Title

Toward a Life in Balance: An Analysis of Commuting Characteristics and Jobs/Housing Balance in Southern California

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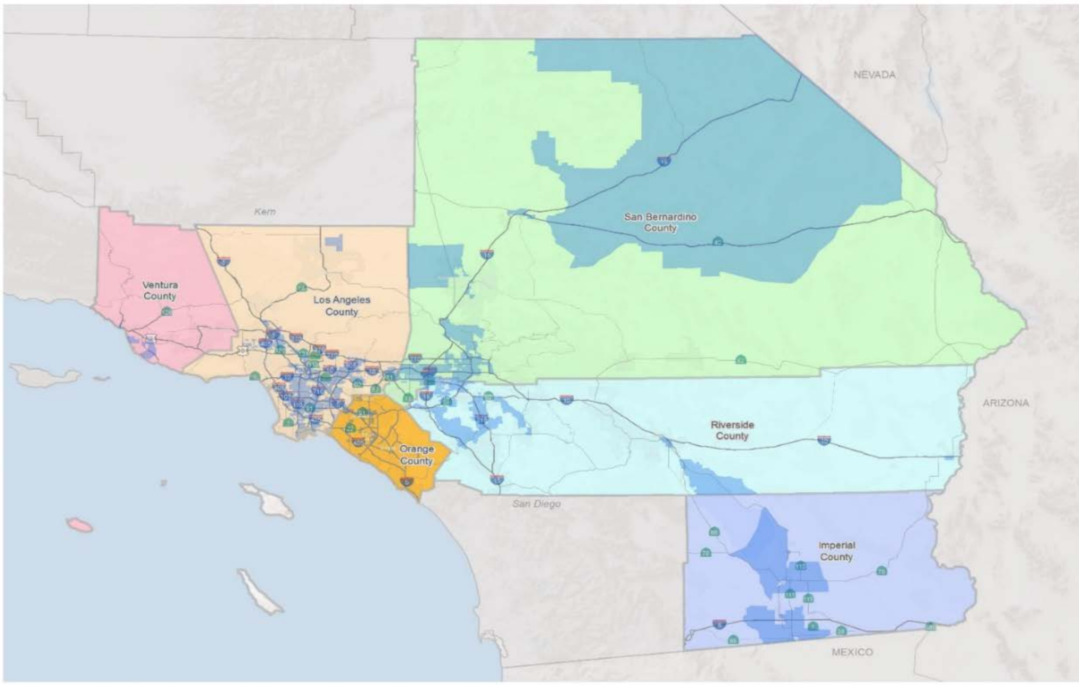

Report Prepared for the Southern California Association of Governments

A comprehensive project submitted in partial satisfaction of the requirements for the degree Master of Urban and Regional Planning

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Disclaimer:

This report was prepared in partial fulfillment of the requirements for the Master in Urban and Regional Planning degree in the Department of Urban Planning at the University of California, Los Angeles. It was prepared at the direction of the Department and of the Southern California Association of Governments (SCAG) as a planning client. The views expressed herein are those of the authors and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, UCLA as a whole, or the client.

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Executive Summary

The issue of jobs-housing imbalance is one of both quality of life and equity. Longer commutes incur higher transportation costs, contribute to traffic congestion, and leave less room for other daily activities. Workers without automobiles, especially those who cannot afford them, are more constrained in housing options due to housing affordability and a need for adequate transit access. The Southern California Association of Governments (SCAG) has proposed several major initiatives in its 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) to promote environmental justice and to focus household and employment growth around transit. In the RTP/SCS's Environmental Justice appendix, SCAG has performed extensive jobs-housing imbalance analysis for inter-county and intra-county commuters. This project seeks to expand on SCAG's analysis by assessing the current state of jobs-housing imbalance in the SCAG region as it specifically relates to labor market mismatch between disadvantaged communities and non-disadvantaged communities.

I find that the SCAG region's job clusters are heavily concentrated in the coastal counties of Orange and Los Angeles and that few disadvantaged communities tend to be found in these clusters, although many disadvantaged community tracts sit adjacent to clusters. The region's jobs have become increasingly concentrated, as the number of jobs has increased, the number of census tracts in job clusters has decreased, and the average distance to a job cluster has increased. Apart from the quantity of jobs in a census tract, housing costs are most strongly associated with high job-to-worker ratios in census tracts, suggesting that good job access increases housing prices. Housing growth has outpaced jobs growth in the inland counties (Imperial, Riverside and San Bernardino) since 2000, while the opposite has occurred in the coastal counties. Despite these differences, the share of single-occupancy commuters increased

for both inland and coastal counties between 1990 and 2016. Workers in disadvantaged communities are more likely to take transit or carpool to work, and most of the disadvantaged community tracts with the highest share of transit commuting are, not surprisingly, found in high quality transit areas. My findings indicate that SCAG could encourage housing growth in the region's largest job clusters, especially within high quality transit areas where transit works most effectively. My findings further suggest that SCAG should encourage jobs growth in growing inland job centers in order to reduce lengthy mean commuting times in the region's outlying areas.

Introduction

Jobs-housing balance refers to the distribution of employment opportunities and workforce population across a given area. The arrangement of jobs and housing shapes metropolitan areas. Jobs and housing can be mixed and dispersed throughout an area, with the former concentrated and the latter dispersed, or each can be concentrated. In general, public transportation best serves concentrations of jobs and housing, while private automobiles typically best serve dispersed areas. Regions with too few jobs relative to the housing supply tend to struggle economically, while regions with too few housing units in comparison with jobs, such as Southern California, often have high housing costs and longer commutes to work. Thus, the issue of jobs-housing imbalance is one of both quality of life issue and equity. If the ratio of jobs to housing is too high, housing may become unaffordable to workers in the area, forcing them to relocate further from their jobs. Longer commutes incur higher transportation costs, contribute to traffic congestion, and leave less room for other daily activities. Workers without automobiles are more constrained in housing options due to housing affordability and a need for adequate public transportation access. Increasing the housing supply in job-rich areas helps to decrease the separation between jobs and housing and can help mitigate quality of life and equity issues.

Disadvantaged Communities Legislative Framework

Assembly Bill 32, known as the Global Warming Solutions Act of 2006, requires California Air Resources Board to develop regulations to reduce California's greenhouse gas emissions. The California Air Resources Board created a statewide cap-and-trade program that places an upper limit on large-scale polluters' greenhouse gas emissions. In California's cap-and-trade system, the state places a "cap" on the collective allowable emissions that declines annually by 3 percent. The state issues permits for emissions, which it auctions. Businesses can then sell, or "trade," the permits.

In 2012, California passed Senate Bill 535, which requires that 25 percent of funds from cap-and-trade credits be spent on projects that benefit disadvantaged communities (DACs). The California Environmental Protection Agency (CalEPA) and the Office of Environmental Health Hazard Assessment (OEHHA) identify DACs using the California Communities Environmental Health Screening Tool (CalEnviroScreen). CalEnviroScreen measures a variety of indicators that quantify the socioeconomic, environmental, and public health factors affecting populations. The full list of CalEnviroScreen indicators can be found in the Appendix. CalEPA defines DACs to be the top 25 percent scoring areas, "along with other areas with high amounts of pollution and low populations."[1]

[1] "Disadvantaged Community Designation," OEHHA. April 2017.

Preparing for the Future: SCAG's 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy

The Southern California Association of Governments (SCAG) is the metropolitan planning organization (MPO) for the counties of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura. The largest MPO in the United States, SCAG serves approximately 18.5 million people in unincorporated areas and 191 cities in an area covering more than 38,000 miles. SCAG's primarily responsibilities include creating regional transportation plans, growth management forecasts, housing needs assessments, and air quality management programs. Every four years, SCAG produces a Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) that addresses a variety of regional needs. SCAG produced their most recent plan in 2016 and will release their 2020 RTP/SCS in April 2020. The 2016 plan uses 2012 data as its base for which it includes projections up to 2040, the plan's horizon year. The 2020 plan uses 2016 data as its base and makes projections up to 2045.

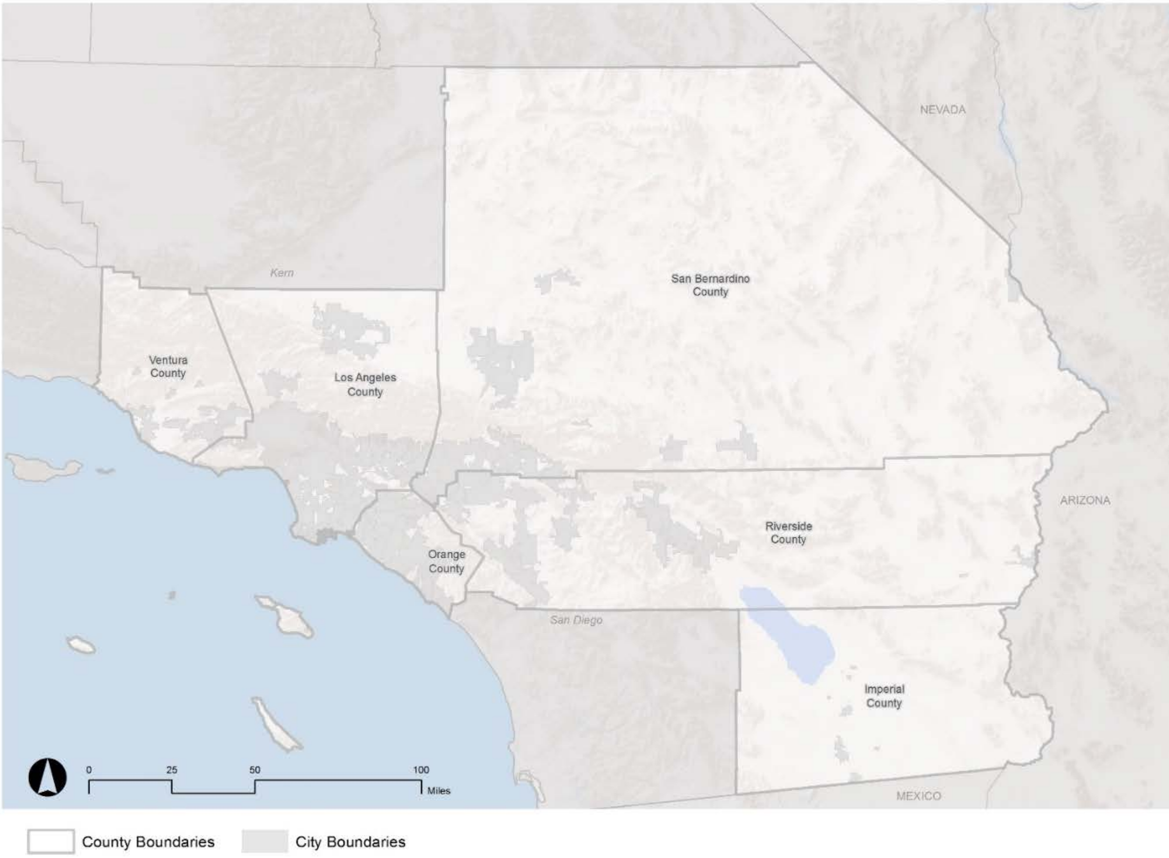

FIGURE 1: SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS COUNTIES AND INCORPORATED CITIES

SCAG addresses the balance of jobs and housing in the 2016 RTP/SCS's Environmental Justice Appendix. Their most recent analysis uses 2009-2013 American Community Survey (ACS) median wage data for inter-county and intra-county workers, aggregated to the county level. SCAG staff analyzed job-to-worker ratios at the census tract level[2] to understand the balance of jobs and housing with greater detail. In their analysis, SCAG addressed "whether there are significant differences in commute distance and job-to-worker ratio (1) between different income levels, (2) between coastal counties (Los Angeles and Orange Counties) and inland

[2] A census tract is a small subdivision of a county or county equivalent used for statistical purposes. Census tracts generally have populations between 1,200 and 8,000 people "with an optimum size of 4,000 people." ("Geography," https://www.census.gov/geo/reference/gtc/gtc_ct.html)

counties (Riverside and San Bernardino Counties), and (3) between temporal periods."[3] The key findings from this analysis in the region were:

- Higher wage workers tend to commute longer distances than lower wage workers
- Average commute distance increased for all wage levels in all SCAG counties between 2002 and 2012
- Average commute distance grew more rapidly in the less densely developed inland counties (Imperial, Riverside, and San Bernardino) than in the more densely developed coastal counties (Los Angeles, Orange, and Ventura)
- Average commute distance grew most rapidly for low-wage workers in the inland counties, indicating a worsening jobs-housing separation for these workers
- Inland counties are more housing-rich than coastal counties (they have a relatively lower jobs-housing ratio)
- Places in coastal counties tend to have concentrations of low-wage jobs, but have less affordable housing for people employed in those jobs
- Conversely, places in inland counties that have concentrations of affordable housing, but have shortages of low-wage jobs[4]

Housing costs typically make up the largest share of household expenses in the region, followed by transportation. Low-income households are generally more constrained in their housing and transportation options and must sometimes choose between quality housing and quality

[3] SCAG 2016 RTP/SCS Environmental Justice Appendix, 61.
[4] SCAG 2016 RTP/SCS Environmental Justice Appendix, 61.

transportation. These households often show preference for lower housing costs, as housing typically constitutes the largest share of household expenses and can be difficult to change.

The 2016 RTP/SCS calls for land use patterns that encourage infill, open space preservation, and development around transit as a way to directly address the balance of jobs and housing[5]. Based on their findings, SCAG calls for more jobs growth in the inland counties and more housing growth in the coastal counties. SCAG's Demographics and Growth Forecast Appendix also indicates that employment growth will outpace population growth in the inland counties, which implies that "job-housing balance will likely improve and may result in the reduction of transportation congestions and related air quality problems. The spatial mismatch issue of low-income workers and jobs also may be less in the future than was observed from the recent data."[6]

SCAG staff have extensively analyzed commuting characteristics and transportation data at the public use microdata area (PUMA) level. However, PUMA data sacrifice geographic granularity for precision, as the US Census Bureau "has to balance geographic details with details in the data."[7] As a result, Public Use Microdata Sample (PUMS) data, which allow one to cross tabulate different responses for the same household, cover much larger geographies, and each PUMA contains at least 100,000 people. (By contrast, census tracts contain much smaller populations over smaller geographies, but household data are aggregated, preventing one from cross tabulating responses from the same household) SCAG's jobs-housing analysis, while performed at the census tract level, largely consists of descriptive findings. The RTP/SCS and

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[5] SCAG RTP/SCS 2016, 75.
[6] SCAG RTP/SCS 2016 Environmental Justice Appendix, 68.
[7] Javier Gomez, "Introduction to the American Community Survey Public Use Microdata Files (PUMS) Files." https://www.census.gov/content/dam/Census/programs-surveys/acs/guidance/training-presentations/2017_PUMS_Transcript.pdf

Environmental Justice Appendix make vague recommendations over wide geographies (i.e., add more jobs in inland counties) and leave it to the reader to identify more specific housing-rich or job-rich places. SCAG's jobs-housing analysis has also considered changes in commute distance over time but does not consider changes in commute time or mode over time. These factors are also important to consider, as commute distance alone does not fully explain the balance of jobs and housing or inform appropriate policy solutions.

As part of its environmental justice analysis, SCAG outlines a number of "specific areas of concern" that may face disproportionately negative effects due to projects implemented under the 2016 RTP/SCS. These areas include Environmental Justice Areas, SB 535 Disadvantaged Communities, Communities of Concern, Urban Areas, and Rural Areas. I compare SB 535 Disadvantaged Communities (DACs), which correspond to census tracts, to non-DACs in the SCAG region because the former tend to have higher percentages of vulnerable populations[8] and are also exposed to higher pollution levels than other areas in California. The SCAG "region accounts for 67 percent of Californians who live in disadvantaged communities."[9] Furthermore, DACs correspond to census tracts, allowing my jobs-housing analysis to remain consistent with SCAG's. My analysis expands on SCAG's analysis using census tract level data and regression analysis to consider (1) how commuting trends for DACs and non-DACs have changed over time, (2) how the distribution of jobs and residents is changing over time in the region, (3) whether there are significant differences in commuting trends and jobs-housing ratios between DACs and non-DACs, (4) the implications of the trends taking place, and (5) areas in the SCAG region that are most suitable for jobs growth and areas that are most suitable for housing growth.

[8] Low-wage and non-white population groups
[9] SCAG 2016 RTP/SCS

I begin in the next section by discussing the spatial mismatch hypothesis (SMH), the theory that non-white residents have not suburbanized as much as jobs and white residents due to discrimination. I then discuss ways that researchers have measured jobs-housing balance and jobs accessibility, as well as acknowledge factors that affect residential decisions. I then discuss my research methodology and approach, acknowledging limitations and tradeoffs in my analysis. Next, I identify the region's jobs clusters and investigate the SMH in the SCAG region. I also analyze historical commuting data from 1990 to 2016 to provide context for recent travel behavior trends, which show that increased private vehicle access has most significantly contributed to declining public transportation ridership in the SCAG region. I then discuss factors that are associated with job-to-worker ratios. Last, I discuss my findings and the policy implications of regional commuting and jobs accessibility trends.

The Spatial Mismatch Hypothesis

The spatial mismatch hypothesis (SMH) centers on the idea that minority groups experience more discrimination in housing markets than in labor markets. The SMH suggests that geographic separation of jobs and residences reduces access to employment opportunities because of racial discrimination in suburban housing. Kain (1968) first proposed the concept of a separation between the jobs and residences, analyzing disparities in African-Americans' residential and employment locations due to "exclusionary zoning, postwar suburbanization, and implicit or explicit collusion by realtors, banks, mortgage lenders, and other agencies" (177). Kain holds that, as cities decentralize, jobs and white residents will suburbanize, but African-American residents will not. Because of this discrimination, the average distance between an African-American worker and a job opening grows faster over time than for a white worker and a job opening. While the existence and significance of a spatial mismatch have been debated for decades, researchers have shown that increased geographic access to employment leads to better labor market outcomes (Sultana 2002; Hu and Giuliano 2017; Blumenberg and Ong 1998; Ihlanfeldt 1994; Ihlanfeldt and Sjoquist 1991).

Disputes regarding the validity of the spatial mismatch hypothesis focus on two main points: (1) the extent to which geographic separation between jobs and housing affects underrepresented groups and (2) the effectiveness of increased jobs access in improving employment rate. Stoll (2005) finds a stronger negative correlation between geographical mismatch and employment in African Americans than among other racial groups. Wenglenski and Orfeuil (2004) measured job market accessibility for blue-collar and white-collar jobs within a 40-minute car and public transit commuting shed in Paris, finding that blue collar workers (defined in the 1990 and 1999 French Census of Population as workers who are not managerial staff, in "intermediate professions," or clerks) are disproportionately disadvantaged in terms of distance from jobs. Others find no significant difference in employment outcomes. Taylor and Ong (1995), analyzing spatial mismatch along racial lines, find no significant difference in commute times between white and minority commuters. For those who live in high-poverty places, proximity to jobs does not significantly affect their commute distances (Hu and Giuliano 2017). Gordon, et al. (1989) find no evidence that inner city workers experience longer commutes than suburban commuters, although they find that workers in different sectors of the economy do show variation in commuting times. Improving transit access was shown to have little effect on employment (Shen 2001; Cervero, Sandoval, and Landis 2002), while better automobile access appears to more strongly correlate with higher employment rates (Stoll 2005; Stoll 2006; Shen 2001). Geographic accessibility alone does not appear to explain employment outcomes. Other factors, such as job and worker skill matchup (Cervero 1989) and discrimination (Kain 1968), may also affect employment. Ultimately, the mixed results found within the literature can be attributed to differences in research methodologies.

The previously-mentioned trends that SCAG has observed indicate increases in commuting distance for workers and an uneven distribution of employment opportunities throughout the region.   Both of these factors can affect workers' ability to access jobs. Increased commute lengths further separate jobs and housing. An increasing separation of jobs and housing can result in longer commutes that waste time, resources, and harm the environment.

Furthermore, the separation of jobs and housing can increase barriers to employment for low-wage workers with limited automobile access. While analyzing the available data may not definitively prove or disprove the SMH, observed commuting trends, worsening traffic, and increasingly unaffordable housing in the region are enough to warrant an investigation of the factors that might be increasing separation of jobs and housing, the region's housing affordability crisis, and worsening traffic congestion and the extent to which this increasing separation affects disadvantaged communities.

Measuring Jobs-Housing Balance and Jobs Accessibility

Jobs-housing balance refers to the distribution of jobs and households across a geographic area. Unlike the SMH, which describes supposed increasing disparities between whites and non-whites in housing and employment over time, jobs-housing balance describes the static ratio of jobs to housing in an area. Researchers and agencies analyze jobs-housing balance because excessive geographic separation of jobs and housing can result in long commutes, less time for non-work related tasks, and negative environmental impacts in the form of excessive greenhouse gas emissions. Excessive separation of jobs and housing can also increase barriers to employment for lower-skill workers, especially those without motor vehicle access. The California Planning Roundtable (2008) includes three measures of a jobs-housing balance that have been widely used in literature: jobs-households ratio, jobs-housing units ratio, and jobs-employed residents.

The jobs-households ratio measures the total jobs count and total occupied household count. Cervero (1989) defines jobs-housing balance as the extent to which "the share of jobs in a community [are] actually filled by residents, and conversely the share of workers finding a place to live in that community" (137). Notably, Cervero's definition also includes the need for "a match-up between the skill levels of local residents and job opportunities as well as between the earnings of workers and the cost of local housing," as the absence of a matchup would suggest that residents are not working in their communities (137).

Unlike jobs-households, the jobs-housing units ratio accounts for all housing units, including vacant units (Sultana 2002). Like Cervero, Sultana's definition of balance also extends to include a parity of jobs and worker skill. Using the total number of housing units to measure housing shows the potential for balance in a geographic area, as it shows the total housing supply. However, in terms of measuring employment, the inclusion of vacant units can misrepresent the true working population count.

The last ratio, jobs-employed residents, substitutes housing for active labor force members. Cervero (1996) notes that those employed must be residents in order to measure "self-containment" (496). This ratio best expresses the measure of balance between employment opportunities and workers, as a ratio of 1 indicates perfect balance, although it does not account for employees that may hold multiple jobs (CPR 2008). Giuliano (1991) uses a ratio of jobs to resident workers. Large ratios indicate an influx of long distance commuters from outside the region, while small ratios imply longer commutes for residents from outside the region. Giuliano also notes that choosing the appropriate geographic scale and commuting range poses some issues, as "reasonable" commuting sheds can be overlapping and arbitrary.

While most commonly expressed as a ratio, the relationship between jobs and housing can be operationalized in other ways. Kain (1968) measured an employment ratio, the percentage of African American workers in a given zone, as a function of black population and distance from the nearest ghetto to determine the extent of African American residential segregation from employment opportunities (182). Bento et al. (2003) employ a Lorenz curve to determine the cumulative proportion of employment to the cumulative proportion of population in ZIP codes across 114 cities. This "imbalance measure" is expressed as the area between the curve and a 45-degree line; greater values indicate greater imbalance (13). While this approach is more sophisticated than a ratio, the graph more effectively expresses imbalance across subareas than numerical values. The Virginia Transportation Research Council makes use of linear and exponential dissimilarity indices to measure imbalance within a given subarea; completely balanced areas, in which each zone has the same population and jobs, receive a value of 0, while completely unbalanced areas, in which zones with residents contain no jobs and zones with jobs contain no residents, receive a value of 1 (Miller, 2010). The exponential dissimilarity index, unlike the linear dissimilarity index, accounts for jobs-rich and housing-rich areas' being in close proximity to each other (Marion and Horner 2008, VTRC 2010).

Operationalizing the relationship between jobs and housing becomes complicated as no single definition of "jobs" or "housing" exists. "Housing" commonly extends to all housing units within a region, occupied housing units, total population, or employed residents, each of which can show different findings. "Jobs" may include only salary and wage workers or may extend to selfemployed workers and farmers. Furthermore, an even distribution of jobs and workers alone may not constitute a balance, as disparity between jobs skill and worker skill implies that workers are not living near their jobs. It is therefore essential to define “jobs” and “housing” as well as the sources that provide data.

Because a "balanced" geography of jobs and housing requires parity of worker skill in addition to worker residence, jobs accessibility can differ among workers of different skills living in similar jobs-rich, housing-rich, or mixed areas. SCAG staff calculated jobs accessibility for specific areas of concern as a ratio of local job sector share of the regional job market. This measure shows the percentage of reachable employment opportunities. Jobs accessibility, found in SCAG's 2016 Environmental Justice Appendix, is calculated in two ways:

1. Region job sector share within one mile, $S = (\frac{n}{N})$,

   where *S* represents the regional job sector share, *n* represents the number of jobs in a particular sector within a mile of the specified area, and *N* represents the number of jobs for the same sector in the SCAG region
2. Jobs accessibility for a particular environmental justice (EJ) group, $A = \sum \frac{e}{E}$,

   where *A* represents jobs accessibility for a particular group (i.e., Hispanics or low-income workers), *e* represents the EJ group's representation in a particular job sector within a mile of the specified area, and *E* represents the total number of the EJ group's households in the region

Travel Data: How Important are Commuting Data?

While commuting data make up most of the travel data analyzed, commute trips comprise a small share of overall vehicle travel. Data from the 2009 National Household Travel Survey

(NHTS) show that trips for "family/personal errands" comprise the largest share of person miles traveled (PMT)[10] by automobile at 28.5 percent in 2009. By comparison, trips to and from work comprised 17.9 percent of PMT. Of the average 3.79 person trips per day, more than two and a half times as many are for family/personal errands (1.61) than for work (0.59). However, excluding "other" trips, trips made for work purposes made up the longest average person trip lengths (20.0 miles for "work related business" and 11.8 miles for trips to and from work). While work trips made up the longest average trip lengths, people traveled more in total for social and recreational purposes on average (10.93 miles) than for work (6.85 miles).

Vehicle miles traveled (VMT)[11] data also show that commuting makes up a relatively small share of total vehicle travel, despite the relatively long average trip lengths. While trips to and from work made up the largest average annual VMT per household in 2009, they make up less than 28 percent of all VMT. Similar to PMT data, VMT data also show that trips for work purposes make up the longest average trip lengths (12.2 miles).

National data show that commuting comprises a surprisingly small share of overall vehicle travel. Therefore, even if the jobs-housing ratio were to increase in housing-rich areas and decrease in job-rich areas, vehicle travel and emissions may be less than casual observers might expect. Despite its relatively small role in overall personal travel, the journey-to-work remains an important trip purpose worth studying. It is closely linked to employment and income, which are critical to quality of life in the SCAG region. Commute trips are also more likely to occur in

[10] "Person mile of travel" (PMT) refers to the distance (in miles) that an individual travels, calculated by multiplying the number of individuals by the number of miles traveled.
[11] "Vehicle miles of travel (VMT) refers to the distance (in miles) that a private vehicle travels. Unlike PMT, which quantifies individual travel, VMT does not account for the number of individuals in a vehicle.

peak hours and in the peak travel directions, making them more important contributors to regional congestion than their share of overall personal travel might suggest.

Factors Affecting Employment and Housing Choices

Wachs, et al. (1993), analyzing the relationship between jobs and housing in the Los Angeles area, find that factors beyond home-work separation factor into residential location choices, including housing costs, neighborhood quality, and crime rate. Furthermore, increasing commute distance, which was hypothesized to increase commute times, does not appear to contribute to increased commute times. Instead, Wachs, et al. find that increasing traffic volume has contributed to these increased travel times, and commute distance has actually decreased.

Giuliano (1991) argues that a direct causal link between commuting patterns and jobs-housing balance may not exist because people choose residences for reasons beyond housing and commuting costs. Giuliano cites neighborhood quality, availability of parks and other amenities, quality of schools, racial and ethnic mix, and microclimate characteristics as important factors in residential decisions. Furthermore, the growing number of multiple-worker households suggests that, even if proximity to employment plays some role, housing decisions become more complex as employment locations differ within the same household. Despite other factors' affecting residential decisions, jobs-housing as a policy issue is worth studying because the spatial arrangement of jobs and housing appear to influence commute times. For example, Giuliano finds evidence of shorter commutes where jobs are dispersed, while finding the longest commute times for workers who commute to presumably denser, job-rich central business districts.

Conclusion from the Literature

Literature on the spatial mismatch hypothesis shows mixed support for its existence. The primary debates over its importance deal with the extent to which geographical separation of jobs and housing affects employment prospects and the effects of increased mobility on employment. Differing results arise from the various methods that researchers use for measuring the relationship between jobs and housing. While spatial mismatch appears to play some role in employment rate and access to employment, other factors, such as discrimination and worker skill, likely play a more significant role in minority employment outcomes. Differences in methodologies have led to mixed results regarding the SMH's existence, which focuses more on increasing minority commute lengths with regard to those of non-minority workers, as there exist many ways to measure "spatial mismatch."

Jobs-housing balance, while similar conceptually to spatial mismatch, quantifies the geographic distribution of jobs and housing over a given geography and does not measure changes in distribution over time or among groups. Jobs-housing balance, like spatial mismatch, can be quantified in multiple ways. While establishing a balance of jobs and housing is important, policymakers should not see improving jobs-housing "balance" as a singular transportation policy objective that will *solve* congestion, excessive greenhouse gas emissions, and lengthy commutes, as commutes comprise a small share of overall trips and because factors beyond housing costs and jobs proximity influence housing decisions. However, it may help all of these things.

SCAG’s 2016 RTP/SCS conducted median commute distance and job-to-worker ratio analyses at the census tract level, looking at commute distance and job-to-worker ratios between income levels, between coastal[12] and inland[13] counties, and between time periods. Given this previous work, my focus here is to add to these analyses by comparing commuting and jobs-housing balance between specific areas of concern and advantaged communities in the SCAG region.

Research Design and Methods

Overview

My study builds on SCAG's analysis described above by analyzing jobs-housing balance and commuting in Southern California[14] with reference to the differences between disadvantaged communities and non-disadvantaged communities in the region. I aim to address the following question:

What factors are associated with jobs-housing balance in disadvantaged communities and non-disadvantaged communities in Southern California?

To answer the above question, I address the following research questions:

1. How have county population, housing prices, and shares of motor vehicle commuters changed over time in the region?
2. How have commuting times changed for workers in Disadvantaged Community (DAC) census tracts compared with non-DAC tracts between 1990 and 2016? What trends do the current commuting data show?
3. Where are the region's largest jobs clusters? Are these clusters becoming more geographically concentrated, remaining stable, or becoming more dispersed over time?

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[12] Los Angeles, Orange, and Ventura counties

[13] Imperial, Riverside, and San Bernardino counties

[14] For the purposes of the study, "Southern California" consists of the six SCAG counties and the cities and unincorporated areas within these counties. Although San Diego County would be considered a part of Southern California, a separate metropolitan planning organization, SANDAG, governs this region.

4. Do significant differences in job-to-worker ratios exist between disadvantaged and non-disadvantaged communities? Where in the SCAG region have job-to-worker ratios lessened, remained stable, or increased over time?
5. What contributes to differences in jobs-housing balance in DAC and non-DAC tracts over time? Specifically, how much of the differences are explained by:
    a. Median commute distance
    b. Commute mode share
    c. Mean commute time
    d. Housing prices?

I provide a basic overview of regional population, housing, and commuting trends, which serve as framework for the statistical analysis. Next, I study 2016 data, referencing the 2018 UCLA report *Falling Transit Ridership: California and Southern California*, which examines the largest contributing factors to public transportation ridership decline in Southern California. I then show clusters of jobs relative to their proximity to disadvantaged communities and identify the region's largest clusters. I show job-to-worker ratios, differentiating ratios for disadvantaged and non-disadvantaged communities. Next, I analyze whether observed jobs-housing imbalances are lessening, stable, or increasing over time in the SCAG region. Last, I estimate a linear regression statistical model using commuting distance, travel mode, commuting time, and housing price variables in order to determine the factors most strongly associated with higher job-to-worker ratios.

Approach

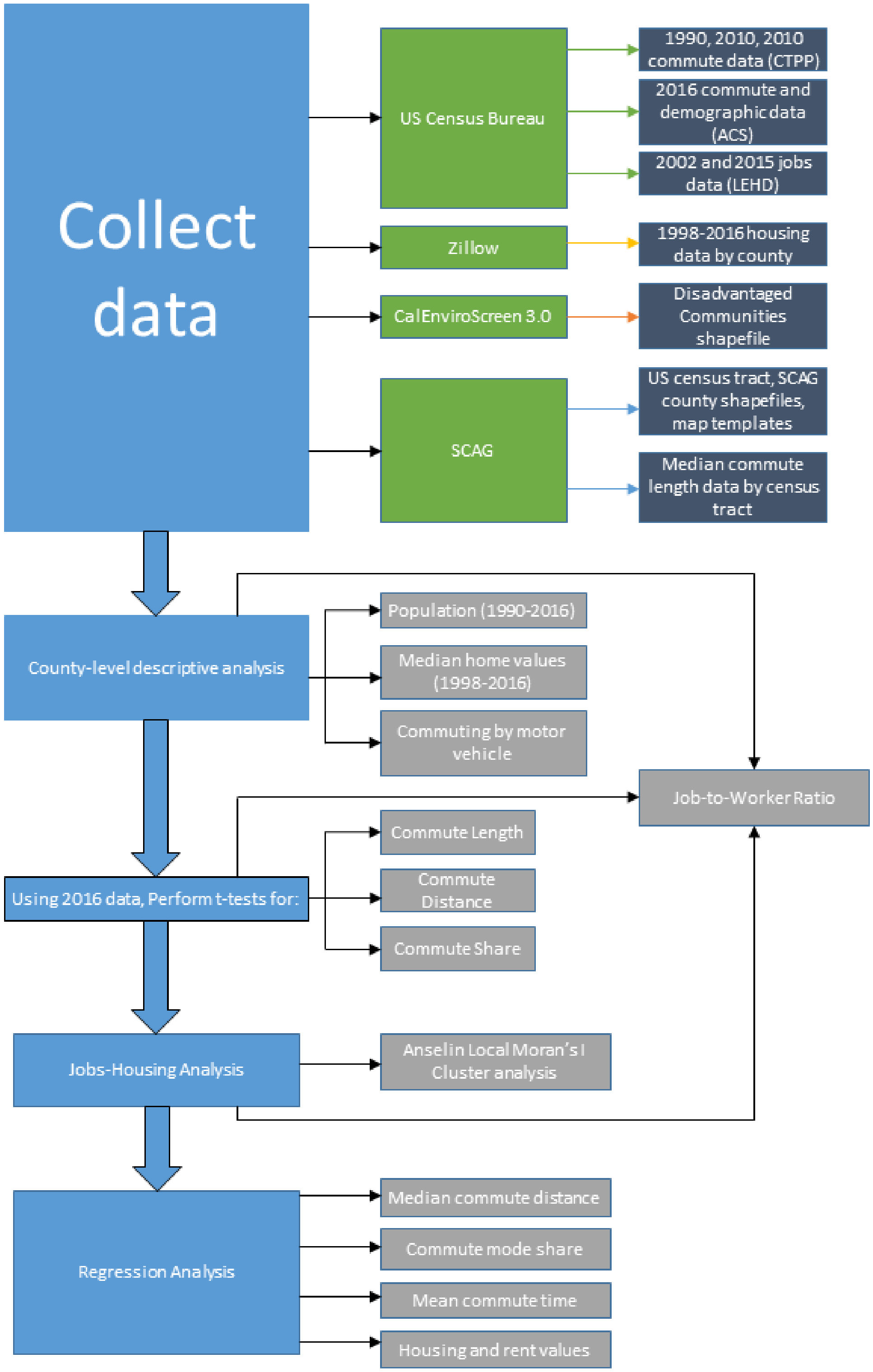

FIGURE 2: RESEARCH APPROACH FLOW CHART

I use the US census tract as my unit of analysis. I obtained a 2017 "SB 535 Disadvantaged Communities" shapefile,[15] created by CalEPA, from the California Open Data Portal. My universe of tracts is restricted to all census tracts that make up the six SCAG counties. Of the 3,956[16] census tracts in the SCAG region, CalEPA classifies 1,369 as disadvantaged communities. US census tracts generally hold between 1,200 and 8,000 inhabitants, with an average population of approximately 4,000. In the SCAG region, tracts range in physical size from 0.02 square miles in the densely populated Los Angeles Basin to 6,991 square miles in sparsely populated San Bernardino County.

I approach my primary question and my five related sub-questions as shown in Figure 2. I first begin with a descriptive analysis of historical data, graphing trends over time up to and including 2016, to provide context for the 2016 data. I use Zillow housing data to compare each county's changes in median home values from 1998 to 2016. Using US Census data from 1990, 2000, 2010, and 2016, I show changes in commuting times (1) among counties and (2) between disadvantaged communities and non-disadvantaged communities between the years 1990 and 2016. I also show how the share of solo drivers in each county has changed over time, as SCAG and the *Falling Transit* report indicate that driving has increased over time.

To address the second question, I find the difference in average commute time for disadvantaged and non-disadvantaged community census tracts for the years 1990-2016, running a t-test for statistical significance. To address the third question, I run an Anselin Local Moran's I test on ArcGIS, which identifies census tract clusters with high numbers of jobs, for

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[15] A shapefile is a data format (.shp) for geographic information systems (GIS) software. Shapefiles can spatially describe points, lines, or polygons.
[16] This number is the sum of the census tracts in each of the six SCAG counties. It comes from the most recent (2010) US Census.

both 2002 jobs and 2015 jobs. I then find average distance and changes in average distance to the nearest high-jobs cluster, calculating averages for disadvantaged and non-disadvantaged tracts to test the SMH.

To address the fourth question, I separate census tract level job-to-worker ratios, which SCAG had previously calculated, by disadvantaged and non-disadvantaged community status to find mean and median ratios. I then show the changes in job-to-worker ratios between 2002 and 2015 to show areas that have seen increases, decreases, or no changes in job to worker ratios. To address the fifth question, I estimate multiple regression statistical models using STATA in which job-to-worker ratio is the dependent variable and total jobs, median commute distance, transit commute share, carpool commute share, walking commute share, share of workers with hour-long or greater commutes, mean commute time, median gross rent, and median home are the independent variables.

Data Collection and Sources

This project consists of secondary quantitative data. Below, I list the data I use and sources from which I gather them:

Shapefiles

- US Census Tracts: TIGER/Line – US Census Bureau, 2017
- Disadvantaged Communities: CalEnviroScreen 3.0, 2017
- Jobs data: Longitudinal Employer-Household Dynamics – US Census Bureau, 2002 and 2015
- Map templates: Southern California Association of Governments, 2018

Tabular Data

- Commuting Data: Census Transportation Planning Products – AASHTO, 1990, 2000, and 2010. American Community Survey 2012-2016 5-year Estimates
- Housing Data: American Community Survey 2012-2016 5-year Estimates. US Census Bureau, 2000
- Demographic Data: American Community Survey 2012-2016 5-year Estimates. US Census Bureau, 2000

Limitations and Tradeoffs

My findings are exploratory and not definitive; they are intended to identify dimensions of a problem, rather than test a particular hypothesis. Because I limit my study location to Southern California, my analysis and results are only directly applicable to the SCAG region.

Data Limitations and Tradeoffs

LIMITATIONS IN THE DATASETS

For 2016, I use 2012-2016 5-year American Community Survey (ACS) data, the year for which data are most recently available, and data from the 2000 US Census to make comparisons. However, Longitudinal Employer-Household Dynamics (LEHD) data only cover the years 2002-2015, which may affect the accuracy of some data. However, demographic and jobs data have not changed within the last two years such that my analysis may not accurately reflect regional trends.

CENSUS TRACT VERSUS PUBLIC USE MICRODATA AREA

Public Use Microdata Areas (PUMAs) are geographic units that contain at least 100,000 people. By comparison, US census tracts usually contain 1,200 to 8,000 people, with an "optimum size" of 4,000 inhabitants.[17] PUMAs often cover a much larger geographic area than census tracts, but data about individuals and housing units can be tabulated. US census data are aggregated to the tract level, which does not allow one to cross-tabulate individual or household responses. To preserve geographic granularity, I choose to use census tracts with the caveat that the aggregate data do not necessarily represent the range of experiences of all individuals in each tract.

[17] https://www.census.gov/geo/reference/gtc/gtc_ct.html

USE OF CENSUS TRACTS FOR HISTORICAL DATA

Census tracts sometimes change when significant population changes occur. They can be split by the Census Bureau when significant growth occurs, or merged in response to significant population decline. Because of these spatial changes, some census tracts and DAC designations may not align through the years 1990-2016. Because I focus on the most recently available data and because legislation that created DAC designations did not become law until 2012, I use the most recent US census tract boundaries. I retroactively apply DAC designations for historical tracts that have their centroid within the boundaries of a DAC tract.

Analysis

Overview of the SCAG Region

The SCAG region consists of six counties and 191 incorporated cities. There were 3,956 census tracts in 2016, the most recent year for which ACS data were made available. Table 1 provides a summary of the total number of census tracts and the number of DAC census tracts for each SCAG county. Los Angeles County has by far the greatest number of census tracts and DAC census tracts and has nearly 75 percent of the region's DACs, while Imperial County has, by far, the fewest number of census tracts. Despite Los Angeles County's having nearly 70 times as many DACs tracts as Imperial County, Imperial County DAC tracts cover an area that is 1.5 times greater than Los Angeles County DACs, reflecting the large population density differences.[18] Most of San Bernardino's DAC land area comes from a single 6,991-square mile census tract.

[18] As previously mentioned, census tracts generally contain an average of 4,000 inhabitants. Large differences in tract size can be indicative of differences in population density.

TABLE 1: SCAG COUNTIES SUMMARY OF CENSUS TRACT AND DAC CENSUS TRACT INFORMATION, 2016

County	Land Area (square miles)	Census Tracts (2016)	DAC Census Tracts	Percentage of DACs in the SCAG Region	DAC Total Land Area (square miles)[19]
Imperial	44,810.9	31	15	1.1%	656.8
Los Angeles	4,096.3	2,346	1,020	73.5%	421.0
Orange	799.5	583	69	5.1%	45.1
Riverside	7,298.5	453	101	7.3%	476.0
San Bernardino	20,096.0	369	156	11.3%	7,525.5
Ventura	1,860.8	174	8	0.5%	32.8
Total	38,632.0	3,956	1,369	100%	9,157.2

[19] I calculated the DAC land area by summing the land area of all DAC census tracts in the given geography.

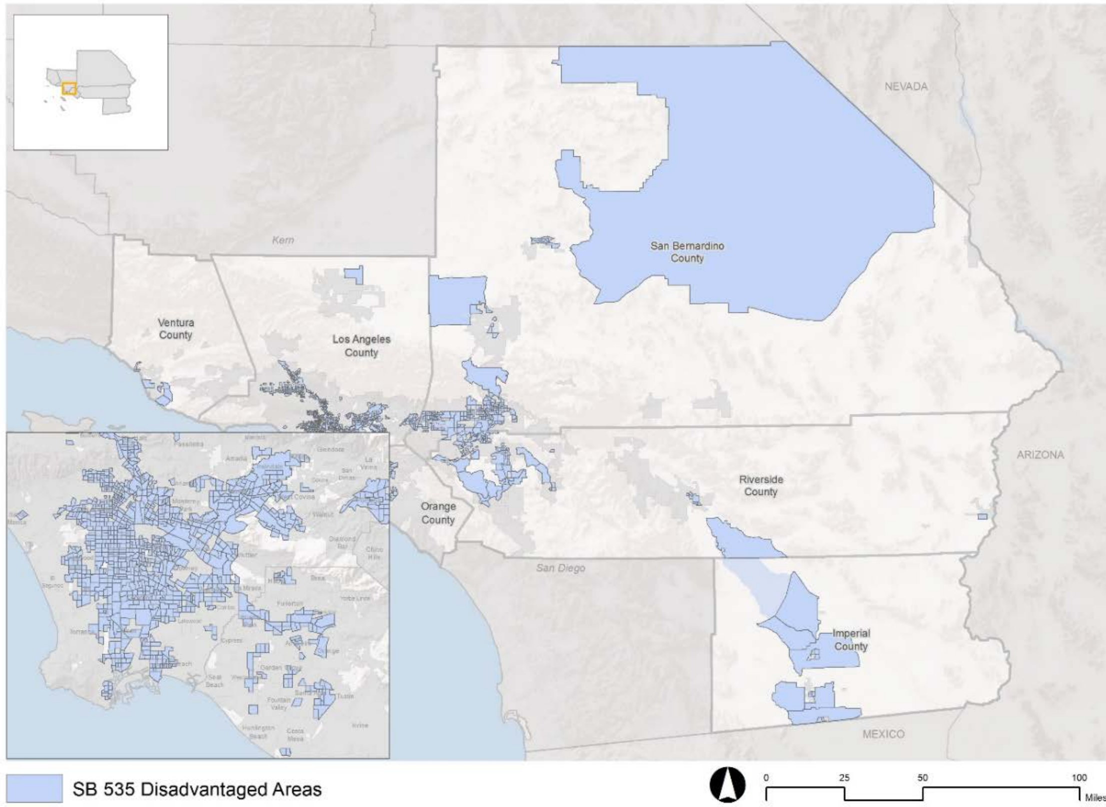

FIGURE 3: SB 535 DISADVANTAGED COMMUNITIES IN THE SCAG REGION WITH LA BASIN INSET

In 2016, 18,641,929 people lived in the SCAG region.[20] Figure 4 shows the population distribution by county for the years 1990-2016. Figure 5 shows the county population density for the years 1990-2016. Los Angeles County constitutes the largest share of the region's population, with nearly 54 percent of the region's residents. Imperial County, the county with the smallest population share, makes up just under 1 percent of the region's population. Orange County, the most densely populated county, is 98 times denser than Imperial County, the most sparsely populated county in the region. Los Angeles and Orange Counties' disproportionately high share of the Southern California's inhabitants compels SCAG to direct

[20] ACS 2012-2016 5-year estimates

most of its attention and infrastructure projects toward these counties. Figure 6 shows the population density of census tracts mapped across the region and Table 2 groups disadvantaged community and non-disadvantaged community population densities by county. Similar to the rest of the region, disadvantaged community population densities vary considerably, with Los Angeles County's having the highest aggregate[21] population densities of any county, while San Bernardino disadvantaged tracts have the lowest population per square mile. Each county's disadvantaged communities have a higher aggregate population density than the counties' non-disadvantaged tracts. Denser areas tend to create more pollution; therefore, people living in denser parts of the region are more likely to be exposed to higher pollution levels.

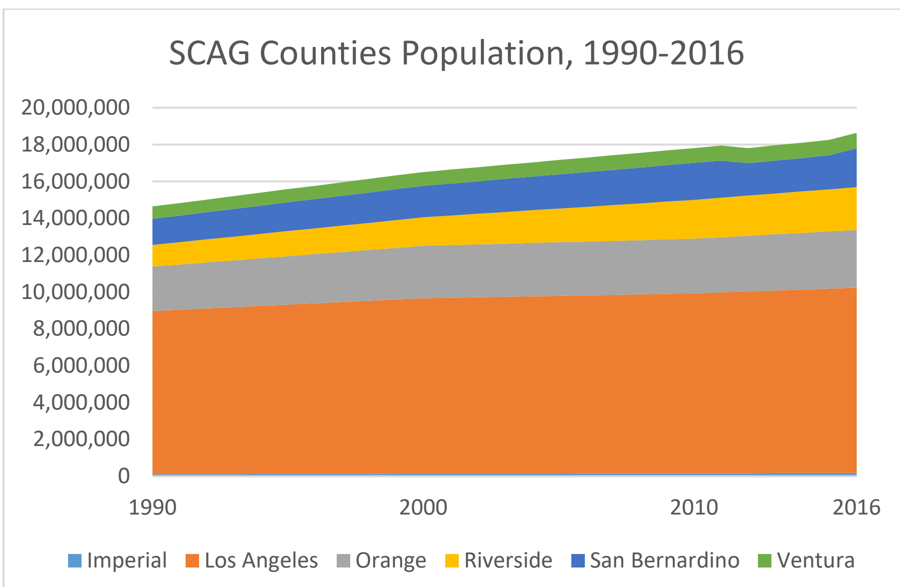

FIGURE 4: SCAG REGIONAL POPULATION GROWTH BY COUNTY, 1990-2016

[21] For each county, I summarized the total population and total area of disadvantaged and non-disadvantaged community tracts.

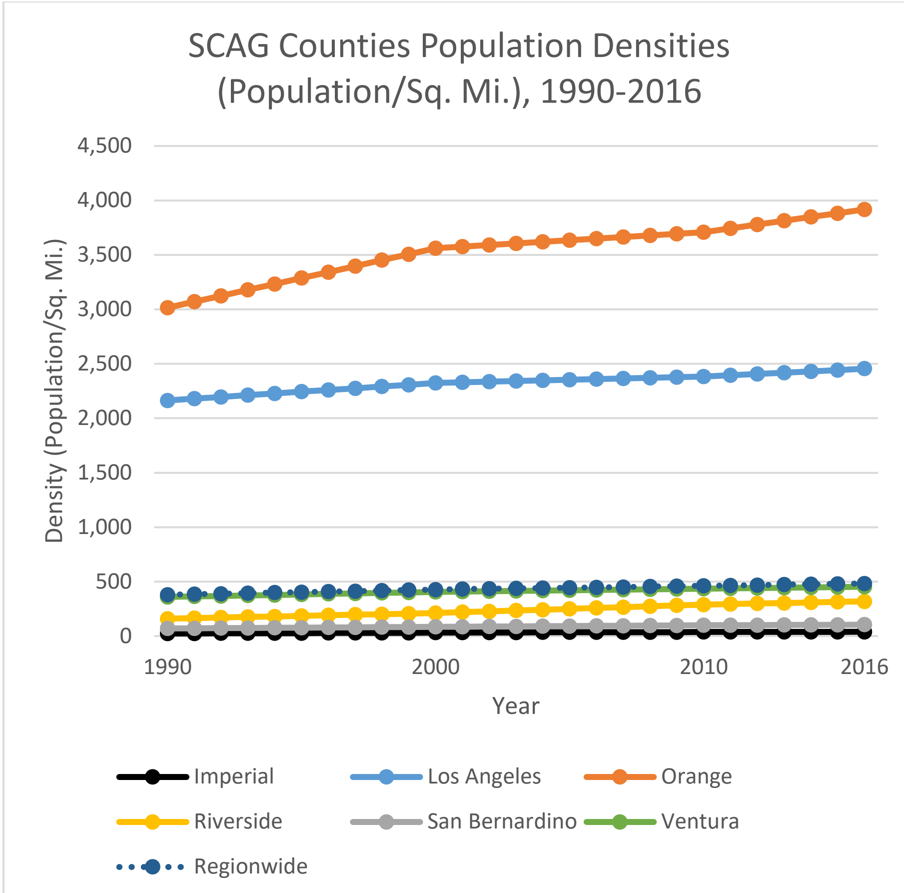

FIGURE 5: SCAG COUNTIES POPULATION DENSITIES, 1990-2016

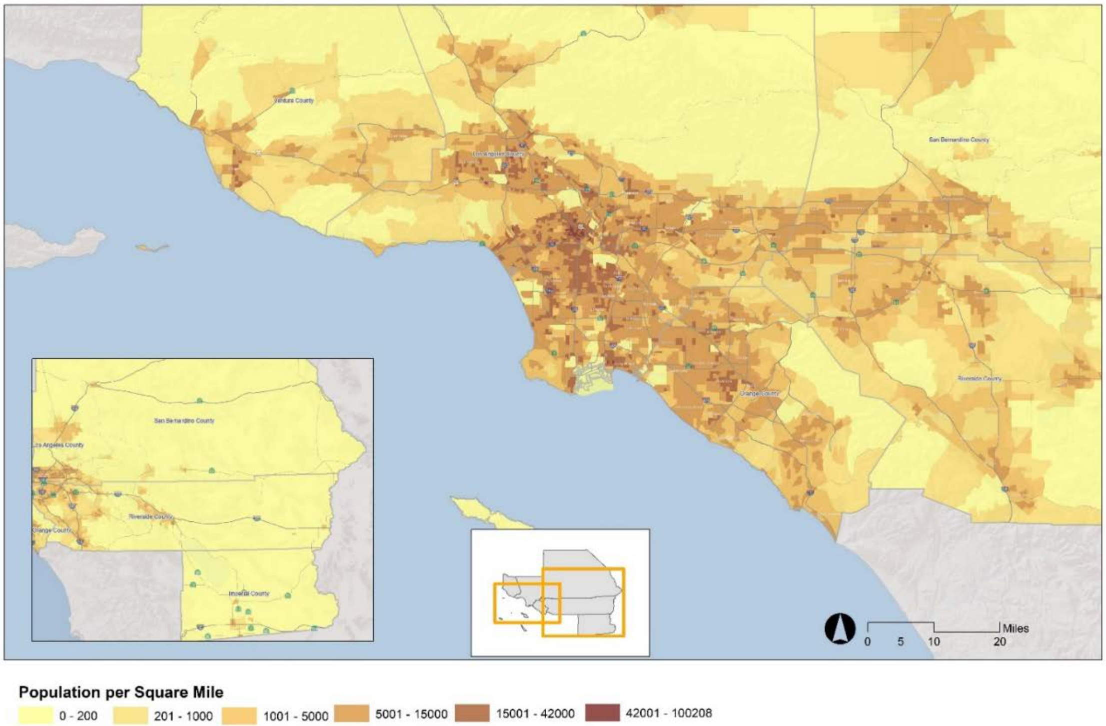

FIGURE 6: SCAG REGIONAL POPULATION DENSITY BY CENSUS TRACT, 2016

TABLE 2: 2016 POPULATION DENSITIES, DISADVANTAGED COMMUNITIES AND NON-DISADVANTAGED COMMUNITIES

	Disadvantaged Communities			Non-Disadvantaged Communities			
	Area (sq. mi.)	Population	**Population Density per sq. mi.**	Area (sq. mi.)	Population	**Population Density per sq. mi.**	**Population Density Ratio**[22]
Imperial	656.8	88,782	**135.2**	3823.513	90,025	**23.5**	**5.7**
LA	420.9	4,452,191	**10,577.6**	3676.626	5,600,021	**1,523.1**	**6.9**
Orange	45.1	411,056	**9,122.1**	754.1572	2,721,155	**3,608.2**	**2.5**
Riverside	476.1	539,048	**1,132.3**	6824.739	1,784,844	**261.52**	**4.3**
San Bernardino	7,526.2	854,961	**113.6**	12570.04	1,251,793	**99.6**	**1.1**
Ventura	31.4	28,857	**920.0**	1826.914	814,253	**445.7**	**2.1**

[22] I express the population density ratio as a ratio of the disadvantaged communities to non-disadvantaged communities for each county.

Median Home Values

Figure 7 shows the median estimated home values for each county between the years 1998 and 2016. Median housing prices grew more rapidly in the coastal counties[23] than in the inland counties.[24] Los Angeles County experienced the greatest increase between 1998 and 2016 (201.5 percent), while Imperial County experienced the smallest increase during the same time (37.5 percent). Unaffordable housing prices in the coastal counties push residents to the more affordable inland counties, contributing to longer commutes.

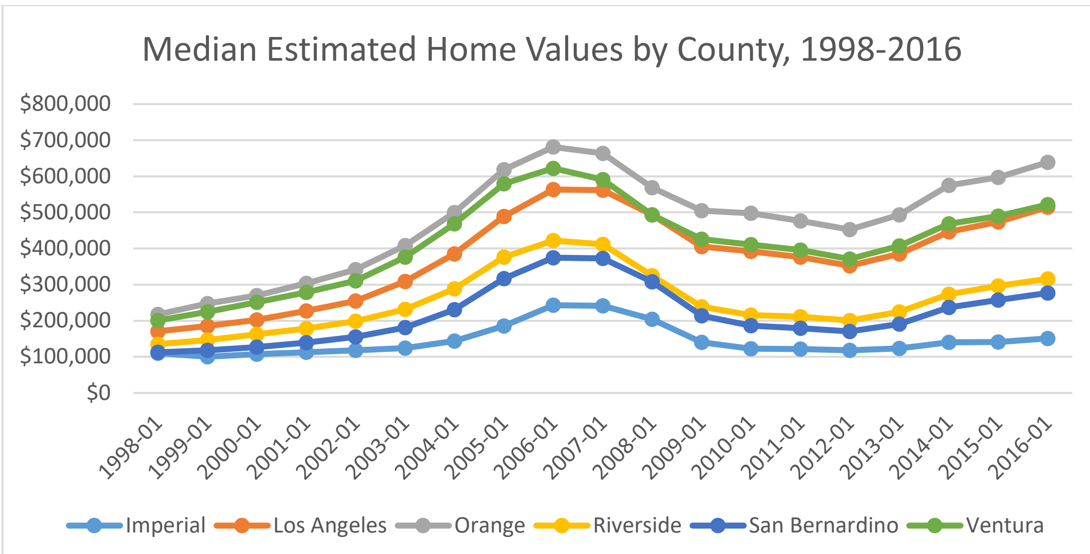

FIGURE 7: MEDIAN ESTIMATED HOME VALUES[25] BY COUNTY, 1998-2016. SOURCE: ZILLOW, 2018.

Commuting Trends in the Region

Mode Split

Table 3 shows the 2016 commuting mode split by county. Imperial County had the highest share of commuters who drove alone (80.8 percent) and lowest share of public transit commuters (0.9 percent), while Los Angeles County had the lowest share of solo commuters

[23] Los Angeles, Orange, and Ventura counties
[24] Imperial, Riverside, and San Bernardino counties
[25] Median home values are for single family residences, condominiums, and co-ops. Values come from the month of January. https://www.zillow.com/research/data/

(73.3 percent) and highest share of public transit riders (6.5 percent). Transit best operates in dense, urban environments; Los Angeles County as a whole fits this description well, while driving best suits sparsely populated Imperial County. Riverside and San Bernardino counties have the highest shares of carpool commuters; motor vehicles are better suited for navigating sparsely populated areas than public transportation.

TABLE 3: COMMUTE MODE SPLIT BY COUNTY, 2016

County	Drove alone	2-person carpool	3-person carpool	4-or-more person carpool	Transit	Walked	Biked	Taxi, motorcycle, or other	Worked at home
Imperial	80.8%	6.1%	1.6%	1.9%	0.9%	2.2%	0.6%	1.9%	4.0%
Los Angeles	73.3%	7.5%	1.4%	0.9%	6.5%	2.8%	0.9%	1.4%	5.2%
Orange	78.5%	7.6%	1.2%	0.9%	2.4%	1.9%	0.9%	1.2%	5.4%
Riverside	77.1%	9.7%	1.9%	1.7%	1.3%	1.5%	0.4%	1.3%	5.2%
San Bernardino	78.3%	9.5%	1.8%	1.6%	1.3%	1.8%	0.5%	1.1%	4.0%
Ventura	77.5%	8.8%	2.1%	1.4%	1.3%	1.8%	0.6%	1.0%	5.4%

Average Commute Time by Mode

Solo commuters have the shortest average commute times for all counties, while public transit commuters have the longest average commute times (Table 4). Imperial County workers who drove alone faced the shortest average commute times (20.0 minutes), while San Bernardino workers who took public transportation faced the longest (62.7 minutes). Motor vehicle trip speeds tend to be between 1.4 to 1.6 times faster than public transit trip speeds;[26] in the SCAG region, there is even greater separation between motor vehicle speeds and public transit

[26] HS Levinson. *Analyzing transit travel time performance*

speeds, likely explaining why individuals who take transit out of necessity ride less frequently once they are able to access motor vehicles.

TABLE 4: COUNTY AVERAGE COMMUTE TIMES BY MODE (IN MINUTES), 2016

	Drove Alone	Carpooled	Public Transportation	Transit to Solo Commuting Travel Time Ratio
Imperial	20.0	28.6	47.5	2.4
Los Angeles	29.2	31.8	50.5	1.7
Orange	26.4	29.1	53.6	2.0
Riverside	31.6	39.6	60.4	1.9
San Bernardino	29.5	37.2	62.7	2.1
Ventura	25.4	27.8	59.1	2.3

Commute Distance

Figure 8 shows the median commute distance of all jobs in 2012, as calculated by SCAG staff and incorporated into the 2016 RTP/SCS. The average median distance to work for commuters in 2012 across the region was 9.1 miles. Workers in disadvantaged communities had a lower than regional average median commute distance (8.7 miles), as most of these communities are in densely-populated, job-rich Los Angeles County – though this difference is relatively small; about 700 yards. Workers in non-disadvantaged communities experienced a longer than average median commute distance (10.4 miles). Of the 100 census tracts with the longest median commute distances in 2012, the mean of the tract distances was 36.3 miles, four times that of the region-wide average. Most of the tracts with the longest commute distances are located in the outlying areas of the region. Just six of the top 100 tracts were disadvantaged communities, suggesting that most workers in disadvantaged communities do not face disproportionately longer commutes than workers in non-disadvantaged communities.

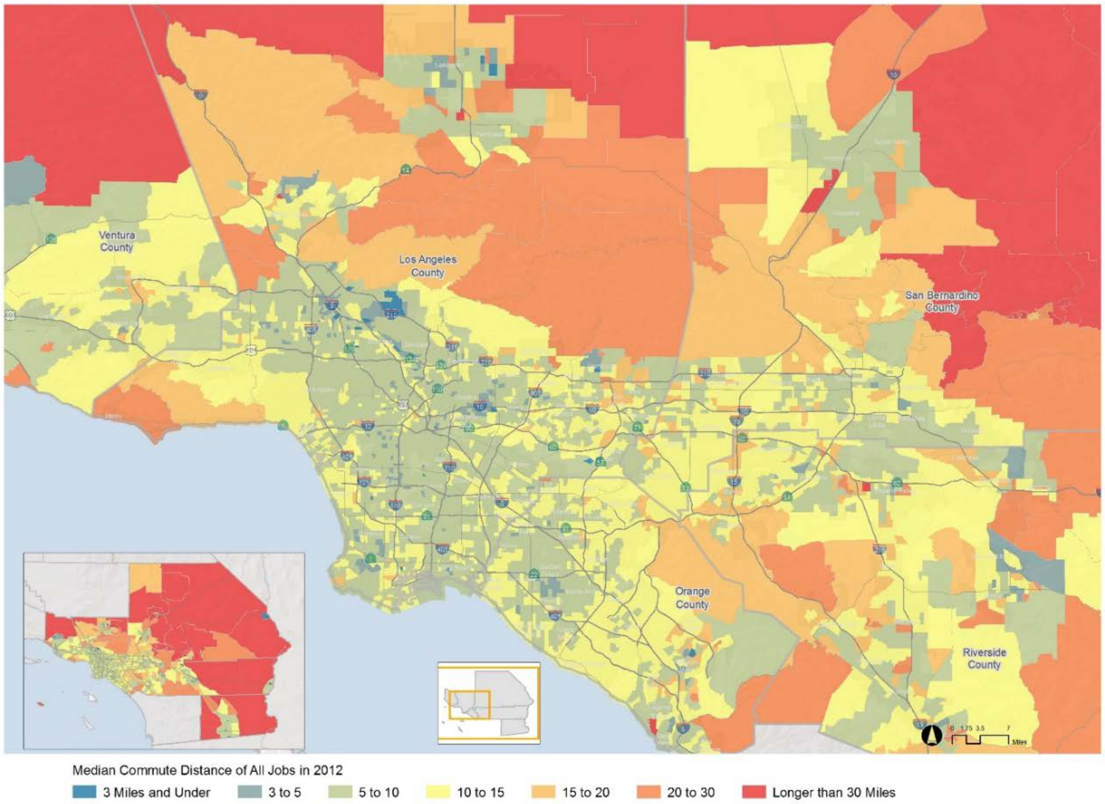

FIGURE 8: MEDIAN COMMUTE DISTANCE OF ALL JOBS, 2012. SOURCE: SCAG, 2018

TABLE 5: COUNTY AVERAGE MEDIAN COMMUTE DISTANCE (MILES), 2012

County	Average Median Commute Distance (Miles), 2012
Imperial	10.7
Los Angeles	8.7
Orange	10.0
Riverside	11.8
San Bernardino	14.3
Ventura	9.6
SCAG Region	9.8

Commute Times

Between 1990 and 2016, the mean commute time to work rose for both disadvantaged communities and non-disadvantaged communities. Overall, the region experienced a mean commute time increase of four minutes between 1990 and 2016. In 1990, non-disadvantaged communities' mean commute lengths exceeded disadvantaged communities' by 30 seconds; in 2016, disadvantaged communities' commutes were 48 seconds longer, reflecting a shift of 78 seconds. While the increase in mean commute time and the difference in commuting times between disadvantaged and non-disadvantaged communities are statistically significant, these time differences are barely perceivable.

TABLE 6: MEAN COMMUTE TIME TO WORK, 1990-2016

Tracts	1990	2000	2010	2016	Percent Change, 1990-2016
DAC	25 min 24 sec	29 min 36 sec	28 min 48 sec	30 min 6 sec	+18.5%
Non-DAC	25 min 54 sec	29 min 6 sec	28 min 30 sec	29 min 18 sec	+13.1%
Regional	25 min 30 sec	29 min 6 sec	28 min 36 sec	29 min 36 sec	+16.1%
Difference (DAC – non-DAC)[27]	-30 sec	+30 sec	+18 sec	+48 sec	

Figure 9 shows the 2016 census tracts mean commute times and Table 7 shows the county average commute times. Imperial County, with its high share of solo commuters and lowest share of carpool (9.6 percent) and transit commuters (0.9 percent) and its relatively low levels of traffic congestion, has the lowest average commute time of any county. Riverside County has the longest average commute time and the largest share of carpool commuters (13.3 percent). Northern Los Angeles County, southeastern Riverside County, wester Imperial County, and some tracts in the denser Los Angeles Basin saw the highest mean travel times across all modes in 2016. Los Angeles County, despite having the shortest average median commute distance (8.7

[27] Positive values indicate that mean commute times are longer for DAC tracts than for non-DAC tracts. Negative values indicate that mean commute times are shorter for DAC tracts than for non-DAC tracts.

miles), has relatively long average commute times because of its relatively higher levels of both traffic congestion and public transit use. Longer median commute distances and higher carpool rates likely explain Riverside and San Bernardino counties' longer average commute times.

TABLE 7: AVERAGE COMMUTE TIME IN MINUTES BY COUNTY, 2016

County	Average Commute Time (Minutes), 2016
Imperial	20 min 54 sec
Los Angeles	30 min 24 sec
Orange	27 min 12 sec
Riverside	32 min 54 sec
San Bernardino	30 min 42 sec
Ventura	26 min 0 sec
SCAG Region	29 min 54 sec

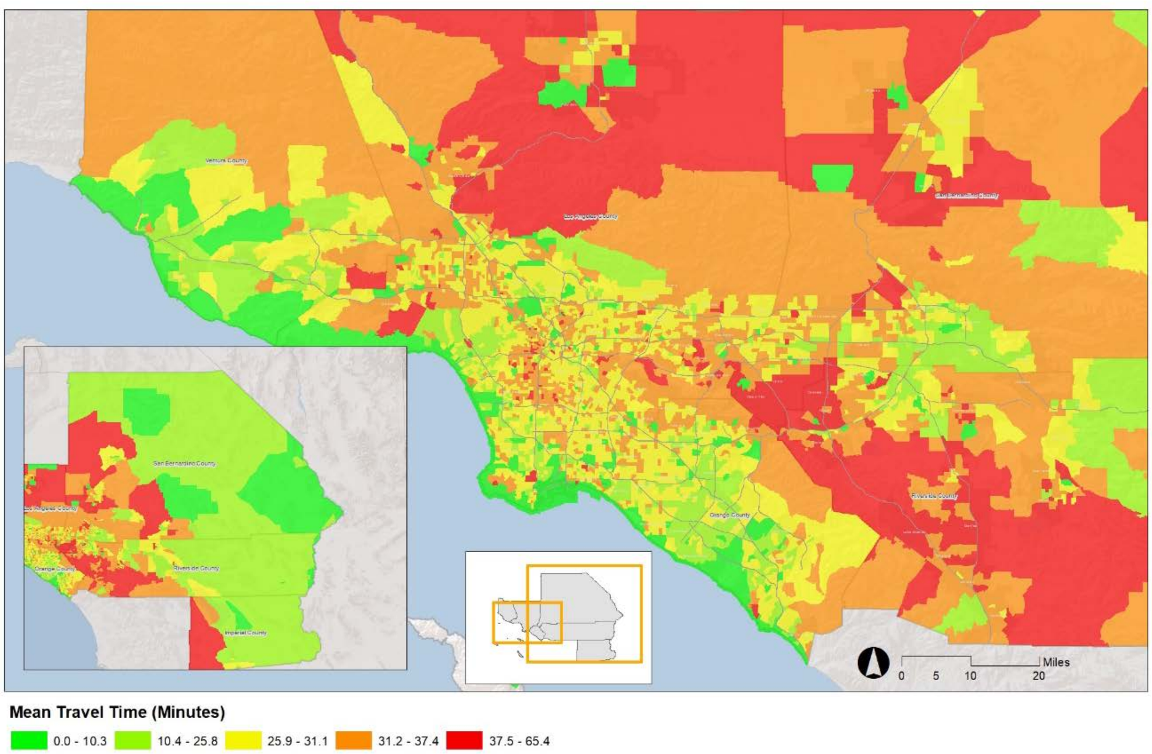

FIGURE 9: MEAN COMMUTE TIMES BY CENSUS TRACT, 2016

Workers who Commute by Private Vehicle

The share of commuters who drove alone to work decreased during the 1990s, but increased again during the 2000s to exceed 1990 levels by 2016. Orange County was home to the largest share of solo commuters between 1990 and 2010, while Los Angeles County had the largest share of commuters to traveled to work my means other than driving alone.

Comparing disadvantaged tracts to non-disadvantaged tracts across the region, non-disadvantaged communities have, on average, a higher percentage of commuters who drove alone and was higher between 1990 and 2016. During the same time, the average percentage of drivers who commuted alone increased for both disadvantaged and non-disadvantaged communities. However, disadvantaged communities experienced a greater increase in share of commuters who drove alone between these years. Increased automobile access among low income households between the years 2000 and 2015 has likely contributed significantly to increases in solo driving commutes among disadvantaged communities. Low income households have traditionally made up Southern California's stable transit ridership base, which has slowly declined during this time in part due to increased private vehicle access.[28]

[28] Manville, et al. *Falling Transit Ridership*. 2018.

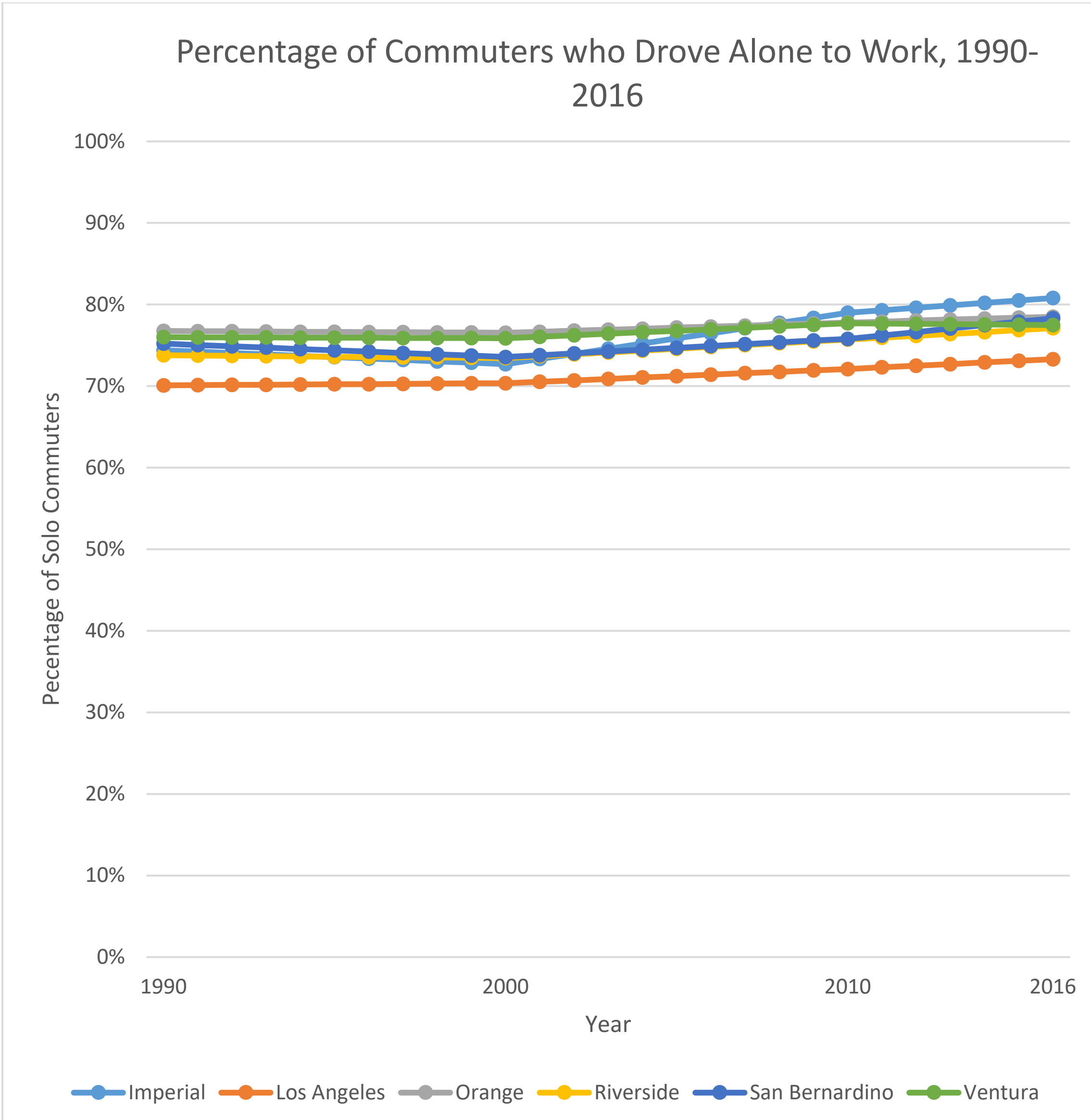

FIGURE 10: PERCENTAGE OF COMMUTERS WHO DROVE ALONE TO WORK, 1990-2016

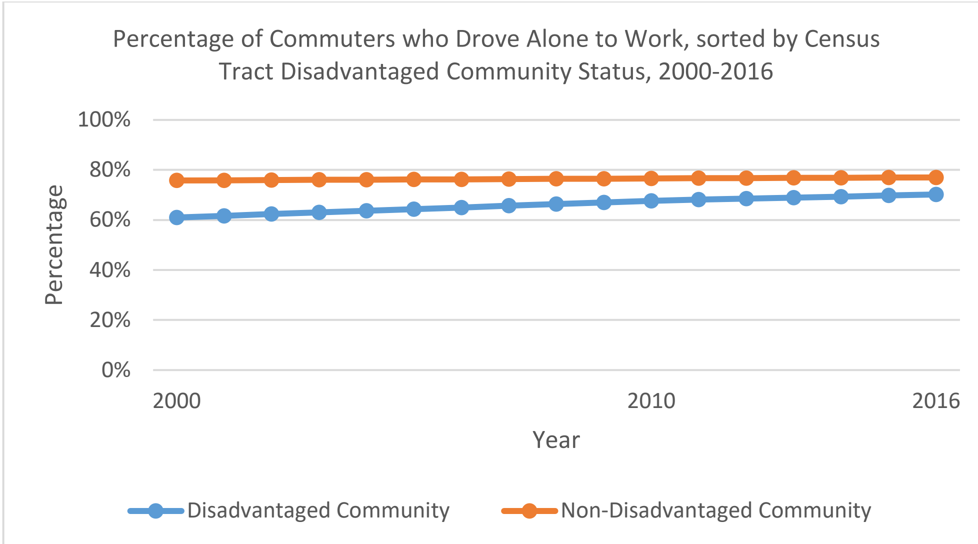

FIGURE 11: PERCENTAGE OF COMMUTERS WHO DROVE ALONE TO WORK, SORT BY CENSUS TRACT DISADVANTAGED COMMUNITY STATUS, 2000-2016

Commutes by private vehicle also include work trips made via carpooling. While non-disadvantaged tracts see higher percentages of solo commuters, disadvantaged tracts, on average, have a higher percentage of commuters who travel to work via carpool than Non-disadvantaged tracts. The “increased motor vehicle access” discussed in *Falling Transit Ridership* includes carpooling in addition to solo commuting. Workers living in disadvantaged communities are predominantly low-income and may be less likely to own private vehicles than workers living in non-disadvantaged communities (and may therefore be more likely to rely on others to drive), but tend to make use of private vehicles if given the opportunity. While motor vehicles do not hold as many occupants as buses or trains, drivers rarely fill their vehicles to capacity, as indicated by the high percentages of solo commuters across most of the region's census tracts. Higher rates of carpooling increase the average number of occupants per vehicle, helping to reduce traffic congestion and per capita greenhouse gas emissions. Figure 12 shows the 2016 percentage of commuters who carpool to work.

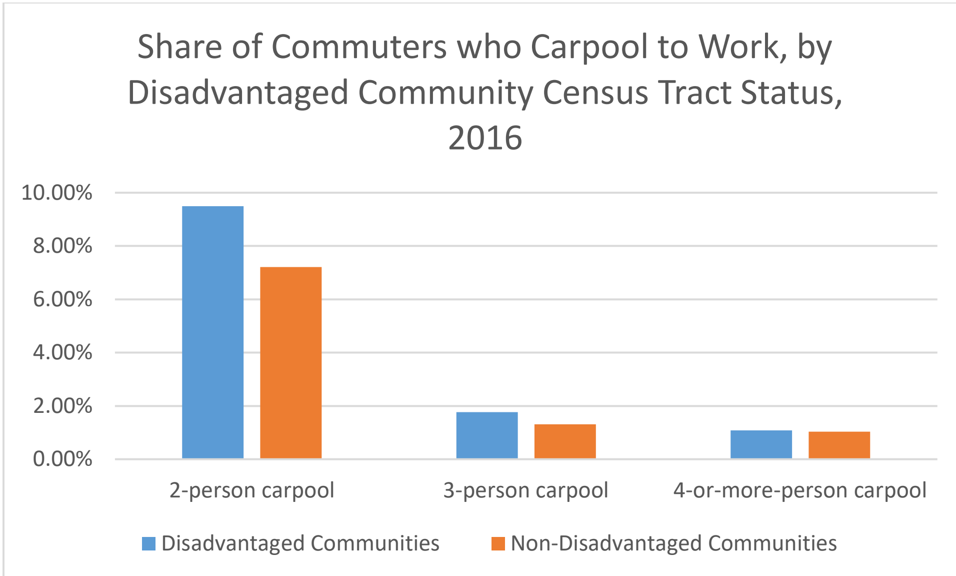

FIGURE 12: SHARE OF COMMUTERS WHO CARPOOL TO WORK, BY DISADVANTAGED COMMUNITY CENSUS TRACT STATUS, 2016

Workers who Commute by Transit

Disadvantaged communities, on average, have a significantly higher percentage of commuters who take transit to work (8.6 percent) than non-disadvantaged communities (2.9 percent). Figure 13 shows the change in percentage of transit commuters from 1990 to 2016. Transit commuters have dipped slightly between 1990 and 2016. Disadvantaged communities, which have seen larger increases in the share of solo commuters compared to non-disadvantaged communities, also saw a greater decline in transit commute share, indicating that many of these former transit commuters may have purchased private vehicles. Transit ridership has declined even as agencies region continues to invest in bus and rail service, further supporting *Falling Transit Ridership*'s finding that increased motor vehicle access has most significantly contributed to ridership decline.

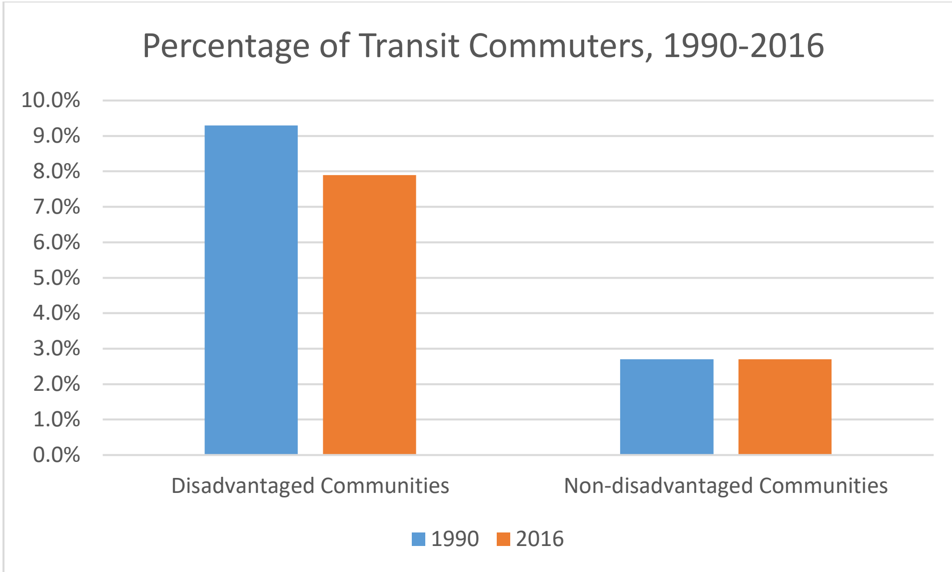

FIGURE 13: COMPARISON OF PERCENTAGE OF COMMUTERS WHO TAKE TRANSIT TO WORK, BY DISADVANTAGED COMMUNITY CENSUS TRACT STATUS, 1990 AND 2016

SCAG defines High Quality Transit Areas (HQTAs) as areas within ¼-mile of a bus or rail stop that have a peak headway[29] of 15 minutes or less. Figure 14 shows the 2016 percentage of commuters who traveled to work via all forms of public transit, overlaid with the region's HQTAs. HQTAs are largely restricted to Los Angeles and Orange counties, with some high-frequency stations found near the Los Angeles County border with San Bernardino County. Census tracts within HQTAs have a higher than average share of transit commuters (10.1 percent) than census tracts outside of HQTAs (2.5 percent), suggesting that high quality transit service plays a role in sustaining ridership figures. Ninety-nine of the 100 highest transit commuting DAC tracts are located within a HQTA. Eighty-six of the top 100 Non-DAC tracts are in a HQTA, with 91 in Los Angeles County, one in Riverside, and eight in Orange County. Sixty-six of the 100 disadvantaged community tracts with the smallest percentage of commuters who drove to work alone were also among the top 100 tracts with the greatest share of transit

[29] Headway is defined as the time interval between transit vehicles.

commuters. These findings indicate that 1) workers in disadvantaged tracts (who are also more likely to have low incomes) tend rely disproportionately on transit commuting, though this reliance is diminishing over time, and 2) HQTAs and high shares of transit commuters are heavily concentrated in the region and largely confined to the Los Angeles Basin area. Given declining transit ridership despite improved service, policy that directly discourages driving in these areas may be more effective than continuing to improve service or investing in service in more sparsely populated parts of the region.

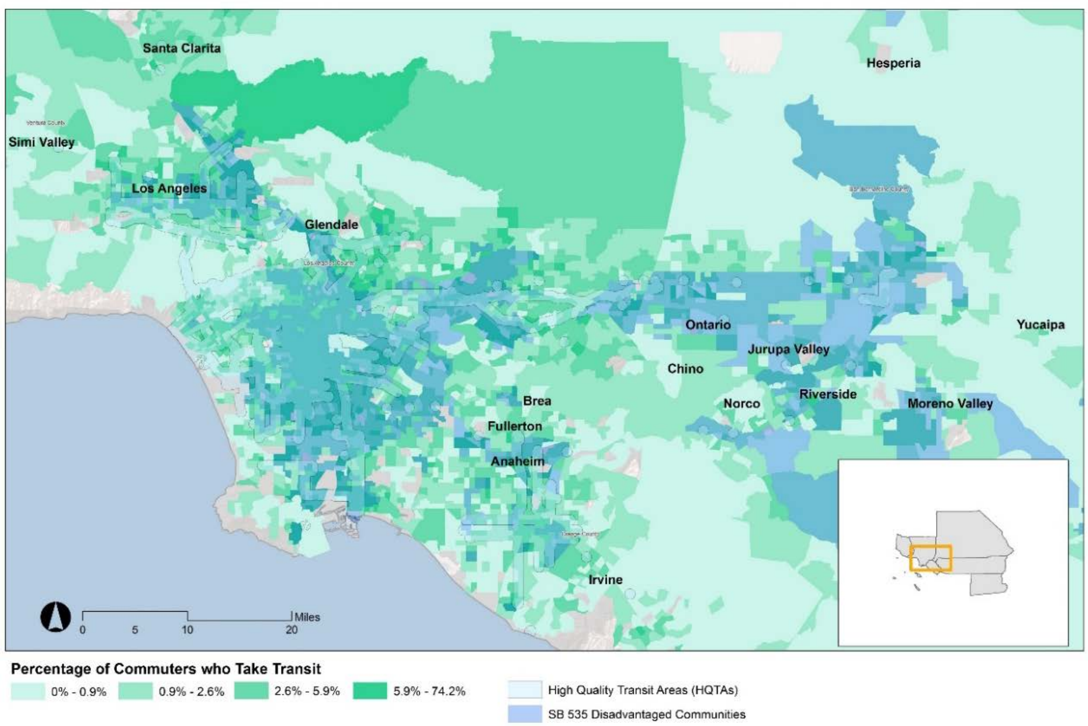

FIGURE 14: PERCENTAGE OF WORKERS WHO COMMUTE BY TRANSIT, 2016, OVERLAID WITH HIGH QUALITY TRANSIT AREAS AND DISADVANTAGED COMMUNITIES

Spatial Mismatch and Job Cluster Analysis

Because the census does not allow one to study disaggregated data at the household level, I use disadvantaged tracts as a proxy for low-income, minority, and housing-burdened households. One should note that average census tract data do not represent all individuals living in a census tract; for example, high-income individuals may live in disadvantaged tracts. However, because CalEnviroScreen takes socioeconomic factors into account, one can assume that a significant percentage of low-income, minority, and housing-burdened individuals reside in these census tracts.

Using Local Moran's I cluster analysis, I identify major job clusters in the region. The region was home to a total of 7,719,500 jobs in 2015, up from 6,661,254 in 2002. "High-high" job clusters indicate groups of census tracts that have a significantly high number of jobs compared to the regional average that are surrounded by other job-rich census tracts. "High-low" job clusters indicate clusters of job-rich census tracts surrounded by tracts that do not have high numbers of jobs. I show disadvantaged communities and indicate disadvantaged tracts that are also job clusters. Of the 1,369 census tracts designated as "disadvantaged," 73 (5.3 percent) are job-clustered census tracts. By comparison, 9.1 percent of non-disadvantaged census tracts (237 of 2,581) are job-clustered tracts. While these differences are not large, the adjacency and relatively small overlapping of job-clustered tracts and disadvantaged tracts, shown in Figure 15, indicates segregation between clusters and disadvantaged communities.

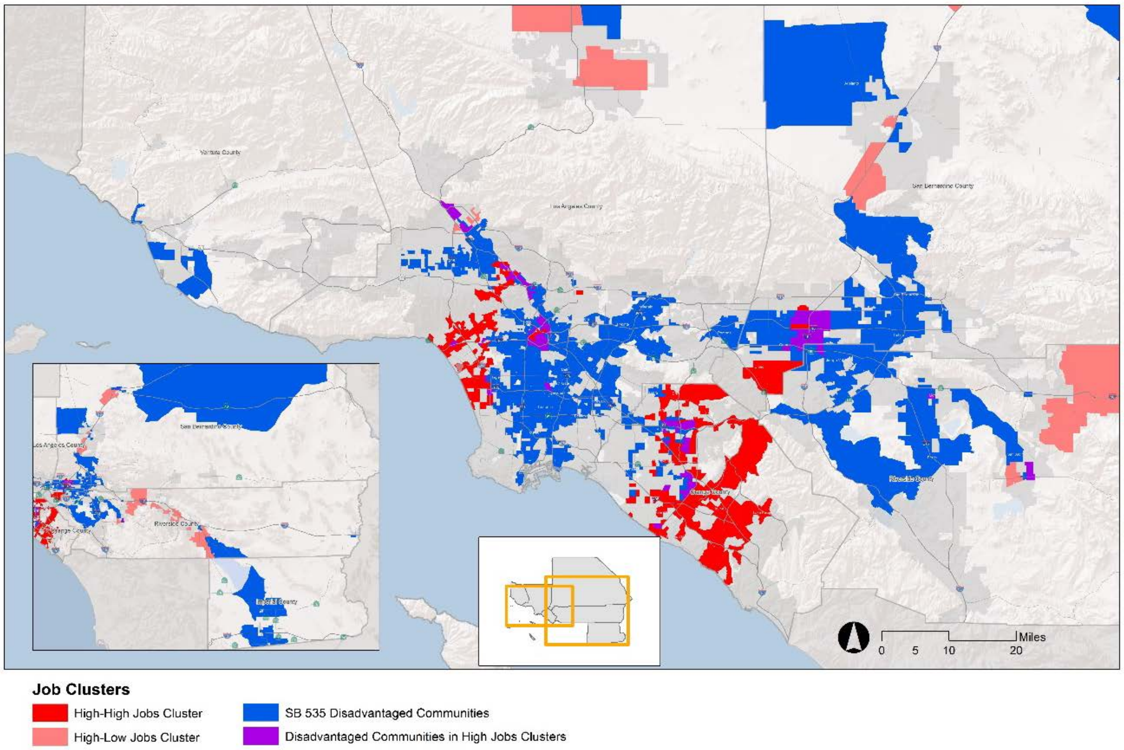

FIGURE 15: JOBS CLUSTERS AND DISADVANTAGED COMMUNITIES

The jobs clusters identified in the cluster analysis constitute groups of census tracts. These clusters can cross city boundaries, particularly across smaller cities. Therefore, I use census county divisions (CCDs) to identify distinct job clusters. Table 8 identifies the SCAG region's 10 largest clusters. Within the CCDs, the jobs count only includes jobs from census tracts that I identified as job clusters. Eight of the top 10 largest clusters, and all of the top six, are located in coastal counties. Imperial, Riverside, and Ventura Counties did not show significant jobs clustering within their boundaries. The job numbers indicate that job clusters in the SCAG region are concentrated in the coastal counties (specifically Los Angeles and Orange).

TABLE 8: TOP TEN LARGEST JOBS CLUSTERS IN THE SCAG REGION, 2015

County Subdivision	County	Jobs Count
Los Angeles CCD	Los Angeles	827,739
Anaheim-Santa Ana-Garden Grove CCD	Orange	580,727
San Fernando Valley CCD	Los Angeles	287,962
Central Coast CCD	Orange	201,749
Irvine-Lake Forest CCD	Orange	141,875
Santa Monica CCD	Los Angeles	81,453
Ontario CCD	San Bernardino	78,271
San Bernardino CCD	San Bernardino	65,754
South Coast	Orange	46,643
North Coast CCD	Orange	34,609

Table 9 shows the change in average distance to the nearest high-high or high-low jobs cluster for all disadvantaged census tracts and for all non-disadvantaged census tracts in the SCAG region between 2002 and 2015. The average distance between a census tract and a jobs cluster increased for both disadvantaged and non-disadvantage communities. Disadvantaged tracts are, on average, located *closer* to jobs clusters than non-disadvantaged tracts. While non-disadvantaged tracts' average distance to a jobs cluster increased more than the disadvantaged tracts' average distance, disadvantaged tracts experienced a greater percent change in distance to a job cluster between 2002 and 2015. These data present conflicting evidence with respect to the spatial mismatch hypothesis; while disadvantaged tracts are closer to job clusters, on average, mean distances between disadvantaged tracts and job clusters are increasing faster than for non-disadvantaged tracts. However, the number of clustered high-jobs census tracts decreased from 339 to 303; both the decrease in number of clustered tracts and the increase in average distance to a jobs cluster suggest that jobs are becoming more concentrated in the region.

TABLE 9: CHANGE IN AVERAGE DISTANCE TO A JOB CLUSTER, BY DISADVANTAGED COMMUNITY CENSUS TRACT STATUS, 2002-2015

Census Tract Type	Average Distance from a Job Cluster, 2002	Average Distance from a Job Cluster, 2015	Change in Average Distance (miles)	Percent Change in Average Distance
Disadvantaged	3.2	4.4	1.2	+37.5%
Non-disadvantaged	4.7	6.1	1.4	+29.8%

Jobs-Housing Analysis

Table 10 shows the 2015 median and mean job-to-worker ratios, broken down by disadvantaged community status and by county. Los Angeles County had the largest job-to-worker ratio of the six SCAG counties (1.17), while Riverside County had the smallest ratio (0.86). Los Angeles and Orange Counties, which have eight of the region's ten largest job clusters, are slightly jobs-rich, while Imperial, Riverside, San Bernardino, and Ventura Counties are slightly housing-rich. Los Angeles disadvantaged communities had the highest mean job-to-worker ratio of any census tract category (15.19). Orange County non-disadvantaged communities had the highest mean job-to-worker ratios of non-disadvantaged communities in any county. Mean job-to-worker ratios for the region as a whole is slightly housing rich; there are more workers living in the region than there are jobs, meaning that some workers commute to work outside of the region. Interestingly, Los Angeles County disadvantaged communities have a much higher mean job-to-worker ratio than the county's non-disadvantaged communities, while the opposite holds true in Orange County. Many census tracts (21) in the Downtown Los Angeles area are both job clusters and disadvantaged communities, which contribute to the high ratio; by contrast, just 15 census tracts in all of Orange County are both job clusters and disadvantaged communities.

TABLE 10: MEDIAN AND MEAN JOB-TO-WORKER RATIOS, BY COUNTY AND BY DISADVANTAGED COMMUNITY STATUS, 2015

	County	Disadvantaged Community		Non-Disadvantaged Community	
		Median	**Mean**	**Median**	**Mean**
Imperial	0.94	1.13	1.59	0.64	2.33
Los Angeles	1.17	0.38	15.19	0.39	1.32
Orange	1.13	0.51	1.57	0.42	9.41
Riverside	0.86	0.55	1.53	0.31	0.69
San Bernardino	0.91	0.49	1.36	0.30	0.77
Ventura	0.91	2.40	2.53	0.40	0.72
SCAG Region	0.95	0.42	11.53	0.38	2.72

Figure 16 shows the jobs-to-workers ratio for both DACs and Non-DACs. A ratio less than 1.00 indicates that a census tract has more workers than jobs can be described as "housing-rich." The median jobs to worker ratio for DACs in 2015 was 0.42, while the median for non-DACs is 0.38. These relatively small differences indicate that job-to-worker ratios likely contribute very little to differences in commuting trends between disadvantaged communities and non-disadvantaged communities. The distribution of jobs-to-worker ratios for DAC tracts and non-DAC tracts for each county is skewed right,[30] which indicates that some census tracts have very high jobs-to-worker ratios. Census tracts with the highest ratios tend to be found in the Downtown Los Angeles area, central Orange County, the Westside region of Los Angeles County, and the San Bernardino area.

[30] In statistics, skewness measures the asymmetry of a distribution. In a right skewed distribution, the mean is greater than the median.

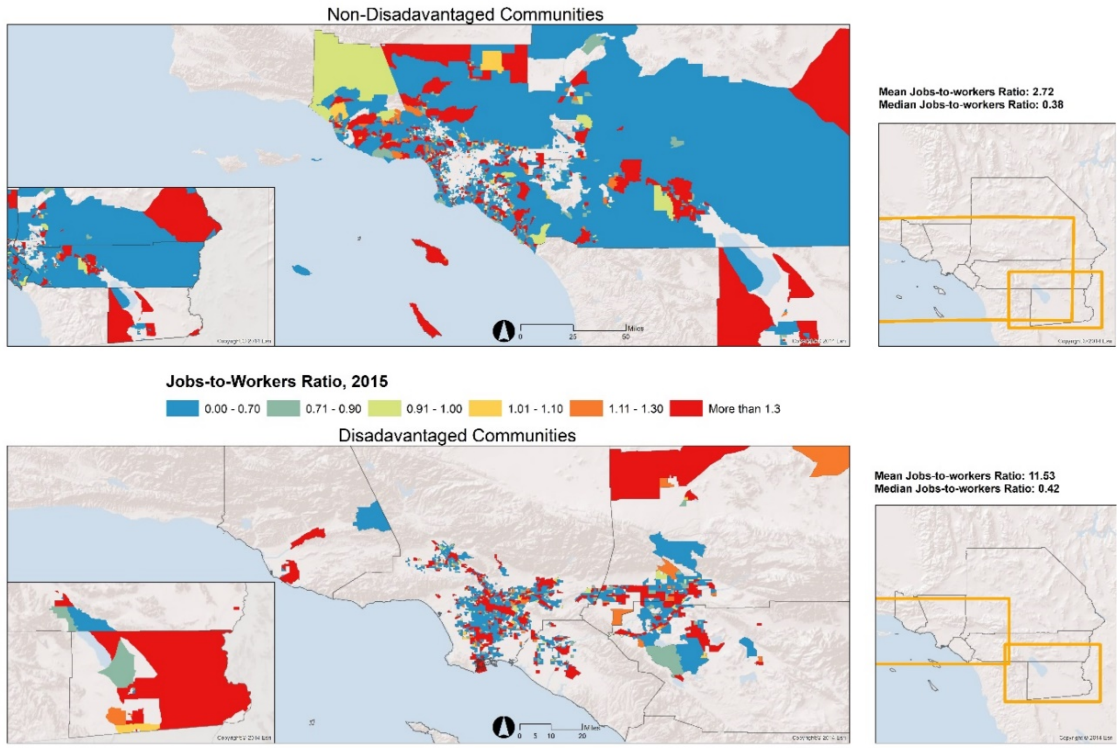

FIGURE 16: JOB-TO-WORKER RATIOS, DISADVANTAGED COMMUNITIES AND NON-DISADVANTAGED COMMUNITIES, 2015

Figure 17 shows the change in jobs-to-workers ratio for all census tracts between the years 2000 and 2015. A negative change indicates that the change in workers exceeded the change in jobs, while a positive change indicates that the change in jobs exceeded the change in workers. The mean ratio change of -0.03 suggests that the change in number of workers has slightly outpaced the increase in number of jobs. Places where regional job growth outpaced worker growth include western San Bernardino County and Imperial County, consistent with SCAG's findings that jobs are growing faster than workers in the inland counties. More specifically, areas where groups of census tracts experienced greater jobs growth than housing growth include the Coachella Valley, Downtown Los Angeles, eastern San Bernardino County, eastern Riverside County, and much of Imperial County.

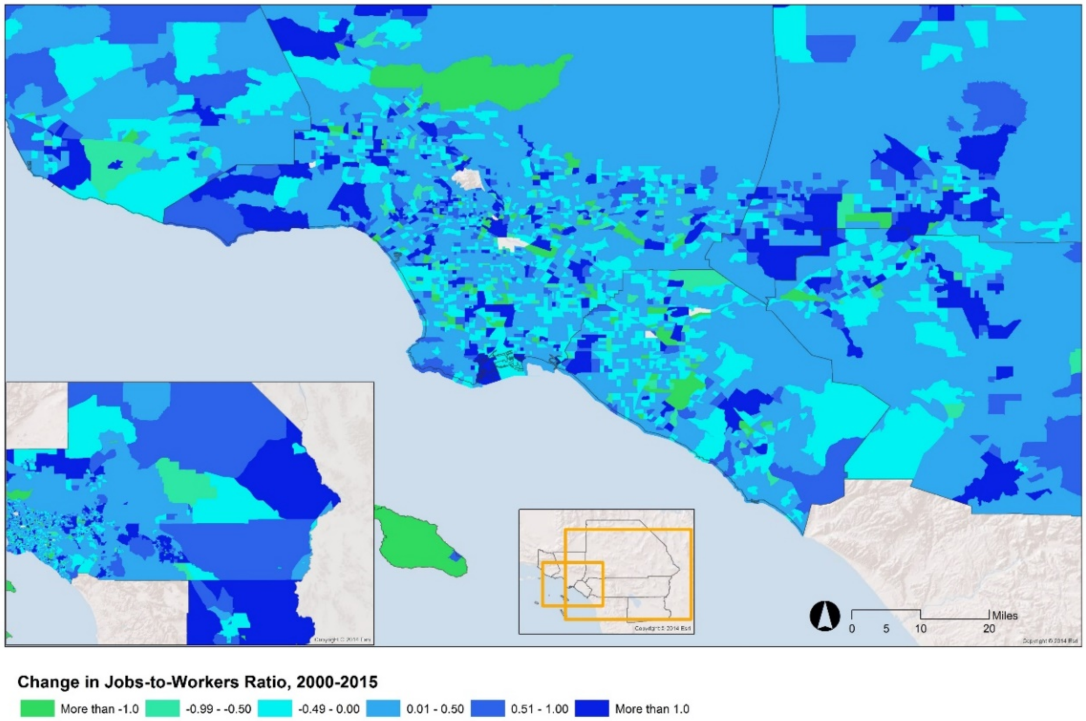

FIGURE 17: CHANGE IN JOB-TO-WORKER RATIO, 2000-2015

Regression Analysis

Table 11 shows the regression results for job-to-worker ratio as a function of several variables. I focus on ratios for both all jobs and lower-paying jobs. Apart from the number of jobs, mean commute time is most strongly (negatively) associated with a higher jobs-to-worker ratio. This result suggests that residents in tracts with fewer jobs-to-workers tend to experience longer commute times. However, commute distance has only a slightly positive association with jobs-to-worker ratio. These findings are consistent with those of Wachs, et al. (1993), who found that commute times had negligible effects on the balance of jobs and housing. Median home values and, to a lesser extent, gross rents were positively associated with higher jobs-to-worker ratios. These findings indicate that lower valued homes tend to be located in housing-rich areas, which tend to be found in the Inland Empire. Disadvantaged communities were slightly negatively associated with job-to-worker ratios, a finding that is inconsistent with the finding that mean and median job-to-worker ratios are slightly higher in disadvantaged communities than in non-disadvantaged communities.   Carpooling is weakly negatively associated with jobs-to-workers ratios; this result is consistent with my finding that disadvantaged communities have higher shares of carpool commuters than non-disadvantaged tracts.

TABLE 11: REGRESSION ANALYSIS

Jobs-to-Workers Ratio	Coefficient	Standard Error
All Jobs*	+	An increase in the number of jobs will lead to a higher jobs-to-housing ratio.
Median Commute Distance*	-	Median commute distance has a slightly negative relationship with job-to-worker ratios.
Carpool to Work*	-	Higher rates of carpooling to work are slightly negatively associated with job-to-worker ratios. Disadvantaged communities have higher carpooling rates than other census tracts.
Take Transit to Work*	+	Higher rates of transit commuting are slightly positively associated with job-to-worker ratios. Jobs-rich tracts tend to be found in dense areas that can support transit use.
Walk to Work	-	Higher rates of commuting by walking have a slightly negative relationship with job-to-worker ratios.
Commute 60 minutes or more to work one way*	-	The number of commuters who travel 60 of more minutes to work is negatively associated with job-to-worker ratios. Workers with long travel times tend to come from housing-rich areas.
Mean Commute Time*	-	Longer median commutes are negatively associated with job-worker ratios. Commuters from these tracts either travel long distances to their jobs and/or are more likely to take transit, which is slower than travel by private vehicle.
Median Gross Rent*[31]	+	Median gross rent is positively associated with job-worker ratios. Housing demand tends to be greater in job-rich locations, which tend to have greater access to amenities.
Median Home Value*[32]	+	Similar to rent values, median home value is positively associated with job-worker ratios because housing demand tends to be greater in job-rich locations.
SB 535 Disadvantaged Community*	-	Disadvantaged tracts are slightly negatively associated with job-worker ratios. While this result is inconsistent with my finding that mean ratios are greater in disadvantaged communities, it remains consistent with my cluster analysis that indicates little overlap between disadvantaged communities and job clusters.

[31] The housing dataset designates median gross rent values greater than $3,500 per month as $3,500.
[32] The housing dataset designates median gross home values greater than $2,000,000 as $2,000,000.

Implications for Policy

Commute Times

While results show statistically significant differences in mean and median commute times between disadvantaged and non-disadvantaged tracts, in practical terms, the magnitude of differences between the two groups is small. The differences range from just 30 to 48 seconds per one-way commute. However, both types of tracts and the region as a whole experienced large mean commute time increases between 1990 and 2016, increasing an average of four minutes and six seconds, or 16 percent over the two decades. Lengthier average commute times can imply (1) longer distance commutes, (2) more commutes in traffic congestion, and/or (3) use of slower (non-solo-driving) transportation modes – like carpooling and public transit. Driving to work, specifically driving alone to work, increased from 1990 to 2016. Solo commutes tend to be the fastest, so the regional increase in average commute times were likely the result of (1) and (2) above. According to the RTP/SCS, commute times and distances are likely to increase, particularly in the inland counties, if population, housing, and employment trends continue at their current rates.

Jobs-Housing and Jobs Accessibility

While results show differences in mean and median job-to-worker ratios between disadvantaged and non-disadvantaged tracts, in practical terms, the magnitude of the differences between the two groups is small. The 2015 median job-to-work ratio for disadvantaged community census tracts was 0.42, slightly greater than the ratio for non-disadvantaged community census tracts (0.38), indicating that job-to-worker ratios may contribute very little to differences in commuting trends between disadvantaged communities and non-disadvantaged communities. While there is more variation in job-to-worker ratios between disadvantaged and non-disadvantaged communities among census tracts, the magnitude of the differences remain small.

Jobs in the region have likely become more concentrated, evidenced by the decrease in number of clustered census tracts between 2002 and 2015, increase in the region's total number of jobs, and increase in the average distance to a job cluster. Furthermore, the mean job-to-worker ratios for disadvantaged communities (11.53) and non-disadvantaged communities (2.72) are much larger than their respective median values, indicating that a few census tracts have very high job-to-worker ratios. Eight of the region's ten largest job clusters are located in Los Angeles or Orange Counties, the only counties with more jobs than workers. To access these jobs, an increasing percentage of workers in all counties are commuting alone by motor vehicle, the transportation mode with the greatest average speed. Low-density areas tend to have longer distance commuters, which, on its own, is not problematic. However, low-density census tracts in the SCAG region's outlying areas have some of the longest average commutes in the region.

Factors Associated with Higher Job-to-Worker Ratios

Median gross rent, median home values, share of transit commuters, and number of jobs were all positively associated with a higher ratio of jobs-to-workers. Transit use's positive association with job-to-worker ratios indicates that job-rich areas tend to be denser and better suited for transit use. Median gross rent and median home values tend to be higher in job-rich areas, as these areas tend to allow for better access to jobs and other amenities than housing-rich areas. Orange County, the densest county, had the highest median home value of any county in the region between 1998 and 2016.

Commute distance, commute time, long travel times, disadvantaged communities, carpooling to work, and walking to work were negatively associated with higher job-to-worker ratios. Census tracts in outlying areas of the region tend to have longer commuting times, commuting distances, and higher shares of commuters who carpool than areas, suggesting that a number of commuters from these areas commute to jobs-rich areas in Los Angeles and Orange Counties. Disadvantaged communities tend to be adjacent to job clusters, with some overlapping of job-clustered tracts and disadvantaged tracts, indicating segregation between clusters and disadvantaged communities.

Working Toward a Balanced Region

SCAG's 2016 RTP/SCS jobs-housing analysis shows that, although the commute distance grew in all six of the region's counties between 2002 and 2012, the commuting distance of workers in the inland counties grew more rapidly than for workers in coastal counties. Comparing median commute times with job-to-worker ratios shows that "counties with lower job-to-worker ratios generate more long distance commuters," indicating "the need for more job growth in inland counties, while coastal counties need more housing growth."[33] Consistent with my findings, SCAG's analysis shows that job growth already outpaces housing growth in the inland counties, indicating that "job-housing balance will likely improve and may result in the reduction of transportation congestion and related air quality problems"[34] as these counties are already home to a substantial percentage of the region's labor force. SCAG's role as a regional agency gives it limited power to effect such changes, leaving local jurisdictions to add jobs and housing where SCAG recommends.

My analysis shows little difference in both commuting and in job-to-worker ratios between disadvantaged communities and non-disadvantaged communities. Consistent with SCAG's jobs-

[33] SCAG 2016 RTP/SCS Environmental Justice Appendix, 65.
[34] SCAG 2016 RTP/SCS Environmental Justice Appendix, 68.

housing analysis, my analysis indicates a need for more housing growth in the coastal counties and more job growth in the inland counties in order to reduce average commute distances. My findings therefore suggest that there are greater differences in commuting trends and job-to-worker ratios among different parts of the region than there are between disadvantaged communities and non-disadvantaged communities, suggesting that SCAG's approaches to balancing the region should focus on adding jobs and housing to specific locations rather than to disadvantaged communities.

Median home values and gross rents were positively associated with job-to-worker ratios, implying that jobs-rich areas have becoming increasingly unaffordable for some workers, pushing them toward cheaper housing-rich areas. The number of jobs had the strongest positive association with job-to-worker ratios, indicating that areas with high numbers of jobs tend to also be jobs-rich (and have much less housing by comparison). Therefore, SCAG could encourage new housing in areas with high numbers of jobs and high job-to-worker ratios. The region's ten largest job clusters are strong candidates for additional housing, as they are home to the SCAG region's highest concentration of jobs. These areas also have many census tracts with the region's highest job-to-worker ratios. Los Angeles and Orange Counties, which are home to eight of the ten largest job clusters, also have most of the region's high quality transit areas, and the best and third best transit to solo commuting travel time ratios, respectively. Adding housing in these areas, specifically in high quality transit areas and areas that are both job clusters and disadvantaged communities, may shorten commutes and increase transit use.

SCAG expects the effects of long commute times to lessen as jobs continue to grow in the inland counties. My analysis indicates that areas where jobs growth has outpaced housing can be found both in inland and coastal counties. Some areas, such as Downtown Los Angeles, contain census tracts with high existing job-to-worker ratios and have seen jobs growth outpace housing growth; further encouragement of jobs growth in these areas could exacerbate lengthening average commute times and solo commuting shares currently taking place in the region. Because census tracts in the region's outlying areas (especially in the inland counties) tend to have the highest mean commute times and lowest job-to-worker ratios in Southern California, jobs growth in areas closest to these areas could reduce commuting times. However, jobs growth cannot occur without an existing demand for jobs; therefore, SCAG could encourage jobs growth in areas outside of the region's largest jobs clusters where job growth has outpaced housing growth. The Coachella Valley provides a strong foundation for job growth in the inland counties, as several jobs clusters exist there and jobs have outpaced housing in the area. The Ontario and San Bernardino areas have also seen job growth outpace housing growth, have a relatively small but growing presence of jobs, and are located near census tracts with long mean commute times.

Appendix

Complete list of CalEnviroScreen 3.0 indicators used to calculate vulnerability

For more information on individual indicators, visit the Office of Environmental Health Hazard Assessment website at https://oehha.ca.gov/calenviroscreen/indicators.

Exposure Indicators

Air Quality: Ozone

Air Quality: PM2.5

Diesel Particulate Matter

Drinking Water Contaminants

Pesticide Use

Toxic Releases from Facilities

Traffic Density

Environmental Effect Indicators

Cleanup Sites

Groundwater Threats

Hazardous Waste Generators and Facilities

Impaired Water Bodies

Solid Waste Sites and Facilities

Sensitive Population Indicators

Asthma

Cardiovascular Disease

Low Birth Weight Infants

Socioeconomic Factor Indicators

Educational Attainment

Housing Burden

Linguistic Isolation

Poverty

National Household Travel Survey Tables

Table 3. Summary of Travel Statistics
1969, 1977, 1983, 1990, and 1995 NPTS, and 2001 and 2009 NHTS.

	1969	1977	1983	1990	1995	2001	2009	95% CI
Per Person								
Daily Person Trips	2.02	2.92	2.89	3.76	4.30	3.74	3.79	0.03
Daily PMT	19.51	25.95	25.05	34.91	38.67	36.89	36.13	1.35
Per Driver								
Daily Vehicle Trips	2.32	2.34	2.36	3.26	3.57	3.35	3.02	0.03
Daily VMT	20.64	19.49	18.68	28.49	32.14	32.73	28.97	0.71
Per Household								
Daily Person Trips	6.36	7.69	7.20	8.94	10.49	9.66	9.50	0.09
Daily PMT	61.55	68.27	62.47	83.06	94.41	95.24	90.42	3.38
Daily Vehicle Trips	3.83	3.95	4.07	5.69	6.36	5.95	5.66	0.06
Daily VMT	34.01	32.97	32.16	49.76	57.25	58.05	54.38	1.34
Per Trip								
Average person trip length (miles)	9.67	8.87	8.68	9.47	9.13	10.04	9.75	0.36
Average vehicle trip length (miles)	8.89	8.34	7.90	8.85	9.06	9.87	9.72	0.22

Note:

- Average trip length is calculated using only those records with trip mileage information present.
- 1990 person and vehicle trips were adjusted to account for survey collection method changes (see 2001 Summary of Travel Trends Appendix 2).
- PMT is Person Miles of Travel. VMT is Vehicle Miles of Travel. CI is Confidence Interval. NPTS is Nationwide Personal Transportation Survey.

Table 5. Average Annual PMT, Person Trips and Trip Length by Trip Purpose
1969, 1977, 1983, 1990, and 1995 NPTS, and 2001 and 2009 NHTS.

Trip Purpose	1983	1990	1995	2001	2009	95% CI
Average Annual PMT per Household						
All Purposes	22,802	30,316	34,459	35,244	33,004	1,235.1
To/From Work	4,586	5,637	7,740	6,706	6,256	170.1
Work Related Business	1,354	1,043	1,987	2,987	2,078	247.2
Shopping	2,567	3,343	4,659	4,887	4,620	181.4
Other Family/Personal Errands	3,311	7,167	7,381	6,671	5,134	222.8
School/Church	1,522	1,599	1,973	2,060	2,049	123.0
Social and Recreational	8,964	11,308	10,571	10,586	9,989	585.8
Other	500	214	131	1,216	2,878	864.6
Average Annual Person Trips per Household						
All Purposes	2,628	3,262	3,828	3,581	3,466	31.8
To/From Work	537	539	676	565	541	7.9
Work Related Business	62	38	100	109	106	7.4
Shopping	474	630	775	707	725	14.6
Other Family/Personal Errands	456	854	981	863	748	13.9
School/Church	310	304	337	351	333	9.8
Social and Recreational	728	874	953	952	952	14.1
Other	61	22	6	30	61	4.1
Average Person Trip Length (miles)						
All Purposes	8.7	9.5	9.1	10.0	9.7	0.4
To/From Work	8.5	10.7	11.6	12.1	11.8	0.3
Work Related Business	21.8	28.2	20.3	28.3	20.0	2.0
Shopping	5.4	5.4	6.1	7.0	6.5	0.2
Other Family/Personal Errands	7.3	8.6	7.6	7.8	7.0	0.3
School/Church	4.9	5.4	6.0	6.0	6.3	0.3
Social and Recreational	12.3	13.2	11.3	11.4	10.7	0.6
Other	8.2	10.3	22.8	43.1	51.5	14.5

Note:

- Average person trip length is calculated using only those records with trip mileage information present.
- 1990 person and vehicle trips were adjusted to account for survey collection method changes (see 2001 Summary of Travel Trends Appendix 2).
- 1995 Vehicle Miles of Travel (VMT) and vehicle trips with "To or From Work" as a trip purpose is believed to be overstated.
- "Other Family/Personal Errands" includes personal business and medical/dental. Please see Appendix A - Glossary for definition.
- PMT is Person Miles of Travel. CI is Confidence Interval.

Table 6. Average Annual VMT, Vehicle Trips and Trip Length by Selected Trip Purposes
1969, 1977, 1983, 1990, and 1995 NPTS, and 2001 and 2009 NHTS.

Trip Purpose	1969	1977	1983	1990	1995	2001	2009	95% CI
Average Annual VMT per Household								
All Purposes	12,423	12,036	11,739	18,161	20,895	21,187	19,850	490.5
To or From Work	4,183	3,815	3,538	4,853	6,492	5,724	5,513	146.7
Shopping	929	1,336	1,567	2,178	2,807	3,062	2,979	95.9
Other Family/Personal Errands	1,270	1,444	1,816	4,250	4,307	3,956	3,515	120.1
Social and Recreational	4,094	3,286	3,534	5,359	4,764	5,186	4,842	257.8
Average Annual Vehicle Trips per Household								
All Purposes	1,396	1,442	1,486	2,077	2,321	2,171	2,068	20.8
To or From Work	445	423	414	448	553	479	457	7.8
Shopping	213	268	297	431	501	459	468	9.2
Other Family/Personal Errands	195	215	272	579	626	537	500	9.2
Social and Recreational	312	320	335	460	427	441	436	8.4
Average Vehicle Trip Length (miles)								
All Purposes	8.9	8.4	7.9	8.9	9.1	9.9	9.7	0.2
To or From Work	9.4	9.0	8.6	11.0	11.8	12.1	12.2	0.3
Shopping	4.4	5.0	5.3	5.1	5.6	6.7	6.4	0.2
Other Family/Personal Errands	6.5	6.7	6.7	7.4	6.9	7.5	7.1	0.2
Social and Recreational	13.1	10.3	10.6	11.8	11.2	11.9	11.2	0.6

Note:

- Average vehicle trip length is calculated using only those records with trip mileage information present.
- "Other Family/Personal Errands" includes personal business and medical/dental. Please see Appendix A - Glossary for definition.
- "All Purposes" includes other purposes not shown above, such as trips to school, church, doctor, dentist, and work-related business trips.
- 1995 Vehicle Miles of Travel (VMT) and vehicle trips with "To or From Work" as a trip purpose is believed to be overstated.
- 1990 person and vehicle trips were adjusted to account for survey collection method changes (see 2001 Summary of Travel Trends Appendix 2).
- NPTS is Nationwide Personal Transportation Survey. CI is Confidence Interval.

Table 11. Daily Trip and Travel Rates per Person by Trip Purpose
1977, 1983, 1990, and 1995 NPTS, and 2001 and 2009 NHTS.

	1977	1983	1990	1995	2001	2009	95% CI
Person Trips per Day							
Total	**2.92**	**2.89**	**3.76**	**4.30**	**4.09**	**3.79**	**0.03**
To or From Work	0.57	0.59	0.62	0.76	0.65	0.59	0.01
Family/Personal Errands	0.91	1.02	1.71	1.97	1.79	1.61	0.02
School/Church	0.35	0.34	0.35	0.38	0.4	0.36	0.01
Social and Recreational	0.71	0.8	1.01	1.07	1.09	1.04	0.02
Other	0.38	0.14	0.06	0.12	0.16	0.18	0.01
Person Miles of Travel per Day							
Total	**25.95**	**25.05**	**34.91**	**38.67**	**40.25**	**36.13**	**1.35**
To or From Work	5.16	5.04	6.49	8.69	7.66	6.85	0.19
Family/Personal Errands	5.68	6.46	12.1	13.51	13.2	10.68	0.31
School/Church	1.61	1.67	1.84	2.21	2.35	2.24	0.13
Social and Recreational	7.81	9.85	13.02	11.86	12.09	10.93	0.64
Other	5.68	2.04	1.46	2.39	4.8	5.43	0.99

Note:

- All tables reporting totals could include some unreported characteristics.
- Trip rates are calculated including travelers and non-travelers, resulting in travel estimates per-capita.
- 1990 person and vehicle trips were adjusted to account for survey collection method changes (see 2001 Summary of Travel Trends Appendix 2).
- The 1995 "To or From Work" person trips and person miles are believed to be overstated. Other trip purpose includes trips for work-related business.
- "Family/Personal Errands" includes personal business, shopping, medical/dental. Please see Appendix A - Glossary for definition.
- NPTS is Nationwide Personal Transportation Survey. CI is Confidence Interval.

Table 12. Distribution of Daily Person Miles of Travel per Person by Mode of Transportation and Trip Purpose, Adjusted 1990 and 1995 NPTS, 2001 and 2009 NHTS.

	Private					Public Transit				
	1990	1995	2001	2009	95% CI	1990	1995	2001	2009	95% CI
TOTAL	**30.85**	**35.26**	**35.49**	**31.92**	**0.88**	**0.74**	**0.82**	**0.47**	**0.53**	**0.11**
Percent	***88.37%***	***91.18%***	***88.17%***	***88.35%***		***2.12%***	***2.12%***	***1.17%***	***1.47%***	
To or From Work	6.15	8.09	7.11	6.47	0.17	0.27	0.30	0.24	0.18	0.04
Percent	*17.62%*	*20.92%*	*17.66%*	*17.91%*		*0.77%*	*0.78%*	*0.60%*	*0.50%*	
Work Related Business	0.63	1.85	2.27	1.88	0.21	0.01	0.02	0.01	0.02	0.01
Percent	*1.80%*	*4.78%*	*5.64%*	*5.20%*		*0.03%*	*0.05%*	*0.02%*	*0.06%*	
Family/Personal Errands	11.39	12.7	12.77	10.30	0.32	0.14	0.19	0.10	0.10	0.02
Percent	*32.63%*	*32.84%*	*31.73%*	*28.51%*		*0.40%*	*0.49%*	*0.25%*	*0.28%*	
School/Church	1.32	1.68	1.87	1.80	0.13	0.12	0.07	0.04	0.05	0.01
Percent	*3.78%*	*4.34%*	*4.65%*	*4.98%*		*0.34%*	*0.18%*	*0.10%*	*0.14%*	
Social and Recreational	11.12	10.83	11.01	9.98	0.52	0.18	0.24	0.07	0.10	0.03
Percent	*31.85%*	*28.01%*	*27.35%*	*27.62%*		*0.52%*	*0.62%*	*0.17%*	*0.28%*	
Other	0.23	0.10	0.36	1.49	0.35	0.01	0.00	0.00	0.08	0.09
Percent	*0.66%*	*0.26%*	*0.89%*	*4.12%*		*0.03%*	*0.00%*	*0.00%*	*0.22%*	

*Table 12 is continued on the following page.

Table 24. Commute Trips and VMT and Total VMT by Year
1969, 1977, 1983, 1990 and 1995 NPTS, and 2001 and 2009 NHTS.

	1969	1977	1983	1990	1995	2001	2009	95% CI
Commute Vehicle Trips (000,000)	27,844	31,886	35,271	41,792	54,782	51,395	51,699	897
Commute VMT (000,000)	260,716	287,710	301,644	453,042	642,610	614,548	623,479	16,794
Total VMT (000,000)	775,940	907,603	1,002,139	1,695,290	2,068,368	2,274,797	2,245,112	56,158
% Commute VMT of Total VMT	33.60%	31.70%	30.10%	26.72%	31.07%	27.02%	27.77%	
Workers (000)	75,758	93,019	103,244	118,343	131,697	145,272	151,373	893
Annual Commute Vehicle Trips per Worker	368	343	342	353	416	354	342	5.41

Note:

- 1995 Vehicle Miles of Travel (VMT) and vehicle trips with "To or From Work" as a trip purpose is believed to be overstated.
- Slightly different approaches were used in defining workers and commute trips between the 1990 and 1995 Nationwide Personal Transportation Survey (NPTS).
- CI is Confidence Interval.

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