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MTI MINETA TRANSPORTATION INSTITUTE

Is Parking Cash-Out Worth It? Comparing Cost-Effectiveness and Climate and Equity Benefits in the Bay Area and South Coast Air Quality Management Districts

Fynnwin Prager, PhD
Ashley Membere, PhD
Tianjun Lu, PhD
Parveen Chhetri, PhD

CSUTC California State University Transportation Consortium

CSUDH CALIFORNIA STATE UNIVERSITY, DOMINGUEZ HILLS

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16. Abstract
This research explores the potential impacts of California parking cash-out policy changes on the Bay Area and LA County. Parking cash-out—a California law since 1992—requires that certain qualifying employers who subsidize employee parking offer employees the option to give up their parking space and receive cash instead. Studies show parking cash-out substantially reduces VMT and emissions, yet enforcement remains voluntary. Current policy covers few firms (<1%) and employees (around 11%) in the study regions. Policy reform to include companies with 20+ employees could increase this to 18%. Our experimental-design survey (n=963) explores behavioral changes in response to multiple policy variables and finds that 76.9% of employees would accept cash-out if offered, and that participants who had to pay the market rate for parking and were full-time commuters were more likely to switch to using public transportation at lower cash minimums. VMT related to employees covered by parking cash-out are substantial (5.6 million in the Bay Area; 5.7 million in LA County), and account for a combined 6,593 daily tons of GHG. As even limited adoption could have significant environmental benefits, parking cash-out would be a more cost-effective approach to reducing VMT than traditional TDM programs such as trip-reduction programs, workplace parking taxation, or transit subsidies and road diets, though further evidence on the direct influence of parking cash-out on commuter behavior is needed.

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Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219

Tel: (408) 924-7560
Fax: (408) 924-7565
Email: mineta-institute@sjsu.edu

transweb.sjsu.edu/research/2335

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Contents

List of Figures

List of Tables

List of Abbreviations

AB	Assembly Bill
AQMD	Air Quality Management District
CAM	Criteria-Alternative Matrix
CARB	California Air Resources Board
CBD	Central Business District
CSUDH	California State University, Dominguez Hills
DOE	Department of Energy
EDD	Employment Development Division
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GIS	Geospatial Information System
HOV	High-Occupancy Vehicle
LA	Los Angeles
MPC	Metropolitan Planning Commission
MPO	Metropolitan Planning Organization
NHGIS	National Historic Geographic Information System
NROS	Non-Residential Off-Street
PM2.5	Particulate Matter less than 2.5 Microns
PT	Public Transit
SOV	Single-Occupancy Vehicle
TDM	Transportation Demand Management
VMT	Vehicle Miles Traveled

Executive Summary

We explore the potential impacts of changes to state parking cash-out policy on two major California regions: the Bay Area and Southern California. Parking cash-out is a California law that requires certain qualifying employers who subsidize employee parking offer employees the option to give up their parking space and receive cash in place of this parking subsidy, and aims to reduce the incentives for commuters to drive solo that may result from employer-provided free or subsidized parking. Numerous studies have shown substantial reductions in vehicle miles traveled (VMT) and emissions due to parking cash-out; however, recent research on this policy remains limited. Despite parking cash-out being law in the State of California since 1992, enforcement remains voluntary and there are few examples of local jurisdictions adding further monitoring or enforcement mechanisms. Parking cash-out has also been adopted across U.S. states, counties, and cities, often as part of a broader suite of transportation demand management (TDM) practices. Because of this, it is difficult to assess empirically the effectiveness of parking cash-out.

For this study, we first undertake a thorough literature review. Literature suggests parking availability/accessibility plays a key role in commuting decisions, with price playing a mediating factor. This suggests that broader policy reforms would ideally address land use for parking. While California development requirements previously included parking minimums, which were often too high, recent state and local policy changes have prohibited parking minimums or imposed parking maximums in transit-oriented areas. Given the long-term nature of land-use decisions, pricing is easier to target. In LA County, there appears to be a substantial over-supply of parking spaces—in general and non-residential off-street parking in particular—limiting the influence of policy on prices and thus on commuter decisions.

We had three research objectives. First, we aimed to identify the status of the parking cash-out policy in California by asking: How many companies and workers are covered by the current parking cash-out policy? And: Which policy variables, such as size of company included, price minimums, and location, are the most important in terms of coverage? We estimate that current California cash-out law covers only a small share of firms (< 1%) and employees (3% of California and around 11% of LA County and the Bay Area). Expanding the policy to include organizations with 20+ employees would increase coverage from 11% to around 18%. The main constraint appears to be high ownership of employee parking spaces, and so, revising the policy to include owned parking could significantly broaden the coverage. Longer-term land use/planning requirements would be the most effective solution, especially in LA County, where the 1.77 non-residential off-street parking spaces per job rate is much higher than in the Bay Area, where the corresponding rate is 0.75. Our analysis of parking prices in both regions, while based on data with limitations, suggests that cash-out minimums may currently be set too low and that wages are a key driver of prices in the denser, urban cities in the study regions.

Second, we investigated the equity dimensions and behavioral implications of this policy, by asking: Who would accept cash-out if offered to them? And: What factors influence commuter

willingness to accept cash-out, their valuation of it, and related mode changes? This includes equity-relevant factors such as race, ethnicity, income, and location, as well as behavioral and attitudinal factors related to the sustainability beliefs and practices of individuals and their organizations. We used a multifactorial (3x2x3) experimental survey design (n = 963) to explore behavioral changes in response to multiple policy variables. Respondents were randomly assigned to one of 18 prompt combinations, whereupon they were asked to assume various commuting and parking conditions alongside their current commute time, income levels, and demographics. The 3x2x3 prompts were varied according to (1) the commute time on public transit compared to driving (same as driving vs. 30 minutes longer vs. 1 hour longer), (2) commuting frequency (commute full-time vs. commute and work from home), and (3) parking arrangements (paying market rates, workplace subsidizing half the monthly costs, and free parking).

PROCESS regression analyses allow for the investigation of a three-way interaction between public transportation commute time, commuter type, and parking arrangements on the three outcomes of interest. The key significant result in the experimental design is that full-time commuters who had to pay market-rate parking were more likely to switch to using public transportation at lower cash-out minimums. This finding suggests that there is an appetite for parking cash-out, especially when commuters are paying market rates for parking. Indeed, significant numbers of employees surveyed (76.9%) stated they would take parking cash-out if offered. An important caveat here is that this is a stated rather than revealed preference, and as such it is possible that some of the same individuals would not opt for cash-out if offered at their workplace. Nonetheless, this finding suggests that cash-out could have a notable influence in reducing solo car commuting if enforced.

Higher scores for sustainability attitudes, sustainability workplace behaviors, and perceptions of transit, as well as higher education levels, are all positively associated with cash-out choice. These results all follow intuition and provide insights for program managers as to which employees are the most likely to adopt cash-out, and which might need additional persuasion. Being White is associated with cash-out choice, which suggests that program managers may need to pay additional attention to non-White employees when considering program marketing to avoid potentially inequitable outcomes.

To keep the commuting conditions and choice sets simple, respondents were asked to state whether they would drive alone or take transit following the experimental prompts. The results here do not always follow intuition. Sustainability attitudes and behaviors were both associated with the choice to take transit (rather than drive); however, the associations were in opposite directions, negative for attitudes and positive for behaviors. Choosing transit is also positively associated with organization size, suggesting that, if parking cash-out were expanded to workers at small companies, there may be a lower relative uptake. Counter-intuitively, respondents living in urban zip codes are negatively associated with choosing transit. This finding may be influenced by variability in the multifactorial prompts.

Following intuition, respondents' valuation of cash-out appears to be negatively associated with sustainability attitudes, sustainability workplace behaviors, perception of transit, and education levels. In other words, respondents appear to be willing to access lower values of cash-out if they are more highly educated and have positive perceptions of sustainability. While organizational sustainability offers a counter-intuitive result here, the positive association between income and cash-out value suggests also that program managers may need to account for income levels when designing policies and informational materials. That organizational size has a positive association with cash-out value suggests that cash-out policies might have a broader impact if rolled out to smaller organizations, as their employees may be willing to accept a lower incentive to switch behaviors.

Third, we explored the cost-effectiveness in terms of climate benefits of implementing the parking cash-out policy by asking: What are the VMT and emissions implications of parking cash-out under different scenarios? And: How does cash-out compare to other policy measures to reduce solo car commuting? Looking at VMT and emissions, in the Bay Area, employees who benefit from free parking and commute solo account for a daily VMT total of 5,683,200. This results in average daily greenhouse gas (GHG) emissions amounting to 3,226 tons, particulate matter (PM2.5) emissions averaging 42.65 kilograms, and a daily fuel consumption of 512,000 gallons. Meanwhile, Los Angeles (LA) County reports a marginally higher VMT of 5,749,800, with average daily GHG emissions at 3,367 tons, increased average daily PM2.5 emissions of 54.94 kilograms, and a lower daily fuel consumption of 362,600 gallons.

Implementing a parking cash-out policy that encompasses 25% of these employees could yield significant environmental benefits. For the Bay Area, this policy change could lead to a 24% drop in VMT among applicable commute trips, decreasing to 4,319,000. Consequently, daily GHG emissions would fall to 2,433 tons, PM2.5 emissions would reduce to 32.49 kilograms, and fuel consumption would decline to 362,600 gallons. In LA County, a 25% participation in the parking cash-out policy could reduce VMT to 4,306,800, cut daily GHG emissions to 2,522 tons, lower PM2.5 emissions to 41.15 kilograms, and decrease fuel consumption to 271,600 gallons.

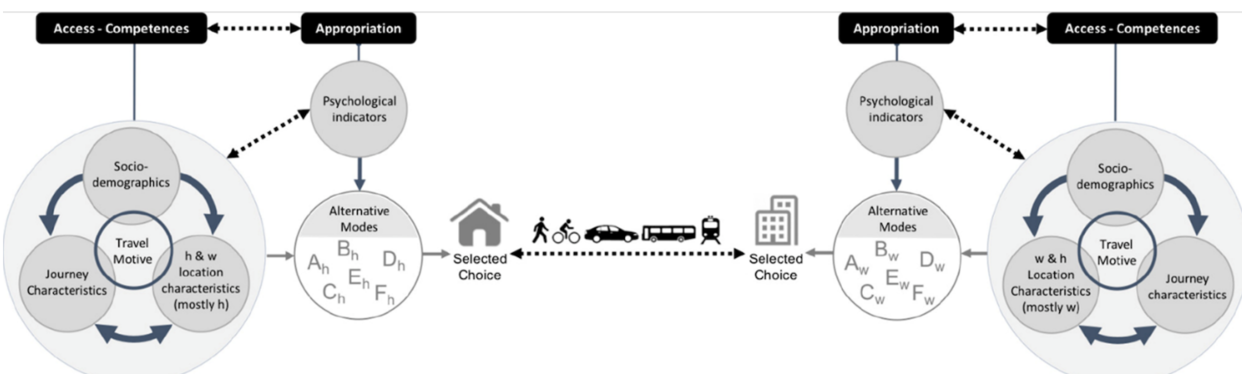
Looking more broadly at cost-effectiveness and related implementation issues, we find that parking cash-out provides a direct financial incentive to reduce solo driving, proving to be more cost-effective than traditional TDM programs. Unlike more complex measures, such as trip-reduction programs and taxation of workplace parking, parking cash-out simplifies the subsidy structure and directly encourages a shift away from driving alone. Compared to alternatives such as increased transit subsidies and road diets, parking cash-out requires minimal initial investment and has lower ongoing operational costs. Parking cash-out faces fewer barriers in terms of political and public opposition compared to strategies like removing tax exemptions for employer-paid parking; however, further policy dissemination and clarification is needed. Parking cash-out generally appears to outperform other alternatives in terms of simplicity and equity, but further evidence on the direct influence on commuter behavior is needed.

1. Introduction

This study examines parking cash-out policy in California, which aims to influence commuter decisions, especially to reduce solo driving, and to mitigate some of the harmful incentives created by an over-supply of parking spaces in land-use and urban design. Parking plays an important role in transportation systems and appears to influence commuter decision-making at both residential and workplace locations, which in California have traditionally included an abundant supply of parking due to a combination of consumer preferences and minimum parking requirements within planning laws. In this section, we explore existing car-dependent patterns, especially the large percentages of commuters driving to work alone in the United States, how these patterns exacerbate greenhouse gas (GHG) emissions and degrade air quality, and how parking-friendly land uses and parking infrastructure have encouraged solo driving.

The decision-making process for daily commuting is multifaceted and influenced by numerous factors (Figure 1). Specifically, parking is an important aspect of the decision to drive to work. This matters because, according to the U.S. Census Bureau, solo driving or "single occupancy vehicle" (SOV) driving remains the dominant mode of commuting in California, with 65.5% of full-time commuters driving alone (U.S. Census Bureau, 2022).

Figure 1. Conceptual Model of Daily Commute Mode Choice



Source: Zarabi and Lord (2019)

Solo driving has serious implications for travel, including traffic congestion and travel times, which result in direct and indirect costs in various economic, social, and environmental categories (Litman, 2009). It can be costly in terms of household budgets and commute time, though it is important to acknowledge that public transit and other alternative modes are seldom devoid of such costs, and commuters may be willing to pay for the convenience of driving alone. However, commuters may wish to take alternative transportation but face limited options. This is particularly relevant in LA, where public transit alternatives can be limited due to the polycentric urban form and legacy of car-oriented development.

Solo driving can also be energy inefficient. While concerns around energy self-sufficiency and security in the United States have declined in recent years as the nation has become a net exporter of oil, a reasonable goal of transportation systems is to be as energy efficient as possible. Solo driving can also be more emissions-intensive compared to alternative modes. Currently, fossil fuel-powered private vehicles emit a significant amount of GHG, diminishing air quality and contributing to climate change effects (U.S. EPA, 2020). Additionally, studies have shown a correlation between increased levels of air pollution from vehicle emissions and negative health outcomes, such as respiratory diseases and cardiovascular issues (World Health Organization, 2021), which warrants effective strategies to reduce automobile reliance. An important caveat here is that widespread use of electric vehicles has significantly changed the energy and emissions efficiency of California's fleet of commuter vehicles. 25% of new cars sold in California in 2023 were electric or hybrid (Lazo, 2024). In 2022, 903,620 electric vehicles were registered in California, which accounts for 37% of U.S. electric vehicles (U.S. DOE, 2023). On the other hand, gasoline and diesel vehicles accounted for 86% of all cars registered in California in 2022 (U.S. DOE, 2023).

Parking-friendly land uses (e.g., ubiquitous free parking) and subsidized parking often promote and encourage solo driving, despite the implementation of various strategies aimed at reducing automobile reliance (e.g., the provision of multiple transportation options and commuter incentives) (br& Breinholt, 1997). That is, the availability of abundant parking spaces near destinations creates an incentive for commuters to drive alone rather than exploring alternative modes of transportation. For example, a survey encompassing 4,000 commuters across 17 major metropolitan areas found that 89% of drivers have access to free parking at their workplace (Shoup, 2005). When parking costs are negligible, this can influence the decision of whether a commuter chooses to drive to work (Shoup, 2005).

Studies have found that employer-paid parking greatly increased solo driving (Surbur et al., 1983; Hess, 2001). Ample parking infrastructure is prominent in suburban and low-density areas, encouraging car ownership and solo driving (Litman, 2012). Extensive parking facilities at shopping centers or office complexes are also correlated with increased solo driving rates (Ewing & Cervero, 2010). Similarly, minimum parking requirements are imposed by local governments in downtown areas, resulting in excessive parking provision. This oversupply of parking spaces not only encourages solo driving but also contributes to urban sprawl and other associated consequences (Cervero & Kockelman, 1997).

1.1 Parking Cash-Out Policy

Parking cash-out is one policy intervention that can be used to support broader transportation demand management (TDM) approaches. TDM can be framed in different ways. In a broad sense, "[m]anaging demand is about providing travelers, regardless of whether they drive alone, with travel choices, such as work location, route, time of travel and mode. In the broadest sense, demand management is defined as providing travelers with effective choices to improve travel reliability" (Gopalakrishna et al., 2012). However, TDM has traditionally focused on approaches that workplaces and government policy makers can use to reduce commuter trips—and therefore vehicle miles traveled (VMT), emissions, and parking needs—by using more sustainable transportation modes such as ridesharing, transit, biking, and walking (Gopalakrishna et al., 2012). Parking cash-out can be used alongside other incentives such as tax benefits (also known as "commuter benefits") or tax credits, which could be provided to the employer or the individual directly.

The parking cash-out law introduced across California in 1992, broadened in 2009, and further amended in 2022, aims to mitigate automobile dependency, reduce traffic congestion, and improve air quality by reducing employer-generated parking incentives to drive solo (Shoup, 2005). This approach was first proposed by UCLA emeritus professor Donald Shoup to encourage employers to reduce the perk of free parking that counteracts other VMT reduction efforts, as well as to increase fairness for those who do not drive to work.

Parking cash-out policy serves as an innovative approach to managing parking demand. The policy encourages employers to offer employees the option to cash out parking benefits and incentivizes employees to choose alternative modes of transportation. For example, if solo drivers were given a monetary compensation for not parking at their workplace, some of them who currently park for free might opt for alternative modes of transportation (e.g., carpooling, using public transit, walking, or biking to work, or telecommuting). This policy could help achieve enormous benefits in social, economic, and environmental aspects by subsidizing people instead of providing free parking (Shoup, 2005).

The early implementation of this law in the 1990s did not appear to achieve the intended outcomes. Some employers are exempt from the law: current law requires employers to offer cash allowances in lieu of a parking space if they (1) have 50 or more employees, (2) are located in the air basin designated as non-attainment by the State Air Resources Board, and (3) provide subsidized parking for eligible employees (LCW, 2017). Moreover, this law does not apply to employers who own their property.

Other large employers may have not conformed to the law due to loopholes. As many commercial leases do not separate out the costs of parking, calculating the cash-out value is challenging. The 2022 amendments attempted to close some of these loopholes, for example by requiring employers to inform workers about their right to the cash-out benefit, and to document doing so. The bill also establishes a "market rate cost of parking"—the value of a parking space at the facility if purchased by an unaffiliated individual at no special rate, or the closest publicly available parking within a quarter mile of the workplace—which has a minimum of $50. The employer is required to maintain evidence of such prices (AB-2206, 2022).

Studies show that parking cash-out can be effective in reducing vehicle commuting and promoting sustainable travel (Peyton, 2022). One study of eight firms found a 12% reduction (1.1 million) in commuter VMT from parking cash-out (Shoup, 1997). However, this policy has been largely unenforced in California (Lee, 2021). AB 2206 was enacted to clarify key terms (California Legislation Information, 2022); however, enforcement remains voluntary.

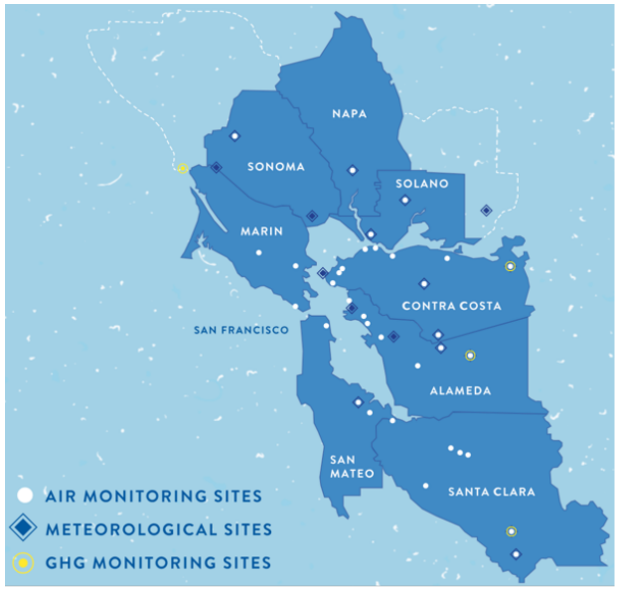
2. Literature Review

This literature review supports this report's analyses of parking cash-out policy, which include (1) the development of a model to estimate current employee parking based on existing parking inventory, (2) an experiment-informed estimation of the willingness to use parking cash-out, and (3) an estimation of VMT and emissions reductions resulting from parking cash-out enforcement as compared to other sustainable transportation strategies. As such, we start by looking at parking in LA County and the Bay Area before reviewing current implementation and enforcement of parking cash-out across California. Next, we review research exploring the influence of parking cash-out on travel behavior. In the last section, we explore the cost-effectiveness of parking cash-out policy in comparison to other sustainable transportation strategies. This includes the environmental impact of parking cash-out, greenhouse gas emissions from transportation in California, factors controlling emissions, and finally emissions calculation approaches.

2.1 Parking in LA County and the Bay Area

As shown in Table 1, in this study, we compare the Bay Area Air Quality Management District (AQMD) with South Coast AQMD, and LA County, which has a more comparable population size. The Bay Area AQMD (Figure 2) is similar to the Metropolitan Planning Commission (MPC); however, Solano and Sonoma are fully represented in MPC. In 2021, the Bay Area AQMD covered 7 million residents and 6.6 million registered vehicles, implying approximately 0.94 vehicles per person. The South Coast AQMD covered 17.8 million residents and 15.1 million registered vehicles, with a lower rate of 0.84 vehicles per person. LA County has 10 million residents and 8 million registered vehicles, at approximately 0.8 vehicles per person. While LA has the reputation that the "car is king", it appears that Bay Area residents own more registered vehicles per capita.

Figure 2. Bay Area Air Quality Management District Monitoring Sites



Source: Bay Area Air Quality Management District

These differences could be explained by numerous factors, which are presented in Tables 1 and 2. Publicly available data on Bay Area AQMD parking for 2020 are available from Chester et al. (2022) and on LA County parking for 2010 from Chester et al. (2015), which are updated to 2020 in this study. The comparison of the South Coast AQMD and the Bay Area AQMD is not ideal due to population size differences (17M > 7M). While LA County is closer in population size (10M) to the Bay Area AQMD (7M), there are some important transportation differences. LA County has more land for parking (14% > 8%) and more spaces per car (3.3 > 2.4), as well as lower median income and more poverty.

While the Bay Area MPC is not identical to the Bay Area AQMD, comparison with LA County Housing and Transportation Index metrics highlights differences between the regions that are relevant to our analysis. In terms of demographics, the Bay Area has significantly higher household income than LA County, which is relevant as income levels are correlated with commuting patterns. For housing, the Bay Area has fewer commuters, smaller households, and many more location-efficient neighborhoods, higher housing costs, and a higher share of owner-occupied dwellings. The Bay Area also has more “affordable” housing and transportation costs, though it is important to note that this is only relative to income. Looking at transportation access metrics, the Bay Area has both lower job access and lower transit performance scores, a similar number of vehicles per household, higher VMT and GHG emissions per household, higher transit costs and trips, and lower transit “shed” (i.e., the geographic area accessible within 30 minutes of public transportation).

Table 1. Characteristics of the Bay Area and South Coast AQMDs

	Bay Area AQMD	South Coast AQMD
Counties	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano (South West only), Sonoma (South only)	LA, Orange, Riverside, San Bernardino
Population (registered vehicles)	2021: 7M (6.6M) 0.94 vehicles per person	2021: 17.8M (15.1M) 0.84 vehicles per person LA County: 10.0M (8.0M) 0.80 vehicles per person
Average daily miles traveled per vehicle	2015: 25 miles	2018: 28 miles
Parking spaces	Bay Area (2020–21): 15M 7.9% land used for parking 2.4 spaces/car 1.9 spaces/person	LA County (2010): 18.6M 14% land used for parking 3.3 spaces/car 1.9 spaces/person
Land area	6,906 sq mi (1,013 residents/sq mi)	South Coast AQMD: 31,111 sq mi (554 residents/sq mi) LA County: 4,058 sq mi (2,464 residents/sq mi)
Median household income	$99–149K (by County 2022)	South Coast AQMD: $77–109K (2022) LA County $83K (2022)
Persons in poverty	7.2–10.5% (by County 2022)	South Coast AQMD: 10–13.9% (2022) LA County: 13.9% (2022)
Mean travel time to work	25.4–32.7 mins (by County 2022)	South Coast AQMD: 27.3–36.8 mins (2022) LA County: 31 mins (2002)

Sources: Chester et al. (2015), Chester et al., (2022), Metropolitan Transportation Commission (2024), South Coast AQMD (2019), U.S. Census Bureau (2023)

Table 2. Transportation Data Comparison of Bay Area MPO and LA County

	Bay Area MPO	LA County
Affordability		
All transit performance score	6.5	6.8
Annual auto ownership cost (U.S.$)	11,631	11,213
Annual GHG per acre (tons)	34.19	36.23
Annual GHG per household (tons)	6.33	5.41
Annual transit cost (U.S.$)	464	13
Annual transit trips	179	17
Annual transportation cost (U.S.$)	15,499	14,163
Annual VMT per household	15,446	13,490
Annual VMT cost (U.S.$)	3,404	2,937
Autos per household	1.79	1.79
Available transit trips per week	3,011	2,675
Average block perimeter (meters)	3,593	3,066
Average block size (acres)	17	11
Average monthly housing cost (U.S.$)	2,554	2,021
Block groups	4,748	6,421
Commuters	1.28	1.36
Compact neighborhood	1.6	2.6
Demographics		
Employment access index (jobs per square mile)	68,553	91,920
Employment mix index (0–100)	76	75
Environmental characteristics		
GHG from household auto use		
Gross household density (hh per acre)	0.62	1.28
Household income (U.S.$)	106,025	72,998

	Bay Area MPO	LA County
Household size	2.71	2.99
Households	2,731,115	3,316,795
Housing and transportation costs (% of income)	44%	52%
Housing costs (% of income)	29%	33%
Housing costs		
Intersection density (number per square mile)	39	70
Job access	7	7.9
Jobs accessible in 30 minute transit ride	216,563	326,652
Median gross monthly rent (U.S.$)	1,929	1,519
Median selected monthly owner costs (U.S.$)	2,847	2,312
Neighborhood characteristic scores (1–10)		
Percent of location efficient neighborhoods*	49%	11%
Percent owner occupied housing units	0.59	0.49
Percent renter occupied housing unit	0.41	0.51
Percent single family detached households	0.53	0.49
Population	7,709,518	10,081,570
Regional household intensity (hh per square mile)	39,829	61,601
Regional typical household		
Residential density 2010 (hh per residential acre)	2.17	3.05
Transit access shed** (kilometer squared)	74	119
Transit connectivity index (0–100)	29	24
Transit ridership % of workers	0.09	0.07
Transportation costs % income	15%	19%
Transportation costs		

Source: Housing and Transportation Affordability Index (https://htaindex.cnt.org/)
* Places that are compact, close to jobs and services, with a variety of transportation choices, allow people to spend less time, energy, and money on transportation.
** Geographic area accessible within 30 minutes of public transportation.

2.2 Current Parking Cash-Out Implementation and Enforcement

This section explores examples of parking cash-out policies and programs implemented by states, cities, and organizations in the U.S. Through these case studies, we will identify some enforcement challenges for early policies and impacts identified by research studies. We finish by exploring some limitations of current policies and programs and highlight understudied areas.

California has led the way in parking policy. Since 1992 (through Assembly Bill [AB] 2109), California state law has required employers with more than 50 employees who provide parking subsidies to offer a parking cash-out program (CARB, 2022). However, the state did not initially require that firms comply with the law and did not fund the California Air Resources Board to enforce it. In September 2022, AB2206 amended the parking cash-out program definitions and requirements for employers. The amendment requires that employees are notified of their benefits available through the program.

In lieu of state enforcement, some cities instituted local laws. For example, in 1996 the City of Santa Monica created a parking cash-out law as part of its Emission Reduction Plan for the South Coast Air Quality Management District, which cost $250,000 per year to administer. A 1998 survey of city firms found that around one-third of firms with 100 or more employees and 10% of employers with 50–99 employees were operating a parking cash-out policy. 20% of employees given the option to participate were doing so.

More recently, in 2014, Rhode Island created a parking cash-out program. Like California, employers with 50 or more workers and providing parking subsidies are covered; however, unlike California, the employers must also be located within a quarter mile of Rhode Island public transit services and are required to provide a transit pass instead of a cash payment.

In 2020, the District of Columbia instituted a parking cash-out law covering employers with 20 or more employees, yet exempting companies that had owned their parking before the policy was enacted. If companies choose not to offer cash-out, they can pay a monthly $100 fee per employee to the District Department of Transportation or implement an approved TDM plan.

Several U.S. cities and counties require that some companies offer pre-tax benefits (so-called "commuter benefits") to commuters. The City of San Francisco's Commuter Benefits Ordinance requires that employers with 20 or more employees provide commuter benefits to support workers to bike, take transit, and carpool to work. These payments could include an employer-paid benefit or pre-tax benefit up to $300/month for transit/vanpool or employer-provided transportation. The Cities of New York and Washington D.C. have very similar programs, though the latter only covers companies with non-union employees. The Cities of Richmond and Berkeley, California, have very similar programs but cover employers with 10 or more employees working 10 or more hours per week and with different limits for the pre-tax payments.

Numerous U.S. states offer tax credits to employers implementing parking cash-out. Maryland provides a 50% tax credit, up to $100 per employee per month, to employers that implement parking cash-out. Through Colorado's HB22-1026 (Alternative Transportation Options Tax Credit), employers can receive a 50% refundable income tax credit for expenses providing employees with alternative transportation. Delaware, Connecticut, Oregon, and New Jersey all provide tax credits for companies to implement TDM programs that may include parking cash-out. Numerous other counties—such as the County of Santa Clara, CA (County of Santa Clara, 2023), and Athens-Clark County, GA—offer employers tax-based incentives if they provide employees with parking cash-out or parking benefits.

Several notable public- and private-sector employers provide voluntary parking cash-out programs. Seattle Children's Hospital provides a "commute bonus" of $4.50 per day for alternative commuting (Seattle Department of Transportation, 2023). The City of Austin, TX, ran a pilot parking cash-out program, commencing in 2012 (City of Austin, 2012). While participation was not as high as anticipated, the emissions benefits and gained revenue from leasing out parking spaces were found to be substantial (Spillar et al., 2012). This finding supports the idea that California parking cash-out policy should be revised to also include owned parking. In 2016, the Spectrum Health company launched a parking cash-out program, offering workers a $75 monthly stipend, due to a lack of onsite parking at a new facility in Grand Rapids, MI (Manes, 2016). At the time, 26% of workers opted into the stipend rather than purchasing parking spaces in city-owned ramps at a reduced rate. In 2019, Google's new campus in Seattle offered employees parking cash-out for taking alternative transit modes (Merten, 2020). This reduced the company's solo-occupancy vehicle commute rate by 36%.

Major factors have contributed to the lack of implementation and enforcement, including (1) disagreement over enforcement methods among local and state government agencies, (2) unclear policy definitions, and (3) vague noncompliance penalties (Medina, 2019). To illustrate, underfunding frequently results in the reliance on local government for enforcement strategies. When implementation requires involvement from multiple levels of government, the potential for disagreements increases, leading to inefficient and noncompliant approaches (Burby & Paterson, 1993). Consequently, in 2009, an amendment was proposed to address these challenges in the enforcement of the parking cash-out law throughout California. Additionally, if the language of the law is complicated and poorly defined, compliance may be undermined. Specifically, when agencies, companies, and other stakeholders are uncertain about their obligation to adhere to the law, it diminishes the efficacy of the legislation, as is the case with the existing cash-out policy. Policies with clear and specific mandates are more likely to succeed compared to broad ones where standards and enforcement procedures are inadequate (Hoch, 2007). Furthermore, the issue of handling noncompliance with the California parking cash-out law poses a challenge for both local and state officials. However, imposing strict penalties for not complying with the mandated requirements seems to be the most effective approach (Burby et al., 1998). Overall, these factors act as obstacles to the successful implementation of the California parking cash-out policy.

Other challenges and limitations also exist. One of the primary challenges is resistance from employers and employees. Employers may be concerned about the administrative complexities of implementing the policy, including verifying commuting choices and managing cash incentives (Shoup, 1997). This issue can be more complex when the policy is implemented based on various scenarios (e.g., monthly, daily) (Parking Reform Network, 2023). Employees who are already used to free parking may resist shifting towards alternative transportation modes, which makes it difficult to expand such policy (Shoup, 1997). Additionally, parking cash-out policy may exacerbate transportation equity issues as parking cash-out is a flat rate to all, and so high-income employees can more easily afford to retain their free or subsidized parking (Litman, 2020). Such equity-related considerations may intensify implementation issues in California, which is home to a large population of vulnerable communities. Another challenge arises from the regional variation between urban and suburban areas. For example, urban and suburban contexts may require different approaches due to variations in transportation infrastructure, land use patterns, and commuting behaviors (Cervero & Gorham, 1995). These challenges and limitations suggest that parking cash-out policy should be tailored to suit the specific needs and contexts of the target regions.

2.3 Parking Cash-Out and Travel Behavior

While parking cash-out has been implemented in several jurisdictions and by many organizations, there is limited research on the specific impacts of this policy. As such, this review casts a broader net and explores the impacts of parking on travel behavior. We first summarize two published literature reviews of (1) travel behavior changes following workplace relocations (Zarabi & Lord, 2019), and (2) policy interventions to reduce car commuting (Graham-Rowe et al., 2011). We then look at other literature on the relationship between parking and travel behavior, especially considering an earlier review on the influence of parking policies by Marsden (2006).

Zarabi and Lord (2019) conducted a systematic literature review of studies relating to workplace relocation. These studies provide examples of natural experiments of transportation behavioral changes when workplace relocation occurs. One limitation of these analyses is that numerous conditional variables could be changing at the same time, which Zarabi and Lord identify as the methodological approach, locational characteristics (pre- and post-move, especially in terms of transportation and the built environment), and socioeconomic and attitudinal conditions. Of relevance here is that most of the studies that featured a significant increase in commute distance as well as shifts away from public transit accessibility saw shifts in commute mode towards solo driving. Conversely, the two studies where the workplace relocations moved from suburbs to subcenters or Central Business Districts (CBDs) both saw shifts towards public transit usage. In studies where relocation was more modest, the results were mixed.

Of the 22 studies Zarabi and Lord (2019) identified as relevant to workplace relocations, nine reference parking as a factor. These nine studies are summarized in Table 3. Of those nine studies, seven discussed explicitly the fact that changes in parking conditions caused changes in commute mode. Improved access to parking, regardless of price, increased car commuting even when workplaces were walkable from public transit; however, parking prices may have dampened shifts in some instances. In the three cases where workplaces relocated to CBDs, accessible public transit and reduced parking availability combined to result in increased public transit usage. Based on these studies, the level of parking accessibility appears to be paramount, with pricing playing a mediating role. Knott et al. (2019) confirm these findings in a study of Cambridge, MA, commuters where parking policies were changed. The introduction of free workplace parking appeares to have increased the proportion of motor vehicle trips by 11% and reduced the proportion of walking and cycling by 13% and public transit by 6%.

Table 3. Characteristics of Studies on Impacts of Workplace Relocation on Commuting Behavior

Study and data set	Methods	Transportation and built environment	Socio-economic	Commute mode shift
Aarhus (2000) Oslo, Norway. Three different companies N:6,500; N:370; N:80	Interviews with representatives of the companies; review of the relevant planning documents.	Pre-move: High accessibility to Public Transit (PT). Post-move: Significant increase in the share of car-based commutes; still within walking distance of PT.	N/A	PT to car. Increased access to the main road system and free parking.
Van Wee and Van Der Hoorns (2002) Netherlands	Two surveys (6 months before and 4.5 years after the move).	Post-move: Commuting distance increased for most of the employees. 23% residential relocation (a small number moved towards the new workplace).	Income, age, household size.	Car to PT. Easily accessible by PT and very little provision for parking. Total kilometer of commuting journeys (all travel modes) increased more in short-term than long-term equilibrium situation.
Meland (2007) Trondheim, Norway, 2000 N: 444 Average response rate: 47%	Two survey questionnaires before and two after the move (based on a one-week travel diary).	Pre-move: Unlimited parking facilities for all employees. Bus services only to and from the city center. Post-move: 43% reduction in car use; 23% increase in PT use. Walking and cycling for commute almost doubled in total.	Married/cohabitating participants with kids aged 11 or below tended to have a lower degree of change than the average.	Car to PT. Easy access to the entire PT system including the surrounding municipalities. Free parking for only 20% of employees and the number of parking spaces close to the offices decreased. However,

Study and data set	Methods	Transportation and built environment	Socio-economic	Commute mode shift
				parking was paid by the employer for 30% of workers. Out-of-office duties positively related to car use.
Bell (1991) Melbourne, Australia, 1987 N: 1,700 Response rate: 64%	Two survey questionnaires (five months before and ten months after the move) based on a one-day travel diary.	Pre-move: Accessible to train, bus, tram, company car and private car, and by walking. Free car parking for 38% of the employees. Post-move: Commute distance decreased for most employees. Bus, tram, and train within walking distance (400 m) of the site.	Age, gender, occupation, household size, employment details, car, and driver's license ownership.	PT to car. Reduced accessibility to PT and free parking spaces for almost 100% of the employees. Reduction in activities during the day such as leisure and social activities and an increase in activities en route home from work such as taking the children to school. 15% residential relocation (directly and indirectly related to the job relocation). Car and driver's license ownership increased.
Hanssen (1995) Oslo, Norway, 1991 N: 1,200 Response rate: 64%	Two survey questionnaires based on a one-day travel diary (one month before and 10 months after the move).	Pre-move: Free car parking for 6% of the employees. PT use: 61%. Car use: 25%. PT commuters' home location served by the radial subway system connected them to	N/A	PT to car. Free parking for 45% of the employees. 20% increase in PT commuters having to make transfers (their travel time increased by 7 min).

Study and data set	Methods	Transportation and built environment	Socio-economic	Commute mode shift
		the work location without any transfer. Post-move: PT use: 46%. Car use: 41%. Inner city residents switched from active modes to car. Many regional bus routes, railway, and a ferry served the site. The train was within a five-minute walking distance of the building. Average travel time remained almost the same.		Business journeys during working hours significantly decreased. Onerous journeys by PT after the move.
Aarhus (2000) Oslo, Norway N: 1,900	Interviews with representatives of the companies; review of the relevant planning documents.	Pre-move: High accessibility to PT. Post-move: PT accessibility and quality remained unchanged.	N/A	Car to PT. Decreased accessibility to car parking.
Vale (2013) Lisbon, Portugal N: 1,016 Response rate: 42.9%	A self-completion questionnaire before and after the move; binary and multinomial logit model.	Pre-move: High accessibility to PT. Post-move: Mixed-use transit-oriented center in the inner suburbs. Commuting distance increased. 11% increase in car use. Commuting time only changed slightly. The number of active (–4%) and	N/A	PT to car. Travel mode inertia and faster transport use to maintain commuting time within an acceptable limit. The availability of free parking mitigated the impact of land use characteristics and high access to PT.

Study and data set	Methods	Transportation and built environment	Socio-economic	Commute mode shift
		PT (-12%) users considerably decreased.		
Sprumont et al. (2014) Luxembourg City, Luxembourg, 2012 N: 397 Response rate: 36.4%	Multinomial logit model.	Pre-move: High accessibility to PT. Post-move: A new developing area at the city fringe and the country border. Accessibility to PT. High monthly parking cost.	Country of residence.	PT to car. Lack of mixed land use and increased commuting distance were the main reasons for a shift from PT to car commuting. PT subsidy and high monthly parking cost did not stimulate workers to quit car commuting.
Sprumont and Viti (2017)	A two-week travel-activity diary both before and after the move. GIS data collection, descriptive statistics, standard deviational ellipses combined with cluster analysis.	Pre-move: Few kilometers away from the city center. Post-move: Average commute distance increased. Significant distance between the new and the old workplace (twenty kilometers). Commuting time increased.	Age, gender, profession, having a child, home location, coincidence of other life events was investigated (e.g., home relocation, childbirth, buying a car).	PT to car. Slight increase in car-based commutes because of parking costs imposed on the new workplace, a car-sharing system, an online car-pooling platform, and an inter-campus shuttle. 19% of respondents relocated their homes but not necessarily because of job relocation. After workplace relocation, people significantly modified their activity space and kept it close to home.

Source: Adapted from Zarabi and Lord (2019)

Another review of studies by Graham-Rowe et al. (2011) aimed to identify the impacts of interventions to reduce GHG emissions from road transport. Of the 77 evaluations, 12 were determined to be methodologically "strong", and none of these focused on mode changes; instead they focused on distance and trip frequency. Most of the studies focusing on mode changes were deemed medium or low quality due to cohorts being analyzed in an uncontrolled setting. Of the medium quality studies, reductions in car travel were identified using "a range of personalized travel advice, information and sometimes incentives to change travel mode" (Graham-Rowe et al., 2011, 414). Of the 77 interventions, only five featured parking, as shown in Table 3. In terms of methodology, two were deemed medium quality (Miller & Everett, 1982; Shoup, 1997) and three were deemed low quality (Kristensen & Marshall, 1999; Rye & McGuigan, 2000; Olsson & Miller, 1978). All five observed reductions in the number of solo drivers; however, the lack of a control group raises questions about the generalizability of these findings. Nonetheless, all five studies found that changes in parking pricing, information, or availability reduced total car travel. In the study most relevant here, eight parking cash-out programs were evaluated by Shoup (1997), who identified a 13% decrease in single-occupancy vehicle driving, an 11% reduction in vehicle trips per commuter per day, and a 12% decline in VMT.

Table 4. Characteristics of Studies on Intervention Strategies for Car Usage Reduction

Author & date	Methodological quality	Effectiveness of intervention	Measure type	Intervention strategy
Shoup (1997)	Medium	Successful at reducing % of solo drivers, number of vehicle trips & vehicle miles travelled.	Distance, mode and trips	Structural (cash alternative to parking subsidies)
Miller and Everett (1982)	Medium	Mixed results across 15 worksites. Some decreased drive alone mode share, some increased it.	Mode	Structural (parking price increased at the workplace)
Kristensen and Marshall (1999)	Low	Successful at reducing vehicle kilometer per day and average trip length from gate at the outer perimeter of the city to parking locations.	Distance	Structural (Telematics parking information system)
Rye and McGuigan (2000)	Low	Successful at reducing the proportion of people driving to work alone.	Mode	Structural & psychological (carpool matching, preferential parking for car-poolers, reductions in PT costs, & travel information)
Olsson and Miller (1978)	Low	Somewhat successful at increasing carpool users.	Mode	Structural (parking discounts & carpool formation)

Source: Adapted from Graham-Rowe et al. (2011)

As the case studies in the Zarabi and Lord (2019) review suggest, parking availability and prices play an interactive role in influencing commute decisions such as mode choice and frequency. This applies to parking availability at the home and close to the workplace. While we focus on the latter here, the former matters too (Christiansen et al., 2017; Sherman, 2010). Manville and Pinski (2020) analyzed 2013 American Housing Survey data and found that when housing was bundled with parking, residents spent less on transit and more on gasoline. Even when they traveled by transit, commuters were more likely to drive to the transit stop from their homes. Moreover, Currans et al. (2023) analyzed 2017 National Household Travel Survey data and found that when on-site residential parking was limited to less than one parking space per unit in LA County, it resulted in a 10–23% reduction in VMT, depending on location type. Tian et al. (2019) also studied U.S. Household Travel Survey data and found that location type matters too, as more compact neighborhoods are associated with lower vehicle trip generation and vehicle ownership.

Regarding availability, Smith (2013) conducted two parking utilization surveys of neighborhood shopping centers on transit routes in San José, CA and found that free surface parking spaces were far below capacity, even during holiday periods. Hamre and Buehler (2014) used multinomial logistic regression of surveys of Washington D.C. workers and found that the availability of free car parking offset the effects of workplace benefits provided to support usage of public transit, walking, and cycling. These findings support the work of others in the field that minimum parking requirements for new developments are too high in California. These minimums effectively create a surplus of free or low-cost parking (Chester et al., 2015; Hess, 2001). Indeed, Chester et al. (2015) analyzed the California Household Travel Survey and found that 98% of automobile trips within the LA Metropolitan Statistical Area (MSA) begin or end with free parking. This confirmed earlier work by Willson and Roberts (2011) who showed that required parking exceeded demand in the Inland Empire region of Southern California, including availability of free parking.

A related aspect here is the location of parking facilities relative to workplaces and transportation systems. One way to measure this is "egress time", that is, the time taken to walk from the parking lot to the destination. Yan et al. (2019) analyzed revealed-preference survey data on University of Michigan, Ann Arbor commuters and found that travelers were more sensitive to changes in egress time than to changes in parking cost. Moreover, travelers were more likely to switch parking locations than transportation mode in response to parking policy changes.

Khordagui (2019) used a discreet choice model to analyze the California household travel survey dataset and estimated that a 10% increase in parking prices would decrease the probability of driving to work by 1–2%. Earlier reviews of empirically derived parking demand elasticities suggest that behavioral responses are somewhat inelastic to price changes (Marsden, 2006). Whitfield et al. (2016) found associations between parking prices and active commuting rates across densely populated U.S. cities: the number of people walking to work was 3.1% higher when prices increased by $1 for off-street daily parking. Proulx et al. (2013) surveyed UC Berkeley commuters and found that parking prices and transit fares influenced mode choices. The value of time for solo car commuters was estimated at $30 per hour. They concluded that to reduce solo car commuting, parking price increases would need to be combined with incentives to use other modes. On the other hand, commuters with lower incomes who did not have access to free parking were more inclined to choose alternative transportation modes such as riding transit, walking, or biking to work. This preference arose from their limited ability to afford parking expenses (Shoup, 2005).

In a literature review of parking policy and its influence on travel behavior, Marsden (2006) noted that carpooling often increases in response to TDM that includes parking policy changes. For example, Bianco (2000) found that a TDM package in Portland Oregon's Lloyd district appeared to reduce commuters driving alone, increase commuter carpooling, and yet had no discernible impact on commuter public transit use. Moreover, Marsden (2006) suggested that a "shift to carpooling appears to be a particularly important response, at least in the U.S. context. Any switch to public transport is highly context-dependent and interlinked with the degree to which carpooling is viewed as a viable option." That said, the U.S. Transit Cooperative Research Program (2003) found that when parking pricing and supply adjustments are combined with other TDM measures, commute mode shifts towards public transit can be substantial. Parking cash-out is relevant in both contexts as it offers the ability for commuters to benefit from mode shifts away from solo driving and towards carpooling or transit use.

In the absence of recent empirical studies on the influence of parking cash-out, Abou-Zeid and Greenberg (2022) conducted policy simulations of the impacts of different parking cash-out scenarios across nine major U.S. regions using a model based on employee numbers, commutes, travel costs, and elasticities. As shown in Table 5, cash-out is increasingly effective when combined with other policy measures, especially the pre-tax transit benefits. However, eliminating parking subsidies combined with a subsidy for non-SOV commuting would appear to have the most impact on VMT. Despite this important contribution, questions remain on how best to implement a parking cash-out policy, highlighting the need to design surveys to experiment with different scenarios.

Table 5. Reductions (%) in Daily Citywide Commute VMT by Scenario and City

City	S1: Monthly cash-out	S2: Monthly commuter benefit	S3: Monthly cash-out + pre-tax transit benefit	S4: Daily cash-out + pre-tax transit benefit	S5: Eliminate parking subsidies + $5 non-SOV subsidy
Boston/Cambridge, MA	10%	1%	10%	18%	29%
Chicago, IL	11%	7%	13%	18%	36%
Houston, TX	3%	2%	3%	7%	17%
Indianapolis, IN	5%	2%	5%	15%	24%
LA, CA	9%	5%	9%	17%	27%
New York, NY	3%	1%	11%	12%	36%
Philadelphia, PA	13%	9%	14%	21%	34%
San Diego, CA	6%	3%	6%	15%	25%
Washington, DC	4%	2%	6%	11%	24%

Source: Abou-Zeid and Greenberg (2022)

Equity

The equity impacts of parking cash-out can be considered in terms of numerous indicators, including race and ethnicity, gender, and income. There appears to be little discussion in the literature on the race, ethnicity, and gender dimensions of parking in general. Abou-Zeid and Greenberg (2022) also explored the equity implications of cash-out parking, focusing on impacts with respect to the household income distribution. There is a concern that—as free or subsidized parking is often provided to commuters in particular industries, occupations, and income levels—cash-out could disproportionately benefit those same groups. However, Abou-Zeid and Greenberg argue that if parking cash-out is offered to all employees, it provides an alternative benefit to those employees who are offered free parking but are unable to use it, for instance because they do not own a vehicle or they have access to a more convenient transportation mode.

2.4 Cost-Effectiveness of the Parking Cash-Out Policy

According to Shoup, it has been demonstrated that, in providing a direct financial incentive to reduce solo driving, the parking cash-out policy is cost-effective (Shoup, 2005). Unlike traditional TDM programs that often unintentionally subsidize solo driving, parking cash-out uniformly redistributes parking subsidies to all commuting modes. In general, parking cash-out simplifies the subsidy structure and ensures a direct shift away from driving alone.

Shoup (2005) compared parking cash-out with five alternatives and highlighted major weaknesses of those alternatives. Alternative 1, which offers traditional TDM programs (e.g., carpool initiatives and public transit subsidies), provides relatively lower subsidies for higher occupancy vehicles and could lead to an increase in the number of vehicles in commuter driving. This alternative may be less effective and cost inefficient (Shoup, 2005). Alternative 2, which mandates trip-reduction programs, is often costly but achieves minimal benefits. For example, in the South Coast Air Quality Management District, firms would spend approximately $3,000 annually to eliminate a single peak-hour trip (Shoup, 2005). Alternative 3 removes tax exemptions for employer-paid parking. Designed to discourage solo driving, it faces significant implementation barriers due to political and public opposition (Shoup, 2005). The weakness of alternative 4—an increase of tax exemptions for transit subsidies—is that it does little to counteract the impact of parking subsidies and is unlikely to significantly shift commuter behavior on its own (Shoup, 2005). Lastly, alternative 5, which taxes workplace parking spaces, theoretically reduces solo driving by increasing the cost of parking. However, this approach could also inadvertently promote employer-paid parking if the tax is not passed on to employees, thus diminishing its potential effectiveness (Shoup, 2005). Above all, Shoup asserts that parking cash-out policy is superior in terms of simplicity, equity, and direct influence on commuter behavior while achieving environmental goals.

Environmental Impact of Parking Cash-Out

Greenhouse gases (GHGs) are mainly composed of CO_2 and its emission reduction is important to curb the global temperature rise. In the United States, CO_2 represents approximately 83% of total GHG emissions (Kenney et al., 2014). The transportation sector accounts for the largest portion (28%) of total U.S. GHG emissions in 2022, and light-duty vehicles (including passenger cars and light-duty trucks) were by far the largest category, contributing 57% of GHG emissions genereated by the transportation sector (EPA, 2024). In 2022, light-duty vehicles represented 37% of CO_2 emissions from the transportation sector in the U.S. (U.S. EPA, 2024). The worldwide transportation sector contributes 23% of current CO_2 emissions, most of which come from road transport (Graham-Rowe et al., 2011). Car travel in the developed world significantly contributes to emissions from road transport; for example, in the United States, it has been observed that up to 91% of all vehicle miles traveled (VMT) are attributed to cars (FHWA, 2021). Within the U.S., the transportation sector is a significant contributor, responsible for about 28% of all GHG emissions, with passenger cars alone accounting for nearly 58% of transportation emissions. Cars are the primary transportation mode to workplaces in the United States, therefore reducing car travel to work by promoting telecommuting and remote service or switching to alternative transportation modes can significantly reduce CO_2 emissions.

Free parking at workplace locations is common and widespread in the United States. According to Brueckner and Franco (2018), more than 80% of all U.S. firms provide parking for their workers. This number varies across the country: LA and San Diego (90%), Indianapolis (79%), Chicago (52%), Philadelphia (52%), Houston (41%), Washington (31%), and New York (5%)

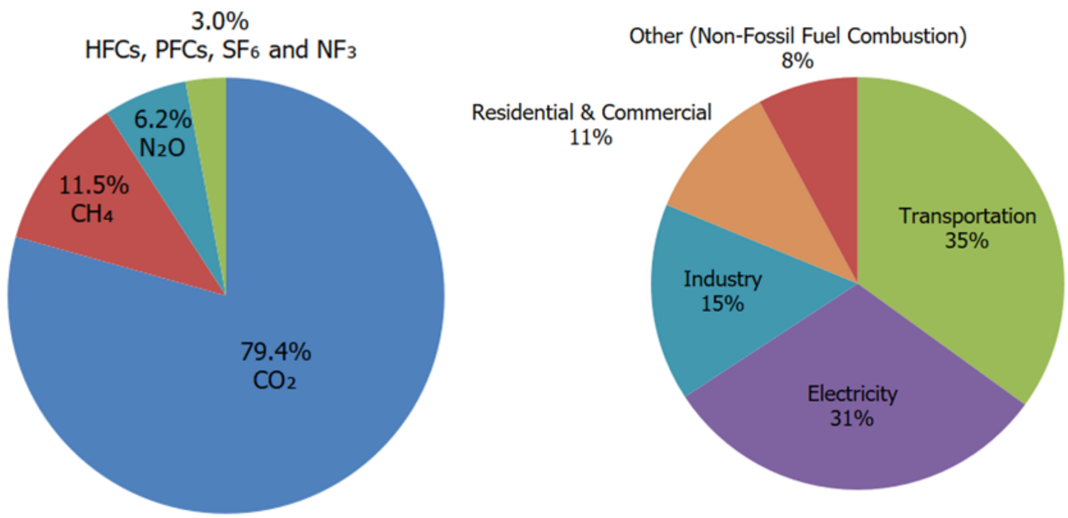
(Tscharaktschiew & Reimann, 2021). Several studies have indicated that there is no economic benefit from free parking; however, free parking at the workplace encourages more employees to drive. This ultimately results in urban sprawl, traffic congestion, environmental pollution, stress, reduced land area available for green spaces, increased housing costs, degraded urban design, reduced walkability, damage to the economy, and the exclusion of poor people (Shoup, 2005; Davis et al., 2010; Brueckner & Franco, 2018).

Several studies have demonstrated the positive impact of parking cash-out on reducing work-related VMT. For instance, Shoup (1997) conducted a study on eight firms in Southern California and observed a 13% reduction in drive-alone commute trips and a 12% reduction in commute VMT following the implementation of parking cash-out policies. Similarly, Glascock et al. (2003) found a 10% decrease in employee parking demand in Seattle as a result of parking cash-out. Additionally, Van Hattum (2009) examined seven employers in the Minneapolis–St. Paul area and reported a 12% reduction in SOV travel due to parking cash-out programs. These findings highlight the effectiveness of parking cash-out in reducing VMT and promoting sustainable transportation options.

Greenhouse Gas and Transportation

The transportation sector is the biggest contributor to GHG emissions in the U.S. (U.S. EPA, 2024). The heavy reliance on motor transport has led to the increased release of greenhouse gases, especially CO_2; and in 2021, the transportation sector contributed the largest percentage of GHG emissions (35%) (U.S. EPA, 2023a; Figure 3). Reducing GHG emissions from transportation is an important strategy for addressing global climate change (Goodchild et al., 2018). GHG emissions from the transportation sector can be lowered by reducing the amount of work travel (reducing the number of VMT). VMT can be significantly reduced by encouraging alternative commuting options such as walking, biking, taking transit, telecommuting, and carpooling (Hass et al., 2010). Many Metropolitan Planning Organizations (MPOs) throughout the United States are implementing VMT reduction strategies, which can fall under short-term VMT reduction and long-term reduction (Kenney et al., 2014). Short-term VMT reduction strategies focus on influencing individual travel behavior by promoting rideshare programs, adding managed high-occupancy vehicle lanes, specifying priority parking spaces for carpool vehicles, and by encouraging employers to provide a guaranteed ride home from work in the case of a mid-day emergency for employees who do not drive their vehicles to work (Kenney et al., 2014). On the other hand, long-term VMT reduction strategies focus on modifying travel patterns in the long run. These strategies involve more fundamental changes in transportation-related systems and may be related to land use, employment, or other areas (Kenney et al., 2014). A policy like a parking cash-out has the potential to discourage solo driving to work and thus to reduce oil consumption, which would limit GHG emissions (particularly CO_2).

Figure 3. U.S. Greenhouse Gas Emissions and Sinks: 1990–2021



Note. GHS types appear on the left and GHG contributions by sector appear on the right. Source: U.S. EPA, 2023.

A study conducted by Hass et al. (2010) considers the example of a worker residing in a suburb with no access to public transportation. In this scenario, their household's average carbon emissions resulting from VMT amount to 7.15 tons of CO_2 per year. However, if the individual decides to relocate to the city, opting for a walkable neighborhood near a transit system with job opportunities and amenities, the average VMT-related carbon emissions for their household decrease to 4.07 tons (Hass et al., 2010).

Factors Influencing Emissions

About 95% of transportation GHG emissions are CO_2 emissions, and most of the quantification methods to estimate GHG emission are focused on this pollutant (Weigel et al., 2010). Several studies have considered multiple factors that can have an influence in controlling emissions. According to Yaacob et al. (2020), the amount of CO_2 emissions depends on the vehicle's condition and the type of fossil fuel it consumes. Mickunaitis et al. (2007) have demonstrated a linear relationship between CO_2 and fuel consumption; Shu et al. (2010) proposed a method for estimating CO_2 emissions from transportation that considers fine spatial scales. The method combines data on vehicle activity, road networks, and emission factors to calculate CO_2 emissions at a more detailed level, allowing for a better understanding and analysis of transportation-related carbon emissions; Heres-Del-Valle and Niemeier (2011) explored the relationship between land-use changes, VMT, and CO_2 emissions in California; Zhang et al. (2014) emphasized the use of traffic volume, traffic speed, and road networks in traffic CO_2 emission; Gharineiat et al. (2018) studied the effect of vehicle type and speed on CO_2 emission; and Kan & Tang (2018) focused on the amount of fuel consumed with travel distance.

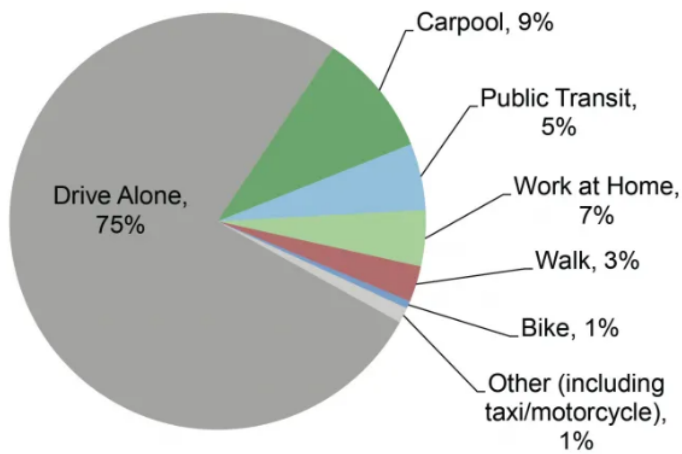
The amount of carbon emitted by motor vehicles is influenced by: vehicle or fuel characteristics, including engine type and technology, air conditioning, fuel properties and quality, deployment, and the effectiveness of maintenance; fleet characteristics, which include vehicle utilization by vehicle type, transport mode, the age profile of the vehicle fleet, and the adequacy of fleet maintenance programs; operating characteristics, namely, the distance traveled, speed, degree of traffic congestion, and traffic control system (Faiz et al., 1996). According to Zhang et al. (2014), accurately quantifying CO_2 emissions from the transportation sector is challenging due to limited statistical and spatial data in certain areas. This limitation hinders the identification of the number of vehicles and their corresponding travel distances. Additionally, the factors influencing traffic-related CO_2 emissions vary depending on the traffic conditions. For instance, vehicles in stop-start traffic emit more CO_2 compared to vehicles traveling on freeways. Therefore, any calculation of carbon emissions from a transportation system should consider both traffic conditions and the spatial distribution of roads, along with the total number of vehicles on the road. Table 6 highlights the CO_2 emission measurement method used in a few representative studies.

Table 6. Summary of the CO_2 Emission Measurement Method Used in Certain Representative Studies.

Authors	Methods	Factors considered
Shu et al. (2010)	Implemented a volume-preserving interpolation method for detailed spatial representation of CO_2 emissions from transportation.	Vehicle activity, road networks, and emission
Weigel et al. (2010)	Reviewed calculation tools available for quantifying GHG emissions. Categorized inventory-based calculators (suitable for standardized voluntary reporting, carbon trading, and regulatory compliance).	Fuel use and vehicle miles traveled
Heres-Del-Valle & Niemeier (2011)	Utilized a two-part model with instrumental variables to assess the impact of land-use changes on vehicle mileage and emissions.	Land use
Zhang et al. (2014)	Employed a four-step traffic prediction model to calculate traffic-related CO_2 emissions.	Traffic volume, traffic speed, and road networks
Barzyk et al. (2015)	Used community-LINE Source Model, a web-based tool to estimate and track emissions and dispersal of toxic air pollutants for U.S. roadways.	Traffic volume, fleet mix, and vehicle speed

According to the U.S. DOE, in 2020, about 75% of workers commuted by driving alone (Figure 4), suggesting significant potential for VMT savings if commuters were to switch to alternative modes of transportation (U.S. DOE, 2022).

Figure 4. U.S. Modes of Transportation to Work in 2020



Source: U.S. DOE (2022).

A comparison of estimated annual VMT savings per commuter for major transportation modes and policies is provided in Table 7, based on calculations from various sources. For example, the parking cash-out policy incentivized employees to opt out of employer-provided parking and reduced VMT, which resulted in estimated annual savings of 652 miles per commuter (Shoup, 2005; Russo et al., 2019). However, there is limited information on the VMT reduction associated with other alternative travel modes; and the findings were mixed. For example, it is estimated that telecommuting could reduce VMT, leading to annual savings of 3,300 miles per commuter (Choo et al., 2005). Public transit and carpooling can also significantly contribute to VMT savings, though precise data are less readily available. Studies suggest that robust public transit systems can reduce individual commuter VMT by 20% to 30% depending on the extent of their network and service frequency (Litman, 2017). For a daily commute of 30 miles, this could result in savings of six to nine VMT per day per commuter and 2,190–3,285 miles per year per commuter. According to a recent report by the California Air Resources Board (CARB), which uses a default adjustment factor of 0.27 (an adjustment factor accounts for transit dependency and induced trips (new trips that would not have otherwise been made without car sharing) (CARB, 2019)), commuters who switch from auto trips to carsharing can save 2,957 miles per year. Similarly, with an adjustment factor of 0.5 (primarily to account for induced trips and recreational bike share use) for bikeshare and scooter share programs, commuters can achieve an annual savings of 5,475 miles (CARB, 2020).

Table 7. Estimated VMT Savings per Year per Commuter for Major Modes/Policies

Transportation mode/policy	VMT savings per year per commuter	Source
Parking cash-out	652 miles	Shoup, 2005; Russo et al., 2019
Telecommuting	3,300 miles	Choo et al., 2005
Public transit	2,190–3,285 miles	Litman, 2017
Carsharing/carpooling	2,957 miles	CARB, 2020
Bikeshare and scootershare	5,475 miles	CARB, 2020

According to a mitigation playbook recently released by Caltrans, various VMT mitigation measures demonstrate different levels of ease of implementation, efficacy, and requirements (Caltrans, 2022; Table 8). Among these, parking pricing and restrictions stand out with high ease of implementation and high efficacy, suggesting that parking cash-out policy may be comparatively effective.

Table 8. VMT Mitigation Measures

Measure	Ease of implementation	Efficacy	Key considerations
Active transportation	High	Low	Must provide access to destinations, not simply recreational opportunities.
Land use – residential	Low	High	Requires partnership agreements with land use jurisdictions, housing authorities, and private developers. VMT benefits come from density, affordability, and location.
Land use – employment	Low	High	Requires partnership agreements with land use jurisdictions, housing authorities, and private developers. VMT benefits come from density and location.
Transit service improvement	Low to high	Low to high	Usually requires partnership agreements with transit operators.
Local road networks/ connectivity	Low to high	Low to high	Can relieve pressures on the State Highway System and provide more direct, multimodal access to destinations.
Micro-mobility	High	Low	Requires partnership agreements with transit operators and/or transportation network companies.
Telecommuting	High	Minimal	Telecommuting tends to shift trip-making, but not reduce VMT. Any claim here would need careful, specific support.
Schedule-shifting	N/A	None	Reschedules rather than reduces trips. Likely increases VMT.
Road diets	High	High	Lane removals can be considered roughly equivalent to lane additions for similar facilities.
Transportation pricing strategies	Low to high	High	Operational details and market analysis needed during Project Approval and Environmental Documentation.
Lane management	Low to high	Low	VMT effect depends on specific management strategy such as transit/HOV priority.
Parking pricing/restrictions	High	High	Potentially powerful tool for specific land uses in a highway corridor.
Park and ride lots	High	Low	Removes commute trips. The effect on total VMT needs to be addressed in mitigation plan.
Land preservation	High	Unclear	Could work in theory but measurement is difficult. May be best combined with transfer of development rights to spur infill Transit Oriented Development.

Source: Caltrans (2022)

Several studies have been conducted to calculate emissions from the transportation sector (Shoup, 1997; Yaacob et al., 2020). Shoup (1997) examined the impact of cashing out employer-paid parking. The study primarily focused on assessing the travel behavior changes resulting from the cash-out policy and their potential impact on transportation-related emissions. The author conducted eight case studies to evaluate the effects of this policy. In these case studies, the method of calculating emissions related to transportation was not explicitly mentioned. Shoup (1997) evaluated the effects of parking cash-out in a report initially prepared for the CARB. In this study, survey data reported in the employers' Trip Reduction Plans submitted to the South Coast AQMD were used to collect information on the distance traveled to work. Weigel et al. (2010) reviewed tools available for quantifying the GHG emissions associated with different types of public transit services and the tools' usefulness in helping a transit agency reduce its carbon footprint through informed vehicle and fuel procurement decisions. According to Weigel et al. (2010), mobile combustion of GHG emissions can be estimated based on fuel used and VMT. Illic et al. (2014), Yuan-yuan et al. (2015), and Velaquez et al. (2015) used the "distance traveled" method and multiplied the individual travel distance with the CO_2 emissions factor of the travel mode.

Even though many researchers have calculated the emission factors of CO_2 for a particular city, they cannot be used by researchers conducting research in another location or city since the emissions factor is dependent on vehicle type, passenger load factor, and engine size. Furthermore, the number of vehicles on the road during peak hours is different for each study area (Wei & Pan, 2017). Goodchild et al. (2018) developed analytical mathematical models to understand the marginal impacts on emissions and VMT for goods delivery under various logistics scenarios. The article compared the carbon emissions of different goods delivery methods, such as personal vehicle travel, local depot delivery, and regional warehouse delivery.

Government organizations such as the EPA and the CARB have developed tools to calculate GHG emissions and local MPOs are using these tools extensively (Kenney et al., 2014). The EPA's MOtor Vehicle Emission Simulator is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria such as air pollutants, greenhouse gases, and air toxics (U.S. EPA, 2023b). CARB's EMission FACtors (EMFAC) model calculates statewide or regional emissions inventories by multiplying emissions rates with vehicle activity data from all motor vehicles, ranging from passenger cars to heavy-duty trucks, operating on highways, freeways, and local roads in California (CARB, 2023). It is used to estimate the official emissions inventories of on-road mobile sources in California. The model reflects California-specific driving and environmental conditions, fleet mix, and the impact of California's unique mobile source regulations such as the Low-Emission Vehicle program. In this model, the emission factors are combined with data on vehicle activity (miles traveled and average speeds) to assess emission impacts.

3. Methodology

The objectives of this project and related research questions are to:

- Identify the current status of the parking cash-out policy in California.
    - How many companies and workers are covered by the current parking cash-out policy?
    - Which policy variables, such as size of company included, price minimums, and location, are the most important in terms of coverage?
- Investigate the equity dimensions and behavioral implications of this policy.
    - Who would accept parking cash-out if offered to them?
    - What factors influence commuter willingness to accept cash-out, their valuation of it, and related mode changes?
    - This includes equity-relevant factors such as race, ethnicity, income, and location, as well as behavioral and attitudinal factors related to sustainability beliefs and practices of individuals and their organizations.
- Explore the cost-effectiveness in terms of climate benefits of implementing the parking cash-out policy.
    - What are the VMT and emissions implications of parking cash-out under different scenarios?
    - How does cash-out compare to other policy measures to reduce solo car commuting?

3.1 Policy Analysis Model

We develop a baseline policy analysis model to estimate California employee parking covered by cash-out based on factors available in the academic literature along with the following policy-relevant parameters:

Organization size. Currently, only firms with 50 or more workers are covered by the parking cash-out policy. We analyze 2023 data from the California Employment Development Department (EDD) by sector and city to estimate the number of firms and employees in LA County and the Bay Area that are covered by the parking cash-out policy. We also explore the implications of changing the 50+ limit to a 20+ limit, and hence expand the number of firms and employees covered by the parking cash-out policy.

Own vs. lease employee parking. Only leased parking is covered by cash-out. Due to a lack of available data, we draw upon literature by Shoup and Breinholt (1997) and Long (2002) to estimate the number of firms and employees covered by cash-out.

Parking spaces by city. Data on parking spaces by cities within LA County and the Bay Area are provided by two studies by Mikhael Chester et al., for 2010 and 2020, respectively. We extrapolate LA County parking data to 2020 and focus on non-residential off-street (NROS) parking that is most relevant to cash-out policy. We compare these against employment by city, in total and for large (50+ employee) firms.

Parking prices. The current code states that "[i]f the amount cannot be determined by looking at the closest public parking costs or through an advertisement, then the market rate cost of parking is the higher of either (a) the lowest priced transit serving within one-quarter mile of the site or (b) fifty dollars ($50) per month." The literature suggests that prices are secondary to availability and even egress, which implies that prices may play a limited role in commuter decision-making. We explore parking prices by city by gathering data from price checking websites such as Spacer.com and SpotHero.com.

Equity considerations. There is limited information available in the literature on the equity aspects of parking. The survey results discussed in Section 4.2 suggest that income levels matter for the valuation of cash-out but not necessarily for the decision to accept cash-out. As it is possible that subsidized parking is only provided to occupations with higher incomes, we explore the implications of coverage (using CA EDD data by sector and city) with respect to income level. This could also significantly influence the coverage and hence impact of the policy.

3.2 Amazon Mechanical Turk (MTurk) Survey

Since there was a lack of data about parking cash-out, we conducted an about 1,000-sample statewide online survey using a crowd-sourced online platform (i.e., Amazon Mechanical Turk; MTurk), which offers reliable sampling, cost-effective pricing, and pre-built qualifications based on historic task performance (Bentley et al., 2017; Kees et al., 2017). Our previous study found that this approach was effective to draw most samples from the Bay Area AQMD and the South Coast AQMD (Lu et al., 2022). Responses on employee parking subsidies by region—with respect to factors such as sector, occupation, and income—are combined with the data discussed in the literature review to estimate the propensity of employees in these sectors to change commute behavior through cash-out parking.

Our study received the approval of the CSUDH Institutional Review Board on September 5, 2023 (Subject: IRB-FY2023-98). To limit the geographic location based on the project goal, we allowed only respondents with a registered address in California (at least 18 years of age with a valid

Amazon account). We launched the survey on September 8, 2023, with a goal of retrieving ~1,000 valid responses.

Evidence from pilot cash-out parking programs is used to validate what portion of employees choose to receive parking cash-out. MTurk survey responses are used to assess what factors may have changed since these pilots, for example pandemic-related changes to commuting and workplace practices, and how they might affect cash-out participation.

The MTurk survey instrument includes an experimental design while also collecting data on factors listed in Table 9 (e.g., demographics and workplace diversity measures, occupation type, income level, and employment sector). Both of these inform the employee parking model and allow the investigation of how to account for intersectional factors when promoting behavior changes under the parking cash-out policy.

Table 9. Psychological Constructs Measured in Experimental Survey

Variable	**Source citation**	**Example item**	**Likert scale**
Organizational sustainability	Magill et al. (2020) - Organizational climate for climate sustainability	Employees have the necessary job knowledge and skills to carry out organizational environmental objectives.	5 point - agreement
Sustainability attitudes	Haan et al. (2018) - Sustainable mobility	I like to travel by public transit (e.g., the bus or the train).	5 point - agreement
Sustainable behaviors	Haan et al. (2018) - Sustainable mobility	I only travel by public transit when the corresponding costs are compensated.	5 point - agreement
Sustainable organizational citizenship behaviors	Robertson & Barling (2017) - Organizational environmental citizenship behavior	I persuade my organization to purchase environmentally friendly products.	5 point - frequency
Public transportation perceptions	Deb & Ahmed (2018) - City bus service quality attributes measure	Cleanliness of the vehicle.	7 point - satisfaction

To measure travel and parking behaviors and preferences, the survey captures baseline commuting and parking practices, current parking perks offered by the respondent's employer, and pandemic-related changes in these factors. We also capture other factors such as pre-existing organizational sustainability goals and workplace culture that might influence employees' choice to use the cash-out policy.

The experiment employed a 3 (public transportation commute time: same as driving vs. 30 minutes longer vs. 1 hour longer) x 2 (commuter type: commute full-time vs. commute and work from home) x 3 (parking arrangements) factorial design using scenarios. For parking arrangements, respondents were told that: (1) they either paid market rate for their parking, (2) their workplace subsidized half the monthly costs, or (3) there were no costs associated with parking at their workplace. Participants were presented with scenarios regarding their workplace which included climate-related transportation initiatives that would either feature a cash-out policy initiative (treatment group) or other VMT-reduction strategies and CARB and AQMD programs. A number of variables were measured to ascertain the unique effects of policy on employee choice such as perceived organizational sustainability climate, individual-level attitudes towards climate change initiatives and prior adoption of sustainability efforts, and socioeconomic status. We also built elements into our experimental design to explore other questions, for example: What is the minimum level of government intervention required—such as enforcement level, incentives, or information-based "nudges"—to produce results? Do different socioeconomic groups respond differently to these interventions; or are the interventions uniform in their impact? We acknowledge that one challenge here is finding a pool of respondents that meets the requirements of the research design, that is, participants employed in relevant industries and occupations.

Since stated-preference surveys may not provide a fully accurate picture of actual policy outcomes, survey findings are validated against study results of cash-out parking pilot programs available in the literature. These studies were run prior to the COVID pandemic, so it remains important to gain insights into post-COVID employee perceptions of cash-out parking in a significantly changed commuting context in which the use of telecommuting and other flexible workplace practices have substantially increased and public transit use has declined, partly due to safety and exposure concerns.

The survey data collection was completed on October 12, 2023. We applied a series of rigorous data cleaning processes to the 2,008 raw survey responses that we received. Our initial step focused on ensuring the completeness of the survey data, specifically with regard to the responses to questions about transportation perceptions. This was achieved by removing any rows that had missing responses in critical columns, leading to the exclusion of 102 responses and leaving us with 1,906 valid entries. We further identified and eliminated suspicious or redundant entries. Specifically, we removed responses that showed repeated vehicle model information or were from participants who had explicitly declined to participate in the study. This step resulted in the removal of an additional 30 responses, reducing the number to 1,876.

We then assessed the completion time of the surveys, setting a threshold of 300 seconds (5 minutes) as the minimum time required for a response to be considered valid. Responses that fell below this completion time were deemed too quick to ensure thoughtful participation, leading to the removal of 235 responses and bringing the number down to 1,641. Attention to detail and engagement with the survey content were evaluated through a series of post-manipulation check questions designed to verify if the participants' responses aligned with the scenarios presented to them. We excluded responses that failed to pass at least two out of three of these checks, specifically targeting those respondents who reported more than 5 days of commuting and at least 3 modes of commute but failed the manipulation checks. These criteria led to the removal of 349 responses, further narrowing down the pool to 1,292.

Lastly, we assessed the data for realistic reporting of commute frequency and the number of modes used, removing entries that indicated more than 5 days of commuting and at least 6 different commute modes. This final filtering step led to the exclusion of 329 responses, ultimately leaving us with 963 valid responses for further analysis. This rigorous data cleaning process ensures that the remaining dataset is both reliable and reflective of the study's target demographic, setting a solid foundation for subsequent analyses.

Table 10. MTurk Post Hoc Survey Response Checks

Participants enter survey	Random assignment to one of 18 multi-factorial design options (3x2x3)	Survey completeness checks	Survey completion time check	Survey attention check	Final multi-factorial options
2008 raw survey responses.	111 or 112 respondents assigned to each option.	(1) Remove 102 missing responses on transportation perception (1,906 remain). (2) Remove 30 repeated responses with those rejected (1,876 remain).	Remove 235 responses that took <5mins (1,641 remain).	(1) Remove 349 responses that did not answer 2/3 review questions correctly (1,292 remain). (2) Remove 329 responses with unreasonable commute responses (963 remain).	Between 48 and 61 responses per option.

Comparison of Survey Respondent Demographics with Regional Demographics

Table 11 compares survey respondent income levels by AQMD region with California household income distribution data. The responses by AQMD region match our expectations. As discussed above, Bay Area residents have higher average incomes. The lowest (<25k) and highest (150k+) income brackets appear to be less represented among the survey respondents compared with the California household income distribution. However, the *household* element here is important, especially at the high end, as this inflates income levels compared to individual respondents. On the other end of the spectrum, households with low incomes might be underrepresented in part due to lower internet access rates. In sum, while these income distributions are not perfectly aligned, it is not clear that weighting with respect to income levels is needed to account for differences between regions or in comparison with California averages.

Table 11. Survey Respondent Income Levels by AQMD Region; Comparison with California Household Income Distribution

AQMD	Income							Total
	<25k	25k–49k	50k–74k	75k–99k	100k–149k	150k+	Prefer not to say	
Bay Area	9	48	48	82	45	23	4	259
	3.5%	18.5%	18.5%	31.7%	17.4%	8.9%		
Rest of CA	23	87	99	105	57	10	5	386
	6.0%	22.5%	25.6%	27.2%	14.8%	2.6%		
South Coast	31	60	101	64	41	16	5	318
	9.7%	18.9%	31.8%	20.1%	12.9%	5.0%		
Total	63	195	248	251	143	49	14	963
	6.5%	20.2%	25.8%	26.1%	14.8%	5.1%	1.5%	
CA households	5.5%	17.1%	15.3%	12.3%	17.1%	22.7%		

Source: Survey responses and U.S. Census (2020)

Table 12 shows the average commute mode choices of survey respondents by day per week and a comparison with California commuter patterns. At face value, Table 12 suggests that survey respondents are reporting higher levels of all modes except for driving alone, and especially so for ride hail and public transit. It is possible that respondents are not accurately reporting their commuting patterns. However, it is also notable that U.S. Census data only provides full-time commuting patterns, which is distinct from our additive approach that includes all modes (and could account for hybrid or part-time commuting patterns).

Table 12. Survey Respondent Average Commute Mode Choices by Days per Week; Comparison with California Commuter Patterns

Commute mode	Days								Avg days /week	Share (days)	U.S. Census
	0	1	2	3	4	5	6	7			
Drive alone	8.3%	6.5%	8.7%	11.9%	11.9%	25.6%	12.1%	14.9%	4.13	41.5%	65.5%
Carpool	46.5%	11.2%	10.2%	10.1%	8.7%	7.7%	3.8%	1.9%	1.71	17.2%	9.8%
Ride-hail	47.4%	12.9%	11.5%	9.2%	9.3%	6.3%	2.1%	1.2%	1.54	15.5%	1.7%
Public transit	42.3%	13.4%	9.4%	10.4%	10.3%	7.3%	4.5%	2.4%	1.85	18.6%	2.7%
Bike	45.9%	10.8%	7.5%	7.4%	9.0%	6.8%	7.2%	5.4%	0.57	5.7%	0.7%
Walk	50.1%	9.2%	9.3%	6.9%	7.7%	6.7%	5.3%	4.8%	0.14	1.5%	2.4%

3.3. Cost-Effectiveness Analysis

For the cost-effectiveness analysis, we used the MTurk survey data sample to estimate the VMT and emission reduction potential of parking cash-out compared to other policy alternatives—for example, telecommuting, public transit, carpooling, bikeshare, and scootershare programs—in California. The survey included questions about travel mode and frequency as well as other travel behaviors. For example, if the respondent selected parking cash-out, they could choose what travel options to use instead and how many days they would use those options. These answers, along with other travel behavior questions, provided data to estimate VMT reduction through parking cash-out compared to other policy alternatives. On this basis, we calculated associated emission reductions using relevant emission factors provided by the California Air Resources Board and other survey studies and calculation models (Russo et al., 2019; Shoup, 2005; Goodchild et al., 2018). These estimates are integrated into geospatial mapping using geospatial information systems to provide the spatial patterns of the VMT and emission reductions and neighborhood impacts in the two study regions. Finally, we analyzed the correlation between the associated VMT and CalEnviro Screen score to understand policy-related environmental impacts and socio-economic characteristics. The CalEnviro Screen is a screening method used to identify communities within California disproportionately burdened by multiple sources of pollution, and the score accounts for the pollution burden and population characteristics (OEHHA, 2010).To further evaluate the effectiveness and feasibility of parking cash-out and its alternatives, we adopted a Criteria-Alternative Matrix (CAM) approach based on Eugene Bardach's eightfold policy analysis framework (Bardach & Patashnik, 2023). This method allows for a systematic comparison across a set of predefined criteria that assess the viability and impact of transportation policies and measures. Our criteria included cost, effectiveness, equity, implementation issues, political feasibility, and legal issues if applicable.

The alternatives evaluated in this analysis included TDM programs, trip-reduction programs, removal of employer-paid parking, increased transit subsidies, taxation of workplace parking, and several other measures such as active transportation, micro-mobility, and road diet, among others (Shoup, 2005; Caltrans, 2022). Each alternative was examined against the selected criteria using the best available data sourced from existing literature, expert consultations, and case studies. Specifically, the effectiveness and cost assessments were largely derived from transportation studies and government reports (Shoup, 2005; Caltrans, 2022), while equity and implementation considerations were supported by both scholarly articles and practical insights from existing implementations (Shoup, 2005; Caltrans, 2022). The political and legal aspects were evaluated based on historical outcomes and expert opinions on similar policy implementations, ensuring a comprehensive analysis aligned with documented policy analysis practices. This approach facilitated an in-depth comparison of each policy's merits and drawbacks, thus providing insights into policy design and implementation. To best achieve consistent and comparable evaluations, we mainly relied on sources from Shoup, (2005), CalTrans, (2022), and Litman, (2020). These criteria were selected for their relevance to policy evaluation in urban planning and transportation management. They provide a general view of each policy's strengths and weaknesses.

4. Results

4.1 Policy Analysis

As stated above, our preliminary analysis aims to identify the current status of the parking cash-out policy in California and explore the following questions:

1. How many companies and workers are covered by the current parking cash-out policy?

2. Which policy variables, such as size of company included, price minimums, and location, are the most important in terms of coverage?

Our model accounts for the following factors, each of which is explored in the sections that follow:

- Organization size
- Owned vs. leased employee parking
- City characteristics and parking spaces by city
- Parking prices and monthly price minimums
- Equity considerations

Organization Size

California's parking cash-out law only applies to companies with 50 or more employees. Around 59% of workers in the state of California work for organizations with more than 50 employees. However, this varies significantly between industries and regions. As shown in Table 13, in LA County, 53.8% of workers (2.2% of firms) work for organizations with more than 50 employees, whereas in the Bay Area, 58.3% of employees (3.3% of firms) work in organizations of that size.

According to 2021 California EDD data, which includes annual, monthly, and quarterly establishment and employment numbers by sector for each of the 186 cities in the two regions (the Bay Area AQMD and LA County) the number of jobs in these two regions totaled 7.0 million in 2021, of which 3.7 million were in LA, and 3.3 million were in the Bay Area. With respect to company size, in both regions, 3.8 million employees worked for companies with 50 or more employees, and 4.9 million employees worked for companies with 20 or more employees. LA is the largest city in terms of employment (1.57 million total, 1.16 million 20+, 0.90 million 50+), followed by San Francisco (0.66 million total, 0.48 million 20+, 0.37 million 50+), and San José (0.36 million total, 0.27 million 20+, 0.21 million 50+). The top 5 cities—also including Oakland and Burbank—account for 41% of all jobs in these regions.

Table 13. Estimated Employees by Industry and by County, 2023

	LA County			Bay Area AQMD		
Industry	Total	50+	Share	Total	50+	Share
Total	3,647,394	1,963,574	53.8%	3,326,592	1,939,552	58.3%
Agriculture, forestry, fishing, hunting	4,811	976	20.3%	24,740	10,285	41.6%
Mining and construction	154,442	63,917	41.4%	214,711	88,027	41.0%
Utilities	11,975	4,157	34.7%	15,610	0	0.0%
Manufacturing	322,059	224,972	69.9%	387,522	301,838	77.9%
Wholesale trade	201,485	65,378	32.4%	105,472	42,064	39.9%
Retail trade	165,443	111,967	67.7%	179,744	106,503	59.3%
Transportation and warehousing	204,288	146,540	71.7%	116,648	64,299	55.1%
Information	182,283	152,606	83.7%	191,971	150,743	78.5%
Finance and insurance	124,387	62,411	50.2%	127,682	59,436	46.6%
Real estate & rental and leasing	89,064	16,154	18.1%	62,935	9,843	15.6%
Services	2,187,157	1,079,666	49.4%	1,899,557	989,643	52.1%

Source: Authors' calculations based on California EDD data

Owned vs. Leased Employee Parking

California's parking cash-out law only applies to companies that lease and subsidize employee parking. The initial rationale for excluding owned parking from state policy was that employers would encounter difficulty in dividing and selling their property rights. These conditions have shifted somewhat since the 1990s. A 2022 Legislative Counsel opinion stated that cash-out applies to leased parking even if an employer cannot easily stop leasing the parking, suggesting that the distinction between leased and owned parking is less relevant. Further, there are now several tools to monetize parking spaces as well as more flexibility post-COVID at the city level in terms of using parking spaces for outdoor business activities.

To estimate the number of firms and employees in the study regions covered by parking cash-out, we turn to the literature. The only study that identifies this specific factor is a national survey conducted by Shoup and Breinholt (1997), who find that 20% of large firms lease parking and provide it for free. As shown in Table 14, applying this finding to data on firms and employment by California city suggests that 10.8% of LA County employees and 11.8% of Bay Area employees are covered by the cash-out policy.

Long (2002) also looked at this issue for the California Legislative Analyst's Office, with the number of parking spaces covered by the policy as the unit of analysis, and estimated that 3% of Californian parking spaces were covered. An estimated 84% of free parking is owned as opposed to leased, thus not subject to the program. Moreover, most leased employer-paid parking is through small companies (less than 50 employees) and hence not covered by the law. Therefore, Long estimated that only 290,000 or 3% of the 11 million free parking spaces were covered by the law. These calculations are not cited in the Legislative Analyst's Office report, and data used to make the calculations are not provided. However, they appear to be either based on or in line with national surveys of employer parking subsidy policies published by Shoup and Breinholt (1997).

Free parking at workplaces has been studied over time, and the estimates seem to be somewhat consistent. In 1995, 92% of LA commuters parked for free, compared to "76 percent in Auckland, 70 percent in Brussels, 80 percent in Cape Town, 96 percent in Dublin, 87 percent in Edinburgh, 81 percent in London, 68 percent in Paris, and 59 percent in Seoul" (Shoup, 2005). The California Air Resources Board calculated that more than 90% of commuters in LA and Orange Counties receive free worksite parking (2022). The Society for Human Resource Management estimated that 87% of U.S. employers offer free on-site parking for employees, which is lower than Shoup's 1997 estimate of 95%. As discussed above, Brueckner and Franco (2018) found that more than 80% of all firms in the United States provide parking for their workers and this number varies across the country—LA and San Diego (90%), Indianapolis (79%), Chicago (52%), Philadelphia (52%), Houston (41%), Washington (31%), and New York (5%) (Tscharaktschiew & Reimann, 2021). As LA free parking rates appear to be higher than national averages (which are the basis for our estimates of Californian parking cash-out), our estimates are probably on the conservative side.

Table 14. Share of Firms Offering Free Leased Parking

Firm size (# of employees)	Number of firms in U.S.	Share of firms that lease parking	Number of firms that lease parking	Share of leasers that offer free parking	Number of firms that offer leased parking free	Share of firms that offer leased parking free
(1)	(2)	(3)	(4)=(3)x(2)	(5)	(6)=(5)x(4)	(9)=(3)x(5)
1–19	7,905,400	32%	2,529,728	98%	2,479,133	31%
20–49	524,900	26%	136,474	100%	136,474	26%
50+	226,700	21%	47,607	96%	45,703	20%
Not given	1,947,000	31%	603,570	98%	591,499	
All firms	10,604,000	31%	3,317,379	98%	3,252,809	30%
LA County						
All firms	513,114	31%	159,065	98%	155,884	30%
Employees	3,647,394		1,130,692		1,108,078	
50+	11,512	21%	2,418	96%	2,321	20%
Employees	1,963,574		412,351		395,857	
Bay Area						
All firms	312,323	31%	96,820	98%	94,884	30%
Employees	3,326,592		1,031,244		1,010,619	
50+	10,492	21%	2,203	96%	2,115	20%
Employees	1,939,525		407,300		391,008	

Source: Shoup and Breinholt (1997); additional calculations for LA County and the Bay Area based on California EDD data.

City Characteristics and Parking Spaces by City

As highlighted in the literature, parking availability (supply) appears to influence both parking prices and commuter decision-making. We examine data on parking spaces by cities within LA County and the Bay Area. We use estimates of parking spaces by region and city based on two studies of LA County (2015) and the Bay Area (2022) by Chester et al., based on 2010 and 2020 data, respectively. We have updated the LA County data to 2020 using forecasting tools. To estimate residential off-street parking in LA County for 2020, we used linear models based on total housing units and available non-residential off-street (NROS) parking data from 2000 and 2010 (Chester et al., 2015). We extracted total housing unit data at the census tract level from the National Historical Geographic Information System (Manson et al., 2023). For estimating NROS parking for 2020, we employed linear mixed-effect models that consider variations in data, using job numbers and NROS parking data from 2000 and 2010. Job data at the census tract level was sourced from the U.S. Census Bureau Longitudinal Employer-Household Dynamics (2024). We kept on-street parking values consistent with those recorded in 2000 and 2010. Ultimately, we merged the datasets for both Bay Area AQMD and LA County parking. Table 15 presents 2020 estimates for parking spaces by county for counties in both study regions. LA has a higher level of parking and a higher share of non-residential off-street parking.

Table 15. Total Estimated Parking Spaces by County, 2020

County	Residential off-street	Non-residential off-street	On-street	Total parking
Alameda	782,019	685,737	1,628,432	3,096,188
	25%	22%	53%	
Contra Costa	684,242	360,549	1,462,758	2,507,549
	27%	14%	58%	
Marin	164,506	90,493	508,014	763,013
	22%	12%	67%	
Napa	80,814	33,426	395,305	509,545
	16%	7%	78%	
San Francisco	172,845	147,230	313,988	634,063
	27%	23%	50%	
San Mateo	395,665	238,296	768,748	1,402,709
	28%	17%	55%	
Santa Clara	975,860	770,645	1,600,879	3,347,384
	29%	23%	48%	
Solano	248,760	65,372	933,662	1,247,794
	20%	5%	75%	
Sonoma	320,712	165,646	1,024,859	1,511,217
	21%	11%	68%	
Bay Area Total	3,825,423	2,557,394	8,636,645	15,019,462
	25%	17%	58%	
LA	5,724,788	10,159,801	3,564,099	19,448,688
	29%	52%	18%	

Sources: Chester et al. (2015), Chester et al. (2022), Authors' calculations

We focus on NROS parking that is both the most consistent according to our pre-analysis assessments of the data, and the most relevant to cash-out policy. According to the linear regression model presented in Table 16, the major predictors of parking spaces are total wages and the number of firms within a city. We look at the relationship between NROS parking spaces and jobs, as shown in Figures 57. Whether jobs are measured by all jobs (Figure 5), jobs at firms with 20+ employees (Figure 6), or jobs at firms with 50+ employees (Figure 7), the variables are positively related. The trend line suggests that, from an average basis of around 20,000 parking spaces in cities, every additional parking space is associated with 0.13 jobs. As shown in Figures 8 and 9, most cities have fewer than 10 NROS parking spaces per job, and 125 of 176 (71%) cities with data on both indicators have 2 NROS parking spaces per job or less.

Table 16. Factors Influencing Non-Residential Off-Street Parking

	NROS parking by city
Employment access: jobs per square mile	0.247
	(1.139)
Los Angeles County dummy	6962.767
	(0.504)
Total wages	-6.078***
	(-6.865)
Establishments	24.703***
	(20.444)
Constant	1264.772
	(-0.128)
N	176
Adj. R-squared	0.852

*p < 0.1. **p < 0.05. ***p < 0.01. t-stats in parentheses.

Figure 5. Scatterplot of NROS Parking Spaces (x-axis) by All Jobs (y-axis), for Study Region Cities Except Three Largest Cities (LA, SF, San José)

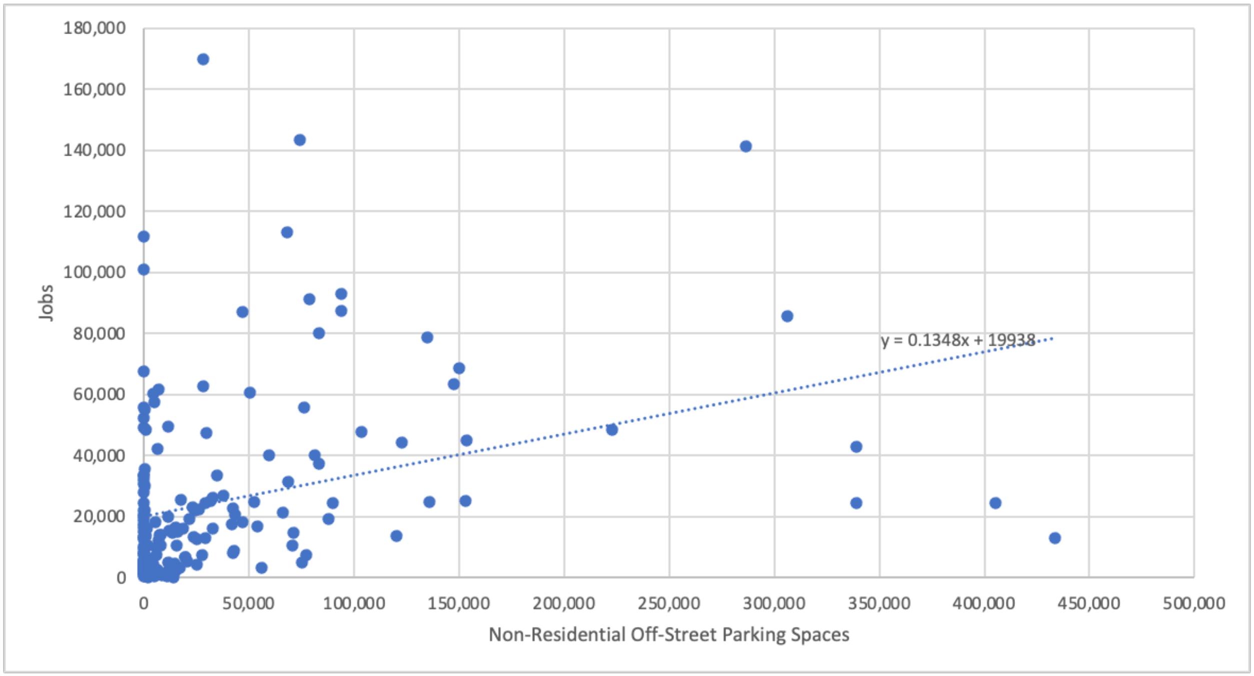


Figure 6. Scatterplot of Parking Spaces (x-axis) by Jobs at 20+ Employee Firms (y-axis), for Study Region Cities Except Three Largest Cities (LA, SF, San José)

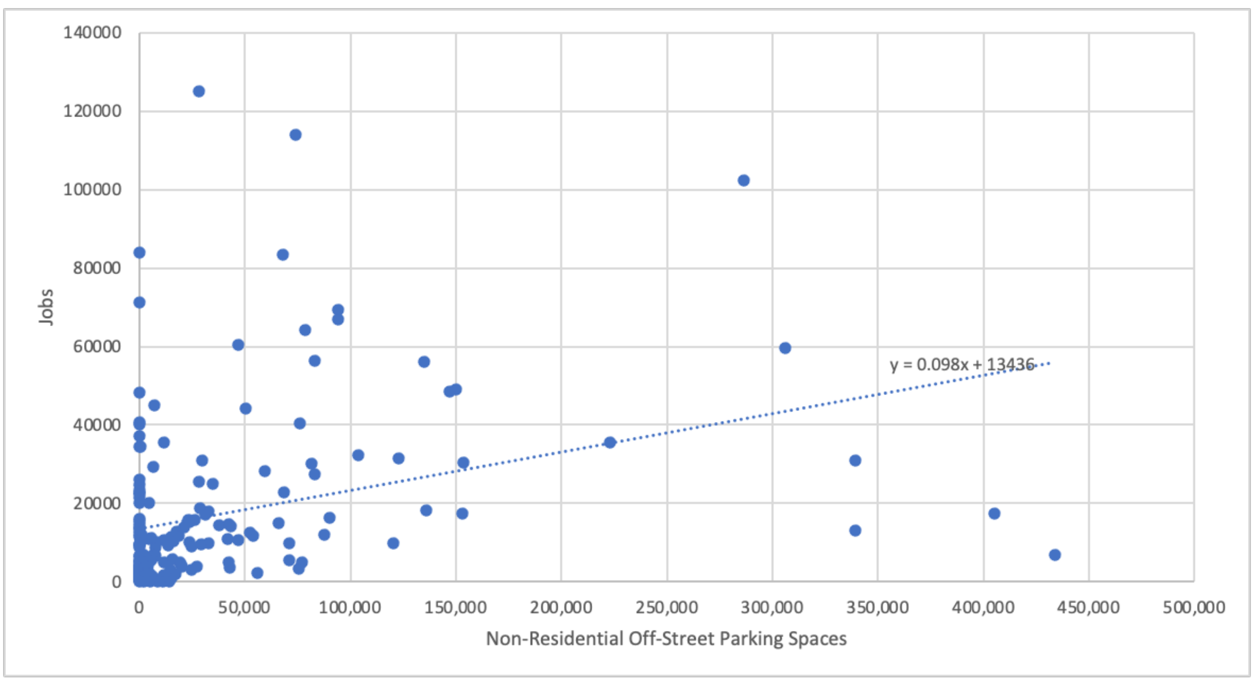


Figure 7. Scatterplot of NROS Parking Spaces (x-axis) by Jobs at 50+ Employee Firms (y-axis), for Study Region Cities Except Three Largest Cities (LA, SF, San José)

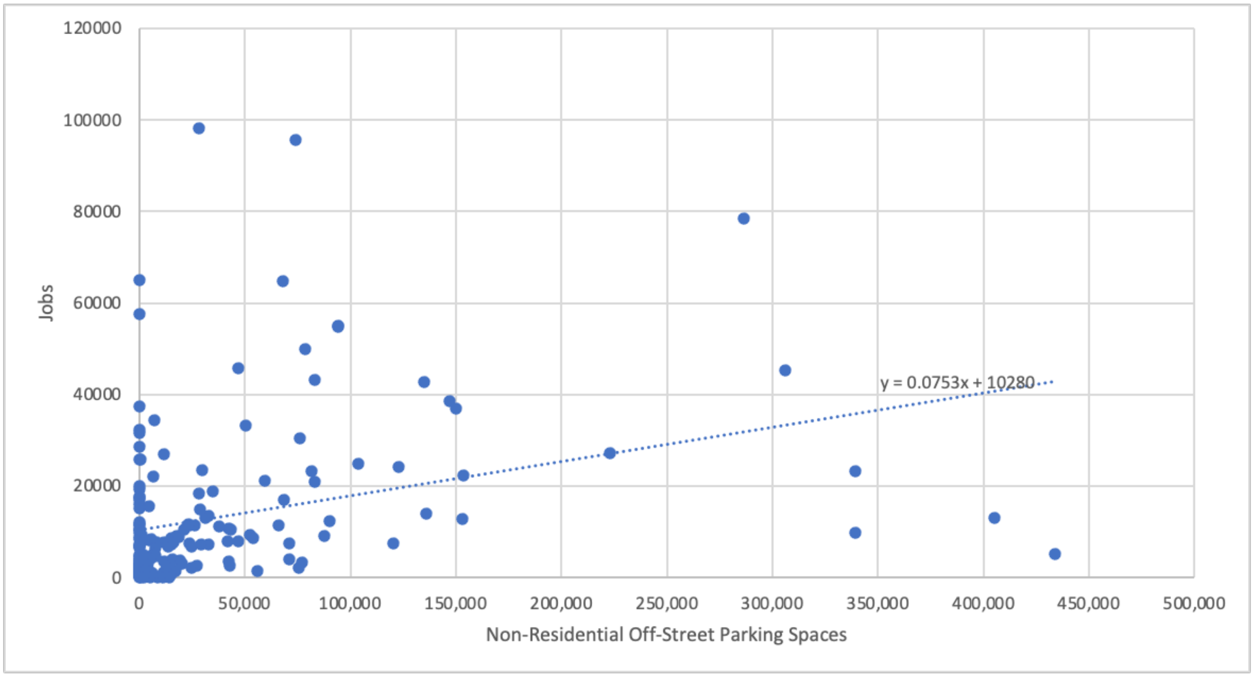


Figure 8. Ordered Distribution of NROS Parking Spaces per Job

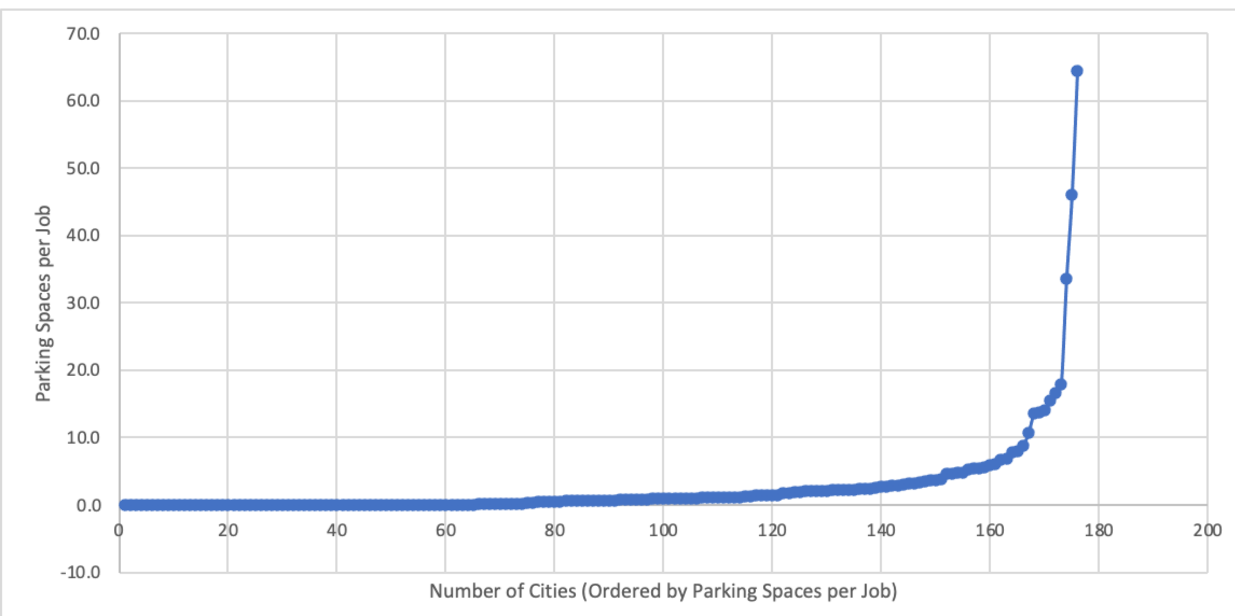
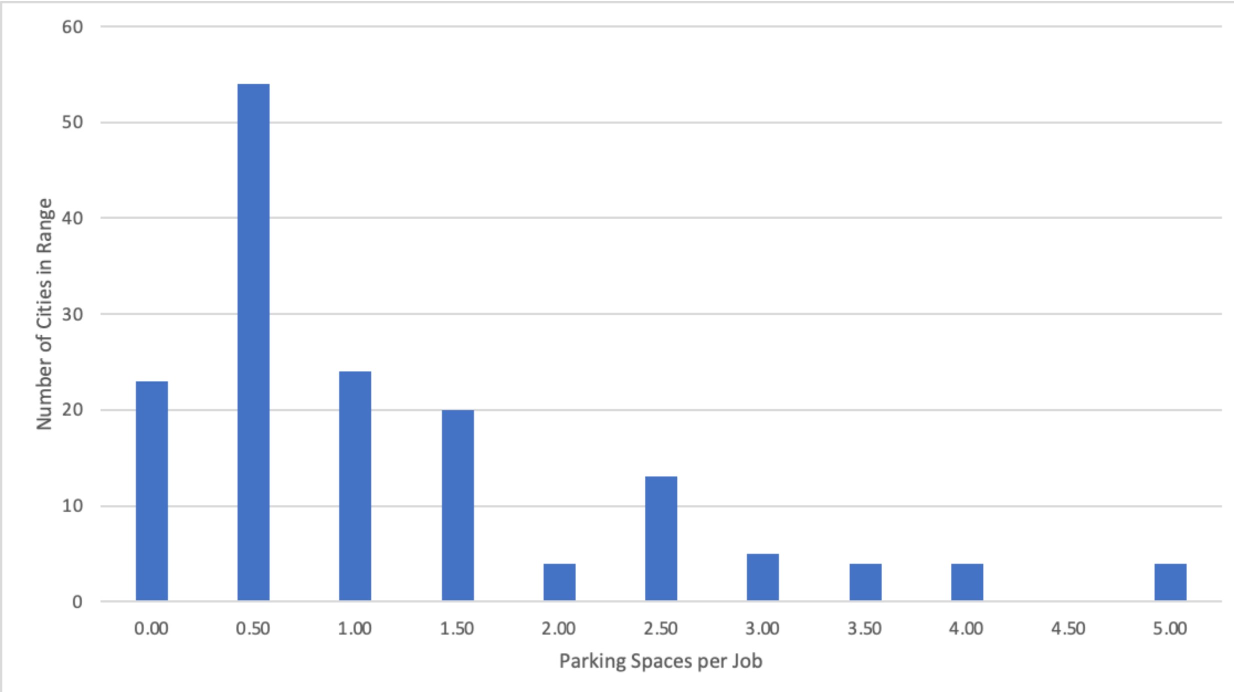


Figure 9. Histogram of NROS Parking Spaces per Job, for Cities with 5 or fewer



Relating this to the number of NROS parking spaces, according to the data by Chester et al., there are 2.46 million parking spaces in the Bay Area cities, and 6.58 million in LA County cities. The number of total employees in the whole regions are 3.29 million in Bay Area cities (implying an NROS parking per job ratio of 0.75), and 3.71 million in LA County cities (and therefore a much higher NROS parking per job ratio of 1.77). This might contribute to LA's regional higher solo driving rates (see Tables 1 and 2).

Parking Prices and Monthly Price Minimums

The current parking cash-out policy states that "[i]f the amount cannot be determined by looking at the closest public parking costs or through an advertisement, then the market rate cost of parking is the higher of either (a) the lowest priced transit serving within one-quarter mile of the site or (b) fifty dollars ($50) per month" (CARB, 2022). Literature suggests that prices are secondary to availability in terms of influencing commuter behavior. This is supported by our analysis, which finds that prices do not appear to be strongly correlated with employment or parking availability.

Parking prices by city (Spacer.com, SpotHero.com) suggest that average monthly costs are above the price minimums. Where data is available, there do not appear to be any cities in LA County or the Bay Area where the average price is below $50. Of the 186 cities in our dataset, 26 do not have prices available in Spacer.com, so it is possible some of these have prices lower than $50. Cities with prices on the lower end of the spectrum are American Canyon ($80; 4 samples) and Westlake Village ($99; 1 sample). Cities with prices on the higher end are Hidden Hills ($483; 4 samples), Calabasas ($467; 5 samples), Bradbury ($462; 3 samples), Santa Rose ($448; 5 samples), and Burbank ($438; 10 samples). This might suggest that the minimum is too low. However, there are important caveats with the data, which are not always available for all cities in study regions. There are also concerns as to whether parking is used for residential or workplace-related commuter purposes. Parking spaces have many purposes—they could be for long-term storage, short-term trips, or anything in between. Prices could refer to long-term parking rather than commuter parking.

We compare parking prices and density at the Metropolitan Statistical Area (MSA) level, which suggests that there is a correlation between the two (Figure 10). However, these results do not translate well to LA County and the Bay Area, which both show higher densities. According to regression analyses of city level data (from Spacer.com; Table 17), wages appear to be a key driver of parking prices. Employment density and establishments are also influential, but negatively correlated in this context. The LA County dummy variable highlights the higher price of parking compared with the Bay Area. This is surprising given the availability of NROS parking in LA County. The limitations with the data described above may contribute to this counter-intuitive result.

Figure 10. Scatterplot of Parking Prices and Regional Density by Metropolitan Statistical Area

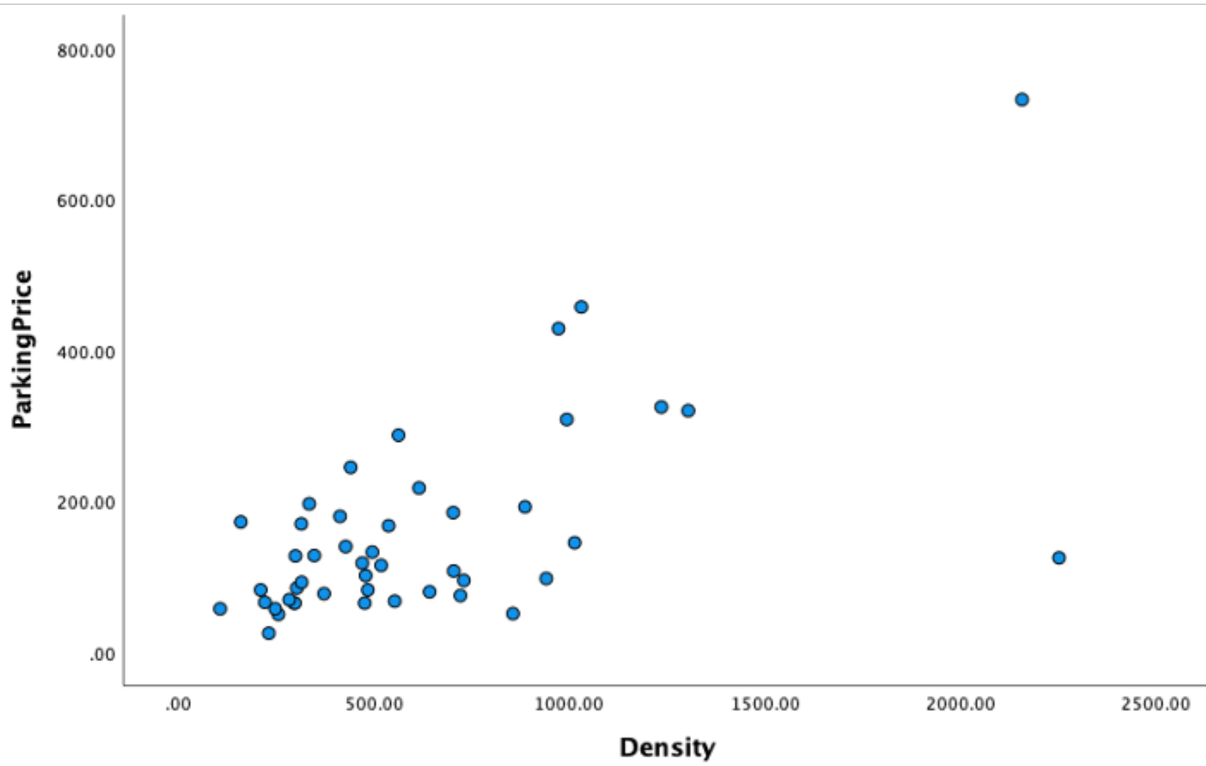


Table 17. Factors Influencing Parking Prices in Study Region Cities

	Parking prices (Spacer.com)
Employment access: jobs per square mile	-0.001*
	(-1.681)
LA County dummy	111.625**
	(2.056)
Total wages	0.009**
	(2.224)
Total parking spaces	0.000*
	(1.663)
Autos per HH	-90.190
	(-0.734)
Establishments	-0.021**
	(-1.975)
Constant	465.563*
	(1.835)
N	153
Adj. R-squared	0.016

*p < 0.1. **p < 0.05. ***p < 0.01. t-stats in parentheses.

Equity Considerations

Survey results presented in Tables 18–20 suggest that income levels matter for valuation of cash-out (though not necessarily for cash-out decision). It is also possible that subsidized parking is only provided to employees in higher income brackets or occupations. On that basis, we explore the implications of coverage (using CA EDD data by sector and city) with respect to income level. This could also significantly influence the coverage and hence impact of the policy.

In addition, CA EDD data by sector and city provide further evidence—in addition to the data provided in Tables 1 and 2—of the differences between the two study regions. In this data, average (mean) incomes are as follows:

- Both region cities: $113k
- LA County cities: $82k
- Bay Area cities: $149k

If only higher wage earners are offered free or subsidized parking, the data for the different regions may reflect regional differences as the Bay Area has a much higher average wage. Moreover, based on the above analysis, higher wages in cities are associated with higher parking prices.

Table 18. Crosstabulation of Survey Responses for Commuting Choice by Income Level

	Commuting choice		
Income ($)	Public transit	Drive alone	Total
Less than 25k	25	38	63
	39.7%	60.3%	100.0%
25k–49k	57	138	195
	29.2%	70.8%	100.0%
50k–74k	68	180	248
	27.4%	72.6%	100.0%
75k–99k	81	170	251
	32.3%	67.7%	100.0%
100k–149k	33	110	143
	23.1%	76.9%	100.0%
150k+	7	42	49
	14.3%	85.7%	100.0%
Prefer not to say	3	11	14
	21.4%	78.6%	100.0%
Total	274	689	963
	28.5%	71.5%	100.0%

Table 19. Crosstabulation of Survey Responses for Money Choice by Income Level

Income ($)	Money choice: Less than 50	50-75	76-100	101-125	126-150	151-175	176-200	201-225	226-250	251+	Total
<25k	24	8	8	4	4	1	4	1	1	8	63
	38%	13%	13%	6%	6%	2%	6%	2%	2%	13%	100%
25k–49k	38	63	32	21	10	2	5	0	4	20	195
	20%	32%	16%	11%	5%	1%	3%	0%	2%	10%	100%
50k–74k	49	64	56	22	17	6	9	9	1	15	248
	20%	26%	23%	9%	7%	2%	4%	4%	0%	6%	100%
75k–99k	51	43	62	41	14	7	14	3	2	14	251
	20%	17%	25%	16%	6%	3%	6%	1%	1%	6%	100%
100k–149k	31	27	16	12	13	3	8	12	5	16	143
	22%	19%	11%	8%	9%	2%	6%	8%	4%	11%	100%
150k+	2	6	4	6	1	5	3	8	1	13	49
	4%	12%	8%	12%	2%	10%	6%	16%	2%	27%	100%
Prefer not to say	3	2	1	0	1	0	0	0	0	7	14
	21%	14%	7%	0%	7%	0%	0%	0%	0%	50%	100%
Total	198	213	179	106	60	24	43	33	14	93	963
	21%	22%	19%	11%	6%	3%	5%	3%	2%	10%	100%

Table 20. Crosstabulation of Survey Responses for Cash-Out Choice by Income Level

	Cash-out choice		
Income ($)	Accept	Reject	Total
Less than 25k	46	17	63
	73.0%	27.0%	100.0%
25k–49k	143	52	195
	73.3%	26.7%	100.0%
50k–74k	201	47	251
	81.0%	19.0%	100.0%
75k–99k	208	43	251
	82.9%	17.1%	100.0%
100k–149k	104	39	143
	72.7%	27.3%	100.0%
150k+	34	15	49
	69.4%	30.6%	100.0%
Prefer not to say	5	9	14
	35.7%	64.3%	100.0%
Total	741	222	963
	76.9%	23.1%	100.0%

Policy Simulations

We explore hypothetical changes to the parking cash-out coverage, specifically if the size of the organization that is covered in the policy criteria was changed from 50+ employees to 20+ employees. This analysis is based on the 20% and 30% coverage levels for both groups, respectively (Shoup and Breinholt, 1997), and California EDD data on employees and firms per city. As shown in Table 21, making this change would increase the number of firms and employees covered by parking cash-out policy from around 11% to 18%. These numbers would be lower still in both scenarios if free parking was only provided to particular income groups.

Table 21. Percentage of Workers Covered by the Parking Cash-Out Policy under Different Policy Conditions

Free parking provided only when median incomes ($) above:	Percent of workers receiving free (and leased) parking					
	50+ employee firms			20+ employee firms		
	LA County	Bay Area	Both	LA County	Bay Area	Both
0 (all)	10.9%	10.6%	10.8%	18.5%	17.9%	18.2%
50k	8.9%	9.7%	9.3%	14.3%	15.8%	15.0%
75k	6.2%	9.9%	8.0%	8.1%	12.9%	10.3%
100k	2.4%	5.5%	3.8%	3.7%	9.0%	6.2%

4.2 California Parking Surveys

This section presents and analyzes results from the surveys described in the methodology section. We first look at the crosstabulations of responses for the three experimental factors (parking subsidy, commuting time, and commuting frequency) against the two of the three experimental outcomes (cash-out choice and cash-out value). More factor interactions are analyzed with respect to other factors through PROCESS multivariate regression analyses. Finally, responses for each experimental outcome are analyzed with individual multivariate regression analyses: logistic for cash-out choice and commuting choice, and linear for cash-out value.

As shown in Table 22, cash-out choice does not appear to be influenced by the level of parking subsidy provided in the experimental conditions. While not presented here, neither of the other two experimental factors appears to influence cash-out choice. For all conditions, the proportion of respondents accepting cash-out is similar, between 75.7% and 78.0%. There is more variation around commuting choice. As would be expected, respondents assuming commuting times that are similar between public transit and driving alone are much more likely to take public transit (Table 23). Similarly, commuters with a hybrid telecommuting frequency are more likely to take public transit (Table 24). In both conditions, it makes sense that commuters with lower weekly commuting times would be more open to taking public transit.

Table 22. Crosstabulation of One Experimental Factor (Parking Subsidy) by One Experimental Choice (Cash-Out Choice)

Experimental factor:	Experimental Outcome: Cash-out choice		
Parking subsidy	Accept	Reject	Total
No charge	234	72	306
	76.5%	23.5%	
Half subsidized	261	78	339
	77.0%	23.0%	
Market rate	246	72	318
	77.4%	22.6%	
Total	741	222	963
	76.9%	23.1%	

Table 23. Crosstabulation of One Experimental Factor (Commuting Time) by One Experimental Choice (Commuting Choice)

Experimental factor: commuting time	Experimental Outcome: commuting choice		
	Public transit	Drive alone	Total
Same time	105	198	303
	34.7%	65.3%	
30 minutes	77	229	306
	25.2%	74.8%	
1 hour	86	241	327
	26.3%	73.7%	
Total	268	668	936
	28.6%	71.4%	

Table 24. Crosstabulation of One Experimental Factor (Commuting Frequency) by One Experimental Choice (Commuting Choice)

Experimental factor: commuting frequency	Experimental Outcome: commuting choice		
	Public transit	Drive alone	Total
Hybrid	141	313	454
	31.1%	68.9%	
Full-time	127	355	482
	26.3%	73.7%	
Total	268	668	936
	28.6%	71.4%	

Regression analyses using the PROCESS Macro Version 4.2 in SPSS (Hayes, 2021) were conducted in order to assess the relationship between the three experimental conditions and the outcomes of cash-out choice, commute mode choice, and cash-out value. In addition to simple regression analyses, the PROCESS macros allow analyses of the effect of a predictor on an outcome based on the levels of up to two moderators. Thus, PROCESS allows us to investigate if there is a three-way interaction between public transportation commute time, commuter type, and parking arrangements on the three outcomes of interest. PROCESS uses bootstrapping techniques where the sample is resampled many times over to represent a sampling distribution of the statistic of interest (Hayes, 2021; Wood, 2005). 5,000 bootstrapped samples were run to generate the 95% confidence interval (Hayes, 2021, Model 3). If the confidence interval does not include zero (e.g., a negative regression coefficient has lower and upper confidence intervals that are also negative), then we can conclude that the relationship is statistically significant.

Demographic covariates in the regression analyses included race (White vs. non-White), gender, location (home and work zip code), education, AQMD, and income. Individual differences such as organizational sustainability, sustainable attitudes, sustainable behaviors, sustainable organizational citizenship behaviors, and transportation perceptions were also entered as covariates.

For the factorial design, a significant pattern of results only emerged for the interaction between parking arrangements and commuter type for cash-out value, $b = -1.62$ ($SE = 0.69$), $t = -2.36$, $p = 0.02$, 95% CI [−2.98, −0.27]. Respondents who were full-time commuters and had to pay market rates for parking were more likely to have lower starting values for cash-out and switch to using public transit.

In terms of psychological variables, sustainable attitudes emerged as a significant predictor across all three outcomes as shown in Table 26. Table 25 presents the related descriptive statistics and associated hypotheses. Correlation matrix results (not presented here) suggest high bivariate correlation levels between all of the following independent variables: organizational sustainability, sustainability attitudes, sustainability organizational behaviors, and transit perceptions; as well as between work zip dummy and home zip dummy. Those with more positive attitudes toward public transit were (1) more likely to cash-out, (2) more likely to choose public transit for their commute, and (3) more likely to have lower starting values to switch to public transit. Employees who worked for organizations that engaged in sustainable practices were more likely to have higher starting cash-out values compared to individuals in less sustainable organizations. Those who engaged in sustainable organizational citizenship behaviors and had more positive perceptions of public transit were more likely to choose cash-out and had lower starting values for their cash-out choice.

In terms of equity considerations, the regression analyses in Table 26 provide some insights as to whether parking cash-out decisions might vary with respect to race, gender, and income levels. Demographic analyses revealed that non-White participants were more likely to choose to cash-out compared to their White counterparts. More highly educated participants were more likely to choose to cash-out and had lower starting values for their cash-out choice compared to their counterparts. Participants who worked in urbanized areas and had higher incomes were more likely to have higher starting values for their cash-out choice compared to those who worked in non-urbanized areas and had lower income.

To explore the influence of respondent race further, we provide an additional inter-sectional crosstabulation between race, income, and cash-out choice in Table 27. A few results here are important to note. First, 80.8% of respondents are White, which is higher than the California average. According to the 2022 U.S. Census American Community Survey, 40% of Californians are Latino, 35% White, 15% Asian American or Pacific Islander, 5% Black, and 4% are multiracial (Census 2024). Within the income groups, White respondents have a significantly lower share of the lowest and highest income brackets. Similarly, higher- and lower-income White respondents are less likely than average to accept cash-out (with middle-income bracket White respondents more likely to accept cash-out). On the other hand, non-White respondents in the highest income bracket are more likely to accept cash-out. Non-white respondents of all but the lowest income bracket are less likely than average to accept cash-out.

Table 25. Descriptive Statistics for Regression Models and Hypotheses

Variable	N	Minimum	Maximum	Mean	Std. deviation	Hypothesis
Commuting choice	936	1	2	1.71	0.452	N/A
Money choice	963	1	10	3.79	2.8	N/A
Cash-out choice	963	1	2	1.23	0.421	N/A
White/non-White	926	0	1	0.1922	0.39426	Unclear
Organizational sustainability	936	1	5	3.7056	0.88823	Positive association with cash-out choice and transit commute; negative with cash-out value.
Sustainability attitudes	936	1	4.4	2.8126	0.9452	As above
Sustainability behaviors	936	1.8	4.2	3.0692	0.43277	As above
Sustainability organizational behavior	936	1	5	3.1755	1.25082	As above
Transit perceptions	936	1	7	5.0233	1.14834	As above
Commute miles	963	1	5	2.3	0.855	Negative association with cash-out choice and transit commute; positive with cash-out value.
Organizational size	963	1	5	2.99	1.004	Unclear
Education	963	1	7	4.91	0.985	Unclear, though may be linked to income.
Income	963	1	7	3.44	1.35	Negative association with cash-out choice and transit commute; positive with cash-out value.

Variable	N	Minimum	Maximum	Mean	Std. deviation	Hypothesis
AQMD dummy (South Coast = 1)	963	0	1	0.3302	0.47054	Negative association with cash-out choice and transit commute; positive with cash-out value.
Home zip dummy (urban = 1)	963	0	1	0.7134	0.45241	As above
Work zip dummy (urban = 1)	963	0	1	0.6978	0.45944	As above

Table 26. Factors Influencing Cash-Out Choice, Commute Mode Choice, and Cash-Out Value

	Cash-out choice (logistic regression)	Commute mode choice (logistic regression)	Cash-out value (linear regression)
White/non-White	0.441*	-0.005	-0.081
	(1.554)	(0.995)	(-0.394)
Gender dummy	-0.213	-0.192	0.014
	(0.808)	(0.825)	(0.086)
Organizational sustainability	-0.098	0.062	0.242**
	(0.907)	(1.064)	(2.000)
Sustainability attitudes	0.976***	-0.799***	-0.659***
	(2.653)	(0.450)	(-5.279)
Sustainability behavior	-0.041	0.650***	0.079
	(0.960)	(1.916)	(0.413)
Sustainability organizational behavior	0.241**	-0.138	-0.522***
	(1.273)	(0.871)	(-4.852)
Transit perception	0.210**	0.145	-0.253***
	(1.233)	(1.156)	(-2.612)
Commuting miles	0.050	0.032	0.164*
	(1.051)	(1.032)	(1.687)
Organization size	-0.105	0.424***	0.183**
	(0.901)	(1.528)	(2.225)
Education levels	0.222**	0.017	-0.243***
	(1.249)	(1.018)	(-2.612)
Income levels	-0.079	0.043	0.343***
	(0.924)	(1.044)	(5.283)

	Cash-out choice (logistic regression)	Commute mode choice (logistic regression)	Cash-out value (linear regression)
AQMD dummy (South Coast = 1)	-0.022	0.295	0.292
	(0.979)	(1.343)	(1.623)
Home zip dummy (urban = 1)	0.182	0.055	-0.393*
	(1.200)	(1.057)	(-1.797)
Work zip dummy (urban = 1)	-0.199	-0.363*	0.363*
	(0.820)	(0.696)	(1.651)
Constant	-2.998***	-0.563	6.429***
	(0.050)	(0.569)	(8.094)
N	921	921	921
R-squared (Cox & Snell for Logistic; Adjusted for Linear)	0.232	0.115	0.268

***p < 0.01. **p < 0.05. *p < 0.1. Exp(B) values in parentheses for Logistic; T-stat in parentheses for Linear.

Table 27. Crosstabulation of Respondent Income, Race, and Cash-Out Choice

Income	Race	Experimental Outcome: Cash-out choice		
		Accept	Reject	Total
Less than 25k	White	26	10	36
		72.2%	27.8%	100.0%
	Non-White	18	5	23
		78.3%	21.7%	100.0%
25k–49k	White	111	35	146
		76.0%	24.0%	100.0%
	Non-White	26	10	36
		72.2%	27.8%	100.0%
50k–74k	White	168	34	202
		83.2%	16.8%	100.0%
	Non-White	27	12	39
		69.2%	30.8%	100.0%
75k–99k	White	181	29	210
		86.2%	13.8%	100.0%
	Non-White	24	12	36
		66.7%	33.3%	100.0%
100k–149k	White	87	31	118
		73.7%	26.3%	100.0%
	Non-White	17	7	24
		70.8%	29.2%	100.0%
150k+	White	17	12	29

Income	Race	Experimental Outcome: Cash-out choice		
		Accept	Reject	Total
		58.6%	41.4%	100.0%
	Non-White	15	3	18
		83.3%	16.7%	100.0%
Prefer not to say	White	2	5	7
		28.6%	71.4%	100.0%
	Non-White	1	1	2
		50.0%	50.0%	100.0%
Total	White	592	156	748
		79.1%	20.9%	100.0%
	Non-White	128	50	178
		71.9%	28.1%	100.0%

4.3 Cost-Effectiveness Analyses

Alternatives to Parking Cash-Out

According to Shoup, the parking cash-out policy has demonstrated notable cost-effectiveness by providing a direct financial incentive to reduce solo driving (Shoup, 2005). Unlike traditional TDM programs that often unintentionally subsidize solo driving, parking cash-out uniformly redistributes parking subsidies to all commuting modes. In general, parking cash-out simplifies the subsidy structure and ensures a direct shift away from driving alone. As discussed in Section 2.4 above, Shoup compared parking cash-out with five alternatives and highlighted major weaknesses of those alternatives. Shoup believes that parking cash-out policy is superior in terms of simplicity, equity, and direct influence on commuter behavior while achieving environmental goals. However, with emerging alternative approaches, further evidence on the direct influence of parking cash-out on commuter behavior is needed.

As shown in Table 28, we applied the Criteria-Alternative Matrix (CAM) approach based on existing literature and case studies. In addition to Shoup's five alternatives, we further compared other policies and measures as described in the Caltrans VMT report (Caltrans, 2022). Our result is based on a comprehensive comparison analysis based on a series of factors such as cost, effectiveness, equity, implementation issues, political feasibility, and legal issues. While it seems that parking cash-out might be cost-effective due to ease of implementation, the specific impact will be based on cases and implementation scales. As pointed out by Shoup (2005), parking cash-out is expected to be more feasible than the other five alternatives; however, certain policies should be evaluated on a case-by-case basis.

Additionally, we acknowledge that employer buy-in is not a significant barrier given the existing legal framework and the proactive steps taken by regulatory bodies to ensure compliance (CARB, 2024). Such feasibility of enforcing the policy suggests that relatively low-effort interventions can ensure compliance and support the broader goal of emissions reductions. For example, AB2206 has streamlined the enforceability of California's parking cash-out law by simplifying the compliance requirements for employers. Under this amendment, regulatory bodies such as the CARB or Air Districts are required to merely verify whether employers have offered cash-out to eligible employees and documented this communication. This approach assumes that employers are unlikely to falsely claim compliance, making enforcement straightforward and effective. Once employers confirm that they have offered the cash-out option, they are considered to have met the legal requirements.

Each evaluation resulted from the discussions from our sources as well as our own judgment. For example, in terms of cost of parking cash-out, we assessed it to be "Low" based on the minimal administrative costs observed in Shoup (2005), where it's noted that parking cash-out requires less infrastructure compared to other TDM measures. However, we should also note that this policy implementation requires clear and detailed guidance from the state agencies (e.g., the CARB), which may involve research costs that were not accounted for in our analyses. Similarly, for traditional TDM programs, we assigned a rating of "Medium" based on the varied costs of program elements such as subsidies for transit and carpooling, as discussed in studies like Litman (2020), which outline the expenses involved in these initiatives. In comparison, the "High" cost rating of trip reduction programs resulted from the South Coast AQMD indicating firms spend about $3,000 annually per peak-hour trip reduced (Shoup, 2005). In terms of the effectiveness of parking cash-out, our evaluation was based on empirical evidence from Shoup (1997), which documented significant reductions in VMT among firms adopting the policy. We judged the effectiveness of the taxation of workplace parking to be "High" due to its direct impact on reducing solo driving, as modeled in scenarios from the Caltrans VMT reduction playbook (Caltrans, 2022). We assessed the equity of increased transit subsidies, to be "High" to reflect findings from Litman (2020) that highlight the benefits to lower-income groups who rely more heavily on public transportation.

We rated active transportation as "High" in consideration of the need for significant infrastructure development such as bike lanes and pedestrian pathways, as detailed in municipal planning documents and studies like those referenced in the Caltrans VMT report (Caltrans, 2022). We rated political feasibility of removal of employer-paid parking as "Low" due to substantial opposition, based on political analysis from sources such as urban policy reviews which discuss resistance from businesses and political groups (Shoup, 2005). Lastly, we assigned a rating of "Low" to legal issues of road diets, assuming minimal legal barriers in implementing traffic calming measures based on municipal case studies such as those in Seattle and Minneapolis where road diet initiatives were implemented without significant legal challenges (https://highways.dot.gov/safety/pedestrian-bicyclist/safety-tools/seattle-washington-dexter-avenue-road-diet-case-studies).

We also acknowledge that limitations in data availability and the inherent complexities of cost and effectiveness comparisons may affect our evaluations. Some factors, especially political feasibility and legal issues, are subject to change and can be influenced by variables beyond the scope of this study. Where direct data were unavailable, we relied on analogous information and expert judgment to estimate potential outcomes. In general, we advise readers to interpret the CAM results with caution due to the limited data sources we relied on and a lack of comparison metrics.

Our analysis also suggests that pricing strategies and road diets may score high on effectiveness; however, they face varying degrees of political and public resistance, which hinder widespread adoption in the transportation management field. With regard to equity aspects, the removal of employer-paid parking, increased transit subsidies, taxation of workplace parking, and active transportation can have a high equity impact and create more balanced and inclusive commuting options. However, these measures may face challenges in funding acquisition, infrastructure development, and travel mode shift. For example, while the initial costs of increased transit subsidies can be high, they could significantly enhance transit ridership while promoting equity by improving access for lower-income groups (Litman, 2020). Similarly, road diets, which typically involve modifying roadways to accommodate fewer cars and more space for active transportation (e.g., cycling and walking), have proven highly effective; however, they often encounter political resistance due to perceived inconveniences (Litman, 2020). These strategies may be more effective when integrated into a broader, multimodal, and phased transportation policy framework that includes more robust measures such as parking restrictions and enhanced public transit systems.

Table 28. Criteria-Alternative Matrix (CAM) results

Alternative	Cost	Effectiveness	Equity	Implementation issues	Political feasibility	Legal issues
Parking cash-out	Low	Medium to high (depending on the mode shift performance)	Medium	Low (some measure of enforcement is needed)	High	Low
Traditional TDM programs	Medium	Low to medium	Low	Medium (varies by program)	Low	Low
Trip-reduction programs	High	Low	Medium	High (complex coordination)	Low	Medium
Removal of employer-paid parking	Low	Medium	High	High (resistance expected)	Low	High (political pushback)
Increased transit subsidies	High (depends on targeted population groups)	Medium	High	Medium (depends on funding)	Medium	Low
Taxation of workplace parking	Medium to high	High	High	High (implementation complexity)	Medium	Medium
Active transportation	Medium	Low	High	High (infrastructure needed)	High	Low
Micro-mobility	Low	Low	Low	Medium (infrastructure and partnerships needed)	High	Low

Alternative	Cost	Effectiveness	Equity	Implementation issues	Political feasibility	Legal issues
Road diets	High	High	Medium	High (public opposition likely)	Medium	Low
Pricing	Varies	High	Medium	High (public acceptance issues)	Varies	Medium
Lane management	Low to Medium	Low to Medium	Medium	Medium	High	Low
Parking pricing/restrictions	Low	High	High	Low	Medium to high	Low
Park and ride lots	High	Low	Medium	Medium (land use concerns)	High	Low

Note: Cost reflects both the initial setup and ongoing operation expenses. Effectiveness is measured by the degree of VMT reduction and compliance with environmental goals. Equity considers how fairly impacts and benefits are distributed across different population groups. Implementation issues highlight practical challenges in techniques, infrastructure, and coordination. Political feasibility represents the likelihood of policy acceptance. Legal issues represent legal challenges or compliance with existing laws. The alternatives were compared based on Shoup (2005) and Caltrans (2022).

Emission Reduction Potential Due to Parking Cash-Out

Our emission reduction estimates are based on different scenarios for parking cash-out: (1) 25% of employees, (2) 50% of employees, or (3) 75% of employees accept parking cash-out. Table 29 shows how many workers would be impacted in both regions, the Bay Area and LA County, in the three different scenarios. Scenarios 1 and 2 (25% and 50% cash-out, respectively) are very conservative approaches for emission reduction estimation. Scenario 3 (75% cash-out) was based on our survey findings: a little over 75% respondents indicated that they would accept cash-out.

Our base case is the drive-alone population which receives the free parking space from their employer (Table 30). According to the EPA, the average VMT/capita for light-duty vehicles for 2015–2018 is 22.2 miles/day. If we use this average value, the base case is 5,683,200 VMT/day for the Bay Area and 5,749,800 VMT/day for LA County. Emissions for these scenarios were estimated using the CARB EMission FACtors (EMFAC) model. CARB's EMFAC model calculates statewide or regional emissions inventories by multiplying emissions rates with vehicle activity data from all motor vehicles, ranging from passenger cars to heavy-duty trucks, operating on highways, freeways, and local roads in California (CARB, 2023).

Based on the light-duty truck vehicle model year 2010 data in the EMFAC model, a vehicle in LA County consumes 1.4 gallons of fuel per day and a vehicle in the Bay Area consumes 2.0 gallons/day. For average daily GHG emissions, we use the EPA data for a typical passenger vehicle in California, which is estimated to be 4.6 metric tons of CO_2 annually.

Reduction in vehicle miles traveled (VMT) and estimates for greenhouse gas (GHG) emissions, particulate matter (PM2.5), and fuel consumption under different scenarios for the Bay Area and LA County are presented in Table 30.

Table 29. Impact of Parking Cash-Out Incentive on Employee Commuting Patterns in the Bay Area and LA County

Region	Firms/companies providing free parking space (Shoup and Breinholt, 1997)	Total employees under free parking space	Drive alone population 65.50% (American Community Survey)	25% cash-out acceptance scenario	50% cash-out acceptance scenario	75% cash-out acceptance scenario
Bay Area	20%	11.8% 391,000	256,000	64,000	123,000	192,000
LA County	20%	10.8% 396,000	259,000	65,000	130,000	194,000

Table 30. Emissions and Fuel Consumption for Three Scenarios of VMT Reduction Compared to a Base Case for Both the Bay Area and LA County

Emission	Base case		25% scenario		50% scenario		75% scenario	
	Bay Area	LA County	Bay Area	LA County	Bay Area	LA County	Bay Area	LA County
VMT miles/day	5,683,200	5,749,800	4,329,000	4,306,800	2,952,600	2,863,800	1,420,800	1,437,450
Average daily GHG (tons)	3,328	3,367	2,496	2,522	1,729	1,677	832	842
Average daily PM2.5 (kg)	42.65	54.94	32.00	41.15	22.16	27.37	10.66	13.74
Average daily fuel consumption (gallons)	512,000	362,600	362,600	271,600	246,000	180,600	128,000	91,650

The data shows that both areas experienced considerable reductions in emissions and fuel consumption correlating with the percentage decrease in VMT. LA County generally displayed slightly higher reductions in emissions per VMT reduction when compared to the Bay Area, which is evident in scenario 2 (50% cash-out) where both areas nearly halved their VMT and corresponding emissions. This reduction in VMT, GHG emissions, PM2.5, and fuel consumption is very small because only a small percentage of employees in the Bay Area (11.8%) and in LA County (10.8%) received free parking. Other studies such as Koenig et al. (1996) found that a 27% reduction in the number of personal vehicle trips associated with telecommuting will result in a 77% decrease in VMT, and a 39% (and 4%) decrease in the number of cold (and hot) engine starts. Another study conducted by Shabanpour et al. (2018) found that telecommuting as a sustainable transportation policy can alleviate network congestion by reducing the total daily VMT and vehicle hours traveled up to 0.69% and 2.09%, respectively. They also found that telecommuting could potentially reduce GHG and PM2.5 emissions by up to 0.70% and 1.14%, respectively.

In order to be effective, strategies to reduce VMT will need to be based on the patterns and distributions of VMT per household in the Bay Area and LA County. To visualize the spatial distribution patterns of VMT, we used VMT per household data obtained from the Housing and Transportation Affordability Index (https://htaindex.cnt.org/) for these two areas and generated maps (Figures 11 and 12). Based on the VMT distribution, we can identify areas with the highest VMT per household as primary targets for intervention. In both areas, higher VMT per household is associated with suburban or peri-urban areas compared to central urban locations. This means that residents from these areas are traveling larger distances, mostly for work and other activities. In areas with high VMT but close to existing public transit infrastructure (mostly in the Bay Area), parking cash-out can be a good strategy to encourage transit service use. However, in areas such as LA County with limited transit options, a parking cash-out strategy will be not as effective.

For California to achieve a 40% reduction in GHG emissions (from 1990 levels) by 2030—a plan mandated by SB-32 (Chapter 249, Stats. 2016)—it needs to significantly reduce VMT. Government needs to consider several strategies to do so. These include public transportation enhancement, carpooling and rideshare incentives, development of bike and pedestrian lanes, remote work policies, and smart urban growth plans.

Figure 11. VMT per Household in the Bay Area

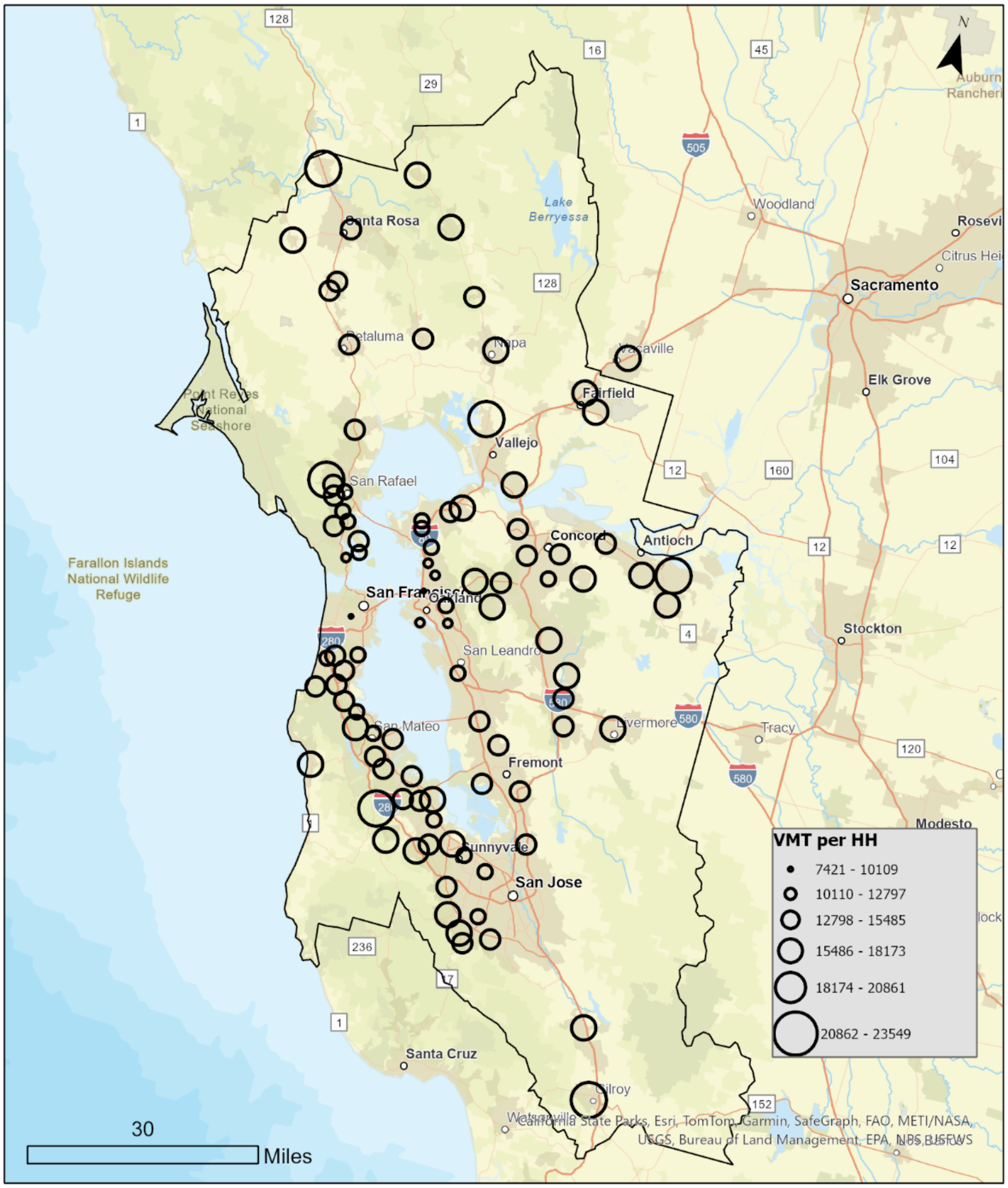
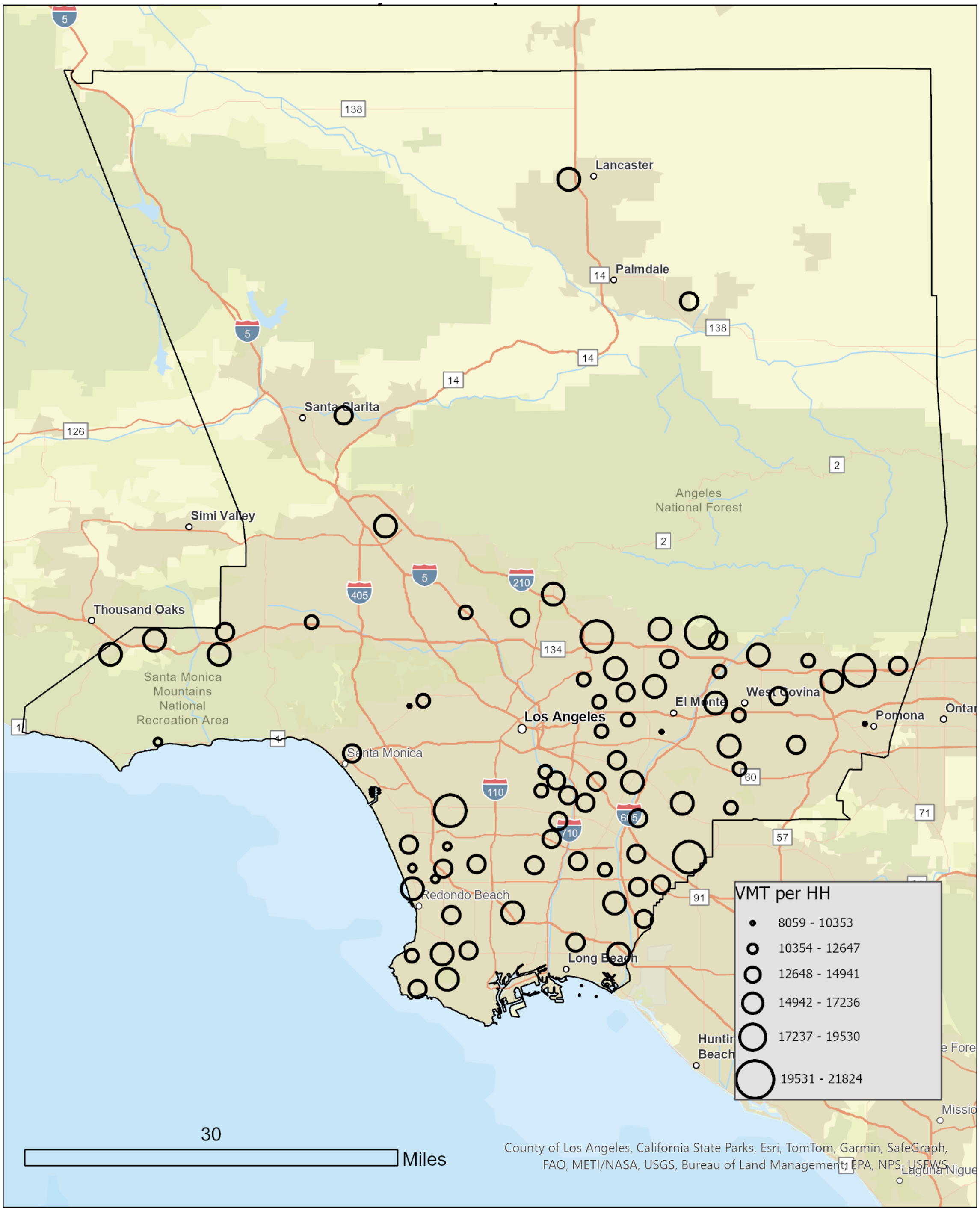


Figure 12. VMT per Household in LA County



Figures 13 and 14 show a visual comparison of VMT/household and CalEnviro scores. CalEnviro score identifies California communities that are most affected by many sources of pollution, and where people are often especially vulnerable to pollution's effects. It uses environmental, health, and socioeconomic information to produce scores for every census tract in the state. LA County has more areas with the lowest score (red color in the map) and comparatively high VMT/household than the Bay Area.

Figure 13: Relation between VMT per Household and CalEnviro Score in the Bay Area

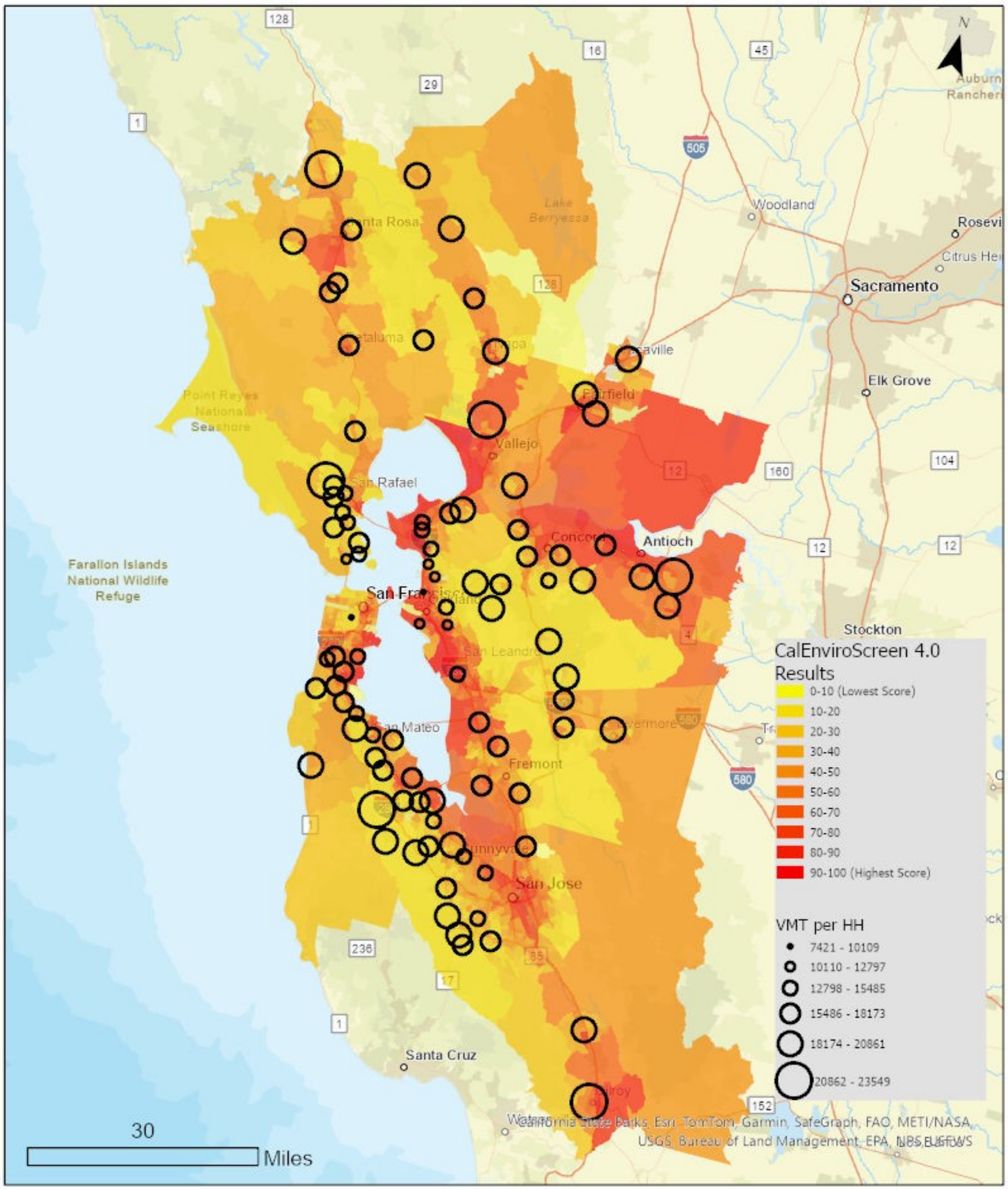
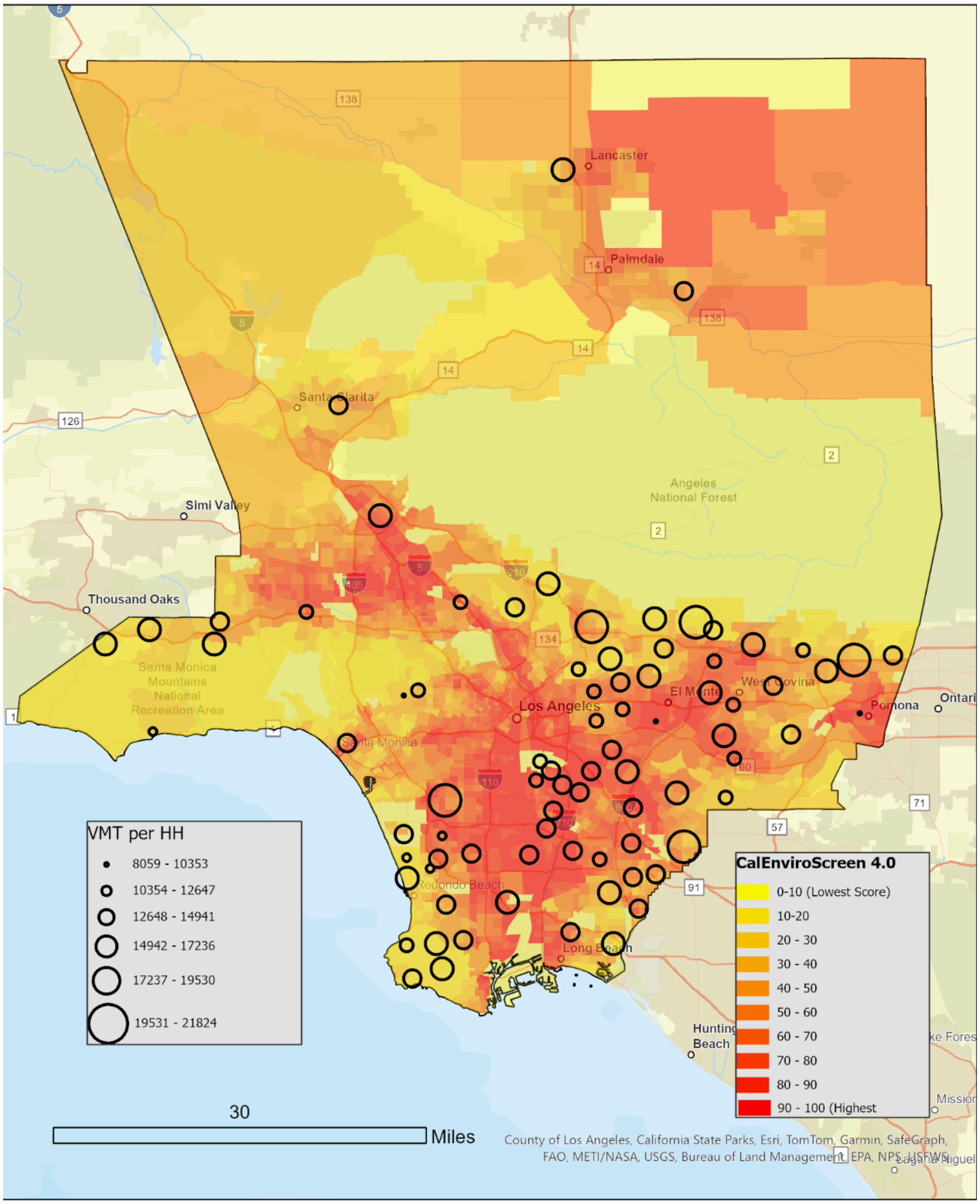


Figure 14: Relation between VMT per Household and CalEnviro Score in LA County



5. Summary and Conclusions

Our study explored the implications of the parking cash-out policy in California, particularly focusing on its potential to alter commuting behaviors in the Bay Area Air Quality Management District and LA County. We conducted a comprehensive literature review on the implementation and enforcement of parking cash-out, the influence of parking cash-out on travel behavior, cost-effectiveness as compared to other state-level programs and measures, and the environmental impact in terms of VMT and GHG emissions. We then leveraged a crowd-sourced platform, namely, Amazon Mechanical Turk, to conduct a multifactorial survey with various scenarios of parking cash-out implementation involving 963 respondents. We investigated the current coverage and impact of the parking cash-out policy, alongside its behavioral, equity, cost-effectiveness, and VMT and emission reduction dimensions.

Key Findings:

- Survey results indicate a strong stated preference for parking cash-out, especially among respondents who are currently paying market rates for parking. Approximately 77% of participants expressed a willingness to accept parking cash-out if offered, highlighting a substantial potential for reducing solo car commutes.

- Increased policy adoption could lead to a significant decrease in VMT in both the Bay Area and LA County.

- The Bay Area could see a decrease in daily GHG emissions from 3,328 tons to 832 tons as the policy adoption goes from base to 75%. In LA County, emissions could be reduced from 3,367 tons to 842 tons under the same scenarios.

- There would be a notable decrease in PM2.5 emissions with increased adoption rates. In the Bay Area, emissions could decrease from 42.65 kg to 10.66 kg, and in LA County from 54.94 kg to 13.74 kg when moving from the base case to a 75% policy adoption.

- In the same scenario, fuel consumption could significantly decline as well. In the Bay Area, daily fuel consumption could drop from 512,000 gallons to 128,000 gallons, while it could decrease from 362,600 gallons to 91,650 gallons in LA County.

- The cost-effectiveness analysis reveals that parking cash-out provides a more direct and economically viable incentive to reduce solo driving compared to more complex and costly measures like trip-reduction programs or road diets.

- The parking cash-out policy, while established, suffers from limited enforcement and coverage, impacting less than 1% of firms and about 3% of employees in California. Therefore, expanding this policy could increase its reach and effectiveness.

- Extending the policy to include organizations with 20 or more employees (as opposed to 50 or more employees currently) could enhance coverage significantly, potentially increasing it from 11% to around 18%.

- A major impediment to broader adoption is the high ownership rate of employee parking spaces. In places like LA County, addressing long-term land use and planning requirements may be essential for effective policy implementation.

- Parking cash-out policies have been implemented across various states in the U.S. as part of comprehensive travel demand management strategies. However, assessing the empirical effectiveness of these policies remains challenging.

- Literature suggests that decisions around parking, parking availability and accessibility play key roles in commuter choices.

- California development requirements include high parking minimums.

The factors influencing the acceptance of parking cash-out include sustainability attitudes, workplace behaviors, and socio-economic status, with higher education levels correlating with a greater inclination towards the policy.

Limitations and future research:

The study faces several limitations that may affect the generalizability and interpretation of the findings. First, our experimental design of the survey did not incorporate other commuting modes (e.g., carpooling, active transportation) aside from public transit. Therefore, our survey does not provide a comprehensive comparison between parking cash-out and various other measures. Additionally, the survey did not include questions about respondents' current parking situations, a factor that could significantly influence their propensity to opt for parking cash-out or other alternatives. These limitations may result in a degree of uncertainty, leading to variations in how participants perceive and respond to the presented policy interventions. Another limitation is the cost-effectiveness assessment, which primarily relied on a general comparison from literature reviews and partial quantitative analysis. This approach may not fully capture the nuanced economic impacts and benefits of the policies examined. Furthermore, the study's reliance on MTurk for data collection, while cost-effective and convenient, may not fully represent the population group that would be impacted by the parking cash-out policy. These limitations suggest the need for cautious interpretation of the study results and underscore the importance of further research to address these gaps.

Future research should explore additional and relevant policy questions such as the implications of cash-out parking being applied to owned parking, and not just leased parking.

Further research is needed into the potential of broader implementation of parking cash-out. It may reduce free and subsidized employer parking. In some cases, employers may choose to offer different types of benefits than subsidized parking so as not to be forced to offer cash-out. This could have broader consequences than just the employer parking. If employers reduce subsidized parking, then parking may be more accurately priced and managed throughout the vicinity.

Future Implications:

Our findings suggest that policy enhancements are necessary to increase the effectiveness and coverage of parking cash-out. Specifically, broadening the eligibility criteria to include smaller companies and revisiting the cash-out minimums could make the policy more inclusive and impactful. Moreover, addressing the survey limitations by incorporating more comprehensive questions and possibly using revealed preference methods could provide a more accurate picture of the policy's potential effects. While parking cash-out has shown promising results in terms of potential VMT reductions and environmental benefits, its success depends on improved enforcement, expanded coverage, and continuous monitoring of its impacts. Policymakers should consider these factors to optimize the effectiveness of parking cash-out strategies in promoting more sustainable commuting practices in California and beyond.

Appendix

Transportation Survey

Start of Block: Informed Consent

Q1

California State University, Dominguez Hills

Study Information Sheet

(California Parking Study)

Introduction:

You are being asked to participate in a research study conducted by Dr. Tianjun Lu (Assistant Professor) and Dr. Parveen Chhetri (Associate Professor) from Earth Science and Geography, Dr. Ashley Membere (Assistant Professor) from Psychology, and Dr. Fynnwin Prager (Associate Professor) from Public Administration at California State University, Dominguez Hills. You are eligible to participate in this study if you are 18 years or older and live in California.

Purpose and Description of the Study:

The purpose of this study is to evaluate the challenges and opportunities of implementing a policy known as "parking cash-out" in California, especially the parking cash-out policy that requires certain employers who provide subsidized parking for their employees to offer these employees the option to receive cash allowance in lieu of a parking space. If you decide to participate in this study, you will complete a survey via Amazon Mechanical Turk. The survey will focus on your experience and preference with parking in relation to demographics, travel, and employment patterns. The survey should take approximately 15-20 minutes in total to complete.

Risk and Discomfort:

The risk associated with this study is psychological. Participation in this study is voluntary. If you volunteer to participate in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don’t want to answer and still remain in the study.

Benefits:

The benefits associated with the study include contribution to the literature and broader knowledge base on the parking topic. If you complete the survey, you will receive the corresponding compensation as set forth by the Amazon Mechanical Turk task.

Confidentiality:

The study is confidential, so any information that you provide cannot be traced back to you. Please do not include your name or other identifying information in your survey responses that can identify you. All survey responses will be collected anonymously and all personally-identifiable information (if any) will be confidential.

Contact information:

If you have any questions or concerns about the research, please feel free to contact the principal investigator: Dr. Tianjun Lu, email: tilu@csudh.edu.

If you have questions regarding your rights as a research participant, contact the California State University, Dominguez Hills IRB Office at 310-243-3756 or irb@csudh.edu.

Please save or print a copy of this page for your records or take a screenshot of it.

Please indicate your choice to participate in this study down below.

- ○ YES, I am over 18 and live in California and consent to participate.
- ○ NO, I will not participate.

End of Block: Informed Consent

Comm_Days Please indicate how many days a week you use the following modes of transportation to commute to work. If you have not used this mode, please choose 0.

	0	1	2	3	4	5	6	7
Drive alone		○	○	○	○	○	○	○
Carpool		○	○	○	○	○	○	○
Ridehail (e.g., Uber, Lyft)		○	○	○	○	○	○	○
Public transit		○	○	○	○	○	○	○
Bike		○	○	○	○	○	○	○
Walk		○	○	○	○	○	○	○
Other		○	○	○	○	○	○	○

Comm_Miles What is the distance of your one-way work commute in miles? If you are not sure, please provide your best guess.

- ◯ 0 - 5
- ◯ 6 - 20
- ◯ 21 - 40
- ◯ 41 - 60
- ◯ 61+

Comm_Time How many minutes does it usually take you to get from home to work (one way, door to door)?

____

Comm_Model What is the model and year of your vehicle?

____

Employment What is your current work status? Please check all that apply.

- ☐ Full-time employed
- ☐ Part-time employed
- ☐ Full-time student
- ☐ Part-time student
- ☐ Homemaker
- ☐ Retired
- ☐ Not working
- ☐ Other

Industry Which industry do you mainly work in?

- Natural resources
- Construction
- Manufacturing
- Wholesale trade
- Retail trade
- Information
- Financial activities
- Health care
- Government
- Transportation/utilities
- Professional/Business services
- Educational services
- Leisure and hospitality
- Other services
- Other (please specify)

Ethnicity Are you of Spanish, Hispanic, or Latino origin?

- ○ Yes
- ○ No

Race Choose one or more races that you consider yourself to be

- ☐ White or Caucasian
- ☐ Black or African American
- ☐ American Indian/Native American or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other
- ☐ Prefer not to say

Gender How do you describe yourself?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer to self-describe ____
- ○ Prefer not to say

County What California county do you currently work in? Please select your answer from the dropdown menu below.

▼ ALAMEDA ... PREFER NOT TO ANSWER

County_TEXT If you selected Other in the previous question, please specify your answer here.

____

OrgSize What is the size of the organization/company for whom you work for?

- ○ Very small (< 25 employees)
- ○ Mid-size (25 - 50 employees)
- ○ Large (51 - 250 employees)
- ○ Very large (> 250 employees)
- ○ Not applicable

Education What is the highest level of education you have completed?

- ○ Some high school or less
- ○ High school diploma or GED
- ○ Some college, but no degree
- ○ Associates or technical degree
- ○ Bachelor's degree
- ○ Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.)
- ○ Prefer not to say

Income What was your total household income before taxes during the past 12 months?

- ◯ Less than $25,000
- ◯ $25,000-$49,999
- ◯ $50,000-$74,999
- ◯ $75,000-$99,999
- ◯ $100,000-$149,999
- ◯ $150,000 or more
- ◯ Prefer not to say

Marital What is your current marital status?

- ◯ Married
- ◯ Living with a partner
- ◯ Widowed
- ◯ Divorced/Separated
- ◯ Never been married

Zip_Home What is your home zip code?

____

Zip_Work What is your work zip code?

____

OrgShort Think about the place where you currently work. Then, for each of the following statements, please select the option that corresponds to your level of agreement:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Employees have the necessary job knowledge and skills to carry out organizational environmental objectives.	○	○	○	○	○
My organization effectively measures progress towards their environmental objectives.	○	○	○	○	○
My organization has a formal recognition and reward system for employee environmentalism.	○	○	○	○	○
My organization's environmental initiatives have a large impact on employee environmental behaviors.	○	○	○	○	○
Leadership shown by management in my organization adequately supports our environmental objectives.	○	○	○	○	○
My organization effectively communicates to employees about environmental objectives.	○	○	○	○	○
Employees have the necessary resources to carry out organizational environmental objectives.	○	○	○	○	○

FFSustain5_Att Please rate your level of agreement with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I like to travel by public transport (e.g., the bus or the train)	○	○	○	○	○
I prefer to travel by car	○	○	○	○	○
Fuel should become more expensive, so that more people will travel by public transport	○	○	○	○	○
Car owners should pay more for driving their cars	○	○	○	○	○
Car owners are careless about the environment	○	○	○	○	○

FFSustain4_Beh Please rate your level of agreement with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I only travel by public transport when the corresponding costs are compensated	○	○	○	○	○
I usually take the bike, even if this means that I am traveling longer	○	○	○	○	○
I avoid rush hour to save fuel	○	○	○	○	○
Whenever I travel by plane, I pay a little extra to be able to fly CO2 neutral	○	○	○	○	○
I travel by bike or public transport because this is better for the environment	○	○	○	○	○
I use the car whenever it suits me	○	○	○	○	○
I make the conscious decision to travel less often to disrupt the environment as little as possible	○	○	○	○	○
I travel by public transport to avoid traffic jams	○	○	○	○	○

SusOCB3 Please rate the frequency in which you engage in the following behaviors.

	Never	Sometimes	About half the time	Most of the time	Always
I persuade my organization to purchase environmentally friendly products.	○	○	○	○	○
I discuss with my leader how my organization can become more environmentally friendly.	○	○	○	○	○
I encourage my organization to support an environmental charity.	○	○	○	○	○
I encourage my organization to reduce its environmental impact.	○	○	○	○	○

PSaCFaCTa_1 Please read over the following information carefully:

Please assume that you have your current income level, occupation and position, but with the following differences: You are able to park at your workplace, and there is no direct fee or charge associated with parking. You are a "hybrid commuter": on an average week, you spend 2 working days at your workplace and 3 working days at home. For your commute, you can choose between two transportation modes: 1) driving alone and 2) public transit (e.g., bus, light rail, subway). Please also assume that on average these two transportation modes have the same travel times between your home and your workplace (door to door).

PSaCFaCTa_2 On the days you commute to your workplace, which transportation mode would you take: public transit or drive alone?

○ Public transit

○ Drive alone

PSaCFaCTa_3 Assuming that you drive to and park when travelling to your workplace, approximately how much would you be willing to accept for your workplace parking? In other words, approximately how much money would you have to receive monthly to switch from driving and parking to using public transit?

- ◯ Less than $50
- ◯ $50-75
- ◯ $76-100
- ◯ $101-$125
- ◯ $126-$150
- ◯ $151-175
- ◯ $176-200
- ◯ $201-$225
- ◯ $226-250
- ◯ $251 or more

PSaCFaCTa_4 Some organizations are required under California law to offer a "cash-out" option when they offer free or subsidized parking. Instead of driving and parking at work, you can "cash-out" the free or subsidized parking up to the market value of the parking space. Instead, you would take other modes of transportation. Given the scenario described above, would you take the parking "cash-out" option or continue driving and parking?

- ◯ Accept parking "cash-out": instead of free or subsidized parking, you are paid a monthly amount equivalent to the market value of the parking subsidy.
- ◯ Reject parking "cash-out": continue to receive free or subsidized parking.

[Other assigned experimental scenarios were excluded for brevity; details can be found in the Methodology section].

Q50 Please base your responses on the information you received on the previous page.

What type of commuter were you?

- Full-time commuter
- Hybrid commuter

Q128 Please base your responses on the information you received on the previous page.

What type of parking was provided?

- Free parking
- Subsidized parking
- Pay market rate

Q129 Please base your responses on the information you received on the previous page.

What was the difference between the commute time between your drive and the use of public transportation?

- No difference
- 30 minutes
- An hour

TranspPercp Please read over the following statements and rate your level of satisfaction regarding your local public transportation services.

	Extremely dissatisfied	Moderately dissatisfied	Slightly dissatisfied	Neither satisfied nor dissatisfied	Slightly satisfied	Moderately satisfied	Extremely satisfied
Boarding and alighting time	○	○	○	○	○	○	○
On board safety against crime	○	○	○	○	○	○	○
Safety in terms of accidents	○	○	○	○	○	○	○
Safety in the bus stops	○	○	○	○	○	○	○
Condition of the vehicle	○	○	○	○	○	○	○
Cleanliness of the vehicle	○	○	○	○	○	○	○
Cleanliness of the seats	○	○	○	○	○	○	○
Condition of the doors and windows	○	○	○	○	○	○	○
Comfortability of the seats	○	○	○	○	○	○	○
Availability of the seats	○	○	○	○	○	○	○
Overcrowding nature	○	○	○	○	○	○	○
Behavior of staff	○	○	○	○	○	○	○

	Extremely dissatisfied	Moderately dissatisfied	Slightly dissatisfied	Neither satisfied nor dissatisfied	Slightly satisfied	Moderately satisfied	Extremely satisfied
Overall journey experience	○	○	○	○	○	○	○
Facilities provided for the disabled	○	○	○	○	○	○	○
Frequency of breakdowns	○	○	○	○	○	○	○
Availability of the service	○	○	○	○	○	○	○
Prior information about the travel fare	○	○	○	○	○	○	○
Travel cost	○	○	○	○	○	○	○
Travel speed	○	○	○	○	○	○	○
Arrival and departure time	○	○	○	○	○	○	○
Prior information about journey time	○	○	○	○	○	○	○
Prior information about waiting time	○	○	○	○	○	○	○
Regularity of service	○	○	○	○	○	○	○

Debriefing

Thank you for your participation in this research. The purpose of this study was to investigate transportation and parking policies and behaviors. If you have any questions, the main point of contact for this research is tilu@csudh.edu.

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About the Authors

Fynnwin Prager, PhD

Dr. Prager is Associate Professor of Public Administration, Director of the School of Public Service and Justice, and Co-Director of the South Bay Economics Institute at CSU Dominguez Hills. He received his PhD from—and undertook a Postdoc at—the USC Price School of Public Policy. He is an External Research Fellow at USC's Center for Risk and Economic Analysis of Threats and Emergencies. His research and publications in journals such as Risk Analysis, International Journal of Disaster Risk Reduction, Transportation Research Part A, Contemporary Economic Policy, Transport Policy, Research in Transportation Business and Management, Journal of Entrepreneurship and Policy, and The World Economy have focused on the policy and economics of disasters, particularly environmental and terrorism policy, as well as regional economies and transportation systems. Dr. Prager has published two books: Terrorism: An International Perspective with Professor Gus Martin at CSUDH and Economic Consequence Analysis of Disasters with Professor Adam Rose and colleagues at USC. Dr. Prager is committed to teaching, research, and service at CSUDH, and interconnects his classroom with research for numerous regional and national organizations, including U.S. Customs and Border Protection, U.S. National Biosurveillance Integration Center, California Air Resources Board, World Trade Center, Los Angeles, South Bay Workforce Investment Board, CSU Transportation Center, and Department of Cannabis Control.

Tianjun Lu, PhD

Dr. Lu is an Assistant Professor in the Department of Epidemiology and Environmental Health at University of Kentucky. He received his Ph.D. in Planning, Governance, and Globalization from Virginia Tech and was a Research Scientist at the University of Washington. Dr. Lu's recent work has been published in Transportation Research Part D: Transport and Environment, Environmental Science and Technology, and Science of the Total Environment. His scholarly contribution mainly falls into multidisciplinary fields including transportation planning, air pollution exposure assessment, environmental justice, and environmental health. Dr. Lu has rich experience in developing nationwide air quality models funded by the U.S. Environmental Protection Agency (i.e., air pollution exposure models in the continental U.S.), a community-level air quality project funded by the Minneapolis Department of Health, MN, and CSUDH, and community-based transportation measurements and modeling work funded by U.S. Department of Transportation. Currently, he has served as the primary investigator for multiple funded projects in California and Texas, including the California telecommuting project to identify statewide patterns and trends of telecommuting, climate and environmental impacts of warehousing, the Community Air Monitoring Program in Southern California, and a community-based air monitoring campaign in the Gulf Region in Texas.

Ashley Membere, PhD

Dr. Membere is an Assistant Professor in the Psychology Department at California State University Dominguez Hills. Her area of specialty is Industrial/Organizational Psychology. Dr. Membere's research focuses on diversity, equity, and inclusion related issues in the workplace. Her program of research includes investigating the experiences of marginalized employees and developing intervention strategies to create more inclusive and equitable work environments. To address these topics, Dr. Membere employs the use of complex experimental methodologies and survey designs for both cross-sectional and longitudinal studies as well as the use of secondary data sources.

Parveen Chhetri, PhD

Dr. Chhetri is an Associate Professor in the Department of Earth Science and Geography and serves as the Program Director of the MS Environmental Science at California State University Dominguez Hills. His expertise lies in Environmental Geography and Geospatial Technology, particularly in Geographic Information Systems (GIS) and Remote Sensing (RS). Dr. Chhetri teaches a range of courses, including Physical Geography, Natural Resources, GIS, and RS. Dr. Chhetri's expertise in GIS, RS, and Energy and Climate Change is reflected in his publication record of peer-reviewed articles covering these subjects. Currently, he is engaged in a research project that examines the environmental impact of telecommuting. Additionally, Dr. Chhetri is working with numerous graduate and undergraduate students on various research projects. These projects encompass the response of forest ecosystems to climate change, energy and climate change concerns specific to the LA region, GIS-based flood mapping, and the assessment of ecosystem services provided by urban trees using geospatial technology.