in the

inner-city can lead to racially exclusionary and ecologically unstainable patterns of transit usage. Policies designed to boost transit ridership have the potential to price out transit dependent populations. If transit dependent populations do not have access to public transit, appealing to non-discretionary riders to give up their automobiles and use public transit is simply wishful thinking. Cities need to invest in increasing transit services for those who need it the most if they want to reduce automobility and address climate change at a local level.

Yet, Pellow (2018) notes that confronting the reality of the third pillar of critical environmental justice studies suggests, "scholars and activists are not asking how we might build environmentally just and resilient communities that can exist beyond the state, but rather how we might do so with a different model of state intervention" (pg. 22). One approach would be to involve local community organizers to conceptualize a city with community owned housing projects and transportation systems that are designed by the people they seek to benefit. Pattillo (2017) notes that it is the commodification of housing that automatically leads to housing inequity and this dissertation demonstrates that housing inequity is intrinsically linked to transit inaccessibility. Thus, creative solutions to the decommodification of housing are needed to truly tackle the growing crisis of transportation inaccessibility.

None of this is to suggest that non-discretionary riders are not important to the future of public transportation. On the contrary, it is imperative that non-discretionary riders support and use mass transit systems in the age of climate change. However, confronting the issue of increasing non-discretionary ridership means not only confronting the role that white supremacy has played in creating a system of urban apartheid but also how white supremacy has shaped cultural views of public transportation itself. Public transit, and especially bus systems, have been historically linked to Black bodies since before the civil rights movement and Rosa Park's

historic bus ride in Montgomery in 1943 (Bullard, Johnson & Torres, 2004; Bullard & Johnson, 1997). “Moving Africans Rapidly Through Atlanta” is still a well-known backronym for the Metropolitan Atlanta Rapid Transit Authority due to primarily Black ridership.

Charles Mill’s (2001) theory of “black trash” demonstrates how Black bodies have historically been associated with filth and pollution, both of which have also been used to describe inner-city living before cities enacted policies to encourage redevelopment to appeal to wealth and whiteness. This same concept maps onto the dominant cultural views on the bus itself quite well, as the bus is seen as both an object of pollution as well as a transit mode specifically for poor people and racial minorities (Bullard & Johnson, 1997). The irony of this manifestation of white supremacy is that the culture of secessionist automobility that was created by wealthy whites to spatially segregate themselves from the inner-city has cumulatively led to more air pollution than bus systems. Even so, attracting these non-discretionary riders to urban transportation systems means dismantling the racialized aspects of various forms of transit and reframing public transportation as a tool for sustainability.

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APPENDIX

Appendix Table 1: CSA Models for Chapter 2

	San Jose-San Francisco-Oakland, CA CSA				Portland-Vancouver-Salem, OR-WA CSA				Seattle-Tacoma-Olympia, WA CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Total Population (ln)	.09	.07	0.12	1.0	.03	-.02	.07	1.0	.03	.01	.05	1.0
% Hispanic	.10	.06	.14	1.0	.06	-.02	.14	1.0	-.02	-.05	.00	1.0
% White (Non-Hispanic)	.24	.24	.02	1.0	.19	.11	.28	1.0	.10	.07	.13	1.0
% Black (Non-Hispanic)	-.11	-.14	-.08	1.0	.01	-.03	.06	1.0	.00	-.03	.02	1.0
Median Income	-.03	-.08	.03	1.0	-.02	-.10	.05	1.0	.03	-.01	.06	1.0
% Rent Burdened	-.06	-.09	-.03	1.0	-.14	-.19	-.09	1.0	-.03	-.05	-.01	1.0
Median Home Value (ln)	.16	.11	.21	1.0	.06	.00	.12	1.0	-.06	-.09	-.03	1.0
Median Gross Rent	-.05	-.09	-.01	1.0	-.07	-.13	-.02	1.0	-.04	-.06	-.01	1.0

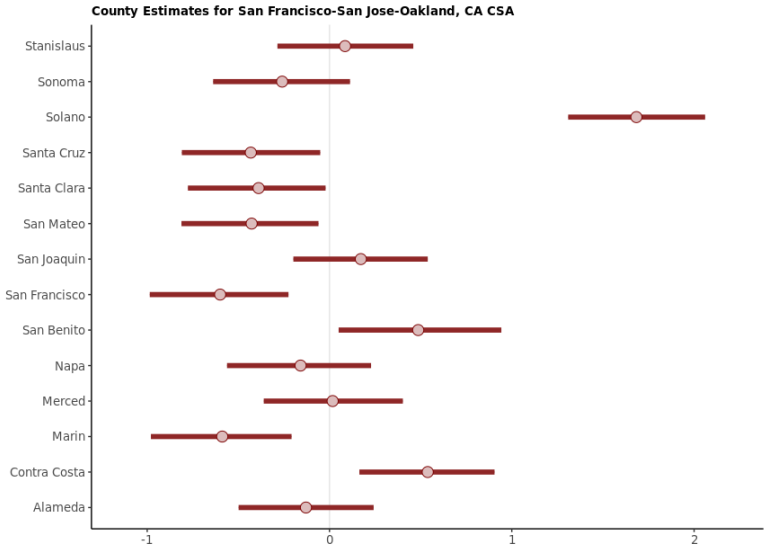
Notes: The 95% credible intervals are represented by the 2.5th and 97.5th percentiles of the distribution of posterior draws. The standardized point estimate is represented as the mean of the posterior distribution.

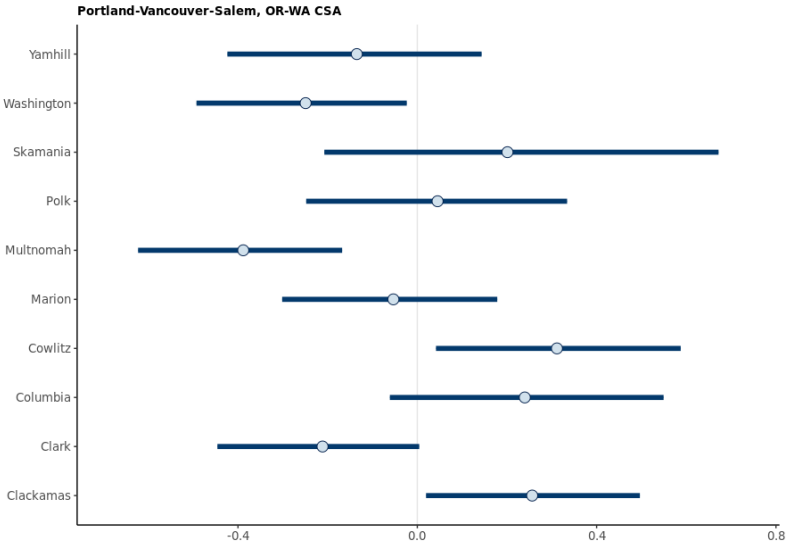
Appendix Table 1: CSA Models for Chapter 2 (Continued)

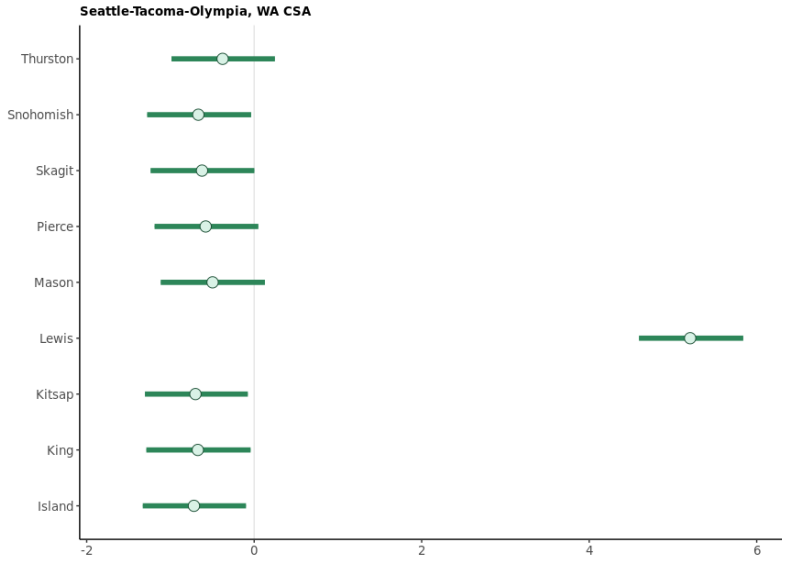
	Dallas-Fort Worth, TX-OK CSA				Los Angeles-Long Beach, CA CSA				Denver-Aurora, CO CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Total Population (ln)	.03	.02	.05	1.0	.03	.01	.05	1.0	.04	-.01	.10	1.0
% Hispanic	.0.2	-.01	.06	1.0	-.09	-.13	-.06	1.0	.29	.11	.47	1.0
% White (Non-Hispanic)	.12	.08	.16	1.0	.20	.17	.24	1.0	.50	.30	.70	1.0
% Black (Non-Hispanic)	.04	.01	.07	1.0	-.03	-.05	.00	1.0	.12	.03	.22	1.0
Median Income	.02	-.01	.04	1.0	.02	-.02	.05	1.0	.12	.03	.22	1.0
% Rent Burdened	-.01	-.02	.01	1.0	-.06	-.09	-.04	1.0	-.02	-.08	.05	1.0
Median Home Value (ln)	-.06	-.08	-.04	1.0	-.26	-.29	-.24	1.0	.00	-.07	.07	1.0
Median Gross Rent	-.03	-.05	-.01	1.0	-.07	-.10	-.04	1.0	-.17	-.23	-.10	1.0

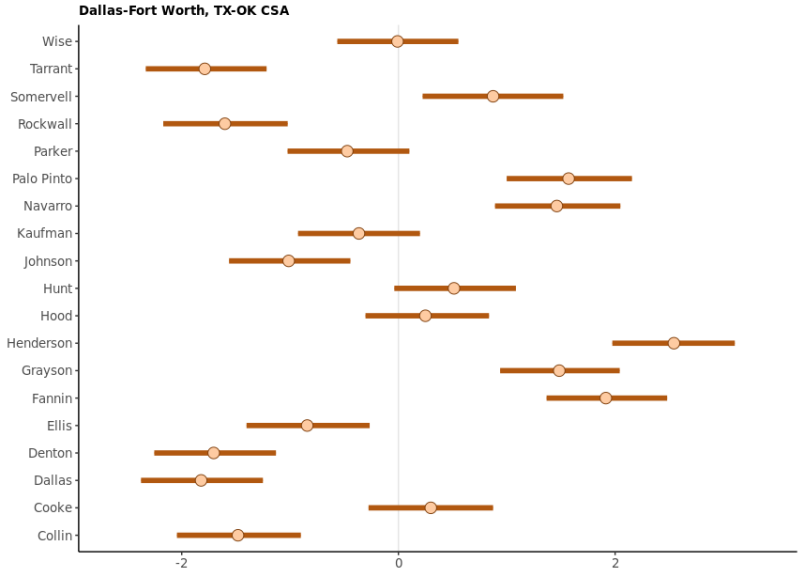
Notes: The 95% credible intervals are represented by the 2.5th and 97.5th percentiles of the distribution of posterior draws. The standardized point estimate is represented as the mean of the posterior distribution.

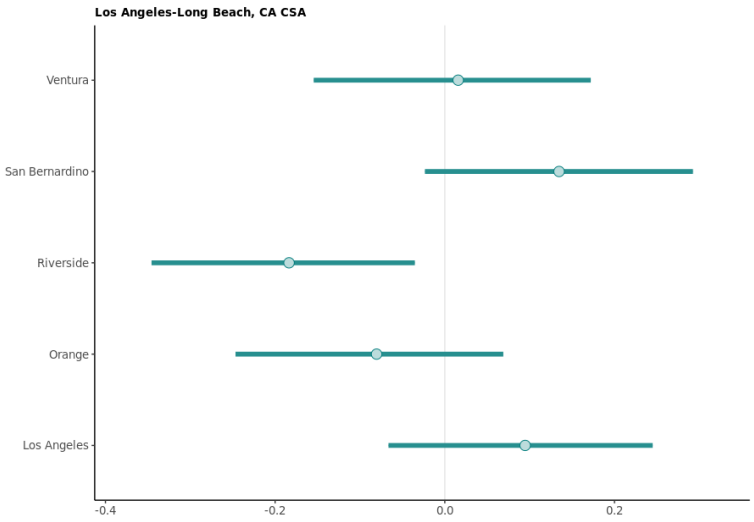
Appendix Figures 1-6: County Level Regression Results for CSAs in Chapter 2







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San Bernardino
Riverside
Orange
Los Angeles
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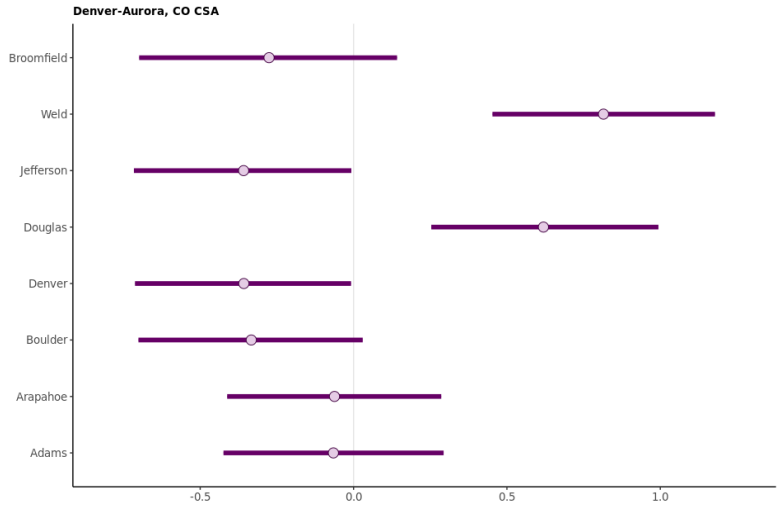
-0.2
0.0
0.2


Denver-Aurora, CO CSA
Broomfield
Weld
Jefferson
Douglas
Denver
Boulder
Arapahoe
Adams
-0.5
0.0
0.5
1.0

Appendix Table 2: MSA Models for Chapter 2

	San Francisco-Oakland-Berkeley, CA MSA				Portland-Vancouver-Hillsboro, OR MSA				Seattle-Tacoma-Bellevue, WA MSA			
	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Total Population (ln)	.21	.18	.25	1.0	.02	-.04	.08	1.0	.10	.06	.14	1.0
% Hispanic	.01	-.03	.06	1.0	.05	-.05	.14	1.0	-.05	-.10	.01	1.0
% White (Non-Hispanic)	.27	.22	.32	1.0	.20	.09	.32	1.0	.25	.18	.31	1.0
% Black (Non-Hispanic)	-.03	-.07	.01	1.0	.03	-.04	.10	1.0	-.02	-.08	.04	1.0
Median Income	.06	.01	.12	1.0	-.08	-.18	.02	1.0	.05	-.03	.13	1.0
% Rent Burdened	.03	-.01	.07	1.0	-.13	-.20	-.05	1.0	-.02	-.07	.03	1.0
Median Home Value (ln)	-.02	-.08	.04	1.0	-.03	-.10	.05	1.0	-.13	.19	-.06	1.0
Median Gross Rent	.03	-.72	.48	1.0	-.06	-0.13	.01	1.0	-.07	-.13	-.02	1.0

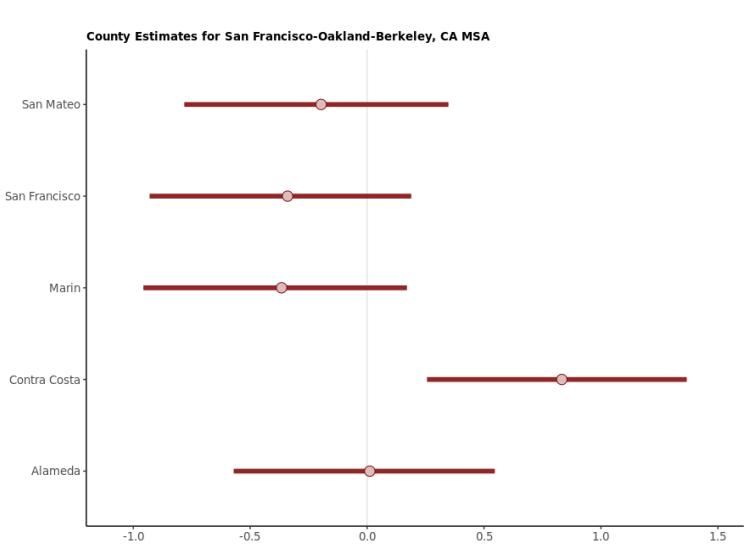
Notes: The 95% credible intervals are represented by the 2.5th and 97.5th percentiles of the distribution of posterior draws. The standardized point estimate is represented as the mean of the posterior distribution.

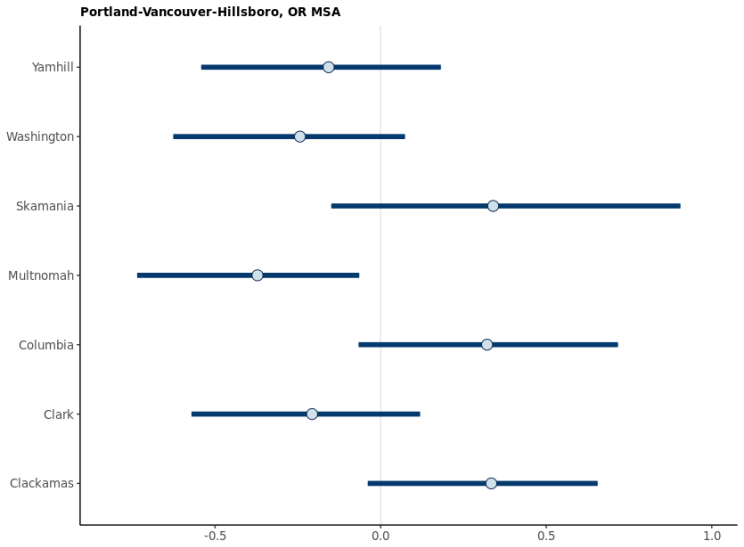
Appendix Table 2: MSA Models for Chapter 2 (Continued)

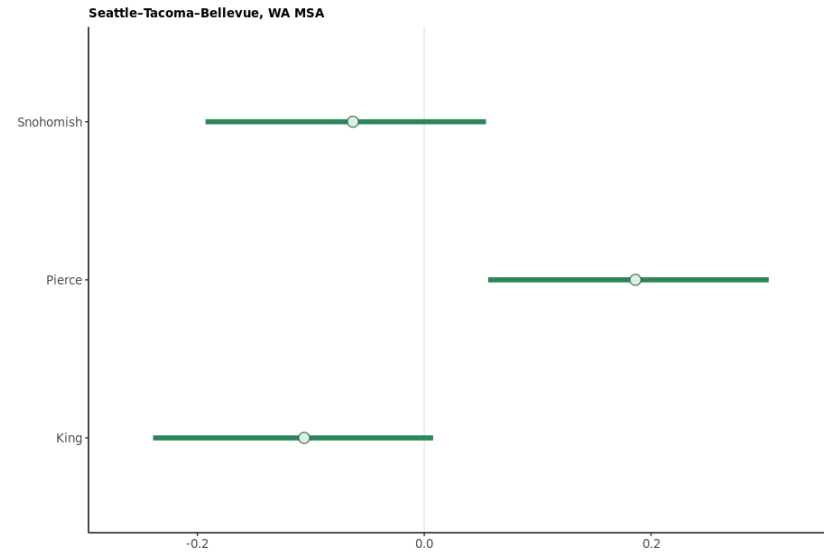
	Dallas-Fort Worth-Arlington, TX MSA				Los Angeles-Long Beach-Anaheim, CA MSA				Denver-Aurora-Lakewood, CO MSA			
	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Total Population (ln)	.06	.04	.09	1.0	.09	.07	.11	1.0	.01	-.05	.08	1.0
% Hispanic	.06	.00	.12	1.0	.00	-.04	.03	1.0	.32	.11	.54	1.0
% White (Non-Hispanic)	.23	.17	.29	1.0	.25	.21	.29	1.0	.54	.29	.81	1.0
% Black (Non-Hispanic)	.07	.03	.12	1.0	.01	-.01	.04	1.0	.14	.01	.26	1.0
Median Income (ln)	.03	-.01	.08	1.0	.11	.07	.15	1.0	.12	.00	.24	1.0
% Rent Burdened	.00	-.03	.02	1.0	-.04	-.07	-.01	1.0	.03	-.05	.11	1.0
Median Home Value (ln)	-.12	-.15	-.08	1.0	-.26	-.28	-.23	1.0	-.03	-.11	.06	1.0
Median Gross Rent	-.05	-.08	-.02	1.0	-.03	-.06	.00	1.0	-.15	-.23	-.07	1.0

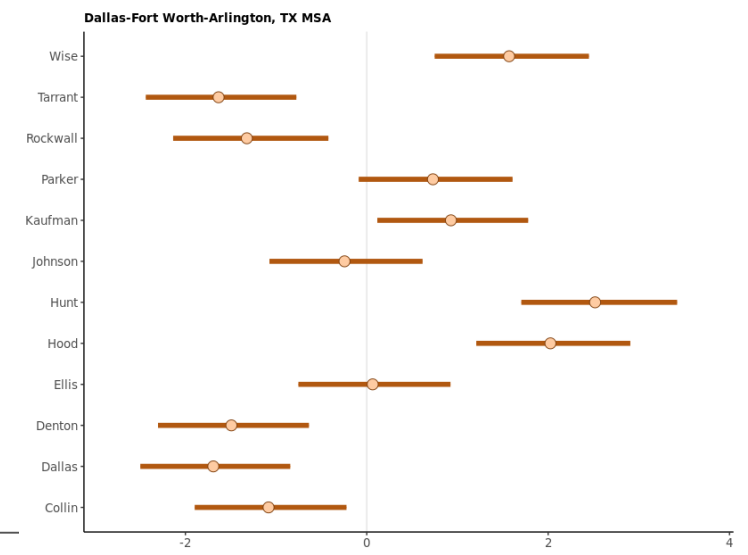
Notes: The 95% credible intervals are represented by the 2.5th and 97.5th percentiles of the distribution of posterior draws. The standardized point estimate is represented as the mean of the posterior distribution.

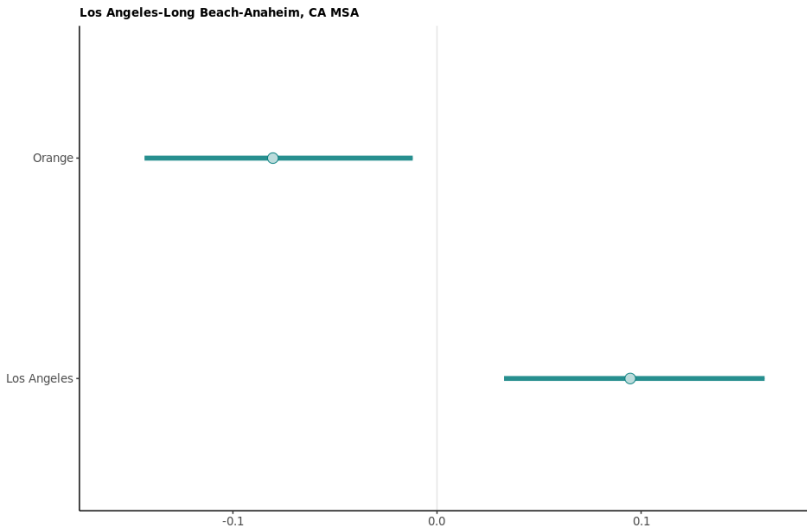
Appendix Figures 7-12: County Level Regression Results for MSAs in Chapter 2

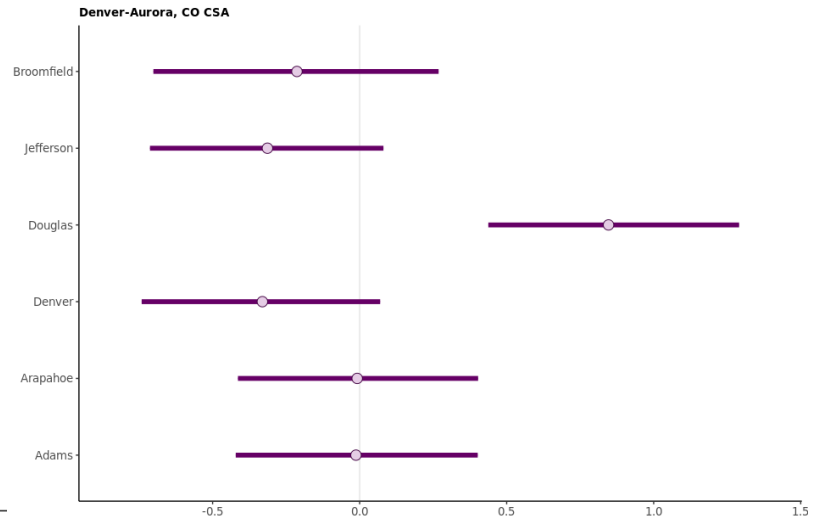









Los Angeles-Long Beach-Anaheim, CA MSA
Orange
Los Angeles
-0.1
0.0
0.1


Denver-Aurora, CO CSA
Broomfield
Jefferson
Douglas
Denver
Arapahoe
Adams
-0.5
0.0
0.5
1.0
1.5

Appendix Table 3: 2018 Models for Chapter 4

	San Jose-San Francisco-Oakland, CA CSA				Seattle-Tacoma-Olympia, WA CSA				Dallas-Fort Worth, TX-OK CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Transit Dependent Population	.00	-.09	.09	1.0	.11	-.05	.28	1.0	-.02	-.13	.09	1.0
Home Value (ln)	-.86	-.97	-.75	1.0	-1.06	-1.20	-.91	1.0	-1.53	-1.70	-1.36	1.0
% Rent Burdened	.09	.02	.16	1.0	.06	-.03	.15	1.0	.10	.00	.19	1.0
Population (ln)	.29	.21	.38	1.0	.95	.78	1.13	1.0	.63	.51	.75	1.0
% Hispanic	.46	.36	.56	1.0	.03	-.10	.17	1.0	-1.67	-1.96	-1.36	1.0
% White	1.16	1.07	1.26	1.0	.90	.75	1.05	1.0	-.52	-.89	-.16	1.0
% Black	-.30	-.39	-.21	1.0	-.46	-.60	-.32	1.0	-1.10	-1.33	-.86	1.0
High-Income Earners	.11	-.02	.25	1.0	-.30	-.46	-.13	1.0	.05	-.14	.25	1.0
Low-Income Earners	-.41	-.54	-.29	1.0	-.82	-.96	-.68	1.0	-.47	-.64	-.30	1.0

Appendix Table 3: 2018 Models for Chapter 4 (Continued)

	Los Angeles-Long Beach, CA CSA				Denver-Aurora, CO CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable								
Transit Dependent Population	.17	.07	.27	1.0	.70	.22	1.22	1.0
Home Value (ln)	-.87	-.94	-.80	1.0	-1.03	-1.21	-.85	1.0
% Rent Burdened	.01	-.04	.06	1.0	.13	.01	.25	1.0
Population (ln)	.11	.04	.17	1.0	.30	.16	.45	1.0
% Hispanic	-.07	-.15	.02	1.0	.01	-.35	.38	1.0
% White	.59	.51	.68	1.0	.69	.28	1.11	1.0
% Black	-.15	-.21	-.09	1.0	-.17	-.37	.05	1.0
High-Income Earners	.47	.37	.57	1.0	.44	.19	.68	1.0
Low-Income Earners	-.44	-.53	-.35	1.0	-.77	-.99	-.56	1.0

Appendix Table 3: 2010-2018 Change Models for Chapter 4

	San Jose-San Francisco-Oakland, CA CSA				Seattle-Tacoma-Olympia, WA CSA				Dallas-Fort Worth, TX-OK CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable												
Change in Transit Dependent Population	-.11	-.23	-.01	1.0	.18	.06	.31	1.0	.09	-.01	.20	1.0
Change in Home Value (ln)	-.09	-.14	-.03	1.0	-.40	-.49	-.31	1.0	-.06	-.14	.02	1.0
Change in % Rent Burdened	-.08	-.14	-.02	1.0	.01	-.08	.09	1.0	.03	-.06	.11	1.0
Change in Population (ln)	-.09	-.17	-.01	1.0	-.01	-.13	.11	1.0	-.01	-.13	.11	1.0
Change in % Hispanic	.07	.00	.15	1.0	.06	-.04	.16	1.0	-.18	-.35	-.01	1.0
Change in % White	-.07	-.14	.01	1.0	.00	-.11	.10	1.0	-.40	-.55	-.24	1.0
Change in % Black	.11	.05	.17	1.0	.00	-.09	.09	1.0	.04	-.09	.19	1.0
Change in High-Income Earners	-.17	-.22	-.10	1.0	-.07	-.16	.01	1.0	-.25	-.35	-.15	1.0
Change in Low-Income Earners	.07	.00	.13	1.0	.13	.04	.21	1.0	-.06	-.16	.03	1.0

Appendix Table 3: 2010-2018 Change Models for Chapter 4 (Continued)

	Los Angeles-Long Beach, CA CSA				Denver-Aurora, CO CSA			
	Mean	2.5th	97.5th	R-Hat	Mean	2.5%	97.5%	R-Hat
Variable								
Change in Transit Dependent Population	.11	.05	.18	1.0	-.08	-.22	.04	1.0
Change in Home Value (ln)	-.01	-.05	.03	1.0	-.25	-.36	-.15	1.0
Change in % Rent Burdened	-.01	-.05	.03	1.0	-.01	-.11	.09	1.0
Change in Population (ln)	.09	.02	.16	1.0	-.03	-.17	.09	1.0
Change in % Hispanic	.00	-.06	.06	1.0	.22	.05	.40	1.0
Change in % White	-.17	-.23	-.11	1.0	.11	-.07	.30	1.0
Change in % Black	.08	.03	.13	1.0	.15	.02	.28	1.0
Change in High-Income Earners	-.20	-.25	-.15	1.0	-.07	-.21	.07	1.0
Change in Low-Income Earners	.06	.01	.11	1.0	.18	.05	.31	1.0