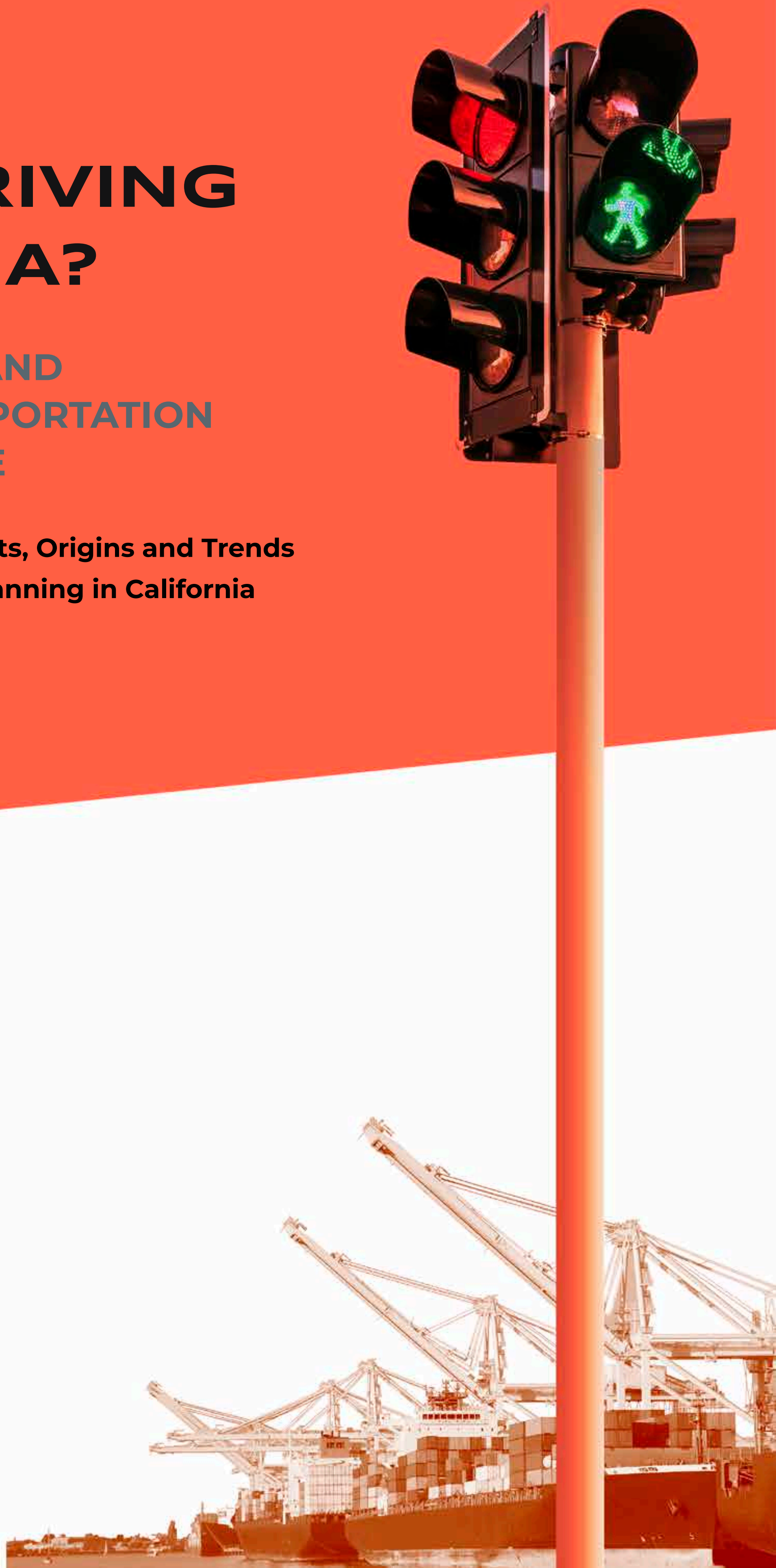
WHAT'S DRIVING CALIFORNIA?

THE PAST, PRESENT, AND FUTURE(S) OF TRANSPORTATION IN THE GOLDEN STATE

An In-Depth Analysis of the Facts, Origins and Trends of Transportation and Urban Planning in California



CALIFORNIA 100

VISION & STRATEGY FOR THE NEXT CENTURY

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The California 100 Initiative envisions a future that is innovative, sustainable, and equitable for all. Our mission is to strengthen California's ability to collectively solve problems and shape our long-term future over the next 100 years.

California 100 is organized around 15 policy domains and driven by interrelated stages of work: research, policy innovation and engagement with Californians. California 100's work is guided by an expert and intergenerational Commission. Through various projects and activities, California 100 seeks to move California towards an aspirational vision—changing policies and practices, attitudes and mindsets, to inspire a more vibrant future.

This California 100 Report on Policies and Future Scenarios was produced as part of California 100's research stream of work, in partnership with 20 research institutions across the state. California 100 sponsored grants for data-driven and future-oriented research focused on understanding today and planning for tomorrow. This research, anchored in California 100's 15 core policy domains, forms the foundation for the initiative's subsequent work by considering how California has gotten to where it is and by exploring scenarios and policy alternatives for what California can become over the next 100 years.

The California 100 initiative is incubated through the University of California and Stanford.

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UCLA Institute of Transportation Studies

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ABSTRACT

This report examines transportation in California: where we are today, how we got here, and where we might be headed. We begin with facts on travel and transportation systems in California today. The vast majority of personal travel is by car across all socio-economic groups, and commercial travel is by truck. Public transit plays an important role in the biggest cities but a small one elsewhere; walking is the most popular way to get around outside of a car or truck. Californians are taking fewer trips overall, though reduced vehicle travel for personal trips is more than offset by increases in commercial travel and deliveries.

We next explore the decades of public and private land development and transportation systems that have shaped the current state of play. We explore the state's massive investments in freeways—both between and within cities—and its land use policies complementary to driving. Low-density land uses, exemplified by dispersed single-family housing, have encouraged automobile ownership and use, resulting in suburban living and universal automobile access for most of the population, at the cost of increasing travel distances, increasing isolation for those unable to drive, chronic traffic congestion, health- and environment-threatening vehicle emissions, and a housing affordability crisis. Today's transportation problems stem, in significant part, from yesterday's land use decisions.

We then consider factors that have either recently come to the fore or are likely to emerge in the near future: the growing reliance on automobile and truck travel and declining in transit use (both before and during the pandemic), shifting patterns of public spending on transportation, changing patterns of jobs and housing locations, the travel habits of younger generations, advancements in goods movement, and the challenges of resilience in disasters. Technology, too, is reshaping Californians' mobility, with electrification of the vehicle fleet, technology-enabled mobility services, telecommuting, and the gradual automation of driving.

We conclude by reviewing possible context-specific reforms to reshape transportation in the state, in order to better manage vehicle travel and reduce chronic congestion, shift patterns of development to make them less car-dependent, and increase access for all.

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The Institute of Transportation Studies at UCLA acknowledges the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles basin and So. Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), ‘Ahiihirom (Elders) and ‘Eyoohiinkem (our relatives/relations) past, present and emerging.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

GETTING AROUND THE GOLDEN STATE

California is a remarkable place. With its lush redwood forests, bounteous San Joaquin Valley, towering Sierra Nevada Mountains, and spectacular Mojave and Colorado Deserts, California is arguably among the most diverse geographic regions on the planet. The Golden State's diversity is not limited to geography: its nearly 40 million inhabitants include outsized shares of immigrants from all corners of the world. The global center of the tech and entertainment industries, if California were a nation, its economy would rank as the world's fifth-largest (Egel 2018).

The many firms in that vibrant economy and those many Californians are linked to one another and the world by its remarkable, diverse transportation systems. The freeway was not invented in California, but the state was the first to mass produce them—including in metropolitan areas—after the Second World War (Taylor 2000). While California's image is defined in no small part by cars, freeways, and driving—and indeed it has plenty of all three—the state actually ranks among the ten U.S. states with *the least* driving per person (Davis 2019). Belying its car-crazy image, Los Angeles early in the last century had the most extensive streetcar system in the world (Jones 1985). While public transit plays a decidedly peripheral role in urban mobility for most Californians today, among the nation's 497 urbanized areas, it is home to two of the five areas with the most transit riders and seven of the top 50 (Hughes-Cromwick and Dickens 2018).

California stands out for commercial travel as well as personal. The twin Ports of Long Beach and Los Angeles are, combined, the largest in the Western Hemisphere, handling about 40 percent of the container imports in the U.S. (LAEDC 2021). California is also home to the third (Los Angeles) and 23rd (San Francisco) busiest pre-pandemic airports on the globe (Levine et al. 2020), and five more that boarded over five million passengers per year (FAA 2018). When it comes to transportation and travel, California is both exceptional and an exception.

THE TRANSPORTATION SYSTEM IN CALIFORNIA

California's transportation ecosystem is both enormous and complex. There are thousands of miles of interstate and state highways and tens of thousands of miles of local roads, serving automobile, motorcycle and truck traffic. There is also an extensive rail network, used by both private companies and public agencies to haul freight and passengers. Several of those lines serve the state's major port facilities, as California has become a major center in pan-Pacific shipping and trade. Public transit plays a key transportation role in many cities, ranging from local vanpools and paratransit services, to fleets of buses, and now in many urban areas, light, heavy, and, in the future, high-speed rail. There are even ferry services that operate in the Bay Area and elsewhere. California is also home to nine international airports and hundreds of smaller commercial and private airports. In addition, there is another major transportation system that is often overlooked: sidewalks. Not only do they make it possible to get around by foot, they also provide access to essentially all other modes.

The California State Legislature sets transportation policy for the state, including establishing major programs like cap-and-trade and raising the state's fuel taxes in 2017 (California Climate Investments 2020; Caltrans 2021b). In the executive branch, the California State Transportation Agency (CalSTA) is a cabinet-level agency that oversees the operations of several state departments including the California Department of Transportation (Caltrans), Department of Motor Vehicles, High-speed Rail Authority, and Highway Patrol (CalSTA 2021).

CalSTA is responsible for the preparation of the state's federally-required statewide long-range transportation plan, the most recent version of which, the *California Transportation Plan 2050*, was published in February 2021. The plan established the state's transportation goals over the next three decades in the areas of equity, accessibility, safety, climate, health, economy, infrastructure, and the environment. Among the goals are reducing automobile and truck travel, increasing the use of alternative modes, including walking, biking, and transit, and reducing air pollution, while promoting economic growth (Caltrans 2021a).

At the regional level, metropolitan planning organizations (MPOs) are responsible for preparing and periodically updating regional transportation plans that implement the state's overall vision. There are 18 MPOs covering nearly all areas of the state, governed by boards of mostly local elected officials (Institute for Local Government 2015). Funding for metropolitan and local transportation projects, whether repair, retrofit, or new construction, comes from myriad sources, including federal and state funds (largely collected from gasoline and other fuel taxes), local property taxes, and increasingly local option sales taxes (LOSTs) levied at the county level.

ACCESSIBILITY, MOBILITY, AND EQUITY

A number of key concepts are used throughout this report, including accessibility, mobility, and equity. Accessibility is the ability to avail one's self, household, firm, or institution of goods, services, activities, and opportunities. It is, in essence, the *raison d'être* of transportation systems. Access often entails travel, such as by walking to a café, driving to a grocery store, or taking a bus to work, but the internet enables access as well, without travel. Mobility, by contrast, refers to the ability to move about. Walking for ten minutes to reach a drugstore 500 meters away or driving for ten minutes to reach a drugstore five kilometers distant both convey similar levels of drugstore access, but entail vastly different levels of mobility. So while mobility (be it 500 meters or five kilometers) often conveys access, more mobility does not necessarily mean more access. In fact, traveling long distances can result in lower levels of access, as time spent traveling *to* destinations is time away from activities *at* destinations (Mondschein and Taylor 2017). Transportation policy, planning, and engineering is in the midst of a significant, albeit gradual, shift from a mobility focus to an accessibility focus (Siddiq and Taylor 2021).

Transportation equity is a critical concept as well, and one that is both waxing in importance and evolving in definition. Transportation equity can be evaluated with respect to individuals, classes or interests (such as how Latinos/as, women, cyclists, or truckers fare relative to others), or geographies (such as how various neighborhoods or municipalities compare). Transportation equity includes both the distribution of the benefits of travel and the distribution of the costs and burdens of travel (financial, health and safety, environmental, etc.), including by those (living close to transportation facilities, excluded from desired activities or social resources, etc.) not traveling at all (Karner, Rowangould, and London 2016). These benefits and costs, in turn, can be evaluated in terms of outcomes (such as food access or the incidence of asthma adjacent to highways), outputs (such as levels of walking or driving), or markets (such as the balance of payments for and benefits received from travel). In addition and importantly, transportation equity is also evaluated in terms of who (across individuals, classes or interests, and geographies) has a voice and influence over transportation system decision-making and whose voices, both presently and historically, are or have been excluded.

DRIVING, MORE DRIVING, AND WHAT TO DO ABOUT IT

While the typical Californian drives less than the average American, there are a lot of Californians and together they drive a lot. Better than four in five person-trips statewide are via car, truck, or motorcycle, ranging from a low of 72 percent in the Bay Area to a high of 90 percent in Southern California's Inland Empire. While both automobile ownership and driving are less in low-income households, most (78%) low-income Californians commute by car, their own or someone else's. Transportation policymakers in California, by fits and starts, have struggled with how best to cope with all of this driving. On one hand, those with access to cars enjoy high levels of both mobility and access to opportunities. But on the other, as the state has grown larger and denser, traffic congestion has become chronic, and those without cars are increasingly left behind.

In response, policymakers in California have repeatedly adopted seemingly contradictory positions: we should widen clogged streets and freeways to ease traffic flows, reduce congestion, and make driving easier. We should invest in new public transit systems to lure drivers out of their cars and onto gleaming, new rail lines. We should mandate plenty of free parking at every new development to make it easy for drivers to reach their destinations without traffic-snarling searches for parking. We should promote more "compact" developments to increase opportunities to walk, bike, or scooter to nearby destinations instead of driving. We should discourage compact development in already built up areas to reduce their traffic impacts. We should replace curb parking with transit-only or bike lanes to make travel by these modes more attractive vis-a-vis driving. And on and on. While each of these choices may make sense when considered in isolation, taken together they can collectively result in outcomes that undercut one another.

The car-friendly policies aim to give Californians access primarily by improving auto-mobility, while the travel-alternatives-friendly policies aim to provide access by de-emphasizing auto-mobility. Note that these policies are not limited to transportation but entail land use and development policies as well. Transportation policies that favor driving encourage land developments designed to accommodate cars. Conversely, land uses that put destinations close together encourage travel by means other than cars. Sorting out which of these policies to pursue in which urban, suburban, and rural context will go a long way toward determining the transportation future of California.

THE URBAN FORM/TRANSPORTATION NEXUS

While the last half of 20th century California was characterized by suburban growth paired with central city disinvestment, the first two decades of the 21st century witnessed continued suburban expansion but amidst reinvestment and expansion of many (though not all) central city neighborhoods. This back-to-the-city movement has increased population, development, and incomes in many central city neighborhoods, and reduced dependence on driving relative to new suburban developments in the process. But this urban expansion has also raised the specter of gentrification, wherein more affordable urban neighborhoods, which are disproportionately home to people of color, become more expensive and may displace lower-income, Black, and Latino/a residents to less transit-friendly, more car-oriented areas.

High density, transit-friendly urban communities are one way to increase accessibility (by putting destinations closer together) and diversify mobility (by increasing the practical options for getting around). To support such communities and reduce dependence on driving, the state and its regions, counties, and cities have collectively invested substantially in improving and expanding public transit since the 1970s. While statewide transit patronage has increased since then, ridership was mostly down in the 2010s, before collapsing amidst the COVID-19 pandemic in 2020. Since then, ridership has recovered, but at a substantially slower rate (as of this writing) than driving, walking, or biking (Taylor et al. 2020; Dai et al. 2021; FTA 2021).

But while the popular and political focus has often been on public transit as the principal alternative to driving, walking to destinations is an important, albeit often overlooked, means of travel—particularly in densely-developed places like San Francisco and West Hollywood. As we show in the Facts section of this report, about one in eight trips to destinations by Californians are by foot, while just one in 33 trips are via public transit. Places can often be made more walkable by mixing land uses and increasing densities, so more travel destinations are nearby, and improving walking infrastructure by widening sidewalks, increasing crosswalk ease and safety, and "calming" traffic to reduce motor vehicle speeds. Such improvements can also encourage more biking and micromobility use, like scooters.

The concept of "complete streets" is becoming more widespread in California's cities, which entails configuring streets for all users, and not just drivers. Complete streets improvements can include new lanes for bikes and scooters, devoting more curb space for transit stops, small package deliveries, and ridehail pick-ups and drop-offs, and repurposing street parking for outdoor dining (which has expanded greatly as a result of the COVID-19 pandemic).

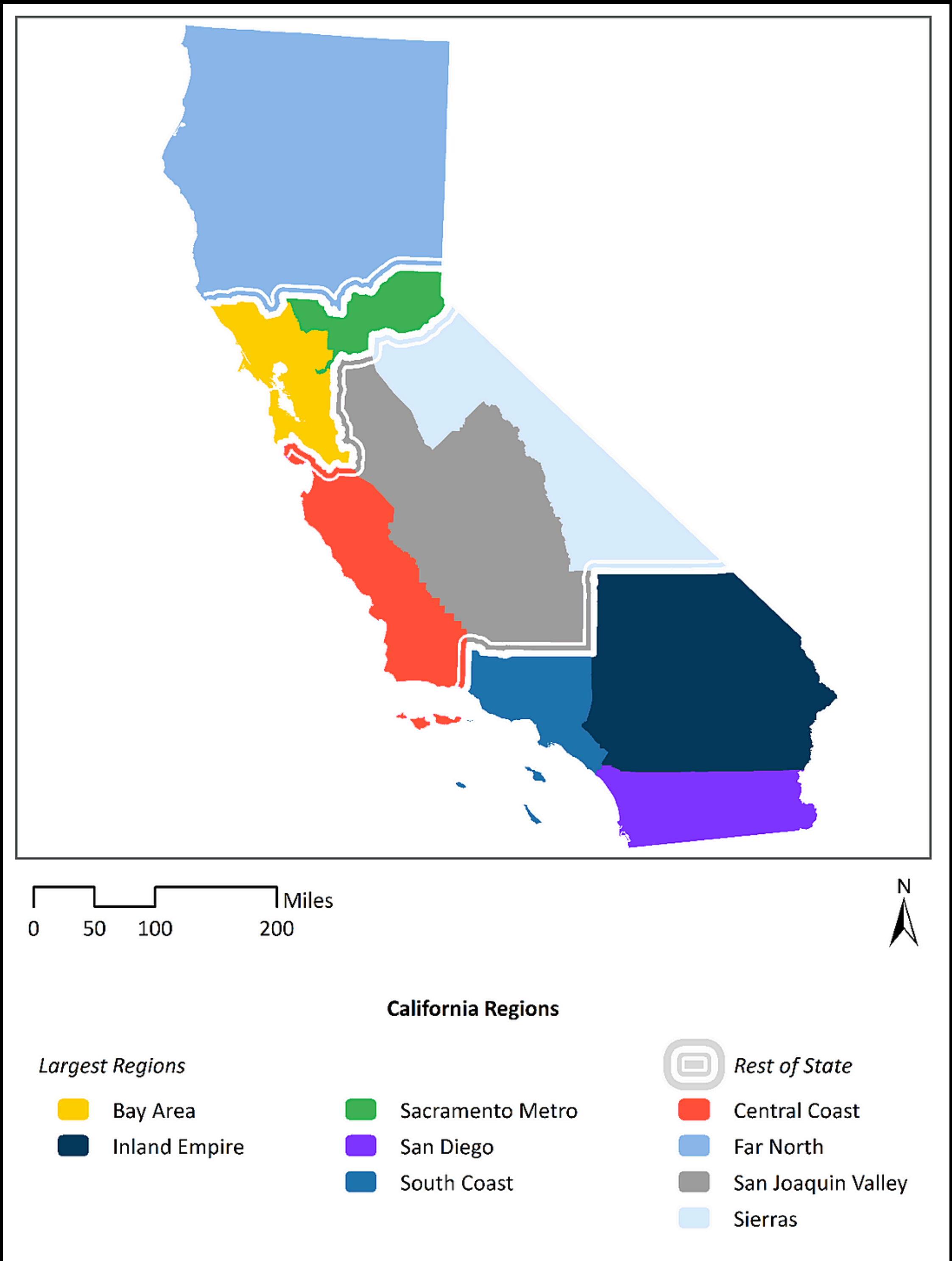
LOOKING AHEAD

In short, there is no "one size fits all" transportation answer for the many diverse, different parts of our immense state. But while driving remains the mode of choice for most Californians, it is generally recognized that our decades-long focus on planning for automobility must give way to a more diversified transport portfolio; one that gives people the accessibility they need, but in a more equitable and environmentally sustainable way.

This report begins with a Facts section that presents data on travel and transportation systems in California today. We then, in the Origins section, consider the decades of public and private land development and transportation systems that have shaped the current state of play. Finally, in the Trends section, we present information that points to possible transportation futures for the state. Given its extraordinary diversity, we aim to break down the data we present to help differentiate regions, travelers, and their trips. For example, we divide the state into nine primary regions, following Public Policy Institute of California (Johnson 2002) and the California 100 Initiative's definitions, as shown in Figure 1 below (For certain analyses, due to sample size or dataset organization limitations, we group together the four smallest regions.).[1]

[1] Due to the geographic classifications of the dataset, in analyses using the National Household Travel Survey, the Bay Area region includes San Benito County and excludes Napa, Solano, and Sonoma Counties; the San Diego region excludes Imperial County; and the South Coast region excludes Ventura County.

Figure 1 **California Regions**



DATA SOURCE: California Open Data 2019, "CaliDetail" n.d.; Johnson 2002

FACTS

OVERVIEW OF TRAVEL IN CALIFORNIA

California was long defined by its population growth and the travel that comes with it. For most of the past century, the U.S.' population grew substantially, but California's population grew even more. Likewise, personal and commercial travel by cars and trucks outpaced population growth for most of the 20th century, both across the U.S. and in California. But in the 21st century, those trends have begun to shift.

Between 2009 and 2017, the state's population increased by five percent (compared to 6% nationally), but remarkably, the annual number of trips per Californian fell by 15 percent (See Table 1). However, while *personal* trips per capita have been falling, overall vehicle miles of travel nonetheless grew by six percent between 2009 and 2017, as *commercial* travel grew more than personal travel during this period. Total vehicle person-trips decreased by five percent in California, and personal vehicle miles traveled (VMT) fell by nine percent (FHWA 2009, 2011, 2017, 2020; Ruggles et al. 2021b). In sum, individual Californians and California households are taking fewer trips overall, though their reduced vehicle travel for personal trips is more than offset by increases in commercial travel, including small package deliveries that are replacing household shopping trips (discussed further below).

Despite its automobile-centric reputation, the Golden State is not so different from the rest of the nation in its car ownership. Californians own about 11 percent of all U.S. vehicles while making up 11.5 percent of the nation's population. Californians drive less than the average U.S. resident, accounting for just 8.7 percent of all vehicle travel. All told, Californians today own more cars—25 million—but drive them fewer miles per person than in years past (FHWA 2009, 2017; Ruggles et al. 2021b).

Table 1 Summary of U.S. and California Demographic and Personal Travel Statistics

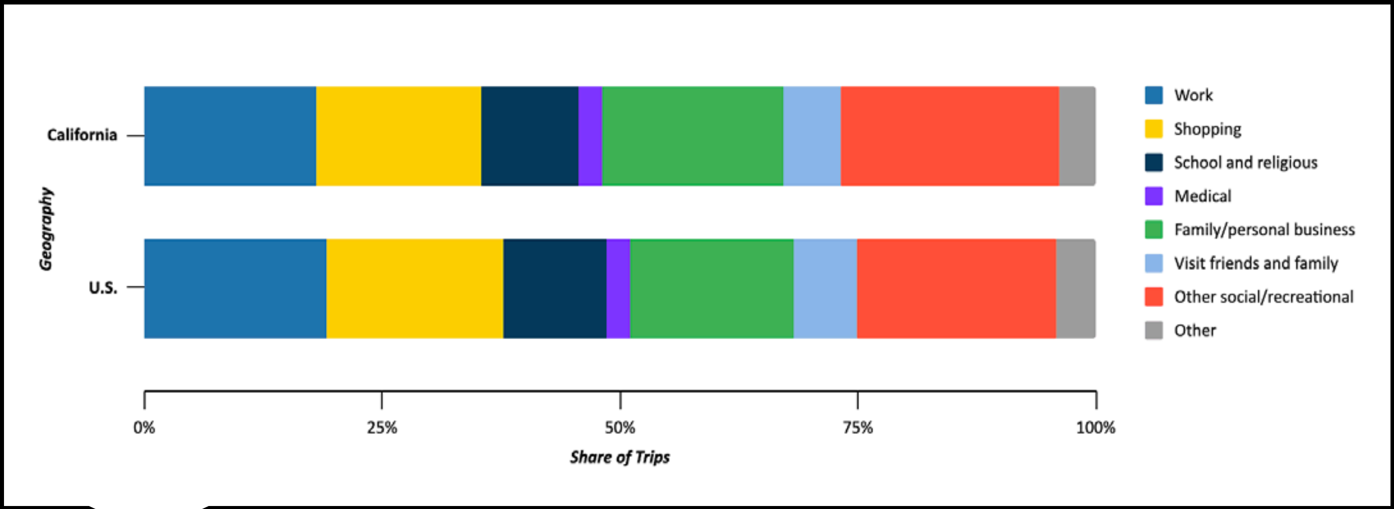
		California			U.S.		
		2009	2017	Change	2009	2017	Change
Population		37 mil.	39 mil.	+5.4%	307 mil	325 mil	+5.9%
Personal	Total annual person-trips	47 bil.	44 bil.	-6.4%	392 bil.	371 bil.	-5.4%
Personal	Annual trips per person	1,382	1,182	-14.5%	1,385	1,228	-11.3%
Personal	Total annual personal vehicle trips	38 bil.	36 bil.	-5.3%	327 bil.	306 bil.	-6.4%
Personal	Annual vehicle trips per person	1,118	973	-13.0%	1,065	942	-11.5%
Personal	Total annual personal VMT	203 bil.	184 bil.	-9.3%	2.245 tril.	2.105 tril.	-6.2%
Personal and Commercial	Total annual VMT	325 bil.	344 bil.	+6.0%	2.976 tril.	3.225 tril.	+8.4%

DATA SOURCES: FHWA 2009, 2011, 2017, 2020; Ruggles et al. 2021b

WHY CALIFORNIANS TRAVEL

Californians travel for all sorts of reasons. While commutes to work are often the center of transportation analyses and we have the best data on these trips (Wasserman and Taylor 2021), household-serving travel—shopping and family/personal business travel—are the most common trip purposes both in the state and nationally (See Figure 2). Indeed, trips to and from work make up fewer than one in five (18%) of all trip-taking in California (FHWA 2017).

Figure 2 Trip Purposes, 2017

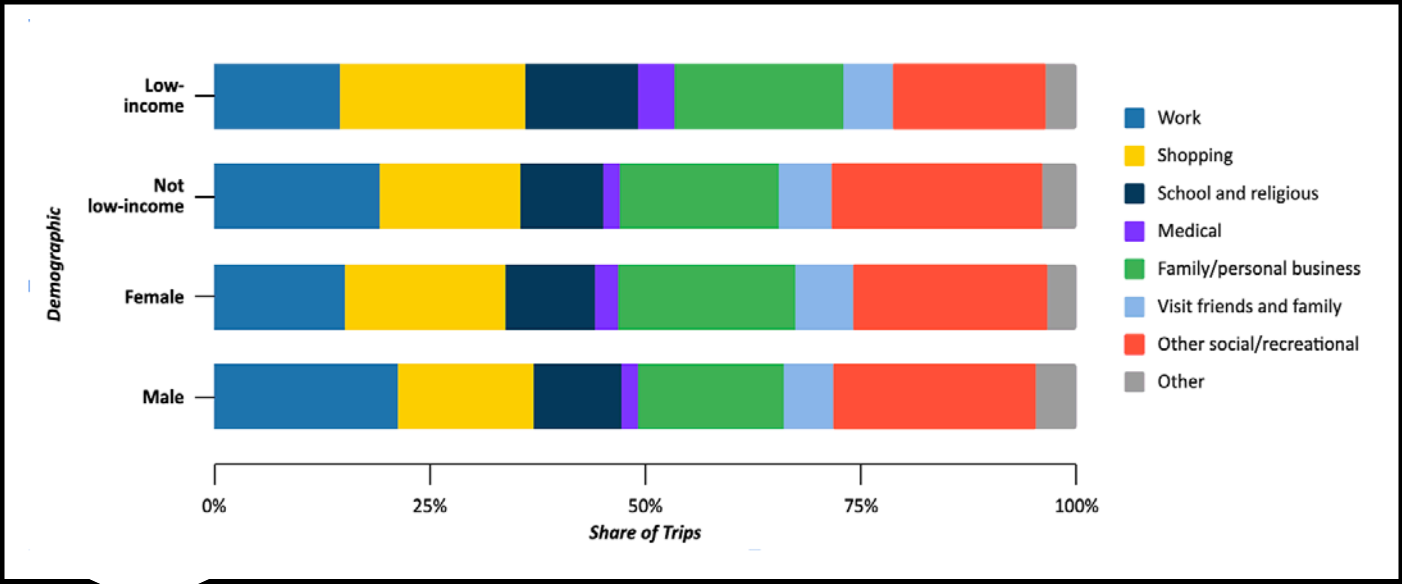


DATA SOURCE: FHWA 2017

By and large, the reasons for trip-taking in California, like the U.S. overall, vary little across racial and ethnic lines. Black Californians tend to take a slightly lower proportion of their trips to and from work and a slightly higher percentage of shopping trips, while white Californians are less likely to travel for family and personal reasons, or to school or religious locations. But again, these differences are relatively minor. Gender differences in travel are somewhat more pronounced, largely because women tend to make more child- and household-serving trips (B. Taylor, Ralph, and Smart 2015) (See Figure 3). Men take more trips to and from work than women, who take slightly more trips for all other purposes, especially for medical care, shopping, and family and personal business. Nineteen percent of women's trips are for shopping, compared with 16 percent for men. Finally, members of low-income households 2 make higher shares of shopping, medical, and school and religious trips, while those in higher income households tend to make more trips for work, and other social purposes (See Figure 3) (FHWA 2017).

[2] We define "low-income" to best match the 2017 federal poverty line, within the limitations of the categories of our datasets: one- to two-person households earning less than $15,000 per year, three- to four-person households earning between $15,000 and $24,999, and households with five people or more earning between $25,000 and $34,999.

Figure 3 **Trip Purposes in California by Income and Gender, 2017**



DATA SOURCE: FHWA 2017

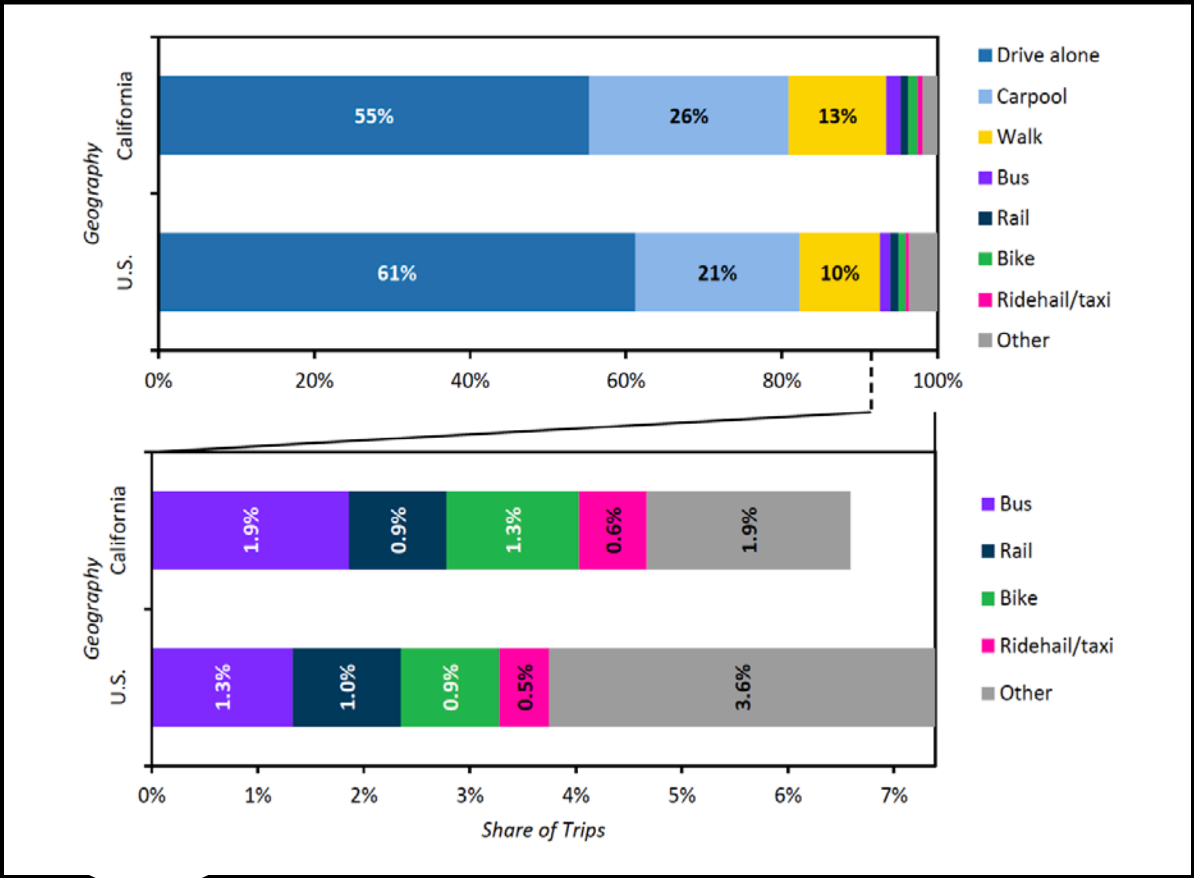
HOW CALIFORNIANS TRAVEL

Travel Modes

For any purpose, most Californians make the overwhelming majority of their trips by car. Nationally and in the state, better than four in five person-trips are by automobile, and well over half by driving alone (See Figure 4). However, Californians do walk (13% to 10%) and ride transit (3% to 2%) more than the average American. Perhaps surprisingly, walking is—by far—the second most common means of travel after driving. Walking trips (for the whole way to a destination, as opposed to walking to one's car, walking to a transit stop, or going on a recreational walk) are four times greater than all trips by bus and rail (FHWA 2017).

Even as overall personal travel has been decreasing, the number of trips by transit, taxi, ridehail, and other modes have risen. Californians took 3.4 percent of trips on transit and for-hire (ridehail, taxi, and limousine) vehicles combined in 2017, the most recent year of data (See Figure 4). However, the number and share of carpool trips has been on a decline for decades (Polzin 2015), falling to 26 percent of all trips in California in 2017 (FHWA 2017).

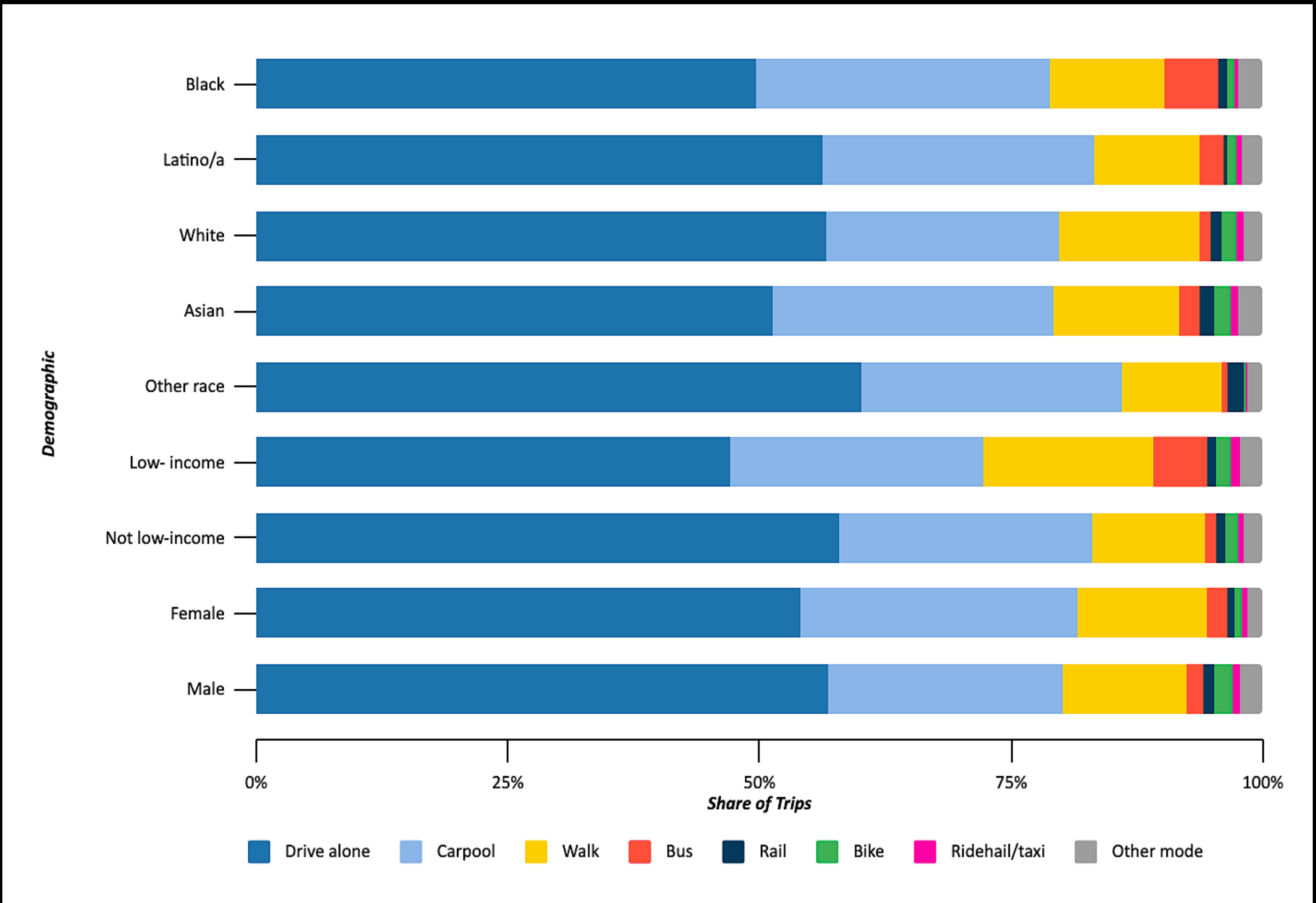
Figure 4 Travel Mode Share, 2017



DATA SOURCE: FHWA 2017

While non-automobile travel is relatively uncommon, non-white, female, and low-income Californians take a larger share of their trips by other modes (See Figure 5). For instance, Black Californians use buses at over twice the rate of other racial/ethnic groups and Asians use rail at slightly higher rates. Women tend to drive more often than men, perhaps because driving allows them to juggle more domestic responsibilities and because they may feel safer driving than using other travel modes (Blumenberg 2004; Loukaitou-Sideris 2014; B. Taylor et al. 2015). However, the starkest differences in travel are by income. Purchasing, insuring, maintaining, and fueling vehicles is expensive (costs discussed further in the Origins section), as are trips by ridehail or taxi. Given this, low-income Californians drive much less, on average, than those with higher incomes (Blumenberg 2017); instead, they walk and ride transit more. Nevertheless, even low-income Californians still make the overwhelming share of their trips by car (72%, compared to 83% for higher-income travelers) (FHWA 2017).

Figure 5 **Travel Mode Share in California by Race/Ethnicity, Income, and Gender, 2017**



DATA SOURCE: FHWA 2017

Travel Time and Distance

Part of the reason so many Californians drive for so many trips is that driving is typically the quickest way to get around, particularly when public policies ensure that plenty of free parking will be available at the destination. The average California bus trip takes 2.4 times longer in time than the average car trip, even though bus trips are over a quarter shorter in distance (though rail trips are longer). Walking and biking trips, meanwhile, take less time than driving, but cover far shorter distances, on average (See Table 2) (FHWA 2017).

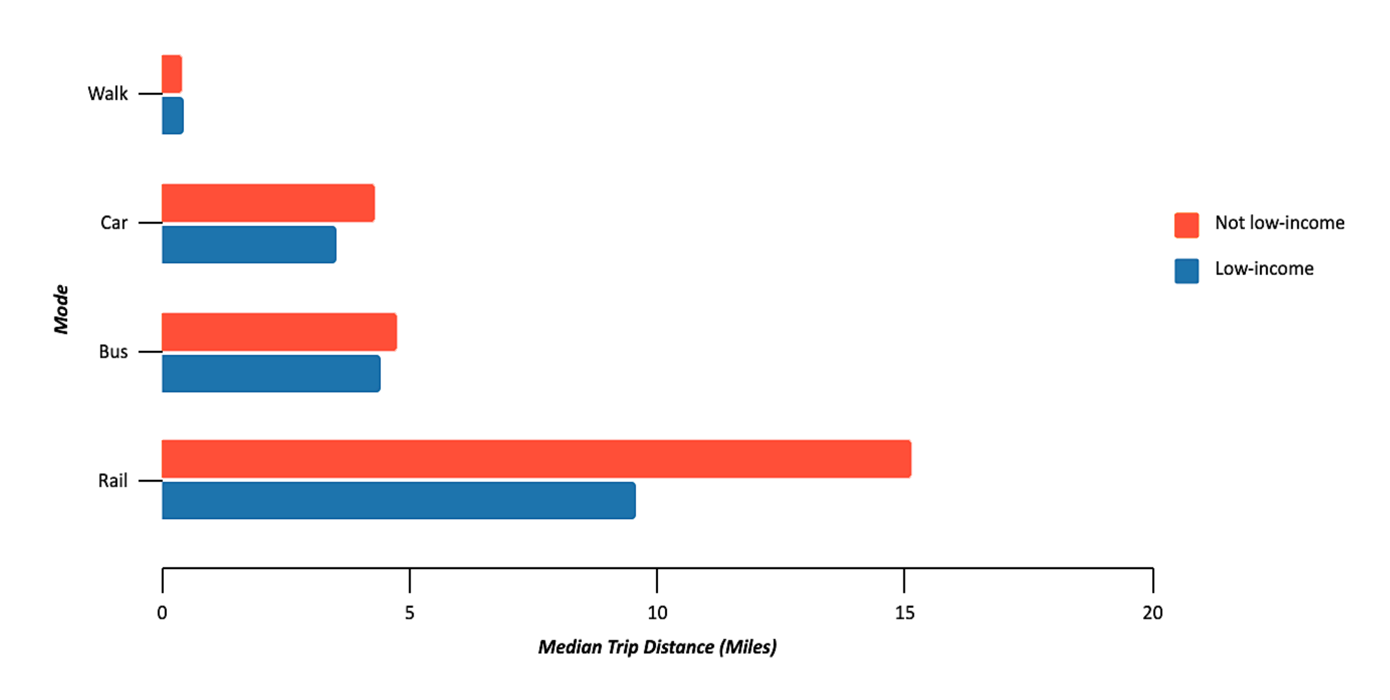
Table 2 **Average Trip Statistics by Mode in California, 2017**

	Drive	Walk	Bus	Rail
Time	22.3 min.	16.9 min.	53.7 min.	68.7 min.
Distance	10.6 mi.	0.7 mi.	7.7 mi.	19.7 mi.
Speed	28.5 mph	2.5 mph	8.6 mph	17.2 mph

DATA SOURCE: FHWA 2017

Overall, Californians tend to spend more time on each trip than the national average, despite comparable travel distances by mode. Most trips in California (62%), though, do take less than 20 minutes. The median car trip is just over 4 miles, and the median walk just under half a mile. Within California, travel time and distance differences across demographic groups are generally small. Broadly, though, low-income travelers take shorter trips by slower modes (FHWA 2017), in part as a function of geography as low-income people tend to live in denser, more congested areas better served by public transit (Glaeser, Kahn, and Rappaport 2008). The median distance for a car trip for a low-income traveler is 3.5 miles compared to 4.3 miles for someone more affluent. Bus and particularly rail trips by low-income travelers are also shorter. On the other hand, walk trips tend to be a bit longer as well as taking up more time: the average time a low-income traveler spends walking is 19 minutes compared to 16 for someone who is not low-income (See Figure 6) (FHWA 2017).

Figure 6 **Trip Distance by Mode and Income in California, 2017**



DATA SOURCE: FHWA 2017

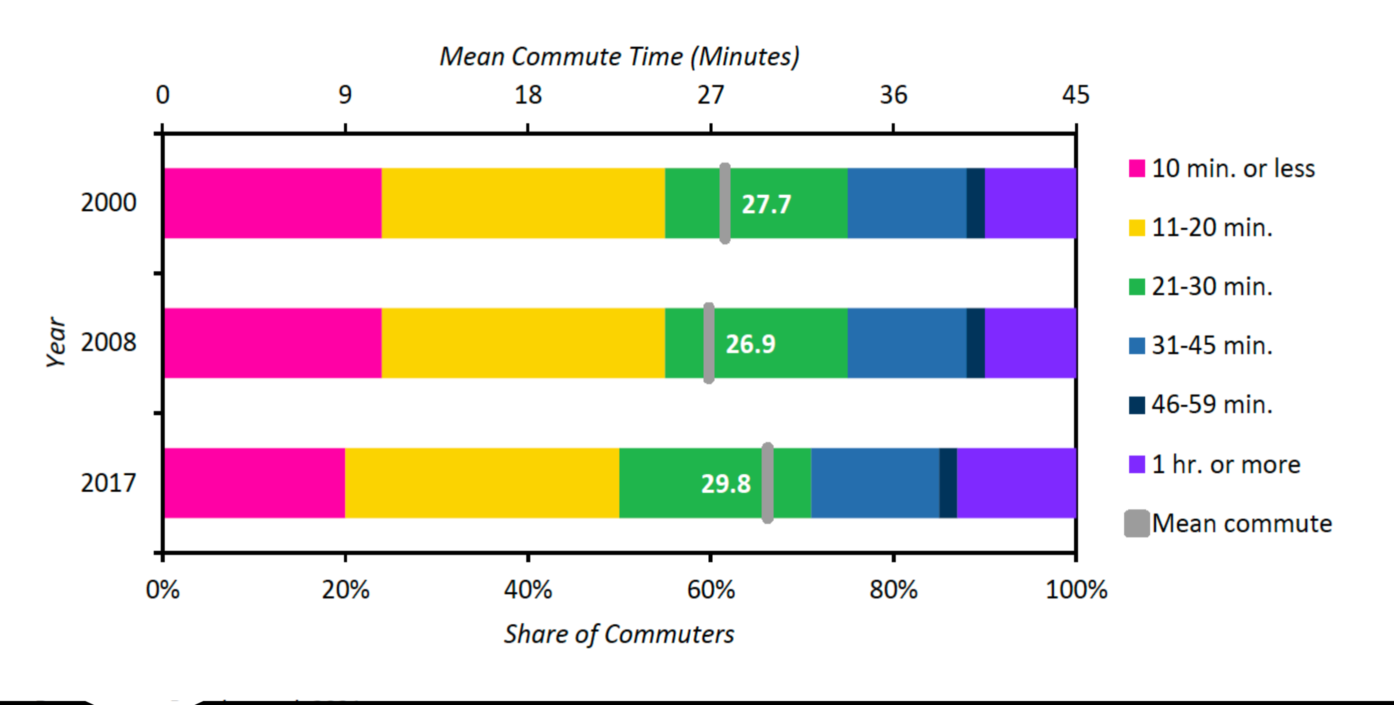
HOW CALIFORNIANS COMMUTE

Commuting, or the journey-to-work, is often regarded as the bane of travel. While it accounts for a relatively low share (18%) of Californians' trips, commuting has an outsized influence on traffic congestion, as trips to work are (or at least were, prior to the pandemic) concentrated at peak periods and in peak directions. And across the state's regions and demographic groups, commutes have lengthened, as people have moved farther away from their jobs (discussed further in the Trends section) and become more auto-dependent (Ruggles et al. 2021a).

Commute Times

Over the past two decades, the average one-way commute travel time rose from 28 minutes to 30 minutes. Though this increase may seem slight, the share of Californians traveling ten minutes or less to work also fell from 24 percent in 2000 to 20 percent in 2017, and commuting one hour or more rose from 10 percent to 13 percent. While the "mega-commute" phenomenon of trips to work of 90 minutes or more is more of an outlier than popular accounts suggest, commutes are nonetheless growing, due primarily to increasing distances, increasing congestion, or some combination of the two (See Figure 7) (Ruggles et al. 2021a).

Figure 7 **Travel Time to Work in California**



DATA SOURCE: Ruggles et al. 2021a

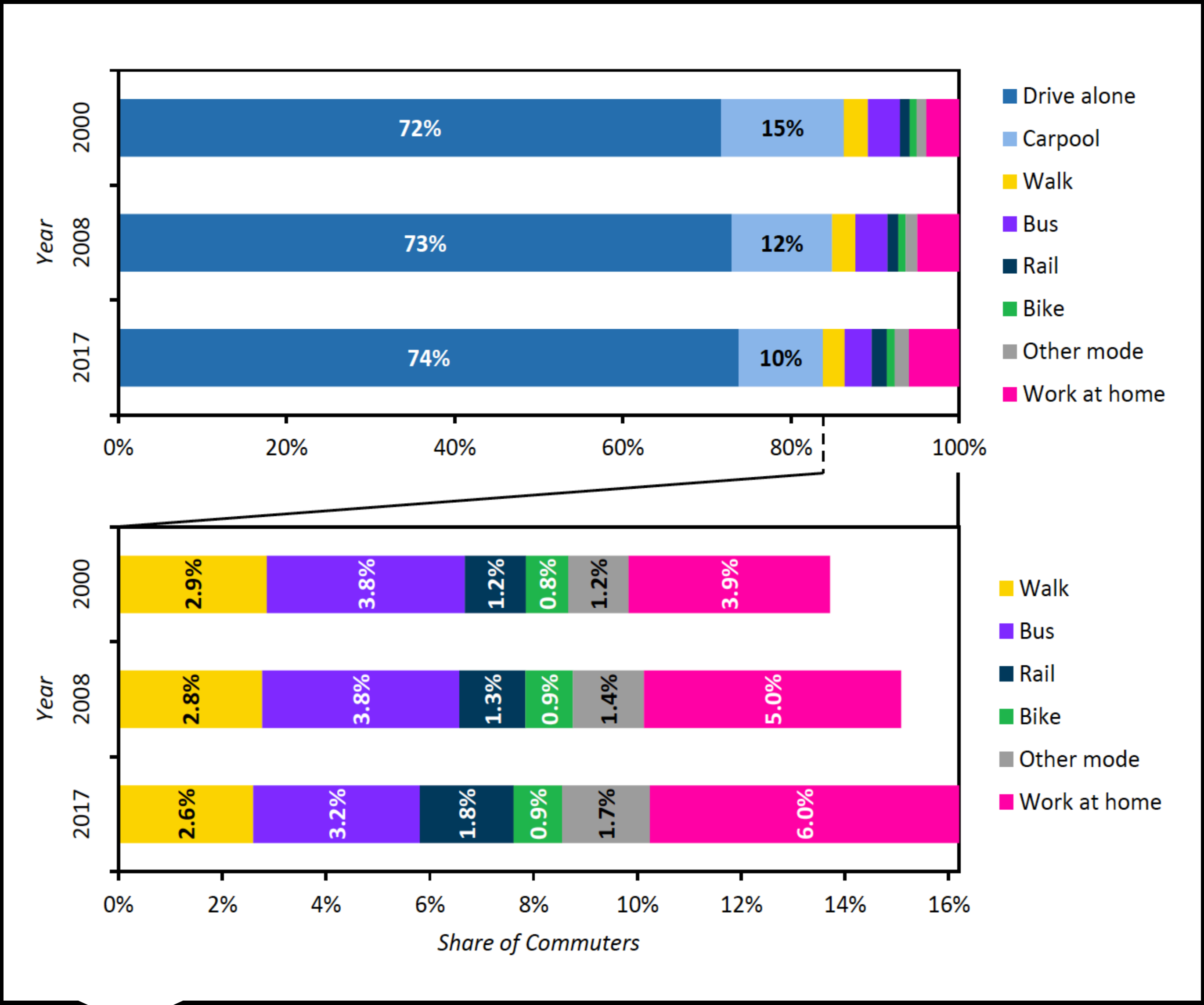
Black Californians continue to endure the longest commutes (33 min.), due substantially to their higher reliance on relatively slow public transit. Only 16 percent of Black Californians commute 10 minutes or less compared to 22 percent of white Californians. Furthermore, 16 percent of Black Californians commute for one hour or more compared to only 12 percent of white Californians. Meanwhile, Californians living in poverty have shorter commutes than their wealthier peers (28 vs. 30 min.). Interestingly, the share of people commuting one hour or longer to work is similar regardless of poverty status. Finally, men had longer duration commutes than women in California, on average. Across socioeconomic categories, commute times have risen since 2000 (See Appendix, Figure A-1) (Ruggles et al. 2021a).

The greatest disparities in commuting times in California are by mode and vehicle access (See Appendix, Figure A-2). Californians without a car in their household have longer average commutes and are far less likely to have very short trips to work (16% with commutes of 10 min. or less). Even starker, Californians who drive alone to work have commutes 41 percent shorter than bus-riders and half as long as rail-riders. Those who can walk to work usually have shorter commutes (Ruggles et al. 2021a).

Commute Modes

These travel-time comparisons highlight a major reason that most Californians drive alone to work—somewhat increasingly so this century (72% in 2000 versus 74% in 2017) (See Figure 8). Mirroring trends in all trips, Californians have decreased their reliance on carpooling to work as well (15% in 2000 versus 10% in 2017). The share of people who work from home prior to the pandemic increased modestly (4% in 2000 versus 6% in 2017) (Ruggles et al. 2021a), with the long-term effect of the pandemic on working from home yet to be determined.

Figure 8 Commute Mode in California

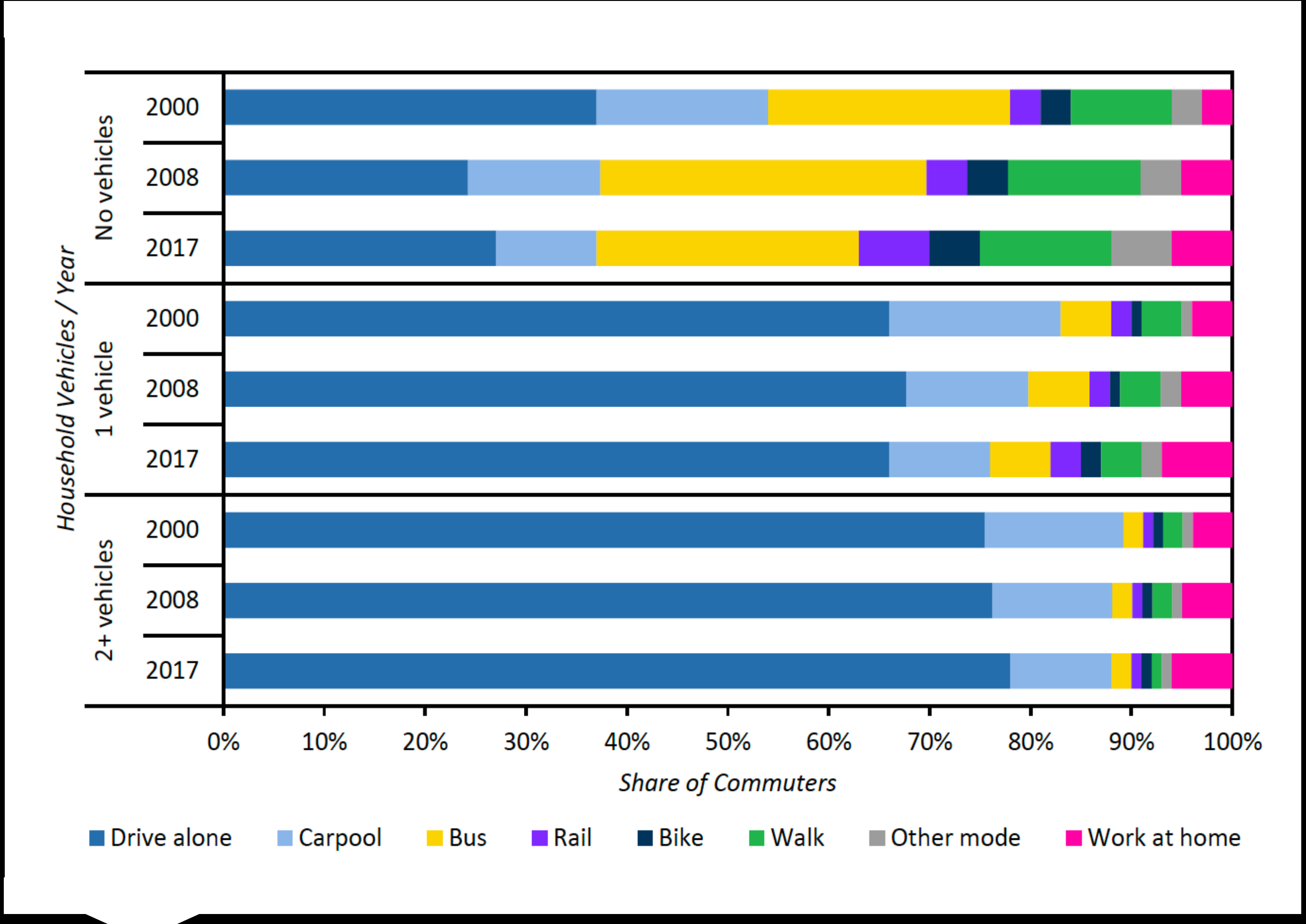


DATA SOURCE: Ruggles et al. 2021a

As with trends for all travel, commuting patterns vary by race, ethnicity, wealth, and gender (See Appendix, Figure A-3). Unlike other racial/ethnic groups, white Californians became less likely to drive alone to work (from 77% in 2000 to 75% in 2017) and more likely to work from home (5% to 9%) pre-pandemic. Californians in poverty consistently use the bus, walk, and carpool at slightly higher rates than wealthier commuters, while women were more likely than men to work from home before the pandemic (Ruggles et al. 2021a).

Perhaps the fact that best underlines the dominance of driving in California is that 27 percent of Californians with no household vehicles nonetheless drive alone to work (by borrowing cars from non-family members, non-household relatives, etc.)—though this rate has fallen since 2000. About two-thirds of those in one-vehicle households drive alone to work and about three-quarters of those with two or more household vehicles do so. Rates of bus commuting rose in 2008 for people who lacked vehicle access, before falling back by 2017 to 26 percent (See Figure 9) (Ruggles et al. 2021a).

Figure 9 **Commute Mode in California by Vehicle Access**

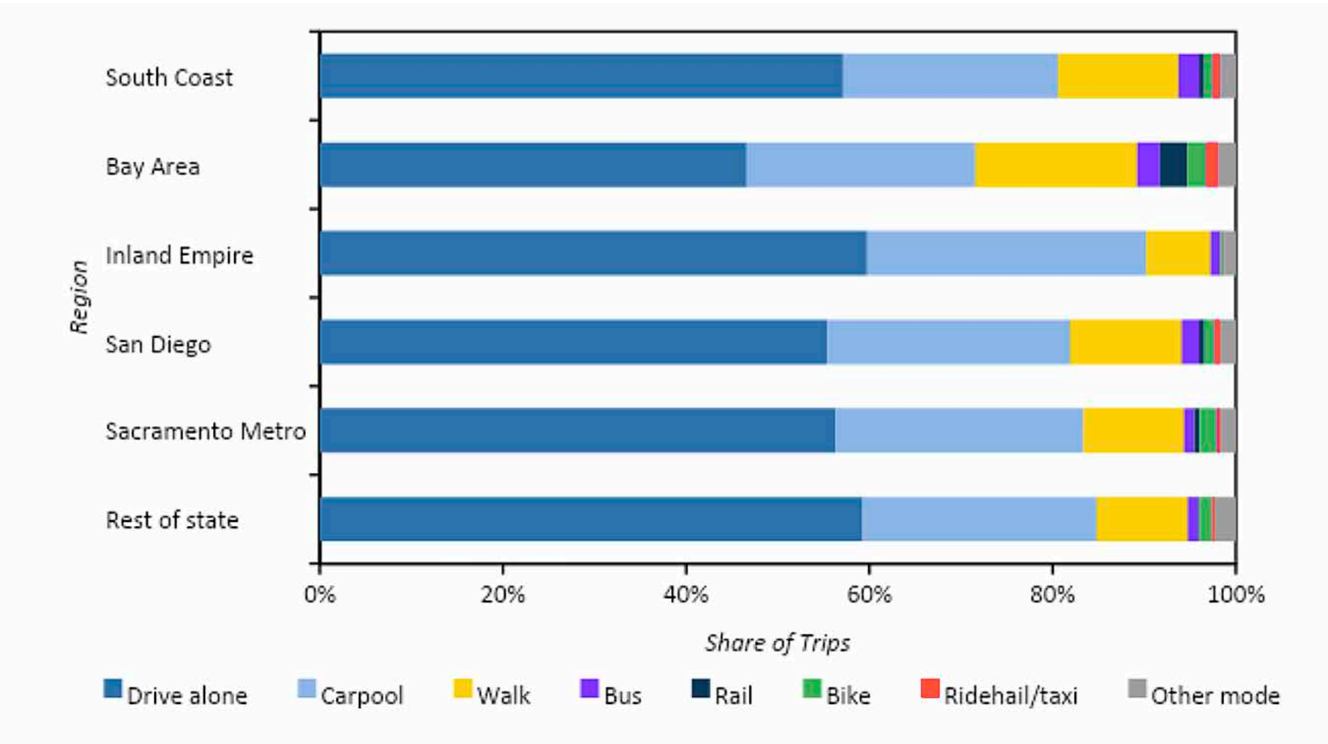


DATA SOURCE: Ruggles et al. 2021a

REGIONAL TRAVEL DIFFERENCES ACROSS CALIFORNIA

Across the state, how Californians travel varies widely (See Figure 10). In general, in the more urbanized parts of the state, travelers tend to drive less. With a more transit-friendly and walkable structure and built environment, particularly in the central cities of San Francisco, Oakland, and Berkeley, the Bay Area hosts by far the highest levels of walking (19%) and public transit use (6%) and lowest levels of automobile use (70%) in the state. At the other end of the spectrum, the Inland Empire is the state's most auto-oriented region; nine in ten trips are by car, which is higher even than in non-metropolitan California (FHWA 2017).

Figure 10 **Travel Mode Share in California by Region, 2017**



DATA SOURCE: FHWA 2017

In parts of the state where people drive for a greater share of trips, they also travel further distances and for longer times; even their non-driving trips are further and longer. Average automobile travel distances for non-work trips are longest in the Inland Empire and South Coast regions in metropolitan Los Angeles, while residents of the Inland Empire and outside the major metropolitan areas tend to spend the most time per transit trip. As we discuss below, this points to the importance of land use: a car-oriented landscape spreads destinations further apart, to the point that driving is often the only reasonable option. In these more car-oriented regions, people even take fewer social trips: whereas approximately a quarter of trips in the Bay Area and South Coast are for social purposes, only 21 percent of trips in Riverside and 20 percent of trips outside of major urban regions are for social purposes. At the same time, automobiles offer far more mobility than other modes. A resident of the Inland Empire spends far less time making a short trip by car (6.5 min.) than a driver in Los Angeles (8.7 min.) (FHWA 2017).

Commute travel patterns likewise differ across the state (See Appendix, Figure A-4). They do, though, mostly share a trend towards greater automobility: over the past 20 years, most parts of California saw increased rates of solo driving to work. The Inland Empire had the highest increase, while the Bay Area proved the exception, with a four-percent-point decrease in driving alone to work. The South Coast has the second-highest rates of commuting by bus, yet it experienced a drop since 2000 (Ruggles et al. 2021a), part of the larger decline in Southern California transit ridership described below.

Despite the difference in land use and modes of transportation to work, the Inland Empire and the Bay Area both have the longest duration commutes, with an average of about 32 minutes. The Bay Area has the lowest share of people with commutes of less than 10 minutes (17%) (Ruggles et al. 2021a). This last figure may seem counterintuitive, as the Bay Area is home to some of the state's densest and most transit-friendly areas, but recall that transit trips (because of the extra walking, waiting, transferring, and multiple stops en route) tend to be much slower than driving.

Overall, Californians are highly dependent on automobile use across all regions. Yet people in sprawling, auto-friendly environments, like the Inland Empire, tend to drive the most, while people in denser, transit- and pedestrian-friendly environments, like the Bay Area, tend to use transit or active transportation at higher levels than the rest of the state.

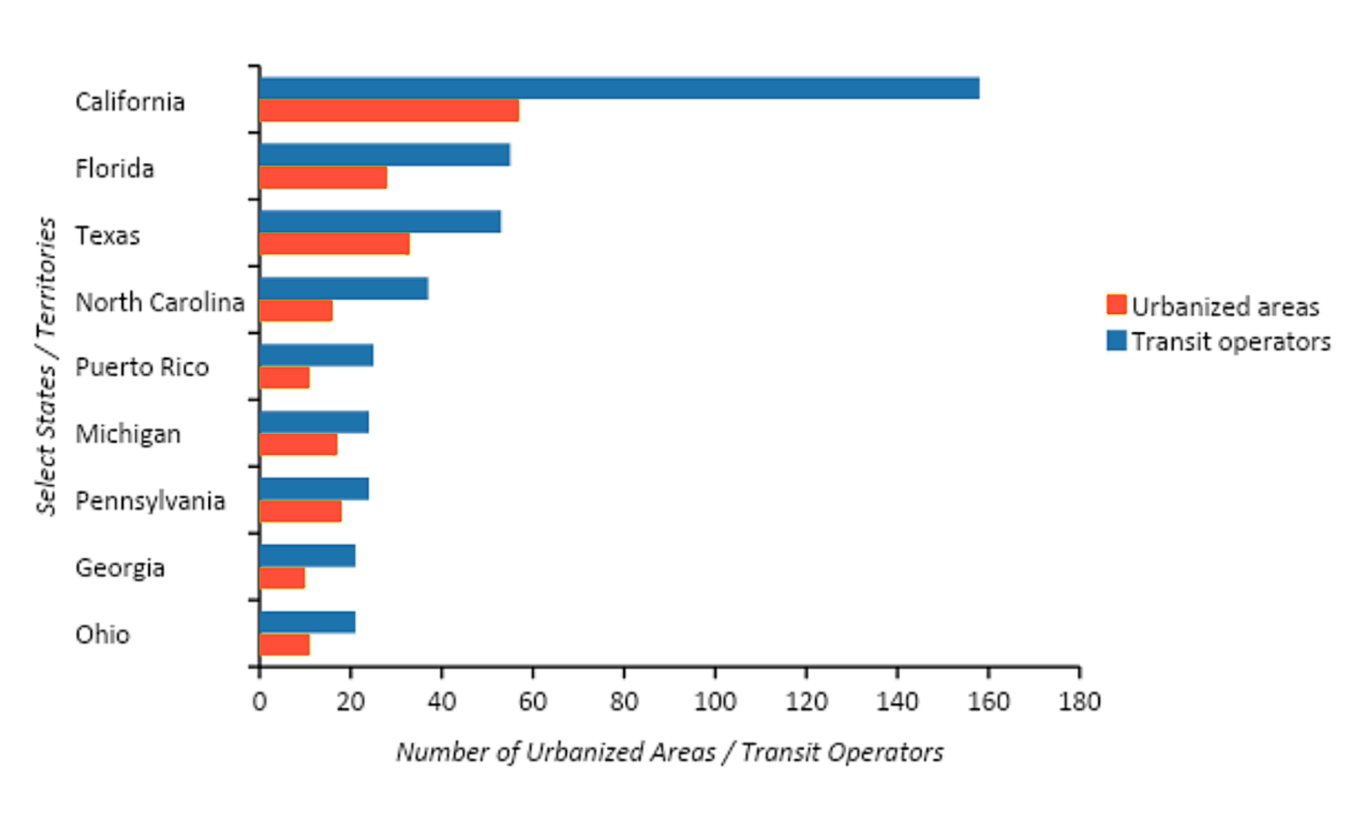
THE TRANSIT PICTURE IN CALIFORNIA

Though it is a relatively uncommon mode of transportation, public transit in California is a particular focus of the state's transportation policy and spending and a key element of state plans to reduce greenhouse gas emissions (each of which we discuss below). It is thus particularly worrisome that transit ridership declined in the second half of the 2010s across the state, though with somewhat different contours and causes in the state's different regions (Taylor et al. 2020).

Transit ridership declines are not unique to California. Across the nation, while transit service continued to increase, ridership began falling consistently in 2014 nationally (Taylor et al. 2020). Research has shown that factors external to the transit industry, such as population density, household income, employment, immigration, increased access to private automobiles, and increased use of ridehailing (like Lyft and Uber) all likely had depressing effects on transit demand (Blumenberg 2009; Manville, Taylor, and Blumenberg 2018; Taylor et al. 2009; Taylor and Fink 2013).

Yet in other ways, California's transit landscape is distinctive, matching its varied geography. Whereas many states have a single large transit system serving a given metropolitan area, along with many rural transit providers, California—with its numerous cities and regions—has many large metropolitan systems in addition to a multitude of transit services in rural areas. Moreover, even accounting for its high number of urbanized areas, California has an unusually large, splintered number of public transit providers; Florida, which shares in California's multicentricity and has the second-most transit operators, still has fewer than half as many transit agencies (See Figure 11). At the same time, the share of operating funds that transit operators receive from the state is relatively low in California: only 14 percent on average (Gahbauer et al. 2019). Instead, most transit operating subsidies in California come from local, regional (such as local option sales taxes, discussed below), and federal sources.

Figure 11 California's Splintered Transit Landscape



DATA SOURCE: Gahbauer et al. 2019

Transit Blues in the Golden State

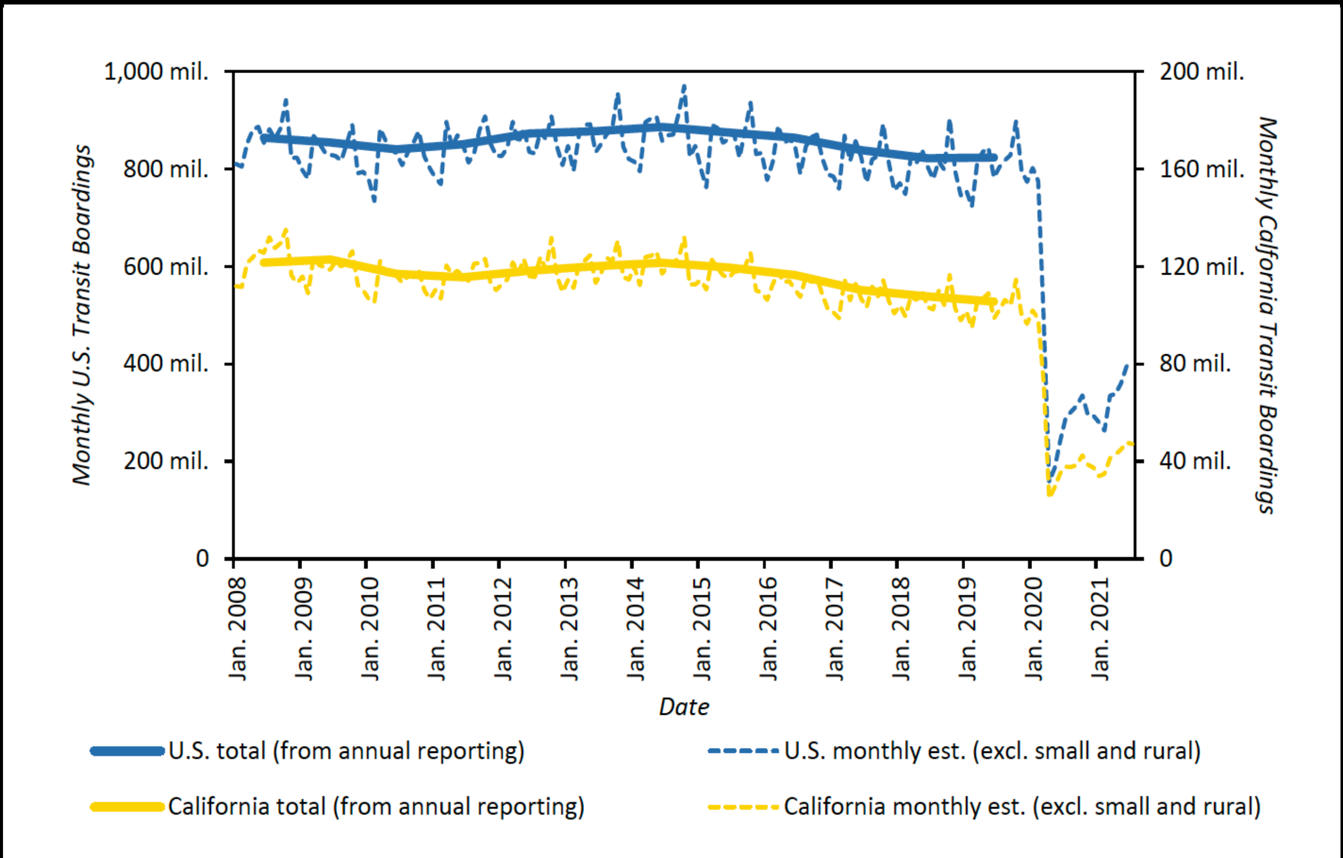
Most California transit systems lost riders after the end of the Great Recession through 2019, before hemorrhaging riders in 2020 amidst the COVID-19 pandemic. Though transit ridership in California grew through much of the last decade of the last century and the first decade of this one, it faltered during the Great Recession and, across a number of metrics, never fully recovered (Taylor et al. 2020; FTA 2021).

Before the 2010s, transit ridership in California had been increasing at a modest clip. From 1995 to 2009, patronage across the state increased every year but two. However, accounting for population growth, these gains were both more modest and more uneven. Nonetheless, California maintained higher per capita ridership than the U.S. as a whole (Taylor et al. 2020; FTA 2021).

Both absolute and per capita ridership peaked just prior to the start of the Great Recession. During the Recession, transit use fell across the U.S. and in California, before recovering some in 2011, and even reached substantial recovery by 2014 (Taylor et al. 2020; FTA 2021).

In many ways, the 2010s should have been boom times for public transit. The economy was mostly growing, public support for transit was considerable (Manville and Levine 2018), and public investments in transit were expanding. Driven by increases in both capital and operating budgets, especially for rail, inflation-adjusted transit subsidies per capita in the U.S. were at an all-time high in the late 2010s. Despite these reasons for optimism, public transit use nationwide and in California fell each year since 2014 (See Figure 12). Overall, California lost over 191 million annual boardings between 2014 and 2019—a drop of 15 percent. This was worse than the nation as a whole, where transit trips fell by just over 7.5 percent [3] (Taylor et al. 2020; FTA 2021). As a

Figure 12 **Monthly Transit Ridership**



DATA SOURCE: FTA 2021

result, transit performance has also fallen. Prior to the COVID-19 pandemic, boardings per vehicle revenue hour were down 21 percent, costs per hour (adjusted for inflation) were up 32 percent, and subsidies per boarding had grown a whopping 78 percent (Taylor et al. 2020).

These losses, of course, pale in comparison to those of 2020 (See Figure 12). Due to the pandemic, transit ridership in California and indeed around the globe plunged staggeringly. Monthly boardings statewide dropped drastically in the first several months of the pandemic, from 102 million in January 2020 to about a quarter of that in April. Typically, when transit use experiences a sudden decline in patronage, for instance from a labor action, or extensive service reductions due to repair operations, it takes a while to rebound (Giuliano and Golob 1998). Since April 2020, ridership has increased modestly and reached 47 million monthly boardings in July 2021, which is still less than half of pre-pandemic levels. The long-term impact of COVID-19 (and the emergent Delta variant) on transit use is hard to predict, especially if many continue to work from home and the public remains leery of confined crowded spaces (Dai et al. 2021; FTA 2021).

Modal, Regional, and Demographic Trends

Both before and during the pandemic, bus boardings made up the largest share of all transit trips. However, bus ridership has been generally falling since 2009 and consistently and steeply since 2014, accounting for most of the state's ridership losses. Rail patronage, on the other hand, grew significantly through 2014, after which urban rail also declined. The small number of commuter rail trips continued to grow until the onset of the pandemic. These trends have reversed in the recovery from the pandemic: by July 2021, bus ridership returned to a little over half of pre-pandemic levels, urban rail to around 30 percent, and commuter rail only to 20 percent (See Figure 13) (Taylor et al. 2020; FTA 2021).

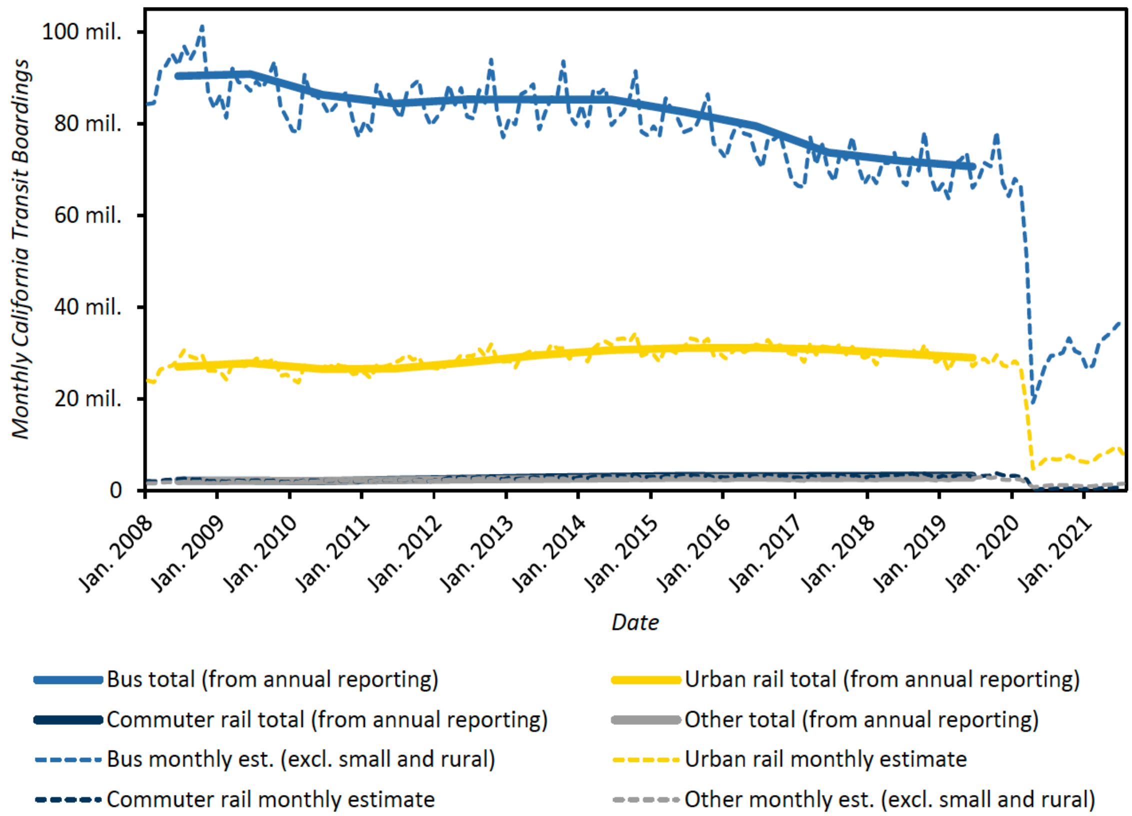
Most regions in the state lost transit riders over the past decade, except for the two mostly rural regions, the Sierras and the Far North, where per capita ridership remains the lowest among all regions. The South Coast became the epicenter of this decline in the later half of the 2010s, along with the Inland Empire and Sacramento Metro regions. Pre-pandemic, the South Coast did have the highest per capita ridership among all regions, despite Los Angeles's reputation for car dependence. [4] However, the region's ridership collapsed in the years leading up to the

[3] Following Wasserman and Taylor (2021), we reference annual NTD data by calendar year in graphs and text, though technically the data are the aggregate of each operator's fiscal year (whose start and end dates vary among operators).

[4] This is likely because the South Coast has the densest counties in Southern California, whereas the Inland Empire—which is part of the same metropolitan planning organization and is often included as part of the same region in analyses—is much less dense and transit use much less there (Taylor et al. 2020; Wasserman and Taylor forthcoming).

Figure 13

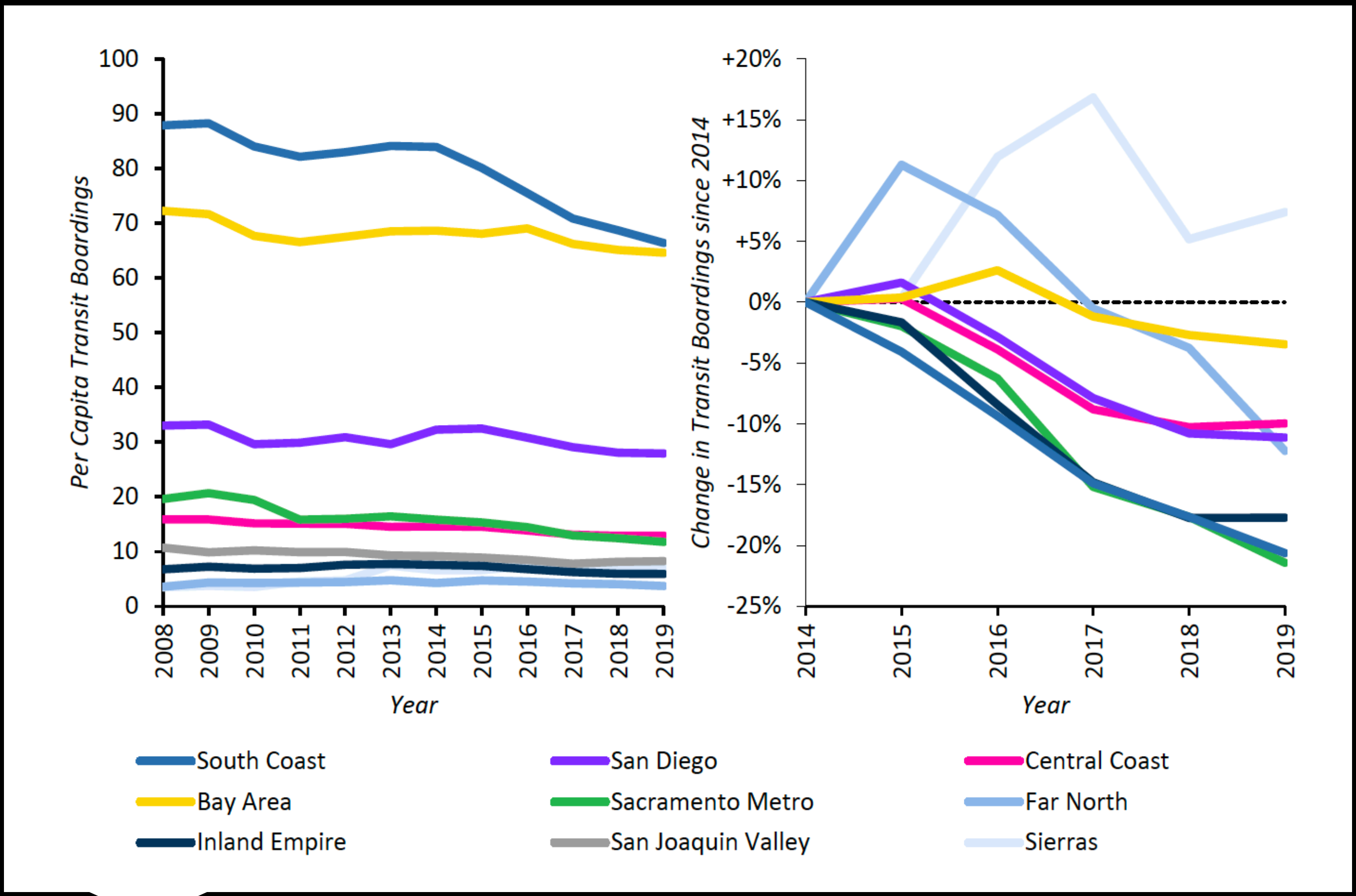
Transit Ridership in California by Mode



DATA SOURCE: FTA 2021

pandemic, from 1.18 billion annual boardings in 2014 to 933 million in 2019, a drop of 20 percent. Per-capita trips there were in decline for even longer, falling most years since 2009 (See Figure 14). The majority of California's ridership losses since 2014 have occurred in the South Coast, primarily from staggering declines on the Los Angeles County Metropolitan Transportation Authority (LA Metro), California's largest transit operator. Despite the opening of new rail services, LA Metro's ridership losses from 2014 to 2018 accounted for 11 percent of the entire transit ridership decline *nationwide*, the second-most of any American transit agency by absolute numbers. For perspective, just 21 routes in the South Coast—20 LA Metro lines and one Orange County Transportation Authority line—accounted for a quarter of the entire state's ridership losses from 2015 to 2018, despite carrying only 14 percent of the state's trips in 2015. Almost one in nine lost trips in California came from five LA Metro routes alone, and lines passing through *a* *single block* of downtown Los Angeles accounted for 11 percent of the state's losses over that period (Taylor et al. 2020; Manville et al. 2018; Wasserman and Taylor forthcoming; FTA 2021).

Figure 14 **Transit Ridership by California Region**



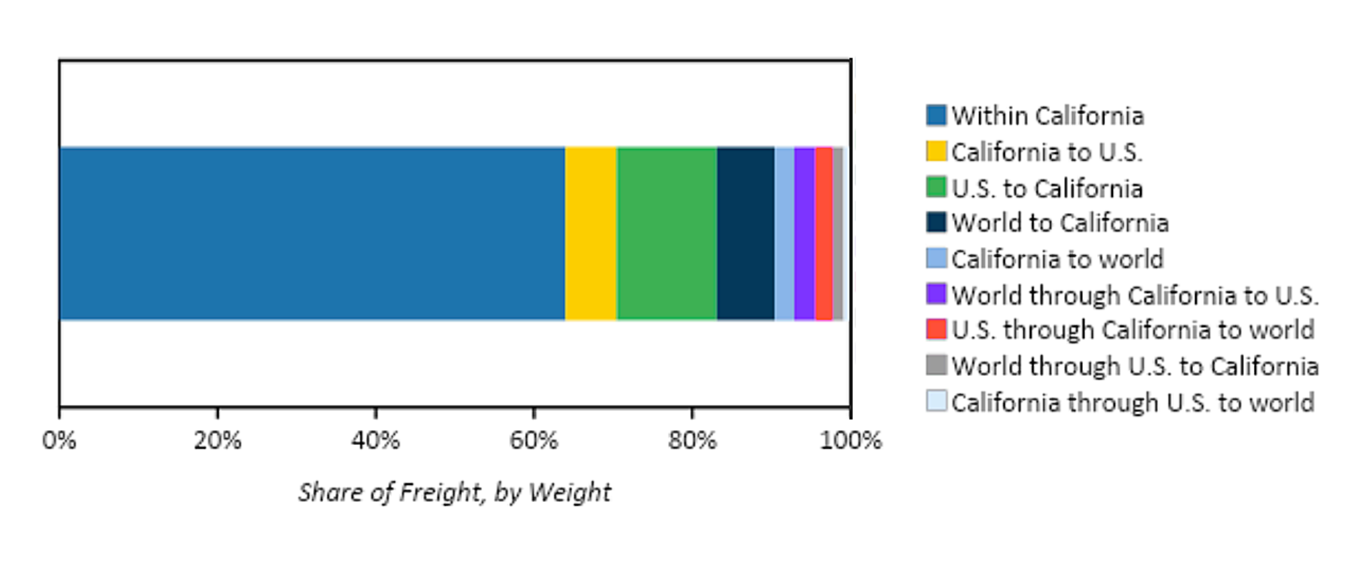
DATA SOURCE: FTA 2021

In contrast, transit ridership in the Bay Area and San Diego, where pre-pandemic per-capita ridership was the second and third highest in the state, held steadier (See Figure 14). Indeed, in the growth years of 2011 to 2015, just one operator, the Bay Area Rapid Transit District (BART) accounted for half of the state's net patronage gains, with BART trips crossing San Francisco Bay alone representing over 31 percent of the entire state's net ridership growth. Held aloft by its largest operators, Bay Area ridership rose in 2015 and 2016 while other major regions saw declines, only faltering thereafter. However, ridership trends in the rest of the Bay Area—on mid-sized and smaller operators, in outlying areas, in non-commute directions, on weekends, and at off-peak times—fell similarly to other parts of the state (Taylor et al. 2020; Blumenberg et al. 2020; Wasserman et al. 2020; FTA 2021).

GOODS MOVEMENT

California's unique position on the west coast of North America, placing it between the Asia-Pacific region and the rest of the U.S., makes the state both a key node in the global movement of goods and an important global economic region in its own right. Indeed, California's freight transportation system handles the highest value of international commerce of any state in the U.S. In 2015, freight flows within the state, to and from the rest of the U.S., and through California to and from the U.S and the rest of the world added up to about 1.4 gigatons (1,400,000,000 tons) in weight and $2.7 trillion in nominal value, of which about two-thirds by weight and one-third by value were transported within the state alone (See Figure 15). These flows are projected to grow 63 percent in weight and 146 percent in value, respectively, by 2045. Foreign commerce passes through the state's port system, particularly the twin Ports of Long Beach and Los Angeles, together the ninth-busiest in the world and busiest in the U.S. pre-pandemic. Unloaded cargo from these ports makes its way by truck and rail throughout the state and across the

Figure 15 **Freight in California by Flow, 2015**

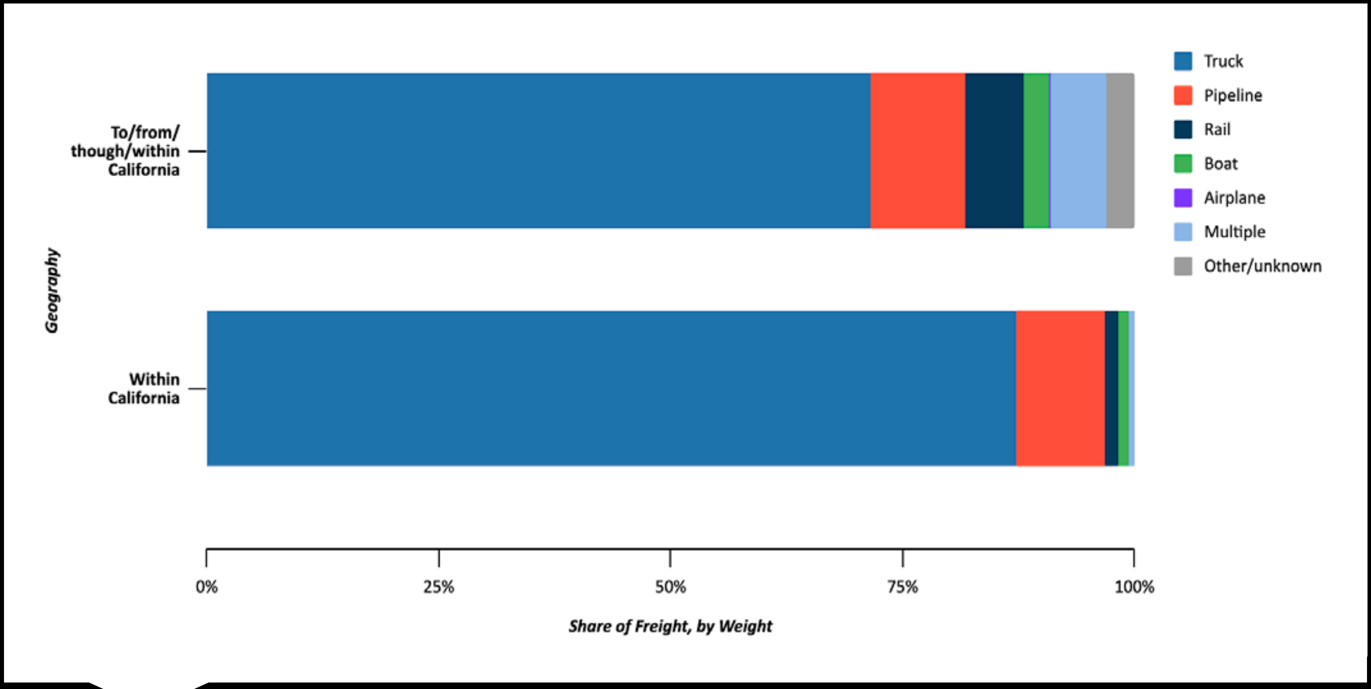


DATA SOURCE: Caltrans 2020

nation, facilitated in the South Coast region by the partly grade-separated Alameda Corridor and Alameda Corridor East rail projects (Caltrans 2020).

Despite California's considerable freight rail infrastructure, as well as its many airports, trucking is the primary means by which goods are transported in the state. Trucking accounts for 72 percent of all freight flows, and will likely remain so in the future (See Figure 16). Trucking has an even higher modal share of intrastate freight flows (Caltrans 2020). The dominance of trucking over other modes of freight transportation parallels the dominance of private automobiles in passenger transportation in both its point-to-point flexibility and its negative environmental and public health effects. Here too, the dominance of trucks in goods movement is abetted by the state's extensive system of freeways and other highways.

Figure 16 **Freight in California by Mode, 2015**



DATA SOURCE: Caltrans 2020

In addition to—or more accurately because of—its extensive system of ports, airports, railroads, and highways, California is home to major warehouse and logistics distribution centers, often at the fringes of its major metropolitan areas. While there is evidence that the growth of these massive new inland logistics facilities had begun to slow prior to the pandemic (Jaller et al. 2020), goods movement has continued to increase due to the steady population and economic growth in the state. Freight vehicles have contributed disproportionately to increased traffic congestion because trucks, especially large ones, are less maneuverable and take longer to accelerate and decelerate (Giuliano et al. 2018).

ORIGINS

The foregoing survey of the current state of transportation in California reveals an important reality: motor vehicle use is by far the dominant means of personal travel across all income and socioeconomic groups, and trucking is the principal means of surface goods movement as well. Trips by car remain on the rise, even as trip making overall is sliding (likely as a result of information and communications technologies, such as e-commerce, video streaming content, etc.). Despite the drop the past decade in per-capita personal vehicle trips statewide, total vehicle miles of travel (personal and commercial) continue to climb due to aggregate population and employment growth, including a substantial rebound following unprecedented drops in all forms of travel in the spring of 2020 at the outset of the COVID-19 pandemic (FHWA 2009, 2011, 2017, 2020; BTS 2021).

In this section, we explore how Californians came to depend so heavily on cars and trucks. California, like the U.S. as a whole, is an auto-oriented place by the design of its built form and metropolitan structures. The state's massive investments in freeways—both between and within cities—as the centerpiece of travel date back three-quarters of a century. While its proportionally smaller public investments in transit, particularly rail, date back nearly as far, land use policies in the Golden State, outside of major central business districts, have tended to be far more complementary with driving than walking, biking, or riding public transit. Low-density land uses exemplified by dispersed single-family housing have accommodated and encouraged automobile ownership and use. The results have meant suburban living and universal automobile access for most of the population, at the cost of increasing travel distances (especially for commuting), chronic and worsening traffic congestion in many places, health- and environment-threatening vehicle emissions, and a statewide crisis in housing affordability. Today's transportation problems stem, in significant part, from yesterday's land use decisions.

THE LONG VIEW: URBANIZATION AND TRANSPORTATION IN CALIFORNIA

California's Urbanization

During the Gold Rush of the mid-1800s, the state's population grew rapidly, particularly in places with ports, mines, and farms nearby. By 1885, when just 35 percent of the country was urbanized, half of Californians were living in cities or towns (Phelps 2000). Indeed, historians have argued that urban areas have long played a more significant role in the state's economy and development than in many eastern states (Phelps 2000; McWilliams 1949). Early urbanites relied on walking and horseback, as cities were small and destinations clustered together. With the advent of the streetcar—first powered by horses in the 1870s, then electricity in the 1890s—residential development could and did spread further from city centers. As automobiles grew more popular in the early decades of the 20th century, suburbs were no longer tethered to rail tracks and could spread even further from cities (Fischel 2004). A population and housing boom following the Second World War spread suburban development even further as widespread automobile ownership and use allowed for even greater separation of land uses. The federal government spurred this decentralization by planning the Interstate Highway System in the 1940s and funding most of it in the 1950s (Taylor 2000), as localities likewise widened streets and mandated off-street parking to ease driving (Wachs 1984).

Land use changed as much due to political and regulatory involvement as to population and transportation shifts. California's legislature enacted its first official land use law for subdivision mapping in 1893 and began to adopt zoning and planning laws in the 1920s (Fulton and Shigley 2012). In response to industrialization and urbanization at the turn of the 20th century, governments began to restrict through zoning how people could use their private property if that use was considered a "nuisance." Early zoning ordinances aimed to separate land uses to keep noxious uses, such as industrial plants, apart from commercial, multi-family residences, and, above all, single-family housing. And while homeowners constituted a minority of Americans in the early 20th century, they soon used zoning and redlining to exclude low-income and minority residents from their neighborhoods, through exclusionary policies such as large lot requirements, setbacks from the street, and racially restrictive covenants (Fulton and Shigley 2012; Heyman and Gilhool 1964)—practices with legacies that continue to shape race- and class-based divisions in where people live and work to the present day.

Freeways and Suburbanization

Our current driving dependency is also a result of auto-oriented transportation infrastructure decisions made during the state's postwar freeway planning periods. California in many ways pioneered the mass production of freeways, which were routed into the very hearts of its cities. In contrast to the massive, high-design-speed facilities of today, urban freeways were initially conceived of as numerous small highways that would disperse traffic; they had fewer lanes, slower design speeds, smaller interchanges, and some included transit in the medians. Early California freeways, like the Arroyo Seco Parkway, were designed for recreational motoring, with limited access and grade separation (Brown, Morris, and Taylor 2009). California also led the way in adopting a state gasoline tax to pay for freeway construction—a finance mechanism that blazed the trail other states would follow (Morris, Brown, and Taylor 2016). In funding the Interstate Highway System, the federal government adopted this finance model, which relied on state fuel taxes and generous federal matching grants (Taylor 2000).

After these early efforts, California's own freeway system emerged and grew from a construction frenzy owing to both ambitious state freeway plans and the powerful financial incentives provided by the federal government. The Federal-aid Highway Act of 1956 and the Highway Revenue Act of 1956 combined to provide the necessary funding—90 percent of capital costs—in exchange for states keeping highways toll-free, meeting certain design criteria, paying for operation and maintenance costs, and accepting responsibility for the finished freeways (Wachs 2003). By agreeing to accept the federal government's tempting matching grant offer, control over metropolitan freeway development shifted from local officials and urban planners to the state and its cadre of highway engineers (Taylor 2000).

The negotiations over freeway finance that took place from the 1930s to the 1950s in Sacramento and Washington, D.C. led state highway planners to adopt freeway designs with very fast design speeds and high capacities, even in cities. Whereas early freeway plans reflected prevailing urban concerns over congestion and paid close attention to the scale of expressways in cities, federal money biased planning decisions toward Interstate highways built to high design standards. Moreover, the state highway departments and engineers who guided the Interstate Highway System both between and within cities beginning in the 1950s had far more experience building and operating rural highways than urban ones. In a sense, they built rural intercity freeways in cities for intracity travel (Brown et al. 2009).

As a result, new freeways crisscrossed California's cities, bulldozing disproportionately through low-income urban neighborhoods of color, where economic and political costs were lower and resistance more easily ignored (Brown et al. 2009; Jain et al. 2021). Planners in the post-war era often justified freeway development as a means to cure "urban blight" (Hall 2014). Freeways were frequently routed through disinvested neighborhoods, causing the very blight they were supposed to eliminate and forcing businesses and residents to move to other areas (Brown et al. 2009). After the 1965 uprisings in Watts in Los Angeles, two federal commissions cited high rates of unemployment and lack of access to jobs among Black residents as root causes, as many jobs had followed the suburbanizing white population out of Black neighborhoods (Kain 1992). Kain (1968) followed up on these findings by proposing the "spatial mismatch" hypothesis: that race-based housing market discrimination, exacerbated by decentralizing employment, explained high rates of Black unemployment. The ensuing spatial mismatch literature influenced President Johnson's War on Poverty initiatives to better connect inner-city residents to suburban employment centers via fixed route transit. However, these policies had limited effectiveness in improving employment outcomes and were cut short by President Nixon (Rosenbloom 1992).

At the same time, federal housing policy encouraged "white flight" by diverting federal housing subsidies into suburbs by offering low-interest loans with little or no down payment. Millions of Americans, most always white, took advantage by buying homes, a new car, and moving to the suburbs, abandoning denser central cities that had been well served by transit (Hall 2014). Urban residents of color, meanwhile, often saw their homes demolished, their communities physically divided, and their neighborhoods polluted with freeway noise and exhaust (Avila 2004; Schulz et al. 2016). All told, the legacy of the state freeway program, aided and abetted by federal highway policy, has been a predominance of car-oriented, spread-out, large-lot, single-family suburbs; shopping malls replacing downtown commercial districts; and, perhaps ironically, increasingly congested roadways.

One of the earliest "freeway revolts" in the U.S., over the displacement and blight caused by urban freeway construction, was in San Francisco in the late 1950s. By the 1960s, the state's massive metropolitan freeway program began to face growing opposition from civil rights and, later, environmental advocates. This and other factors, including rising freeway construction costs and lagging revenues, slowed the completion of the Interstate Highway System and caused many planned urban freeway links, such the Beverly Hills and Pacific Coast Freeways, to eventually be dropped. While California had initially developed plans for a much denser but smaller-scale freeway network, funding shortfalls scaled back those plans, resulting in the sparser network of much higher capacity freeways we have today. This shift shunted more and more intracity automobile traffic onto fewer but ever-more congested roadways (Taylor 2000).

Transit

In addition to freeways, California invested significantly in public transit over the past half-century as well, though at a much smaller scale than for freeways. By the 1970s, limited federal and state monies began to flow into transit, in part to counter growing concerns over increasing traffic congestion and air pollution. Bay Area Rapid Transit was the first all-new rail transit system in the U.S. built after the Second World War. New rail transit lines have subsequently been added in San Diego, Los Angeles, San José, and Sacramento, with commuter rail service added to more suburban metropolitan counties as well (Webber 1976; Demery 2011; Morrow 2019).

After public transit transitioned from private to public ownership in the middle of the 20th century, transit operators needed public subsidies to maintain, expand, and operate their systems. The federal government began funding public transit operators in 1964, but mostly limited support in large metro areas to rolling stock and other capital equipment (Morrow 2019). With capital expenditures subsidized but operating expenditures covered by farebox revenues, transit agencies struggled to run and maintain their growing systems. Operations funding shortfalls led to funding commitments from the State of California to help subsidize operations with the passage of the Transportation Development Act (TDA) in 1971. Its hard-won passage involved compromises necessary to address opposition from both freeway users and rural and suburban areas, to meet Governor Ronald Reagan's interest in "local control," and to assuage state senators' concerns over weakening "fiscal discipline" by subsidized transit operators. The result of these compromises, including funding transit through sales taxes rather than fuel taxes and adding many complicated criteria (and later exemptions to them), remains in the structure of the TDA, a foundational program that is still a major source of funding for the state's transit operators (Gahbauer et al. 2019).

Since 1976, much of the increased funding for public transit in California has come from local option sales taxes, which are incremental increases (usually an added 0.5 or 1 percent of each purchase) to sales taxes, combined with transportation expenditure plans, put before county voters. Today, LOSTs generate nearly $5 billion per year for transportation, much of it for public transit, though substantial shares go to highways as well, depending on the county (Lederman et al. 2018). We discuss LOSTs and their effects further in the Trends section below.

THE CONSEQUENCES OF HISTORIC AND CURRENT TRANSPORTATION INVESTMENTS

California's transportation and traffic problems today cannot be disentangled from its transportation investments that have made the automobile not only useful but necessary for so many. The suburban lifestyle, with its single-family residences, together with the ongoing separation of homes and workplaces, continues to favor automobile travel over alternatives such as walking and public transit. Attempts to develop transit alternatives, particularly rail, in order to coax automobile users, especially commuters, out of their vehicles have had some success but have not changed the fundamental dynamics favoring automobile travel.

The Benefits and the Burdens of Automobility

A person's travel mode choice clearly affects how easily, quickly, and affordably they can travel. While public transit is less expensive, private cars offer many advantages that help explain their popularity. Cars help job seekers access a greater range of employment opportunities, allow shoppers to carry their groceries and purchases home, and more generally enable travelers to more easily travel to multiple destinations throughout the day.

Decades of land use and transportation policies supporting automobile ownership and use in California have combined to confer significant personal benefits on those able to drive. Today, access to a personal vehicle is a powerful predictor of improved welfare generally. Having a reliable vehicle in California (and the U.S.) is tied to improved employment outcomes, higher wages, better job stability, and greater likelihood of leaving welfare (Ong 2002; Raphael and Stoll 2001; Gurley and Bruce 2005). Studies that analyze how automobile access affects employment by race find that car ownership helps to explain employment differences between Black and white travelers (Raphael and Stoll 2010). For instance, travel mode, particularly differences in automobile access, more powerfully predict racial gaps in unemployment between Black and white job seekers today than travel distance alone (Covington 2018; Taylor and Ong 1995). Moreover, for women—who often must shoulder both work and caretaking responsibilities—the car provides more travel flexibility and greater safety after dark (when transit service is often limited and perceptions of safety worse) (Blumenberg 2004). By comparison, the relationship between transit access and employment or other outcomes is mixed at best, though the effects are typically stronger in high-density, transit-rich environments (Sanchez, Shen, and Peng 2016; Kawabata 2003; Blumenberg and Pierce 2014).

Of course, the many individual benefits of car travel come at a cost. Many very low-income households in California are dependent on public transportation precisely because purchasing and maintaining a car is so expensive (Blumenberg and Pierce 2012). But the benefits above help explain why many other low-income households seek car access, despite the high costs. The marginal benefits for a household of shifting from zero cars to one car are high (much higher than the benefits when a household with at least one car already adds another). Indeed, that the car enables better job access and employment outcomes is clear, given how much already-struggling households are willing to sacrifice in order to drive (Fletcher, Garasky, and Nielsen 2005). To enjoy the benefits of car travel, poor drivers must contend with the relatively high costs of automobile ownership, including purchasing used cars that may be in poor condition and require more maintenance over time or paying higher rates of interest and fees on car loans that result from lower credit scores (Van Alst 2009; Sutton and Moy 2007). Low-income families seeking to avoid the high costs of driving by purchasing fewer and older cars often pay more to live in places with better transit access, and therefore end up facing higher housing and transportation costs compared with all households (Blumenberg 2017).

Studies find that low-income households are constrained in how much they travel, often contend with unreliable cars, and must find strategies to manage transportation costs. For instance, even with access to high-quality transit service, most very low-income San José residents interviewed by Blumenberg and Agrawal (2014) chose to spend their very limited resources on car travel as either a driver or passenger. To save on transportation, many low-income Californians have multiple coping strategies, including relying on multiple travel modes, monitoring the miles they travel and gas consumed, spending less on other items, and relying on institutional and informal support networks. Forgoing a car is usually involuntary, rather than a chosen lifestyle, for low-income, less educated, and non-white Californians (Brown 2017).

Roads and Freeways: Providing Mobility, Enabling Decentralization

Conceptually, the degree to which a new street or freeway project affects mobility and accessibility depends on both the surrounding built form and the existing transportation system to which it connects. Adding a new turn lane on an existing boulevard will be less impactful than a new freeway built into a previously inaccessible area. Thus, new highways built a half-century or more ago, especially in previously inaccessible areas, often dramatically improved accessibility and, in turn, strongly influenced nearby developments (Giuliano and Agarwal 2017). Early studies found that areas that became more accessible with the addition of a highway gained in land value, whereas the areas that became comparatively less accessible lost value (Garrison et al.

1959). As freeway networks expanded, developers took advantage of waxing automobile use by building low-density residential and commercial development near freeways.

These added access benefits of freeway construction began to wane in the 1970s, as the U.S. Interstate Highway System, with its extensive metropolitan extensions, had come to crisscross the nation and its cities, elevating automobility, accelerating suburban expansion, and disproportionately bisecting and uprooting communities of color (Karas 2015). Adding to or expanding these highways in later decades occasioned more modest, marginal gains in accessibility (Giuliano and Agarwal 2017). Still, low-density, largely single-family communities and regional shopping complexes near massive freeway cloverleafs became emblematic of the new suburbs that increasingly defined California's metropolitan areas.

Whether highways cause decentralization or if they were simply part-and-parcel of larger forces toward urban decentralization is very much a chicken-and-egg question. Comparing areas in which planned highways were built and those where planned highways were not ultimately constructed, Baum-Snow (2007) concluded that, had the Interstate Highway System never been built, U.S. central cities would likely have experienced an eight percent growth in population, rather than the 17 percent decline that actually occurred. While building highways does tend to attract economic activity near the highway, much of that activity may simply have shifted from other locations rather than generated anew (Boarnet 2011). In Los Angeles, Chalermpong (2002) found that areas near Interstate 105, the last all-new freeway built in the county, saw two-to-three times more employment growth than comparable areas elsewhere. But the suburbs proved the most significant beneficiaries of the freeway system. Between 1990 and 2000, 83 percent of commuting growth occurred in the suburbs, such that by 2000, 44 percent of commutes started or ended in the suburbs (Blumenberg and Pierce 2012).

Automobile use has become more attractive to lower-income travelers despite its high costs due to the suburbanization of poverty. In the South Coast region in the 1990s and 2000s, poverty spread from central business districts to inner-ring suburbs and even further out (Tong and Kim 2019), reversing the decades-long trend of middle- and upper-income suburbanization. Over the 2000s, the number of jobs a poor resident could reach within a typical distance declined 17 percent (Kneebone and Holmes 2015). At the same time, many low-income workers and low-skill job opportunities remained concentrated in central cities (Blumenberg et al. 2003; Kawabata 2003).

Transit-oriented Development

As with freeways, new public transit investments have likewise seen development spring up around major stops and stations. Transit-oriented developments (TODs) are an explicit attempt to encourage developments adjacent to major transit stops and stations through local land use policies that permit increased densities in order to encourage alternative modes of travel (Boarnet and Compin 2007). While TODs aim to entice drivers to switch to transit (Arrington and Cervero 2008), their effects on travel behavior have proven relatively modest. TODs provide those who live or work in them with opportunities for carless travel, these typically medium-density, new developments usually include lots of parking as well. Research has shown that lower automobile ownership and use rates in TODs can be better explained by on- and off-street parking requirements than proximity to rail transit (Chatman 2013).

Further, because TODs are new, and newer housing is usually more expensive than older housing stock, the residents of TODs are often wealthier, more likely to own cars, and less likely to ride transit than previous residents displaced by the new TOD. A study of light-rail stations in Los Angeles found that station areas near newly added light rail stops in Los Angeles after 2008 attracted higher income households who were more likely to drive than to take transit to work, compared to county averages or earlier residents of the neighborhoods hosting the TODs (Dominie 2012).

Research shows that the number of motor vehicle miles traveled is largely a function of *regional* accessibility, so small TOD islands in a sea of sprawling auto-oriented development will only slightly affect driving (Ewing and Cervero 2001). Automobile trips are fewer, trip lengths are shorter, and travel speeds are slower where development densities and accessibility are higher and land uses are compact and mixed (Boarnet and Crane 2001; Chatman 2013). However, academic debates still rage over the magnitude of effects of urban form on travel, though the general consensus is that they are statistically significant, albeit relatively modest (Boarnet 2011; Boarnet and Crane 2001; Stevens 2017). Part of the confusion is because the relationship is nonlinear: modestly increasing development densities or transit availability in low-density developments saturated with free parking has little effect on driving, but at very high densities where parking is limited or expensive (like in northeastern San Francisco), the effects of the built form on driving, walking, and transit use can be substantial (Voulgaris et al. 2017).

Many cities explicitly planned for TOD near rail stations and implemented policies that encouraged development, such as by reducing parking requirements, offering low-cost loans, assembling parcels of land, and offering density offsets (Schuetz, Giuliano, and Shin 2018). Yet it is unclear whether development in TOD areas has occurred due to the presence of a rail station or if it is largely a product of local policies that encourage mixed-use development more broadly (Knapp, Bolen, and Seltzer 2003; Duncan 2011). Analyses of rail transit development largely find that new rail investments often fail to generate development that would not otherwise have occured (Chapple and Loukaitou-Sideris 2019; Belzer and Autler 2002). Whereas some cities successfully attracted development near transit, such as Portland, Oregon, other cities, such as Oakland, have not (Giuliano and Agarwal 2017).

These mixed results can be explained by differences in underlying conditions and policies: favorable land use policies and a fast-growing population help attract significant commercial or residential development to TODs (Giuliano and Agarwal 2017). Los Angeles Metro's Blue Line (now A Line) light rail, which runs through historically disinvested, redlined, and industrial South Los Angeles neighborhoods, never attracted significant investment along most of its corridor, with stagnant population, business, and activity density near the stations and no concomitant, sustained political and financial support (Loukaitou-Sideris and Banerjee 2000). The type of rail also matters: heavy rail, which usually has a higher carrying capacity and speed than light rail, appears to exert more influence on land use (Giuliano and Agarwal 2017). Without supportive land use policies and economic conditions, rail stations alone proved largely unable to generate much ridership or economic development (Belzer and Autler 2002).

LAND USE'S EFFECTS ON TRANSPORTATION

While transportation policy choices have affected both land development and travel, land use policy choices have also affected the state's transportation systems and travel patterns. Overall, California's land use policies, particularly with respect to housing production and affordability, tend to restrict land uses and housing supply and increase development costs (Manville, Monkkonen, and Lens 2020; Glaeser and Gyourko 2002; Quigley and Raphael 2004). These land use regulations have, with some notable exceptions, broadly limited compact residential development in already built-up areas, as housing developers have found it far easier to build at lower densities on cheaper land on urban peripheries, where walking and public transit are far less viable than driving. While there has been more central-city population growth in the early 21st than in the late 20th century, the bulk of metropolitan population growth continues to be on the suburban fringes (Blumenberg et al. 2019).

Several factors continue to favor lower density, car-centric development: existing land use regulations, the housing affordability crisis, the environmental review process, and parking restrictions; we address each in turn below.

Land-use Regulations and Density

Cities can influence housing construction with a range of regulations that broadly fall into four categories: zoning codes that dictate what can be built, building codes that specify how the development should be built (such as the type of construction materials), permission to build, and fees and exactions in exchange for permits to build. Zoning codes enforce land use types (such as single-family residential), building densities, heights, setbacks from the street, and a range of other regulations that are typically determined by local elected officials and sometimes by ballot initiatives (Metcalf 2018). All of these city-level land use regulations have significant influence on travel behavior in California by shaping the built environment and its accessibility by various modes.

Housing scholars find significant evidence that single-use zoning, particularly low-density residential zoning, makes it harder to build housing (Glaeser and Gyourko 2002; Gyourko and Molloy 2015; Kok, Monkkonen, and Quigley 2014; Manville et al. 2020). Places in California that adopted more land use regulations also issued fewer multi-family and single-family housing permits. According to one estimate, each additional regulation, such as a zoning ordinance, reduces residential permits by an average of four percent (Jackson 2016).

By contrast, adding housing moderates an area's housing prices and enables more workers to move to places rich with jobs without enduring long commutes to and from work (Jackson 2016; Phillips, Manville, and Lens 2021). But nearly two-thirds of all land in California cities is zoned for single-family homes (Mawhorter and Reid 2018). Single-family zoning restrictions have both constricted the supply of housing units in a state that desperately needs additional housing (Jackson 2016) and limited the types of neighborhoods people can choose to live in. Levine (2006) argues that current low-density residential land use patterns do not reflect personal preferences and free-market outcomes but rather choices constrained by restrictive zoning and land use rules.

The Housing Crisis Has Exacerbated the Problem

In the 1970s California's housing prices began to outstrip the rest of the country's, such that between 1970 and 1980, California's average home price went from 30 percent higher than the U.S. average to 80 percent higher. By 2015, the average house price was 2.5 times higher and the average rent 50 percent higher than the rest of the nation. These escalating housing costs are a direct result of housing supply failing to keep pace with population growth, a gap that continues to widen with little relief in sight. Between 1940 and 2000, housing construction in California's coastal metro areas slowed and remained flat during the nation's housing boom in the mid-2000s (M. Taylor, Alamo, and Uhler 2015). By 2019, the number of housing permits actually trended downward, despite a strong economy (Dougherty 2020).

Ironically, high-density, central-city housing development is often successfully opposed on transportation grounds (Ding and Taylor 2021). Homeowners, who stand to benefit financially from increased housing values (and who may also care about local traffic and keeping their neighborhoods from changing), are therefore motivated to support policies and elected officials that constrict housing supply (Fischel 2004). While recent policy changes at the state level are starting to change this (See Conclusion), housing has historically been and is still largely regulated—and vetoed—at the municipal level.

Environmental Review

Environmental review has greatly influenced land development—and consequently travel patterns—in California. Since the passage of the California Environmental Quality Act (CEQA) in 1970, most major housing and commercial developments have been subject to environmental review. Projects deemed to have significant impact on the environment, usually the largest projects, must prepare an environmental impact report (EIR), which is a detailed study of all potential physical impacts of the project of the environment, including effects on travel patterns, their level of significance, and necessary mitigation measures to address them (Fulton and Shigley 2012).

Critics have charged that CEQA procedures have tended to promote low-density, suburban-style development that favors automobile travel while discouraging infill, compact, and higher-density development that would promote greater walking and transit use (Volker, Lee, and Fitch 2019; M. Taylor et al. 2015; Landis 2004; Ohanian and Fernández-Villaverde 2018; Ding and Taylor 2021). In addition to the added time, expense, and uncertainties of the development review process, housing projects that must prepare a full EIR (about 6%, according to Smith-Heimer and Hitchcock (2019)) are mostly large, multi-family projects, accounting for 23 percent of the overall number of housing units proposed. Required mitigation, often in response to public opposition, can further limit housing production, especially for more affordable units, by increasing construction costs and often results in reducing the total number of units to be built. Years of expensive litigation over CEQA reviews of major projects are not uncommon, which raises the cost of projects ultimately approved and results in other proposals being cancelled (Manville 2017a; Hernandez 2018).

Housing, particularly higher-density, multi-family housing projects located in more densely populated urban areas, was the top target of CEQA lawsuits (21% in 2010-2012 and 25% in 2013-

2015, statewide), while local land use plans to raise housing densities and improve transit were the second most popular target (Hernandez, Friedman, and DeHerrera 2015; Hernandez 2018). More strikingly, virtually all CEQA housing lawsuits between 2013-2015 in the San Francisco Bay Area (100%) and the Greater Los Angeles region (98%) targeted infill housing in existing built-up communities. Critics complain that CEQA lawsuits were more often used by "not in my backyard" (NIMBY) groups to exclude needed housing and other public amenities than to genuinely protect the environment (Hernandez et al. 2015; Hernandez 2018).

Along with indirectly influencing today's transportation patterns through their effects favoring low-density development, CEQA reviews (and other local traffic impact assessments) have historically favored transportation mitigations in the form of road capacity improvements that make driving easier. As a result, CEQA analyses tended to favor lower-density development in outlying areas over higher-density infill developments in areas that are already congested but suitable for alternative travel modes such as transit, walking, and biking (Ding and Taylor 2021). While CEQA reviews have in recent years changed from projecting and mitigating nearby traffic levels of service (a measure of vehicle delay) to overall effects of vehicle use and travel, prior to this change the evidence suggests that the costs of CEQA review, the unpredictability associated with the process, and the costs and risks associated with potential litigation following approval likely have driven up housing costs, inhibit housing production and constrain compact, infill, mixed-use developments in higher-density urban areas, all of which encourage sprawl and driving (Ding and Taylor 2021).

Parking Regulations

Finally, an impactful, near-universal, yet often-overlooked policy at the intersection of land use and transportation is minimum parking requirements. To make destinations easier to access by car and to reduce demand for street parking, most cities in California have long required developers to build a minimum—and usually ample—number of off-street parking spots. These parking mandates are often enacted to reduce time spent circling the block searching for free on-street parking, which adds to traffic. In practice, however, adding parking both makes driving more appealing, because mandating lots of expensive-to-build parking makes it easy to find and so much is supplied that it is generally unpriced. When drivers can count on a (usually free) parking place at the end of every trip, it makes them more likely to drive for every trip, and when everyone drives, free parking comes to be seen as a necessity (Shoup 2005). Indeed, policies such as residential off-street parking requirements that make driving more attractive have been shown to both increase automobile ownership and use and decrease transit use (Manville, Beata, and Shoup 2013; Manville 2017b; Manville and Pinski 2020). On top of this, developers may build fewer units of housing than are otherwise allowed in order to avoid the high costs and design constraints of adding more parking. The resulting lower density development spreads out destinations, causing people to travel further, which they can do most easily by car (Manville et al. 2013).

TRENDS

Given the many factors shaping travel in California, where might we be headed? We consider in this section four broad sets of factors that have either recently come to the fore or are nascent or emerging in the near future. First, we discuss the forces behind the state's overwhelming reliance on automobile and truck travel and the pre-pandemic decline in transit use—due to increased automobile ownership and use, as well increasing ridehail use—and, second, put them in the context of California's transportation spending. Looking forward, a variety of other new forces promise to affect travel in the state as well: changing patterns of jobs and housing, the habits of younger generations of travelers, advancements in goods movement, and challenges of resilience in disasters. Finally, atop all of this, technology is reshaping Californians' mobility, with the coming electrification of the vehicle fleet; the rise of technology-enabled mobility services like ridehail, wayfinding, and trip planning; telecommuting; and the gradual automation of driving.

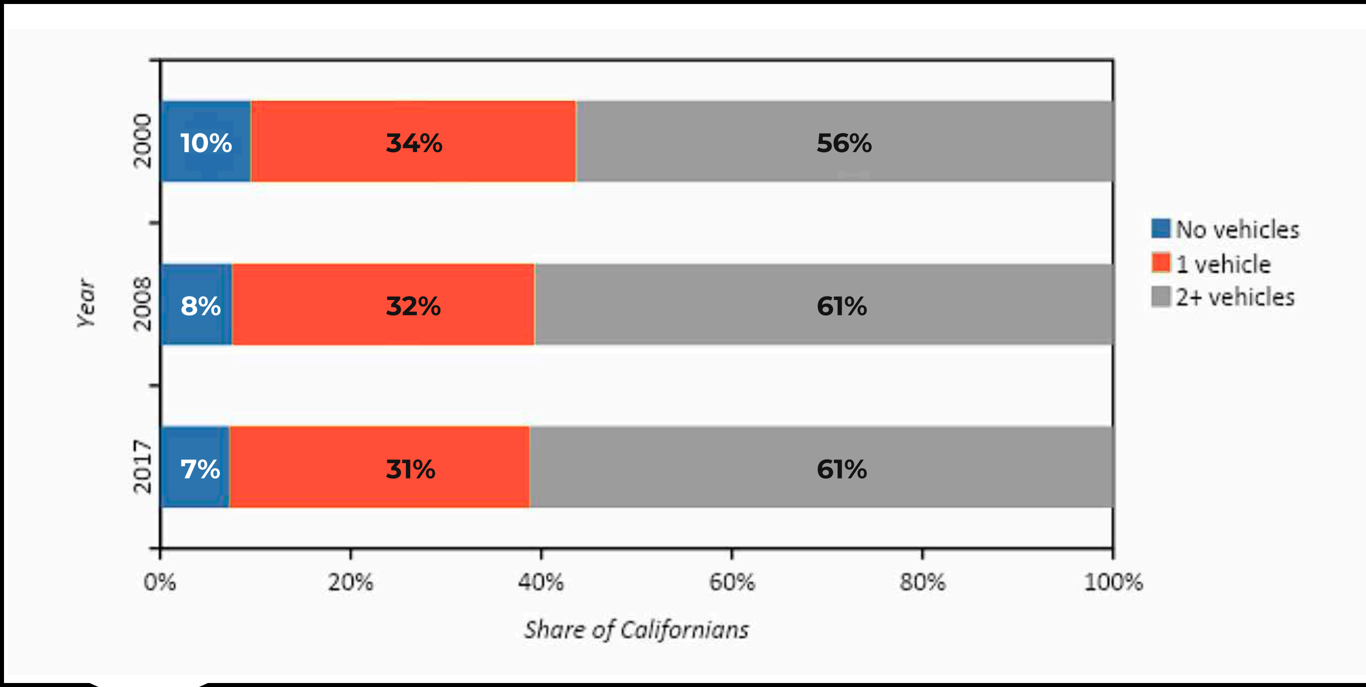
FACTORS DRIVING AUTOMOBILITY TODAY

The forces that are driving (if the reader will pardon the pun) travel behavior trends toward ever-increasing reliance on motor vehicle travel have been with us for some time, and in some cases are even strengthening, despite public policies and investment that aim to promote other travel modes. Among these forces are higher rates of automobile ownership and use, and weakening demand for public transit, on one hand, and a public finance landscape favoring multimodal transportation on the other.

Growing Automobile Ownership

One of the most significant factors behind the continued high use of automobiles and the recent drops in transit ridership in most of the state is rising levels of vehicle ownership, particularly outside of the San Francisco Bay Area. As described in the Facts section, households with cars are far more likely to drive and less likely to take transit. Indeed, residents of zero-vehicle households in California make over five times as many transit trips as those living in households with at least one vehicle (FHWA 2017). However, the share of California households with no vehicles declined from 9.5 percent in 2000 to 7.3 percent in 2017 (Paul and Taylor 2021; Ruggles et al. 2021a) (See Figure 17). This decline in the share of such households has an outsized effect on topline ridership trends. Not only does higher vehicle ownership add to automobile trip-taking, traffic congestion, and environmental problems, household transit use falls off dramatically

Figure 17 **Household Vehicles in California**



DATA SOURCE: Ruggles et al. 2021a

with even one vehicle and becomes almost inconsequential with three or more (FHWA 2017). Across the U.S., about 90 percent of households own at least one vehicle. In California, household car ownership is higher than nationally and has steadily increased over the past 20 years. The state added almost 2 million vehicles from 2000 to 2008 and another 2 million vehicles from 2008 to 2017—almost one new vehicle for every new resident. The share of households with at least two vehicles increased from 56 percent in 2000 to 61 percent in 2017 (Ruggles et al. 2021a).

While automobile ownership has broadly increased across all parts of the state, the Inland Empire in particular has the lowest share of zero-vehicle households (5%) and the highest proportion of households with access to two or more vehicles (66%)—helping explain why automobile use there is highest among all regions in the state. In contrast, automobile ownership has been more stable in the Bay Area (where pre-pandemic transit use remained relatively high), with only a one percentage point decline in households with no vehicle access and a three percentage point growth in households with two or more vehicles, between 2000 and 2017 (Ruggles et al. 2021a).

As with travel patterns, vehicle ownership differs among Californians of different races and ethnicities, genders, and incomes (See Appendix, Figure A-5). Black Californians own fewer automobiles than other groups: in 2017, 17 percent of Black-headed households lacked access to any vehicles, and only 42 percent of Black-headed households owned more than two cars. With few vehicles available, Black Californians remain the heaviest users of transit. While white- and Asian-headed California households have consistently high average levels of vehicle access, the most significant change is among Latino/a-headed households, whose share of zero-vehicle households halved between 2000 and 2017 and whose portion of two or more vehicle households grew by over ten percentage points. And while gendered differences in automobile use exist within households (as described above), male-headed households (in which a man was the primary renter or homeowner and/or a man filled out the survey) have noticeably higher access to two or more vehicles than female-headed ones (67% vs. 55%). Yet, female-headed households have experienced an incredible growth in access to vehicles, with a seven percentage point decrease in the share of households with no vehicle access, and a 19 percentage point increase in the share of two-or-more-vehicle households since 2000 (Ruggles et al. 2021a).

Low-income households are far more likely to be without a vehicle (Blumenberg and Pierce 2012) and face the largest disparity in automobile access, much greater than differences by race, gender, or region. Low-income households in California saw a decline in share of zero-vehicle households since 2000, which is particularly significant since they are the heaviest users of transit (See Figure 5 and Appendix, Figure A-3) (Ruggles et al. 2021a). Moreover, low-income travelers are more likely to cycle into and out of car ownership frequently (Smart and Klein 2015), and they may also compete with other family members when they do own a vehicle (Blumenberg 2017). Among income groups across regions, households living in poverty in the Bay Area had the highest rates of zero-vehicle ownership (33%), while households not living in poverty in the Inland Empire had the highest share of owning two or more vehicles (70%), again helping to explain regional differences in automobile travel (Ruggles et al. 2021a).

Factors Driving Lower Transit Use

As the data presented above show, the great majority of Californians, both poor and not, have access to a private vehicle, and rely on it for the vast majority of their trips (Blumenberg 2017). Transit in almost all of California takes longer than driving for comparable trips, as travelers must get to and from their transit stop, wait at the station and at stops along the route, and potentially transfer. Nevertheless, as we have noted, transit ridership was growing steadily, if slowly, in both California and across the country until 2014 (Taylor et al. 2020). Why did it then decline in the latter half of the decade, with a relatively healthy pre-pandemic economy?

There is little evidence that declining ridership is due to factors internal to the transit industry, such as rising fares or declining service. In fact, both hours and miles of transit service increased through the 2010s in most parts of the state. Instead, it is more likely due to outside factors such as rising incomes, automobile ownership, and changing residential and employment patterns, as well as the growing availability of ridehail services, although all these factors likely have varying effects across different parts of the state (Taylor et al. 2020; Watkins 2021).

The high and rising rate of vehicle ownership described above is the primary reason why transit ridership has been falling. In California, much of the decline in transit use came from among the most regular transit users, groups that have gained automobiles over the past two decades. Latino/a Californians, those in households with no automobiles or fewer cars than drivers, and perhaps most worrisomely, people living in dense neighborhoods (that should encourage ridership), are taking transit less and less (Taylor et al. 2020; Paul and Taylor 2021).

Changes to consumer demand for transit services occur for two reasons: changes in the population of different groups of potential riders ("population effects") and changes in the propensity of persons in those groups to take transit ("usage effects"). Across the state of California between 2009 and 2017, while lower levels of ridership were, in some cases, associated with shifts in the composition of the population, the largest declines in transit patronage were associated with falling ridership *rates* among these groups (See Table 3) (Schouten, Blumenberg, and Taylor 2021; Taylor et al. 2020).

Table 3 Changes in Populations and Their Transit Use in California

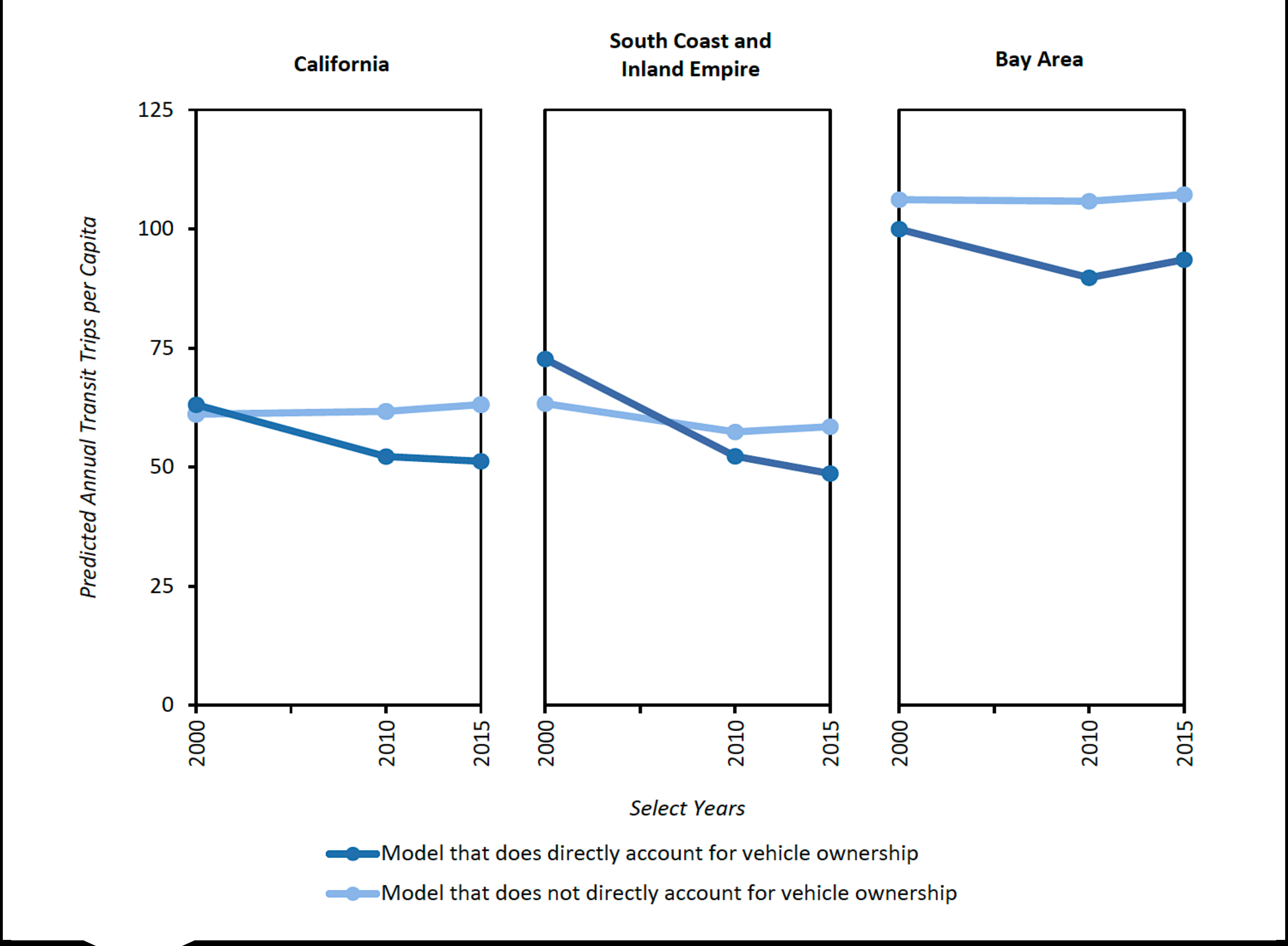
Characteristic		2009 Share of Californians	2009 Transit Trips per Year	2017 Share of Californians	2017 Transit Trips per Year	Population Effect	Usage Effect
Car Ownership	Zero-vehicle households	5.8%	257.8	5.2%	273.3	-1.2%	+2.1%
	Households with between 0 and 1 vehicles per adult	16.0%	87.1	15.5%	42.1	+0.9%	-17.9%
	Households with at least 1 vehicle per adult	78.2%	14.0	79.4%	23.0	+4.7%	+18.4%
Race/ Ethnicity	Hispanic	32.5%	66.6	35.6%	37.5	+5.6%	-26.7%
Population Density	High population density	31.5%	86.5	32.4%	72.6	+6.8%	-11.6%
	Low population density	68.5%	18.5	67.6%	22.7	+2.9%	+7.2%
Income	Low-income	22.5%	93.3	18.0%	76.3	-5.1%	-7.9%
	Not low-income	73.0%	23.6	79.7%	30.1	+10.0%	+13.2%
All		100%	39.9	100%	38.9	+8.6	-2.7%

DATA SOURCE: Schouten et al. 2021

In the Bay Area, between 2009 and 2017, transit agencies actually benefited from positive usage and population changes, particularly increasing transit use among higher-income people and those with high levels of vehicle ownership. As a result, transit ridership in the region just before the pandemic came to be composed of a rising share of “choice riders.” However, in most of the rest of the state and especially the South Coast and Inland Empire, falling ridership rates among Latinos/as and those living in households with few cars depressed ridership and countered efforts to encourage ridership through system expansion (Taylor et al. 2020).

The decline in ridership among Latinos/as came as lower numbers of migrants have arrived in recent years from Mexico and other Latin American countries. While immigrants are, on average, three times more likely to travel by transit than U.S.-born residents, the longer they live in the U.S., the more their assets and access to autos tend to grow—and, hence, their travel behaviors begin to mirror those born in the U.S. With fewer new immigrants and, among those who do immigrate, more better-educated immigrants and more from Asia and fewer less-well-educated immigrants and fewer from Latin America, transit ridership has declined and automobile use has grown (Taylor et al. 2020; Paul and Taylor 2021).

Figure 18 Estimating the Independent Effect of Rising Car Ownership on Transit Ridership



DATA SOURCE: Taylor et al. 2020

The demographic and economic forces that help explain the rise of automobile ownership in turn explain most of the transit ridership decline in California. Across the state and particularly in the South Coast and Inland Empire, transit ridership per capita would have risen or stayed flat in the first 15 years of the 21st century if vehicle ownership had remained constant (See Figure 18). Again, the relationship between vehicle ownership and transit use in the Bay Area was unique, with declines in predicted transit ridership due to changes in car access not nearly as dramatic. In the Bay Area, where pre-pandemic ridership losses were highest outside of peak travel directions and times, increasing ridehail use is a likely culprit (Taylor et al. 2020; Manville et al. 2018; Blumenberg et al. 2020; Wasserman et al. 2020; Erhardt et al. 2021).

Public transit in California was losing riders prior to the pandemic despite increased service and has recovered them far more slowly and haltingly from the pandemic than has been the case with driving, walking, and biking. Even should ridership return to pre-pandemic levels in the near future, structural weaknesses may cause it to continue to lose market share, particularly on non-commute routes and at non-peak times. Growing automobile use and faltering transit use pose serious challenges to attaining California's adopted transportation and environmental policy goals.

THE SHIFTING LANDSCAPE FOR FUNDING A MULTIMODAL TRANSPORTATION SYSTEM

Amidst these trends, California's state and local funding for transportation has provided support for both automobile-supportive infrastructure and new multimodal transportation networks. Traditional transportation expenditures favored highways and low-density residential development, as we have seen. Now, the landscape for funding transportation is shifting at the federal, state and local levels, which may alter the calculus towards alternatives to driving. State, regional, and local governments have dedicated increasing funding to public transit and active travel, like biking and walking. While funding for motor vehicle infrastructure still dwarfs that for other modes, California's financial and political commitment to a multimodal future is a substantial countervailing force to the structural factors promoting automobility, especially at the local level. However, absent supportive land use and transportation policy changes, these investments may not pay off with the desired changes in mode and travel patterns.

State Funding

In California, state funding for transportation comes from a road user fee in the form of a per-gallon state motor fuels (gasoline and diesel) tax, as well as from state sales taxes levied on the purchase of gasoline and diesel fuel. The per-gallon levy was increased for the first time in many years in 2017 by Senate Bill 1 (SB 1). A much smaller, and more volatile, source of funding is the Greenhouse Gas Reduction Fund (GGRF). The GGRF comes from revenue from the state's carbon emission permits auctions through the cap-and-trade program. Grants from the GGRF, with a strong emphasis on sustainable transportation and reducing VMT, support the state's high speed rail project, public transit projects, clean energy programs, and affordable housing development (California Climate Investments 2020). SB 1, the Road Repair and Accountability Act of 2017, raised the state's fuel taxes to provide an additional $54 billion over the next decade to fix roads, freeways, and bridges in communities across California and to improve public transit and road safety as well (Caltrans 2021b).

At the state level, two major funding programs focus primarily on expanding and improving public transit systems and active transportation infrastructures. The Local Transportation Fund (LTF) disburses apportioned revenues under the Transportation Development Act from a quarter-cent state general sales tax to each county for active transportation, transit, and transportation planning programs (Caltrans 2018); in 2020, the state Board of Equalization disbursed $1.16 billion in LTF funds (California State Controller's Office 2021). The State Transit Assistance (STA) fund whose revenues derive from state taxes on diesel fuel, provides funds for mass transportation by a formula (Caltrans 2018); in 2020, STA provided $377.7 million to state transit agencies (California State Controller's Office 2021). Other important transit funds include the Low Carbon Transit Operations Program of operating and capital assistance for transit agencies ($148 million on average per year), the Transit and Intercity Rail Capital Program for capital improvements to rail, bus, and ferry transit systems ($291 million on average per year), and the Active Transportation Program for new bicycle paths or lanes, new pedestrian facilities, and new or expanded bike share programs (about $100 million per year) (CARB 2021a). Each of these programs are framed as emissions reduction strategies, and there are set-asides for disadvantaged communities.

Recognizing the connection between travel, land use, and emissions, another group of state funding programs focus on integrating transportation and land use systems together to promote sustainable development, often with an additional emphasis on social equity. The largest program among these is the Affordable Housing and Sustainable Communities program, which funds housing, transportation, land preservation, and especially affordable housing projects at $110 million per year. The novel Transformative Climate Communities program provides fewer, albeit much larger grants for affordable housing and sustainable infrastructure in select areas, with an emphasis on environmental justice and community choice of projects, at $76 million per year. To date, the program has spent $241 million and is set to spend $41.7 million this year (CARB 2021a).

The state has also added conditions to a number of other transportation funding streams, limiting their use for expanding highway capacity, and has added flexibility to spend freeway funds on transit and active transportation. However, the state still spends about $20 billion per year on automobile infrastructure (CARB 2021a). While much of this funding goes to the operation, maintenance, and rehabilitation of the state's enormous road system, it is nonetheless substantially greater than the less than $2 billion earmarked annually for more sustainable modes and projects.

In addition, the state has commenced construction on a high-speed rail project that aims to connect the state's major metropolitan areas. There are many economic and environmental benefits of high-speed rail: more and faster movement of people between major economic centers, with lower greenhouse gas emissions than flying (Eidlin 2015). However, the project currently faces many challenges, including funding, cost-effectiveness, and equity concerns. Even though the state has committed $20 to $29 billion to design and build the system, an enormous funding gap remains. Current estimates peg the cost to complete the planned system at $77 billion, though this estimate has climbed substantially over time, and further increases are plausible (Vartabedian 2021). The first links of the system are being built in the largely agricultural San Joaquin Valley, where construction challenges are lower but key destinations are more distant. The system's high and rising costs are raising increasing concerns about the affordability and cost-effectiveness of the project because the high-speed rail primarily addresses inter-metropolitan personal travel, which is currently less of a transportation challenge than intra-metropolitan personal travel or goods movement. Further, the benefits of a high-speed rail are more likely to flow disproportionately to higher-income travelers, the environmental and social costs, particularly during its construction, will likely impact lower-income communities to a greater degree (Wachs 2019; Taylor 2019).

Local and Regional Funding

While state level programs provide a large share of funding for local and regional transportation in California, cities and counties have increasingly relied on local option sales taxes to fund local and regional infrastructure projects. Since 1976, 52 county-level LOST measures for transportation have been approved by California voters, of which 35 remained in effect as of June 2020, generating nearly $5 billion per year. The degree of reliance on LOSTs for transportation funding varies across counties, but Los Angeles County and its four LOST measures generate the most local option sales tax revenue among all counties in the state and in the nation (Wachs, Amberg, and Marks 2021). Because California law requires LOSTs to pass by a two-thirds supermajority, they are paired with expenditure plans crafted to attract as many votes as possible. This has resulted in something-for-everybody and every community project lists, even when those popular projects are of dubious merit. Further, because the measures are often in place for 20 years or more, the project lists approved by voters are fixed, even if transportation needs and voter sentiment evolves significantly. Another consequence of the reliance on popular voter support was and is a bias towards capital projects. Compared to essential but mundane maintenance and operating expenditures, voters tend to be more attracted to large scale capital projects (Wachs et al. 2018; Manville and Levine 2018; Wachs et al. 2021; King et al. 2021).

While LOSTs have proven popular with voters who like the small incremental increases in taxes paid over hundred, and even thousands, of transactions, sales taxes are income-regressive, meaning that lower-income residents tend to pay a larger percentage of their incomes in LOSTs than do higher-income residents (though essentials such as grocery food are exempt from sales tax in California (Albrecht et al. 2017)). Further, because the taxes are related to consumption of items subject to the sales tax, and not to use of transportation systems, people who do not travel much cross-subsidize those who travel a lot. This separation of those who impose costs due to their travel from who pays for those costs is a departure from the benefit-principle of taxation and the user-pays logic common in transportation finance (such as with transit fares and gas taxes) (Lederman et al. 2018).

Despite their many problematic elements, LOSTs are proven money-spinners and perhaps the most politically palatable way to raise public revenues for transportation in California. They have even proven a rather resilient funding source. During the COVID-19 pandemic, transit agencies across the country lost substantial portions of their fare revenues while facing significant uncertainties in state and federal support. But, many of the LOST measures were able to generate a continued, relatively stable stream of revenue for transportation expenditures, in part thanks to taxes collected on internet transactions (Wachs et al. 2021; King et al. 2021). So for better and for worse, LOSTs and their largely fixed transportation project lists are likely to shape California's transportation systems for years to come.

Funding the Future of Transportation in California

Both state and local/regional transportation funding has been shifting away from motor-vehicle-first transportation planning to promoting a more multimodal transportation system. However, the increased investment in transit service has yet to be matched with increased transit ridership. As discussed above, the most significant factor behind the pre-pandemic decline in transit use is the increase in access to private vehicles—both vehicle ownership and vehicle access via ridehail. As long as the built environment remains automobile-oriented, increasing transit investment likely will have limited effect on changing people's travel behavior toward increased transit use. While several state-level funding programs have begun to promote better integration of land use and transportation systems to support multimodal travel, local and regional funding has not. Moreover, the bias towards capital projects over more mundane yet necessary operation and maintenance expenditures may be undermining the sustainability of the state's transportation system.

NEW FORCES SHAPING TRAVEL TRENDS

As California policymakers look to the future of travel, powerful forces in job and housing markets, generational differences in travel and lifecycle patterns, the transportation and land use effects of goods movement growth, and challenges to system resiliency will each exert new pressures on post-pandemic mobility in the years ahead.

Changing Patterns of Jobs and Housing

As discussed above, how people travel depends much on the relative locations where they live, work, and go for other activities. Jobs and housing have become more imbalanced in California cities since 2002, as the share of workers who both live and work in a jurisdiction has been falling relative to the number of commuters who travel either into or out of a city for work, particularly in the state's most expensive cities (Blumenberg and King 2021). As a result, average commute distances in California increased 1.7 miles (14%) between 2002 and 2015, which may be shifting former (or previously more frequent) transit riders into more auto-oriented, less transit-friendly areas, again pushing up automobile use (Taylor et al. 2020). Neighborhoods near transit in particular have changed in recent years, sometimes dramatically. Compared to 2000, the state's most transit-friendly neighborhoods in 2017 were home to fewer poor residents, immigrants from Latin America, Black residents, and zero-vehicle households—all among the highest-propensity transit users (Paul and Taylor 2021). High housing costs and central-city neighborhood gentrification may be pushing workers outward. If these trends continue or even grow, automobile use in the state could continue to expand, and the market for transit may stay on its pre-pandemic downward slope.

Millennials and Gen Z: The Future of Travel

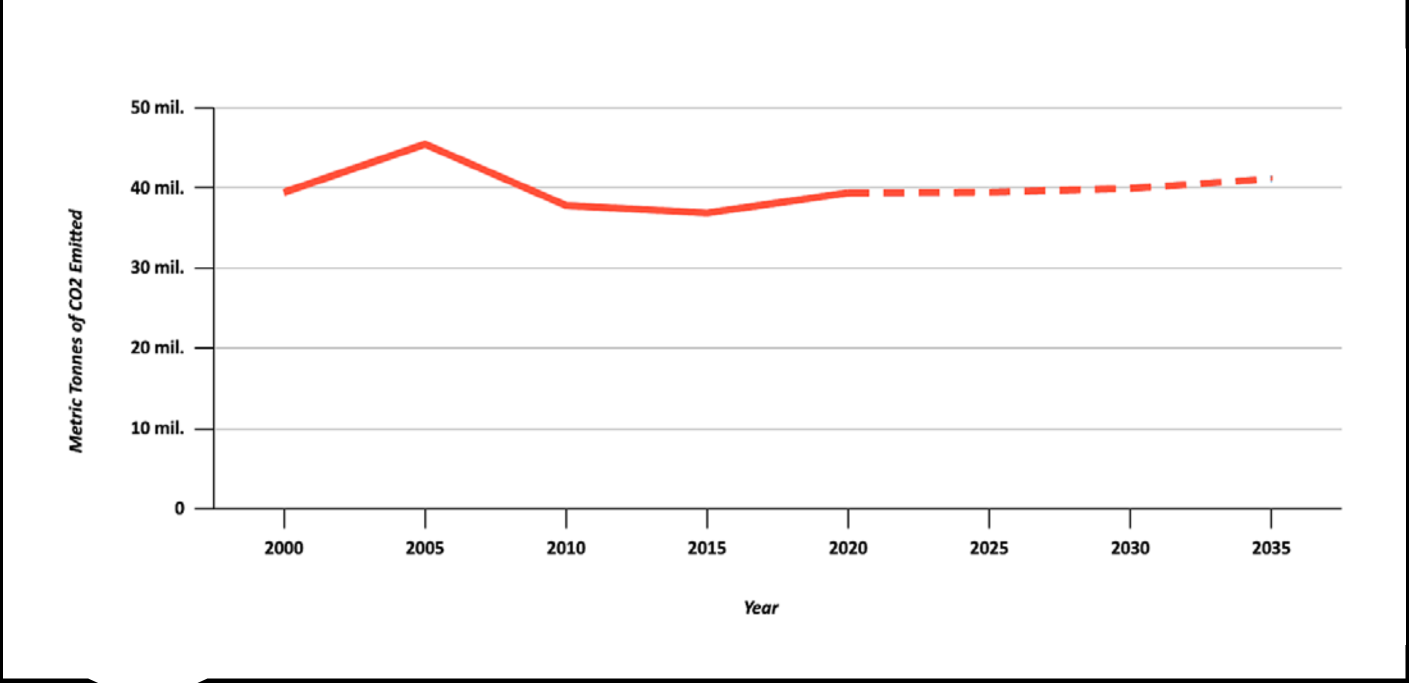
Meanwhile, younger Californians are traveling differently than older generations, though not as much as one might imagine. For instance, Millennials are more likely than older generations to live in denser neighborhoods and central cities, drive less (especially in those areas), own fewer cars, and use new, shared mobility services. However, research in the early 2010s suggested that these differences were due more to the economic effects of the Great Recession (that affected all travelers) than to generational differences per se. In addition, most Millennials still drive for most trips and live in suburban areas (and in fact may be *more likely* to drive alone to work, all else equal). And while Millennials are more likely than members of older generations to live in dense urban neighborhoods, most Millennials live in suburbs. Many surveyed older Millennials who live in urban areas reported planning to purchase a new vehicle in the near future. Thus, their low vehicle ownership rates and different travel patterns may be largely due to Millennials reaching traditional life milestones (like marriage and children) and greater financial stability later in life compared to earlier generations (Blumenberg et al. 2017; Circella et al. 2017). Many observers hoped that Millennials' preferences would, on their own, turn the tide against suburban living and driving to most destinations, and some hold out hope that Gen Z following them may still do so. But research suggests that generational factors, on their own, appear unlikely to bring about substantive location and travel behavioral changes, absent sustained changes in transportation and land use policies.

Changing Patterns of Warehousing and Goods Movements

As housing, employment, and generational patterns shape personal travel in new ways, so too is freight transportation changing. The robust growth of goods movement, driven by population and economic growth, international trade, and e-commerce in particular, has bolstered the state's fast-growing logistics and warehousing industries. But the lack of space for expansion around the state's largest seaports in Long Beach, Los Angeles, and Oakland and airports in Los Angeles and San Francisco has led warehousing facilities to sprawl to other parts of the state since 2000. Major warehousing centers have sprung up in the Inland Empire, southern San Joaquin Valley, and southwestern Sacramento Metro region, all areas close to major metropoli-tan centers, with good access to a logistics workforce and road, rail, air, and/or sea shipping networks, but with available developable land, zoning that permits the construction of large warehouses, and business-friendly policies. Such logistics sprawl has resulted in significant increases in goods movement, higher transfer and delivery costs, and increased environmental impacts (Caltrans et al. 2016).

The continued growth in freight transportation and e-commerce, particularly the growing demand for rapid shipping, have led to substantial rises in freight VMT and hence greenhouse gas emissions, other pollution, and noise. Shipments are becoming smaller and more frequent: since 2015, short-haul truck trips have increased by more than 17 percent annually in California's urban areas. Also, an increasing number of deliveries are made by contractors using personal vehicles, rather than by commercial truck drivers, which further increases freight VMT. Nonetheless, truck travel is still the major component of freight VMT, accounting for 20.9 percent of California's total VMT. Truck VMT increased from 85 to 98 million miles between 2014 and 2018, and is projected to reach 119 million miles by 2040. While greenhouse gas emissions from freight transportation declined until 2015, they increased over the second half of the decade and are projected to continue increasing as freight movement continues to grow (See Figure 19) (Dablanc and Rodrigue 2017; Caltrans 2020).

Figure 19 **Actual and Forecast Greenhouse Gas Emissions from Freight in California**



DATA SOURCE: Caltrans 2020

A key strategy to reduce these emissions is converting freight vehicles to zero-emission or near-zero-emission vehicles. Electric trucks are becoming an increasingly viable alternative to internal-combustion-engine trucks, as batteries become lighter and can store larger amounts of energy, but the adoption of electric trucks and trucks powered by other alternative fuels (including hydrogen and natural gas from the decomposition of organic waste) still needs considerable infrastructure support. This conversion, in combination with other strategies such as shifting more freight onto rail (where the adoption of zero-emission and near-zero-emission locomotives is also increasing), consolidation of goods and more efficient routing, and truck platooning (where a series of trucks following each other are connected and automatically controlled for acceleration and deceleration), can help meet the state's growing demand for freight movement while mitigating its environmental costs (Caltrans 2020; Dablanc and Rodrigue 2017).

All the while, freight transportation remains an important component of the state's transportation funding. For example, Proposition 1B in 2006 dedicated over $2 billion to the improvement of the state's freight infrastructure network and $1 billion for cleaner freight vehicles and equipment. SB 1, passed in 2017, provides $300 million per year for the Trade Corridor Enhancement Program, which funds infrastructure improvement to trade corridors with high volumes of freight movement (Caltrans et al. 2016; CARB 2021a). Yet, funding is still insufficient to meet the full costs of the types of improvements described above.

The Waxing Challenges of Climate Change and Resiliency

Economic globalization and advancing supply chain management rely on globally integrated transportation systems to enable just-in-time production, reduce inventories, and serve just-in-time consumption (Lai and Cheng 2009). California is a global center of such an integrated global logistics system. But in squeezing as much productivity as possible out of systems of production and consumption, transportation networks are stretched thin and becoming increasingly vulnerable to disruption. As a result, disaster recovery, safety and evacuation planning will be increasingly critical.

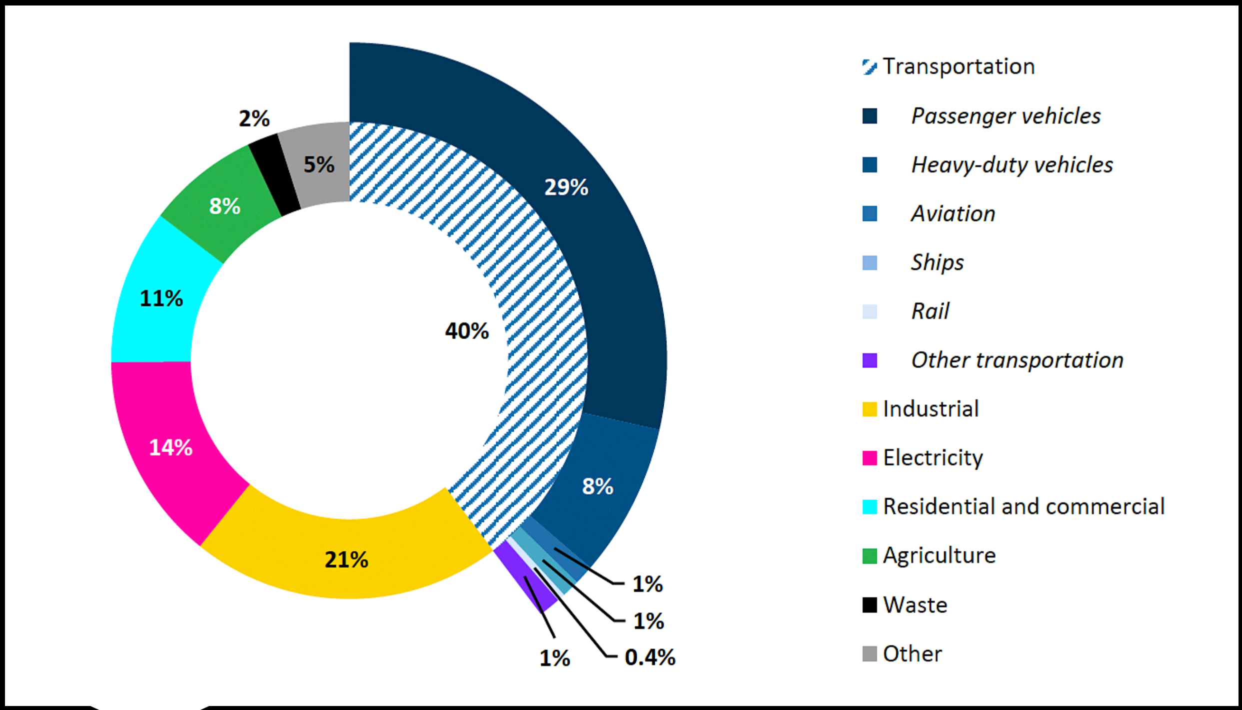
The COVID-19 pandemic has cast the consequences of transportation network disruptions in California for global supply chains and commerce in the sharpest possible relief. As of this writing, dozens of cargo vessels are queued up outside of the Ports of Long Beach and Los Angeles for weeks at a time, waiting to load and unload. The result has been frequent spot shortages of goods, leading to price jumps and contributing to rising inflation. In addition, public health protocols at transportation hubs and warehouses meant to protect workers have also contributed to freight bottlenecks. And, if that were not enough, trucking capacity has also been strained due to increased demand for goods, food, and medical supplies on one hand, and labor shortages on the other (International Finance Corporation 2020; Paris and Smith 2021).

Building more resilient transportation systems will require addressing an array of challenges: climate change contributing to chronic droughts, frequent wildfires, rising sea levels, and electrical grid breakdowns will likely affect transportation networks increasingly in the future. In addition, the ever-present threat of earthquakes is unpredictable and occasionally catastrophic. Rather than simply focusing on the speed and price of travel, resilient transportation systems of the future will have to respond and adapt to shocks and disruptions of all sorts.

With respect to the transportation sector's contribution to climate change, it was responsible for almost 40 percent of California's total greenhouse gas emissions in 2019, and passenger vehicles accounted for about three quarters of that (See Figure 20) (CARB 2021b). Lowering greenhouse gas emissions in the transportation sector depends both on greening (and in particular electrifying) the personal and commercial vehicle fleet, as well as by increasing travel by means other than driving, including public transit, as well as active transportation modes like walking and bicycling.

As we have noted throughout, transportation systems do not meaningfully exist apart from the land uses they connect, and sprawling, low-density urban forms that increasingly reach into fire

Figure 20 **Greenhouse Gas Emissions in California, 2019**



DATA SOURCE: CARB 2021b

and flood risk zones around the state typically require driving—and lots of it—to function. Accordingly, reducing our almost exclusive dependence on private vehicle travel for access is an important climate change mitigation challenge—not only for emissions reductions in the near term but also the long term, because manufacturing zero-emission vehicles can still generate substantial amounts of greenhouse gas emissions. Moreover, reducing driving dependence has additional benefits such as improved health and safety, as well as less burden on transportation infrastructures.

California's transportation system is also susceptible to damages and disruptions due to natural disasters, exacerbated and made more frequent and devastating by climate change. In 2020, the U.S. suffered $95 billion in losses from natural disasters, and California's wildfires were among the most significant. Wildfires have damaged many of the state's transportation systems; for example, landslides from flooding—ultimately due to loss of vegetation from the Dolan Fire in 2020—closed Highway 1. Suburbanization thus spreads out both the number of people who can ignite fires and the structures that are at risk of fire damage (Radeloff et al. 2018). With climate change intensifying wildfires and their human and monetary costs, the regulation of development both in wildland-urban interfaces—and, perhaps just as importantly, in less fire-prone urban areas where people could live instead—will be of great importance (Philson, Wagner, and Nawathe 2021). Even hurricanes, a rarity for the state, have caused chaos: when Hurricane Marie hit California in 2014, operations at the Ports of Long Beach and Los Angeles were halted, and damages to surrounding roads and facilities took months to repair. (Transportation Research Board Committee on Transportation Resilience Metrics 2021; Weilant, Strong, and Miller 2019).

The continued growth of global greenhouse gas emissions means that these increasingly frequent disruptions will likely be a long-term trend, with enormous economic losses and effects on trade and logistics as a consequence. Moreover, disruptions to infrastructure tend to cause greater hardship for low-income communities and communities of color, who are less likely to have multiple travel options and are more likely to work in industries affected by disruptions (Coleman, Esmalian, and Mostafavi 2020). Thus, the resilience of the transportation system—its ability to adapt to, recover from, and respond to a variety of threats to both physical infrastructure and operations—will become increasingly critical in the years ahead.

THE “THREE REVOLUTIONS” IN TRAVEL: NEW VEHICLE TECHNOLOGIES AND NEW MOBILITY

While conventional driving is growing—at the expense of transit, in the face of new multimodal spending, and spurred by new forces in employment, housing, and logistics—innovations in automobility and new modes altogether promise changes to the way Californians travel. As the global center of information technology, it should come as no surprise that California has been, and will likely continue to be, a leader in the development and deployment of new transportation technologies. Three simultaneous technological revolutions may shape travel in the years ahead (Sperling 2018): the electrification of vehicles, the rise of technology-enabled mobility (shared mobility such as ridehail, bikeshare, and scooter share, as well as telecommuting), and vehicle automation. We address each of these in turn below.

Vehicle Electrification

Electric vehicles (EVs) are not new. In fact, EVs dominated the streets of the industrial cities at the turn of the 20th century. However, while internal-combustion-engine technology developed quickly, the slow development of battery technology held back progress for more than a century, resulting in the current dominance of gasoline- and diesel-powered vehicles. In recent years, however, EVs have reemerged as an alternative, as stricter government fuel-economy and emissions regulations since 2010 have pushed new investments and innovation in battery technology. With major cost and range breakthroughs, EVs have become comparable to gas-powered vehicles in performance, styling, and (gradually) price (factoring in various consumer incentives). As costs continue to decrease, driving ranges further increase, and regulations tighten, consumer demand for EVs is predicted to accelerate in the 2020s (Sperling 2018).

As gas- and diesel-powered vehicles cause significant local air pollution and emit about 20 percent of the world’s greenhouse gas, vehicle electrification can help address both air pollution and climate change. While electrification of freight transportation is on the horizon, as discussed above, battery electrification works best for small and light-duty vehicles (Hydrogen fuel cells have significant advantages for heavy-duty vehicles.). However, vehicle electrification will be most effective at reducing emissions if the electricity powering vehicles is green—i.e., if the state’s electricity grid and hydrogen production are decarbonized. The good news is that more than half of California’s electricity already comes from renewable energy sources such as wind, solar, nuclear, and hydropower (Sperling 2018). But, EVs are unlikely to eliminate air pollution due to non-exhaust emissions of particulate matter from brake, tire, and road surface wear. Heavy-duty vehicles tend to emit more of such particles, but regenerative braking, increasingly adopted in EVs, may help reduce such emissions (Beddows and Harrison 2021; Penkała, Ogrodnik, and Rogula-Kozłowska 2018).

While EVs can also offer reliability improvements, new design opportunities, lower operation costs for drivers, and improved driving experiences, consumers have been slow in turning to EVs, even in California (Kurani, Caperello, and TyreeHageman 2016). Government regulations, subsidies, and incentives have been the major drivers of vehicle electrification to date, not consumer demand (Sperling 2018). But as manufacturing costs of EVs continue to fall as a result of technological improvements and economies of scale, the EV market appears likely to continue to grow.

Technology-enabled Mobility

In the past decade, new business models and technologies have enabled a concurrent trend in travel in California: technology-enabled mobility. This includes largely private shared mobility services, such as ridehail firms like Lyft and Uber, scooter share, and bikeshare (the former two of which originated in the Golden State), as well as teleworking.

App-based ridehailing has emerged and grown dramatically in the past decade as a new form of mobility, which in essence allows travelers to purchase automobility one trip at a time. Born in the San Francisco Bay Area, ridehail rapidly spread around the state, the U.S., and the globe. Despite its meteoric rise, the effect of ridehailing on private vehicle ownership and public transit travel, the longer-term viability of the business model, and how it may fit into the state's multimodal transportation system, all remain uncertain (Taylor et al. 2020).

Better-educated, younger, tech-savvy, and employed or student travelers are most likely to use ridehailing services. Whites and those living in higher-income households are also more likely to be frequent ridehail patrons, though less so for shared ridehailing options with multiple riders ("pooled" services). While the geographic spread of ridehail is in many ways remarkably broad, use tends to be higher in transit-rich, central-city areas. Use of cheaper, pooled ridehail services is higher in low-income and non-white neighborhoods. Ridehail use tends to be highest on Friday and Saturday evenings, which has likely reduced drunk driving (Malik, Alemi, and Circella 2021; Brown 2020).

There is a lively debate in the research literature and popular press over the effects of ridehail services on transit use, as well as active modes like walking (Wasserman and Taylor forthcoming; Circella et al. 2018). Conceptually, ridehail may *substitute* for trips once made on transit, on foot, or by bikes, but may *complement* transit by providing first- and last-mile connectivity to transit stops and stations. The true overall effect may be some combination of the two or little noticeable effect either way, as these modes tend to serve different travel markets. Surveys have found that ridehail trips tend to replace transit and active modes like walking and biking, but to various degrees (Schaller 2018; Feigon and Murphy 2016; Circella et al. 2018; Clewlow and Mishra 2017; Gehrke, Felix, and Reardon 2018; Hampshire et al. 2017; Henao 2017; New York City Department of Transportation 2018; Rayle et al. 2016; Dong 2020). There appear to be regional differences, as ridehail increasingly substitutes for transit the longer it has been operating in a given metropolitan area (Babar and Burtch 2017; Graehler, Mucci, and Erhardt 2019; Watkins 2021). A recent study of San Francisco using a unique dataset scraped from ridehail application programming interfaces (APIs), found that ridehail depressed bus ridership ten percent below expected levels, though not rail (Erhardt et al. 2021). However, in the South Coast and Inland Empire, ridehail's arrival and growth only occurred after the regions' ridership slump began (Manville et al. 2018). Despite the somewhat worrisome trend of ridehailing trips replacing transit, walking, and biking trips, the bigger effect of ridehailing services seems to be reducing use of private cars among their users (Circella et al. 2018).

All the while, ridehail firms have battled with politicians and labor groups over how they classify their drivers—as employees or independent contractors—with the latter arrangement enshrined by 2020's Proposition 22 (Myers, Bhuiyan, and Roosevelt 2019; Mollaneda 2021). Between these labor issues, questions about long-term profitability, the effects of the pandemic, the possibility of driverless ridehail vehicles, and the uncertainties discussed above, ridehail's effects on Californians' travel future remains to be seen. But given its incredible growth in the last decade, those effects are potentially significant.

New mobility services have also expanded beyond motor vehicles. "Micromobility" refers to small mobility systems, mainly bikeshare and scooter share. Because of their flexibility, speeds, and ease of use, micromobility services have gained great popularity among travelers. As of 2019, there were at least 51 bike share systems in operation across California. As for how micromobility services may affect travel more broadly, there little no conclusive evidence. On one hand, they can provide convenient "first- and last-mile" access to bus stops and train stations, thereby complementing and even augmenting transit use. On the other hand, they can be a good alternative to driving, transit, and walking for short trips. In fact, most micromobility trips are relatively short, usually less than 2.5 miles on average, and most scooter share trips are less than one mile (Chang et al. 2019; NACTO 2019). At least, because of its advantage in speed over walking, micromobility may replace walking trips (Taylor et al. 2020).

Transit operators and departments of transportation, too, are embracing technologies, such as vehicle location systems; trip-planning apps; automated sensing of vehicles, bicyclists, and pedestrians; curbside management systems; and intelligent transportation systems that can, as Los Angeles' does, optimize traffic signal timing according to real-time traffic conditions and give priority to transit and emergency vehicles (LADOT 2016). Most major California public transportation agencies employ the General Transit Feed Specification (GTFS), an open source data format that can be used to share information about routes and vehicle arrival and departure times. The information can populate a variety of consumer trip-planning applications that can reduce travel times and improve connections between services operated by different transit agencies (Frick, Kumar, and Post 2020). New smart card and mobile app technologies are also facilitating the development of universal fare payment media that should encourage more transit use. Other apps are being tested to assist in curb management, including reserving and paying for parking spaces and loading zones in downtown areas (Hammon 2021).

Finally, technology has replaced some travel altogether. The digital revolution has brought work closer to home, by literally allowing employees to transform their homes into workspaces. While only a small share of California workers has historically worked primarily from home, this portion of the workforce has slowly increased over the past 20 years (Speroni 2020; Morris, Taylor, and Speroni 2020). As noted in the Facts section, work-from-home rates rose from four percent in 2000 to six percent in 2017 (Ruggles et al. 2021a). These pre-pandemic telecommuters, though, actually had more vehicle miles of travel for work purposes than other workers, due to longer commutes when telecommuters did travel into the office and an increased number of work-related trips. They also had higher non-work VMT but typically took those trips at non-peak hours due to the flexibility in their schedules (Speroni 2020).

Due to stay-at-home orders, the COVID-19 pandemic led to truly extraordinary increases in working from home around the globe, including in California. While not every worker had the option of working from home, various estimates confirmed that in April 2020, at least half of employees worked from home at least part of the time (Guyot and Sawhill 2020). Of course, we cannot expect post-pandemic telecommuters to be so numerous or have the same travel patterns as those working from home during the pandemic. However, given the previous trends towards more working from home and reporting that both employees and employers expect substantially higher levels of at least part-time telecommuting post-pandemic, the effects on travel are potentially substantial, though highly uncertain (Economist 2021; Speroni 2020).

Vehicle Automation

The third revolution for vehicle travel perhaps looms largest in the popular imagination but is currently the least developed: vehicle automation. The term "autonomous vehicle" (AV) is less a category than a spectrum (classified into five levels, from "Driver Assistance" to "Partial Driving Automation" to "Full Driving Automation"), with a wide range of different driving functions that can be automated (SAE International 2021). Vehicles that operate in a fully autonomous manner (and that can further connect to one another, to traffic signals, and to roadside infrastructures to increase driving efficiency) are still far from realization. Currently, most AVs still require human input, to various degrees under different circumstances. Nonetheless, partial vehicle automation has grown in both number of functions automated and number of vehicles produced (Sperling 2018; di Palo et al. 2020).

When they do eventually arrive, fully autonomous vehicles will likely prove much safer than those driven by humans. Because they will not require driver input, these automobiles will also improve access for those who cannot drive, including young, old, ill, and disabled travelers (Circella and Mokhtarian 2017). Fully autonomous vehicles will free up driving time for travelers and allow them to perform other tasks. Finally, connected AVs can operate more precisely and follow each other more closely, which can lead to both energy savings and reduced traffic delays (Sperling 2018).

However, these benefits are contingent on the pace of AV development and adoption and installation of AV-supportive infrastructure. For instance, if fully autonomous vehicles are mixed with cars driven by humans, as they are likely to be for many years, the safety benefits are less certain. Moreover, the cost and environmental benefits of AVs depend in large part on the degree to which AVs are shared, both serially and with pooled rides, instead of individually owned and driven. Otherwise, AVs may only benefit a small fraction of society who can afford them (Sperling 2018).

The effects of AVs on traffic congestion are also uncertain. If vehicles are fully automated and connected, they should be able to operate smoothly. But, if owners leave their empty AVs idling on the street or send them home to avoid paying for parking, congestion could worsen. Thus, it is important to promote sharing of AVs and integrate vehicle automation with other forms of shared mobility, to maximize usage of vehicles and reduce overall vehicle usage. This also means that less parking and road space will be needed. Yet sprawl could also occur, as owners of AVs may move farther away from work. Integrating automation, electrification, and pooling all together will maximize the above benefits (Sperling 2018). However, most of these potential dark sides of AV adoption could be meaningfully addressed by intelligently managing all vehicles, both human-driven and AVs (by pricing or some other means). But because managing driving by humans has proven so difficult politically, it may be no easier to do so when fully autonomous vehicles begin to arrive.

However, there are still considerable obstacles for achieving and adopting full automation, and the self-driving car on most streets and roads appears to be many years away. The sensor hardware still needs to be more accurate and much cheaper; software also needs to be better at anticipating and reacting instantaneously to all possible scenarios on the road. In addition, consumers may also be reluctant to embrace full automation, because they may feel unsafe giving away vehicle control (Schoettle and Sivak 2015).

CONCLUSION

REFORMING TRANSPORTATION AND LAND USE POLICIES

As new forms of mobility arise across California, activists, planners, and policymakers are advocating for and implementing reforms to both transportation policy and land use regulations that influence travel. We review below nascent policies and reforms that have the potential to reshape transportation in the state, to better manage vehicle travel and reduce chronic congestion, and to shift patterns of development to make them less car-dependent.

Managing Motor Vehicle Travel

To combat traffic congestion, California governments have long added lanes to freeways and roads. Indeed, the end of the freeway building era, discussed in the Origins section, did not put an end to all freeway construction. While few entirely new freeways are being built today, engineers and planners have continued to try to relieve the burden of traffic congestion by expanding capacity, primarily through added lane mileage on existing freeways, as well as, more recently, by building new rail lines. Smaller roads are also being expanded and extended further into outlying locations, especially as jobs have followed residents to outlying areas, and the once familiar suburb-to-central-city commute has morphed into a cobweb of suburb-to-suburb journeys as once mono-centric cities have transformed into multicentric regions.

In highly trafficked cities across the state, increasing capacity in these ways has yielded disappointing results. When a new freeway lane is added, existing drivers do enjoy more road space and thus faster traffic flows—for a short period. But others, who previously traveled at different *times*, on different *routes*, or by a different *mode* to avoid the congested freeway, soon switch to the newly expanded and less congested roadway. This phenomenon—what Downs (2004) termed the "triple convergence"—means that congestion relief often proves fleeting. While adding road capacity increases the *number* of vehicles that can travel at a given time on a given route, it does not improve traffic conditions nearly as much as one might expect (or as governments forecast). Other transportation capacity expansions or policies follow the same logic: staggered work hours, telecommuting, and expanded public transportation capacity may all pull drivers off of congested roadways, but in doing so make freeways more attractive to people who previously avoided them, leading them to quickly re-congest. To be sure, there can be other benefits to expanding roads, but alleviating traffic is, for the most part, not one of them.

Congestion pricing, which has been touted by transportation economists for decades as the best long-term solution to chronic traffic congestion, has slowly appeared in California. Under congestion pricing, prices for driving on a stretch of road change to reflect the current demand for the road, with prices set to ensure free flow of vehicles. Thus, drivers pay more to travel during peak traffic hours and directions and less at other times and directions (Small and Verhoef 2007). By exchanging time spent sitting in congestion with money spent bypassing it, road pricing sends a clear price signal to motorists both to be judicious in their consumption of scarce road space and to encourage them to shift to other travel times, routes, modes (such as public transit), or destinations for lower-priority trips.

On State Route 91 in Orange County, Interstate 15 in San Diego County, and Interstate 110 in Los Angeles County, drivers can travel in separated lanes to bypass congestion in the parallel, unrestricted lanes, for a fee that varies by time-of-day, direction, and vehicle occupancy (Taylor 2017b). These "high-occupancy-toll" (HOT) lanes do not fill up quickly with cars because the variable tolls ensure that traffic will almost always remain free-flowing (though the more cars that are allowed in for free, for exemptions like electric vehicles and carpools, the less this principle works). However, full congestion pricing of a road, corridor, or district, as opposed to just certain lanes, is being studied extensively, but has yet to be tested anywhere in the state.

In response to concerns raised about the potentially inequitable burdens of congestion pricing, scholars and advocates have noted that low-income people are more likely to live near congested roadways and their elevated levels of vehicle emissions, which result in negative health consequences, establishing an environmental justice case for congestion pricing. Lower-income travelers are also less likely to travel in the peak hours and directions and can benefit from redistributive transfers of congestion pricing revenues, further contesting the notion that congestion pricing would be less equitable than current (mostly inequitable) systems of transportation pricing and finance. In other realms, policymakers address equity concerns with the pricing of electricity, water, and other utilities by offering deeply discounted "lifeline" rates to lower-income customers; utilities do not give electricity and water away to everyone—rich and poor—for free in the name of helping the poor, as we do with scarce road space (Manville 2019).

The three largest California metropolitan planning organizations, in the South Coast and Inland Empire, Bay Area, and San Diego, and/or county transit authorities within them are all studying various potential applications of congestion pricing in their regions, including both expansions of HOT lane facilities and bridge and area congestion pricing (SCAG 2021; Emerson Smith 2019; LA Metro Office of Extraordinary Innovation 2021; Hiatt 2021). Progress has been slow, largely because of initial negative reactions to the idea among motorists who see it as an added fee to sit in traffic, rather than one that alleviates delays. But where tried and demonstrated, as with HOT lanes in California and broader area applications in London, Singapore, and Stockholm, travelers have been far more accepting of the idea after seeing it work. As California's population continues to grow and driving increases faster than road capacity, congestion pricing seems likely to gradually emerge as the most promising way to tame traffic delays while encouraging more travel by means other than driving (Taylor 2017a; Hårsman and Quigley 2011).

Managing Curbs and Parking

While curbs became widespread in the 19th century, they became a hot topic in transportation circles in the 2010s. A century ago, businesses and property owners along heavily trafficked streets built sidewalks, in part, to extend space to sell their goods. Before sidewalk designs were standardized—and cities used curbs to separate sidewalks for pedestrian travel from streets for vehicular travel—streets and sidewalks in the early 20th century were used for any number of social, political, entrepreneurial and transportation purposes (Loukaitou-Sideris and Ehrenfeucht 2010).

With new travel modes like ridehail, bikeshare, and micromobility becoming more popular, motorists are facing even more competition for curb space. Most commonly, though, curbs are used to store private vehicles. Parking, both on- and off-street, makes up a significant portion of urban land: in Los Angeles County, an astounding 14 percent of land is devoted to parking (Chester et al. 2015). And most of that curb parking is unpriced (Shoup 1999). Streets thus face a kind of "commons" problem, in which freely available curb space becomes overrun by drivers, who, when faced with limited free street parking, will cruise for spaces, worsening road safety, traffic congestion, and air pollution in the process (Shoup 2005). Rather than allocate curb space through pricing, policymakers have traditionally required developers to provide additional off-street parking, as discussed in the Origins section.

But many of the changes described in this report are challenging the notion that the street space adjacent to curbs should, first and foremost, be a place to store parked privately-owned vehicles. Priority lanes that allow public transit buses to move more quickly through congested corridors, separate lanes for bicycles and scooters, loading zones for vehicles making the growing number of small package deliveries, loading zones for ridehail vehicles and taxis to pick-up and drop-off customers, small "parklets" to give urban residents a bit of open space, and restaurant seating to facilitate outdoor dining are some of the many new competitors for curb space in cities. Given all of these competing demands, the wisdom of devoting the substantial majority of curb space to vehicle storage, often unpriced, is called increasingly into question.

These trends likely point to less curb space devoted to parking in the years ahead, with the remaining parking dynamically priced to manage demand Dynamically priced parking programs, such as SFpark in San Francisco, sets rates based on measured demand (Demisch 2016). Other innovative curb management programs are being developed to flexibly accommodate the expanding range of curb users. The COVID-19 pandemic dramatically expanded the use of curb space for business, particularly restaurants, making the questions of rights to and management of the curb increasingly urgent. While the future of curb management is still to be written, it seems certain that returning to days of devoting the vast majority of curb space to private vehicle parking is unlikely to return.

Slowing Sprawl in Favor of More Compact Development

As outlined in the Origins section, one of the key challenges California faces is its housing crisis, among the worst in the nation, whose effects range far beyond transportation. In the late 2010s, five of the six most expensive metropolitan housing markets in the U.S. were in California, and four more were in the top 20 (Kiplinger's Personal Finance 2021). This crisis is largely a failure of planning and not housing markets: as described above, planning restrictions make it more difficult and expensive to build housing in California, compared with many other states where building restrictions are less onerous. As a result, land use regulations and political pushback against housing development continue to exacerbate an already supply-constrained housing market in most California metropolitan areas.

With few affordable housing options in urban areas, development is often pushed to the wildland-urban interface, where housing abuts vegetation and wildlands and where fire risk is particularly high, especially compared with other states. Nearly all of these developments are composed primarily or exclusively of single-family houses, which are separated by landscaped features and connected by road networks that are not up to the task of accommodating rapid evacuations in the event of fire (Philson et al. 2021; Radeloff et al. 2018).

With both carrots and sticks, the State Legislature has haltingly begun reforms to the state's local land use policies. In order to meet the state's emissions goals, the state allocates cap-and-trade revenue to fund housing- and transportation-related programs to increase construction of transit-oriented developments (California State Legislature 2014). Recently, the state has begun to modify or preempt local zoning and transportation regulations as well. For instance, in 2008, Governor Schwarzenegger signed Senate Bill 375, which requires metropolitan planning agencies to establish plans to reduce vehicle miles traveled (Steinberg 2008). In 2019, the state passed Assembly Bill 68 to allow for "accessory dwelling units" (smaller second units in the backyard, garage, basement, etc. of a single-family home) (Ting 2019). And in recent years, State Senator Scott Wiener has introduced a number of proposals to increase housing production, particularly along transit corridors, such as by streamlining housing approvals, enabling higher density housing near transit and job hubs, and allowing for new in-law housing units (Office of Scott Wiener 2018). While increasing density in already developed areas of California has proven more politically and logistically difficult than other tools that might reduce driving (Downs 2004), in 2021 alone, Governor Gavin Newsom signed more than two dozen bills into law to increase the production of both market-rate and affordable housing. These bills are expected to add more than 84,000 new affordable homes by encouraging backyard accessory housing units, reforming developer fees, and making it harder for cities to turn down small apartment buildings (Kendall 2021).

On the transportation front, in 2013, California Senate Bill 743 shifted the way traffic impact is assessed under the California Environmental Quality Act, whose details are discussed in the Origins section. Instead of a focus on traffic level of service (LOS), which measures the ease of local vehicular traffic flow at nearby road segments and intersections, projects are now to be assessed on how they affect overall VMT through project design and mitigation measures. While these revised guidelines are, as of this writing, still being developed and adopted, this shift represents a step away from auto-oriented policy and planning toward infill, compact, and mixed-use developments (Lee and Handy 2018; Ding and Taylor 2021).

While what the state has implemented is not yet of the scale to influence transportation patterns writ large, and while housing affordability and anti-displacement measures have lagged behind these land development and CEQA-based efforts, we mark this trend as a potentially powerful counterweight to the historical forces of decentralization discussed above.

CONTEXTS FOR REFORM

We opened this report by arguing that we cannot understand transportation systems and travel apart from the land use contexts within which these systems and travel occur. Given this, shifting California's transportation future will be highly context-dependent as well.

In the state's most urban places, the recipe for a diversified, sustainable, and equitable transportation system already exists. And in most all of these places, the market demand for higher-density development and housing is in place, save the considerable resistance by some incumbent residents to making these already urban places even more urban and home to more people to fill sidewalks, bike lanes, buses, and trains, in places where driving is slow and parking is expensive. The transportation challenges in such places are not functional, but largely political.

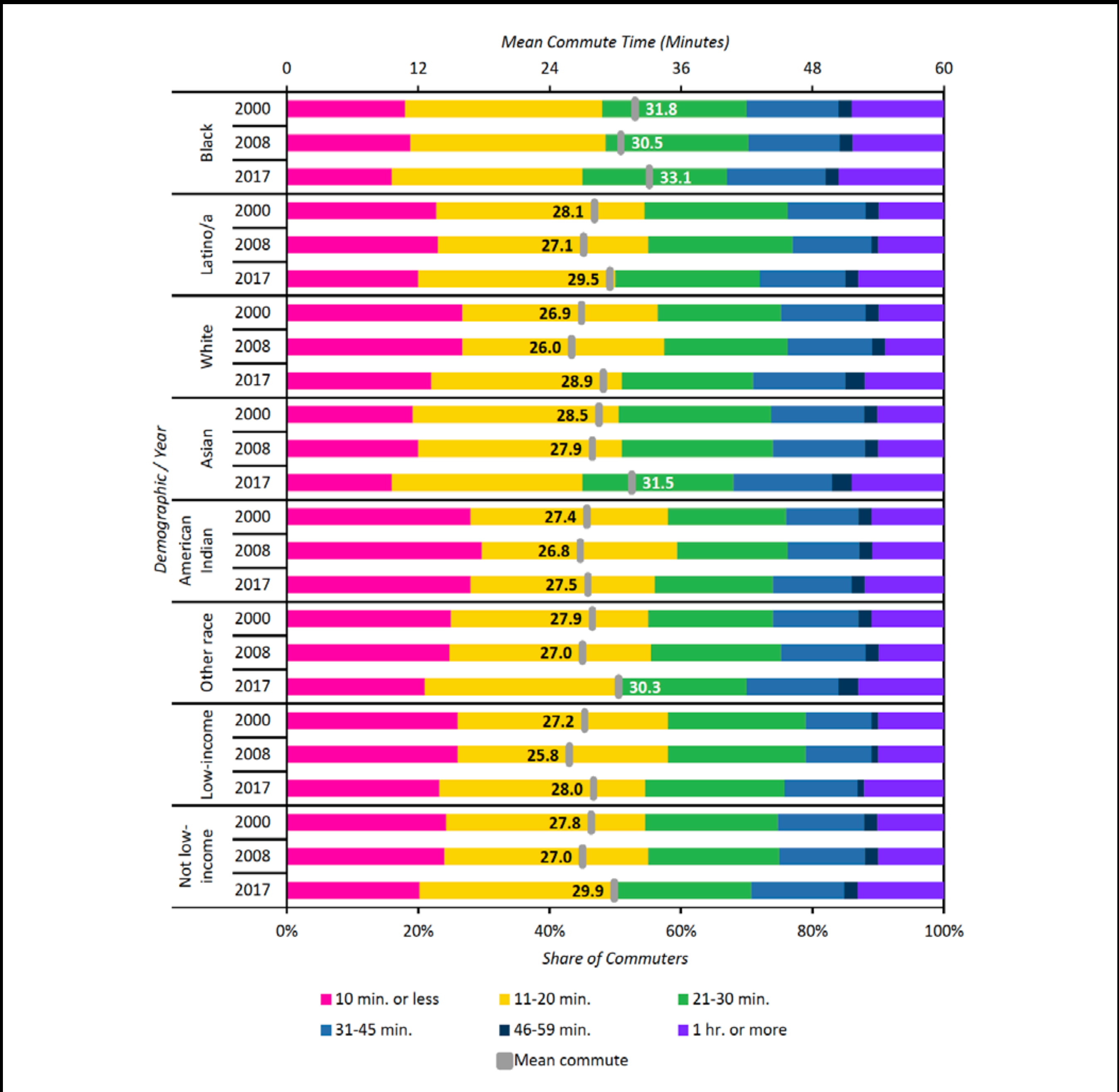
In suburban California, where most residents of the state call home, the challenges are much more than political will. Such environments are built specifically for car travel, and meaningful changes to their form and transportation function will not be easy. Here, greening the vehicle fleet will reduce (though not eliminate) transportation's environmental footprint. While utilitarian walking trips are often long, most suburbs are well-suited to accommodate biking, but often lack sufficient bicycle infrastructure, including bike parking, compared with streets and parking for cars. Traditional fixed-route, fixed-schedule public transit often struggles to compete with driving in places where acres of free parking separate transit riders from businesses. Here, next generation, demand-responsive public transit vanpool services, as well as shared-ride ridehail services hold promise to increase access for those without cars. And, as noted earlier, even in the lowest-density California suburbs, all of that government-mandated parking is expensive to provide. Eliminating these requirements, which would make it easier for builders to increase housing and commercial densities and would make businesses more likely to charge drivers for expensive-to-provide parking, can also shift California's many suburbs toward becoming more diverse, affordable, and multimodal places.

Finally, in small towns and rural parts of California, most travel is likely to continue to be by cars and trucks. However, such places, while numerous and geographically extant, account for a relatively small share of travel in California. Furthermore, here too, biking infrastructure is often sorely lacking, on-demand transit services are sparse and largely limited to those with disabilities, and commercial developments often encourage driving from destination to destination in town, rather than parking once and walking between destinations. In such places, transportation shifts are likely to be more gradual, but more sustainable and equitable forms of travel are possible.

APPENDIX

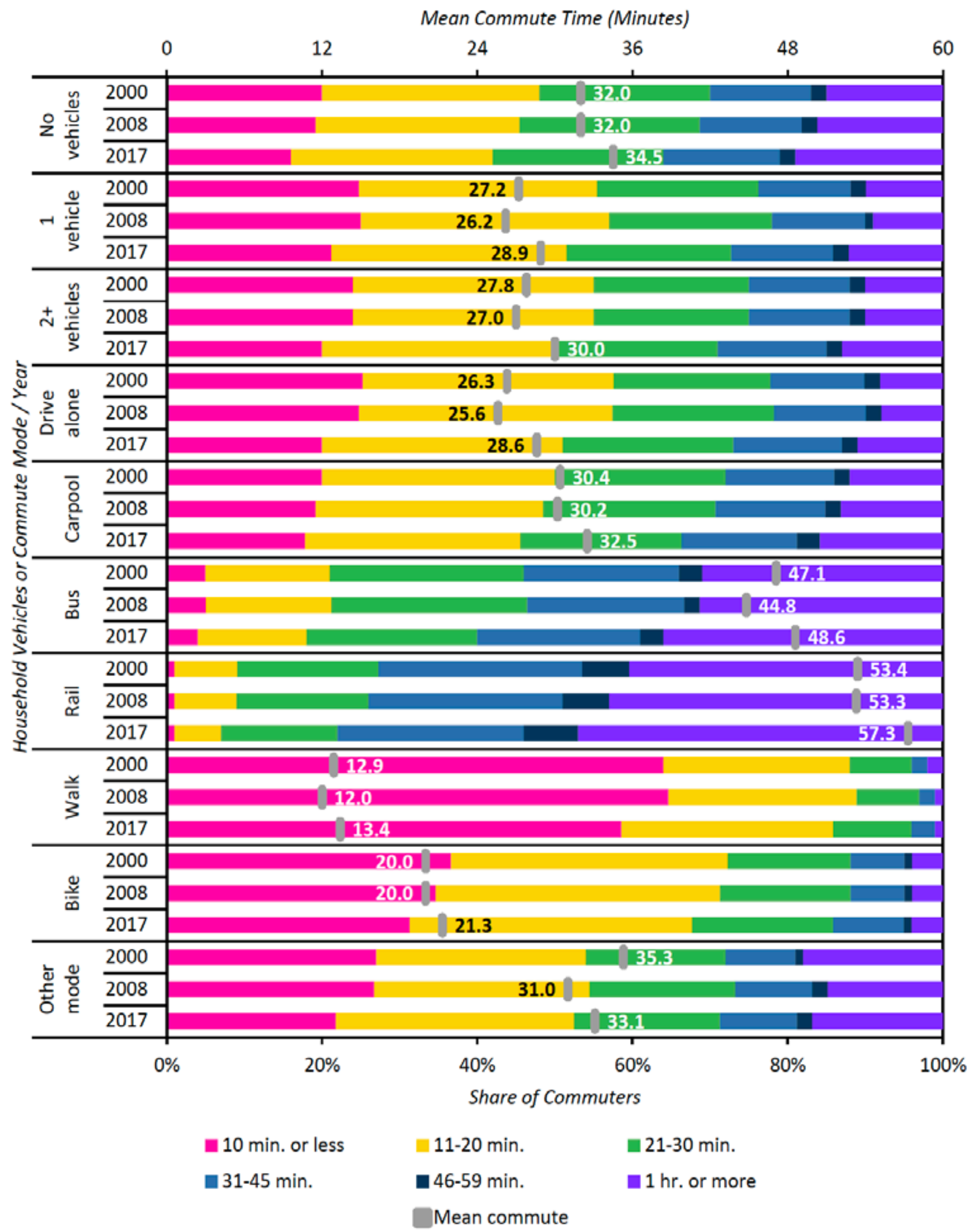
SUPPLEMENTARY FIGURES

Figure A 1 Travel Time to Work in California by Race/Ethnicity and Income



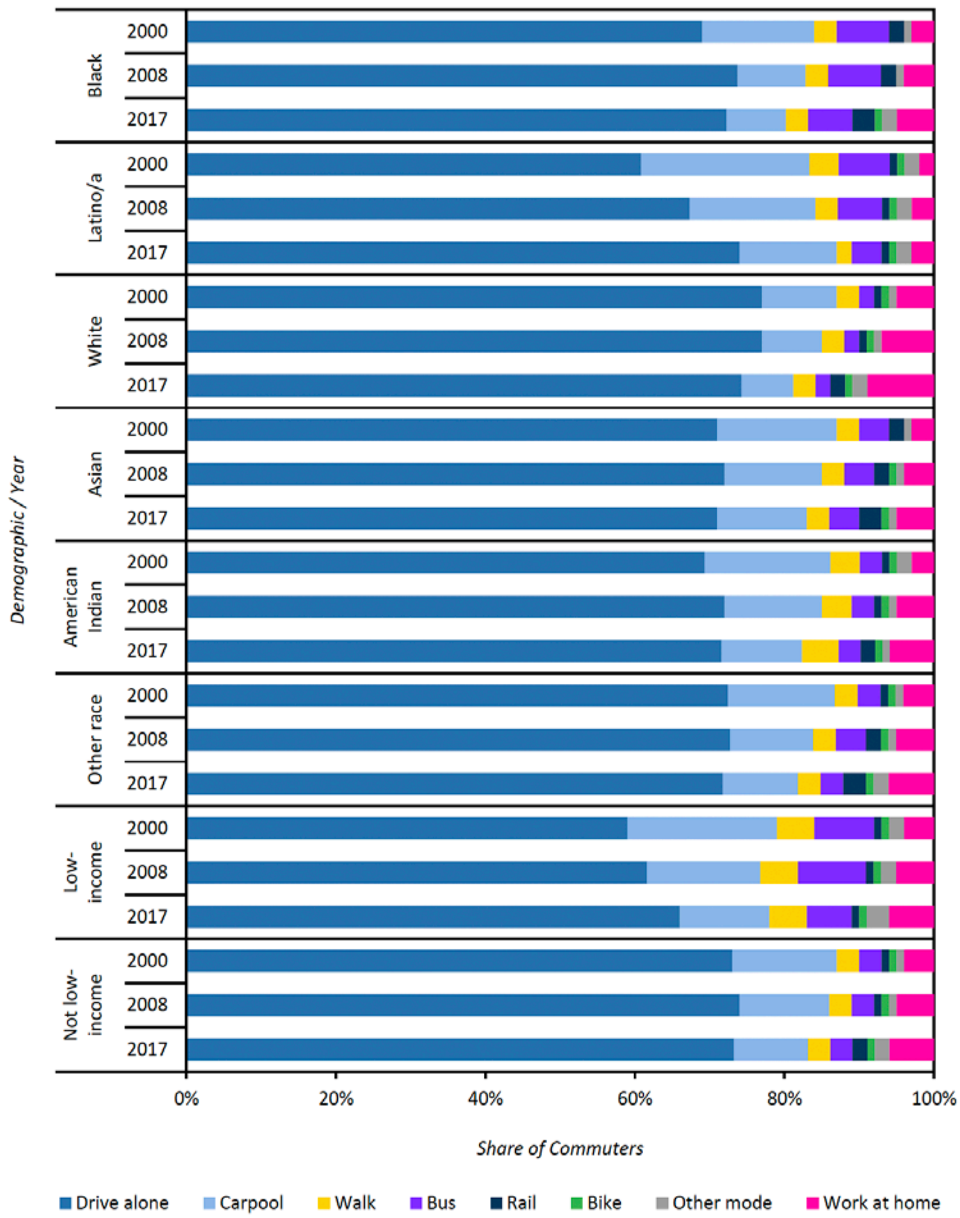
DATA SOURCE: Ruggles et al. 2021a

Figure A 2 Travel Time to Work in California by Vehicle Access and Mode



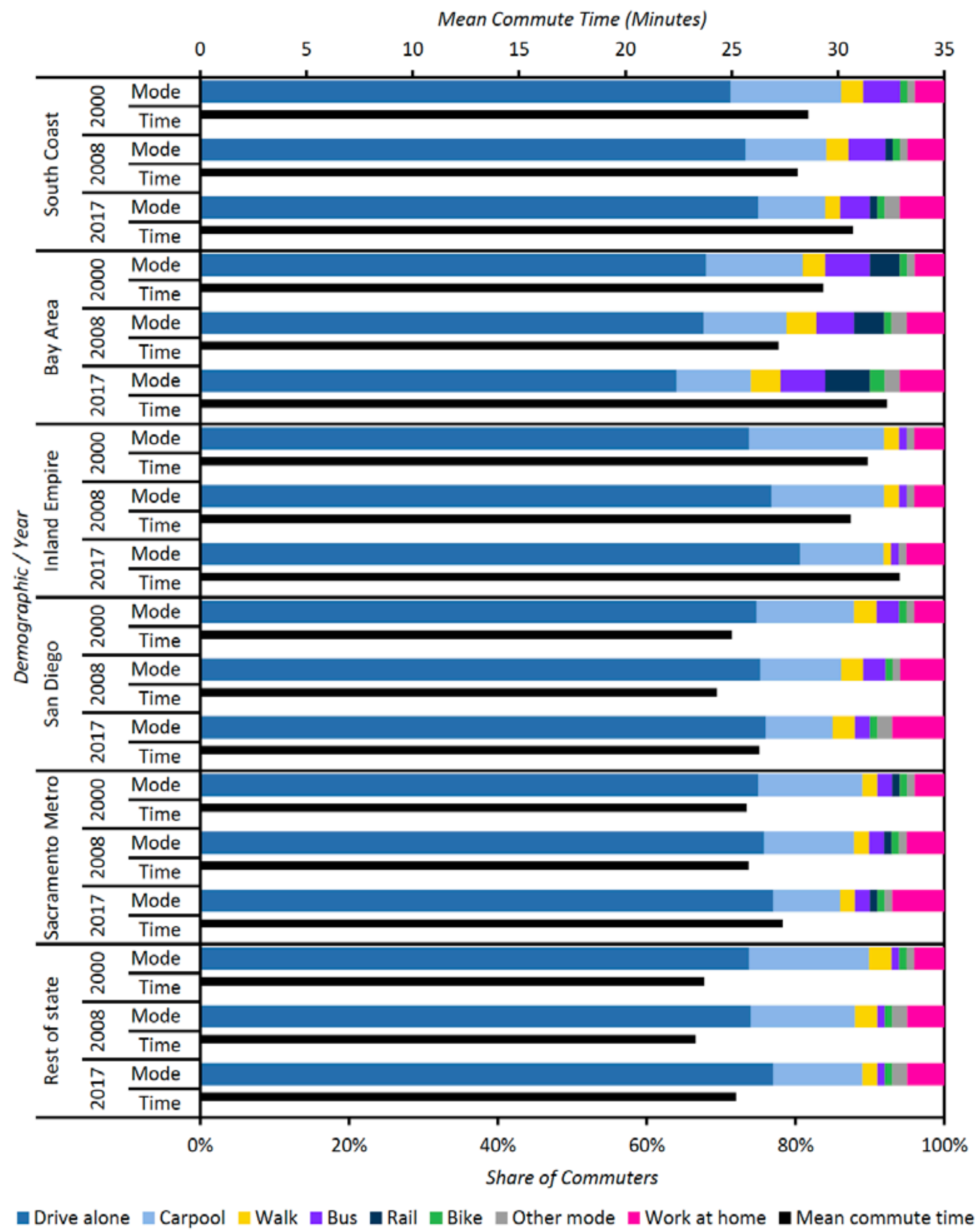
DATA SOURCE: Ruggles et al. 2021a

Figure A 3 Commute Mode in California by Race/Ethnicity and Income



DATA SOURCE: Ruggles et al. 2021a

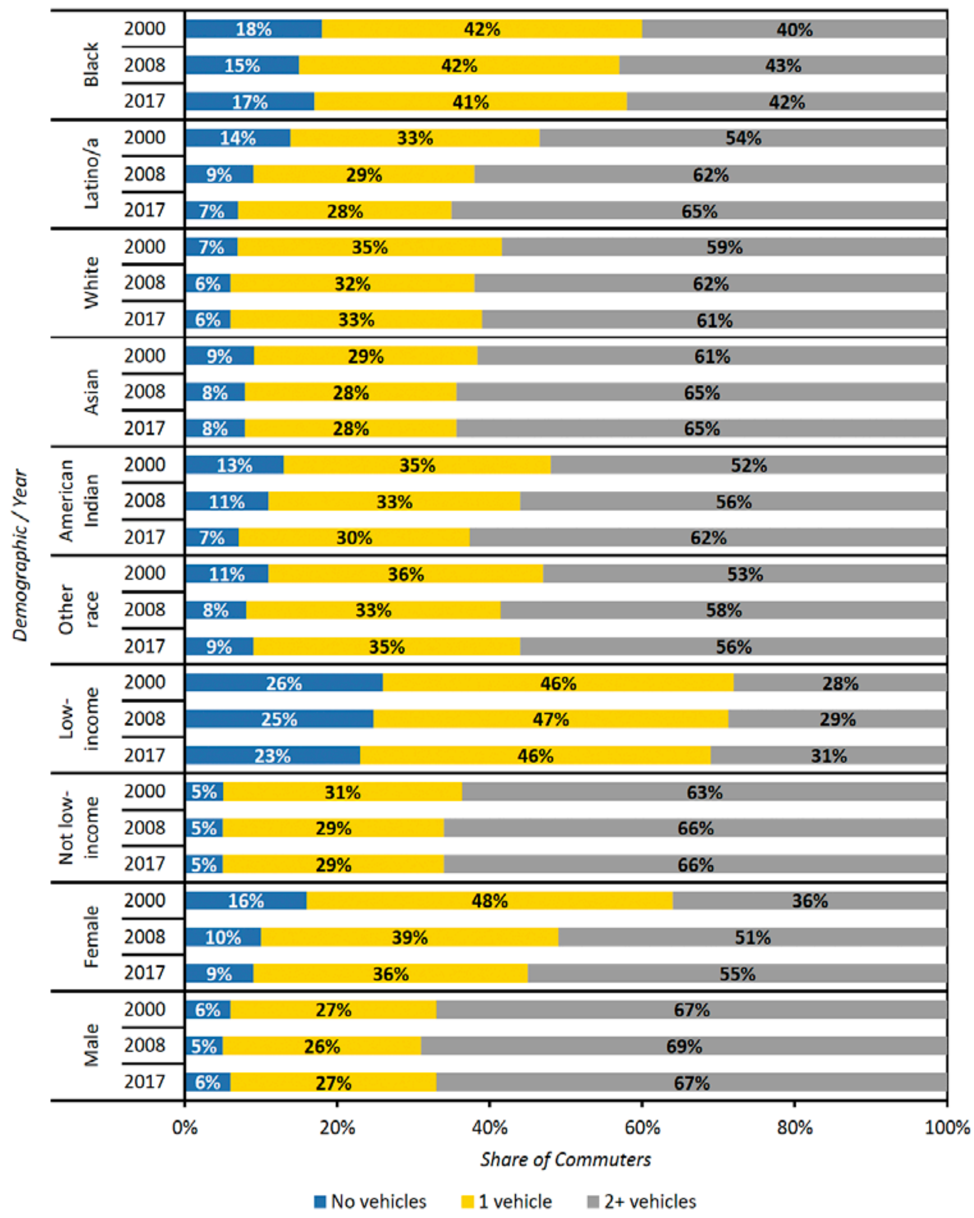
Figure A 4 Commute Mode and Travel Time to Work in California by Region



DATA SOURCE: Ruggles et al. 2021a

Figure A-5

Household Vehicles in California by Race/Ethnicity, Income, and Gender



DATA SOURCE: Ruggles et al. 2021a

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