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Equity and Mileage-Based User Fees: An Analysis of the Equity Implications of Mileage-Based User Fees Compared to the Gas Tax in the SCAG Region



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# Equity and Mileage-Based User Fees:

## An Analysis of the Equity Implications of Mileage-Based User Fees Compared to the Gas Tax in the SCAG Region

Project Lead: Shinah Park
Faculty Advisor: Dr. Evelyn Blumenberg
Client: Southern California Association of Governments

June 2022

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**16. Abstract**

California has set goals to reduce greenhouse gas emissions, prompting stakeholders in the transportation sector to research ways to reduce vehicle miles of travel (VMT) through possible pricing strategies to incentivize less driving. The current transportation funding mechanism relies on the state gas tax. This tax is not a sustainable source of revenue since increases in the fuel economy of vehicles—absent an increase in the tax—will reduce revenue generation. One potential strategy for resolving this is a mileage-based user fee, also called a VMT fee. Rather than taxing the use of gasoline, a VMT fee directly taxes driving based on the number of miles driven.

The Southern California Association of Governments (SCAG) is interested in understanding the equity implications of adopting a VMT tax since one concern that needs to be addressed before introducing a VMT fee is how the program might affect low-income drivers. This study draws on data from the 2017 National Household Travel Survey to estimate the effects of a mileage-based user fee compared to the current gas tax system on drivers by income in the SCAG region. Overall, all households would experience a tax cost increase under the 2.5 cents per mile fee tax scheme, but the increase would vary by household location and income group. Higher-income households would experience a greater increase in their total tax, but only a 0.03 percent increase relative to their income. Low-income households on average would pay 0.1 percent more of their income under the VMT tax.

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# Equity and Mileage-Based User Fees

## An Analysis of the Equity Implications of Mileage-Based User Fees Compared to the Gas Tax in the SCAG Region

UCLA Institute of Transportation Studies

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*Applied Planning Research Project*
*A comprehensive project submitted in partial fulfillment of the requirements for the degree of Master in Urban and Regional Planning*

*Client: Southern California Association of Governments*
*Faculty Advisor: Dr. Evelyn Blumenberg, Professor of Urban Planning and Director of the Lewis Center for Regional Policy Studies*

*June 1st, 2022*

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# Executive Summary

California has set goals to reduce greenhouse gas emissions, prompting stakeholders in the transportation sector to research ways to reduce vehicle miles of travel (VMT) through possible pricing strategies to incentivize less driving. The current transportation funding mechanism relies on the state gas tax. This tax is not a sustainable source of revenue since increases in the fuel economy of vehicles—absent an increase in the tax—will reduce revenue generation.

It is in this context that the Southern California Association of Governments (SCAG), the metropolitan planning organization for the larger Southern California region, is investigating ways to incentivize less driving while generating adequate revenue to support the region's transportation system. One potential strategy for doing this is a mileage-based user fee, also called a VMT tax or VMT fee. Rather than taxing the use of gasoline, a VMT fee directly taxes driving based on the number of miles driven.

SCAG is interested in understanding the equity implications of adopting a VMT tax. This study, therefore, draws on data from the California add-on of the 2017 National Household Travel Survey to estimate the effects of a mileage-based user fee compared to the current gas tax system on drivers by income.

I analyze 3,468 households that have at least one vehicle and have submitted vehicle information, regardless of whether they made a trip on the travel day. I use 1.5 times the federal poverty line of 2016 as a yardstick for determining whether a household is low-income adjusting for household size, since the original poverty threshold is very low and the sample size would be very small to conduct an analysis. In the SCAG region, 335 households are 'low-income households' according to this definition and the remainder are 'higher-income households.'

The NHTS categorizes households using five types of neighborhoods: urban core, urban district, urban neighborhood, suburban neighborhood, and nonurban. I combined the three urban categories (urban core, urban district, and urban neighborhood) into "Urban Areas" and the suburban and non-urban categories into "Non-Urban Areas." Also, since the sample size for low-income households in counties other than Los Angeles County is less than 100, I aggregated the data for the five counties into one category "Outside of LA County."

# Key findings

**1) Low-income households drive less miles on average. For both income groups, VMT is higher outside of urban areas.**

Table ES1 shows daily miles of travel by income and neighborhood type. The VMT of higher-income households is about 20 percent higher than that of the lower-income households. For Los Angeles, the gap between the two income groups regarding median distance traveled is smaller in Non-Urban areas than in Urban areas.

Table ES1. Daily Miles of Travel by Income and Neighborhood Type, SCAG Region

| | Low-Income Households | | Higher-Income Households | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **43** | **25** | **46** | **31** |
| Urban Area | 35 | 22 | 38 | 27 |
| Non-Urban Areas | 51 | 31 | 50 | 35 |
| **Outside LA County** | **43** | **27** | **51** | **31** |
| Urban Area[1] | - | - | 37 | 25 |
| Non-Urban Areas | 44 | 27 | 52 | 32 |

**2) Compared to higher-income households, low-income households in both locations own older, less fuel-efficient vehicles.**

The amount of fuel tax each household pays, which is proportional to gallons purchased, differs based on the characteristics of household vehicles. Thus, I first present descriptive statistics on vehicle characteristics by income for households in the SCAG region. Table ES2 shows age and fuel economy of household vehicles by location. Since low-income households own older, less fuel-efficient vehicles, they pay more than higher-income households, even if they drive the same number of miles.

[1] I omitted statistics for low-income households living in urban areas outside of LA County due to the small sample size (14 households). Because of this, the statistics for low-income households in counties outside of LA may reflect the travel of households in non-urban areas. Only 26 of census tracts in San Bernardino, Riverside, Imperial, and Ventura County are "urban.".

Table ES2. Age and Fuel Economy of Household Vehicles by Location, SCAG Region

| | Vehicles owned by Low-Income Households | | Vehicles owned by Higher-income Households | |
|---|---|---|---|---|
| | Vehicle Age (years) | Vehicle Fuel Economy (mpg) | Vehicle Age (years) | Vehicle Fuel Economy (mpg) |
| **Los Angeles County** | | | | |
| Mean | 11 | 23 | 10 | 25 |
| Median | 12 | 22 | 8 | 22 |
| **Outside LA County** | | | | |
| Mean | 12 | 23 | 10 | 24 |
| Median | 12 | 22 | 9 | 22 |

**3) Compared to higher-income households, a higher percentage of vehicles owned by low-income households use regular gasoline and diesel.**

Fuel tax cost differs by vehicle fuel type. Table ES3 shows the distribution of vehicles by vehicle fuel type and location. In general, compared to higher-income households, a higher percentage of vehicles owned by low-income households use regular gasoline. Interestingly, eight percent and five percent of the vehicles owned by higher-income households in Los Angeles and outside of LA county respectively, are exempt from fuel taxes.

Table ES3. Percentage of Vehicles by Vehicle Fuel Type and Area, SCAG Region

| | Gasoline | Diesel | Other (Electric batteries, biodiesel[2] etc.) |
|---|---|---|---|
| **Los Angeles County** | | | |
| Low-Income | 98 % | 1 % | 1 % |
| Higher-Income | 90 % | 2 % | 8 % |
| **Outside LA County** | | | |
| Low-Income | 97 % | 0 % | 2 % |
| Higher-Income | 92 % | 2 % | 5 % |

[2] In practice, biodiesel cars pay the same rate as regular diesel. Since there is no way to identify biodiesel cars in the 'other' category, I assumed they pay zero tax. This assumption will not introduce significant error since the biodiesel adoption rate is very small.

**4) Low-income households generally pay less fuel taxes than higher-income households, but the cost burden is higher.**

Table ES4 shows the fuel tax amount and tax burden relative by income group. Surprisingly, the low-income households and higher-income households living in Los Angeles County pay the same amount for fuel tax. The median vehicle miles traveled for low-income households in Los Angeles County is lower than that of higher income households, but their fuel tax cost is higher. This might be because eight percent of vehicles in higher-income households in Los Angeles County are not paying fuel tax, likely affecting the average result.

Table ES4. Average and Median Gas Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region

| | Low-Income Households (Tax Burden) | | Higher-income Households (Tax Burden) | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **$ 361 (3.1 %)** | **$ 211 (1.3 %)** | **$ 339 (0.4 %)** | **$ 221 (0.3 %)** |
| Urban Area | $ 289 (2.8 %) | $ 176 (1.2 %) | $ 264 (0.4 %) | $ 166 (0.2 %) |
| Non-Urban Areas | $ 431 (3.4 %) | $ 262 (1.4 %) | $ 381 (0.5 %) | $ 256 (0.3 %) |
| **Outside of LA County** | $ 335 (2.5 %) | **$ 205 (1.4 %)** | **$ 396 (0.5 %)** | **$ 231 (0.3 %)** |
| Urban Area | - | - | $ 271 (0.4 %) | $ 184 (0.3 %) |
| Non-Urban Areas | $ 336 (2.4 %) | $ 195 (1.4 %) | $ 406 (0.5 %) | $ 236 (0.3 %) |

**5) All households would experience a tax cost increase under the VMT tax scheme that applies a flat per-mile fee of 2.5 cents.**

Previous SCAG studies have hypothesized a 2.5 cents per mile VMT fee. I multiply the per-mile fee of 2.5 cents for each household's daily VMT and multiply 365 to translate the cost to an annual unit. Overall, all households would experience a tax cost increase under the VMT tax scheme, but the increase would vary by household location and income group. In general, higher-income households would experience a greater increase in their total tax, but only a 0.03

percent increase relative to their income. Low-income households on average would pay 0.1 percent more of their income under the VMT tax.

Table ES5. Average and Median Total VMT Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region when taxed on all miles

| | Low-Income Households Total Tax (Tax Burden) | | Higher-income Households Total Tax (Tax Burden) | |
|---|---|---|---|---|
| | Average | Median | Average | Median |
| **Los Angeles County** | **$ 396 (3.4 %)** | **$ 231 (1.5 %)** | **$ 416 (0.5 %)** | **$ 284 (0.3 %)** |
| Urban Area | $ 322 (3.1 %) | $ 200 (1.5 %) | $ 346 (0.5 %) | $ 243 (0.3 %) |
| Non-Urban Areas | $ 467 (3.7 %) | $ 282 (1.7 %) | $ 456 (0.5 %) | $ 315 (0.3 %) |
| **Outside LA County** | **$ 395 (2.8 %)** | **$ 247 (1.9 %)** | **$ 468 (0.6 %)** | **$ 287 (0.4 %)** |
| Urban Area | - | - | $ 338 (0.5 %) | $ 225 (0.3 %) |
| Non-Urban Areas | $ 398 (2.8 %) | $ 225 (1.9 %) | $ 478 (0.6 %) | $ 286 (0.4 %) |

# Chapter 1. Introduction and Background

## Context for the potential mileage-based user fees

A reduction in greenhouse gas (GHG) emissions is mandated by law in California. Under Senate Bill 375, regional plans that link transportation, land use, housing, and climate policy at the regional level should be developed and implemented to reduce per capita GHG emissions. The GHG reduction goal will be partially accomplished through reductions in per capita vehicle miles of traveled (VMT). In 2018, the California Air Resource Board set a more aggressive target which aims to reduce GHG emissions from passenger vehicles by 2035, relative to 2005 levels. Currently, stakeholders in the transportation sector are researching ways to reduce VMT through possible pricing strategies that could incentivize less driving.

The introduction of highly fuel-efficient vehicles has led to a greater difference between the most and least fuel-efficient vehicles over time, resulting in a situation where drivers pay varying amounts to use the road, even if they drive the same number of miles. The current funding mechanism is not sustainable for the transportation sector as fuel consumption decreases as fuel economy increases. Meanwhile, the federal fuel tax rate of 18.4 cents per gallon has not changed since 1993, eroding with inflation. A mileage-based user fee, also called a VMT tax or VMT fee, could serve as an alternative revenue mechanism to the current gas tax and support local and regional transportation infrastructure projects.

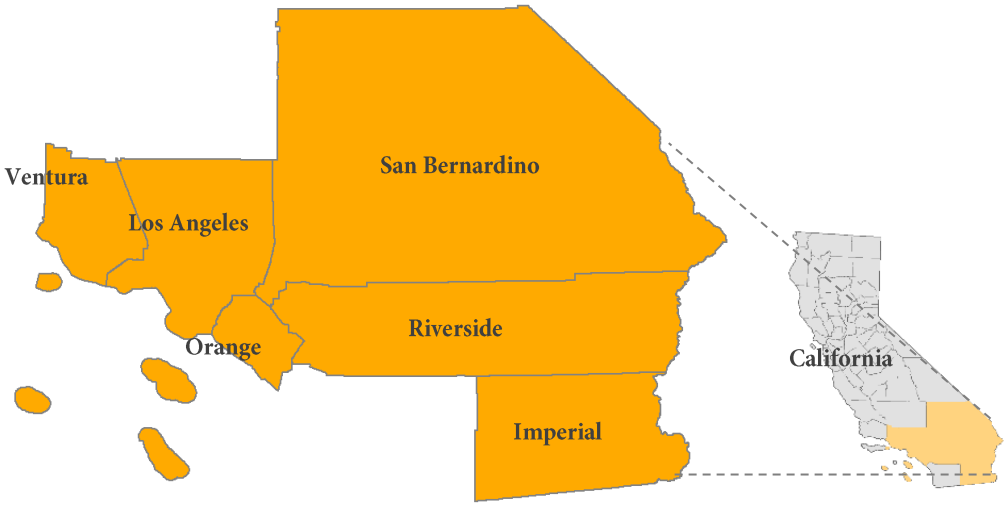
It is in this context that the Southern California Association of Governments (SCAG), the metropolitan planning organization for the larger Southern California region, is investigating ways to incentivize less driving while generating adequate revenue to support the region's transportation system.  One concern that needs to be addressed before introducing a VMT fee is how the program might affect low-income drivers. According to data from the National Household Travel Survey, 16 percent of low-income households own zero vehicles and compared to only two percent of higher-income households (Federal Highway Administration, 2017). Although the percentage of households with zero vehicles is higher in the low-income group, 84 percent of low-income households own at least one vehicle and, therefore, would be affected by the mileage-based user fee program. In addition, SCAG would like to identify households—

particularly low-income households—who live in areas that require long-distance travel and who may be disproportionately burdened by a VMT tax.

## Southern California Association of Governments

The Southern California Association of Governments (SCAG) encompasses six counties (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura) and 191 cities. It is the largest metropolitan planning organization in the US, designated under federal and state law. Its role is to develop long-range regional transportation plans for a sustainable future.

Figure 1. Map of the SCAG Region




In 2014, the California legislature passed Senate Bill 1077, directing California to conduct a pilot program to study the feasibility of a road user charge as an alternative tax system to the gas tax. More than 5,000 participants were sampled to reflect all kinds of populations, locations, and vehicle types; less than four percent dropped out during the program. A revenue neutral fee of 1.8 cents per mile was applied, and the participants were provided options for collecting their miles information. According to the 2017 pilot program summary report, 73 percent of the participants said the road user charge was more equitable than the gas tax. Based on these findings, SCAG noted in 2020 the RTP/SCS that theoretically, the mileage-based user fee is expected to be implemented in 2030 at a rate of $0.025 (in 2019 dollars) per mile.

## Research Question

SCAG was interested in understanding the equity implications of a VMT tax to ensure that future pricing programs do not exacerbate current transportation inequities. In this research, therefore, I draw on data from the California add-on of the 2017 National Household Travel Survey (NHTS) to explore the relationship between income, VMT, and potential tax scenarios. I first examine the effect of two VMT tax scenarios on households in the SCAG region by income. I then compare the cost burden of a VMT tax with the cost burden of the current state gas tax again by household income.

In this report, I first conduct a review on existing literature helpful for understanding the low-income drivers' driving pattern and the equity implications of the gas tax and VMT tax. Next, I explain the NHTS dataset, scope, and flow of my analysis. I then present my analysis results on the daily VMT of households by income and household location. After that, I present descriptive statistics of characteristics of vehicles owned by households in the SCAG region. I then calculate the gas tax and VMT tax cost and cost burden and see the change in burden by income and household location. The results show that all households would experience a tax cost increase under the VMT tax scheme, but the increase would vary by household location and income group.

# Chapter 2. Literature Review

## Low-income households' travel and cost burden

To understand how much low-income drivers will pay under each tax system, it is necessary to understand the general travel patterns of low-income drivers. Researchers have confirmed that low-income individuals travel shorter distances than higher-income individuals. Using data from the 2009 National Household Travel Survey (NHTS), Blumenberg and Pierce (2012) found that low-income travelers travel shorter distances than higher-income travelers; however, they are more likely to use slower modes of transportation (e.g. public transit). Still, 83 percent of trips by low-income individuals are completed in an automobile. Morency et al. (2011) show similar findings; they researched the distance traveled by the elderly, individuals in single-parent households, and low-income households and found that the lowest income class tends to make shorter trips on average.

Although low-income drivers travel fewer miles on average, transportation imposes a significant burden on low-income households compared to other income groups (Blumenberg & Agrawal, 2014; Fan & Huang, 2011; Fletcher et al., 2005; Rice, 2004). Schweitzer and Taylor (2008) argue that no matter how much low-income people pay, they pay a more significant portion of their income than higher-income people. These ideas are also applicable specifically to gasoline expenditures. Data from the 2018-19 Consumer Expenditure Survey show that all households on average spend 3.7 percent of their expenditure on gas while lowest 20 percent of households spent 4.3 percent of their expenditures on gasoline, although their overall expenditure cost was lower (Public Policy Institute of California, 2019).

## Factors relating to vehicle miles of traveled

Under both a VMT and gas tax, the more miles traveled, the more one pays in taxes, unless the vehicle is operated by a fuel other than gasoline. Thus, it is important to distinguish who drives a lot of miles. Among the research addressing long-distance travel, most studies focus on identifying the factors that predict whether individuals commute long distances. For example, Mitra and Saphores (2019) explained that median housing costs and the jobs-housing ratio are

significant factors in people's decision about where to live. In terms of geographic factors, Dargay and Clark (2012) found that individuals' number of long-distance trips increases as the municipality size decreases. Based on the understanding of these factors, this study explores the variance in the miles traveled by income and county and neighborhood type.

Although some research has examined long-distance commuting, relatively few studies have focused on non-work long-distance travel mainly because of data availability issues. (Davis et al., 2018) In one study, Davis et al. (2018) categorized long-distance trips according to trip purpose and found that people living in urban areas are less likely to make long-distance trips for both commute and non-commute trips. Because individuals who have short commute trips may have long errand trips, the current research focuses on total daily VMT to fully understand the implications of road pricing applied to all VMT.

## Equity and road pricing

### Implications of road pricing

A common concern with introducing road user charges is that they can harm low-income drivers (Hering, 2008; Texas Department of Transportation (TxDOT), 2009; Whitty, 2017). Studies show that VMT fees shift the tax burden from low-income households to high-income households and from rural to urban households (Weatherford, 2011). Zhang et al. (2009) argued that the distributional effects of a 1.2 cent per mile flat VMT fee are not significant in either the short- or long- run. They also suggested that distributional concerns should not be a factor that stops the implementation of VMT fees.

### Geographical variances of VMT

SCAG covers a large region in Southern California, and its area includes urbanized areas as well as rural areas. People living in rural or suburban areas travel longer distances to access job centers or other services compared to those living in urban areas, increasing their total vehicle miles traveled. Only a few researchers have explored how a VMT tax might vary across regions. Ke & McMullen (2017) drew on the Oregon Household Activity Survey (OHAS) to study the determinants of VMT in geographic regions in Oregon. The OHAS uses five different location

categories to classify households based on increasing degrees of urban-ness, based on the 2013 American Communities Survey population density measure. The researchers conclude that rural households travel longer distances than households in the four other categories, and regions with similar demographic characteristics may have different underlying factors that determine their travel behaviors.

## Distributional effect of the VMT tax

Much of the existing research on a proposed VMT tax focuses on setting scenarios to decide the amount of the VMT fee and how the tax would affect the total revenue generated for transportation agencies (Robitaille et al., 2011; Verma et al., 2017). Only a few studies have examined the equity implications of VMT fee structures and the effect of the tax on households by income. A VMT fee will shift the burden from low-income households to high-income households and from rural households to urban households (Weatherford, 2011). Using the Nevada portion of the NHTS dataset, Paz et al. (2014) discovered that high-income groups had a larger increase in annual cost than lower-income groups. Zhang et al. (2009) measured the distributional impacts of collected VMT tax by quantifying overall welfare changes and consumer surplus and concluded that in the long term, VMT fees will hurt rural households considering the welfare loss from the higher operating costs of fuel-inefficient vehicles. Another study using the consumer surplus concept reveals that increasing the gas tax by ten cents per gallon will cause the lowest-income group experience a change in revenue contribution equivalent to 0.6 percent of total household income while higher-income households will contribute only 0.17 percent of the total income (Robitaille et al., 2011). When converting the increased federal gas tax to an equivalent VMT fee, older-adult households living in rural regions experienced the least loss of consumer surplus, and households with incomes higher than $60,000 experienced a reduced loss of consumer surplus with the VMT fee than with the gas tax (Robitaille et al., 2011).

However, the VMT tax can discourage the use of clean fuel or vehicles because it does not incentivize users to reduce the number of gallons required to complete trips. Assuming that the tax is a flat rate, the total amount would simply be proportional to the distance traveled. Thus, the state should be mindful of these effects. This is likely to apply to higher-income households since clean vehicles are expensive and more likely to be owned by higher-income households.

# Conclusion

The main goal of this project is to understand the equity implications of a VMT tax compared to the current gas tax system in the SCAG region by mainly focusing on the relationship between income and miles traveled by household unit, which is available using the NHTS data. My study fills a gap in the literature in several ways. First, my analysis centers on equity. The goal is to better understand and mitigate the effect of a VMT tax on lower-income households, a focus has not been dominant in studies of VMT fees. Second, this research includes an analysis of total VMT—commute and non-work trips; analysis of non-work travel is often excluded from studies due to data limitations. Third, existing knowledge of differences in miles traveled by neighborhood type is limited since previous research largely examines trends by state. My study reveals characteristics of the SCAG region itself and connects it to variation in the cost burden across the region.

# Chapter 3. Analysis Plan

## National Household Travel Survey (NHTS)

In this study, I use secondary data from the National Household Travel Survey (NHTS). Provided publicly by Federal Highway Administration (FHWA) every eight years, data from the NHTS allow researchers to analyze trends in how people and households travel. On a given travel day, participants are asked to report all of the locations to which they traveled from 4:00 am to 3:59 am the next day, regardless of how long they were there (NHTS, 2019). The dataset includes trip level data, including the characteristics of travelers, their households, and their vehicles. In this study, I use the NHTS Add On for California and analyze 3,468 household respondents in the six Southern California counties that comprise the SCAG region (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura). The Add On data also include the survey respondents' residential location, allowing me to identify the location of recorded trips. The latest version is from 2017, and the respondents responded between April 19, 2016, and April 25, 2017. Thus, the time context of this study is 2016-17.

Other datasets include travel data. However, most of these—such as data from the American Community Survey—provide information on commute trips only. Although trips to work are essential and tend to be longer than non-work trips, road pricing is charged based on the total vehicles miles of traveled.  NHTS is one of the only dataset to incorporate all trips—both work and non-work.

## Scope of the analysis

The NHTS dataset includes 3,812 household survey records for the SCAG region. Among these households, 216 did not submit vehicle information necessary to calculate their potential gas tax costs. Further, both the VMT and gas taxes apply to households that possess vehicles. Thus, I analyze 3,468 households that have at least one vehicle and have submitted vehicle information, regardless of whether they made a trip on the travel day.  I use the same sample of households in all of my analyses.

In the analysis, I present both the average and median to compare the statistics. In smaller sample sizes (such as my sample of low-income households), average values may be skewed by a few extreme outliers. Thus, I present both the average and median for every analysis but , in most cases, use the median to interpret my  results and increase the reliability of my findings.

## Defining low-income and driving

The survey asked respondents to answer household income by choosing an applicable range, such as $15,000 to $24,999 and $25,000 to $34,999. Thus, it is hard to apply existing low-income thresholds directly to distinguish whether the household is low-income or not. Also, adjustments with household size are necessary when using thresholds for income in a household unit. For this analysis, I utilize existing federal poverty threshold that adjusts income by household size. The threshold isn't a standard for what a family needs, but it is used as a statistical yardstick. It also doesn't vary geographically but is adjusted annually for inflation. I use 1.5 times the federal poverty line of 2016 as a yardstick for determining whether a household is low-income adjusting for household size, since the original poverty threshold is very low and the sample size would be very small to conduct an analysis. For example, in 2016, the poverty threshold for a family of four was $24,563. 1.5 times the poverty threshold for this family would be $36,845. Households with income over the threshold are grouped as higher-income households.

In the SCAG region, 335 households are 'low-income households' according to this definition and the remainder are 'higher-income households.'  As I note above, some households did not drive on the travel survey day.  Interestingly, for low-income households, only one household did not make a vehicle trip.  For non-low-income households, eight households did not make a vehicle trip on the survey day.  Consistent with the broader literature on household vehicles and trip making, the data show that regardless of income most households with vehicles generated trips.[3]

[3] When applying the same poverty standard for the all 3,812 households, 449 households are low-income and 3,313 households are higher-income. Sixteen percent (74 households) of low-income households did not have household vehicles and 24 percent (111 households) of low-income households did not record a vehicle trip. Two percent (62 households) of higher-income households did not have household vehicles and seven percent (217 households) did not record a vehicle trip on the survey day.

VMT tax and gas tax is charged to households that drive. Trips completed by car, SUV, pickup truck, and van are considered *driving*. Trips completed by modes such as walk, bicycle, public or commuter bus, taxi, and school bus are eliminated when assembling the data. Overall, 83 percent of trips are completed by driving for the SCAG region.

## Vehicle miles of travel (VMT) and household income

In the first part of the analysis, I present descriptive statistics on the VMT of two income groups (low-income and higher-income households) to understand the relationship between VMT and household income. I first calculate the total daily VMT of households. I filtered within household carpool trips to prevent duplicating the distances and aggregate distances completed by vehicles. Previous studies confirm that the travel patterns of low-income and other income groups differ in terms of time of day (Giuliano, 2005). Thus, I also calculate the total daily peak hour VMT and make comparisons across income groups.

Lastly, VMT also varies by the characteristics of the neighborhood (Ke & McMullen, 2017; McMullen & Eckstein, 2013). In order to understand the potential impact of the tax scheme on households in diverse communities, I calculate VMT by neighborhood type and by county. I use the neighborhood categories defined in the NHTS. These include five categories, urban core, urban district, urban neighborhood, suburban neighborhood, and non-urban. To create large enough samples across my variables of interest, I combine these categories into two: "Urban Areas" and "Non-Urban Areas".

## Fuel tax calculation

The NHTS provides vehicle information for respondents. The vehicle file includes variables such as vehicle make and model, vehicle age, vehicle type (automobiles, SUV, and pickup truck etc.) and fuel types (regular gasoline, diesel or others). Version 1.2 of the NHTS also provides information on the fuel economy of household vehicles, which is a key variable in estimating total fuel tax which is based on the number of gallons used to make the household vehicle trips. Taking the vehicle make and type information, analysts in the Federal Highway Administration matched the data in the NHTS with fueleconomy.gov database.[4] The database has information on

[4] Since the 2017 NHTS did not explicitly asked the respondents for the full vehicle model names and there were no

real world adjusted miles per gallon by vehicle type dating back to 1984. Before calculating the tax cost, I provide statistics for vehicles in the SCAG region (age, vehicle type, fuel type, and fuel economy) by income group. Then, I calculate the cost and cost burden of the gasoline tax.

## VMT tax calculation

Using the same sample households as the fuel tax analysis, I calculate the cost and cost burden of the VMT tax for households and compare these data with to the data for the planned mileage-based user fees by income in this section of analysis.

To help understand who would be negatively affected by a VMT tax based on the findings in the first part of the analysis, I then develop two possible VMT tax scenarios: (1) a tax on all miles and (2) a tax only on the VMT of trips completed during peak hours. The first scheme would impose a VMT tax on households' total VMT, using the straight odometer of all vehicles in each household. I first calculate the total VMT tax imposed for both low-income and higher-income households and then estimate the cost burden of the tax – the total tax relative to their household income. The second scheme addresses congestion during peak hours since the tax would only apply to the VMT of household trips generated during peak hours. Same as the first scenario, I compare the total tax imposed for both low-income and higher-income households and then explore the cost burden relative to household income. Finally, for each scenario, I then divide households by household location, and compare the cost burden variance across the region.

## Strengths and limitations

The biggest strength of this study is that it includes non-work travel which is very helpful for understanding the full impact of a VMT tax since a VMT tax would be imposed on all trips regardless of purpose. Also, this project includes all six counties in the SCAG region, including rural areas where there is relatively little data. Although the sample size is not large, the effect of a VMT tax on rural households is essential since SCAG is interested in understanding the equity implications of the VMT tax throughout the full region. Also, the analysis considers potential spatial variance in the burden of the tax schemes by county and neighborhood type.

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sales data available, the matching process was challenging. For vehicles with a possible match of more than one vehicle from the fueleconomy.gov dataset, the analysts took the average of them.

There are a few limitations to the data and analysis. The first, as I note previously, is sample size. The sample size is not large enough to analyze data for small geographies; the number of respondents in counties outside of Los Angeles County is relatively small. A second limitation is that the NHTS collects travel data for a single-day and, therefore, does not capture household-level variation in travel behavior over time. The survey addresses this issue by sampling households across days of the week. Finally, a third limitation is in defining low-income households. It is difficult to accurately categorize households by income since the income variable is categorical. The household income data also does not adjust for regional factors. For example, a family of four living in Los Angeles County with an income of $40,000 is different from living in Imperial County, considering the difference in living expenses by region. SCAG have used various ways to categorize demographics for their Environmental Justice analysis for 2020 Connect SoCal. One of their ways to categorize demographics for equity analysis was using the federal poverty threshold. They have used households below poverty, households at 1.5 times poverty level and households at two times poverty level. This project's analysis using 1.5 times poverty level for the region will make the analysis consistent with the existing way of defining low-income households at SCAG.

# Chapter 4. Vehicle Miles of Travel in the SCAG Region

## Descriptive Statistics

Table 1 shows the daily VMT of households in the SCAG region. On average low-income households travel ten percent less than higher-income households. In addition, the median VMT for higher-income households is about 20 percent higher than that of the median of low-income households. These results align with existing research showing a positive relationship between income and VMT (Giuliano, 2005).

Figure 2 shows the distribution of total daily VMT after eliminating the outliers.[5] For both income groups, the distribution of VMT is right skewed. While VMT varies by household income, most households drive less than 100 miles. The percentage of households with VMT less than 50 miles a day is 70 for low-income households and 67 for higher-income households.

Table 1. Household Vehicle Miles of Travel by Income, SCAG Region

| | Low-Income Households | Higher-Income Households | All Households |
|---|---|---|---|
| Mean (mi) | 43 | 48 | 48 |
| Median (mi) | 26 | 31 | 31 |
| Stdev (mi) | 57 | 54 | 55 |
| *N* | 335 | 3,133 | 3,468 |

[5] Households with total daily VMT greater than 500 miles are considered outliers. (BTS, 2020)

Figure 2. Distribution of Household Vehicle Miles of Travel by Income, SCAG Region

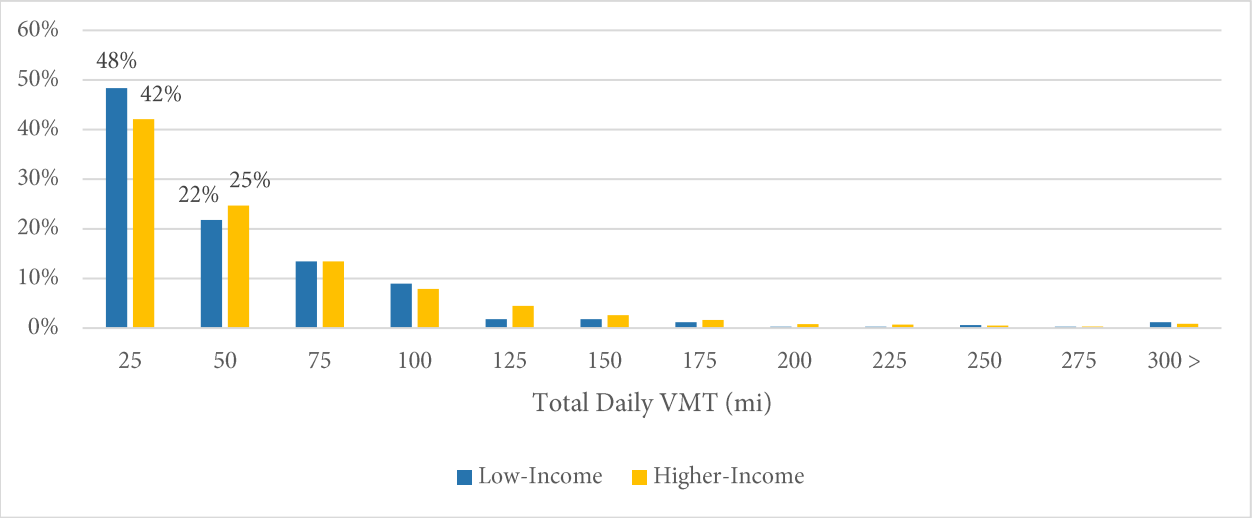



Table 2 presents descriptive statistics of peak hour VMT calculated by aggregating trips started during the peak hour. SCAG defines trips that start between 6:30 am and 9:30 am as morning peak trips, and trips that start between 3:30 pm and 6:30 pm as afternoon peak trips. For both income groups, less than half of trips are generated during peak hours, but this percentage is significant considering the two peak-hour windows account for only a quarter of the hours in a day. The median peak hour VMT of the low-income group is 8 miles which is about 70 percent that of higher-income households. Compared to the median values in Table 1, the distance traveled during the peak hour accounts for 30 percent of the total daily VMT of the low-income group and 35 percent of the total VMT of the higher-income group. Among low-income households with any vehicle miles of travel, 19 percent (62 households) did not travel during peak hours. Among higher-income households that have any vehicle miles traveled, 18 percent (556 households) recorded zero miles during peak hours.

Table 2 Household Peak Hour Vehicle Miles of Travel by Income, SCAG Region

| | Low-Income Households | Higher-Income Households | All Households |
|---|---|---|---|
| Mean (mi) | 19 | 22 | 22 |
| Median (mi) | 8 | 11 | 11 |
| Stdev (mi) | 33 | 32 | 33 |
| *N* | 335 | 3,133 | 3,468 |

## Spatial Variance: Urban vs. Non-Urban and Los Angeles County vs. Outside of LA County

VMT also varies by the characteristics of the neighborhood (McMullen & Eckstein, 2013). To understand the distributional impacts of the gas tax and a potential VMT tax, I calculated VMT by county and by neighborhood type. The NHTS categorizes households using five types of neighborhoods: urban core, urban district, urban neighborhood, suburban neighborhood, and nonurban. Figure 3 shows the distribution of these five neighborhood types across the SCAG region. Because the sample size in urban core and non-urban types is too small to produce reliable results, I combined the three urban categories (urban core, urban district, and urban neighborhood) into "Urban Areas" and the suburban and non-urban categories into "Non-Urban Areas." Also, since the sample size for low-income households in counties other than Los Angeles County is less than 100, I aggregated the data for the five counties into one category "Outside of LA County." See Table 3 for the sample size of the analysis for each of the combined categories.[6]

Table 3. Sample Size of the Analysis[7]

| | Low-Income Households | Higher-Income Households |
|---|---|---|
| **Los Angeles County** | **191** | **1,556** |
| Urban Area | 94 | 563 |
| Non-Urban Areas | 97 | 993 |
| **Outside LA County** | **144** | **1,577** |
| Urban Area | 14 | 113 |
| Non-Urban Areas | 130 | 1,464 |
| Total | 335 | 3,133 |

[6] I did calculate the statistics for each county and the results can be found in Appendix, although they are less reliable.

[7] See Table 14 in Appendix for the sample size by county.

## Figure 3. Map of Neighborhood Type Distribution, SCAG Region

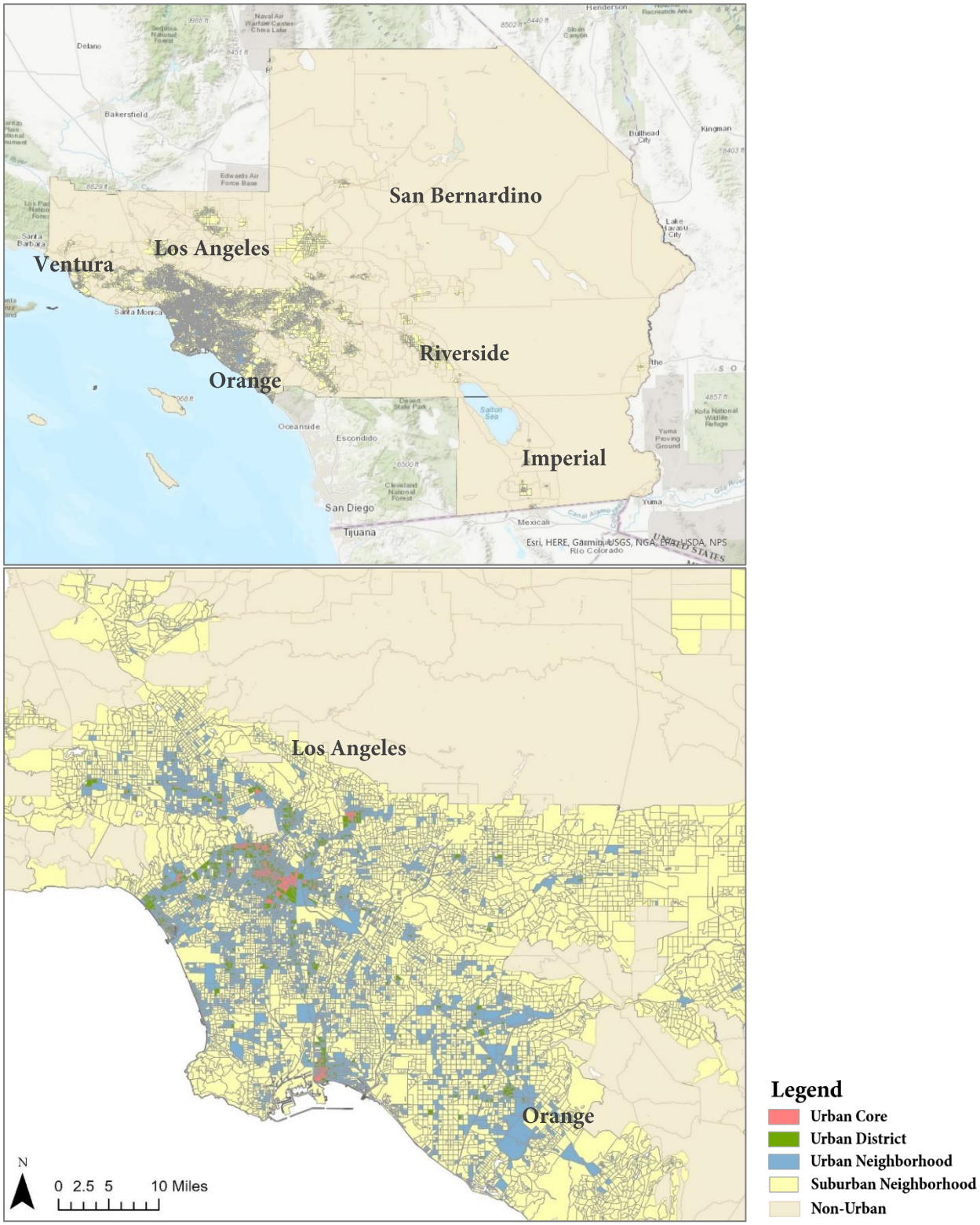


Table 4 shows the average and median daily VMT of households by income group and region. For both income groups, VMT is higher outside of urban areas. Also, the VMT of higher-income households is about 20 percent higher than that of the lower-income households. For Los Angeles, the gap between the two income groups regarding median distance traveled is smaller in Non-Urban areas than in Urban areas.

Table 5 shows the average and median peak hour VMT of households for each category between the two income groups. In general, about one third of daily trips are generated during peak hours. The difference in peak hour VMT between Urban and Non-Urban area is smallest for higher-income households living outside of Los Angeles County, and biggest for higher-income households living in Los Angeles County. Also, the distance traveled during peak hours account least of total VMT for low-income households living outside of Los Angeles County, which means they are more likely to travel outside of peak hours.

Table 4. Daily Vehicle Miles of Travel by Income and Neighborhood Type, SCAG Region[8]

| | Low-Income Households | | Higher-Income Households | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **43** | **25** | **46** | **31** |
| Urban Area | 35 | 22 | 38 | 27 |
| Non-Urban Areas | 51 | 31 | 50 | 35 |
| **Outside LA County** | **43** | **27** | **51** | **31** |
| Urban Area[9] | - | - | 37 | 25 |
| Non-Urban Areas | 44 | 27 | 52 | 32 |

[8] See Table 15 in Appendix for the daily VMT by county.

[9] I omitted statistics for low-income households living in urban areas outside of LA County due to the small sample size (14 households). Because of this, the statistics for low-income households in counties outside of LA may reflect the travel of households in non-urban areas. Only 26 of census tracts in San Bernardino, Riverside, Imperial, and Ventura County are "urban.".

Table 5. Daily Peak Hour Vehicle Miles of Travel by and Neighborhood Type, SCAG Region[10]

| | Low-Income Households | | Higher-Income Households | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **21** | **9** | **21** | **11** |
| Urban Area | 18 | 8 | 16 | 9 |
| Non-Urban Areas | 24 | 10 | 24 | 13 |
| **Outside LA County** | **17** | **7** | **23** | **11** |
| Urban Area | - | - | 20 | 11 |
| Non-Urban Areas | 18 | 8 | 24 | 11 |

[10] See Table 16 in Appendix for the daily peak hour VMT by county.

# Chapter 5. Fuel Tax

## Fuel Economy and Age of Vehicles

In this analysis section, I estimate the fuel tax collected for each household and the burden on each household relative to their income. I then compare these costs to those associated with mileage-based user fees. The amount of fuel tax each household pays, which is proportional to gallons purchased, differs based on the characteristics of household vehicles. Thus, I first present descriptive statistics on vehicle characteristics (fuel economy and age of vehicle) by income for households in the SCAG region.

Table 6 shows that low-income households on average own older vehicles (12 years old) compared to higher-income households (10 years old). The average miles per gallon is higher for higher-income households; however, the median miles per gallon for the two income groups are identical.

Table 6. Age and Fuel Economy of Household Vehicles, SCAG Region

| | Vehicles owned by Low-Income Households | | Vehicles owned by Higher-Income Households | |
|---|---|---|---|---|
| | Vehicle Age (years) | Vehicle Fuel Economy (mpg) | Vehicle Age (years) | Vehicle Fuel Economy (mpg) |
| Mean | 12 | 23 | 10 | 25 |
| Median | 12 | 22 | 9 | 22 |
| *N* | 639 | | 6,658 | |

Figure 4 shows the distribution of household vehicle age by income. About 70 percent of vehicles owned by higher-income households were purchased in the last ten years, compared to 50 percent of vehicles owned by low-income households. Figure 5 compares fuel economy by income. Interestingly, the fuel economy distribution is similar for both income groups. This finding may be due to the complicated set of factors that determine vehicle fuel economy: vehicle age, size, model, etc. For example, compared to lower-income households, higher-

income households tend to own newer vehicles that may be more fuel efficient than similar vehicle models of previous generations. However, they also are more likely to own larger vehicles or luxurious sports cars, both of which have lower fuel economy than smaller, more standard vehicles.

Figure 4. Distribution of Household Vehicle Age by Income, SCAG Region

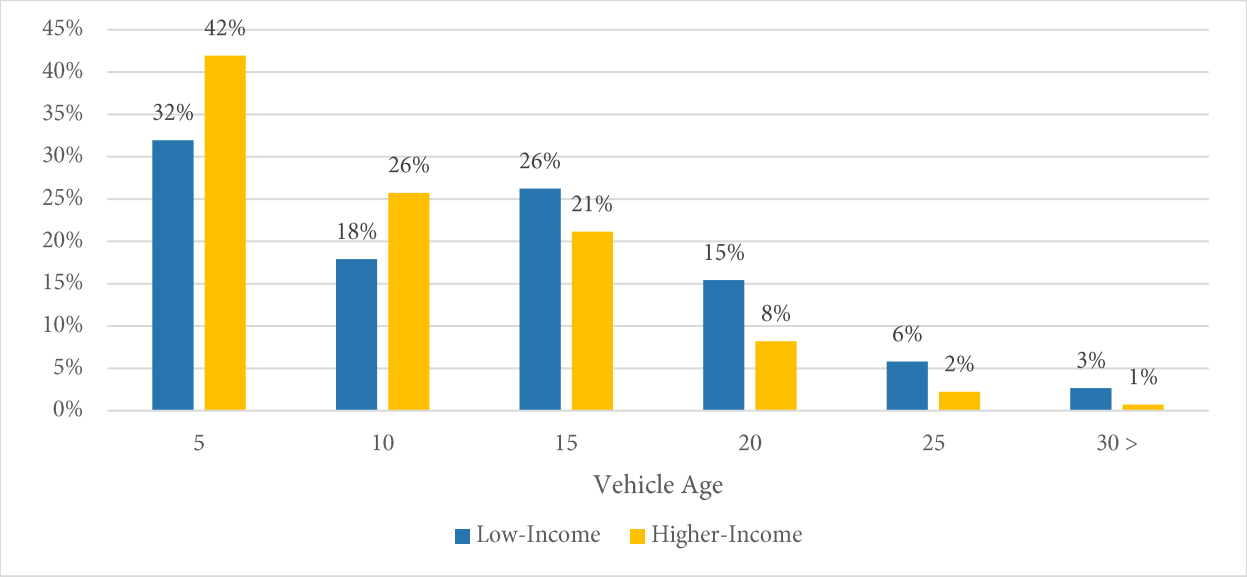
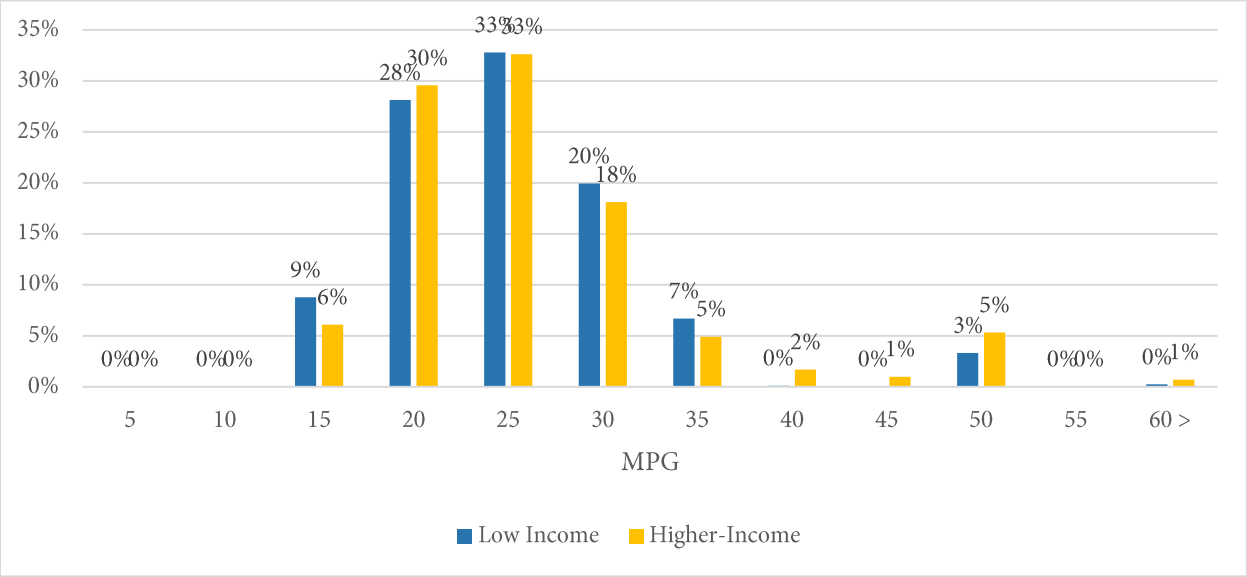



Figure 5. Distribution of Household Vehicles Fuel Economy by Income, SCAG Region



I also consider spatial variance in the fuel analysis. Among 3,564 household vehicles in Los Angeles County, 362 are owned by low-income households and 3,202 vehicles are owned by higher-income households. Among 3,727 vehicles outside of Los Angeles County, 277 are owned by low-income households and 3,450 are owned by higher-income households. See Table 7 for the specific sample size for all cases. Looking at the average number of vehicles per household, higher-income households own more than two vehicles and low-income households on average own less than two vehicles. See **Error! Reference source not found.** for the sample size of the a nalysis.

Table 7. Sample Size of the Analysis

| | Low-Income Households | Higher-Income Households |
|---|---|---|
| **Los Angeles County** | | |
| Number of Households | 191 | 1,556 |
| Number of Vehicles | 362 | 3,203 |
| Mean Vehicles per Household | 1.9 | 2.1 |
| **Outside LA County** | | |
| Number of Households | 144 | 1,577 |
| Number of Vehicles | 277 | 3,450 |
| Mean Vehicles per Household | 1.9 | 2.2 |

Table 8 shows median vehicle age and fuel economy by income group and location. Compared to higher-income households, low-income households in both locations own older, less fuel-efficient vehicles. Also, the data show that the vehicle age and fuel economy of vehicles in low-income households do not vary depending on location. However, higher-income households outside of LA County have vehicles that are about a year older than higher-income households in LA County potentially reflecting household income differences between the two regions.

Table 8. Age and Fuel Economy of Household Vehicles by Location, SCAG Region

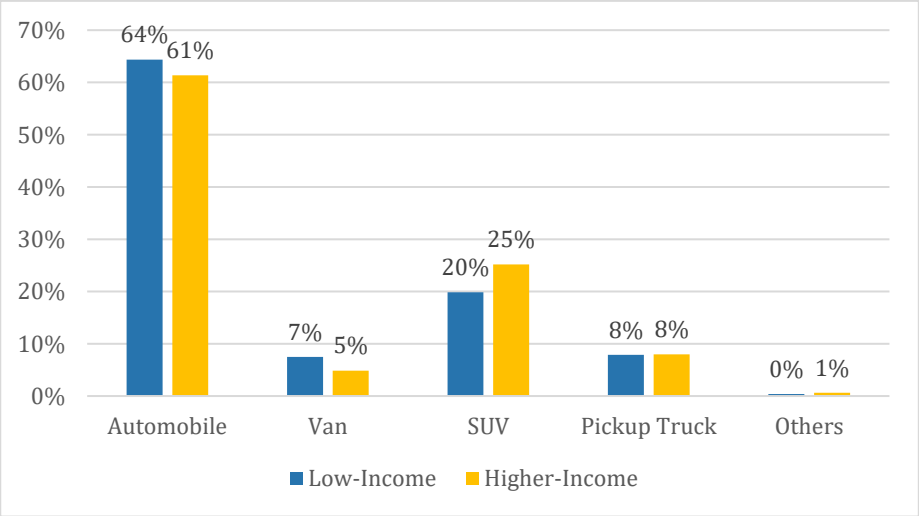
| | Vehicles owned by Low-Income Households | | Vehicles owned by Higher-Income Households | |
|---|---|---|---|---|
| | Vehicle Age (years) | Vehicle Fuel Economy (mpg) | Vehicle Age (years) | Vehicle Fuel Economy (mpg) |
| **Los Angeles County** | | | | |
| Mean | 11 | 23 | 10 | 25 |
| Median | 12 | 22 | 8 | 22 |
| **Outside LA County** | | | | |
| Mean | 12 | 23 | 10 | 24 |
| Median | 12 | 22 | 9 | 22 |

## Vehicle Type and Fuel Type

Fuel economy also differs by vehicle type. The average fuel economy for automobiles recorded in the survey is 27 mpg, 21 mpg for SUVs, 20 mpg for vans, and 16 mpg for pickup trucks. In general, the heavier and larger a vehicle is, the lower its fuel economy. Figure 6 compares the distribution of vehicle types between low-income and higher-income households. Higher-income households are more likely to drive SUVs than low-income households. Other than that, there are relatively minor differences in vehicle type between the two income groups.

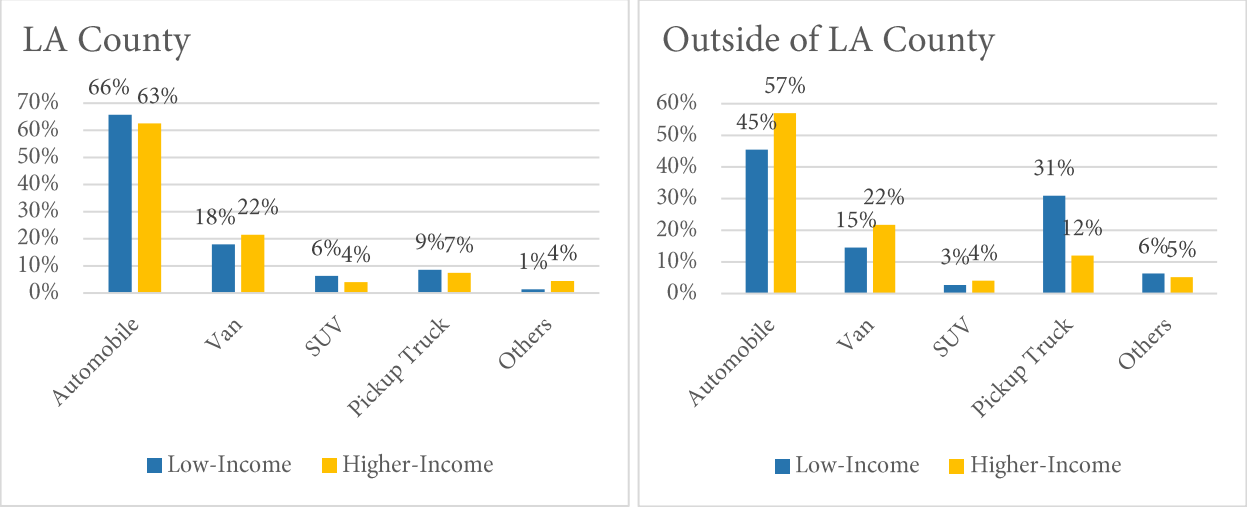
Figure 7 disaggregates the percentage of household vehicle type by household location and reveals a few interesting patterns. First, the percentage of the pickup truck is notable. For LA, the percentage of pickup trucks is less than 10 percent for both low-income and higher-income households. However, the percentage of pickup trucks outside of LA for low-income households is 31 percent, and 12 percent for higher-income households. Second, it is surprising that although the gap is small, SUVs are more popular among low-income households in LA County than outside of LA.

Figure 6. Percentage of Household Vehicle Type by Income, SCAG Region




(The *Others* category include trucks other than pickup trucks, recreational vehicles, and motorcycles)

Figure 7. Percentage of Vehicle Type by Household Location, SCAG Region




Fuel tax cost differs by vehicle fuel type. The NHTS dataset has three options for fuel type: gasoline, diesel, and other. I assume households that only own vehicles that are not operated by regular gasoline or diesel do not pay fuel tax under the current tax scheme. In practice, biodiesel cars pay the same rate as regular diesel. Since there is no way to identify biodiesel cars in the 'other' category, I assumed they pay zero tax. This assumption will not introduce significant error since the biodiesel adoption rate is very small.

Table 9 shows the distribution of vehicles by vehicle fuel type and location. In general, compared to higher-income households, a higher percentage of vehicles owned by low-income households use regular gasoline. Higher-income households are more likely to use diesel cars compared to low-income households, but diesel cars comprise less than three percent of their vehicles. Interestingly, eight percent and five percent of the vehicles owned by higher-income households in Los Angeles and outside of LA county respectively, are exempt from fuel taxes.

Table 9. Percentage of Vehicles by Vehicle Fuel Type and Area, SCAG Region

| | Gasoline | Diesel | Other (Electric batteries, biodiesel etc.) |
|---|---|---|---|
| Los Angeles County | | | |
| Low-Income | 98 % | 1 % | 1 % |
| Higher-Income | 90 % | 2 % | 8 % |
| Outside LA County | | | |
| Low-Income | 97 % | 0 % | 2 % |
| Higher-Income | 92 % | 2 % | 5 % |

## Fuel Tax Calculation

Fuel tax includes both state and federal components. In my analysis, I compare the VMT tax to the state portion of the fuel tax because the state of California has been actively studying mileage-based user fees. Therefore, when calculating the gas tax, I use the state portion of the tax and compare it to the flat VMT rate that SCAG identified.

California's gasoline tax in January 2018 (the year of the travel survey data) was $0.4886 per gallon for regular gas and $0.6316 for diesel (EIA, 2022). I first calculated the gallons of gas a household would need to make each trip segment on the travel day and then the amount of tax they would pay given the fuel type of the vehicle used to make the trip. As I note above, if the household used fuels other than gas or diesel (like electric batteries), I assumed they paid zero tax.

Table 10 shows the fuel tax amount and tax burden relative by income group. Low-income households generally pay less taxes than higher-income households, but the cost burden is higher. Looking at the median, low-income households living outside of LA County pay the least tax but their burden is highest as 1.4 percent. Higher-income households pay 0.3 percent of their

income as gas tax annually. Surprisingly, the low-income households and higher-income households living in Los Angeles County pay the same amount for fuel tax. The median vehicle miles traveled for low-income households in Los Angeles County is lower than that of higher income households, but their fuel tax cost is higher. This might be because eight percent of vehicles in higher-income households in Los Angeles County are not paying fuel tax, likely affecting the average result.

Table 10. Average and Median Gas Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region[11]

| | Low-Income Households (Tax Burden) | | Higher-Income Households (Tax Burden) | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **$ 361 (3.1 %)** | **$ 211 (1.3 %)** | **$ 339 (0.4 %)** | **$ 221 (0.3 %)** |
| Urban Area | $ 289 (2.8 %) | $ 176 (1.2 %) | $ 264 (0.4 %) | $ 166 (0.2 %) |
| Non-Urban Areas | $ 431 (3.4 %) | $ 262 (1.4 %) | $ 381 (0.5 %) | $ 256 (0.3 %) |
| **Outside of LA County** | $ 335 (2.5 %) | **$ 205 (1.4 %)** | **$ 396 (0.5 %)** | **$ 231 (0.3 %)** |
| Urban Area | - | - | $ 271 (0.4 %) | $ 184 (0.3 %) |
| Non-Urban Areas | $ 336 (2.4 %) | $ 195 (1.4 %) | $ 406 (0.5 %) | $ 236 (0.3 %) |

[11] See Table 19 in Appendix for the gas tax cost and cost burden by county.

# Chapter 6. Mileage-Based User Fees

## Mileage-Based User Fees Scenarios

In this section I examine the Mileage-Based User Fees (VMT tax) cost burden relative to annual household income. Although a majority of low-income drivers drive during peak hours, they are less likely to drive during peak hours compared to higher-income households as I show in the previous section. Also, VMT varies by neighborhood type. In this section, I apply two scenarios that have different goals to estimate the average annual cost and burden relative to household income and location:

(1) VMT tax on all miles
   a. Low-income households located in "Urban Areas"
   b. Higher-income households located in "Urban Areas"
   c. Low-income households located in "Non-Urban Areas"
   d. Higher-income households located in "Non-Urban Areas"

(2) VMT tax on miles during the am/pm peak
   a. Low-income households located in "Urban Areas"
   b. Higher-income households located in "Urban Areas"
   c. Low-income households located in "Non-Urban Areas"
   d. Higher-income households located in "Non-Urban Areas"

Previous, SCAG studies have hypothesized a 2.5 cents per mile VMT fee (SCAG, 2020). For Scenario 1, I multiply the per-mile fee of 2.5 cents for each household's daily VMT and multiply 365 to translate the cost to an annual unit. For Scenario 2, since peak hour trips matter during workdays, I multiplied 260, which is the number of weekdays in a year. For peak hours, I define trips that started between 6:30 am and 9:30 am as morning peak trips, and trips that started between 3:30 pm and 6:30 pm as afternoon peak trips. I use the same location categories (Los Angeles County and Outside of LA County) for this analysis. As I note previously, the sample sizes for the counties other than Los Angeles are too small to produce reliable results. However, see Appendix for the calculations by county.

As my analysis of VMT in the previous section shows, there are significant differences between the median and mean values for VMT. Therefore, whether the VMT tax is calculated based on

median or mean VMT makes a lot of difference. For this reason, I display two different values for all categories, the median and average cost, and the burden of households. Since the sample size is small (particularly for low-income households), a few outliers may skew the average. Therefore, in my interpretation of the findings, I emphasize the results based on median VMT values.

## VMT Tax on All Miles

Table 11 shows the average and median cost and cost burden by income under the scenario that taxes all miles – regardless of time of day or location. Since low-income households drive fewer miles, the average total cost of the tax is lower for low-income households. However, the expenditure burden, which is calculated relative to each household's income, is heavier for low-income households and the heaviest for low-income households living in urban areas. Comparing the median cost of Los Angeles County, the burden of low-income households in Urban Areas (1.5 %) is five times the burden on higher-income households in Urban Areas (0.3 %). The cost gap between the two income groups increases for households in non-urban areas. For both income groups, the total VMT tax is higher for households in non-urban areas compared to those in urban areas. For low-income households, the total tax increases by 41 percent (from $200 to $283), and the burden increases accordingly. For higher-income households, the total tax increases by 30 percent (from $243 to $315) but the change in the tax burden is relatively small. The burden stays the same at 0.3 percent. However, for higher-income households outside of LA County, the total tax cost and the burden are higher in non-urban than urban areas; however, the percentage change in the cost burden is relatively small, from 0.3 to 0.4. Also, for households not in LA County, low-income households have a little less than 5 times the burden of higher-income households (1.9 percent and 0.4 percent), whereas low-income households in LA County have burden about five times more than higher-income households in general.  In other words, the tax gap burden is smaller in non-urban areas.

Table 11. Average and Median Total VMT Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region under Scenario 1 (Tax on All Miles)[12]

| | Low-Income Households Total Tax (Tax Burden) | | Higher-Income Households Total Tax (Tax Burden) | |
|---|---|---|---|---|
| | Average | Median | Average | Median |
| **Los Angeles County** | **$ 396 (3.4 %)** | **$ 231 (1.5 %)** | **$ 416 (0.5 %)** | **$ 284 (0.3 %)** |
| Urban Area | $ 322 (3.1 %) | $ 200 (1.5 %) | $ 346 (0.5 %) | $ 243 (0.3 %) |
| Non-Urban Areas | $ 467 (3.7 %) | $ 282 (1.7 %) | $ 456 (0.5 %) | $ 315 (0.3 %) |
| **Outside LA County** | **$ 395 (2.8 %)** | **$ 247 (1.9 %)** | **$ 468 (0.6 %)** | **$ 287 (0.4 %)** |
| Urban Area | - | - | $ 338 (0.5 %) | $ 225 (0.3 %) |
| Non-Urban Areas | $ 398 (2.8 %) | $ 225 (1.9 %) | $ 478 (0.6 %) | $ 286 (0.4 %) |

## VMT Tax on peak hour trips

Table 12 shows the average and median cost and cost burden by income under the scenario that taxes only peak hour trips. Same as the first scenario, since low-income households drive fewer miles, the average total cost of the tax is lower for low-income households and the expenditure burden is heavier for low-income households. For low-income households living in Los Angeles County and outside of Los Angeles County, the burden decreased by 75 percent and 81 percent, respectively, compared to taxes on all miles. For higher-income households living in both Los Angeles County and outside of Los Angeles County, the burden decreased by 75 percent compared to taxing all miles. If taxes are only applied to peak hour trips, low-income households in outside of LA County will experience the greatest percentage decrease in the actual amount they have to pay, although their burden remains higher than for higher-income households.

[12] See Table 17 in Appendix for the Total VMT by county.

Table 12. Average and Median Total VMT Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region Under Scenario 2 (Tax on Peak Hour Miles)[13]

| | Low-Income Households (Tax Burden) | | Higher-Income Households (Tax Burden) | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **$ 139 (1.2 %)** | **$ 58 (0.4 %)** | **$ 139 (0.2 %)** | **$ 71 (0.1 %)** |
| Urban Area | $ 119 (1.1 %) | $ 55 (0.4 %) | $ 104 (0.1 %) | $ 57 (0.1 %) |
| Non-Urban Areas | $ 158 (1.2 %) | $ 62 (0.4 %) | $ 158 (0.2 %) | $ 81 (0.1 %) |
| **Outside LA County** | **$ 110 (0.7 %)** | **$ 47 (0.3 %)** | **$ 152 (0.2 %)** | **$ 73 (0.1 %)** |
| Urban Area | - | - | $ 129 (0.2 %) | $ 73 (0.1 %) |
| Non-Urban Areas | $ 115 (0.8 %) | $ 50 (0.4 %) | $ 154 (0.2 %) | $ 73 (0.1 %) |

[13] See Table 18 in Appendix for the peak hour VMT tax by county.

## Comparing the gas tax with mileage-based user fees

Table 13 shows the average and median increase in expenditure households would experience with the implementation of a Mileage-Based User Fee. I calculated the average and median values for all cases after estimating the change in tax cost and cost burden for every single household. Overall, all households on average would experience a tax increase under the VMT tax scheme. However, the increase would vary by household location and income group. In general, higher-income households would experience a greater increase in their total tax, but only a 0.03 percent increase relative to their income, based on the median values. Low-income households would pay 0.1 to 0.2 percent more of their income under the VMT tax, although the cost they have to pay is about half that of the tax higher-income households would have to pay more. Low-income households living in non-urban areas in LA pay 0.07 percent more than those in LA's urban areas. It is interesting that higher-income households living in urban areas in LA pay $5.00 more than those in non-urban areas of LA. Given that the total VMT is higher for households living in non-urban areas, this may be due to the difference in EV adoption rate. If households living in urban areas own more vehicles that have not been paying the gas tax, the increase in household tax cost can be higher than households living in non-urban areas.

Table 13. Average and Median Increase in Household Tax Cost and Cost Burden of a VMT Tax Compared to the Current State Gas Tax

| | Low-Income Households Total Tax (Tax Burden) | | Higher-income Households Total Tax (Tax Burden) | |
|---|---|---|---|---|
| | Average | Median | Average | Median |
| **Los Angeles County** | **$ 35 (0.36 %)** | **$ 17 (0.12 %)** | **$ 77 (0.09 %)** | **$ 29 (0.03 %)** |
| Urban Area | $ 34 (0.37 %) | $ 16 (0.09 %) | $ 81 (0.11 %) | $ 32 (0.04 %) |
| Non-Urban Areas | $ 36 (0.35 %) | $ 18 (0.16 %) | $ 75 (0.08 %) | $ 27 (0.03 %) |
| **Outside LA County** | **$ 60 (0.39 %)** | **$ 21 (0.15 %)** | **$ 72 (0.09 %)** | **$ 21 (0.03 %)** |
| Urban Area | - | - | $ 67 (0.09 %) | $ 20 (0.03 %) |
| Non-Urban Areas | $ 63 (0.42 %) | $ 21 (0.15 %) | $ 72 (0.09 %) | $ 21 (0.03 %) |

# Chapter 7. Discussion of Results

## Which tax scheme is more favorable to low-income households?

The analysis explores concerns that policymakers have about the impacts on low-income households of mileage-based user fees compared to the gas tax. The results show that low-income households would pay less under the current gas tax and have a lower tax burden compared to a VMT tax, unless the VMT fee is applied only to peak hour trips. However, there are some obstacles to implementing a tax on peak hour trips. It would not generate enough revenue to maintain our transportation system and would not be feasible immediately due to the lack of appropriate technology (Zhang et al., 2009). Thus, when comparing the VMT tax to a fuel tax on all miles, the absolute cost for low-income households would increase by $35 to $63 dollars annually, depending on the location of the household. At the same time, the costs for higher-income households would increase by $67-$77 dollars, again depending on location.

However, the results also show that the gas tax system is not fair to low-income drivers who tend to possess older vehicles with lower fuel economy.  In other words, on average lower-income households use more gallons to travel the same distance compared to higher-income households with newer and more fuel-efficient vehicles. Also, especially for Los Angeles County, nearly ten percent of vehicles owned by higher-income households do not use regular gasoline or diesel, meaning that owners are not paying a gas tax. Road users who do not pay for their use of the roads, shifts the burden onto others, including low-income households. Thus, the VMT tax is more equitable in terms of distributional impact.
Additionally, considering that the state gas tax is increasing gradually, and the EV adoption rate is increasing, particularly among higher-income households, the VMT tax will become a fairer tax than the gas tax.

## Findings compared to those of other studies

A few previous studies have examined the distributional impacts of shifting from the fuel tax to a VMT tax. However, the goal of each of these studies is different and the methodology used to measure the distributional effects vary. Also, the amount of tax per mile applied varies by studies.

Therefore, the results are not directly comparable to the results of this study. (This research used a flat 2.5 cents per mile fee for VMT tax and 48 cents per gallon for the regular gasoline tax.) However, I discuss below whether the general findings from this analysis aligns with other studies.

McMullen et al. (2010) analyzed Oregon households in the 2001 NHTS and applied a tax of 24 cents per gallon and 1.2 cents per mile, which they thought was a revenue-neutral rate. Their results show that households with income between $0 - $14,999 and $15,000 - $29,999 experiences 0.08 % and 0.02 % increase relative to their income, respectively. The highest income group did not experience any tax burden increase. Similar to my findings, this study shows that, on average, households experience increased costs, and the cost burden is negatively related to income; in other words, it gets smaller as household income rises.

Weatherford (2011) analyzed all households from the 2001 NHTS and applied a revenue-neutral tax rate of 0.98 cents per mile. The research concluded that households in rural areas generally experience a decrease in annual tax cost and urban areas experience an increase in tax burden. The research also shows that the tax burden will shift from low-income to high-income households. However, the VMT fee will have negative distributional implications for low-income households in urban households. In Los Angeles County, I do not find this pattern, since the increase in both the tax and the tax burden is almost identical in both urban and non-urban areas; however, as I have noted, the burden will shift from low-income to higher-income households.

Using the Gini coefficient, Larsen et al. (2012) showed that various VMT fee scenarios (revenue-neutral VMT tax, increased revenue VMT tax, and three-tier VMT Fee to encourage “green” vehicles) are all vertically equitable which means they do not exacerbate inequity relative to the gas tax system. My analysis also shows that the VMT tax scheme will redistribute the costs to higher-income households who will pay an amount more proportional to their income.

## Data availability and caveats

My analysis of 3,468 households in the NHTS dataset shows that households in the SCAG region, on average, had a 0.68 percent state gas tax burden. This estimate is slightly higher than those from the Public Policy Institute of California (PPIC) (Bohn & Payares-Montoya, 2022). PPIC researchers found that, on average, Californians spend about four percent of their income on gas for both cars and homes in 2018. Given that the gas price on average was $ 3.62 in 2018 in California and the state tax was $ 0.4886, based on these figures, the state gas tax would have accounted for 13.5 percent of the gas tax expenditure, which means Californians would have spent about 0.54 percent of their income on the state gas tax. The differences in the findings might be due to methodology. The analysis using the NHTS data did not include households with zero vehicles, resulting in a slightly higher tax burden than if all households were included. Also, the analysis is based on the SCAG region specifically, which may have caused the differences.

Although the two estimates are not identical, they are reasonably close. Further, the purpose of this analysis was to compare the tax burden between income groups between the current gas tax and a proposed VMT tax. Estimates of the VMT tax were based on the same sample of households, increasing the reliability of the findings.

# Chapter 8. Policy Recommendations

This section recommends interventions directly related to the design of mileage-based user fees and policies that could be designed around while operating the mileage tax system. SCAG is not a policy implementing organization, so the policy recommendations here are not directly applicable to the organization, but rather helpful when advocating for the needs of local jurisdictions.

**1) Low-income households will have less of a tax burden if the VMT fee policy is designed to price only trips generated during peak hours.**

The existing literature clearly shows the important role of automobiles in low-income households. Having access to cars helps households maintain their income and complete essential household-serving trips. Thus, designing the policy itself to impose less burden on low-income drivers would help mitigate the issue.

Since low-income households drive shorter distances than higher-income households, the absolute amount of VMT fee that average low-income households need to pay is lower than that of average higher-income households. However, as I show, the VMT fee is more of a financial burden on low-income drivers (as is the gas tax) compared to higher-income households. Thus, implementing a tax on trips that low-income drivers are less likely to make—trips during peak hours—can alleviate their burden. However, as I mention above, taxing only peak hour trips is challenging since it greatly reduces the revenue for maintaining the transportation system. Moreover, it requires more sophisticated technology to track travel during the peak.

The benefit of this policy is that it can help reduce congestion. Paying the VMT tax under this policy can be avoided by not traveling during peak hours. Also, the cost of entering highly congested areas is higher because the time and fuel spent are higher than entering other areas. These, in theory, will lead to relieving congestion. However, if the policy works in a way to spread trips outside of peak hours, then this would also contribute to the lowering of revenue necessary for transportation projects.

**2) Consider designing an income-based tiered rate policy that offsets the cost for low-income households.**

The VMT tax applies a flat rate, and it charges users for what they use. Although it is fair, applying a different rate based on income for low-income households will be helpful since it is estimated that a flat rate can be regressive to low-income households (Walls & Hanson, 1999; Yang et al., 2016). Another advantage of a tiered rate is that it can be set to charge consumers as use increases. For example, the first few units of service may be very inexpensive (accommodating the shorter travel distances of low-income drivers) and then the tax would increase with VMT. Under this policy design, low-income households living in non-urban areas would benefit since they have higher vehicle miles of traveled.

One of the main concerns with applying a different rate to address the equity problem is that variance in income does not fully relate to consumption (Manville et al., 2022). For example, for utilities like electricity, some low-income households can use it a lot and higher-income households can end up using very little. This use pattern can lead to applying wrong rates and may not resolve the financial burden on low-income families. However, this concern is not applicable for the VMT tax scheme, since low-income households travel fewer miles on average, as shown in the analysis.

**3) Provide cash assistance to low-income households.**

As mentioned above, the expenditure burden is heavier for low-income households, but households cannot avoid making vehicle trips. Therefore, providing payment assistance to low-income households will alleviate their burden. The payment assistance approach would be very similar to the discounts many electric and fuel companies offer low-income customers and government-assistance programs for lower-income families. Manville et al. (2022) say that cash transfers would be a non-paternalistic way of protecting low-income drivers from congestion pricing. They can decide where to allocate the funds they receive, and the program operators do not have to deal with conditioning program assistance on the behavior the program seeks to reduce, in their case, traveling during peak hours. However, this intervention is challenging since it is expensive to support these households, and also the state would have to collect household income information (Manville et al., 2022). An alternative would be having the low-income

households apply for assistance and get assistance after their income is verified or get assistance from the Universal basic mobility program.

**4) Invest in transit and increase access to transit so that low-income drivers can avoid paying taxes.**

The ultimate solution for mitigating the cost burden of either the gas tax or VMT tax is to create an environment where low-income households do not have to drive by opting alternative modes of transportation such as public transportation. However, public transportation is not a viable option in most places other than neighborhoods in and around the urban core. Transit routes are often not accessible, or the operating schedule is not flexible enough, especially for low-income workers who are likely to work outside of regular business hours. The funds collected from a VMT tax scheme could help mitigate the burden on low-income households by subsidizing transit particularly in places where transit works best. Also, since higher-income households drive more miles than lower-income households, this funding mechanism would transfer dollars from higher-income households to low-income neighborhoods.
Once data are available to analyze variation in the VMT tax burden at smaller geographical levels, this research would help to identify low-income neighborhoods where policymakers ought to invest in mitigation strategies like transit development.

**5) Since the VMT fee does not encourage the purchase of clean fuel and fuel-efficient vehicles, implement other strategies to achieve these goals better.**

If the VMT tax is implemented, there will be less incentive to drive fuel-efficient vehicles, especially for households living in non-urban areas, many of whom own pickup trucks that are less fuel-efficient than other vehicles. Thus, designing a separate policy that encourages "green" vehicles would be helpful in achieving the state of California's goal of adopting electric vehicles fast.

One of the scenarios tested in Larsen et al. (2012) based on the households in Texas was differentiating rates by fuel economy, imposing 1 cent per mile to vehicles greater than the mean value, 1.5 cents to vehicles with fuel economy between the median value and the mean value, and 2 cents to vehicles with fuel economy less than the median. For the SCAG region, since my research shows that low-income households are likely to own less fuel-efficient vehicles, this

scenario would potentially produce inequitable cost burdens. Thus, I think there should be a separate policy for incentivizing fuel-efficient automobiles or EV adoption rather than incorporating the goals into the VMT tax strategy.

# Appendix

## VMT Analysis by County

Table 14. Sample Size of the Analysis[14]

| | Low-Income Households | Higher-Income Households |
|---|---|---|
| **Los Angeles County** | **191** | **1,556** |
| Urban Area | 94 | 563 |
| Non-Urban Areas | 97 | 993 |
| **Orange County** | **41** | **678** |
| Urban Area | 14 | 106 |
| Non-Urban Areas | 27 | 572 |
| **San Bernardino County** | **46** | **291** |
| Urban Area | 0 | 4 |
| Non-Urban Areas | 46 | 287 |
| **Ventura County** | **11** | **213** |
| Urban Area | 0 | 1 |
| Non-Urban Areas | 11 | 212 |
| **Riverside & Imperial County** | **46** | **395** |
| Urban Area | 0 | 1 |
| Non-Urban Areas | 46 | 394 |

[14] I omitted statistics for cases with sample size below five. Those cases are low-income and higher-income households in urban areas of San Bernardino, Ventura, Riverside and Imperial County.

Table 15. Daily Vehicle Miles of Travel by Income and Neighborhood Type, SCAG Region

| | Low-Income Households | | Higher-Income Households | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **43** | **25** | **46** | **31** |
| Urban Area | 35 | 22 | 38 | 27 |
| Non-Urban Areas | 51 | 31 | 50 | 35 |
| **Orange County** | **34** | **24** | **46** | **29** |
| Urban Area | 41 | 33 | 38 | 25 |
| Non-Urban Areas | 31 | 22 | 47 | 30 |
| **San Bernardino County** | **49** | **26** | **57** | **39** |
| Urban Area | - | - | 31 | 19 |
| Non-Urban Areas | **49** | **26** | **57** | **40** |
| **Ventura County** | 32 | 22 | 49 | 31 |
| Urban Area | - | - | - | - |
| Non-Urban Areas | 32 | 22 | 49 | 31 |
| **Riverside & Imperial County** | **49** | **33** | **58** | **32** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | 49 | 33 | 58 | 32 |

Table 16. Daily Peak Hour Vehicle Miles of Travel by Income and Neighborhood Type, SCAG Region

| | Low-Income Households | | Higher-Income Households | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **21** | **9** | **21** | **11** |
| Urban Area | 18 | 8 | 16 | 9 |
| Non-Urban Areas | 24 | 10 | 24 | 13 |
| **Orange County** | **11** | **7** | **23** | **12** |
| Urban Area | 10 | 5 | 20 | 11 |
| Non-Urban Areas | 11 | 8 | 23 | 12 |
| **San Bernardino County** | **20** | **7** | **26** | **15** |
| Urban Area | - | - | 19 | 15 |
| Non-Urban Areas | 20 | 7 | 26 | 15 |
| **Ventura County** | **13** | **5** | **22** | **9** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | 13 | 5 | 22 | 9 |
| **Riverside & Imperial County** | **21** | **9** | **23** | **10** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | 21 | 9 | 23 | 10 |

Table 17. Average and Median Total VMT Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region under Scenario 1 (Tax on All Miles)

| | Low-Income Households Total Tax (Tax Burden) | | Higher-Income Households Total Tax (Tax Burden) | |
|---|---|---|---|---|
| | Average | Median | Average | Median |
| **Los Angeles County** | **$ 396 (3.4 %)** | **$ 231 (1.5 %)** | **$ 416 (0.5 %)** | **$ 284 (0.3 %)** |
| Urban Area | $ 322 (3.1 %) | $ 200 (1.5 %) | $ 346 (0.5 %) | $ 243 (0.3 %) |
| Non-Urban Areas | $ 467 (3.7 %) | $ 282 (1.7 %) | $ 456 (0.5 %) | $ 315 (0.3 %) |
| **Orange County** | **$ 311 (2.9 %)** | **$ 222 (1.8 %)** | **$ 417 (0.5 %)** | **$ 267 (0.3 %)** |
| Urban Area | $ 366 (3.0 %) | $ 301 (1.6 %) | $ 344 (0.5 %) | $ 225 (0.3 %) |
| Non-Urban Areas | $ 283 (2.8 %) | $ 197 (2.0 %) | $ 431 (0.4 %) | $ 274 (0.3 %) |
| **San Bernardino County** | **$ 445 (2.5 %)** | **$ 236 (1.5 %)** | **$ 521 (0.8 %)** | **$ 359 (0.5 %)** |
| Urban Area | - | - | $ 279 (0.5 %) | $ 173 (0.4 %) |
| Non-Urban Areas | $ 445 (2.5 %) | $ 236 (1.5 %) | $ 524 (0.8 %) | $ 363 (0.5 %) |
| **Ventura County** | **$ 446 (3.0 %)** | **$ 297 (2.1 %)** | **$ 447 (0.5 %)** | **$ 279 (0.4 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 288 (3.5 %) | $ 200 (1.3 %) | $ 449 (0.5 %) | $ 280 (0.4 %) |
| **Riverside & Imperial County** | **$ 396 (3.4 %)** | **$ 231 (1.5 %)** | **$ 528 (0.7 %)** | **$ 288 (0.4 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 396 (3.4 %) | $ 231 (1.5 %) | $ 530 (0.7 %) | $ 289 (0.4 %) |

Table 18. Average and Median Peak Hour VMT Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region under Scenario 2 (Tax on Peak Hour Miles)

| | Low-Income Households Total Tax (Tax Burden) | | Higher-Income Households Total Tax (Tax Burden) | |
|---|---|---|---|---|
| | Average | Median | Average | Median |
| **Los Angeles County** | **$ 139 (1.2 %)** | **$ 58 (0.4 %)** | **$ 139 (0.2 %)** | **$ 71 (0.1 %)** |
| Urban Area | $ 119 (1.1 %) | $ 55 (0.4 %) | $ 104 (0.1 %) | $ 57 (0.1 %) |
| Non-Urban Areas | $ 158 (1.2 %) | $ 62 (0.4 %) | $ 158 (0.2 %) | $ 81 (0.1 %) |
| **Orange County** | **$ 69 (0.5 %)** | **$ 43 (0.4 %)** | **$ 149 (0.2 %)** | **$ 78 (0.1 %)** |
| Urban Area | $ 66 (0.3 %) | $ 32 (0.1 %) | $ 130 (0.2 %) | $ 73 (0.1 %) |
| Non-Urban Areas | $71 (0.6 %) | $ 52 (0.4 %) | $ 152 (0.2 %) | $ 79 (0.1 %) |
| **San Bernardino County** | **$ 130 (0.7 %)** | **$ 46 (0.4 %)** | **$ 168 (0.3 %)** | **$ 94 (0.1 %)** |
| Urban Area | - | - | $ 123 (0.2 %) | $ 98 (0.2 %) |
| Non-Urban Areas | **$ 130 (0.7 %)** | **$ 46 (0.4 %)** | $ 169 (0.3 %) | $ 94 (0.1 %) |
| **Ventura County** | **$ 83 (1.1 %)** | **$ 34 (0.3 %)** | **$ 143 (0.2 %)** | **$ 56 (0.1 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 83 (1.1 %) | $ 34 (0.3 %) | $ 143 (0.2 %) | $ 55 (0.1 %) |
| **Riverside & Imperial County** | **$ 133 (0.8 %)** | **$ 57 (0.3 %)** | **$ 150 (0.2 %)** | **$ 65 (0.1 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 133 (0.8 %) | $ 57 (0.3 %) | $ 151 (0.2 %) | $ 65 (0.1 %) |

Table 19. Average and Median Gas Tax Cost and Cost Burden by Income and Neighborhood Type, SCAG Region

| | Low-Income Households (Tax Burden) | | Higher-income Households (Tax Burden) | |
|---|---|---|---|---|
| | Average (mi) | Median (mi) | Average (mi) | Median (mi) |
| **Los Angeles County** | **$ 361 (3.1 %)** | **$ 211 (1.3 %)** | **$ 339 (0.4 %)** | **$ 221 (0.3 %)** |
| Urban Area | $ 289 (2.8 %) | $ 176 (1.2 %) | $ 264 (0.4 %) | $ 166 (0.2 %) |
| Non-Urban Areas | $ 431 (3.4 %) | $ 262 (1.4 %) | $ 381 (0.5 %) | $ 256 (0.3 %) |
| **Orange County** | **$ 275 (2.6 %)** | **$ 163 (1.3 %)** | **$ 339 (0.4 %)** | **$ 220 (0.2 %)** |
| Urban Area | $ 331 (2.9 %) | $ 291 (1.2 %) | $ 276 (0.4 %) | $ 184 (0.3 %) |
| Non-Urban Areas | $ 247 (2.5 %) | $ 141 (1.3 %) | $ 363 (0.4 %) | $ 221 (0.2 %) |
| **San Bernardino County** | **$ 408 (2.3 %)** | **$ 235 (1.6 %)** | **$ 453 (0.7 %)** | **$ 276 (0.4 %)** |
| Urban Area | - | - | $ 222 (0.4 %) | $ 130 (0.3 %) |
| Non-Urban Areas | **$ 408 (2.3 %)** | **$ 235 (1.6 %)** | $ 456 (0.7 %) | $ 281 (0.4 %) |
| **Ventura County** | **$ 267 (3.2 %)** | **$ 206 (1.3 %)** | **$ 384 (0.5 %)** | **$ 225 (0.3 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 267 (3.2 %) | $ 206 (1.3 %) | $ 385 (0.5 %) | $ 225 (0.3 %) |
| **Riverside & Imperial County** | **$ 332 (2.3 %)** | **$ 243 (1.4 %)** | **$ 443 (0.6 %)** | **$ 224 (0.3 %)** |
| Urban Area | - | - | - | - |
| Non-Urban Areas | $ 332 (2.3 %) | $ 243 (1.4 %) | $ 444 (0.6 %) | $ 226 (0.3 %) |

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