Moving Forward Equitably?
Analyzing the Impact of Transportation Changes on Boston's Neighborhoods

By

Yanisa Techagumthorn

S.B. in Materials Science & Engineering and Urban Planning
Massachusetts Institute of Technology
Cambridge, MA (2018)

Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of

Master in City Planning

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

February 2019

Author _____
Department of Urban Studies and Planning
January 16, 2019

Certified by _____
Karilyn Crockett
Lecturer of Public Policy and Urban Planning
Department of Urban Studies and Planning
Thesis Supervisor

Accepted by _____
Associate Professor, P. Christopher Zegras
Chair, MCP Committee
Department of Urban Studies and Planning

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ABSTRACT

The Federal Aid Highway Act of 1956 provided the funds for Massachusetts to build a system of highways that threatened to cut through various neighborhoods in the greater Boston area. A broad coalition of people put a stop to these plans in 1972, and advocacy at the federal level allowed for highway funds to be shifted to public transportation projects. Many organizations within this coalition had broader goals of improving the livelihoods of their communities beyond just shutting down highways. Since equitable public transportation can play a key role in improving economic mobility, this thesis explores how changes in public transit stemming from the Boston anti-highway movement impacted nearby neighborhoods and assesses the areas that may still be lacking in access to adequate transit today.

In 1987, the Massachusetts Bay Transportation Authority (MBTA) used the funds, which were previously allocated for highways, to close down the old Elevated Orange Line on Washington Street and to build a new Orange Line along the Southwest Corridor nearby. As the replacement for the Washington Street Elevated, the Silver Line opened fifteen years later in the form of a bus route with aspects of bus rapid transit. For this thesis, I conducted a demographic analysis of the census tracts surrounding these two corridors and found that the Orange Line moved from an area with relatively lower incomes, lower education levels, and higher African-American population to an area with relatively higher incomes, higher education levels, and higher non-Hispanic White population. The Silver Line, a bus service inferior to the Orange Line trains, was put into the comparatively disadvantaged corridor. Zooming out to the rest of Boston, I conducted a geospatial analysis comparing the supply of transit, with respect to job access, to the demand, measured through a series of demographic indicators, and found the areas where the MBTA does not provide equitable service, especially for transit-dependent populations. Dorchester, in particular, stands out as a neighborhood with a high density of low-income, less-educated, minority populations without adequate public transit to get to economic opportunities.

Thesis Supervisor: Karilyn Crockett
Title: Lecturer of Public Policy and Urban Planning

Acknowledgements

Tremendous thanks to my advisor Karilyn Crockett for her guidance and support throughout the entire thesis process, especially her emphasis on refining my research question and narrative early on. I would like to thank my reader Justin Steil as well for helping me build off my undergraduate thesis that he advised and expand it to encompass my broader interests in transportation equity. The entire DUSP community has taught me so much over the last few years, which I greatly appreciate.

I would also like to thank my family and friends for offering me support over the last semester. Special thanks to Sarah B. and Ben P. for keeping me company during late nights in building 9. Thanks also to Liz M., Noah M., Haley M., Saritha R., Collyn C., and Max A. for their friendship and encouragement throughout this process.

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Executive Summary

Overview

Since the 1950s, several transportation events have impacted the social fabric and built environment of Boston. This thesis explores the relationship between Boston communities and transportation in three sections: 1) the anti-highway movement in the 1950s to 1970s; 2) changes to the Orange Line, Silver Line, and nearby neighborhoods in the 1980s to 2000s; and 3) access to jobs via public transit for different demographic groups in the city in the 2010s. A broad coalition of people put a stop to highway building, and many organizations involved had goals of improving the livelihoods of their communities beyond shutting down highways. Since equitable public transportation can play a key role in improving economic mobility, this thesis aims to answer the question: How have changes in public transit stemming from the Boston anti-highway movement impacted nearby neighborhoods, and what areas are still lacking in transportation access today?

The Boston Anti-Highway Movement: 1950s to 1970s

The Federal Aid Highway Act of 1956 allocated $24.8 billion in federal funding for states to build the Interstate Highway System. In Massachusetts, highway plans manifested in the form of eight highways through the greater Boston area, which threatened to cut through many neighborhoods. Building upon previous work by Crockett (2018), Lupo (1971), Gakenheimer (1976), and Kaiser (2018), I conduct a qualitative analysis of the network of organizations and people involved in the movement against this highway plan, with a focus on the fights against the Inner Belt in Cambridge, MA and the Southwest Expressway in the Boston neighborhoods of the South End, Roxbury, and Jamaica Plain.

The success of the movement in stopping all highway-building after 1969 can be attributed to the broad coalition of civil rights and community groups, transportation and planning organizations, and government entities setting aside their disagreements in favor of a united front against the highways. Specific individuals acted as conveners and communicators between these entities, bringing them together behind a common cause. For example, Ann Hershfang started her activism fighting the highway in the South End as a part of the Tubman Area Planning Council and building the transportation platform for the League of Women Voters. She eventually was given a position in the state Department of Transportation and served on the coalition to redesign the Southwest Corridor, the park and transit line that replaced the Southwest Expressway. Another success came when Governor Sargent advocated at the federal level for transit funding, after placing a moratorium on highway-building in the state. The resulting Federal Aid Highway Act of 1973 included a provision allowing states to use highway funding for transit and community improvements.

However, this movement only stopped destruction to neighborhoods and did not necessarily guarantee an improved economic condition, which was what many of the organizations involved were ultimately advocating for. Thus, for the rest of the thesis, I explore the aftermath of the highway movement in terms of changes to public transportation and how that has translated to economic mobility for different areas of the city.

Changes to the Orange Line, Silver Line, and Nearby Neighborhoods: 1980s to 2000s

In 1987, the Elevated Orange Line on Washington Street, also called the El, closed and the new Orange Line on the path cleared for the highways along the Southwest Corridor opened. Though both of these lines started downtown and ended in Forest Hills, the new route was between two blocks and half a mile away from the old line. In 2002, the replacement service for Washington Street opens as the Silver Line, a pseudo Bus Rapid Transit (BRT) system. In these middle fifteen years, long negotiations occurred between the Massachusetts Bay Transportation Authority (MBTA), the Federal Transit Administration, and various neighborhood groups. The communities were promised service equal to the old Elevated, and they advocated for light rail as opposed to BRT for the replacement service. Even today, many people in Roxbury and the South End call the Silver Line "the Silver Lie" (Carter, 2011).

The Elevated, Orange Line, and Silver Line historically and currently go through a variety of neighborhoods in Boston. I explore the demographic trends surrounding these public transit changes from 1980 to today. The demographics that I analyze are population, race/ethnicity, foreign-born populations, income and poverty, education, and commute times and modes. I mapped the census tracts on the walkshed around these two corridors, comparing the demographics of 1980, before the El was taken down, 2000, after the new Orange Line was put in, and 2014, after the Silver Line was put in. The differing trends were mostly along neighborhood lines, with the majority-White South End tracts faring better than majority-Black Roxbury tracts in terms of income, education level, and commute times. The Jamaica Plain tracts have had an increase in incomes, education levels, and people who commute by transit over the last few decades, as well.

In addition to these neighborhood patterns, there were some trends related to the changes in public transit that crosscut the neighborhoods. By moving the Orange Line from Washington Street to the Southwest Corridor in 1987, service was taken away from tracts that were poorer, less educated, and had a higher Black population, increasing commute times for these communities. Conversely, service was given to tracts that were richer, more educated, and had a higher White population. Though a replacement service did return to

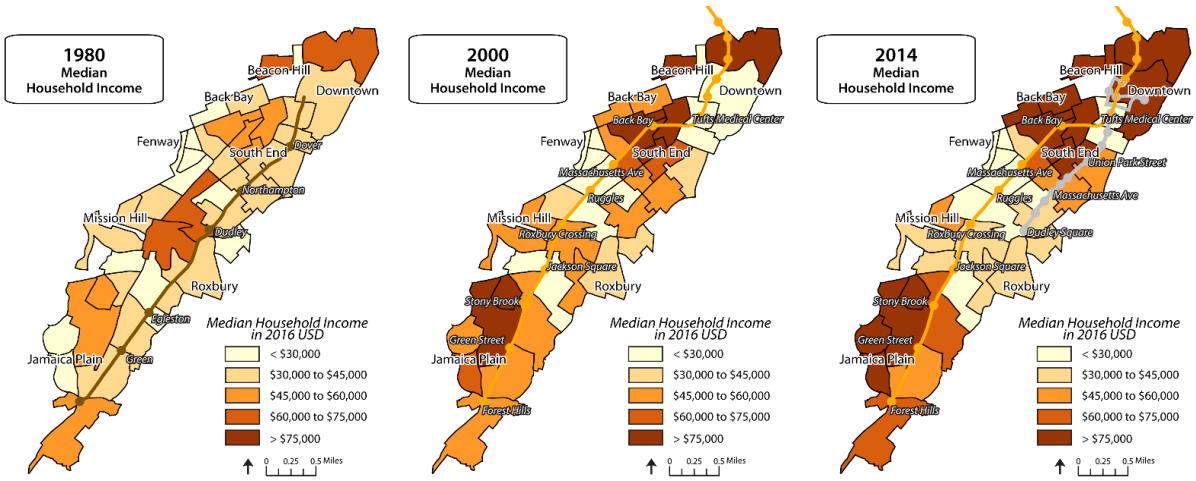


Figure A. Median household income by census tract in walkshed of Southwest Corridor and Washington Street corridor. Elevated Line shown in brown, Orange Line in orange, and Silver Line in silver. Data from Social Explorer (Decennial Census and American Community Survey) and MassGIS.

Washington Street, the more disadvantaged populations only got pseudo-BRT in the Silver Line, as opposed to the fixed route, higher-speed Orange Line. The Silver Line also ended at Dudley Square, so areas just south of that still do not have adequate rapid transit service.

As an example of the demographic analysis, Figure A shows the median household incomes of the census tracts in the walkshed surrounding these transit corridors in 1980, 2000, and 2014. In 1980, median household incomes were more evenly distributed, compared to later years when wealth was concentrated in the north of Downtown, the South End, and Jamaica Plain. The Orange Line moved from tracts with relatively lower incomes to tracts with diverging incomes—much higher around the South End and Jamaica Plain and a bit lower around Roxbury and Mission Hill. The difference in demographics between the tracts in these three neighborhoods and along these two corridors—leading to a difference in transit service—are just one part of the inequities in transportation services that exist today in the city of Boston.

Access to Jobs via Public Transit for Bostonians: 2010s and Today

Since commuting to work is one of the primary reasons for transportation, inadequate public transit can hinder economic opportunities, especially for populations already marginalized by other societal factors. Thus, I continue my investigation of Boston's transportation as it relates to communities by assessing transit access for the whole city today. As shown in Figure B, I use the number of jobs reachable within thirty minutes via public transportation from that area as the metric for transit supply (Owen & Murphy, 2017) and geographically divide this metric into four zones of analysis: dark green for "Most Access," light green for "More Access," orange for "Less Access," and red for "Least Access" (Figure C). For demand, I look at population density (Figure D) and other demographic indicators such as race, income and housing costs, age, employment status, education level, and commute modes and times. Based on the analysis, the MBTA does provide adequate service for many areas; the densest parts of Boston, such as around the downtown core, have the high levels of transit

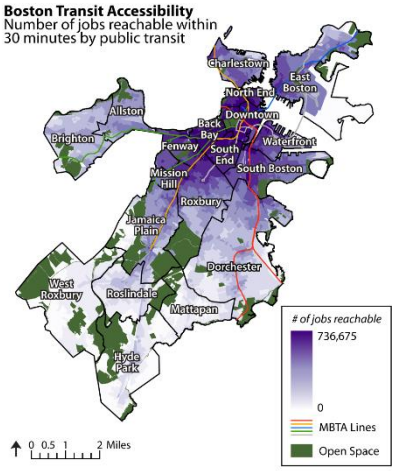


Figure B. Number of jobs reachable by public transit within 30 min from each census block. Data from UMinn Accessibility Observatory.

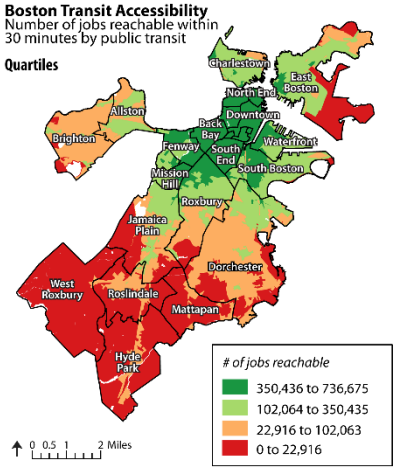


Figure C. Quartiles of transit supply: dark green for "Most Access," light green for "More," orange for "Less," red for "Least."

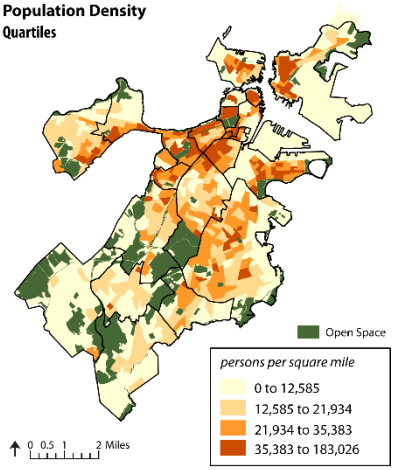
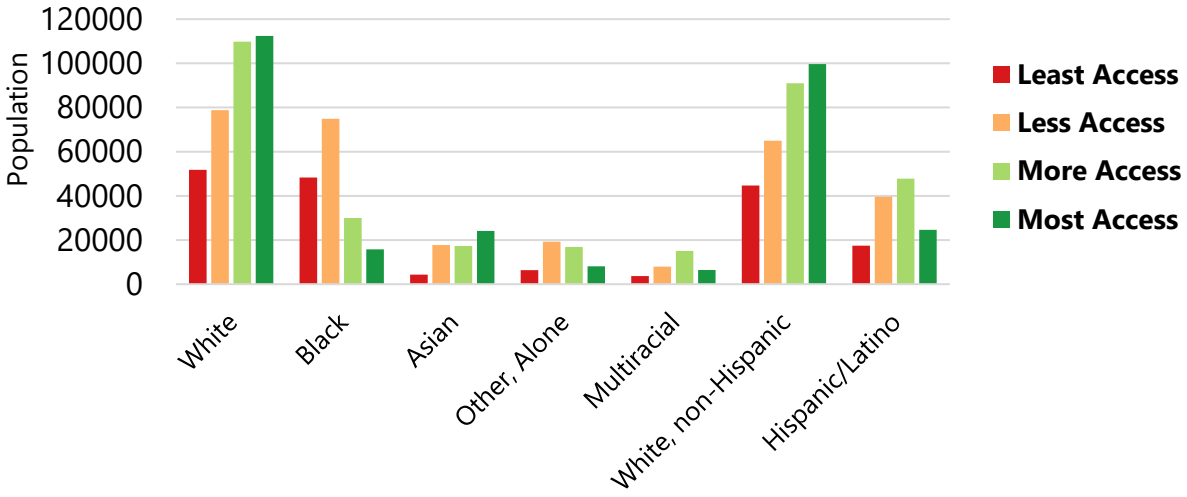


Figure D. Population density by block group in Boston. Data from Social Explorer (ACS 2017).

Figure E: Locational Transit Access & Race



available. However, not all areas are as transit accessible as these neighborhoods, and disadvantage communities tend to receive worse public transportation service.

The supply misses the demand of transit access the most in the zone I have previously labeled "Less Access." These areas contain some level of public transit, but not enough to bring many people to work within 30 minutes. Unlike the "Least Access" zones that are more suburban in nature and contain a wealthier population who have likely chosen car commuting willingly, the "Less Access" zone has a high proportion of minority, low-income, unemployed, and/or less-educated people who may not own cars and have relatively longer commute times. Figure E shows this trend for race, where the Black population peaks in the "Less Access" zone while the White population peaks in the "Most Access" zone.

One neighborhood that falls almost entirely within the orange zone is Dorchester, which has a high population density relative to other areas with low transit access. Since Dorchester has many of the disadvantaged populations listed earlier, the lack of good transit compounds the barriers to economic opportunities. Focusing on regions like Dorchester for improving access to public transportation can help loosen other barriers to economic mobility.

Recommendations for Further Work

By focusing on transportation equity, the City of Boston and the MBTA can improve transit to help residents of neighborhoods like Roxbury and Dorchester reach more economic opportunities. Moving forward from this thesis, further work can be done to propose a series of policy and planning solutions, such as transforming the Silver Line into full BRT. The same type of demographic and spatial analysis can be conducted beyond the city and into the greater Boston area as well. Lastly, the transportation field is changing fast with the introduction of new technology, such as bike- and scooter-share systems and ride-hailing apps. Planning for and figuring out how to extract public benefits from these new technologies can help make public transportation more efficient and equitable, which in turn can act as a catalyst for social and economic mobility.

1. Highways, Public Transit, and Communities

1.1 Overview

On June 29, 1956, President Dwight D. Eisenhower signed the Federal Aid Highway Act of 1956 into law, paving the way to drastic changes in the urban fabric of the United States of America. The Act allocated $24.8 billion in federal funding for states to build what is now known as the Interstate Highway System. The 42,796 mile network of highways increased long-distance mobility, spurring the growth of suburbs and reliance on automobiles throughout the country. The Interstate Highway System also greatly impacted cities, with highway plans threatening to cut through urban cores and neighborhoods, often with success. In cities, these plans largely targeted low-income areas and communities of color and, in combination with white-flight made easier through cars and highways, changed the demographic makeup and social structures of these cities. In almost every major city in America, organized movements formed to protest the existence or placement of highways, which were met with varying success.

Public transportation, with a slower growth and longer history than America's highway system, has its roots in horse-drawn omnibus and electric streetcar services run by private companies in the 1800's. By the turn of the century, many cities had some form of steam- or cable-powered and at-grade or elevated mass transit. Boston and New York City opened the first subway systems on the continent, and other major cities followed suit. Over time, subways were expanded, while streetcars and trolleys soon gave way to gasoline-powered buses. City and state governments formed transportation agencies and authorities to take control of transit services that were previously privately owned. By the mid-1900s however, many systems had fallen to disrepair, and public transportation was only used by the poorest, and often carless, social classes.

The stories of how the highway system and public transportation affect the lives of urban residents collide in Boston during the second half of the twentieth century. In the 1960s and early 1970s, residents of the Greater Boston Area built a metropolitan-wide coalition that successfully protested a highway system planned through their city. After a moratorium was declared on highways in Boston, federal laws were passed to allow highway

funding to be used for public transportation projects. The Massachusetts Bay Transportation Authority (MBTA) was able to expand their subway service, which included removing the elevated Washington Street train and replacing it with a rerouted Orange Line through the Southwest Corridor. This and subsequent changes in transit service around Boston affected different neighborhoods, and while the MBTA is one of the best transit systems in the United States, many communities in the city are still lacking adequate service.

Since the mid-to-late 1900's, Boston residents, especially those who work downtown, have become reliant on the MBTA to transport them to work and play. For those without cars, cannot drive, or work in a place without adequate parking, efficient public transportation plays a major role in ensuring economic success, since it can bring people to job interviews and on time to their work. A lack of adequate transit can perpetuate other existing socioeconomic divides in a city, while better geographic mobility can lead to greater economic mobility.

This thesis explores instances of transportation infrastructure changes in Boston from the time of the highway movement to today and assesses neighborhood changes and current challenges to mobility**.** Coalition building and large networks advanced the anti-highway movement and stopped most of Boston's highways from being built, but many of the organizations involved in this protest had broader goals of improving the livelihoods of their communities, beyond shutting down highway plans. Since public transit plays a key role in improving economic and social livelihoods, this research aims to answer the question: How have changes in public transit stemming from the Boston anti-highway movement impacted nearby neighborhoods, and what areas are still lacking in transportation access today?

The next part of this chapter explores research and work previously done by others adjacent to the research question regarding highway movements, transit access, transportation equity, and Boston's economic context. The chapter ends with an overview of the methodology for the research of this thesis. Chapter 2 investigates anti-highway movements, beginning with an overview of movements across the country, then focusing in on Boston. I explore the network of key players and organizations involved in the movement

and analyze its successes and failures after the moratorium on highways. Chapter 3 deals with a series of related transportation changes linked to the end of the anti-highway movement: the closing of the Washington Street Elevated line, the rerouting of the Orange Line to the Southwest Corridor, and the opening of the Silver Line along Washington Street. I analyze how the demographics of the neighborhoods near Washington Street and the Southwest Corridor change during this shift in transportation infrastructure from the 1980s to the 2000s. Chapter 4 explores transit-related inequities that exist in Boston today, despite the previously mentioned infrastructure changes, through investigating the demographic characteristics of areas with low access to jobs using public transit. Lastly, Chapter 5 provides a summary of the findings from this thesis's research and proposes areas for further research to improve transportation accessibility and equity in Boston and beyond.

1.2 Literature Review

Many scholars have written about anti-highway movements around the United States. Since these movements happened in so many cities, each written piece is often focused on a specific American city and draws conclusions that relate to other anti-highway and social movements as a whole. For example, Alan Altshuler (1965), who was also involved in the Boston anti-highway story, starts his book *The City Planning Process* with a chapter titled "The Inter City Freeway," detailing the unsuccessful anti-highway story of the Twin Cities. Robert Caro (1974), in *The Power Broker*, tells the story of the Cross Bronx and Lower Manhattan Expressways in the context of Robert Moses's relationship to New York. In the more recent *The Folklore of the Freeway*, Eric Avila (2014) writes about various anti-highway movements, with a special focus on Los Angeles, and grounds the analysis around race and diverse communities.

Focusing in on Boston, Karilyn Crockett's (2018) recent book *People Before Highways: Boston Activists, Urban Planners, & A New Movement for Citymaking*, is the most comprehensive account of the city's anti-highway movement, telling the narrative from the passage of the Federal Aid Highway Act of 1956 to the moratorium on highway building in 1972 to the subsequent creation of the Southwest Corridor. Crockett's written and interviewing work is a major source for Chapter 2 of this thesis. Alan Lupo (1971) of the

Boston Globe also wrote a book on the earlier half of the Boston highway story, titled *Rites of Way: The Politics of Transportation in Boston*. Similarly, Ralph Gakenheimer (1976) wrote a piece titled *Transportation Planning as a Response to Controversy – The Boston Case*, which is a case study on the Boston Transportation Planning Review. A few works have focused specifically on Cambridge, MA as well, including Steve Kaiser's (2017) report titled "Citizen Opposition to the Inner Belt" and events conducted by the Cambridge Historical Society.

This thesis also builds off my previous work on the Boston anti-highway movement, from the 1948 state master highway plan to the rebuilding of the Southwest Corridor after 1973, in my Massachusetts Institute of Technology (MIT) undergraduate thesis "Social Movements & Interstate Highways: A study of anti-highway revolts in Boston and beyond." I explored the network of people and organizations that contributed to the success of the movement and how that led to the shift in federal funding to transit (Techagumthorn, 2018).

Shifting to transit-related literature, Jonathan Belcher (2018) maintains a detailed list of changes to the MBTA since 1964, in a document titled "Changes to Transit Service in the MBTA district 1964-2018." With regards to the story of the closure of the Washington Street Elevated Line in 1987 and the opening of the bus rapid transit (BRT) Silver Line in 2002, Kristopher Carter (2011) provides an excellent overview in his Tufts master's thesis, "Equal or Better: The Story of the Silver Line," and accompanying documentary of the same name. Through a series of interviews and in-depth explanatory research, Carter analyzes the long process of picking a type of service for the Silver Line, which was meant to replace the old Elevated, as well as if the ultimate choice of a BRT system was the fair choice for the residents of this area.

In a report titled "Land Use Impacts of Bus Rapid Transit, Phase II—Effects of BRT Station Proximity on Property Values along the Boston Silver Line Washington Street Corridor," researchers for the Federal Transit Administration studied the impact that Silver Line stations have had on surrounding condominiums in terms of property values and land uses. The research team found that, in the walkshed of Washington Street, property values slightly decreased with decreasing distance to Washington Street prior to the opening of the Silver Line and slightly increased with decreasing distance to the Washington Street Silver

Line stations after the opening of the line. There was also an increase in parcels with their land use designated for condominiums, signaling the city encouraging development around these stations, which may have contributed to increasing the attractiveness of building closer to the stations (Perk, Catala, & Reader, 2012).

Though public transportation in Boston is primarily under the jurisdiction of the MBTA and the Massachusetts Department of Transportation (MassDOT), the City of Boston has conducted its own studies and plans as well, with a particular focus on how transit impacts communities and neighborhoods within the city. In May of 2002, as a part of *Access Boston 2000-2010, Boston's Citywide Transportation Plan*, the Boston Transportation Department and the Central Transportation Planning Staff (CTPS, Boston's Metropolitan Planning Organization) released a document detailing demographic, economic, and transportation facts and trends at the neighborhood scale. The report looked at trip profiles, roadway network, auto ownership, public transportation network, parking, and bicycles with neighborhoods as the unit of analysis (Boston Transportation Department, 2002). More recently in 2017, the City of Boston published the "Vision and Action Plan" as a part of the *Go Boston 2030* initiative to envision transportation for the city in the near future. A part of the report analyzes how people in Boston travel to work, including the trips' affordability and time, also by neighborhood. Current planning initiatives after the release of this Action Plan include creating a transportation plan for each neighborhood group (Boston Department of Transportation, 2017).

A number of scholars have specifically studied transit accessibility through mapping and data techniques. Junfeng Jiao (2017) devises a relatively simple methodology for finding "transit deserts," or areas of low transit accessibility, in a city in a paper titled "Identifying transit deserts in major Texas cities where the supplies missed the demands." He compares transit demand, measured by the transit dependent population, with the transit supply, measured by transit infrastructure and service, and deduces areas where demand exceeds supply as the "transit deserts." In the paper "Spatiotemporal dimensions of modal accessibility disparity in Boston and San Francisco," Mizuki Kawabata (2009) studies the disparity in job accessibility by car versus public transit in 1990 and 2000 in Boston and San Francisco. T.L Lei and R.L. Church (2010), in "Mapping transit-based access: integrating GIS,

routes and schedules," review different definitions and measures of transit accessibility and propose a more complex accessibility measure that takes into account time of service and combined trips in getting to a destination. Timothy F. Welch and Sabyasachee Mishra (2013) contribute to the literature, in the paper "A Measure of Equity for Public Transit Connectivity," by creating a methodology to measure transit equity through a variety of factors at the stop, line, and zone scales and applying it to the Baltimore-Washington region. Additionally, Karen Chapple (2009) proposes methods for analyzing susceptibility to gentrification of various areas, especially where transit-proximity is a major factor in "Mapping Susceptibility to Gentrification: The Early Warning Toolkit." She focuses on household income compared to the area median income around areas of high transit.

Lastly, the Accessibility Observatory at the University of Minnesota publishes yearly a study called "Access Across America: Transit 2017," which comparatively shows the access to jobs via transit for the fifty biggest cities in the United States; this data is used for Chapter 4 of this study. This institute provides a measure of the number of jobs within thirty minutes by census block, easily downloadable from their website for major cities (Owen & Murphy, 2017).

1.3 Methodology

The methodology of research differs for each of the next three sections, briefly described below and described in more detail in the chapters:

For Chapter 2, which focuses on the Boston anti-highway movement, the method of research is primarily through secondary sources, presented as the historical background for the chapters that follow. Using these sources, I map out the networks between key players and organizations that led to the moratorium on highway building in 1972. Then, through looking at the outcomes of the movement and goals of the organizations involved, I analyze its successes and failures.

In Chapter 3, which focuses on the shifts in the Orange and Silver Lines and neighborhood demographics, Kristopher Carter's work and other sources serve as a background to the story. Using Decennial Census and American Community survey data, I map out a variety of demographic factors at the census tract level around the Orange and

Silver Line walksheds to see the change over time in the make-up of this area. Specifically, for each turn-of-the-decade, I investigate:

1. Population
2. Race and ethnicity
3. Foreign-born population
4. Income and poverty level
5. Education
6. Commute modes and time

Based on these GIS maps, I then draw conclusions regarding neighborhood change over time near these rapid transit lines. I also look at the trends for these demographics for Boston overall and the neighborhoods of the South End, Roxbury, and Jamaica Plain.

In Chapter 4, I focus on current transit accessibility, especially as a catalyst for economic opportunity. Using the University of Minnesota Accessibility Observatory Access Across America data, I mapped the number of jobs accessible within thirty minutes by public transit from the center of each census block to represent the transit supply of the city. Using American Community Survey 2017 5-year estimates, I mapped the following demographic indicators to represent different variables of transit demand:

1. Access to jobs via transit and population density
2. Race and ethnicity
3. Income and housing costs
4. Age
5. Employment status
6. Education
7. Commute characteristics

By comparing areas with low job access by transit to areas where people who need transit may live, I deduce areas that need more transit investment input by the city and the state.

The thesis ends with a concluding chapter that mentions ways to expand on this research and other analyses that can be conducted to fully understand the historical and current transit equity context in Boston.

2. Anti-Highway Movements and Boston's Limited Success

2.1 The Nation

In 1919, a young lieutenant named Dwight D. Eisenhower was part of a transcontinental convoy that tested the efficiency of the road system of the United States of America. It took the convoy sixty-two days to get from Washington, DC to San Francisco, CA (Rodrigue, 2017). Fast forward to World War II, this young lieutenant became the Supreme Allied Commander in Europe, where he witnessed the efficiency and effectiveness of the German Autobahn. Because of these experiences, when Eisenhower entered his presidency, he made improving the American road system one of his major goals. Three years into his presidency, he signed the Federal Aid Highway Act of 1956 into law, providing the stepping stones for a national highway system. Though he was not the first president to advocate for a highway network, since Franklin D. Roosevelt also advocated for a transcontinental superhighway in the 1930s, the economic conditions in the post-war 1950s were ideal for a focus on domestic infrastructure efforts. Many states already had highways, but they were intrastate roadways and had tolls posted on the roads in order to pay for construction and maintenance. In contrast, the Federal Aid Highway Act of 1956 gave states funding to build larger, non-toll highways that would be interconnected across the country.

The original purpose of the Dwight D. Eisenhower National System of Interstate and Defense Highways was to improve movement of defense machinery and weapons around the country, but the system has drastically changed the landscape of America beyond just creating access for national defense (St. Clair, 2014). The 1956 Act authorized $24.8 billion in funds from 1957 to 1969 to build 40,650 miles (later expanded to 42,796 miles) of highways by 1972 (Schwager, 1997). Many state and city governments took full advantage of this funding, since highway building resulted in a large number of jobs and potential growth for nearby businesses. Car companies, oil companies, and business associations were generally all supportive of the highway building.

The highway system increased mobility to previously hard-to-access parts of the country, paralleling an increase in automobile usage and suburbs. The highways disproportionately benefitted white and affluent families who used the new highways to flee

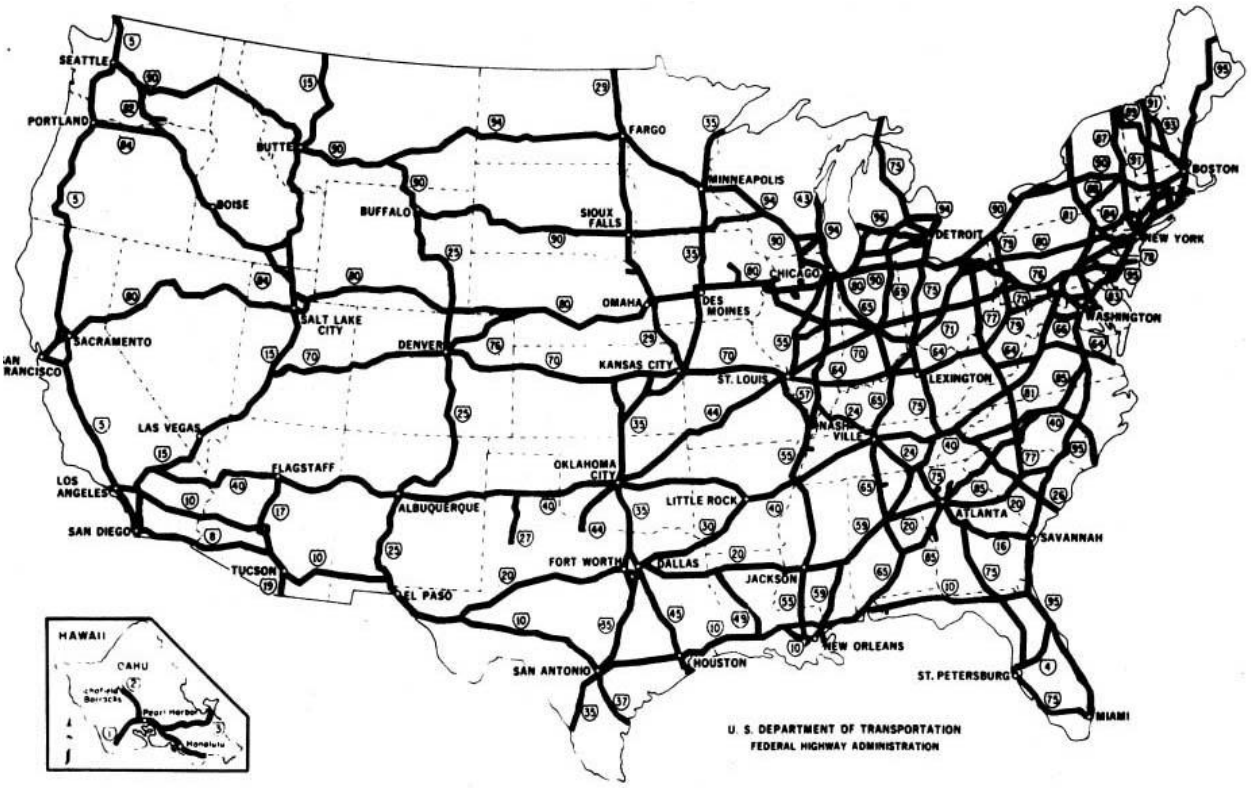


Figure 1. Map of Interstate Highway System. Reprinted from "The Dwight D. Eisenhower System of Interstate and Defense Highways," by *U.S. Department of Transportation Federal Highway Administration*, n.d., Retrieved December 23, 2018, from https://www.fhwa.dot.gov/interstate/finalmap.cfm.

the inner cities and move to the suburbs, while still being able to commute to their jobs in the cities (Nall, 2015). This white-flight increasingly polarized racial and socioeconomic groups. Though Eisenhower's intentions for building the interstate highway system were more focused on defense and politics than social policy, the results of building highways would forever change the social fabric of the nation.

Despite the benefits of highways to certain groups of people, building highways through towns and cities across America was not always welcomed or successful. Looking at the highway system today (Figure 1), it does not exactly match the plans laid out in the 1950s. Gaps remain where highways do not connect and where highways curve around, instead of through, certain areas. Each gap, curve, and modification to the original plan has a story to tell, signifying the successes and failures of various social movements in the cities.

Though the interstate highway system was largely built in rural or suburban areas of America, its construction greatly impacted inner cities. Highway planning was largely done

behind the closed doors of state transportation planning agencies and departments of public works, using models and previous experiences to plan routes. Highway engineers had little concern for the communities that the highways were going to cut through. Many plans optimized for efficiency and cost savings, placing the routes through the most direct configuration. Other plans were optimized for more subjective reasons, such as going around an affluent neighborhood so that its rich residents would not complain. Whatever the intention, in most major cities, highway plans directly cut through many minority and low-income neighborhoods, displacing many dwelling units, and splitting communities apart. Many anti-highway protests around the country arose as a result of these plans. However, only a few were successful at either rerouting or completely removing a highway segment. By briefly examining the highway stories of cities around the US, key takeaways can be noted based on their formation and outcomes:

> *San Francisco, CA* – The highway movement in San Francisco showcased a series of government internal power struggles. In 1947, the California state legislature shifted the focus of highways from multipurpose rural roads to superhighways that went directly into cities from limited towns, through shifting the distribution of funds. California was the first state to have a highway system, and the federal Interstate and Defense Highway Act of 1956 replicated the same focus to the rest of the country. The focus of these acts was on funding, so there was little consideration on how the highways would socially, economically, and environmentally affect cities. San Francisco became one of the first battlegrounds in California to revolt against the new infrastructure policies. The Collier-Burns Act of 1947 promised to make San Francisco's highways rival those of Los Angeles. It called for 25 miles of elevated skyways through the city, one section of which, titled the Embarcadero, was expedited for construction. Opposition within the city quickly arose against the Embarcadero (which was built starting in 1959 and eventually torn down in 1989), as well as a cross-city freeway that would connect the Golden Gate Bridge to San Mateo County in the south. William C. Blake, the San Francisco Supervisor, led the revolt on the city side, eventually pulling the federal government into the issue. The situation was characterized by fights of city groups and city planners versus state

highway engineers, though of course there were many opposing and supporting voices within both the city and state levels. After many close calls, the protestors succeeded, and San Francisco today contains very little of its original highway plans (Johnson, 2009). This case shows how the power struggle regarding highway construction can occur between different levels of government.

New York, NY – New York City was the scene for both early highway construction and early anti-highway protests; the stories of the Cross Bronx Expressway and the Lower Manhattan Expressway are two of the most notable. The Cross Bronx Expressway was built between 1948 and 1963 by Robert Moses, a city official responsible for much of New York's landscape. The highway cut through many low income neighborhoods in the Bronx. Even though the neighborhood and partner organizations tried to propose an alternate plan, which would move the route just one block away, Moses would not alter his plan (Caro, 1974). The movement against the Lower Manhattan Expressway in 1941 to 1968 was more successful. Also planned by Moses, this 10-lane highways was supposed to be an extension of Interstate 78 through SoHo and Little Italy, with 416 buildings proposed for demolition. A coalition of residents, different ethnic groups, intellectuals, laborers, and others led by Jane Jacobs, a neighborhood activist, was successful at stopping the plan from being implemented (Paletta, 2016). The Cross Bronx Expressway marked the last major highway built in the city, and the loss of the Lower Manhattan Expressway fight signaled the decline of Robert Moses's reign over New York. This case, arguably the most well-known of the anti-highway revolts, highlights how key individuals shape anti-highway movements.

St. Paul, MN – First proposed in the 1920s and planned in 1944, the proposal to connect the Twin Cities became realized as Interstate 94 after the passage of the Federal Aid Highway Act of 1956. The route planned between St. Paul and Minneapolis cut through the Prospect Park and Rondo neighborhoods in St. Paul, predominantly African-American neighborhoods, for the sake of efficiency, but spared a richer neighborhood near the university. Downtown business-owners saw the highway as an opportunity to stimulate their businesses, since the vitality of the central business district had been declining for a while. George Herrold, the city

planner, tried to address the issue of equity and proposed a different route, but he was not successful and the city engineers ignored him. Many African-American residents of St. Paul were displaced because of this highway (Altshuler, 1965). This case is important because it highlights the issues of class and race institutionalized in planning and engineering practices.

Baltimore, MD – Interstates 70, 170, 95, 395, and 83 were all planned to intersect Baltimore in some way between the 1950s and 1981. Opposition by various groups prompted multiple redesigns of the highway layout in and around the city. The result was a network that spared some neighborhoods and destroyed others, and left the now-infamous "Highway to Nowhere" in the middle of the city (Kozel, 2007). A particularly successful group called Movement Against Destruction saved 28,000 housing units and many neighborhoods from demolition. This group was a coalition of different races, ethnic groups, and classes, especially since the highway route was set to go through all types of neighborhoods, both predominantly black and predominantly white. Movement Against Destruction and their partner organizations took the highway battle into the courts, challenging the city on the grounds of both planning procedure and environmental quality (Mohl, 2002). This case highlights how forming interest groups can contribute to successful protests through usage of the court system.

Birmingham, AL – Birmingham has a long history of racial conflicts, including highway revolts in the 1950s and 1960s. The city had racial zoning laws from 1926 until the 1950s when these laws were struck down by the federal government. Slum clearance and public housing after the racial zoning laws were lifted perpetuated neighborhood segregation in the city. Planning for the interstate highway system began in 1956, and the original plans bisected at least four of Birmingham's predominantly black neighborhoods, including East Birmingham, East Lake, Smithfield, etc. Some of the routes bisecting these neighborhoods seemed purposeful, especially when the highway curved to avoid a whiter and richer neighborhood. Since the highways displaced so many black residents, they moved elsewhere, such as predominantly white neighborhoods, causing white residents to flee to the suburbs, and Birmingham

soon became predominantly black. Ironically, the method used to destroy black neighborhoods actually led to a decrease in segregation in the city. While many neighborhoods lost the fight against the highway engineers, there was one case of successful opposition in the Central City. The Red Mountain Expressway was planned to go through the Central City, displacing about 200 to 400 dwelling units. The Highway Department and the city council refused to listen to the Central City residents, both blacks and whites, who protested the plan. It was not until the residents joined forces with the Alabama State Tenants Organization and took the city to federal court, that the protestors were able to change the location of the highway, and, interestingly, also were granted renovations for all of their houses (Connerly, 2002). This case highlights the institutionalized racism in many government efforts and how courts can help efforts that lead to success.

Boston, MA – In 1948, the Massachusetts Department of Public Works released a Master Highway Plan for the Boston Metropolitan Area. The plan included eight radial expressways, some of which were interstates (I-90, 93, and 94) and others were state highways: East Boston, Northeast, Northern, Northwest, Western, Southwest, and Southeast Expressways and the Central Artery. A central Belt Route, called I-695 or the Inner Belt, was planned to connect all of these radial expressways together (Joint Board for the Metropolitan Master Highway Plan, 1948). In the path of these highways were neighborhoods that the city deemed as slums and ghettos, especially in downtown Boston (Crockett, 2018). By the mid-1970s, despite many more planned highways, only the Central Artery project remained. Instead of building the other highways, Boston fought for and was granted an expanded subway system. Environmentalists, city planners, community activists, universities, and politicians from around the region came together to protest and were eventually successful in blocking many sections of the proposed highway system (Kleespies). Three notable organizations that aided the anti-highway movement were Urban Planning Aid, the Boston Black United Front, and the Greater Boston Committee on the Transportation Crisis (Crockett, 2018). By the end of the 20th century, a project called the Big Dig was well underway to move the Central Artery underground, removing all major

highways from the surface level of Boston and effectively ending the conversation about cutting up Boston with major highways.

Many of the cities listed here and elsewhere that had successful anti-highway revolts credit their success to building broad coalitions of different stakeholder groups at many levels and employing a variety of tactics. The Boston case in particular showcases this strategy. The results of the Boston anti-highway movement led to changes in public transit in the Boston area and beyond.

2.2 The Boston Anti-Highway Movement

Prior to the anti-highway protests in the 1960s and 1970s, various areas of Boston were targets of urban renewal efforts. In what is now a textbook case of what-not-to-do for urban renewal, the Boston Redevelopment Authority marked the West End as a "slum," razed the whole neighborhood to the ground, and built an underused government center in its place. Enabled by the Federal Housing Act of 1949, this effort displaced thousands of largely immigrant families (The West End Museum, n.d.). Boston's Chinatown was also affected by both highway building and urban renewal. The Central Artery, the extension of the Massachusetts Turnpike into the downtown area, displaced businesses and families in the south and east areas of Chinatown in the 1950s. The nearby Tufts New England Medical Center also placed pressure through urban renewal on the edges of Chinatown. Further urban renewal was halted by the 1960s though, due to the city reevaluating its policies after the West End situation

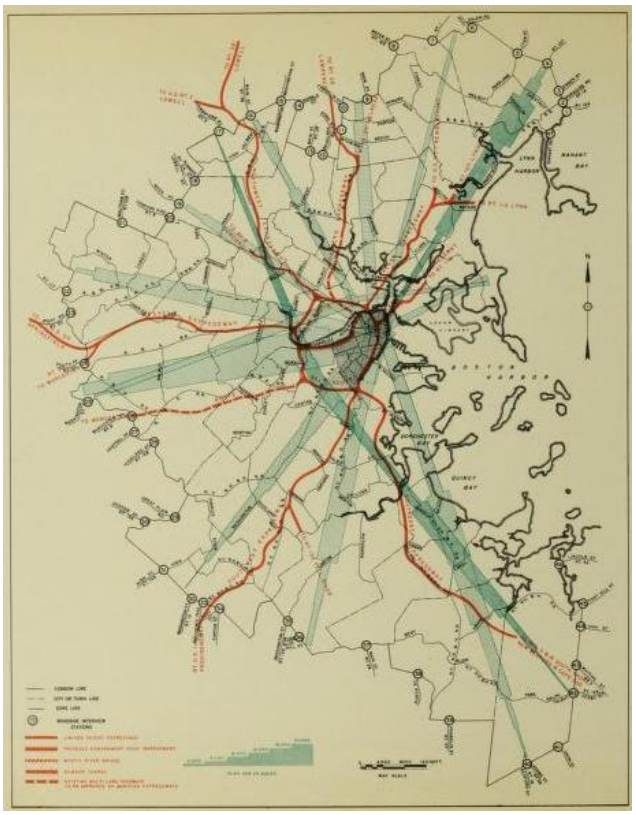


Figure 2. Major Desire Lines of Travel in Boston. Adapted from *Master Highway Plan for the Boston Metropolitan Area*, by Joint Board for the Metropolitan Master Highway Plan et al., 1948.

(Chinatown Atlas, 2018). After the Federal Aid Highway Act of 1956, city and state agencies shifted their attention to transportation infrastructure, especially highway building.

Before funding for highway building became available through the Highway Act, the Joint Board for the Metropolitan Master Highway Plan, in cooperation with the Department of Public Works, the Public Roads Administration, and the Federal Roads Agency, published the Master Highway Plan for the Boston Metropolitan Area on February 1, 1948. A number of consultants prepared the plan by conducting traffic studies, specifically evaluating current traffic conditions and modeling origins and destinations in the Greater Boston Area, shown in Figure 2 as major desire lines of travel. The study concluded on eight highways for the area and these highways were presented in this plan (Joint Board for the Metropolitan Master Highway Plan, 1948). The selected routes were:

1. Southeast Expressway – Brookline, Dorchester Bay, and old Harbor
2. Southwest Expressway – Downtown business district, Roxbury, Dorchester, Hyde Park, Milton, and Dedham
3. Western Expressway –Brookline, Brighton, Watertown, Newton, and Waltham
4. Northwest Expressway –Somerville, Arlington, Concord, Medford, Winchester, and Woburn
5. Northern Expressway – Malden, Everett, and Melrose
6. Northeast Expressway – Charlestown, Chelsea, and Revere
7. East Boston Expressway – East Boston, Revere, Logan Airport
8. Belt Route (including Central Artery) – Crosstown movement between expressways, plus Cambridge and Somerville

The Central Artery section of the Belt Route was the first to be built, and the elevated section opened in 1959 (Turner & Tuite, 2013), disrupting downtown, Chinatown, and North End communities. The Federal Aid Highway Act of 1956 and the funding that came with it allowed the planning of the rest of the expressways to start. The 1960s and 1970s were characterized by protests against these expressways, which already had close to complete funding to build them.

One main pocket of these protests surrounded the Inner Belt in Cambridge, MA. In the 1948 master plan, the Inner Belt was routed through the Riverside neighborhood of Cambridge on Lee Street. In 1957, after highway funding became available, the Cambridge Planning Board proposed a new route through a more "blighted" area of Cambridge, in the Cambridgeport neighborhood on Brookline and Elm Streets, threatening to demolish the homes of 1235 families and businesses with 2366 employees (Samuelson, 1967). The Brookline-Elm route would become the route advocated for by the state and highway builders, solidified in the state's plan for the Inner Belt in 1962 (Kaiser, 2017). Inner Belt opponents first proposed a less disruptive route through Portland and Albany Streets, which bordered MIT, before settling on a position of no highways in the city.

Though the Inner Belt routing was disliked by the city and its citizens since the original plan, opposition truly mobilized shortly after the 1962 Brookline-Elm routing was established. In 1963, the Cambridge Committee on the Inner Belt was formed when Boston Redevelopment Authority planners Fred Salvucci and Tunney Lee realized that the Inner Belt engineering study was biased towards a pro-highway stance. They started conducting studies themselves, and by 1964 joined with sociologist Gordon Fellman, MIT urban anthropology professor Lisa Peattie, Harvard assistant professor of city planning Chester Hartman, and architects Denis Blackett and Robert Goodman to propose alternate highway routes to the City of Cambridge. In early 1966, Jim Morey**,** an analyst turned advocate, joined the group and became the executive director of the organization rebranded as Urban Planning Aid (UPA), now focused on technical advocacy for the whole Boston region. UPA members employed their planning and technical expertise to publish their own reports refuting Department of Public Works (DPW) claims regarding the plans for the Inner Belt and other highways around the Greater Boston Area (Lupo, Colcord, & Fowler, 1971).

Also in Cambridge, the residents whose lives would have been disrupted by the construction of the Inner Belt organized under the Save Our Cities Committee, led by Bill Ackerley a retired small-businessman and Ansti Benfield a Boston University student, both living in Cambridgeport. The committee also worked closely with the Catholic Church, gaining support and members. On October 15, 1966, the committee organized the "Beat the Belt" rally in front of the State House, the first of many similar protests (Kaiser, 2017).

In response to the reports and protests, Governor John Volpe ordered a restudy of the Inner Belt project, which was to be done by a consultant picked by the state DPW, and formed a citizens' advisory committee on the restudy. Community leaders such as Catholic priest Father Paul McManus served on this committee. Even though a year later the restudy resulted in DPW endorsing the same route, traction picked up while the study was being conducted. MIT as a whole was at first largely ambivalent about the Inner Belt, but the administration became involved when one of the proposed alternate routes risked disrupting institute labs and properties. By May of 1967, opposition of the highway had spread within the universities of Cambridge, and 528 faculty and staff from Harvard and MIT released a statement opposing the Inner Belt and calling for a complete restudy of Boston's transportation system (Lupo, Colcord, & Fowler, 1971). Additionally, many key players in the overall Boston anti-highway story had previous or future connections to MIT, as faculty or students.

Within the Cambridge government, the Cambridge City Council became early supporters of the movement against the Inner Belt, and Justin Gray, the assistant city manager, worked closely with community groups and other city governments to push against highways. Another notable name active in the fight against the Inner Belt was Cambridge activist-turned-politician Barbara Ackermann, who served on the school board, then city council, then became mayor of the city. As the network of those opposing the Inner Belt grew, so did the magnitude of the anti-highway movement itself.

Other areas of Boston faced similar issues, and the network between neighborhoods began to intersect. On the other side of Boston, the Southwest Corridor Expressway threatened to cut through the neighborhoods of Roxbury, Jamaica Plain, Hyde Park, and the South End. In contrast to Cambridge, where the Inner Belt was still in its planning stage, bulldozers had already cleared 500 homes and many businesses along the Southwest Corridor by 1966.

Since this expressway was going to disproportionately affect the black population of Boston, one of the main groups fighting against it was Boston's Black United Front, through a specific subcommittee set up for the cause, Operation STOP. Chuck Turner was the

chairman of the Front at this time, and he worked to unite the black residents of the South End, Roxbury, and Dorchester together in protest of the Southwest Expressway, as did Gloria Fox, who would go on to become the state representative for the 7th Suffolk District (Crockett, 2018). The Urban League was also involved with the Front and its anti-highway efforts. Mel King, who was director at that time, often convened large meetings to organize and provide services for the residents around the Southwest Corridor. Though not always in agreement with each other with regards to civil rights tactics, the Black United Front and the Black Panthers did unite in their stance against the expressways going through black neighborhoods. Floyd Hardwick, who served as the Captain of Education for the Panthers in the 1960s, played a role as a community organizer for the anti-highway movement (Crockett, 2018).

Other groups that were involved included Irish and Eastern European populations of Jamaica Plain and the League of Women Voters. Though many good-government groups were initially supportive of the Inner Belt, as it promised jobs and innovations in cities, the Boston chapter of the League set up a transportation committee within it, headed by Ann Hershfang. In this committee, Hershfang came to a position against the highway plans, and went on to propose to the Massachusetts State League that the state convention should also conduct a study of the transportation system. Hershfang chaired this state level League study as well and spread the anti-highway stance to suburban women who were a part of the League, expanding the movement outside of urban Boston (Hershfang, 2010). Since the highways were planned to go through some natural and conservation sites, the Sierra Club also played a role in gathering environmentalists and conservationists to join the cause.

A small group of Jamaica Plain residents, who would eventually call themselves the Jamaica Plain Expressway Committee, connected with Urban Planning Aid in 1967 after learning about the anti-Inner Belt movement in Cambridge. They were seeking help regarding mitigating the effects of the planned highway on the neighborhood, since to them, the elevated highway was a given. UPA helped these residents realize that other areas of Boston had depressed, rather than elevated, highways planned, but since Jamaica Plain was a poorer area than these other neighborhoods, the state was opting for the less costly, but more invasive, option. The Jamaica Plain Expressway Committee conducted their own study

of highway alternatives, presented these findings around Boston, and lobbied for the support of the Boston City Council. Mayor White got involved, leading to him getting Governor Volpe to call for a restudy of the Southwest Expressway (Lupo, Colcord, & Fowler, 1971). The South End had a similar group called the Tubman Area Planning Council, which included Ann Hershfang and architect Ken Kruckemeyer (Hershfang, 2010).

The various groups in Cambridge and Boston formed the Greater Boston Committee on the Transportation Crisis (GBC) in 1968. The GBC comprised of activists, priests, planners, residents, and more, and the group protested the Boston highways through multiple means. Both Chuck Turner and Father Thomas Corrigan chaired this committee at different times. Another active leader in the GBC was Brad Yoneoka, a community organizer living in the South End. Through networks within the agencies and governments, members advocated for a complete restudy of the Boston transportation system, preparing their own research and proposing legislation. On the public-facing side of the committee, they organized "People Before Highways" day—a rally in Boston Common on January 25th, 1969, with nearly 2000 attendees (Crockett, 2018).

By this point in time, Nixon had appointed John Volpe to be the US Secretary of Transportation, which led to Lieutenant Governor Francis Sargent being promoted to Governor of Massachusetts. The rally prompted Governor Sargent to assemble a private task force chaired by MIT professor of political science and future MA Secretary of Transportation Alan Altshuler, with Jack Wofford as executive director. The task force recommended that Sargent halt all construction of the controversial expressways and launch a comprehensive review of Boston's transportation needs. Sargent accepted these recommendations, and on February 11, 1970, announced on television: "Nearly everyone was sure that highways were the only answer to transportation problems for years to come. But we were wrong" (Luberoff, 2012). He announced the creation of the Boston Transportation Planning Review (BTPR) to be headed by Jack Wofford with a mandate for an open public process to reevaluate the state's transportation plan and priorities. In the same year, Boston's Mayor Kevin White ran against Sargent for governorship, and while White lost, the race led to both of them adopting a stronger stance against highways. White's executive assistant Barney Frank and Sargent's

urban affairs aid Al Kramer also worked behind the scenes and with the Greater Boston Committee to coordinate the effort on stopping the highways.

Throughout the next two years, the BTPR conducted many interviews and economic and engineering studies on the transportation system in the Commonwealth. On November 30, 1972, Governor Sargent appeared on television again, this time to announce the findings of the review—stopping all highway building and pursuing a legal means of using federal funding to build more public transportation and commuter rail (Crockett, 2018).

Though the anti-highway protesters achieved victory in 1972, there was still a lot of work to be done both on the government and grassroots side. The Southwest Corridor had already been partially cleared for highway building, so there was the question of what to do with the land. At the time of Sargent's proclamation in 1972, federal highway funding was still solely for highway building, so Massachusetts was going to lose a large amount of needed transportation funding.

At the federal level, Governor Sargent appealed to Congress to allow for usage of highway funds for other transportation infrastructure. Tip O'Neill, the Congressman representing North Boston who transitioned from being Majority Whip to Majority Leader around the same time, was also supportive of the anti-highway cause, since many houses in his district would have been demolished to make room for the expressway. Secretary of Transportation John Volpe, who was the governor Massachusetts during the start of the anti-highway movement, also advocated for a more holistic look at national transportation planning. With many crucial players in Washington supportive of mass transit and the anti-highway cause and after much debate in Congress, the Federal Aid Highway Act of 1973 passed with authorization for $18 million more in transportation infrastructure funding and allowed for transit projects to receive this funding where interstate plans had been withdrawn (DiMento & Ellis, 2013).

This act allowed Boston to convert the Southwest Corridor into what is now the MBTA Orange Line. As a major industrial center throughout the end of the 19th century and the first half of the 20th century, the Southwest corridor and its surrounding neighborhoods were going through a time of transition during and after the anti-highway fight. One such

community was Bromley Heath, a public housing project built in the 1940s and 50s during the peak of urban renewal. In 1971, using federal funds earmarked for tenant managed public housing developments, the residents of Bromley Heath incorporated into an independent non-profit called Bromley Heath's Tenant Management Corporation (TMC). As the creation of this organization coincided with the cancellation of the Southwest Expressway, Bromley Heath TMC became invested in the redesign of the Southwest Corridor, as did residents of the nearby public housing developments Alice Taylor and the Mission Hill Extension Project. Operation STOP and the Boston Black United Front also became involved and pushed for a new umbrella organization, the Southwest Corridor Land Development Coalition (SWCC), connecting the South End, Roxbury, and Jamaica Plain parts of the corridor. The grassroots organizing of the Southwest Corridor eventually lead the Southwest Corridor Park, plus bike and pedestrian trails, basketball courts, and an urban farm network (Crockett, 2018).

The Boston anti-highway story, from the Master Plan of 1948 to the extension of the Orange Line and redesign of the Southwest Corridor, is the story of many intersecting organizations, governments, and people. The organizations that were a part of the Boston highway story, both on the pro- and anti-highway sides, can be loosely categorized as general civil rights or community entities, transportation- or planning-specific community entities, and government entities. Within each of these groups are people who between 1950 and 1980 belonged to one or more of the organizations, or moved between them. Table 1 summarizes the many organizations that were involved in this movement.

2.3 Evaluating the Boston Movement's Success

As shown in the story above, though many of the local movements started with residents getting together to discuss the threat of highways in their neighborhoods, these movements eventually connected and pushed its way into city halls and the State House. Key players within different levels of government influenced each other, and from White to Sargent to Volpe, a cautionary look at highways had spread and led to change. Churches and institutions such as MIT also played roles as large entities important to local governments.

Table 1. Organizations involved in Boston anti-highway movement.		
General Civil Rights and Community Groups	*Transportation & Planning Community Organizations*	*Government Entities*
– Boston Black United Front (Operation STOP) – Urban League – Black Panther Party – League of Women Voters – Sierra Club – Bromley Heath's Tenant Management Corporation – Alice Taylor Public Housing Development residents – Mission Hill Extension Project residents – Church groups – Massachusetts Institute of Technology – Harvard University	– Urban Planning Aid – Cambridge Committee on the Inner Belt – Save Our Cities Committee – Jamaica Plain Expressway Committee – Tubman Area Planning Council – Greater Boston Committee on the Transportation Crisis – Southwest Corridor Land Development Coalition	– US Department of Transportation – Congress + Presidency – State of Massachusetts Government – State Department of Public Works – State Secretary of Transportation – City of Boston Government – Boston Redevelopment Authority – Cambridge City Council – Cambridge Planning Board – Boston Transportation Planning Review

Disagreement between and within racial and social groups, such as between the Black United Front and the Black Panther Party or between inner-city and suburban communities, were set aside in favor of a united front against highways in Boston. Though the Greater Boston Committee had its internal conflicts, some among these groups, the combined effort led to a more powerful coalition in getting the residents of the greater Boston area to come out to rallies and protests—events that politicians listened and responded to.

The world of transportation, even now, is largely male-dominated, and this story showcases the important work of women in community organizing. Though the names of these women were less recorded in literature than that of men in positions of power, women were instrumental in organizing grassroots protests, bringing whole communities (including children) to rallies. The Southwest Corridor redesign was a grassroots effort led by women in the public housing developments nearby. It should also be noted that important work behind-the-scenes often goes unrecognized, especially traditionally feminine and

administrative positions such as secretaries and office managers for these organizations and government agencies.

Another major factor that likely led to the success of this movement was the role of conveners and planners, some of whom adopted many titles in the story. The planners of Urban Planning Aid lent their technical expertise to their communities, while still working for the BRA to improve planning from inside the government. Fred Salvucci, in particular, eventually ended up as the state secretary of transportation, but always kept his community-focused ideology with him. Many players, like Salvucci and Altshuler, also had ties to MIT and used connections within the institution to gain wide support for the anti-highway movement. Jim Morey was instrumental in connecting groups across Boston together and was effective as both an analyst restudying highway routes and a community organizer across different neighborhoods. Justin Gray, Barney Frank, and Al Kramer, young staff in city halls and the State House, respectively, also played important roles behind the scenes, interfacing between each other and the community groups, and finagling a joint strategy leading up to Sargent's 1972 announcement.

After the Boston moratorium on highway building in the metro area, the passage of the Federal Aid Highway Act of 1973 by Congress signaled a successful shift in how the national government thought about highways. The increase in potential public transit funding (from the highway fund) allowed for Boston to extend the Red Line and improve the Orange Line. Connected to the Orange Line, the redevelopment of the Southwest Corridor was successful in its community-oriented planning practices and the involvement of nearby neighborhoods in its design.

However, the successes of the highway protests do not necessarily mean improved lives for the residents of Boston, but rather just the prevention of further harm by government infrastructure to the urban fabric. Many of the civil rights and community groups described earlier were not specifically focused on highways, but rather on fixing societal problems for their members as a whole. For example, the Black United Front and the Women's League had goals of increasing the power of African Americans and women, respectively, which includes securing better economic opportunities. Additionally, there are

no clear indications that the coalitions formed between all of these neighborhood, civil rights, and governmental groups lasted beyond the Greater Boston Committee on the Transportation Crisis. Socioeconomic divides continue to persist in Boston, and sometimes these groups are on opposing sides. Lastly, the redevelopment of the Southwest Corridor likely led to gentrification affects in the surrounding areas, bringing greater polarization between richer neighborhoods and the public housing communities.

One major contributor to economic security and equity is the availability of affordable and efficient transportation, especially public transit that can bring a person to work and back home in a reasonable amount of time. The Red Line expansion provided better transit service to residents surrounding Porter Square, Davis Square, and Alewife. The Orange Line shift provided better transit service to parts of the South End, Roxbury, Mission Hill, and Jamaica Plain. However, this new Orange Line was not an expansion, but rather a replacement for the older Elevated Washington Street Line. The Elevated was taken down in the same year, removing mass transit service from the Washington Street corridor between downtown and Forest Hills. Thus, while affordable and efficient transportation to economic opportunities may have expanded for some residents in this region, these opportunities may have been made more difficult to reach for others. While the Boston Anti-Highway Movement and the subsequent transit funding availability in the Federal Aid Highway Act of 1973 is often considered a success, different neighborhoods in Boston may have been impacted in unequal ways.

3. Public Transit and Neighborhood Changes

3.1 The MBTA Orange and Silver Lines

On Friday, May 1, 1987, the old Orange Line—also called the Washington Street Elevated train, or the El—ran its last trip from downtown Boston to Forest Hills through the Washington Street Corridor. Three days later, the new Orange Line opened for service, also from downtown to Forest Hills, but underneath a new linear park called the Southwest Corridor about half a mile away from the old line at its widest point and two blocks away at its narrowest. An expanded 49 bus route replaced the Washington Street service, which was eventually converted to the Silver Line between Dudley Square and Downtown fifteen years later on July 20, 2002 (Belcher, 2018).

The new Orange Line, its partially depressed and partially underground tracks, and its nine new stations were a direct result of the anti-highway movement described in earlier chapters. The Federal Aid Highway Act of 1973 had a provision that allowed federal highway funding to be transferred to transit and community development, put in place partially due to the advocacy work of Massachusetts government officials after the anti-highway movement at the federal level. After the I-95 project along the Southwest Corridor was officially removed from the Interstate Highway System in 1975, the funding for the now-defunct highway plan was converted to funding for the new Orange Line project, the first time this provision was used. The Southwest Corridor was already cleared for the eight-lane highway, so the space was transferred to transit purposes as well (Salvucci & O'Leary, 1987).

Many Boston residents gladly welcomed the project. The El was old, loud, and blocked sunlight from getting to the ground floor of Washington Street. The new Orange Line was sleek, clean, and underground. The new stations showcased characteristics of the neighborhoods in which they were located, designed with a great amount of community input. Southwest Corridor Park opened around this time as well, and featured beautiful landscaping, trails, basketball courts, community gardens, and more, also designed with

extensive input from the surrounding neighborhoods. The oldest subway system in the country was suddenly getting a revamp with this new line, and people around city, from community activists to government officials, were excited for the change (Howe, 1987).

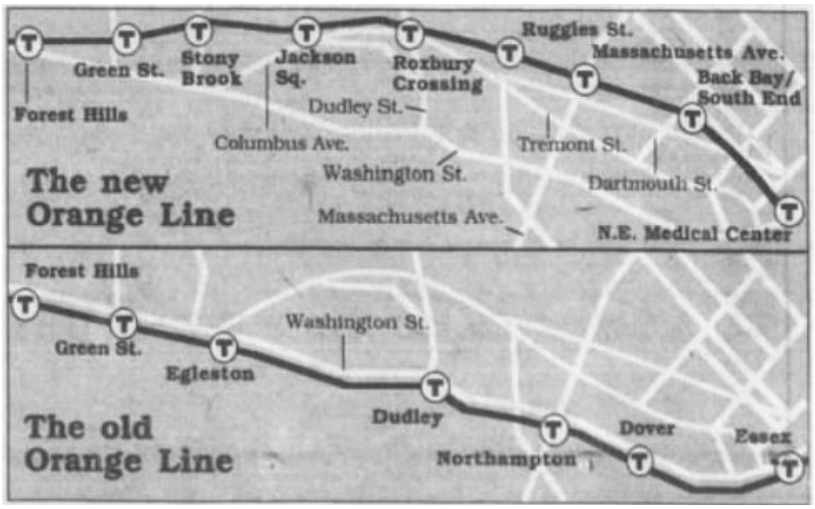


Figure 3. Map of Orange Line change from newspaper clipping. Retrieved from *The Boston Globe*, 03 May 1987.

However, this shift from the El to the new Orange Line did not benefit everyone equally and did disadvantage a subset of the population. For those that lived along Washington Street, the El provided a fast and affordable way to get downtown. The area along the El, especially Dudley Square, was a populous commercial and residential area, as opposed to the mostly residential Southwest Corridor. Since the new Orange Line stations were two blocks to half a mile away from the old El stations (Figure 3), many riders had to walk farther or take a different bus to get to a rapid transit line. In addition to travel times increasing dramatically for some riders of the El, people had to pay an extra fare for the bus and walking in Boston's hot summers and cold winters is not always pleasant. The MBTA promised a permanent replacement on Washington Street to replace El service, but by the time the El closed down, the agency had not yet come to a decision on what the replacement service would look like and expanded the 49 bus service to cover the route in the meantime (Howe, 1987).

Eventually, the MBTA chose the Silver Line as the replacement service for the El, which was finally implemented in 2002, fifteen years after the opening of the new Orange Line. The Silver Line is modeled off bus rapid transit (BRT), made popular by Curitiba, Brazil as a lower-cost way to provide mass transit to dense populations. Elements of BRT include a dedicated lane physically separated from other road traffic, fewer stops and shorter wait times than regular buses, and off-bus fare payments (Carter, 2011). The Silver Line takes a few elements from this list, but is not full BRT; it is a system of large buses along the

Washington Street corridor with a dedicated but not physically separated lane for most of the route, fewer stops and shorter lead times, and the same fare system as other routes. The branding of the "Silver Line," as opposed to a numbered bus route, is similar to the other subway and light rail lines in Boston.

Before coming to the decision of pseudo-BRT for the Washington Street replacement service, the MBTA also considered light rail, trackless trolley (trolley bus), regular bus, and electric bus (Carter, 2011). Since funding for transit projects generally comes from the Federal Transit Administration (FTA), called the Urban Mass Transit Authority (UMTA) before 1991, the MBTA had to make this decision under the confines of the planning and funding decisions of the federal government. On the neighborhood side, communities in both the South End and Roxbury were involved in the replacement decision process, fighting for the quality of service that they lost with the closure of the El.

Between the final environmental impact statement to start the Southwest Corridor Project in 1977 and when the new Orange Line opened in 1987, the MBTA and the UMTA engaged in back-and-forth discussions about conducting the Replacement Transit Improvement Study. After many iterations of the MBTA replacement alternatives feasibility study and the UMTA continually changing what studies they were willing to fund, the MBTA settled on recommending light rail in nearly every category except capital costs. However, the UMTA rejected the plan for light rail as the replacement service, so by 1989 the MBTA was preparing to state-fund an electric trolley bus service (found viable in an earlier feasibility study) (Carter, 2011). During the same decade, local forces were mobilizing in the South End and Roxbury, forming into a community group called the Washington Street Corridor Coalition (WSCC) in 1986 to make sure public voices were heard in the replacement debate.

In 1990, while opposition to the electric bus idea grew within Roxbury and the South End, the WSCC successfully urged the MBTA to resubmit plans for light rail to the FTA, which was then rejected due to cost. In 1995, Mayor Menino created the Washington Street Task Force (WSTF) consisting of residents, business-owners, and others along the corridor, and in 1997, WSTF published a report with new street design improvements. The report

supported calling the service the "Silver Line," but did not recommend between bus, light rail, and trolley bus. At the mayor and state representatives' urging, the MBTA formed the Washington Street Design Oversight Committee (WSDO), which after many meetings approved the pseudo-BRT option favored by the MBTA and the FTA. In 1999, the MBTA got funding from the FTA to create the Silver Line as a BRT pilot, and in 2002, Silver Line service began between Downtown and Dudley Square (Carter, 2011).

The WSCC and other neighborhood activists spent the 1990's protesting for a replacement service that was truly comparable to the El. While the Silver Line was much better all-around than the 49 bus, the comparison was not as clear with the Elevated Orange Line. The El had fewer stops than the Silver Line and blocked daylight from most of Washington Street, so the new service may have made the lives of some along the corridor more convenient. However, travel times increased for those trying to get from Dudley Square to Downtown, hindered even more by the fact that the separated bus lane ended when the Silver Line reached downtown and the buses often got stuck in traffic. The Silver Line also did not go past Dudley Square to the south, compared to the El that went all the way to Forest Hills. Additionally, bus systems, even when rapid, do not have the same permanence as rail systems. Though heavy rail may not have made sense for this corridor, since the Red and Green Lines are close by, a light rail system would have been fitting and more permanent. Putting in place full BRT, as opposed to adopting just some BRT characteristics, also would have likely led to a better Silver Line for the people along the route.

Throughout the story of the movement of the Orange Line and the creation of the Silver Line, Boston was changing as a city. The types of people surrounding the Washington Street and Southwest Corridors—and therefore the populations affected by the above story—also changed, either due to these transportation infrastructure changes or other social factors.

3.2 Demographic Change along Orange and Silver Lines

In order to quantitatively assess which groups and types of people were affected by the changes along Washington Street and the Southwest Corridor, I investigated the socioeconomic demographics of the area from 1980 to today, using Decennial Census data

for 1980, 1990, 2000, and 2010 and American Community Survey 5-year estimates for 2012 (comparable to 2010) and 2016 (comparable to 2014) (Social Explorer, 2018). Census tracts are the chosen units of analysis for these datasets, since data for these years are all easily accessible in terms of tracts adjusted to 2010 boundaries on Social Explorer. Shown in Figure 4, I focused on three particular years of Census data: a) 1980, before the Elevated Orange Line was taken down; b) 2000, after the El was taken down and the new Orange Line was put in place, but before the Silver Line was created; and c) 2014, after the Silver Line was put in place. For these years, I specifically looked at population, race, foreign-born status, income, education, and commute changes for the census tracts around the Washington Street and Southwest Corridors. The census tracts were selected if they mostly fell within a 0.5 mile buffer around the relevant El, Orange Line, or Silver Line stations, and are shown as pink on the maps. I also explored trends from 1980 to 2014 for all of Boston, as well as for the neighborhoods of the South End, Roxbury, and Jamaica Plain, which are the three largest in the area of analysis.

3.2.1 Population

Like many major cities, the population of Boston dropped in the mid-1900s, partially due to white-flight and the perception of urban cores as dirty, grimy places. Since the 1980s however, the population of Boston has increased from about 560,000 people to about 660,000 people, as seen in Figure 5. The population of the South End increased slightly between 1980 and 2000, then at a faster rate between 2000 and 2014. For Roxbury and Jamaica Plain, the population stayed roughly the same between 1980 and 2000, then increased between 2000 and 2014.

Mass transit requires a sizeable population nearby in order to have a large enough customer base. Figure 6 shows the population density of the walkshed site of analysis, and generally the area has become denser over the years. In 1980, the population was concentrated in the tracts to the north of Washington Street (where the El ran and the Silver Line currently runs) and Massachusetts Avenue (Northampton or Massachusetts Avenue Station) in the South End, Back Bay, and Fenway. By 2014, Mission Hill and parts of Roxbury and Jamaica Plain were also relatively dense, mostly near Orange Line stops. The route of the

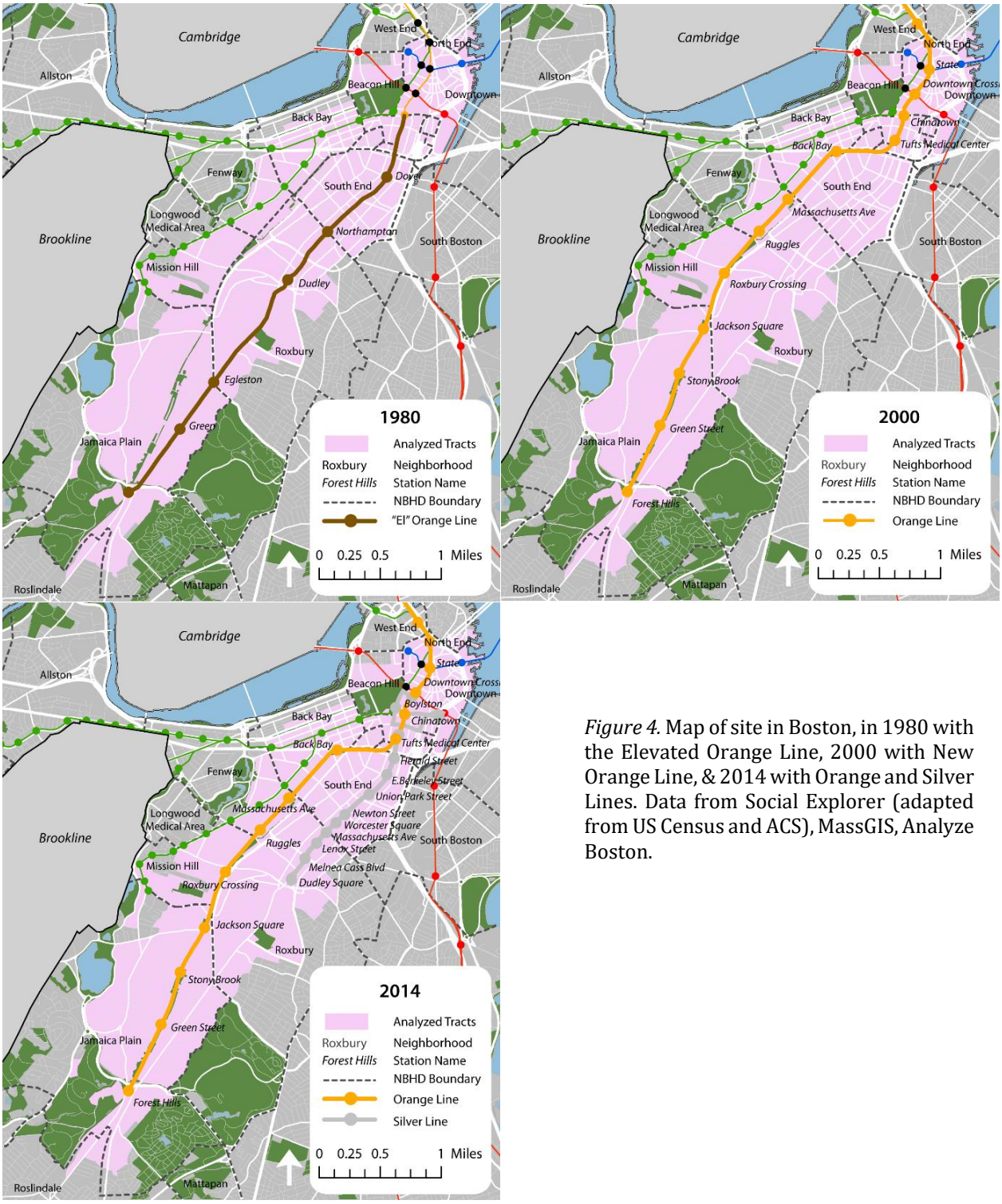
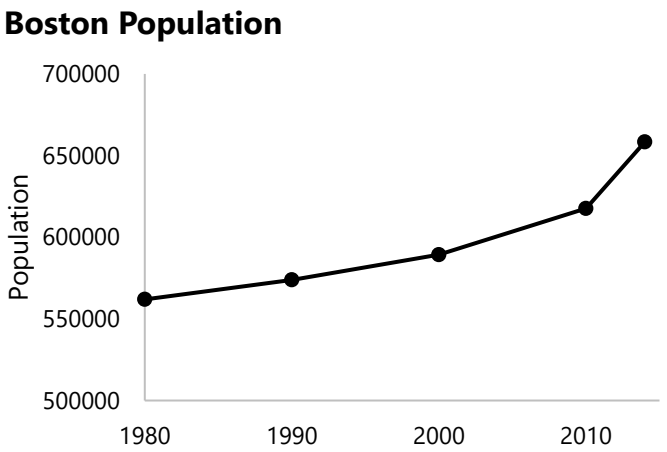


Figure 4. Map of site in Boston, in 1980 with the Elevated Orange Line, 2000 with New Orange Line, & 2014 with Orange and Silver Lines. Data from Social Explorer (adapted from US Census and ACS), MassGIS, Analyze Boston.



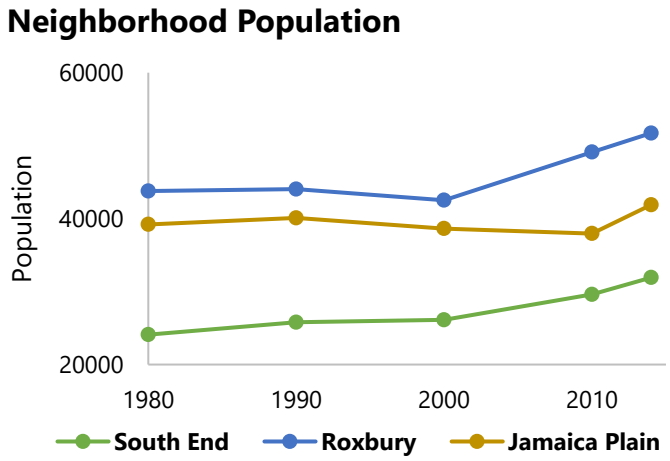


Figure 5. Populations of Boston, and South End, Roxbury, and Jamaica Plain. Data from Social Explorer.

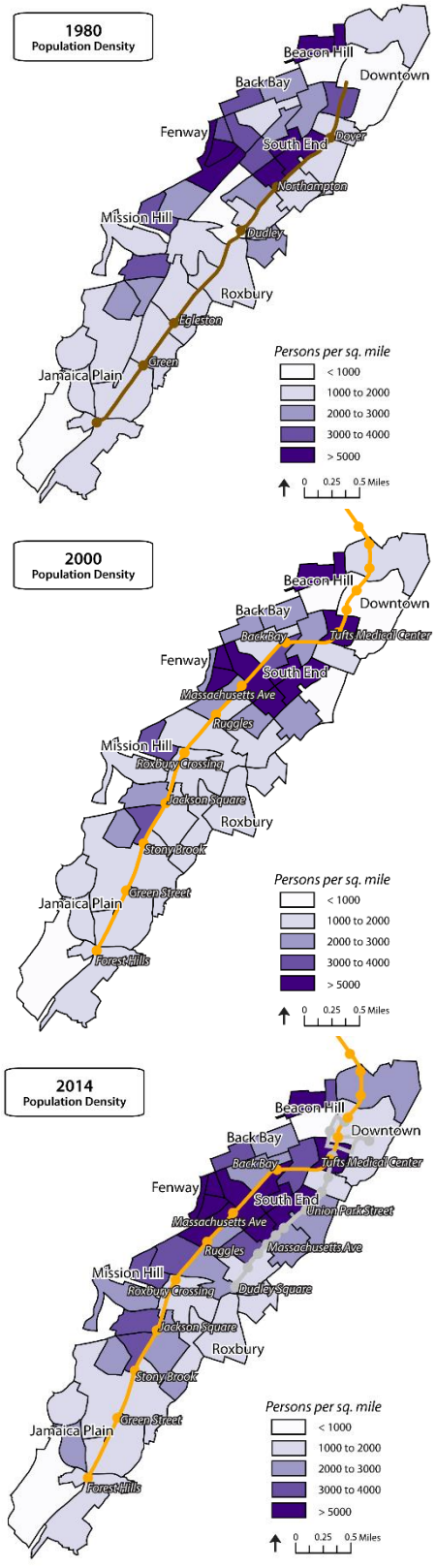


Figure 6. Populations Density of analysis area. Data from Social Explorer.

El went either through areas with very high population densities or through areas that were moderately low, while the new Orange Line went through a more varied mix of densities. The Washington Street part of the Silver Line was added almost entirely to tracts with high density. Figure 7 shows the changes in the population of these tracts between 1980 and 2000, before and after the Orange Line move, and between 2000 and 2014, before and after the Silver line was put in place. Between 1980 and 2000, the areas that decreased in population the most (shown in orange) were adjacent to El stops, likely partially due to the closing of these stops during this time period. Downtown, Back Bay, and the northern parts of the South End gained population, as did a large parcel near Ruggles Station, potentially aided by the new Orange Line. Between 2000 and 2014, most of the area experienced an increase in population, especially the tracts between Massachusetts Avenue and Roxbury Crossing on the Orange Line or adjacent to and to the east of the Silver Lines stops, the latter likely influenced by semi-rapid transit opening along the route.

3.2.2 Race and Ethnicity

Infrastructure changes have historically negatively impacted marginalized racial groups more than the average population. Looking at these population changes in terms of race and ethnicity, the trends between groups begin to diverge. Figure 8 compares the population between 1980 and 2014 of non-Hispanic White, Black, and Hispanic/Latino residents. In Boston overall, the White population decreased over time (especially between 1980 and 200), the Black population stayed relatively level, and the Hispanic population increased. For the three neighborhoods however, the graphs differ from the citywide trend. In the South End, the White and Hispanic populations increased, while the Black population dropped. In Roxbury, the Black population, though consistently very large, experienced a large decrease between 1980 and 2000. The Hispanic population, and Whites to a lesser extent, increased during these four decades. In Jamaica Plain, after a decrease in White residents and an increase in Black and Hispanic residents between 1980 and 1990, the population remained relatively level across racial group.

Figures 9 to 11 show the proportion of various racial groups within each census tract across the three years. In 1980, Figure 9 displays a higher proportion of White people on the

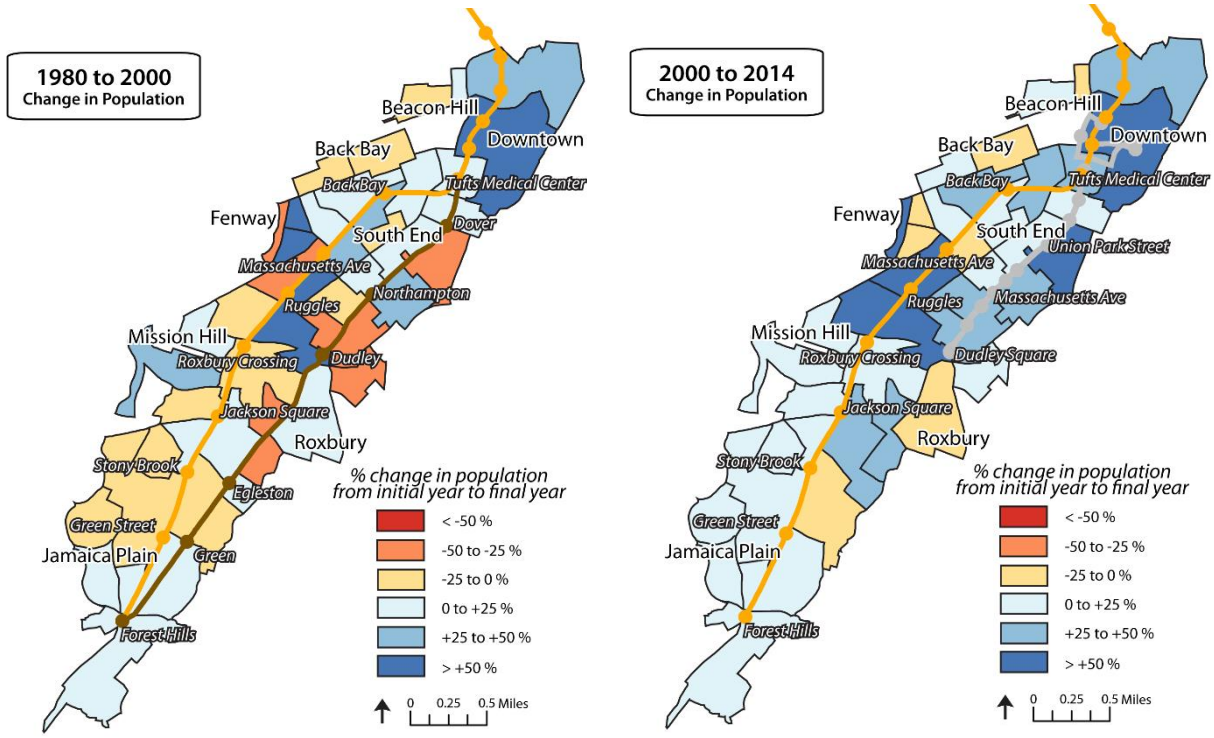


Figure 7. Percent change in population for 1980 to 2000 and 2000 to 2014. Data from Social Explorer

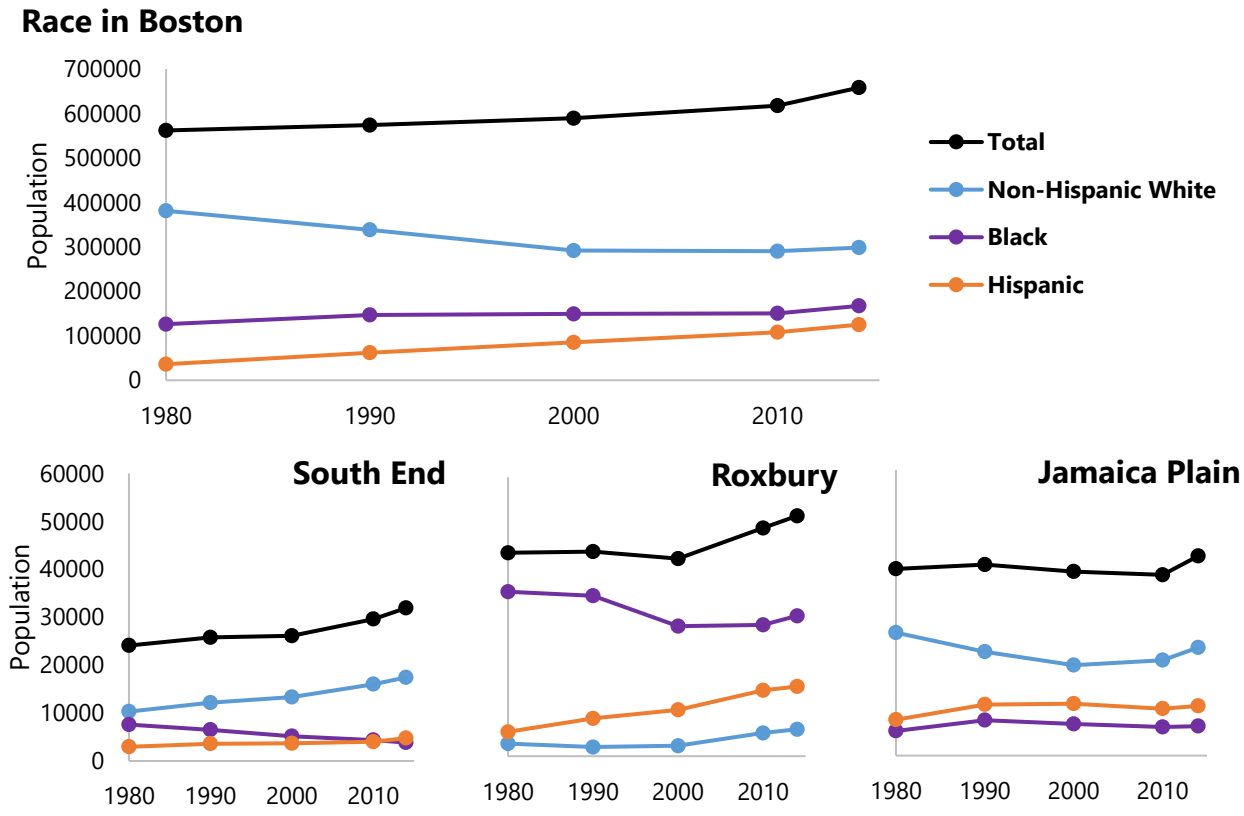


Figure 8. Population by race/ethnicity. Data from Social Explorer.

northeastern side of the Southwest Corridor (where the new Orange Line would go), especially in Back Bay and Jamaica Plain. Roxbury has a distinct lack of a White population, a trend that continues to today, even though other parts of this area of analysis generally show an increase in the White proportion. In Figure 10, the trends of the Black population are basically the opposite of Figure 9. The tracts of Roxbury hold the largest Black populations, as well as the southern parts of the South End, in 1980. By 2014, though the Black proportion in these areas are still relatively high, only the tracts south of Dudley Square show a population over 60% Black. In Figure 11, the Hispanic population generally increases from year to year. The growth is mostly in the southern half of this map though, particularly near Jackson and Dudley Squares. In comparing the placement of the routes, the Orange Line was moved from an area of a lower White and a higher Black proportion to an area of the opposite trend. Hispanics and Latinos were populated around Jackson Square before the Orange Line moved there, and around Dudley Square before the Silver Line was put in place, so adding these two lines likely brought more service to the Hispanic population. Unlike the El route, the Silver Line stopped at Dudley, so service may not have been easily reachable for the tracts with the highest proportion of Black people south of the station.

Figures 12 to 14 display the percent changes in White, Black, and Hispanic populations over the two time periods. Between 1980 and 2000, the trends followed neighborhood boundaries more than the changed train route. The White population grew in the neighborhoods to the north and shrank in the ones to the south. The Black population mostly decreased, except in Jamaica Plain and Downtown, while the Hispanic population grew all around. Between 2000 and 2014, the White population increased in almost all tracts, but especially around the Silver Line route and Roxbury the percent change is very high due to the previously low white population. Population decline for Blacks and growth for Hispanics continued into this time period, scattered throughout the area of analysis.

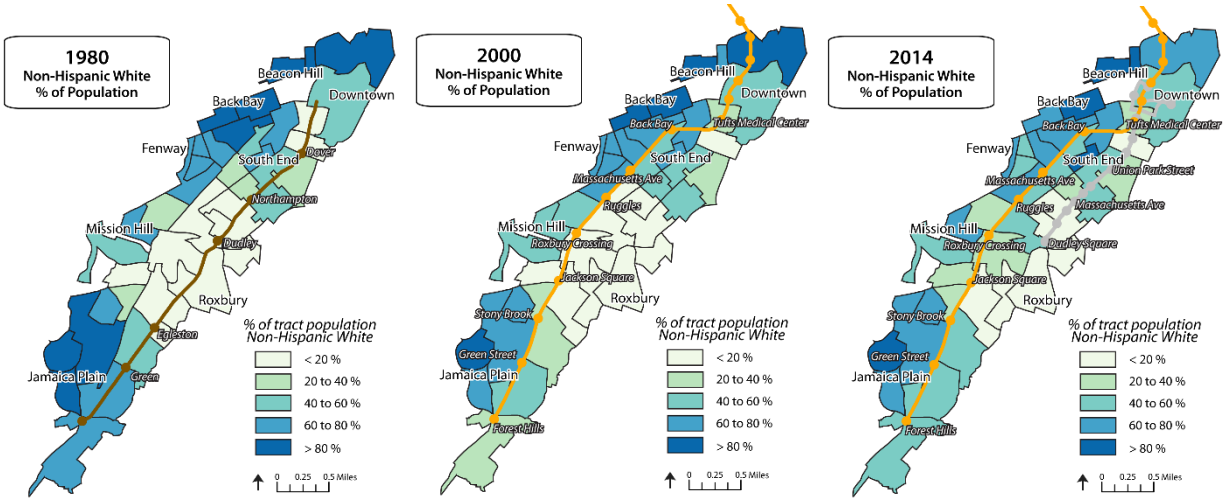


Figure 9. Non-Hispanic White percentage of Census Tract. Data from Social Explorer.

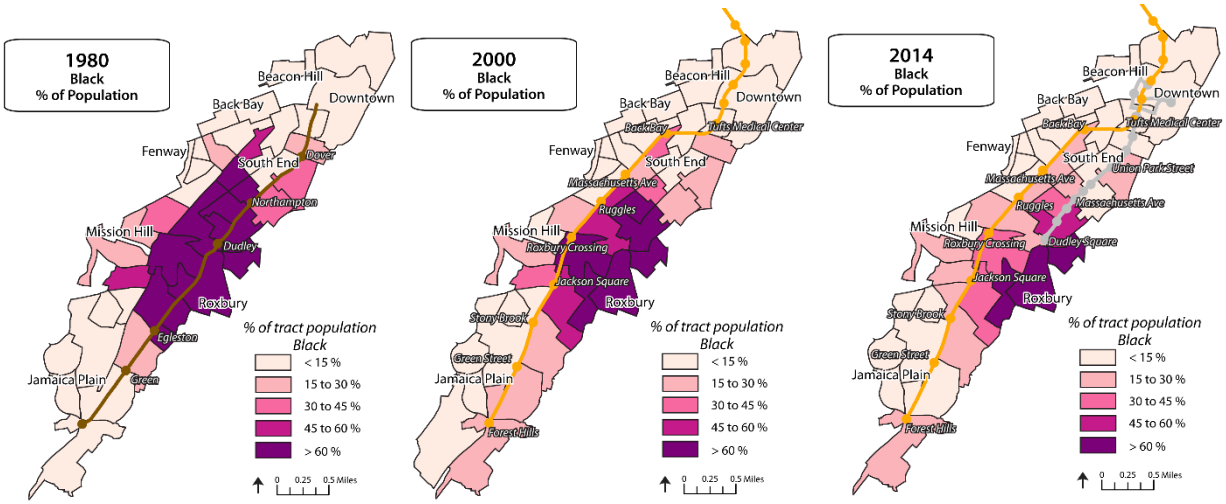


Figure 10. Black percentage of Census Tract. Data from Social Explorer.

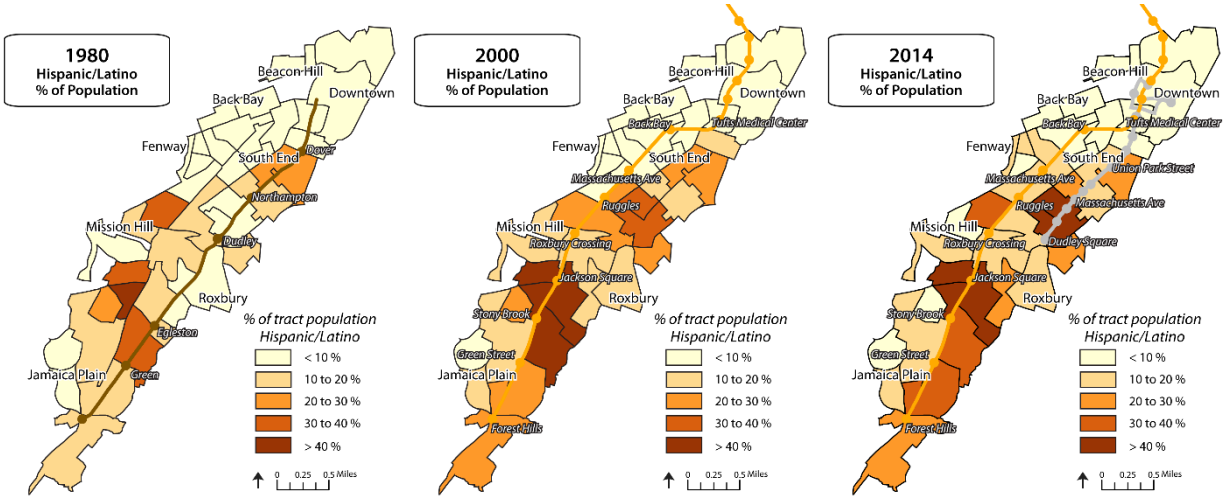


Figure 11. Hispanic/Latino percentage of Census Tract. Data from Social Explorer.

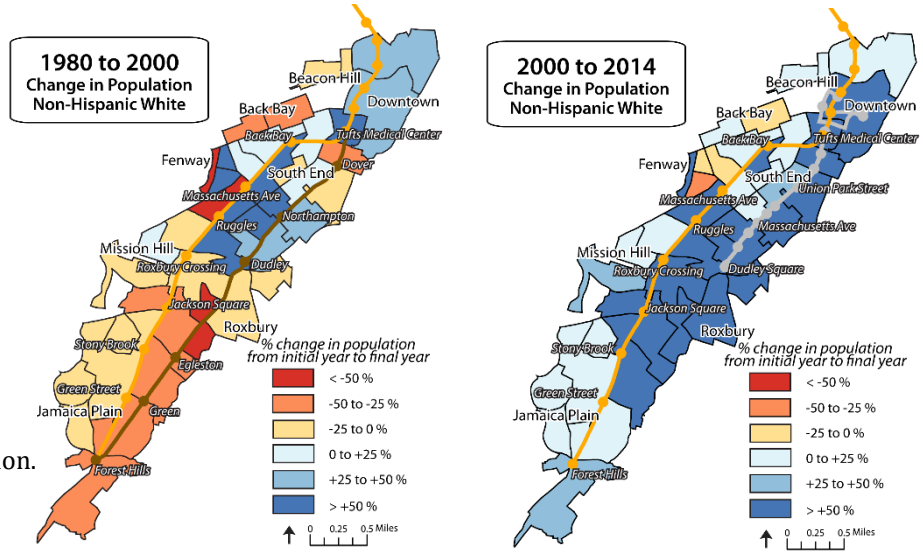


Figure 12. Percent change in Non-Hispanic White population. Data from Social Explorer.

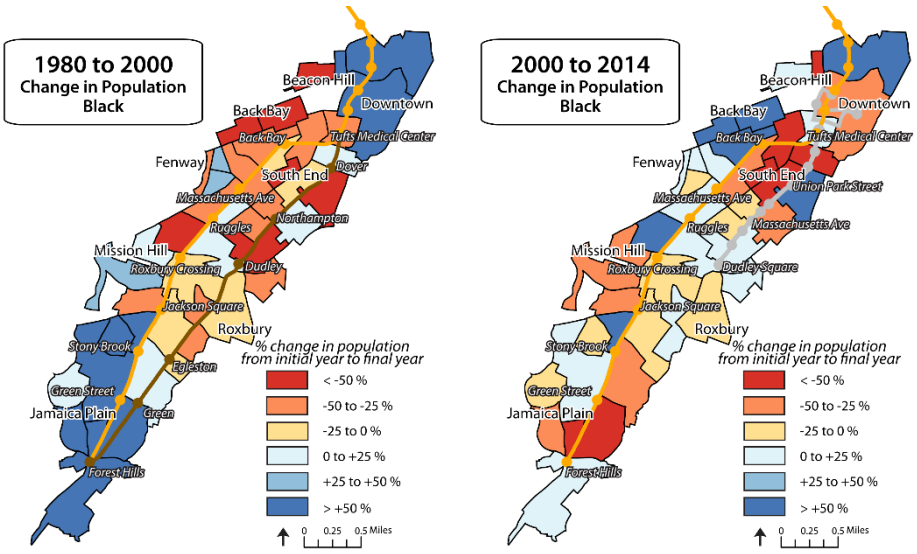


Figure 13. Percent change in Black population. Data from Social Explorer.

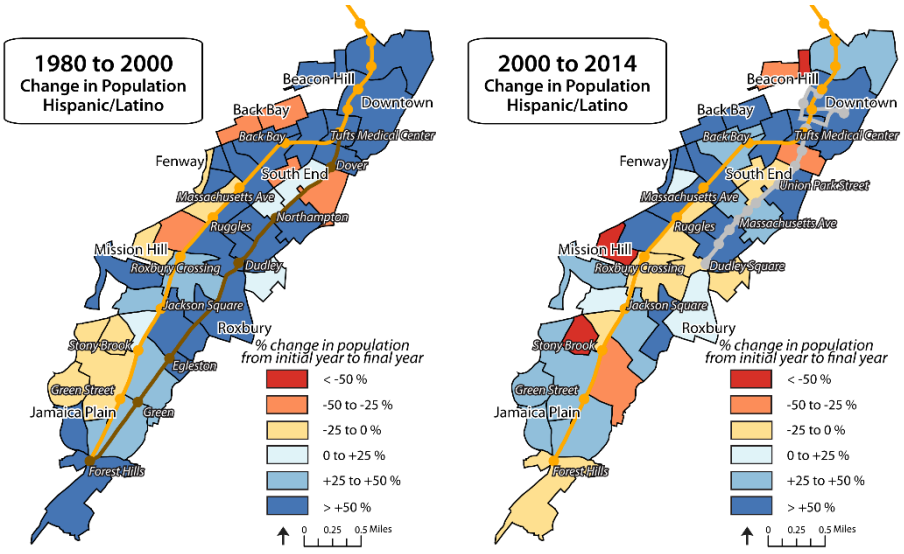


Figure 14. Percent change in Hispanic/Latino population. Data from Social Explorer

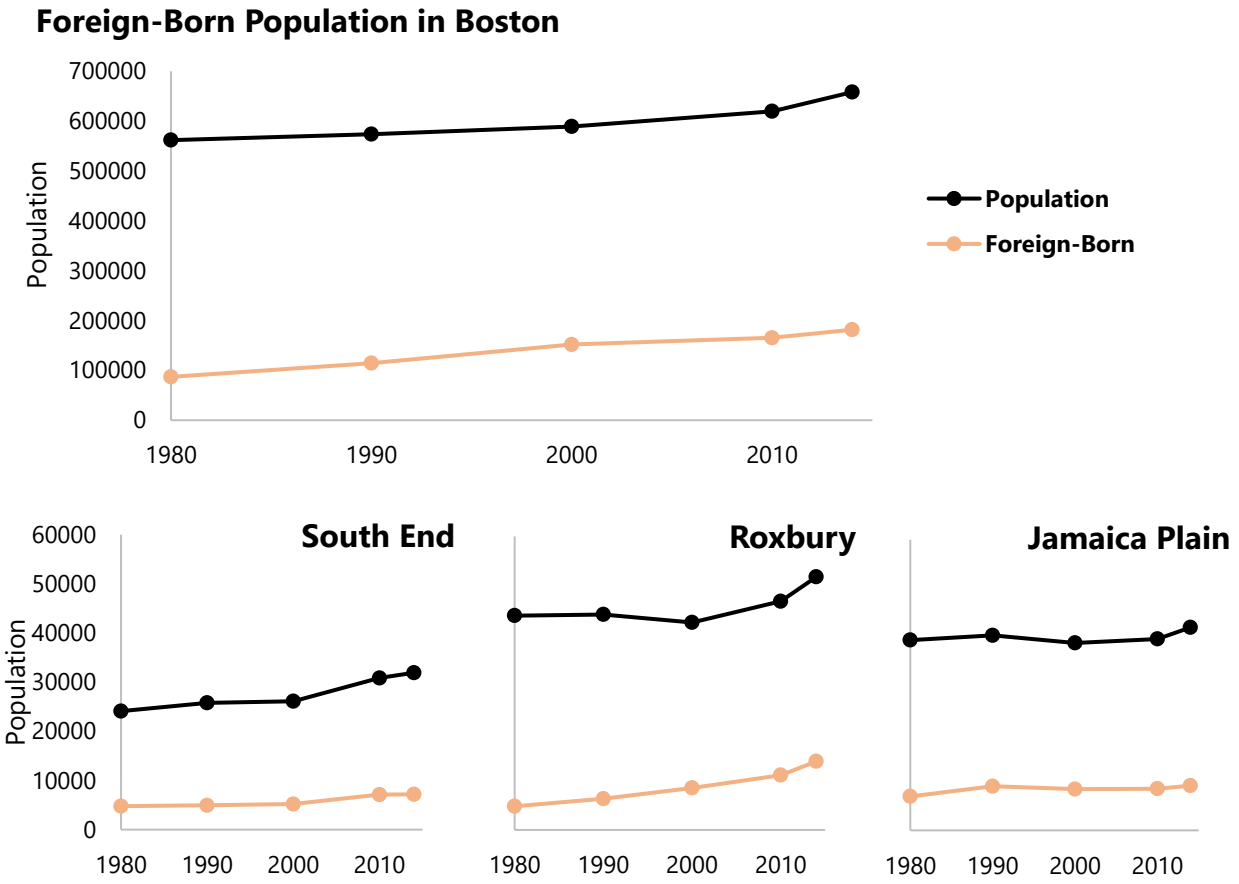


Figure 15. Population by Foreign-Born Status. Data from Social Explorer.

3.2.3 Foreign-Born Population

Foreign-born populations, especially those that recently moved to the U.S., often rely on public transit to get around, partly since getting a car and driver's license takes time and resources. The foreign-born population of Boston has doubled over the last three decades, as seen in Figure 15. Roxbury has also had a large increase in the foreign-born numbers from 1980 to today, even when the general population declined between 1990 and 2000. For Jamaica Plain and the South End, the change in foreign-born population generally matched the changes in the general population. Figure 16 shows the percent foreign-born of the census tracts in question over the three years of analysis. The proportions around Downtown and Chinatown remain the highest over the years. In other areas, the proportion of foreign-born residents continue to grow year to year, clustered around the southern half

of the Orange Line and east of the Silver Line. The trends of growth are reflected in Figure 17, which shows the percent change in foreign-born population for each tract, where almost all of the tracts shown are in some shade of blue. The El, new Orange Line, and Silver Line all provided service to increasing numbers of this population during their respective years of service.

3.2.4 Income

Poorer populations are generally more transit dependent, but housing costs near stations tend to be higher. In exploring how populations of different incomes may have changed in these corridors over time, I first analyzed median household income. As shown in Figure 18, Boston, South End, Roxbury, and Jamaica Plain median household incomes (as the mean of the tracts' median values) start relatively even in 1980. By 2014 however, the incomes for the South End and Jamaica Plain are much higher than the Boston average, while the incomes for Roxbury are much less. Out of the four datasets, only Roxbury experienced an overall decrease in income, while the other three have increased since 1980. Figure 19 tells a similar story. In 1980, median household incomes were more evenly distributed, compared to later years when wealth was concentrated in the north of Downtown, the South End, and Jamaica Plain. The Orange Line moved from tracts with relatively lower incomes to tracts with diverging incomes—higher around the South End and Jamaica Plain and lower around Roxbury, Fenway, and Mission Hill. In the 2014 map, the Silver Line services tracts with relatively average median household incomes. Figure 20 shows the change over time of these incomes. Between 1980 and 2000, incomes generally increased except in Downtown, but increased more for the tracts that touch the new Orange Line compared to those on the old Elevated. Between 2000 and 2014, incomes continued to increase, except in Roxbury. A few of the tracts surrounding the Silver Line have great increases in median household income as well.

Median household incomes capture how much money the household at the fiftieth percentile of the tract makes. In order to evaluate trends in the poorer populations of an area, I used the metric of income as a percentage of the poverty line. Figure 21 shows the trends of the population with incomes under 75% and under 150% of the poverty line, compared

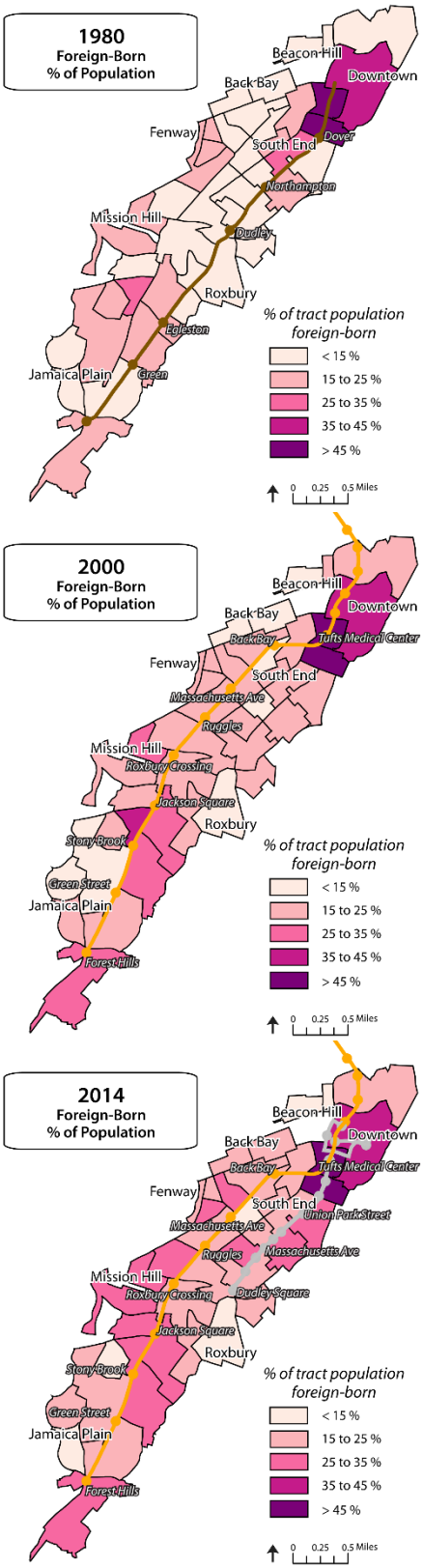


Figure 16. Foreign-Born % of tract population. Data from Social Explorer.

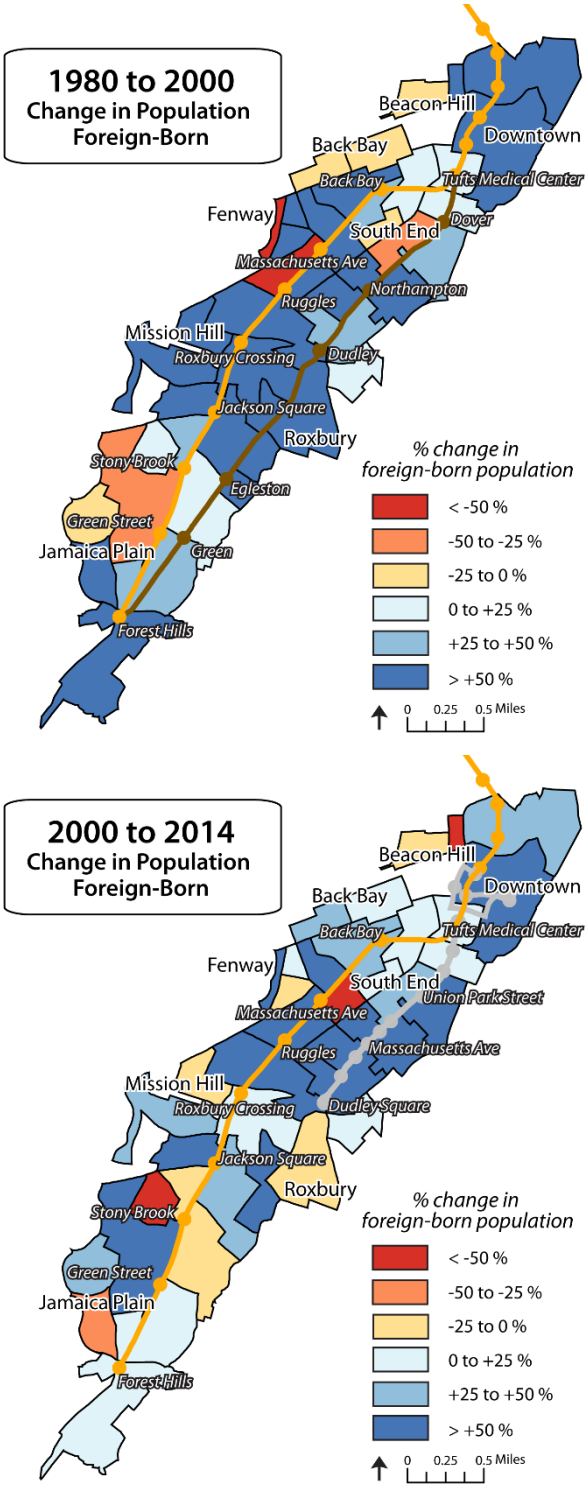


Figure 17. Percent change in foreign-born population by tract. Data from Social Explorer.

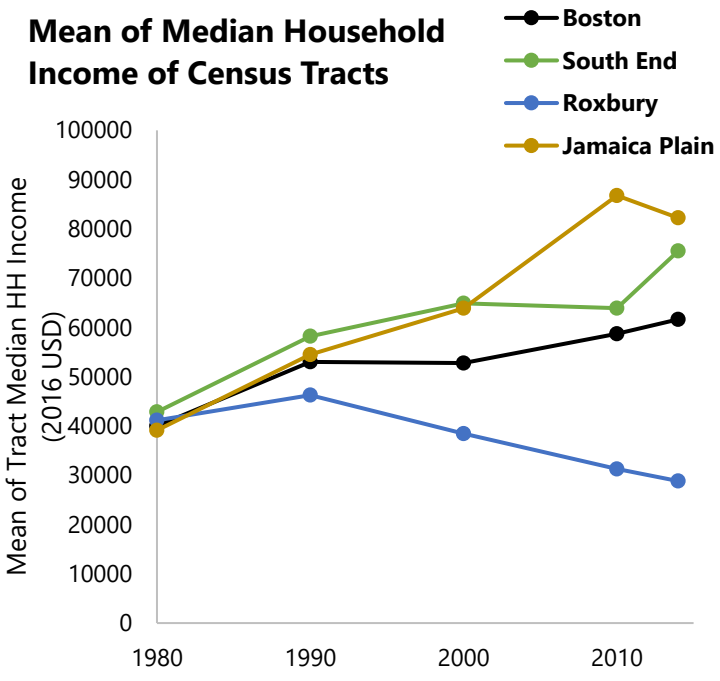


Figure 18. Mean of the Median Household Incomes of Census Tracts in Boston and in three neighborhoods. Data from Social Explorer.

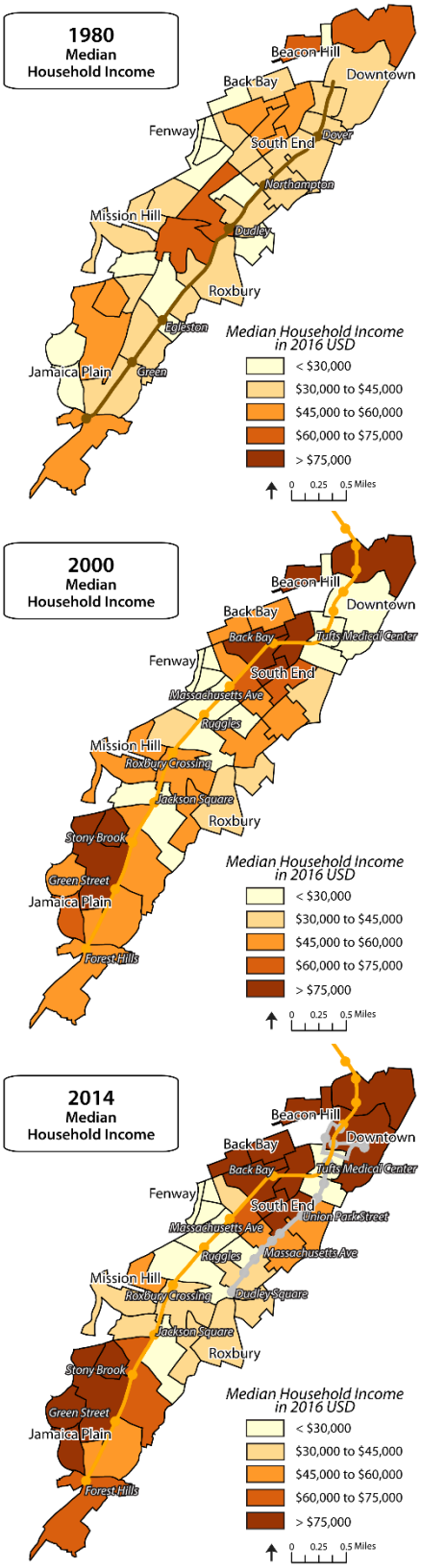


Figure 19. Median Household Income of Census Tracts. Data from Social

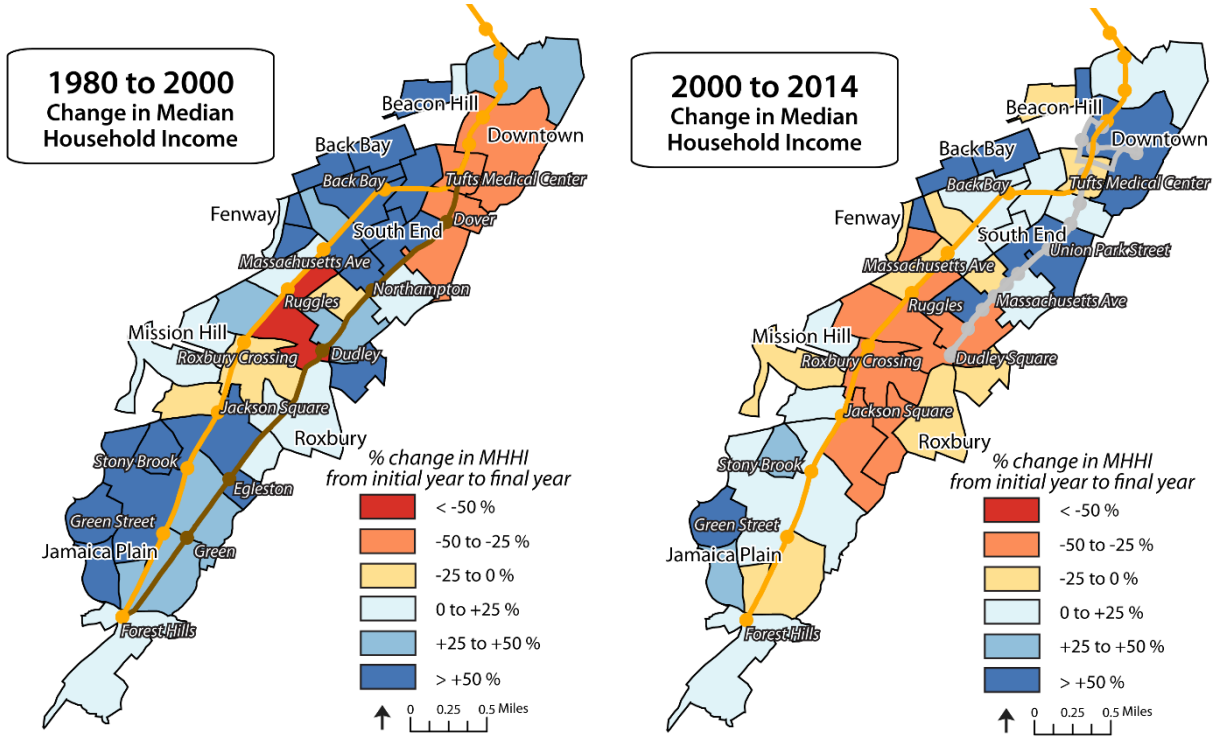


Figure 20. Change in Median Household Income. Data from Social Explorer.

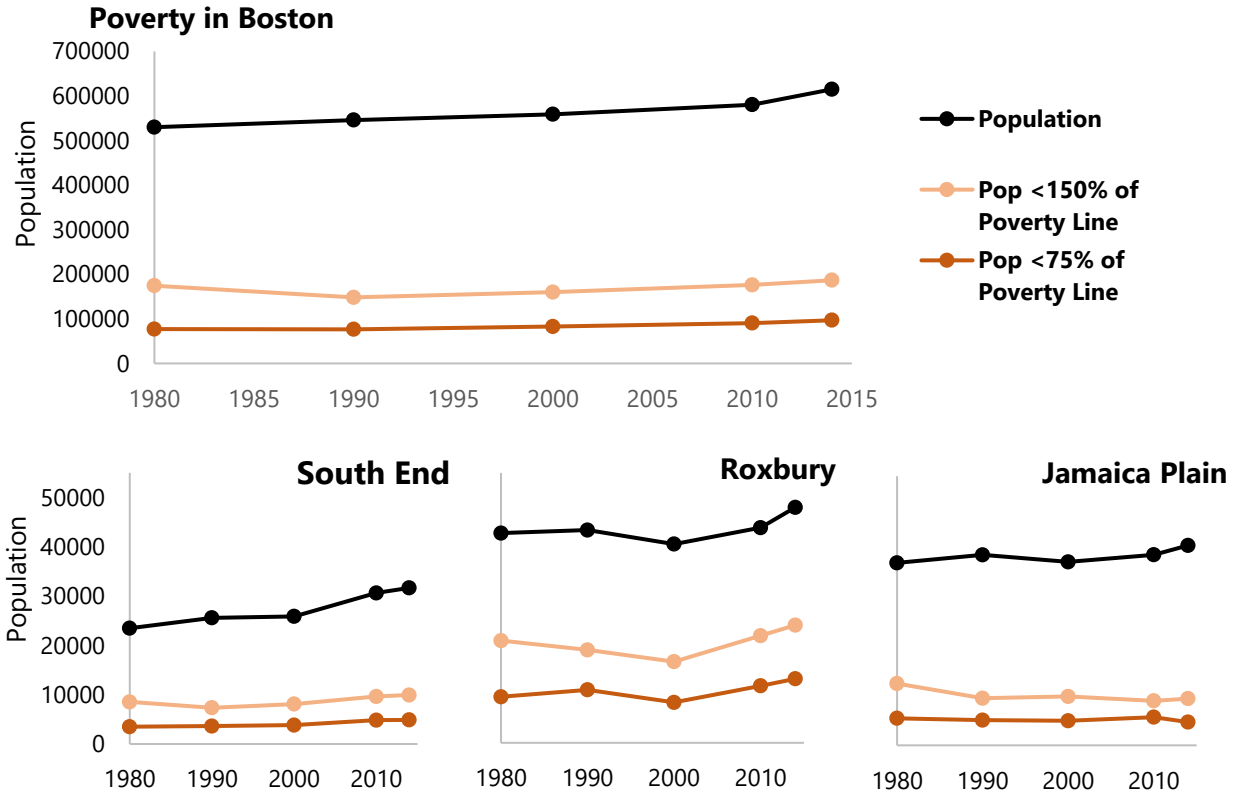


Figure 21. Population with incomes below 75% and 150% of poverty level. Data from Social Explorer

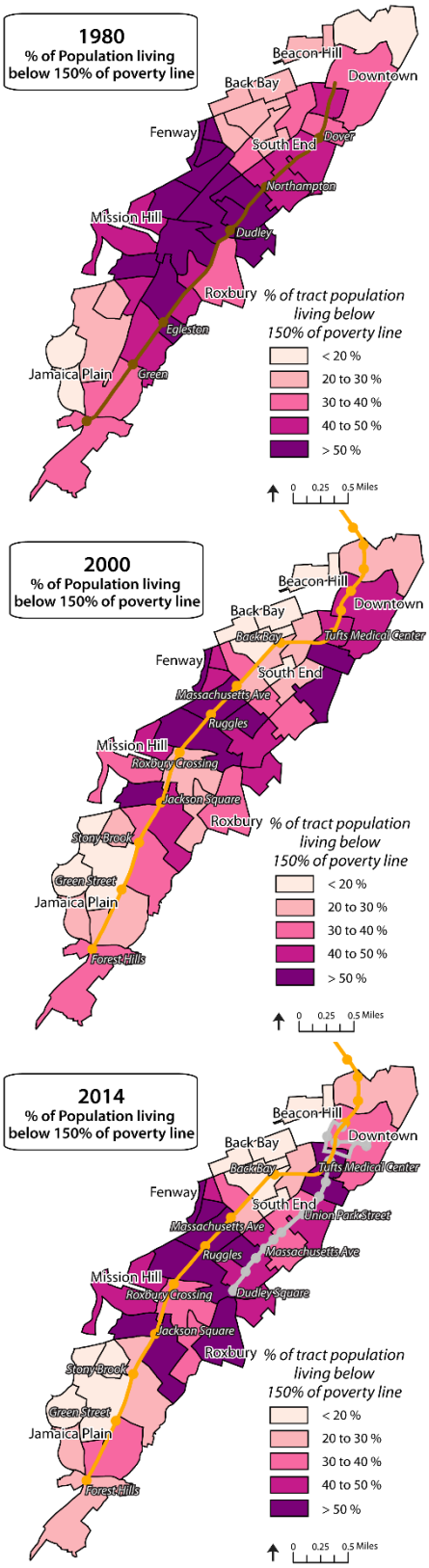


Figure 22. % of tract living < 150% of poverty line. Data from Social Explorer.

to the trend in the general population whose poverty is measured. In the whole city, the populations in poverty have stayed relatively constant over the years. In the South End, despite a large overall population increase, the number of poor residents has stayed mostly the same. In Roxbury, the trends in the population in poverty and the general population are mostly parallel, signifying that the population increases and decreases in Roxbury may be due to changes in the poor. In Jamaica Plain, all three groups have not changed much over the time period. Figure 22 shows the proportion of each tract living under 150% of the poverty line. In 1980, the poor make up a larger percentage of the middle section of the map—Fenway, Roxbury, and Mission Hill—and a smaller percentage in Back Bay and Jamaica Plain. A similar distribution continues throughout the other years, but with an increase in the proportion of those in poverty in the area along where the El used to be. The Orange Line moved from tracts with all relatively high proportions of low-income residents to tracts with relatively lower proportions of the poor. In the 2014 map, the tracts with less than 30% of the population living below 150% of the poverty line are all serviced by the Orange Line, while the Silver Line services the more poor tracts.

Figures 23 and 24 compare the general change in the population for whom poverty status is measured to the change in the population under 150% of the poverty line. Between 1980 and 2000, the tracts that the new Orange Line cross through generally show a

greater decrease in the population in poverty than the decrease or increase in general population, potentially influenced by the opening of the Orange Line bringing in more investment, or displacing the poor. Between 2000 and 2014, the trends in the area around the addition of the Silver Line do not show a visible difference between the general and the poor populations. The tracts around Roxbury Crossing, however, do display a larger increase in the poor population than the general population, while the opposite is true for the Jamaica Plain tracts.

3.2.5 Education

Education is linked to availability of economic opportunities. Lack of access to transit can decrease opportunities even more for people with low levels of education. Figure 25 shows the changes in the population without a high school degree, with a college degree or more, and generally for whom education level is measured (people over 25 years of age). In all four graphs, there is a large increase in college graduates over the three decades and a large decrease in the population without a high school diploma. The South End and Jamaica Plain both currently have a majority college-educated population, while in Roxbury, the population without a high school degree is still greater than those with a college degree.

The trend of an increasingly educated population can be seen in Figures 26 and 27, which show the percent of each tract at the two education levels over the three years. In 1980, most of the tracts have a high proportion of people without high school degrees, except for parts of Jamaica Plain, Back Bay, Downtown, and the northwestern part of the South End. By 2000 and even more so by 2014, this proportion has decreased for the whole area, though Roxbury and the southeastern parts of the South End still have a higher percentage of people who did not graduate from high school. The trends for college graduates are the opposite, with most tracts having very low rates of college graduation in 1980, increasing to a high percentage by 2014. Again, Roxbury has comparatively lower rates than the rest of the area. The Orange Line in 1987 moved from a series of less educated tracts around Washington Street to more educated tracts around the Southwest Corridor. The area that the Silver Line goes through today still has a higher proportion of people who did not graduate high school compared to the rest of the map, but there is a sizeable college graduate population in the

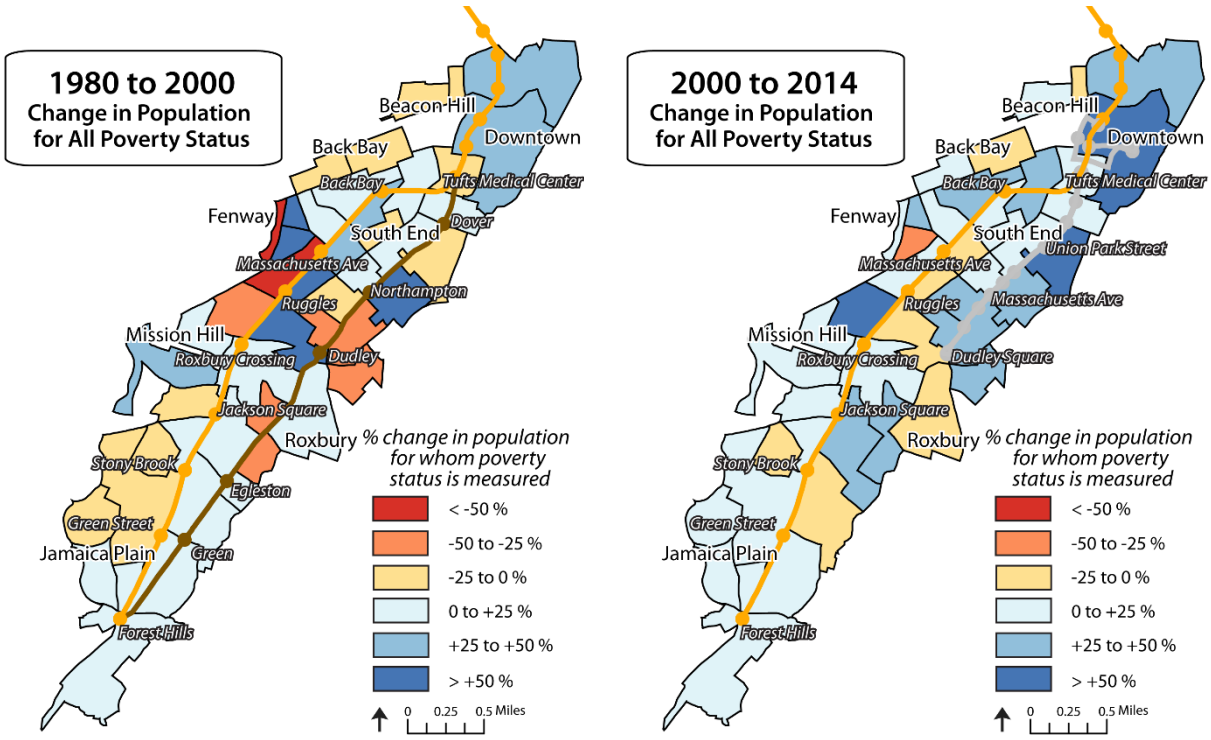


Figure 23. Percent change in population for whom poverty status is determined. Data from Social Explorer.

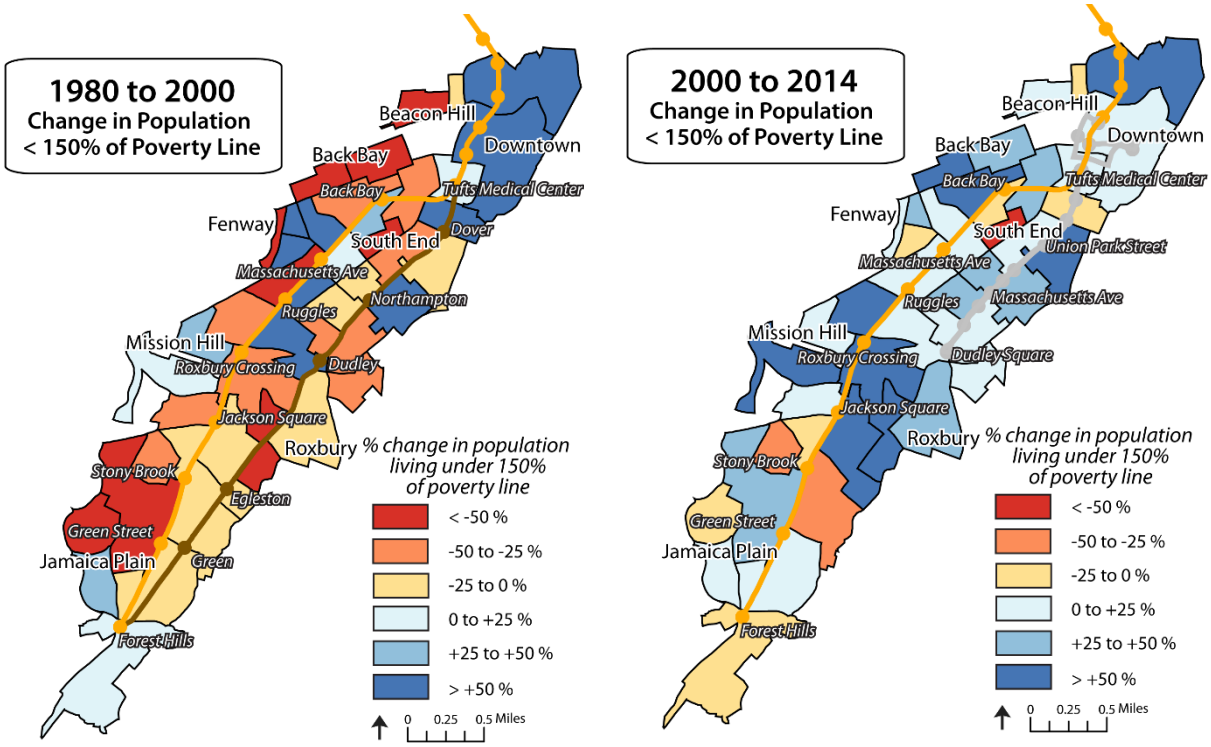


Figure 24. Percent change in population living under 150% of poverty line. Data from Social Explorer.

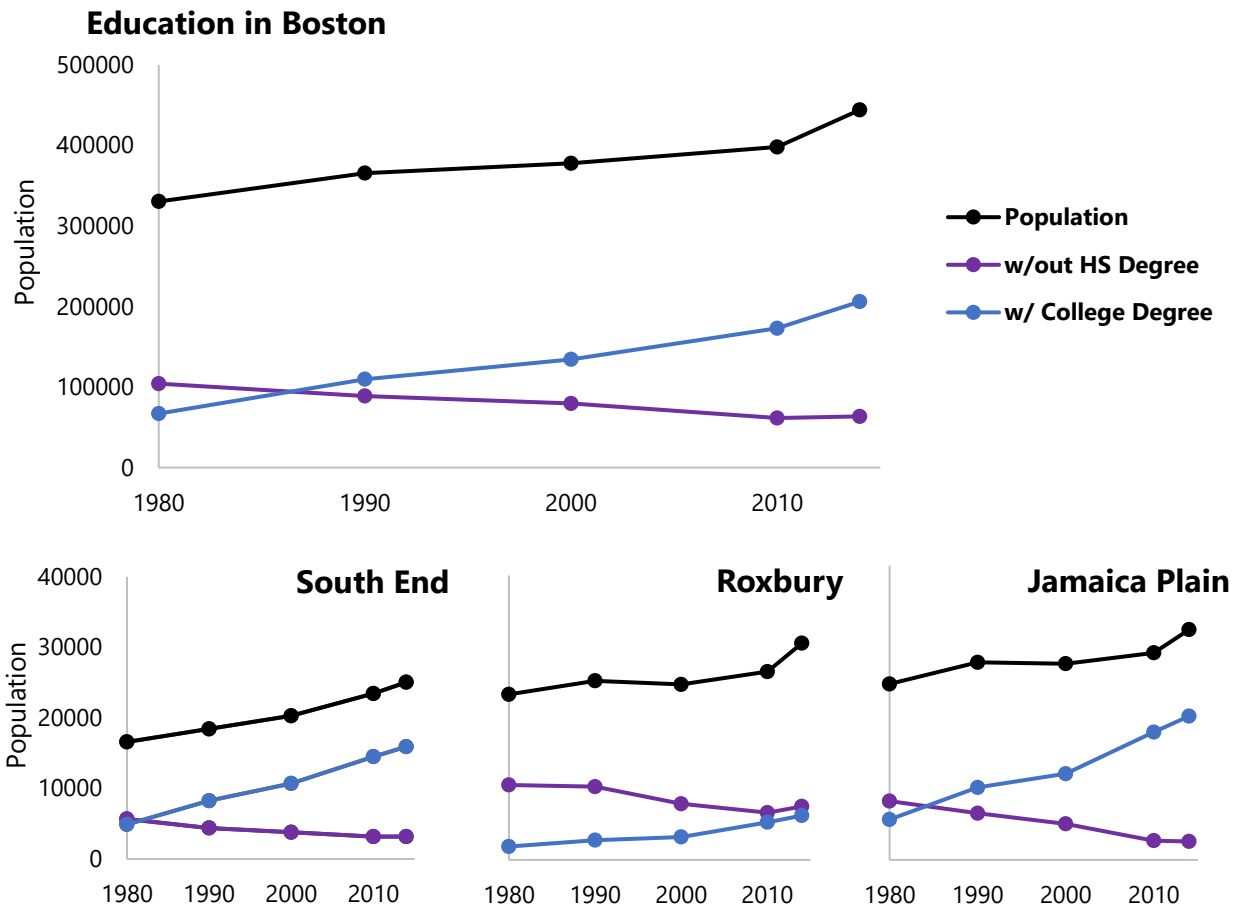


Figure 25. Population with different education levels. Data from Social Explorer

South End parts of the Silver Line.

3.2.6 Commute

The Decennial Census and American Community Survey also track the time it takes for people to get to work and what mode of transportation they use to get there. Changes in transportation infrastructure can definitely impact these commute times and modes. Figure 28 contains information about the general worker population versus the number of people who commute less than thirty minutes and more than sixty minutes to work. In the Boston graph, the number of people with sub-thirty-minute commutes has stayed roughly constant, while the over-sixty-minute commuters have increased slightly and the worker population as a whole has greatly increased. The neighborhood graphs show similar trends, though the South End has a greater proportion of people with sub-thirty-minute commutes, as compared to Roxbury and JP, which makes sense since the South End is closer to Downtown.

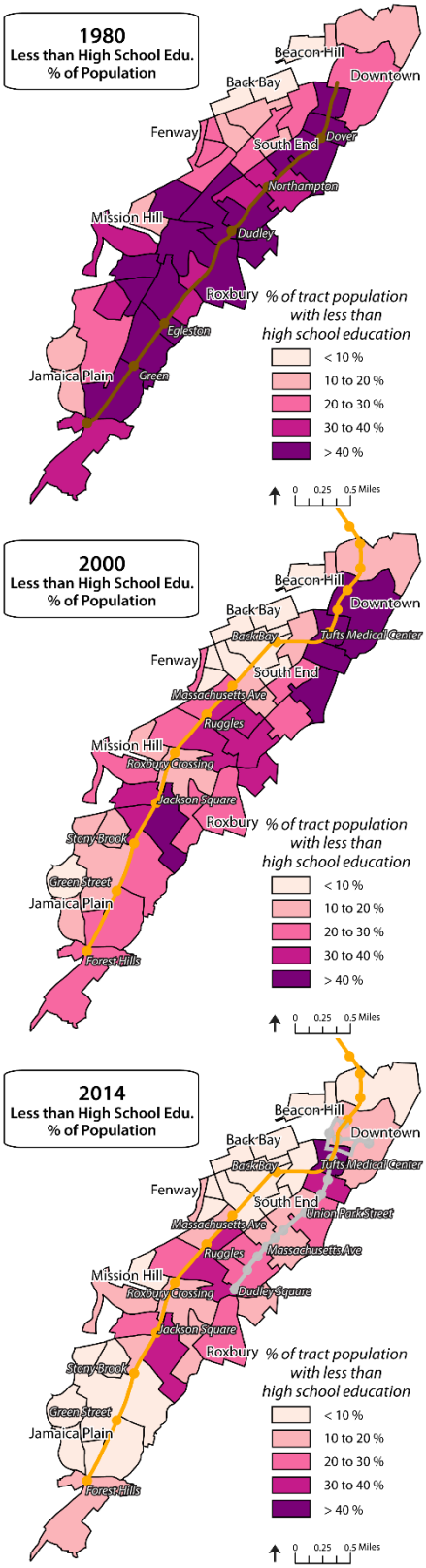


Figure 26. % of tract with less than high school diploma. Data from Social Explorer.

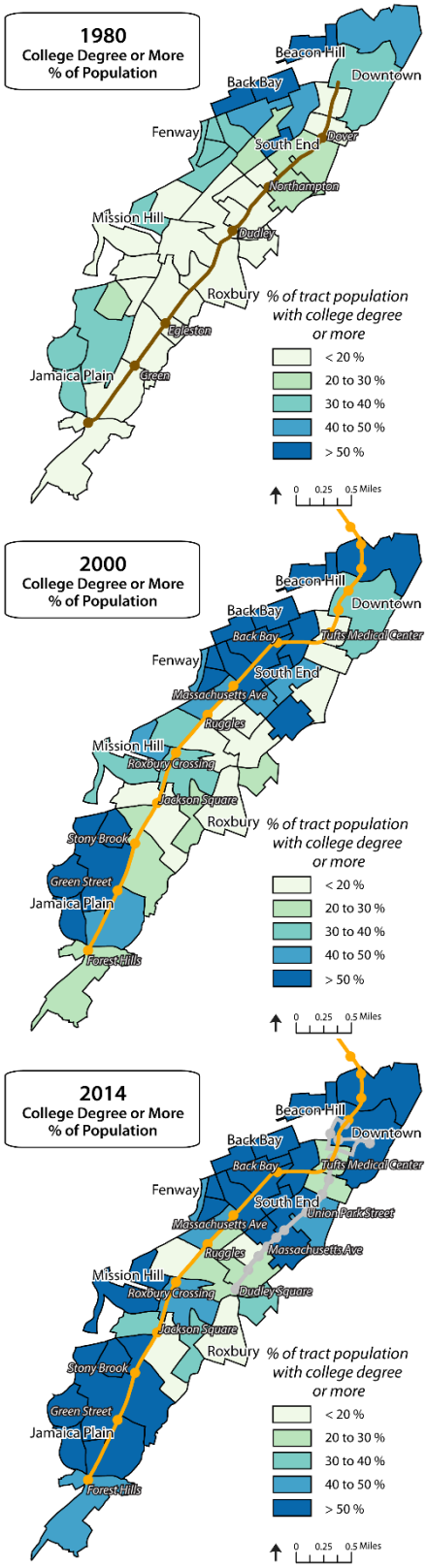


Figure 27. % of tract with college degree or more. Data from Social Explorer.

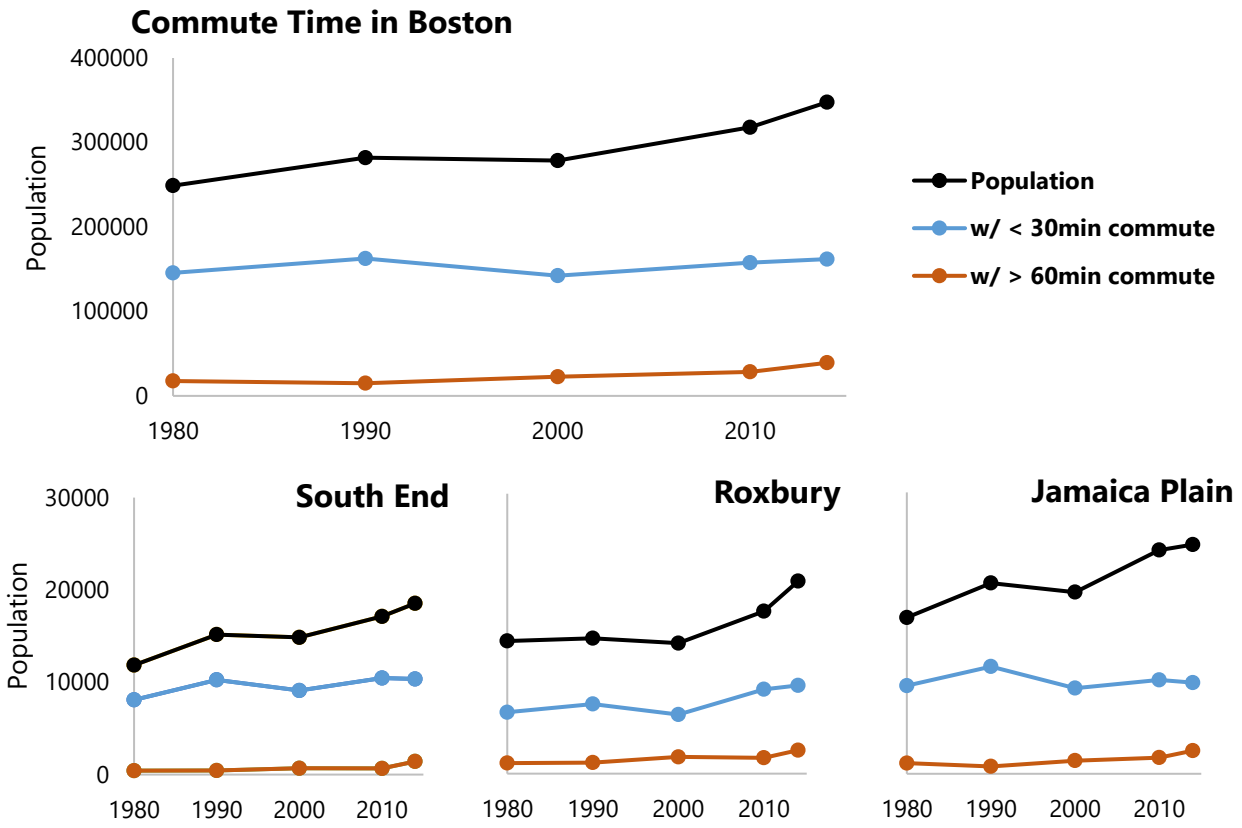


Figure 28. Commute times of worker population. Data from Social Explorer.

The trend of areas closer to Downtown having shorter commutes can also be seen in Figure 29, which is a series of maps showing the percentage of people with less than 30-minute commutes to work by census tract in the area of analysis. In 1980, Downtown and the South End have the highest percentage of short commute times, while neighborhoods to the South have a lower percentage. In 2000, the trend is more divided between the northwest and the southeast tracts, with a greater number of short commutes for the former. In 2014, the north versus south commute time trends return. Between 1980 and 2000, the tracts near the new Orange Line increased or remained at relatively high levels for short commute times, while the tracts where the El used to be generally decreased in the number of people with short commutes, likely due to the new availability or the removal, respectively, of rapid transit options. When the Silver Line was added in, the proportion of short commutes increased again along the Washington Street corridor, but only north of Dudley where the BRT runs.

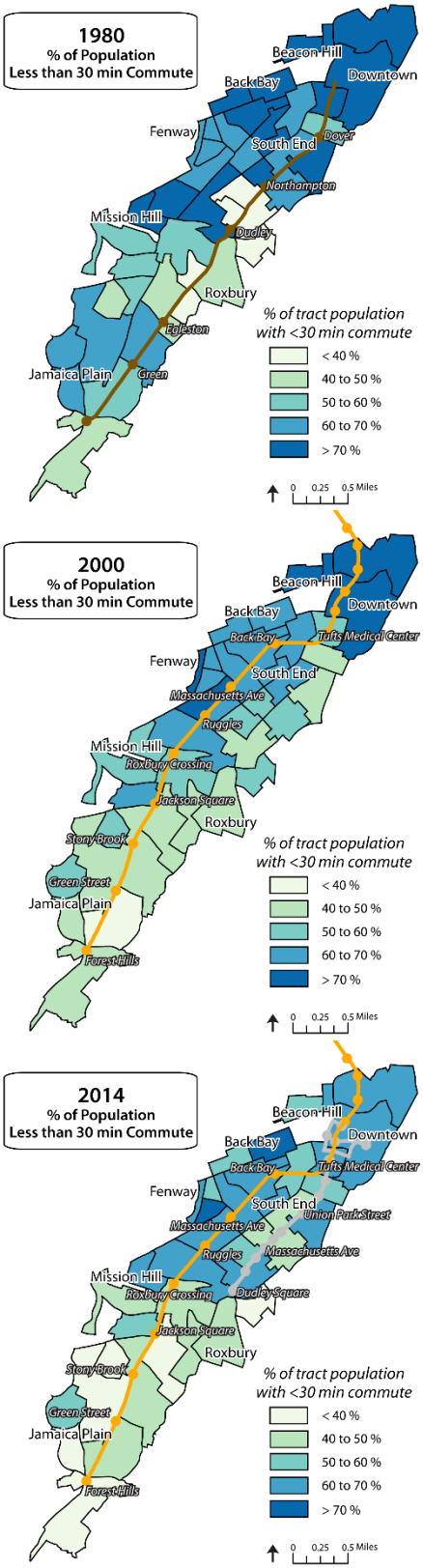


Figure 29. % of tract with less than 30 min commute. Data from Social Explorer.

Looking at modes of commute to work, Figure 30 explores the number of people travelling by car and by public transportation, compared to the general change in worker population. As the population of Boston increased, the population of both car commuters and public transit commuters also slightly increased, though the former still outnumbers the latter. In the South End, the number of car commuters and transit commuters are relatively even and slightly increased over the years, though a smaller increase than the general population, signaling that people may be using other modes such as walking. In Roxbury, the number of car commutes increased over time, while the number of transit commuters dropped between 1980 and 2000, before increasing again, similar to the general population trends. This drop between 1980 and 2000 may be due to the El closing without an adequate replacement service, so people either switched to commuting by car or moved away. In Jamaica Plain, there has been an increase in public transit commuters paralleling an increase in the population since 2000, with stagnating car commuting trends.

As shown in Figures 31 and 32, rates of commuting to work by car was far greater for Jamaica Plain and parts of Roxbury than the areas closer to Downtown in 1980. Public transit commuters were concentrated in Roxbury between the Northampton and Egleston El stops. In 2000, car commuters remained high in the southern parts of the map, and slightly increased where Dudley and Northampton Stations

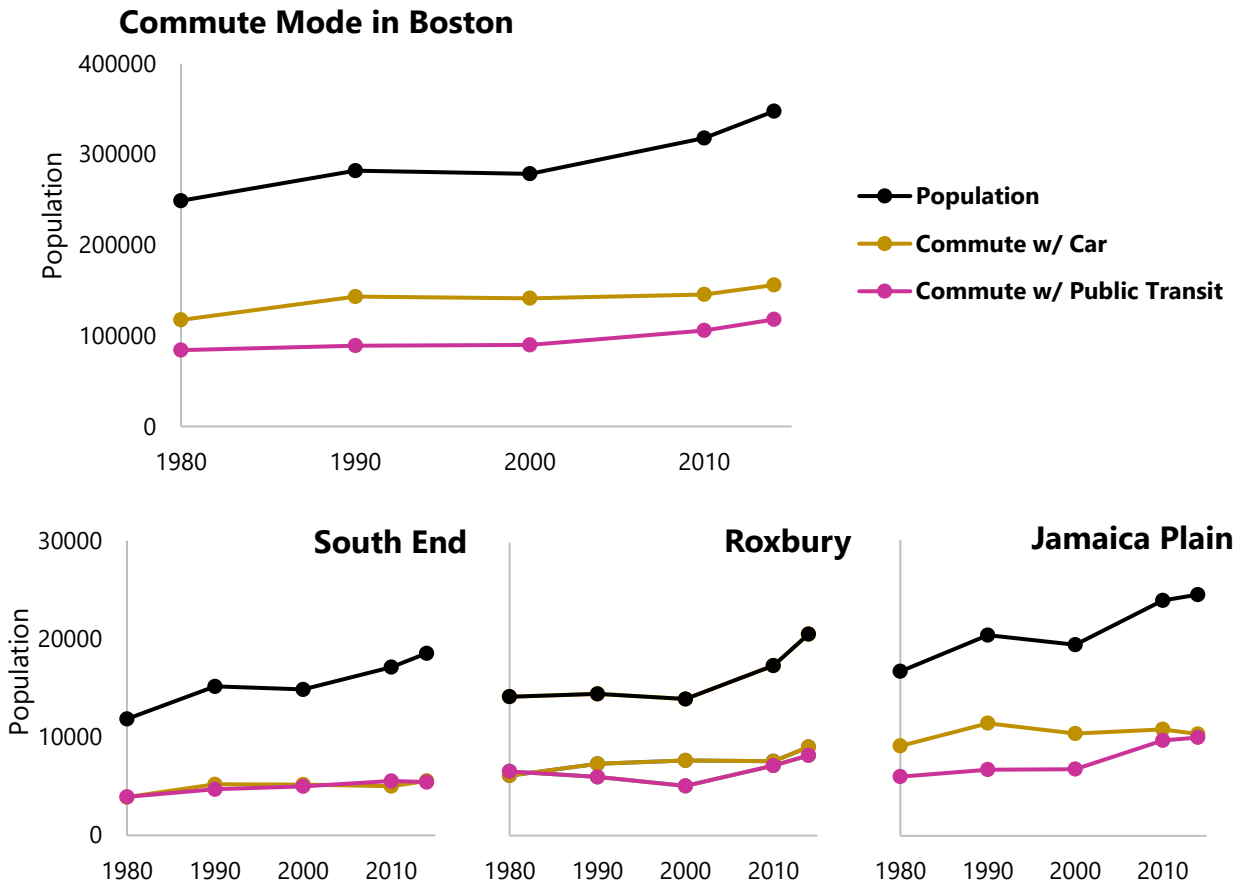


Figure 30. Commute mode of worker population. Data from Social Explorer.

used to be. The proportion of people commuting by public transit decreased in the areas that had high proportions in 1980, but slightly increased near the Massachusetts Avenue Orange Line stop and in Jamaica Plain. In 2014, the percent of people commuting by car had decreased overall, except for the tracts just south of Dudley Station, while public transit use was concentrated in Jamaica Plain and the tracts just north of Dudley Station.

When looking at the South End and the northern parts of Roxbury, the Orange Line moved from an area of relatively higher to an area of relatively lower car usage. This move may have increased car usage even more for the Washington Street corridor, and decreased public transit commuting. After the Silver Line was added, the proportion of car users dropped in this corridor again, but not past Dudley. Jamaica Plain as a whole went from an area of very high car usage in the 1980s to very high public transit usage in 2014, potentially aided by faster rapid transit service from the new Orange Line. Comparing the population

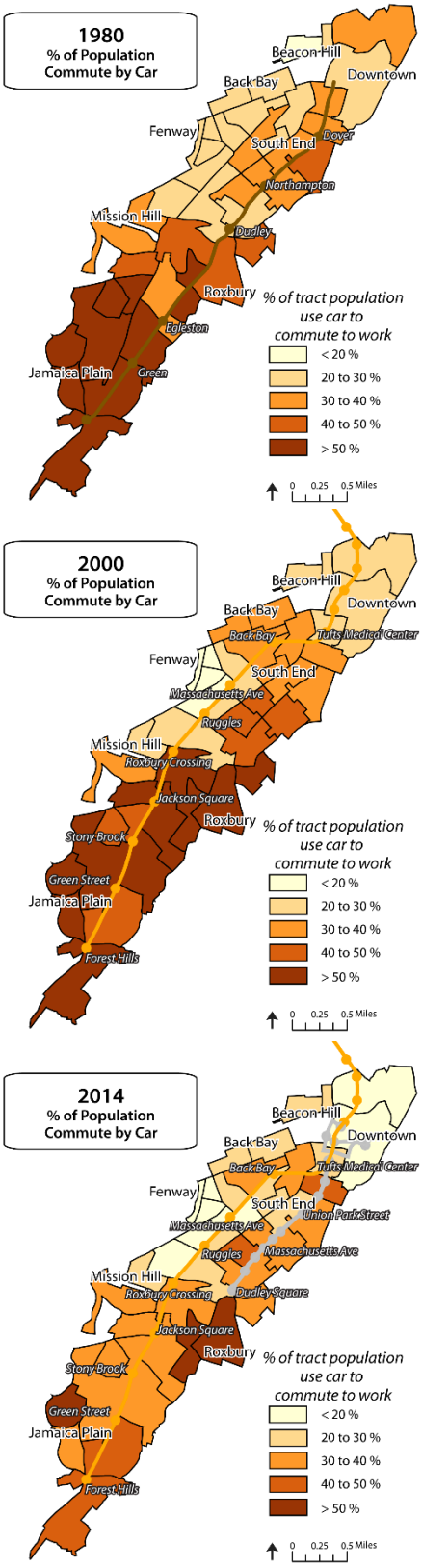


Figure 31. % of tract commute to work with car. Data from Social Explorer.

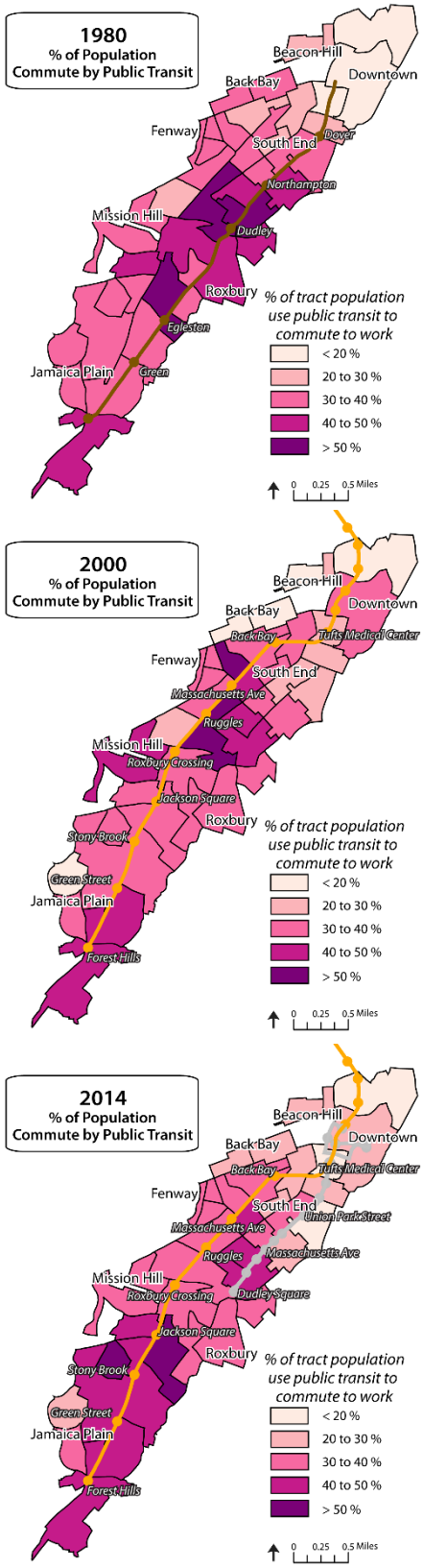


Figure 32. % of tract commute to work with transit. Data from Social Explorer.

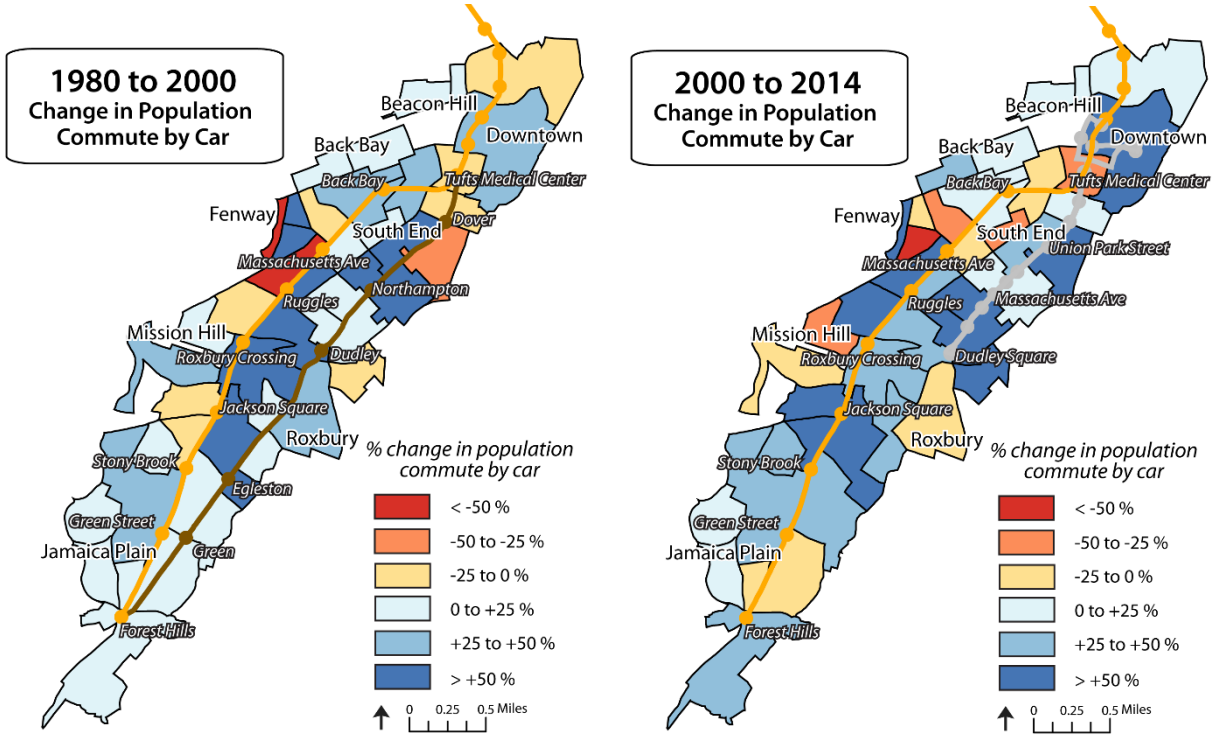


Figure 33. Change in population commuting to work by car. Data from Social Explorer.

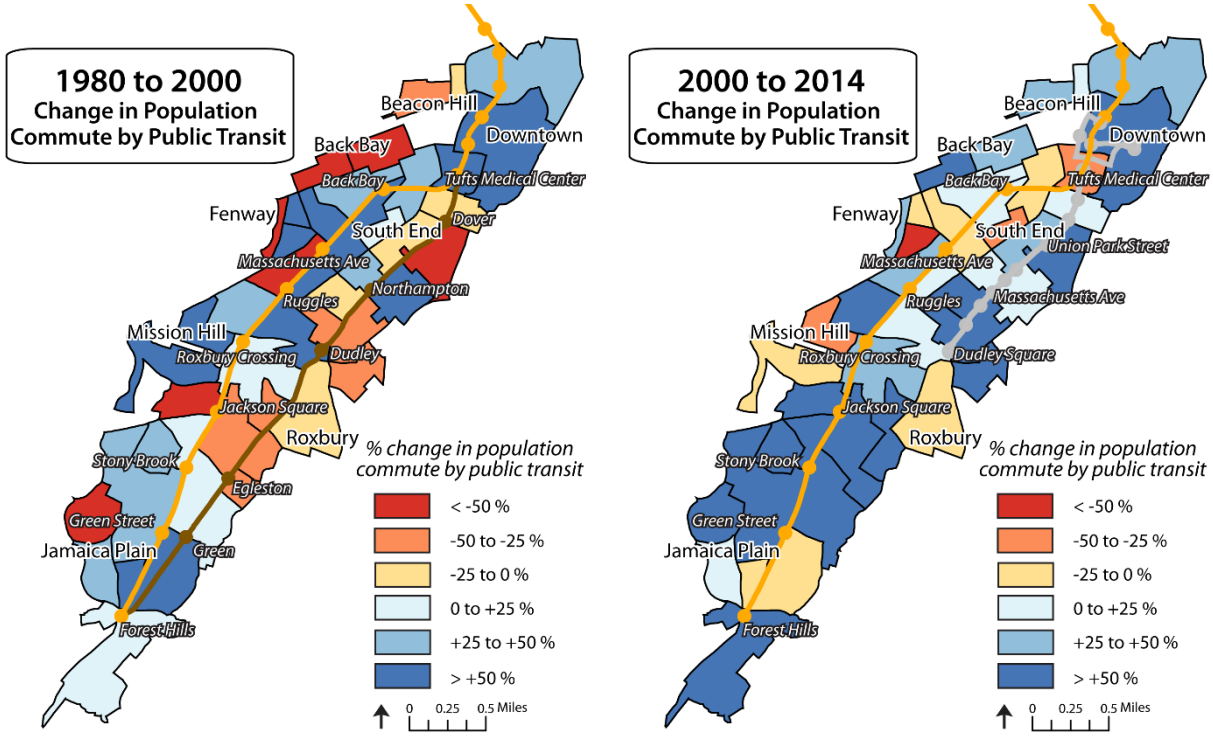


Figure 34. Change in population commuting to work by public transit. Data from Social Explorer.

change maps in Figures 33 and 34, the absolute number of car commuters increased between 1980 and 2000 for most tracts except for a few bordering the new Orange Line. For the public transit map, however, the tracts bordering the El mostly decreased in the population using transit, likely due to the El closing. Between 2000 and 2014, changes were similar for car commuters and public transit users, though Jamaica Plain's increase in population was greater for transit commuters than car commuters, potentially due to people moving to the neighborhood expecting to use the Orange Line to get to work.

3.3 Summary of Findings

The Elevated, Orange Line, and Silver Line historically and currently go through a variety of neighborhoods in Boston. These neighborhoods have changed in terms of overall population, race, foreign-born population, income distribution, education levels, and commute times and modes over the last several decades. The differing trends were mostly along neighborhood lines, but there were some changes likely caused by the Orange Line move and Silver Line addition that crosscut the neighborhoods.

The South End tracts of this area of analysis, especially the ones closer to Back Bay, increased in population, education level, and income between 1980 and 2014. They maintained their high White population and low Black population, as well as a large proportion of people with short commute-to-work times. On the other hand, the Roxbury tracts remain the poorest and least educated of the three neighborhoods. The majority of the population is Black, though that percentage has decreased over the years, with a large increase in Hispanics and a slight increase in the small White population. There are fewer people with commutes less than thirty minutes to work, plus a relatively high reliance on cars over public transportation. Lastly, the Jamaica Plain tracts have stayed generally constant in terms of population, mostly White, but with a sizeable Hispanic and Black population. The area has had increasingly higher incomes as well as a skyrocketing college-educated population. These tracts have also switched from mostly car-commuting to mostly public transit-commuting during this time period.

Concluding that a change in transportation directly impacts a change in demographics is difficult, since many factors may have influenced these tracts over the last several decades.

Instead, I focused on analyzing who was impacted by either the gain or the loss in transit service. By moving the Orange Line from Washington Street to the Southwest Corridor in 1987, service was taken away from tracts that were poorer, less educated, and had a higher Black population, increasing commute times for these communities. Conversely, service was given to tracts that were richer, more educated, and had a higher White population. Though a replacement service did return to Washington Street, the more disadvantaged populations only got pseudo-BRT in the Silver Line, as opposed to the fixed route, higher-speed Orange Line train available to the more advantaged demographics. The Silver Line also ended at Dudley Square, so areas just south of that and too far from the Orange Line still do not have adequate rapid transit service. The differences between tracts along these two corridors are just one part of the inequities in transportation services that exist today in the city of Boston.

4. Transit Access in Boston Today

4.1 Transportation Mobility as Economic Mobility

One of the primary reasons people use public transportation is to get from home to work and back, in order to make the income needed to sustain the individual and their family's livelihoods. Having adequate transportation means that an employed person can have a reasonable daily commute time, consistently get to work on time, and not have a commute be an added stressor to their day. For the unemployed, good transportation options provide more opportunities to search for jobs in a wider geographic area and to get to job interviews on time. Increasing transportation mobility for marginalized populations can help increase economic mobility as well. In a dense city like Boston, improving public transit can help a greater number of people get to work compared to just focusing on roads and highways. Getting car commuters to switch to public transit or active transportation can also better the environmental health of the city.

The MBTA system is set up in a hub-and-spoke system, where all lines converge at a few stops downtown, and neighborhoods in the periphery are generally only serviced by one rapid transit line, if any. Though this system design is an efficient way to bring people to the core of the city, travelling between neighborhoods not in the direction of the center is not as convenient. Looking at just the city of Boston, the downtown core is not located in the geographic center of the city, but rather to the north, so travelling between neighborhoods in the southern parts of the city proves even more difficult. In terms of jobs, the top five industries by number of people employed in Boston are Health Care and Social Assistance; Professional, Scientific, and Technical Services; Finance and Insurance; Government; and Accommodation and Food Services (BPDA Research Division, 2018), which are sectors that are mostly located in commercial and office areas rather than residential. Jobs have historically been and are currently concentrated in Downtown, but the Longwood Medical Area, Fenway, Back Bay, Allston, and the South Boston Waterfront neighborhoods have also had an increase in the number of jobs recently (Boston Department of Transportation, 2017). Since where people are living and working has changed over the last few decades, a transit system should consistently be reevaluated to see if the needs of all people, especially

marginalized groups, are being met. In the next section, I seek to understand how well public transit serves people in different locations and demographic groups in Boston, with a particular focus on access to jobs.

4.2 Transit Access and Neighborhood Demographics

Transit accessibility explores how well a transit system serves people in a defined area, gauged by some measure of the ability for all types of people to get from one place to another in an efficient way using public transportation. The term is broad, but generally includes a supply component—how much service the transportation system is providing—and a demand component—who needs transit and where they are located. For the purposes of this investigation, I use a simplified version of evaluating transit access, with access to jobs as the supply component and different demographic indicators to evaluate demand.

4.2.1 Access to Jobs via Transit

In order to assess the ability to get to jobs via transit from different areas of Boston, I utilized data from the "Access Across American: Transit 2017" study by the Accessibility Observatory at the University of Minnesota. The researchers determined the number of jobs reachable within 30 minutes by public transit from the center of every census block in the top fifty largest metropolitan areas in the U.S., using data from the U.S. Census Longitudinal Employer-Household 2015 Origin-Destination Employment Statistics and GTFS (General Transit Feed Specification) from various transit operators. Though not all jobs are equal in terms of economic opportunity, condensing them down to a numerical count simplifies transit supply to be usable for this analysis. Figure 35 shows this data mapped specifically for the Boston city proper.

In Boston, the areas darkest on the map are around the downtown core, where the lines of the MBTA converge and where many jobs are located. By dividing the city into its neighborhoods and finding the average number of reachable jobs for each, I ranked them by most accessible to least accessible, shown in Table 2. The Leather District, Downtown, Bay Village, and Chinatown are the most transit accessible for jobs, while Roslindale, Mattapan, Hyde Park, and West Roxbury are the least. I divided the range of job availability into four quartiles, geographically shown in Figure 36. For the purposes of looking at demographic

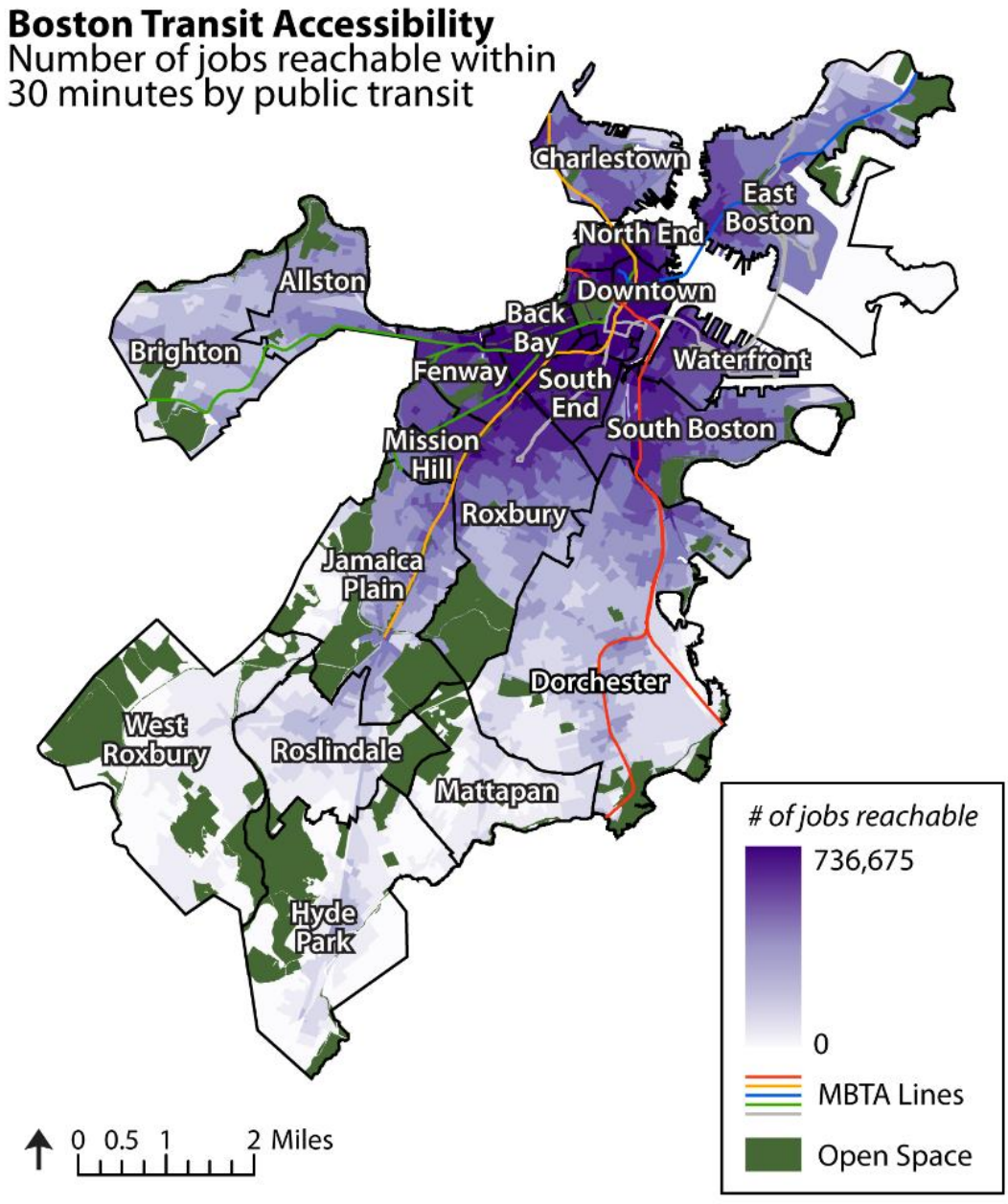


Figure 35. Number of jobs reachable by public transit within 30 minutes for each census block in Boston. Data from University of Minnesota Accessibility Observatory (2017).

data in each of these four quartiles in the following sections, the areas in red with the least number of jobs reachable by at most 30 minutes of transit will be called "Least Access," orange as "Less Access," light green as "More Access," and dark green as "Most Access."

Table 2. Jobs Access within 30 min by Transit		
Rank	*Neighborhood*	*Avg # of jobs reachable by transit*
1	Leather District	600371
2	Downtown	596144
3	Bay Village	574228
4	Chinatown	574082
5	Back Bay	552111
6	Beacon Hill	512851
7	West End	500876
8	South End	493821
9	Fenway	452887
10	North End	436618
11	South Boston Waterfront	385887
12	Longwood Medical Area	338261
13	South Boston	334906
14	Mission Hill	320951
15	Charlestown	256590
16	Roxbury	235742
17	East Boston	231747
18	Allston	128514
19	Jamaica Plain	98684
20	Dorchester	72276
21	Brighton	64617
22	Roslindale	23667
23	Mattapan	15272
24	Hyde Park	15021
25	West Roxbury	9966

Before delving into specific demographic characteristics of these areas, I first looked at the general distribution of population in Boston, shown as a population density map in Figure 37. Comparing it to Figure 36, the more populous areas tend to have better access to jobs via transit and are closer to downtown, while the neighborhoods to the far south with the Least Access tend to be not as dense in population. The neighborhoods that stand out in contrast are the ones that fall into the orange Less Access zones, namely Dorchester, Brighton, and parts of Mattapan and Roslindale. These areas, especially Dorchester, are

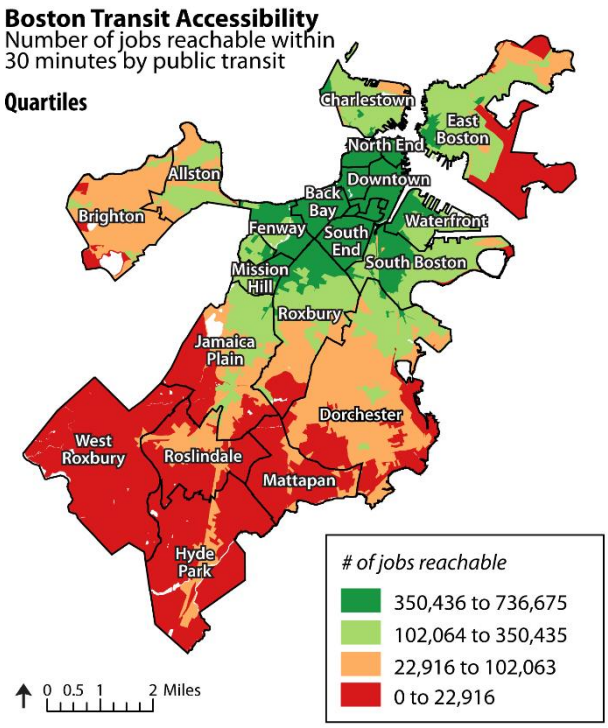


Figure 36. Number of jobs reachable by public transit within 30 minutes for each census block in Boston. Divided into four quantiles for analysis. Data from UMinn Accessibility Observatory (2017).

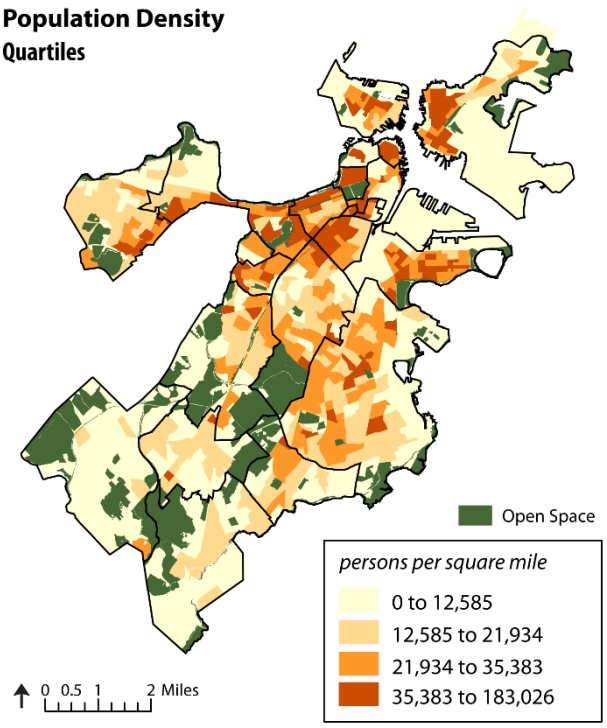


Figure 37. Boston population density at block group scale. Data from Social Explorer, ACS 2017 5-year estimates.

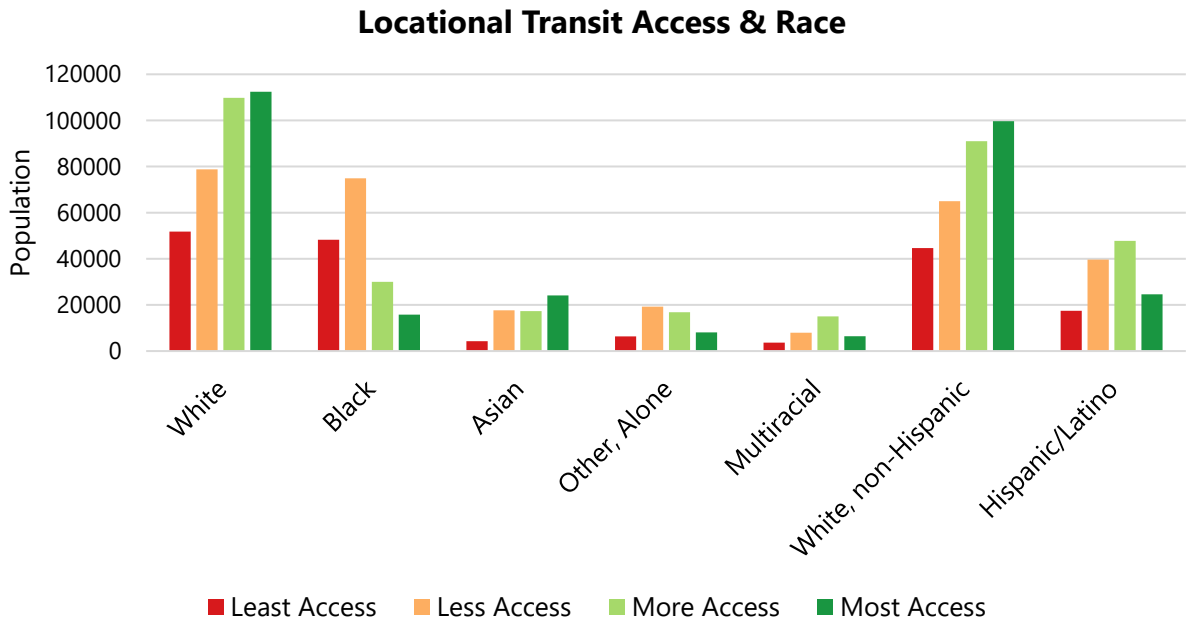


Figure 38. Population of different racial/ethnic groups and the level of transit access to jobs where they live. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

densely populated but lack transit access. The following sections explore the geographic and demographic inequity in transit access further.

4.2.2 Race and Ethnicity

Despite being less than half Non-Hispanic White, Boston is known as a city that is still somewhat racially segregated by neighborhood, leading to varying levels of transit access between people of different racial demographics. Figure 38, a chart of the population of racial/ethnic groups based on the level of transit access to jobs where they live, shows stark contrasts between the White and Black population distribution. Most White people live in areas with the Most Access to transit and the least live in areas with the Least Access. For Blacks, the highest population lives in areas with Less Access, and the second highest is in Least Access. Very few Black people live in the Most Access zones. For Hispanics, most people live in areas with More Access, but Less Access is a close second, signifying a medium level of transit accessibility for the group. Asians have relatively high transit access, with most of the population living in areas of Most Access, though More and Less Access zones are almost as populous.

Figure 39 visualizes the population density for each race, for geographical comparison to the four levels of transit access (Figure 36). Shown in shades of blue, the Non-Hispanic White population is very dense in the neighborhoods in the northern part of the city and South Boston, all places with high transit access. Compared to other races, the White population in less accessible West Roxbury and Brighton are relatively high as well, though these areas are more suburban. The Black population, shown in shades of purple, is concentrated in Dorchester, the southern part of Roxbury, and Mattapan, all areas with Less or Least Access to jobs via transit. Few Black people live in the more northern and downtown areas with great transit access. The third map shows the population density of Asians and Asian-Americans, who are dense in the northern, more transit accessible neighborhoods. However, there is also a sizeable population in Dorchester, which has Less Access. Lastly, the Hispanic/Latino population is distributed throughout the city, both in the More Access area of East Boston, and Less/Least Access areas of Roxbury, Dorchester, and Roslindale. Overall, Blacks in Boston receive the worst transit service to jobs and Whites receive the best, with

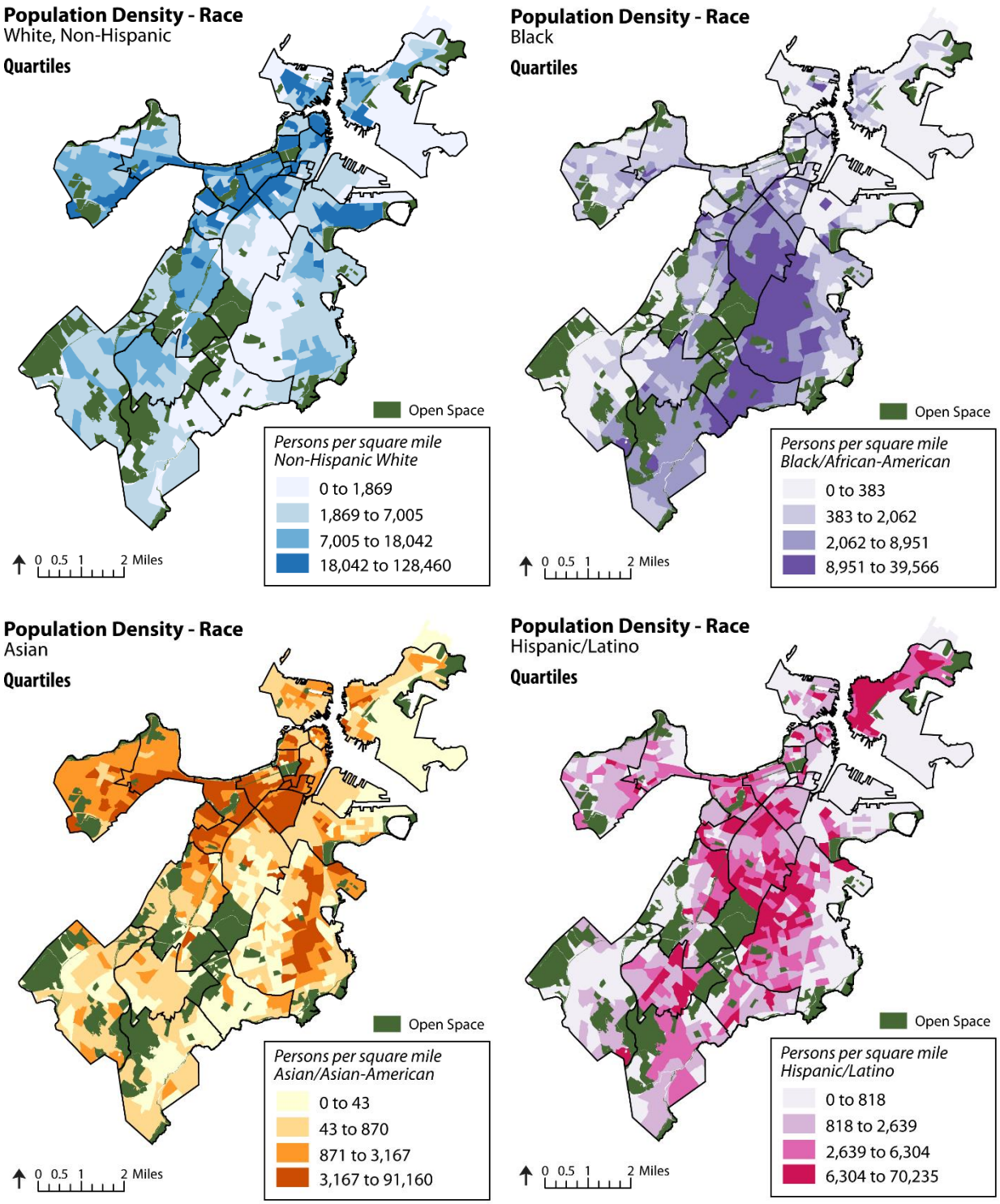


Figure 39. Population density by Race for block groups in Boston. Data from Social Explorer (ACS 2017).

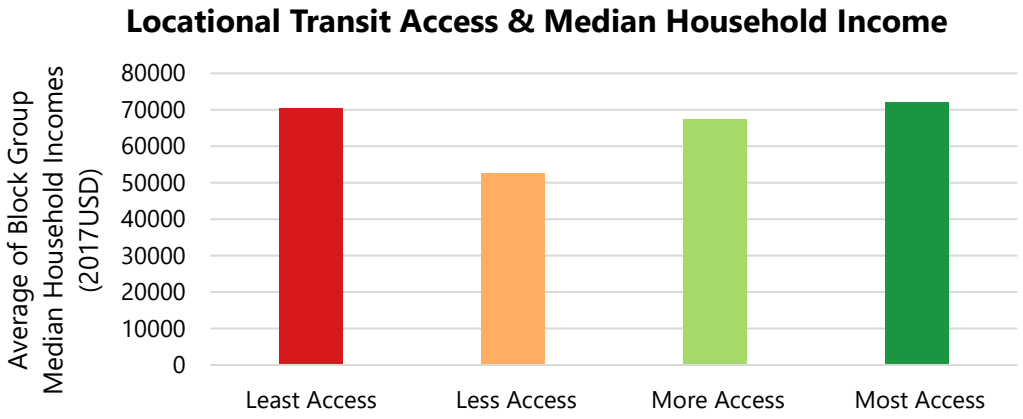
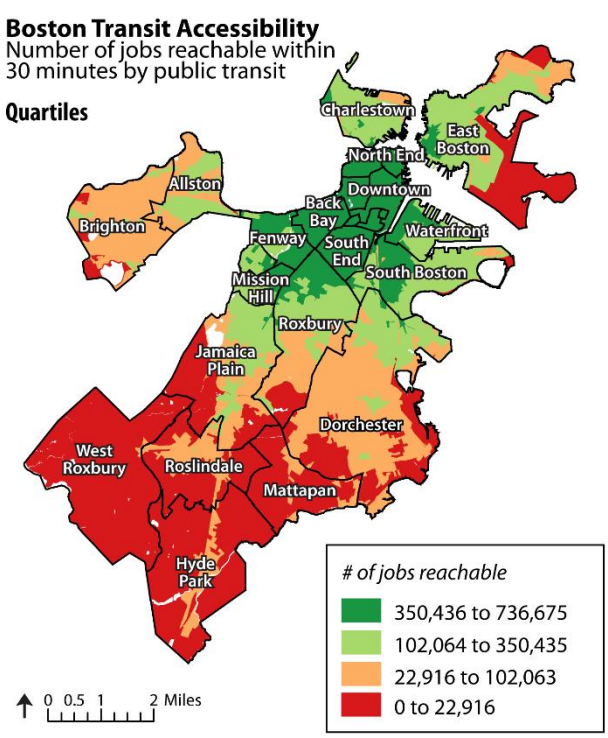


Figure 40. Average of block group median household incomes for each zone of transit accessibility in Boston. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).



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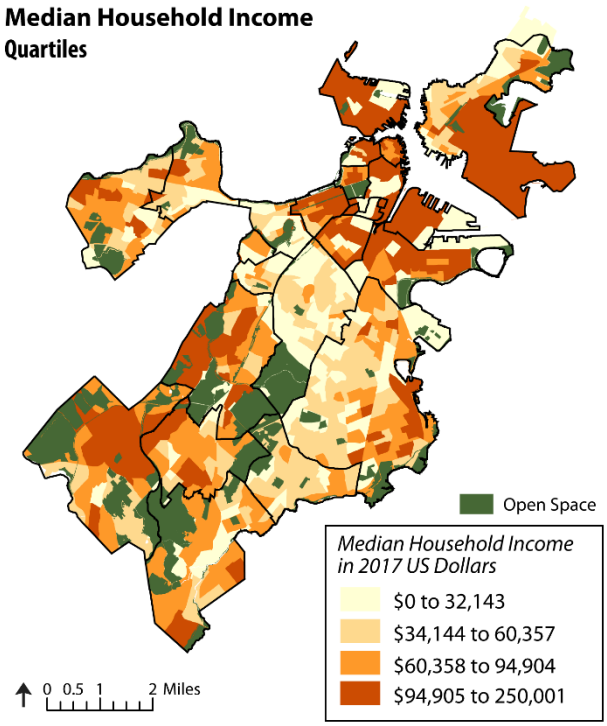


Figure 41. Median household income for block groups in Boston. Data from Social Explorer (ACS 2017).

Asian and Hispanic communities with varying amounts of access. Dorchester sticks out as a neighborhood with a high minority population and low transit access.

4.2.3 Income and Housing Costs

Income is inherently tied to where a person lives. Housing costs tend to be higher close to downtown, but transportation costs increase when one lives farther away, especially if they drive to work. Figure 40 shows the average of the median household incomes for the block groups within each level of transit access. The richest areas either have the Most or the Least Access to jobs via transit, and Less Access areas are the poorest. The spike in household income going from Less Access to Least Access areas is likely because the Least Access zones are more suburban, and well-off families are choosing to live there and commute by car instead. As seen in Figure 41, West Roxbury and the western part of Jamaica Plain are areas with high median household incomes and also contain many single family homes. Looking at just renters in Figure 42, median gross rents increase as transit access increases, which is justification for people with lower incomes to live in areas with worse transit.

In Figure 43, I explore the distribution of people in poverty among the four zones of transit access. Interestingly, a majority of people living under both 100% and 150% of the poverty line live in areas with More or Most Access to transit (with a greater percentage in More than Most). However, the zone with the highest percentage of people is Less Access, with very few people living in areas with Least Access. Since people with low incomes tend to rely on public transit to get around, living in zones with mediocre levels of transit access may be the trade-off for rents slightly lower than in the city center, but higher than in the periphery. Figure 44 reinforces this idea, showing that the population with incomes below 150% of the poverty line is dense in neighborhoods in the two middle levels of transit access: Dorchester, Roxbury, Allston, Brighton, and East Boston.

A general rule of thumb is that a person should spend no more than 30% of their income on their housing costs, and the American Community Survey tracks the number of households with costs over 30%, a statistic that takes into consideration both rent/mortgage and how much someone makes from work. Figure 45 shows the percentage of households with relatively high housing costs within each zone. The Less Access zones have proportion-

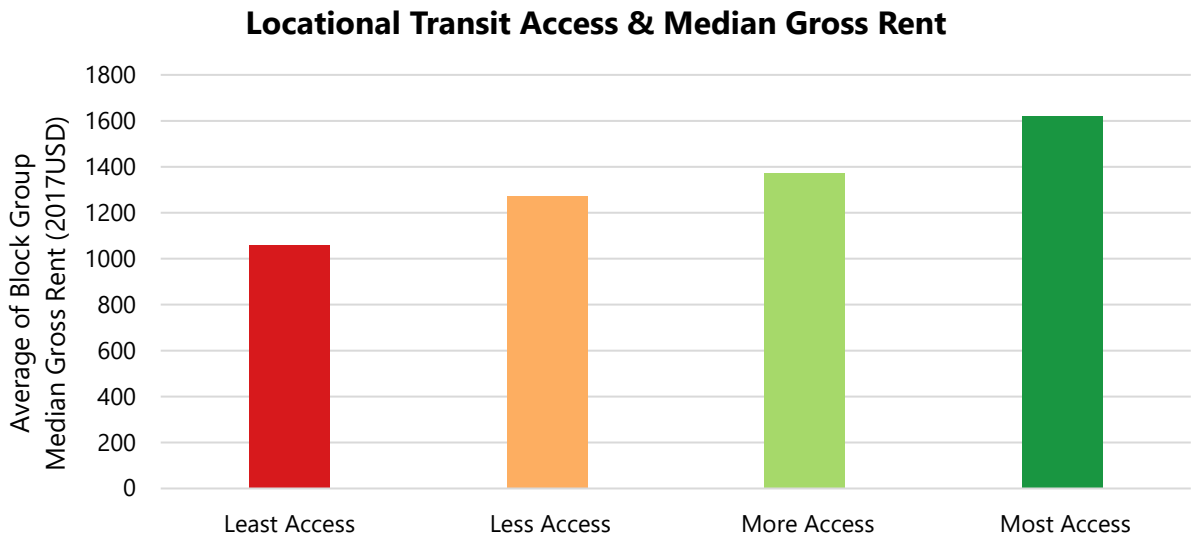


Figure 42. Mean of block group median gross rent for each zone of transit accessibility. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

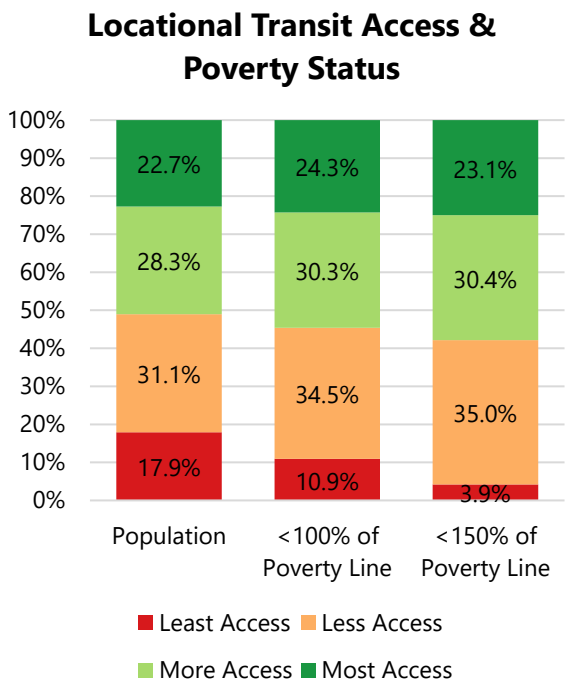


Figure 43. Percent of population (general, under 100% of poverty line, under 150% of poverty line) living in each zone of transit access. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

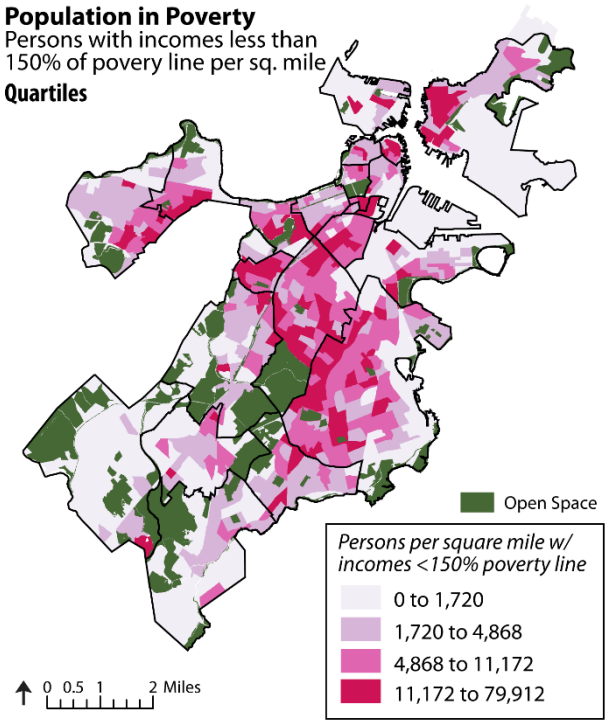


Figure 44. Population density by block group of persons living under 150% of poverty line. Data from Social Explorer (ACS 2017).

ally the most people spending a significant portion of their income on housing, with More Access next, and Most Access after that. While rents in the areas near transit and the downtown core may be high, people living around there tend to have high incomes as well. The poorer, less transit accessible neighborhoods, like Dorchester, Roxbury, and Allston-Brighton in Figure 46, have people with low incomes paying too high of costs for housing for mediocre transportation options.

4.2.4 Age

Different age groups have different transportation needs, and public transit plays a key role for all groups. Children and teenagers, 17 years and younger, may need transit to get to school and places of play if their parents cannot drive them. The older teens may also use transit in order to secure part-time jobs. Adults ages 18 to 64 are fully in the workforce and may rely on transit to get around, due to not owning a car or choosing not to drive. The elderly, aged 65 and over, may not be able to drive anymore and rely on transit to maintain their independence. Figure 47 displays the population of these three age groups in terms of what level of transit access exists where they live. The youth and the elderly both have the most people living in areas with Less Access to transit. The most people in the working age range of 18 to 64 live in areas with More Access, though Less and Most Access also have high populations. Figure 48 shows the geographic distribution of these three age groups. The population densities of the adults of working age matches well with the transit access zones of Figure 36, with more density in areas with better transit accessibility. Seniors also line up moderately well, with dense pockets in the South End, Back Bay and Beacon Hill, but the populated block groups in Dorchester are less well served. The youth population is concentrated in the southern half of Boston, so they are generally underserved by the existing public transportation system.

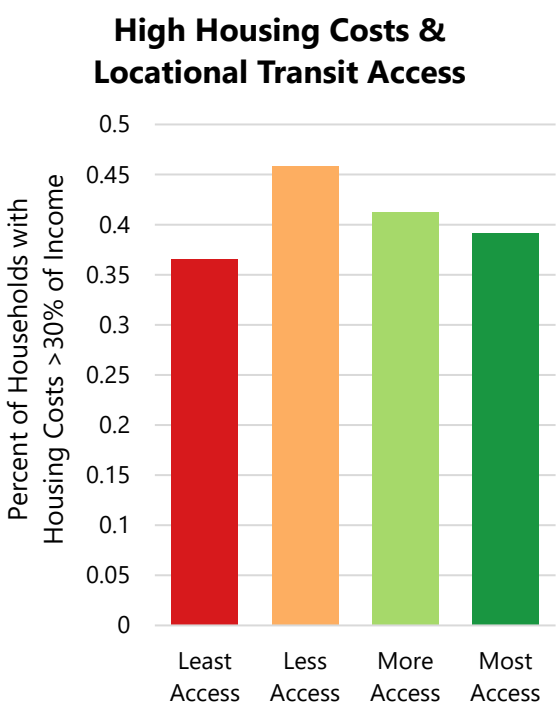


Figure 45. % of households with housing costs over 30% of income by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

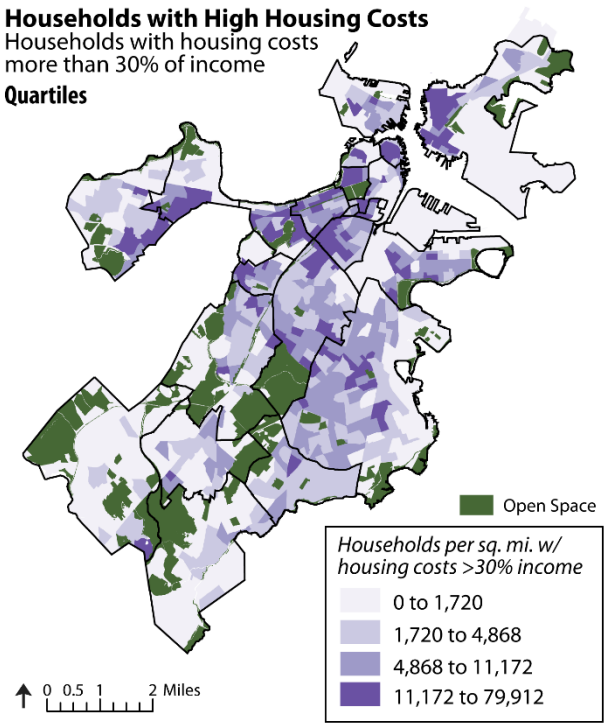


Figure 46. Number of households with housing costs over 30% of income by block group. Data from Social Explorer (ACS 2017).

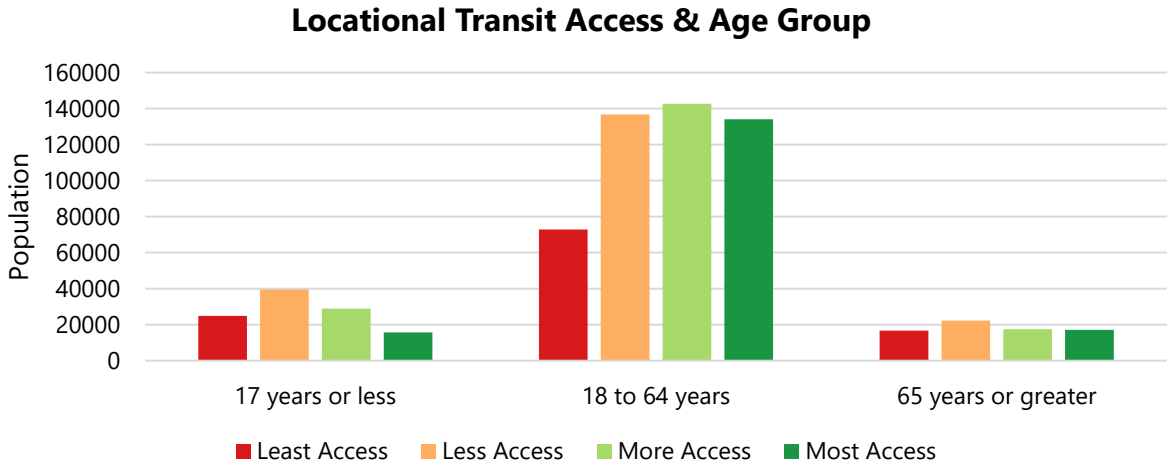
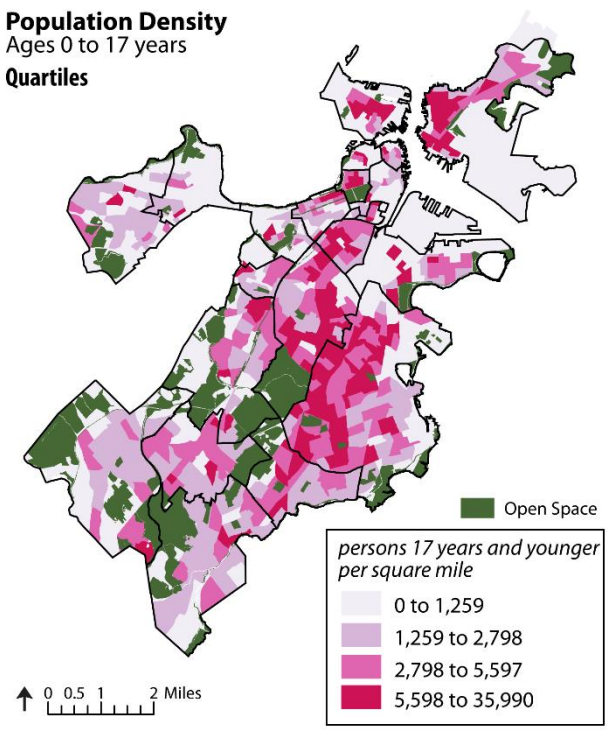
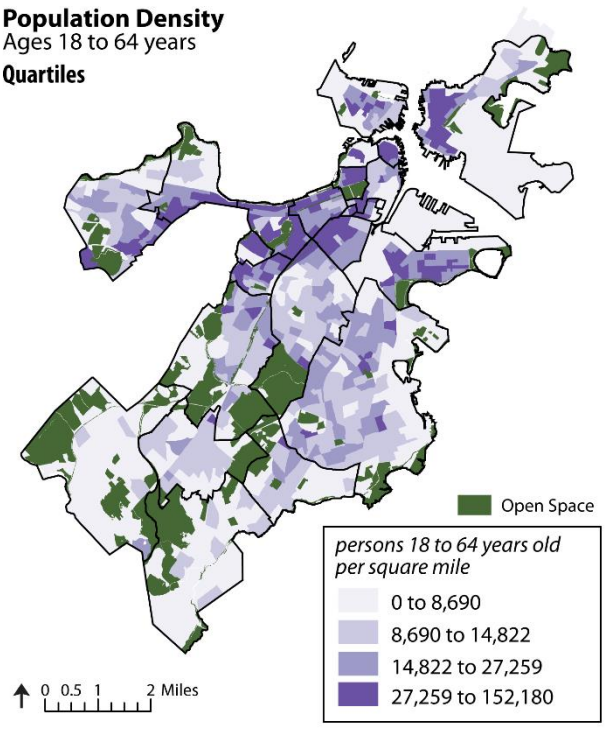
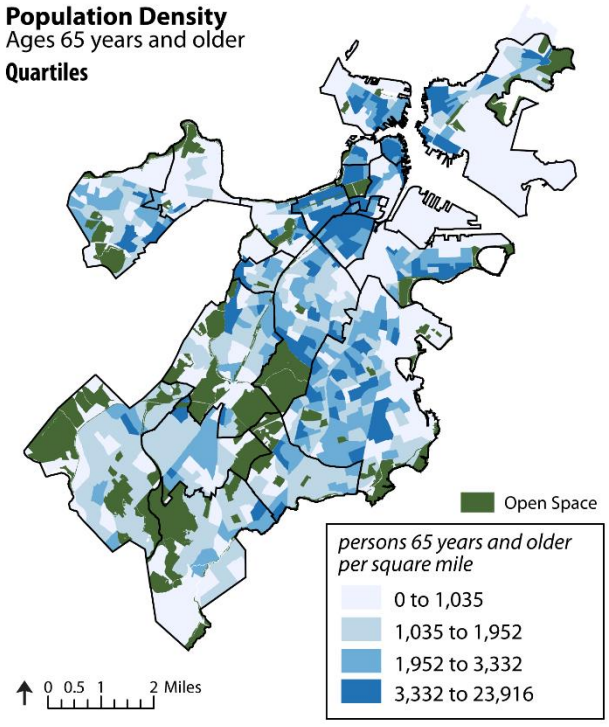


Figure 47. Population by age group by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).







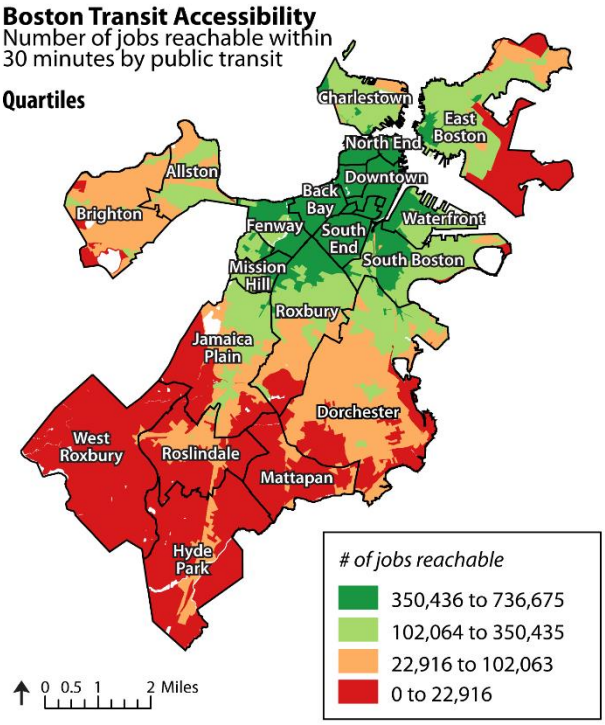


Figure 48. Population density of three age groups by block group. Data from Social Explorer (ACS 2017).

Figure 36. Reprinted for reference.

4.2.5 Employment Status

Since one of the primary purposes of public transit is to bring people to their jobs, I explored where the unemployed populations of Boston live in terms of transit access, compared to the general labor force. Figure 49 shows the distribution of transit access for employed persons compared to the unemployed in Boston. The Less Access to jobs via transit zone contains the most people for the unemployed population, while employed people tend to live in the More Access zone. Looking at these populations geographically, Figure 50 visualizes the general labor force population density and the unemployed population density. While the general population is concentrated in areas with good access to transit to jobs, unemployment is more spread out throughout all of Boston. The southern part of Roxbury, Dorchester, and parts of Mattapan, all areas with Less or Least Access, have higher unemployment rates than the rest of Boston. Improving transit accessibility in these areas can help the unemployed and under-employed find and travel to jobs.

4.2.6 Education

Having low levels of education and inadequate transit access can both hinder economic opportunities, so I looked at how transportation options may differ for the undereducated versus the general population. Figure 51 compares the distribution of the general population with that of people without a high school degree in terms of their transit access. A higher proportion of the less educated population lives in the Less Access areas than that of the general population, with the More Access area as a close second. In Figure 52, the areas with the densest population of undereducated people are not where there is Most Access to transit near the downtown core, but rather in Roxbury and Dorchester. Improving transit access to these areas could bring more economic opportunities to those who are already disadvantaged in the job market.

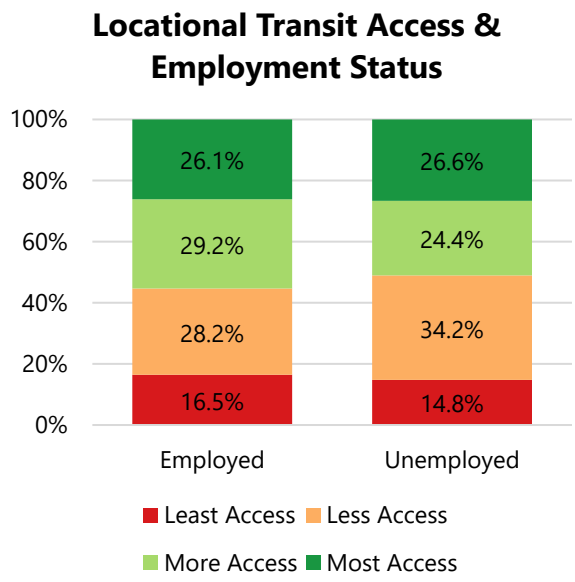


Figure 49. % of population by employment status in each transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

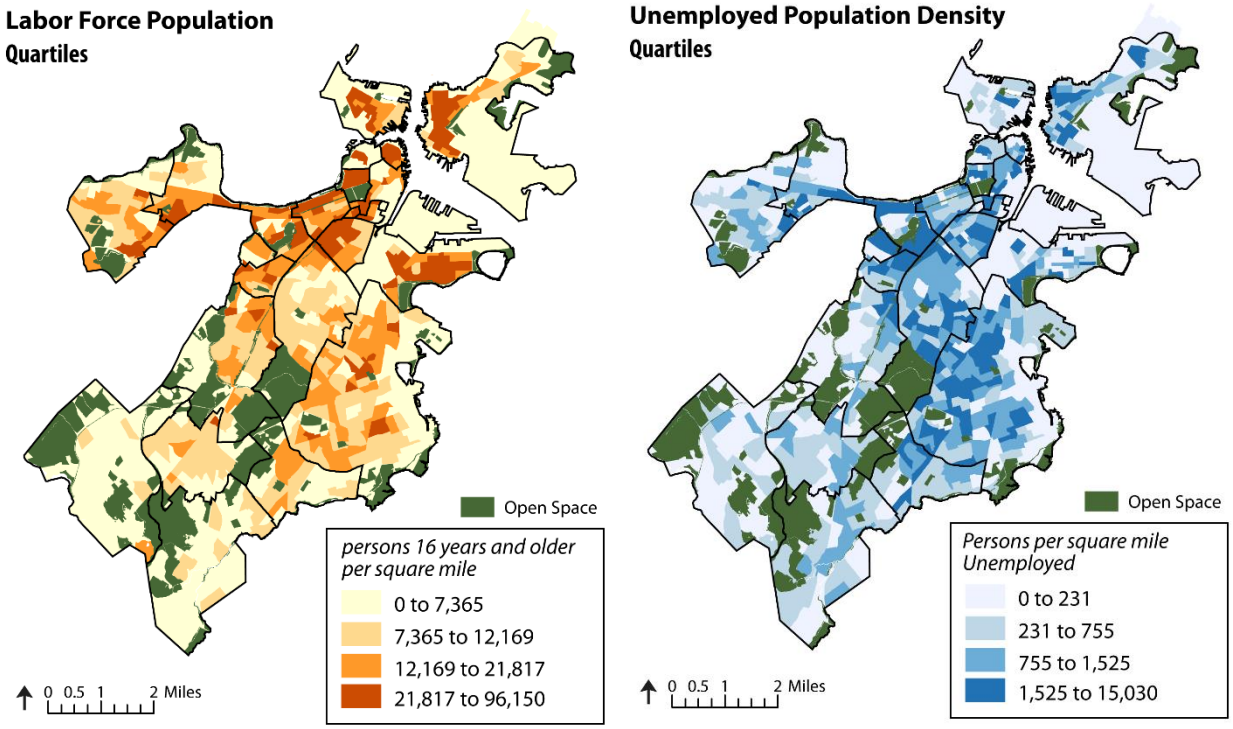


Figure 50. Labor force population density compared to unemployed population density, by block group. Data from Social Explorer (ACS 2017).

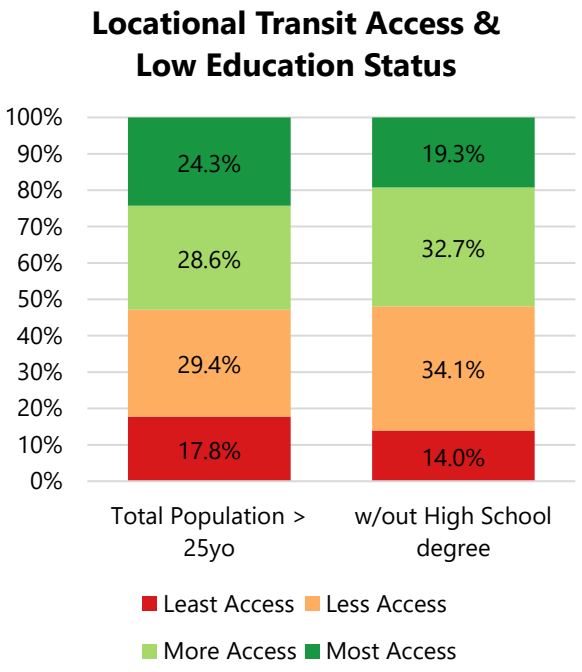


Figure 51. Percent living in each zone of transit access for total population versus those without a high school degree. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

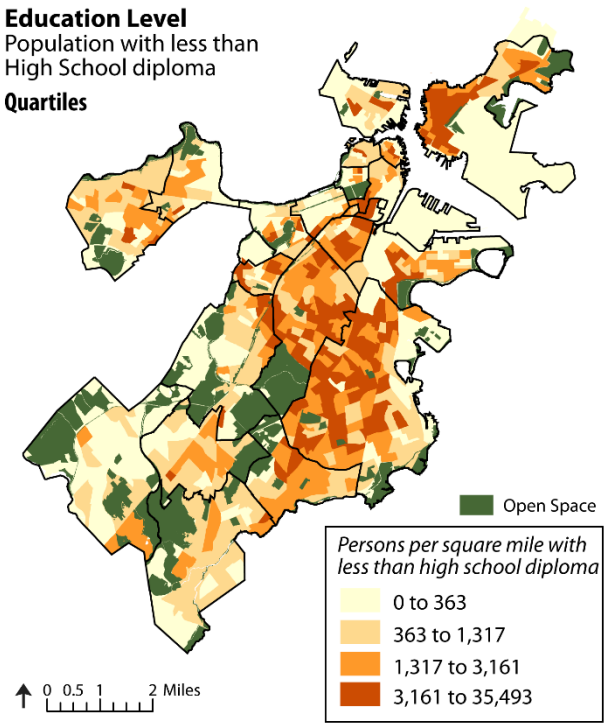


Figure 52. Population density of those without high school degree by block group. Data from Social Explorer (ACS 2017).

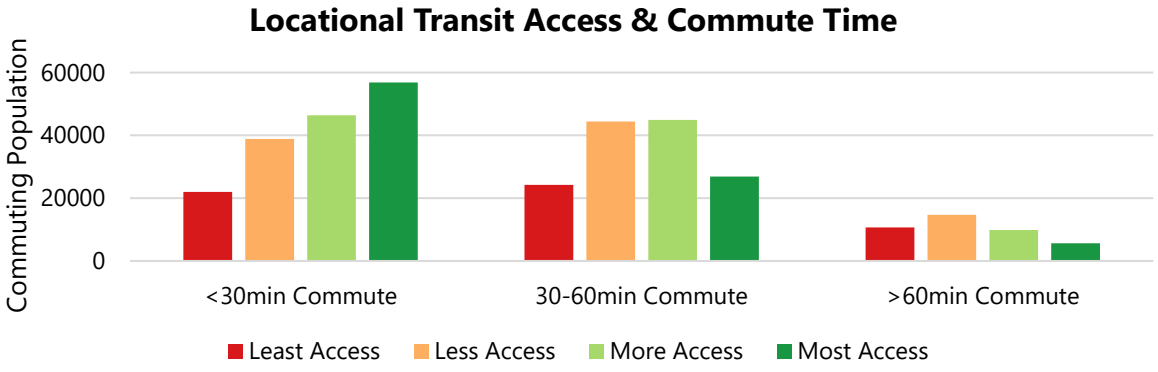


Figure 53. Population by commute time range by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

4.2.7 Commute

As the last demographic consideration, I explored the actual commute patterns of people in Boston. The Accessibility Observatory's Transit Accessibility dataset provides the theoretical accessibility in terms of number of jobs available via transit. I compare this to the population's actual commute times and modes. Figure 53 visualizes the distribution of transit access for people who commute to work under 30 minutes, in 30 to 60 minutes, and over 60 minutes. For those with relatively fast commutes, the number of people is directly proportional to the level of transit accessibility, with the largest group living in Most Access areas. 30 to 60 minute commuters tend to live in the mid-tier areas of transit accessibility, while the distribution is skewed towards Less Access for those with very long commutes. This trend can be seen geographically in Figure 54, which compares the population density of people with commutes less than 30 minutes to those of more than 60 minutes by block group. The people with the shortest commutes tend to live in the northern part of the city, while those with the longest commutes tend to live in the southern part; the south part of Dorchester is particularly dense with people whose commutes are over 60 minutes. The U.S. Census also publishes an average commute time for each census tract, mapped for Boston in Figure 55. Again, the southern part of Dorchester and Mattapan have the longest commutes, either by transit or otherwise. Even though other neighborhoods in the southern part of Boston, like Hyde Park and West Roxbury have the Least Access to transit, their average commute times may still be shorter than that of Dorchester or Mattapan, since people may choose to drive instead.

Figure 56 compares the transit accessibility for people who commute to work by car versus people who commute to work by public transit. Car commuters skew towards living in areas with less access to transit, while transit commuters skew towards living in areas with more access to transit. The maps in Figure 57 show these skews geographically, with a high density of car commuters in the low-density suburban areas of West Roxbury, Hyde Park, and Roslindale, where very little transit exist outside of buses and the commuter rail. Dorchester has a relatively even mix of car and transit users, likely because it does have rapid transit, but takes a while to get to downtown and other job areas using it.

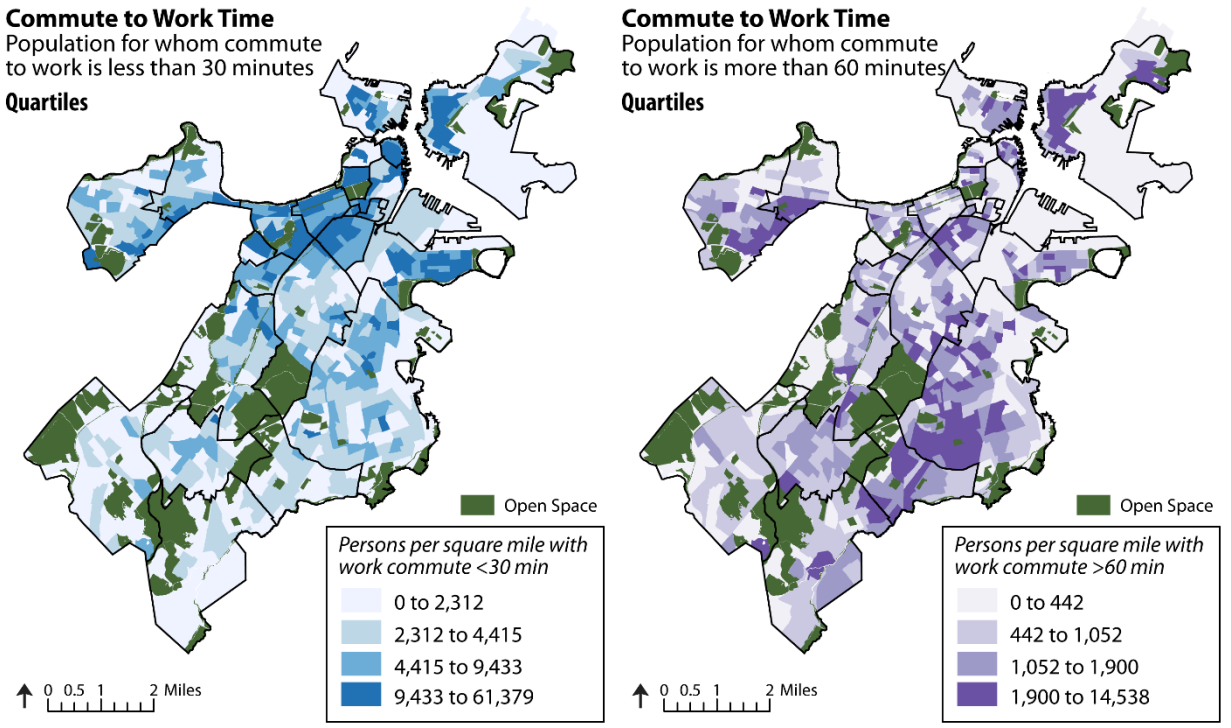


Figure 54. Population density of workers with less than 30 min commutes versus more than 60 min by block group. Data from Social Explorer (ACS 2017).

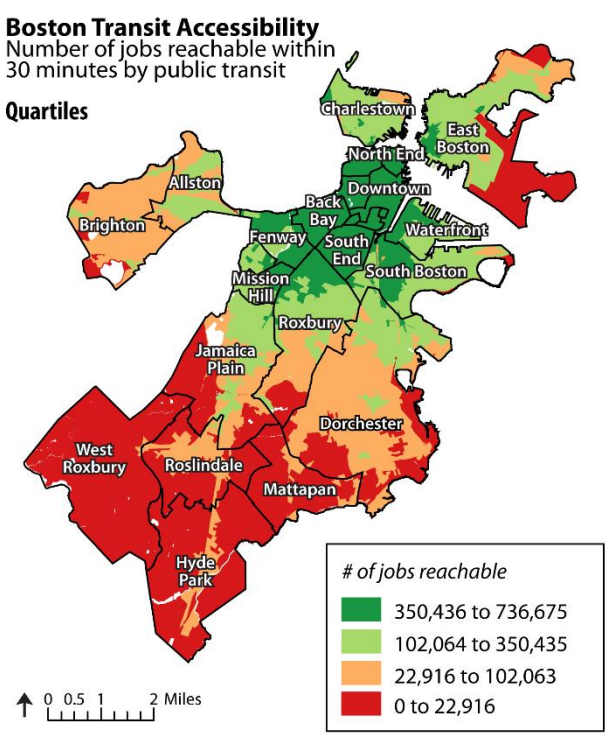


Figure 36. Reprinted for reference.

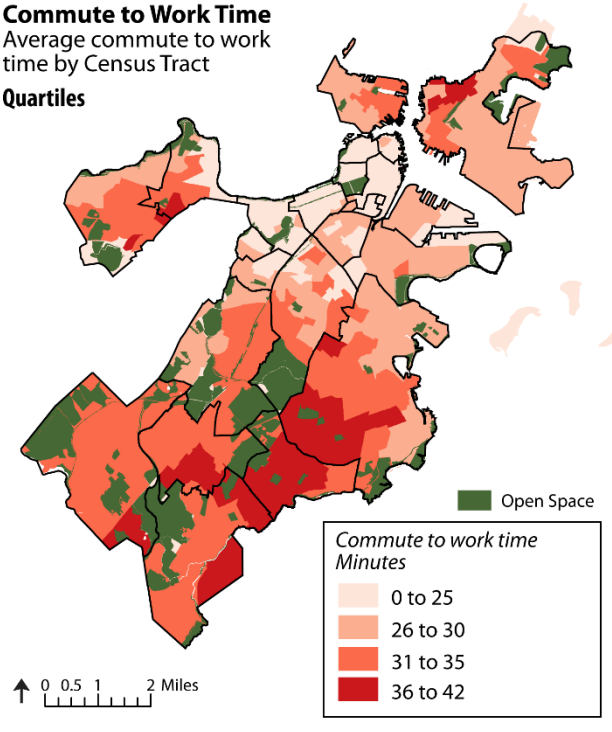


Figure 55. Average commute time to work by census tract. Data from Social Explorer (2017).

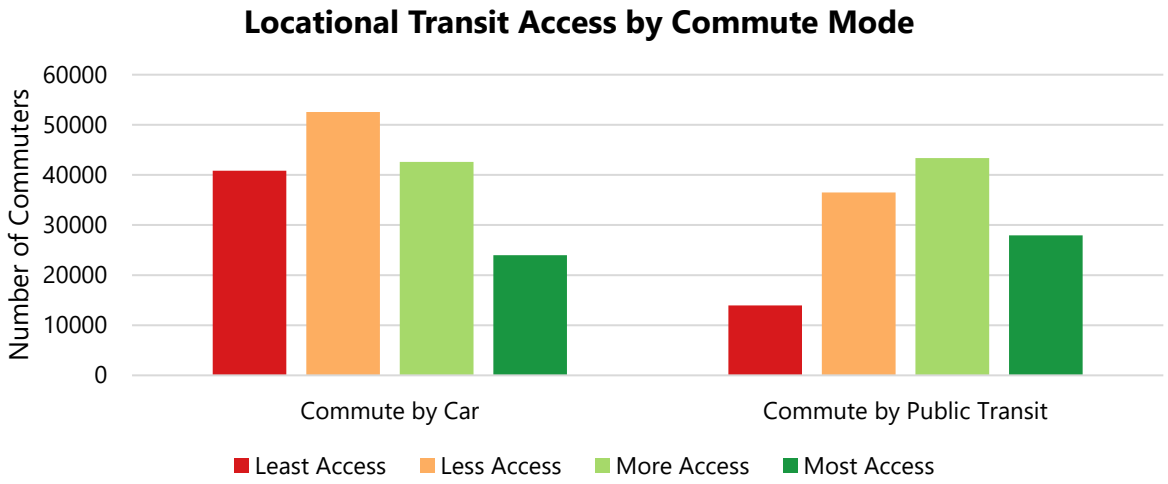


Figure 56. Population by commute mode by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

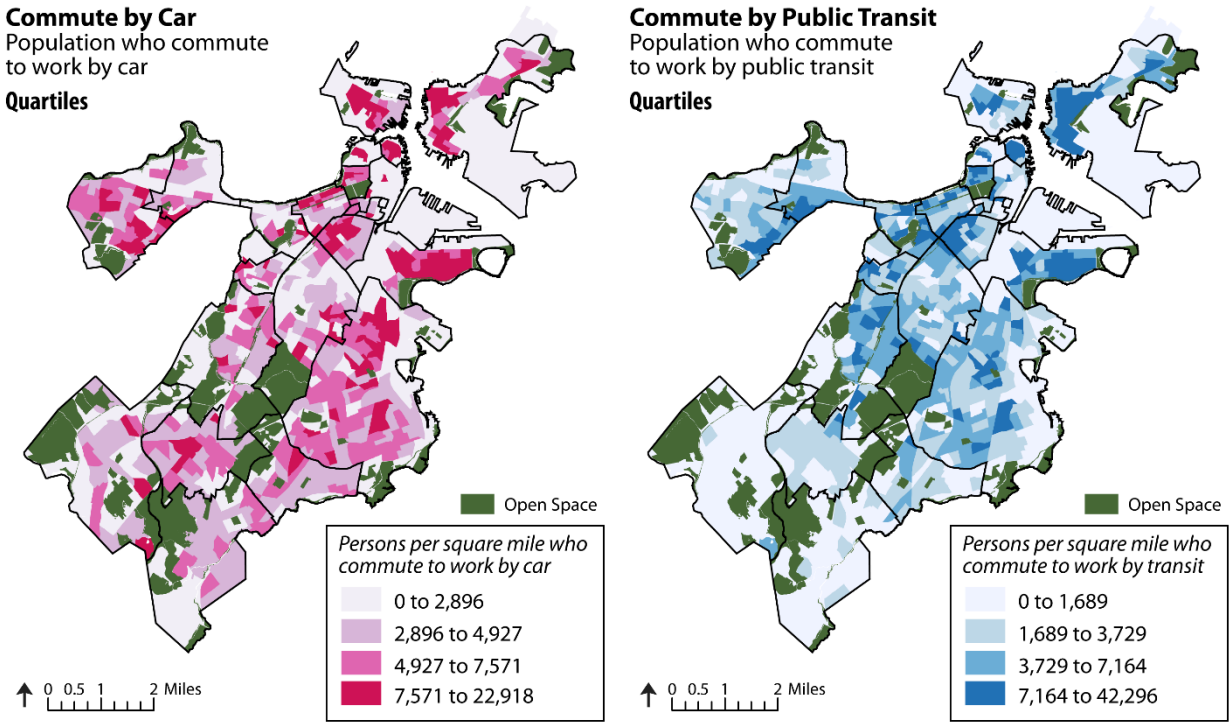


Figure 57. Population density by commute mode of car versus public transit by block group. Data from Social Explorer (ACS 2017).

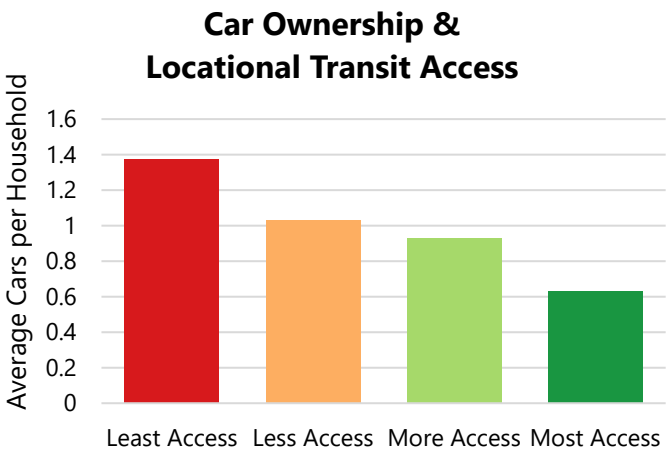


Figure 58. Average number of cars per household by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

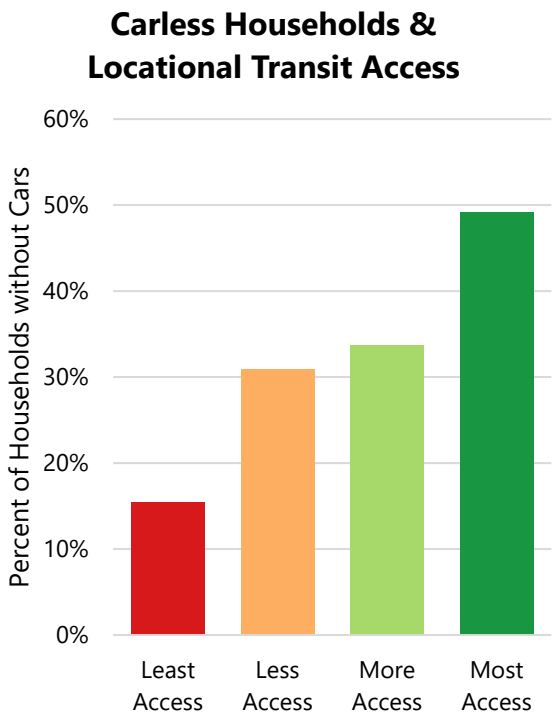


Figure 59. Percent of households with no vehicles by transit access zone. Data from UMinn Accessibility Observatory (2017) and Social Explorer (ACS 2017).

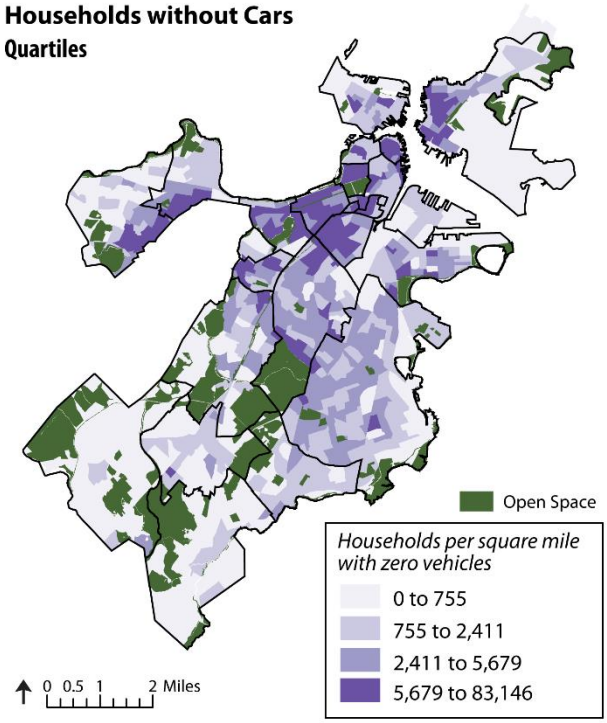


Figure 60. Density of households without cars by block group. Data from Social Explorer (ACS 2017).

Lastly, I looked at car ownership levels in different areas of Boston, which is related to how likely a person will need and/or use transit. Figure 58 shows an increasing number of average cars per household in relation to decreasing access to jobs via transit. Figure 59 shows the opposite trend, with an increasing percent of households without cars in areas with more transit access. These trends make sense: people in transit-poor areas need a car to get places, while people in transit-rich areas can walk or use transit and may not even have room for a car in a dense city. The percent of carless households in the Less Access zone is still relatively high though, which means that many people in these areas still rely on transit to get to work, even if it is inconvenient. Figure 60 shows the density of households without cars throughout the city. While these households are concentrated in the transit-rich areas of the downtown core, the Less Access zones of Dorchester and the southern part of Roxbury still have a sizeable carless population. Improving transit service in these areas can help those without cars get to work in a more efficient way. Improving service elsewhere in the more suburban areas of southern Boston can help convince people to switch modes from car to public transit, decreasing pollution and congestion in the city.

4.3 Summary of Findings

In the previous section, I explored transit access in Boston in terms of population, race, income and housing costs, age, employment status, education level, and commute modes and times. The MBTA system provides adequate service for many areas in the city; the densest parts of Boston, such as the area around the downtown core, have high levels of transit available. However, not all areas are as transit accessible as these neighborhoods, and often the communities already disadvantaged by other societal factors receive poor public transportation service.

The place that the supply (availability of transit to access jobs within 30 minutes of commuting) and the demand (number of people of certain demographics living in area) of transit access fails the most is in the zone I have previously labeled “Less Access.” These areas contain some level of public transit, but not enough to bring many people to work within 30 minutes. Unlike the “Least Access” zones that are more suburban in nature and contain a wealthier population who have likely chosen car commuting willingly, the “Less Access” zone

has a high proportion of minority, low-income, unemployed, and/or undereducated people who may not own cars and have relatively longer commute times reported on the Census.

One such neighborhood that falls almost entirely in this zone is Dorchester. Denser than other neighborhoods in the "Less" and "Least Access" zones, Dorchester is serviced by the Red Line, but mostly on the Ashmont branch, so service does not come as often as the downtown and Cambridge parts of the Red Line. The neighborhood is not only around the Red Line though, since the land area is quite large, so many people do not have access to rapid transit at all. Since Dorchester has many of the disadvantaged populations listed earlier, lack of good transit compounds the barriers to economic opportunities. Focusing on regions like Dorchester to improve access to public transportation can help loosen other barriers to economic mobility.

5. Improving Mobility in Boston and Beyond

This thesis provides a broad look at the interactions between transportation infrastructure and neighborhoods in Boston over the last fifty years, from the anti-highway movement in the 1960's to the areas that lack transit access in the 2010's. Though most of the highways that threatened to cut through the city were blocked and public transit has improved over the years, there are still communities left behind with unfulfilled transportation needs.

During the anti-highway movement, a broad coalition of community activists, government officials, planners, academics, residents, and more from all corners of the greater metro area came together to stop the impending destruction to their neighborhoods. Groups that do not normally work together, like the Black Panther Party and upper-middle-class suburban white families, joined through their advocacy, eventually leading to success at the city, state, and federal levels. Many individuals adopted multiple roles within different agencies and organizations, acting as the conveners, negotiators, and information spreaders. All of this work led to the moratorium on highway building in Massachusetts, which eventually led to the federal government creating a provision to allow for highway funding to be used to fund public transportation and related community development.

The Southwest Corridor project was the first time this provision was used. Since demolition for the proposed Southwest Corridor highway had already started before the project was canceled, there was a cleared path from the South End to Forest Hills in Jamaica Plain for a new community space and a mass transit line. With federal highway money, the MBTA had the funds to tear down the old Elevated Orange Line on Washington Street and build a new modern Orange Line along the Southwest Corridor, leading to a cleaner and more efficient line with stations integrated into many neighborhoods and a beautiful linear park on top. By moving the Orange Line a few blocks to half a mile away from Washington Street however, rapid transit service was taken away from a majority Black, dense, lower-income, less-educated corridor to one that is majority White, mostly-residential, higher-income, and more-educated. Though the Silver Line was eventually added to this street fifteen years later as the long overdue promise of the replacement service for the El, the fact that it is a bus with

some components of BRT added in means that these disadvantaged populations are still not served as well as areas with rail service. Parts of Roxbury ended up being negatively impacted by the Orange Line move, and the Silver Line as the promised replacement service does not go past Dudley Square to the more southern parts of the neighborhood.

Zooming out to the rest of Boston, there is evidence that the MBTA system today does not adequately serve all parts of the city well, especially the parts with marginalized communities. Using the metric of access to jobs via 30 minutes of commuting with public transportation as the measure for transit supply, people living in the downtown core have many opportunities to utilize the T to its full extent. People in the more suburban areas of Boston like West Roxbury do not have much access to transit, but generally have wealthier incomes and vehicles to get them to work. The communities in between these two zones are where public transportation is lacking. Dorchester, especially, has the combined barriers of low access to fast transit and communities already marginalized by other societal factors, such as race, income, education, and unemployment.

By centering equity in the work that the City of Boston, MBTA, and MassDOT do to improve the area's transportation system, the agencies can help residents of neighborhoods like Roxbury and Dorchester reach more economic opportunities. One potential area of further work for this thesis is to propose a series of policy and planning solutions for the government entities to implement to improve transit and economic access. This work could involve exploring existing organizations currently doing great work in the field—such as the LivableStreets Alliance, the T Riders Union, TransitMatters, Transportation for Massachusetts, and many more—to see how their initiatives can be augmented. Another interest tangent would be to see if any of these organizations have connections dating back to the anti-highway movement, to showcase how people are still fighting for the same issues today.

The mapping and demographic data sections of this thesis only focused inside the city boundaries of Boston. The MBTA is a regional system, so the same type of analysis can be done on the broader metropolitan area as well. Looking at the MBTA budget may yield interesting comparisons for how the agency spends money on different communities, such

as the tradeoff between providing better service in the inner city and expanding commuter rail to farther suburbs. The MBTA has many big projects over the next few years, such as the Green Line extension, so looking at neighborhood impacts into the future could prove useful in mitigating potential harmful effects.

Lastly, the transportation field is changing fast with the introduction of new technology. The increasing prevalence of bike and electric scooter share systems can help people get to and from transit stops to their final destinations easier. At the same time, ridehailing companies and the promise of autonomous vehicles have potential to remove from people the mindset of only using single-occupancy vehicles, but may also compete with public transportation in a way that leads to more congestion on the streets. Planning for and figuring out how to extract public benefits from these new technologies can help make public transportation more efficient and equitable, which in turn can act as a catalyst for social and economic mobility.

References

ACS 2012 (5-Year Estimates). (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/ACS2012_5yr

ACS 2016 (5-Year Estimates). (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/ACS2016_5yr

ACS 2017 (5-Year Estimates). (2018, December 22). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/ACS2017_5yr

Altshuler, A. (1965). *The City Planning Process: A Political Analysis.* London: Cornell University Press.

Avila, E. (2014). *The Folklore of the Freeway: Race and Revolt in the Modernist City.* Minneapolis: University of Minnesota Press.

Belcher, J. (2018, August 30). *Changes to Transit Service in the MBTA district.* Retrieved from The MBTA Vehicle Inventory Page: http://www.transithistory.org/roster/MBTARouteHistory.pdf

Boston Department of Transportation. (2017, March 7). *Vision and Action Plan.* Retrieved from Go Boston 2030: https://www.boston.gov/departments/transportation/go-boston-2030

Boston Transportation Department. (2002). Boston Transprtation Fact Book and Neighborhood Profiles. In *Access Boston 2000-2010: Boston's Citywide Transportation Plan.* Boston: City of Boston.

BPDA Research Division. (2018). *Boston's Economy 2018.* Boston: Boston Planning and Development Agency.

Caro, R. (1974). *The Power Broker.* New York: Knopf.

Carter, K. (2011). *Equal or Better: The Story of the Silver Line.* Medford: Tufts University.

Census 1980 on 2010 Geographies. (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/RC1980

Census 1990 on 2010 Geographies. (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/RC1990

Census 2000 on 2010 Geographies. (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/RC2000

Census 2010. (2018, November 11). Retrieved from Social Explorer: https://www.socialexplorer.com/tables/C2010

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

Chinatown Atlas. (2018). *Expansion & Threats: WWII-1970's*. Retrieved from Chinatown Atlas: http://chinatownatlas.org/era/wwii-1970s/

Connerly, C. E. (2002). From Racial Zoning to Community Empowerment, the Interstate Highway System and the African American Community in Birmingham, Alabama. *Journal of Planning Education and Research*, 99-114.

Crockett, K. (2018). *"People Before Highways": Reconsidering Routes to and from the Boston Anti-Highway Movement.* Boston: University of Massachusetts Press.

DiMento, J. F., & Ellis, C. (2013). *Changing Lanes: Visions and Histories of Urban Freeways.* Cambridge: MIT Press.

Gakenheimer, R. (1976). *Transportation Planning as a Response to Controversy - The Boston Case.* Cambridge: MIT Press.

Hershfang, A. (2010, February 9). (K. Crockett, Interviewer)

Howe, P. J. (1987, May 03). Highway never made it, but T line did. *The Boston Globe*, p. 40.

Jiao, J. (2017). Identifying transit deserts in major Texas cities where the supplies. *The Journal of Transport and Land Use*, 529-540.

Johnson, K. M. (2009). Captain Blake versus the Highwaymen: Or, How San Francisco Won the Freeway Revolt. *Journal of Planning History*, 56-83.

Joint Board for the Metropolitan Master Highway Plan. (1948). *The Master Highway Plan for the Boston Metropolitan Area.* Boston: The Commonwealth of Massachusetts.

Kaiser, S. (2017). *Citizen Opposition to the Inner Belt.* Cambridge.

Kawabata, M. (2009). Spatiotemporal dimensions of modal accessibility disparity in Boston and San Francisco. *Environment and Planning*, 183-198.

Kleespies, G. (n.d.). *The Inner Belt.* Retrieved from Cambridge Historical Society: http://cambridgehistory.org/innerbelt/history.html

Kozel, S. M. (2007, May 8). *Baltimore City Interstates.* Retrieved from Roads to the Future: http://www.roadstothefuture.com/Balt_City_Interstates.html

Lei, T. L., & Church, R. L. (2010). Mapping transit-based access: integrating GIS, routes and schedules. *International Journal of Geographic Information Science*, 283-304.

Luberoff, D. (2012, Winter). *The Roads Not Taken.* Retrieved from ArchitectureBoston: https://www.architects.org/architectureboston/articles/roads-not-taken

Lupo, A., Colcord, F., & Fowler, E. (1971). *Rites of Way, The Politics of Transportation in Boston and the U.S. City.* Boston: Little, Brown and Company.

Mohl, R. A. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt.* Birmingham: Poverty and Race Research Action Council.

Nall, C. (2015). The Political Consequnces of Spatial Policies: How Interstate Highways Facilitated Geographic Polarization. *The Journal of Politics*, 394-406.

Owen, A., & Murphy, B. (2017). *Access Across America: Transit 2017.* Minneapolis: University of Minnesota Accessibility Observatory.

Paletta, A. (2016, April 28). *Story of cities #32: Jane Jacobs v Robert Moses, battle of New York's urban titans.* Retrieved from The Guardian: https://www.theguardian.com/cities/2016/apr/28/story-cities-32-new-york-jane-jacobs-robert-moses

Perk, V. A., Catala, M., & Reader, S. (2012). *Land Use Impacts of Bus Rapid Transit: Phase II—Effects of BRT Station Proximity on Property Values along the Boston Silver Line Washington Street Corridor.* Washington, DC: Federal Transit Administration.

Rodrigue, J.-P. (2017). *The Interstate Highway System.* Retrieved from The Geography of Transport Systems: https://people.hofstra.edu/geotrans/eng/ch3en/conc3en/map_interstatesystem.html

Salvucci, F. P., & O'Leary, J. F. (1987, March 3). The New Orange Line. *The Boston Globe*, pp. 924-934.

Samuelson, R. J. (1967, June 2). *Cambridge and the Inner Belt Highway: Some Problems are Simply Insoluble.* Retrieved from The Harvard Crimson: https://www.thecrimson.com/article/1967/6/2/cambridge-and-the-inner-belt-highway/?page=1

Schwager, D. S. (1997, August). Consequences of the Development of the Interstate Highway System for Transit. *Transit Cooperative Research Program: Research Results Digest*.

St. Clair, D. J. (2014). National Defense and the U.S. Interstate Highway Act of 1956. *International Journal of Business, Humanities and Technology*, 64-74.

Techagumthorn, Y. (2018). *Social Movements & Interstate Highways: A study of anti-highway revolts in Boston and beyond.* Cambridge: MIT Department of Urban Studies and Planning.

The West End Museum. (n.d.). Retrieved from The West End Museum: http://thewestendmuseum.org/

Turner, L., & Tuite, L. (2013, June 28). *The elevated Central Artery.* Retrieved from Boston Globe: https://www.bostonglobe.com/lifestyle/2013/06/28/from-archives-boston-elevated-central-artery/4WU6Jq8QJUqKvIfzdfXtRM/story.html

Welch, T., & Mishra, S. (2013). A measure of equity for public transit connectivity. *Journal of Transport Geography*, 29-41.