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Household Income and Vehicle Fuel Economy in California

Christopher E. Ferrell

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MTI Report WP 12-06

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16. Abstract

This white paper presents the findings from an analysis of the fiscal implications for vehicle owners of changing from the current statewide fuel tax to a "road user charge" (RUC) based on vehicle-miles traveled (VMT). Since 1923, California's motor vehicle fuel tax has provided revenue used to plan, construct, and maintain the state's publicly funded transportation systems. Over time, improvements in vehicle fuel efficiency and the effects of inflation have reduced both the revenue from the fuel tax and its purchasing power. Thus, there is growing interest among policy makers for replacing the state's per-gallon fuel tax with an RUC based on VMT.

This study analyzes the 2010-2011California Household Travel Survey (CHTS) to identify the potential effects this policy change would be likely to have on households across the state. The analysis found that while daily household fuel consumption and VMT both appear to increase with household income, urban and rural households show roughly the same amount of fuel consumption and VMT. No statistically significant difference in cost was found between the two programs in any income group. This suggests that an RUC designed to collect the same amount of revenues statewide as the current fuel tax would not place a significant financial burden on California households.

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EXECUTIVE SUMMARY

This paper presents the results of an analysis of the estimated relative cost of a motor vehicle fuel tax versus a road user charge (RUC) for California households based on current driving habits. The analysis looks at the effects on households by income group and area type (urban versus rural).

The analysis used two data sources:

- California Household Travel Survey (CHTS) – Conducted from 2010 to 2011, this survey collected data on household vehicles (year, make, model) and trip making on a sample travel day for a statewide sample of households.
- Environmental Protection Agency database on vehicle fuel efficiency – This database includes estimated vehicle fuel efficiency by year, make, model, and engine type. Fuel efficiency estimates are provided for city driving and highway driving. An additional composite measure reflects the overall expected fuel efficiency for typical driving cycles.

The following are the main results of this study:

- Daily household fuel consumption and vehicle-miles traveled (VMT) both appear to increase with household income.
- Urban and rural households show roughly the same amount of fuel consumption and VMT.
- Although the analysis found the estimated costs of either program would be slightly different for different income groups and for rural versus urban households, it found no statistically significant difference in cost *between* the two programs in any income group.
- These results are based on sample data and are therefore subject to sampling errors in the data. Fuel efficiency for vehicles of the same make, model, model year, and engine type will differ due of a number of variables, including maintenance, driving cycles, vehicle loads, and fuel type (e.g., regular versus premium).

I. INTRODUCTION

This white paper presents the findings from an analysis of the fiscal implications for vehicle owners of changing from the current statewide fuel tax to a road usage charge (RUC) based on vehicle-miles traveled (VMT). California's motor vehicle fuel tax revenues are used to plan, construct, and maintain the state's publicly funded roads and mass transit systems. The fuel tax is subject to two trends that lead to declining revenues for the state over time: inflation and vehicle fuel efficiency improvements.

Fuel is taxed at a flat per-gallon rate collected when purchased. Like any fixed dollar amount, its buying power erodes over time due to inflation. To offset the reduction, the legislature must periodically pass bills to increase the fuel tax, a task that has proven difficult in the post-Proposition 13 political environment.

Vehicle fuel efficiency has increased over the years due to technological improvements and the Federal government's Corporate Average Fuel Efficiency (CAFE) standards. Thus, even when Californians drive more and produce more wear-and-tear on the transportation system, they use less fuel per mile driven than in the past, resulting in lower revenues for the state. Replacing the fuel tax with an RUC would prevent further erosion of the tax base due to vehicle efficiency improvements because it would tie revenues to roadway use rather than fuel use.

The fuel tax has been in place since 1923.[1] Since it is a regressive tax, (everyone pays the same cost per gallon), low-income drivers spend a proportionately larger share of their income on fuel taxes than do drivers in higher income groups. Low-income households may have adjusted their driving patterns and selected vehicles with a higher fuel efficiency to offset this impact, but that is not yet known. Rural households tend to drive longer distances on less-congested roads than their urban counterparts, which increases fuel efficiency, thus they could end up paying more in taxes under an RUC cost-per-mile program. It is not clear *a priori* whether an RUC would result in higher costs for low-income and rural households. Shedding light on these questions is the primary purpose of this study.

This study seeks to identify the potential effects this change in tax policy is likely to have on households and regions across the state. Primary goals were to 1) calculate average daily VMT and fuel consumption for California households by income group and area type (urban versus rural), and 2) identify any correlations between income and area types, VMT, and fuel consumption. The data and analysis will help California policymakers by identifying the potential effects on California households of transitioning from a fuel tax to an RUC.

The first section briefly describes the methods used to collect and analyze data on travel, vehicle ownership, and fuel consumption in California households. The second section presents the results of the analysis. The paper concludes with a summary of key findings and suggested avenues for future work.

II. DATA AND METHODS

The findings presented in this paper were developed primarily from an analysis of data from the 2010-2011 California Household Travel Survey (CHTS), which is curated by the National Renewable Energy Laboratory (NREL). The CHTS collected multimodal travel behavior characteristics and demographic information from 42,431 households in all of California's 58 counties. The survey was designed to ensure the state's entire population was accurately represented.[2]

The initial analysis was performed on the public-access version of the CHTS dataset (the so-called "cleansed" version, with trip-end locations, household addresses, and vehicle model-types removed to protect respondents' privacy). While the public-access version provides the VMT for each vehicle by household and was sufficient for estimating costs under an RUC, it does not identify vehicle model-types – information that is needed to calculate the fuel consumption, and thus fuel taxes, currently paid by those households. Thus, the authors applied for and received permission to access the full, so-called "Spatial" dataset through the secure portal of NREL's Transportation Secure Data Center.

The fuel efficiency of each vehicle was estimated as follows:

- Determine the year, make, model, and number of cylinders for each vehicle.

- Match these vehicle characteristics to those in the Environmental Protection Agency's (EPA) National Vehicle and Fuel Emissions (NVFE) dataset,[3] specifically, the estimates of combined city/highway fuel efficiency.

Several levels of matching were performed using the following combinations of vehicle characteristics, in descending order of precision:

1. Year, make, model, and number of cylinders

2. Year, make, and model

3. Year, make, and body type

4. Year and make

Several factors limited the percentage of households for which vehicle matches could be completed:

- Some vehicles in the CHTS could not be matched to the NVFE database due to differences in model definitions or body type definitions.

- For a household to be included in the analysis, all vehicles used by a household on the survey travel day had to be matched to those in the NVFE database. Thus, if the data for a household contained any trip by a vehicle that was not identified, the entire household was excluded from the analysis. Similarly, households that reported any trip with a vehicle that could not be matched to the vehicles in the NVFE database had to be excluded.

Upon analysis, the data for vehicles that were matched using steps 3 and 4 produced spurious results. Thus, the analysis included only vehicles that could be matched in steps 1 and 2. Vehicles were matched for 25% of the eligible households in the CHTS. Our analysis found no systematic bias in the vehicles matched. This suggests that the necessary exclusion of 75% of the vehicles in the CHTS from the final dataset does not meaningfully change the final analysis results.

Once matching was complete, the daily VMT and fuel consumption for all vehicles in each surveyed household were totaled to create the dataset for the final analysis. Analysis was performed as follows:

- **Descriptive statistical analysis:** Average values of total daily household VMT and fuel consumption for household income quintile groups and urban versus rural counties were calculated.

- **Analysis of statistical correlations:** Kendall rank correlation coefficients were generated to discover any statistically significant correlations between the income quintile ranking and daily VMT and fuel consumption estimates for each household.

Findings from this analysis follow.

III. RESULTS

Fuel use and VMT estimates were computed using weighted averages from individual household VMT and fuel use estimates.[4] Because the data were weighted, a method called *bootstrapping*[5] was used to compute the standard errors of the estimates.

Fuel consumption estimates from statistical analysis of the combined CHTS and NVFE datasets are shown in Table 1.

Table 1. Estimated Average Motor Vehicle Fuel Consumption per Day per Household

	Estimated Average Daily Fuel Use (gal)					
	Rural		Urban		Statewide	
Income	Mean	Std Err	Mean	Std Err	Mean	Std Err
$0 - $24,999	0.8	0.06	1.0	0.03	0.9	0.03
$25,000 - $34,999	1.7	0.19	0.9	0.05	1.0	0.05
$35,000 - $49,999	1.2	0.09	1.2	0.05	1.2	0.04
$50,000 - $99,999	1.5	0.08	1.5	0.03	1.5	0.03
$100,000 and over	2.2	0.14	1.9	0.04	1.9	0.04
All income groups	1.3	0.04	1.3	0.02	1.3	0.02

VMT estimate results from statistical analysis of the CHTS data set are shown in Table 2.

Table 2. Average Household Vehicle-Miles Traveled per Day

	Estimated Average Daily VMT					
	Rural		Urban		Statewide	
Income	Mean	Std Err	Mean	Std Err	Mean	Std Err
$0 - $24,999	17.2	1.5	21.0	1.4	20.7	1.2
$25,000 - $34,999	32.8	2.9	23.6	1.1	24.1	1.0
$35,000 - $49,999	32.6	1.9	28.7	1.0	29.0	0.9
$50,000 - $99,999	40.2	1.7	36.6	0.7	36.7	0.7
$100,000 and over	57.4	2.2	46.9	0.8	47.2	0.7
All income groups	31.7	0.9	31.7	0.4	31.7	0.4

The results show that, generally, estimated daily household fuel consumption and VMT increase along with household income. The lowest income quintile group burns approximately 1 gallon of fuel and drives approximately 21 miles per day, while the highest income group burns almost twice as much fuel (1.9 gallons) and travels more than twice as far (47.2 miles) in a typical day.

Comparisons for rural versus urban households show that both consume roughly the same amount of fuel per day (1.3 gallons) and travel roughly the same number of miles (31.7 miles).

We used a nonparametric correlation measure – Kendall tau[6] – to estimate the degree of relation between income groups and fuel consumption (Table 3) and VMT (Table 4). These results confirm that there are statistically significant (all findings shown are significant at the P>0.01 level) and positive relationships between income and these two key travel variables.

Table 3. Correlations Between Estimated Daily Fuel Consumption and Household Income Groups (Quintiles)

Area Type	Kendall τ
Rural	0.159
Urban	0.172
All	0.174

Table 4. Correlations between Daily VMT and Household Income Groups (Quintiles)

Area Type	Kendall τ
Rural	0.238
Urban	0.198
All	0.202

Therefore, for the state as a whole, in both urban and rural areas, higher income households tend to use more fuel and drive further, on average, than lower income households.

To estimate the financial impact of an RUC on California households, the state's current fuel tax (42.4 cents per gallon) was multiplied by the estimated number of gallons consumed per household per day for each household group. An estimated RUC tax of 1.78 cents per mile was used to estimate the daily cost per household under an RUC. This rate would generate revenues roughly equivalent to those of the fuel tax, which currently costs California households an average of 56 cents per day statewide. The estimated daily fuel tax costs for California households are shown in Table 5.

Table 5. Estimated Average Household Daily Fuel Tax Cost

	Estimated Average Fuel Tax Cost (Cents/Day)					
	Rural		Urban		Statewide	
Income	**Mean**	**Std Err**	**Mean**	**Std Err**	**Mean**	**Std Err**
$0 - $24,999	33	3	41	1	40	1
$25,000 - $34,999	72	8	40	2	42	2
$35,000 - $49,999	51	4	51	2	51	2
$50,000 - $99,999	64	3	64	1	64	1
$100,000 and over	95	6	81	2	82	2
All income groups	55	2	56	1	56	1

Note: Based on an assumed fuel tax of 42.4 cents per gallon.

The estimated daily road user charge costs for California households are shown in Table 6.

Table 6. Average Household Daily Road User Charge Cost

	Estimated Road User Charge Payment (Cents/Day)					
	Rural		Urban		Statewide	
Income	**Mean**	**Std Err**	**Mean**	**Std Err**	**Mean**	**Std Err**
$0 - $24,999	31	3	37	3	37	2
$25,000 - $34,999	58	5	42	2	43	2
$35,000 - $49,999	58	3	51	2	52	2
$50,000 - $99,999	72	3	65	1	65	1
$100,000 and over	102	4	84	1	84	1
All income groups	56	2	57	1	56	1

Note: Based on an assumed road user charge of 1.78 cents per mile.

The estimated difference in average cost per household between the current fuel tax and an equivalent road user charge is within one or two standard errors of the estimated mean values across all income groups. Hence, the costs of a road user charge were found to be indistinguishable from the costs of a fuel tax.

Table 7 presents the average vehicle fuel efficiencies per household for each income and area group.

Table 7. Average Household Vehicle Fuel Efficiency

	Average Household MPG					
	Rural		Urban		Statewide	
Income	Mean	Std Err	Mean	Std Err	Mean	Std Err
$0 - $24,999	23.6	0.1	23.9	—	23.9	—
$25,000 - $34,999	24.1	0.2	24.6	—	24.6	—
$35,000 - $49,999	25.1	0.1	24.8	—	24.8	—
$50,000 - $99,999	25.7	0.1	25.6	—	25.6	—
$100,000 and over	26.8	0.1	27.0	—	27.0	—
All income groups	24.8	—	25.2	—	25.2	—

Note: Blank entries denote standard errors less than 0.05.

Table 8 shows correlation results that confirm a statistically significant, although very weak, positive relationship between household income and average household vehicle fuel efficiency.

Table 8. Correlations between Average Household Vehicle MPG and Household Income Groups (Quintiles)

Area Type	Kendall τ
Rural	0.040
Urban	0.079
All	0.079

Since average vehicle fuel efficiencies increase with household income (ranging from a low of 23.9 mpg for the lowest income group to a high of 27.0 mpg for the highest income group), the lower estimated road user charges for the lowest income group are due entirely to the group's shorter driving distances.

IV. ASSESSING THE RESULTS

The results should be interpreted with several cautions:

- Fuel use estimates are based on sample data in the CHTS and are therefore subject to sampling errors in the data.
- Vehicle fuel use estimates are based on the EPA (NVFE) database, which represents the results of tests on a sample of vehicles. As automobile ads warn, “your own mileage may vary.” Fuel efficiency for vehicles of the same model year, make, model, and engine type will differ due to a number of variables, including maintenance, driving cycles, vehicle loads, and fuel type (e.g., regular versus premium).
- VMT estimates are based on sample data, and may have additional errors based on how the original trip distances were calculated in the survey results.

V. SUMMARY AND CONCLUSIONS

This study identifies the financial effects of a proposed change from a fuel tax to an RUC on households in urban and rural areas as well as different income groups across the state. The findings presented were developed primarily from an analysis of the 2010–2011 California Household Travel Survey (CHTS).

The following are the main findings from this study:

- Daily household fuel consumption and vehicle miles traveled (VMT) both appear to increase with increased household income.
- Urban and rural households show roughly the same amount of fuel consumption and VMT.
- Although slight differences in estimated costs were found over different income groups and rural versus urban households, no statistically significant difference was found between a vehicle fuel tax and a road user charge for any income group.
- These results are based on sample data and are therefore subject to sampling errors in the data. Fuel efficiency for vehicles of the same model year, make, model, and engine type will differ due to a number of variables, including maintenance, driving cycles, vehicle loads, and fuel type (e.g., regular versus premium).

Consideration was given as to whether further research efforts would be likely to produce significantly different results from those presented here. Given sufficient resources, several things might be done to refine the results including:

- More detailed weighting of the survey data.
- Additional efforts to more thoroughly clean the data and match vehicles in the survey sample to vehicles in the EPA fuel efficiency database.

Although these efforts could conceivably yield some refinements of the results, they would still not account for the potentially significant differences between fuel efficiency estimates from the EPA database and actual fuel efficiency experienced by drivers due to the variables identified above. Hence, we do not believe that additional efforts to refine the data would significantly change the findings presented in this paper.

This study is limited strictly to estimating the relative cost of a fuel tax versus a road user charge on households by income and area of residence (urban/rural). However, it is important to note that there are other aspects to these two alternatives that should be examined in order to provide complete information to decision makers. For example, it is readily apparent that a fuel tax is an across-the-board tax that applies equally to all vehicles, regardless of size or weight; however, a road user charge could be tiered based on vehicle class, which would more fairly assess vehicles for the actual wear and tear they impose on the road system.

ENDNOTES

1. California Department of Transportation, Fact Sheet. http://www.dot.ca.gov/hq/paffairs/about/cthist.htm

2. Kunzmann, Martin, NUSTATS Research Solutions. 2010–2012 California Household Travel Survey Final Report Appendix. California Department of Transportation, June 2013.

3. U.S. Environmental Protection Agency & U.S. Department of Energy, National Vehicle and Fuel Emissions Dataset. Updated July 16, 2015, downloaded August 21, 2015, http://fueleconomy.gov/feg/download.shtml

4. Household weights from the survey data were used. Estimated weights for individual trips were not used, as these were found to produce pathological results in some cases.

5. Bootstrapping is a resampling method that has found increasing use in statistics over the past 30 years. See Efron, Bradley, and Robert J. Tibshirani, An Introduction to the Bootstrap (Boca Raton, FL: Chapman & Hall, 1998).

6. Kendall tau is a “nonparametric” correlation measure, in that the measure does not assume any particular underlying distribution for the variables. Because they do not rely on any assumptions about the distributions of the variables, nonparametric measures are inherently more robust than parametric correlation measures, such as Pearson correlation, which assumes that the underlying distribution of the variables is Gaussian (normal).

BIBLIOGRAPHY

California Department of Transportation. “Fact Sheet,” http://www.dot.ca.gov/hq/paffairs/about/cthist.htm

Kunzmann, Martin. NUSTATS Research Solutions. 2010–2012 California Household Travel Survey Final Report Appendix. California Department of Transportation, June 2013.

U.S. Environmental Protection Agency & U.S. Department of Energy. “National Vehicle and Fuel Emissions Dataset.” Accessed August 21, 2015. http://fueleconomy.gov/feg/download.shtml

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