ROAD USAGE CHARGE ECONOMIC ANALYSIS

Final Report

SPR 774

Oregon Department of Transportation

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by

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Abstract: The overall objective of this research is to provide ODOT with up to date information on the economic impact of various Road User Charge (RUC) alternatives on the stakeholders in the state of Oregon. Of particular concern to policymakers were the perceived differences the implementation of a RUC might have on different regions of the state.

Oregon SB 810 creates a program that allows drivers to pay a mileage based RUC of 1.5 cents per mile rather than the current 30-cent per gallon state fuel tax. Major concerns over the adoption of this RUC are that it could increase costs for rural households relative to urban households and that the costs would fall disproportionately on lower income groups. Further, there could be significant differences due to locational distinctions other than simply the urban/rural split. Previous work in the area was limited by the small Oregon sample of households included in the NHTS data set at either the statewide level or using a broad urban/rural distinction. The newly available OHAS data set provides detailed information that permits impacts to be assessed using regional/geographic definition that are more relevant for policymakers in Oregon. Alternatives to the flat RUC of 1.5 cents per mile applied to all vehicles included were:

1. A fee of 1.5 cents per mile applied to only vehicles with >30, >40 and >50 MPG (four different scenarios) while retaining the fuel tax for all others and,
2. A fee of 1.5 cents per mile applied only to new vehicles in the OHAS data set (defined to be 2009, 2010, 2011 or 2012 model year vehicles) while retaining the fuel tax for all others.

Results using the OHAS data show that on average, statewide households will pay 5 cents more daily under a RUC than the current fuel tax (since the 1.5 cent per mile RUC actually would produce more gross revenue than the current fuel tax). However, the increase for rural regions is less than the statewide average while regions with more urban areas will pay slightly more than the statewide average. Further, we find that the distributional impact of imposing this at 1.5 cent RUC on all households in the OHAS data set differs depending on the region of the state examined. Appendix C reproduces the results using a revenue neutral per-mile fee.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

This section contains the definition of abbreviations and acronyms, as well as the definitions of common terms.

Acronym/Abbreviation	Definition
RUC	Road Usage Charge, a per mile charge for miles driven
RUFTF	Road User Fee Task Force
MBUF	Mileage Based User Fee, a per mile charge for miles driven
NHTS	National Household Travel Survey
OHAS	Oregon Household Travel Survey
VMT	Vehicle Miles Traveled
HOV	High Occupancy Vehicle
GPS	Global Positioning System
ODOT	Oregon Department of Transportation
ACS	American Community Survey
MPO	Metropolitan Planning Organization
TAC	Technical Advisory Committee

1.0 INTRODUCTION

1.1 BACKGROUND

The Oregon Department of Transportation (ODOT) has traditionally relied on the fuel tax to fund road infrastructure maintenance, operations, and improvements. The fuel tax has been a reliable source of transportation revenue since 1919 when Oregon became the first state to levy a fuel tax for highway funding. However, increasing vehicle fuel efficiency and other factors are expected to result in permanent funding shortfalls, placing the future of Oregon's highway system in jeopardy. Accordingly, Oregon has been a national leader in exploring a new method of highway finance - a per-mile road usage charge - to replace the highway fuel tax.

The state of Oregon, which has had a weight-mileage tax on heavy trucks (those over 26,000 pounds) in place since 1948, created the Road User Fee Task Force (RUFTF) to develop a design for revenue collection for Oregon's roads and highways that will replace the current system for revenue collection. RUFTF work identified a per-mile charge as the preferred approach and developed the road usage charge concept. Pilot per-mile charge programs were conducted in 2007 and 2013 (Whitty, 2013). Studies of public opinion were conducted as well as a study assessing the distributional impacts of changing from a state fuel tax to a per-mile charge (McMullen et. al., 2009). Drawing on the successful pilot programs and other research, Oregon Senate Bill 810 (SB 810) passed both chambers with bipartisan support and was signed into law by Governor Kitzhaber in 2013.

Oregon SB 810 creates a program that allows drivers to pay a per-mile charge of 1.5 cents per mile in lieu of the current $.30/gallon state fuel tax. The first phase of implementation for this program allowed for participation of up to 5,000 volunteer vehicles and began operations on July 1, 2015.

A major concern over the widespread adoption of a per-mile charge is that it could increase costs for rural households relative to urban households. In the case of Oregon, there could be significant differences due to locational distinctions other than simply the urban/rural split. For instance, the eastern part of the state is sparsely populated with large distances between towns relative to the west of the Cascades where there are large concentrations of population, especially in the Portland metropolitan area. Further, the Oregon coast is separated from the inland valleys by another mountain range and few roads connect the coast to the interior of the state. Accordingly, this research focuses on addressing the impacts a per-mile charge may have for households in different regions in Oregon to see whether it is appropriate to just consider the statewide impact, urban/rural impacts, or whether it might be important to look at more detailed locational distinctions

Concerns have also been raised regarding the possible adverse impact a per-mile charge could have on lower income households as compared to the fuel tax. Accordingly, this research addresses the impacts a per-mile charge may have for households in different income groups as well as disparate regions of Oregon.

Previous work in this area was limited by the small Oregon sample of households (under 500) included in the National Household Travel Survey (NHTS) data set. The newly available Oregon Household Travel Survey (OHAS) opens the opportunity to explore the impacts on Oregon households and geographic regions with much greater precision due to a sample of over 19,000 households. Further, the OHAS data set provides a much larger sample of alternative fuel, hybrid, and fuel-efficient vehicles than included in past data sets.

1.2 RESEARCH OBJECTIVES

The overall research objective is to provide ODOT with up-to-date information on the economic impact of various per-mile charge alternatives on the residents of the state of Oregon. This information can be used to make informed decisions on which per-mile charge structure to adopt. To achieve this end, this research project uses the OHAS data set to assess the economic and regional impacts of three alternate per-mile charge structures:

1. A simple flat per-mile charge of 1.5 cents per mile as specified in SB 810 that applies to all vehicles (Note that the 1.5 cent per-mile charge is used in the analysis, as it is the rate specified in SB 810. However, it is not a revenue neutral rate for the OHAS data set in the sense that it would actually raise slightly more in revenue for the state that the current fuel tax of 30 cents per gallon. For this data set, a revenue neutral rate would actually be less than 1.5 cents per mile. For comparison, a revenue neutral rate for the OHAS data set is identified and the analysis is rerun using the same methodology used for the analysis of the 1.5-cent per-mile charge. Those results are presented in Appendix C.

2. A per-mile charge structure that would retain the fuel tax for existing vehicles but impose the 1.5 cents per-mile charge to new vehicles starting in a specified year.

3. A per-mile charge imposed on vehicles with mpg≥50, or ≥40 or ≥30 while retaining the fuel tax for other vehicles.

The information on regional and income distributional impacts can help policymakers make informed decisions on which per-mile charge structure to adopt.

1.3 ORGANIZATION OF THE REPORT

This paper is organized as follows. Chapter 2 provides a review of relevant literature. Chapter 3 explains the methodology used and Chapter 4 introduces the OHAS data set. Chapter 5 presents the results for the various per-mile charge structures by income group and geographic regions. Chapter 6 discusses key findings, limitations of the results, and recommendations for further research. Appendix C presents the results for the various per-mile charge structures for a revenue neutral rate.

2.0 LITERATURE REVIEW

Nationwide, there have been numerous studies on mileage-based fees. Accordingly, the terminology in literature differs slightly. Depending on the author, they are called mileage based user fees (MBUF) *(Baker 2008; Zupan 2012)*, road usage charges (RUC) *(ODOT 2013; Hansell et al. 2013)*, and vehicle miles traveled (VMT) fees *(McMullen et al. 2010; Kile 2011; Zhang et al. 2009)*. This research uses the term RUC or per-mile fee in order to stay consistent with language used in SB 810.

The topic of RUCs has come to the forefront of political and research discussions in recent years as the revenues produced by current transportation funding sources that rely heavily on fuel (gasoline and diesel) taxes have not kept up with the costs of the road system. Contributing to the revenue shortfall is the fact that the fuel tax system relies on the use of petroleum based fuels and efforts to increase fuel efficiency in the vehicle fleet have also increased the development of vehicles that do not use fossil fuels (such as pure or hybrid electric vehicles). Although those vehicles help achieve national goals of oil independence from the rest of the world and the reduction of carbon emissions, their impact on roads and transportation per vehicle mile is not significantly different than for traditionally fueled vehicles. Thus, what was once a close relatively uniform association relationship between road use and fuel consumption no longer holds for alternative fuel and highly fuel-efficient vehicles that end up not paying a proportionate share of the costs they impose on the road system. Furthermore, the reduced operating costs per-mile to drivers of more fuel efficient vehicles may cause them to increase miles driven, resulting in more road use and increased road damage, an effect referred to in the literature as the "rebound effect" *(Small and Dender 2007)*.

Due to these changes in the vehicle fleet, combined with increasing costs of road construction and repair, fuel tax revenues have failed to keep pace with inflation. The result is that expenditures on roads, especially at the state and local level, are increasingly financed by a variety of funding sources other than user fees such as local property taxes, sales taxes, bond finance, etc. *(Kile 2011; Wachs 2003)*.

Recognizing the shortfalls of the current system of highway user fees at a federal and state level, a VMT fee or RUC is a policy option recommended by the National Surface Transportation Infrastructure Financing Committee *(NSTIFC 2009)* as part of a long-term solution to providing a sustainable funding source for highways. In Oregon, the legislature in 2001 formed a Road User Fee Task Force (RUFTF) to design a new revenue collection strategy that could replace the gas tax with a long-term, stable source of funding. RUFTF recommended a per-mile charge as the principal general revenue source for a new system that would ultimately replace the gas tax for road funding *(Whitty 2007)*.

2.1 ISSUES INVOLVED IN THE EVALUATION OF A RUC

While qualitative studies reveal how the public views a mileage based RUC and the implementation challenges faced by policy makers, they fail to depict how people actually behave under such systems. Because of the small sample sizes as well as possible biases due to voluntary participants, researchers have largely been unable to rely on pilot results as data for empirical work on the impacts of implementing a RUC.

Public opinion surveys show that many Oregonians believe that households in rural areas would be the "losers" under a per-mile RUC, facing higher fee incidences than urban households *(ODOT 2013)*. Rural households drive further distances to reach certain goods and services, however rural household travel behavior suggests that they make fewer trips on average than urban households *(Whitty and Capps 2013; Whitty 2007;ODOT 2013)*. Households that drive more miles will pay more under either the fuel tax or the per-mile RUC. Other research shows that rural households drive less fuel-efficient vehicles on average than urban households, which suggests that they would pay less under a per-mile RUC than under the fuel tax *(McMullen et al. 2010)*.

The majority of empirical work that has been done uses the 2001 or 2009 National Household Travel Survey (NHTS) data set to predict the effects RUCs would have on household behavior *(McMullen et al. 2010; Zhang et al. 2009; Weatherford 2011; Kastrouni et al. 2012; Larsen 2012; Paz 2013)*. The NHTS is a national dataset collected by the Federal Highway Administration and contains only a few hundred samples for each individual state. To accommodate this limitation, studies that focus on the potential impacts of RUC adoption tend to group additional states as being similar to the state under study on a set of econometrically determined criteria *(McMullen et al. 2008; Zhang et al. 2009; Paz et al. 2013)*.

Within the NHTS, households categorization as urban or rural is based on 2000 US Census criteria. Using these definitions for rural and urban, researchers agree that under the current fuel tax system, rural households tend to drive more miles than their urban counterparts *(Zhang et al. 2009; Kastrouni et al. 2012; Paz et al. 2013; Weatherford 2011)*. In the short run, most researchers find that the average rural household stands to gain more from the adoption of RUCs than urban households, perhaps due to rural vehicle fleets being made up of more fuel inefficient vehicles *(Zhang et al. 2009; Weatherford 2011)*. In the longer run, Paz et al. *(Paz et al. 2013)* and Zhang et al. *(Zhang et al. 2009)* find that rural households shoulder more of the tax burden. Zhang et al. *(Zhang et al. 2009)* suggests that this may cause rural households to prefer less fuel-efficient vehicles under a RUC system. Paz et al. *(Paz et al. 2013)* argues that rural households will reduce their vehicle miles traveled in response to RUC implementation. Weatherford *(Weatherford 2011)* suggests that the tax burden will shift from rural to urban households. However, as the NHTS dataset does not include a household's actual location, researchers are unable to refine its urban/rural categorizations for more geospatially disaggregated analysis. Furthermore, because the NHTS relies on the 2000 census, its rural/urban definitions may be outdated. In the last 15 years, many areas across the country have experienced growth, and many formerly rural areas are now considered urban. Finally, the somewhat mixed results from the studies cited above may reflect researchers looking at different states and geographic regions.

Kastrouni et al. *(Kastrouni et al. 2012)* discuss the importance of using a more detailed geographic classification system to examine distributional impacts. They argue that location specific models should be developed to evaluate local changes due to implementing a road usage charge, research on the determinants of vehicle miles traveled demand suggest that determinants are site specific. McMullen and Eckstein *(McMullen and Eckstein 2013)* find that VMT determinants differ even across different sized urban areas and thus VMT reduction policies have different impacts in different urban locations. In their study of VMT in 87 US cities over the period 1982-2009, McMullen and Eckstein *(McMullen and Eckstein 2013)* find that fuel price, transit use, and population density are negatively related to VMT per capita.

Distinguishing urban from rural is a nontrivial task with important policy implications. Distinctions between urban, rural, and the spaces in between are not always clear. In the Oregon context, the extremes of urban, such as downtown Portland, and rural, such as Steens Mountain, are easily classified; however, classification of other locations can be ambiguous. Crandall and Weber *(Crandall and Weber 2005)* examine several classification systems and demonstrate how the demographic profile of rural Oregon changes as definitions of rural change. They suggest eschewing national schemes such as those devised by the US Census Bureau, Office of Management and Budget, and the USDA in favor of an Oregon specific classification scheme. Their proposed five-tiered classification system is similar to locational types included in the Oregon Household Activity Survey (OHAS) data and used in this study.

2.2 EVALUATIONS OF EQUITY IMPACTS OF A RUC

Concerns have been raised regarding distributional impacts of a RUC on different income groups although the Congressional Budget Office *(CBO 2011)* claims that specific to equity the impact of such fees is very similar to the impact of gasoline taxes. The gasoline tax is regressive--- which means that lower income groups pay a larger percent of their income on fuel tax than those in higher income groups. The impact of a RUC on lower income people might be adverse when compared to the fuel tax, however it should be noted that the exact impact depends on the fuel economy of the vehicles driven by those in lower income groups. If, for example, those in lower income groups drive older, less fuel-efficient vehicles, the adverse impact may be negated.

Actual evaluation of equity concerns has not been possible from the limited experience in the U.S. with pilot RUC projects because these projects have used a very small sample of households that are volunteers in urban areas. Thus, the analysis of the equity impacts of RUCs to date has focused on predicting the impact using a sample of the population, for which required variables are available.

Several research efforts that focus on these equity concerns include those that focus on Oregon *(McMullen et al. 2008; McMullen et al. 2010; Zhang et al. 2009)*, Nevada *(Paz et al. 2013)*, Texas *(Larsen et al. 2012)*, and the entire U.S. *(Weatherford 2011)*. All of these studies use data from the National Household Travel Survey (NHTS) either for the nation or for individual states.

Interestingly, these studies show somewhat different results. Assuming a per-mile fee that would approximate a revenue neutral replacement for the fuel tax in Oregon, several studies found a slight increase in regressivity when changing from a fuel tax to a VMT fee *(McMullen et al.*

2008, 2010; Zhang et al. 2009). They conclude that long run distributional impacts of a change from fuel tax to a VMT fee are likely to be minimal. Paz et al *(Paz et al. 2013)* also reported a slight increase in regressivity from a RUC. The study done in Texas also found VMT fees to be slightly more regressive than current fuel taxes *(Larsen et al. 2012)*. On the other hand, using nationwide data and federal data Weatherford *(Weatherford 2011)* found that a flat VMT fee would be slightly less regressive than a fuel tax.

Using the NHTS data set and their definition of rural/urban, McMullen et al. *(McMullen et al. 2010)* found that rural households in Oregon benefit slightly from the change from a fuel tax to a flat VMT fee, a result largely attributable to the fact that rural households drive less fuel-efficient vehicles. The Nevada study found that although a VMT fee would reduce VMT for both urban and rural households, rural households would end up paying slightly more due to the fact that they drive more miles than urban households *(Paz et al. 2013)*. Using the nationwide data it was found that VMT fees are shown to shift the tax burden from rural households to urban households *(Weatherford 2011)*.

When fee structures other than a flat fee are implemented, results can vary. For instance, use of a three part VMT fee with different rates depending on vehicle fuel efficiency (with lower mileage fees for more fuel efficient vehicles) ends up yielding more regressive results in Oregon *(McMullen et al. 2010)* and in Texas there was a larger negative impact on rural households *(Larsen et al. 2012)*.

2.3 METHODOLOGY USED IN PAST STUDIES

Most of the studies reviewed use similar general methodologies in that they first look at the amount a household spends on the fuel tax and then determine the amount that the same households would pay if a vehicle mileage fee were imposed instead of the fuel tax. This follows the procedure used by the Congressional Budget Office (CBO) to evaluate the impact of changes in taxes. In each of the above studies, different structures for the mileage fee are examined and the impact on households either in urban or rural areas, or by income groups, is assessed.

The first study to examine socio-economic and geographic impacts was McMullen et al. *(McMullen et al. 2008).* Variants of their basic methodology, developed and implemented for Oregon, have been used for most of the subsequent studies on this topic. They made use of the Oregon subset of the National Household Travel Survey (NHTS) which had information on household income, vehicles and mileage for each vehicle, estimates of annual mileage per vehicle, fuel economy for each vehicle, urban/rural household location indicator, and various other household attributes such as the number of workers, drivers, and children in the household. Calculations were done in two ways either 1) using a static model where feedback effects on vehicle miles traveled were not considered (the change in tax/fee is thus assumed to have no impact on household driving behavior) or 2) using a dynamic model where the change in the user fee affects the household's driving behavior and this change in miles traveled is used to do the impact calculation.

The dynamic analysis employs a multiple regression model in which total annual household miles are a function of fuel cost per mile, annual household income, household location (urban or otherwise), the number of household variables, household characteristics such as the number of children, number of workers and gender of head of household, and a dummy variable that indicates whether or not the household owned more than one type of vehicle (defined as vehicles with some specified difference in fuel economy) to allow for vehicle use substitutability. Other independent variables often include an interaction term between household income and fuel cost per mile, and an interaction term that allowed for households with more than one vehicle type to respond differently to changes in the cost of driving. Most of the dynamic results in this study and others below employ variations of this general equation to obtain behavioral responses. This information is used to obtain the amount each household pays under the fuel tax and how much they would pay under alternative VMT fee scenarios.

2.4 DISTRIBUTIONAL AND GEOGRAPHIC IMPACT FINDINGS

The 2001 NHTS data set for Oregon only contained 339 valid Oregon households. To increase the sample size, Zhang et al. *(Zhang et al. 2009)* used factor analysis to identify six states that were most similar to Oregon in terms of driving patterns, demographics, geography, and economic status. The addition of observations from Colorado, Michigan, Minnesota, Utah, Virginia, and Washington increased the sample size to 3581. The results of their dynamic model showed that rural households tend to drive more than their urban counterparts, households with male heads and workers drive more than those with female heads and no workers. The lowest income households that own only one vehicle type would drive 1.53% less per year given a 1% increase in fuel cost per mile; highest income households with one vehicle type would reduce driving by 0.4% under the same circumstances, showing that lower income households respond more to a change in the cost of driving than higher income households. This study's results show that the average rural household would pay an average of $9.42 less per year from a VMT fee whereas the average urban household would pay about $2.05 more per year in the short run. The dynamic model they ran found somewhat different results in that rural households did not gain as much in the long run. However, the majority of households in their dynamic model were not located in Oregon and it was not clear whether Oregon households behave the same as those in the other states.

McMullen et al. *(McMullen et al. 2010)* used the same basic model as Zhang et al. *(Zhang et al. 2009)* but only used the NHTS data set of 339 Oregon households to conduct the analysis. They found that lower income groups pay more and higher income groups pay less under both static and dynamic model specifications. In the short term, the average rural household gained more from the adoption of a VMT fee than its urban counterpart did, largely because the rural vehicle fleet contained more fuel inefficient vehicles. "At the extremes, a household may lose up to $5.15/year or benefit up to $35.46/year from the proposed $0.012/mile VMT fee in Oregon…overall the [short term] distributional effects of the proposed VMT fee in Oregon are small and may even be considered negligible given the high volatility in gas price itself" *(McMullen et al. 2010)*. Their overall results indicate very little practical difference between the results from the "static" and "dynamic" models although the dynamic models are much more data intensive and complicated. These results suggest using the static model, which is much less data intensive than the dynamic model, may provide policymakers with "ballpark" figures for assessing the impacts of different user fee structures.

McMullen et al. *(McMullen 2010)* considered three different VMT fee structures: 1) a flat fee structure of 1.2 cents per mile (formulated as an approximation of a revenue neutral fee when the Oregon state fuel tax was 24 cents per gallon), 2) a user fee structure which retains the gasoline tax for vehicles with fuel economies less than 20 mpg and imposes a flat fee of 1.2 cents per mile for other vehicles and 3) a three part fee where vehicles that get less than the sample median fuel economy of about 18 mpg pay 2 cents per mile; those between the median and 20 mpg pay 1.5 cents per gallon, and 1.2 cents per mile for all other vehicles. These scenarios were considered as alternative fee structures to deal with criticism that vehicles with low fuel economy would benefit under a fixed per-mile fee system. These alternative fee structures (#2 and #3) were even more regressive than the per-mile fee structure (#1).

Paz et al. *(Paz et al. 2013)* use data from the 2009 National Household Travel Survey (NHTS), specifically using the Nevada-pertinent subset of 249 households (minus outliers, only 222 complete observations were used) to assess household-level equity impacts of changing to a VMT fee. The Paz et al. *(Paz et al. 2013)* methodology uses a simple linear regression model similar to that employed by McMullen et al.,*(McMullen et al. 2008, 2010)*, Weatherford *(Weatherford 2011)*, and Zhang et al. *(Zhang et al. 2009)*. From the 222 household data set, Paz et al. *(Paz et al. 2013)* found that variables such as urban/rural household location, type of vehicles including hybrids, and interaction between household income and price per mile to drive, while intuitively seem to play a role on annual household miles traveled, do not empirically register as significant at the 0.10 level. However, due to the small number of observations, their estimates are statistically weak. Accordingly, following Zhang et al. *(Zhang et al. 2009)* they broaden the data set to include households from Arizona, Utah, Colorado, Idaho, Montana, Wyoming and New Mexico, states the researcher thought had characteristics similar to Nevada. This increased the total number of observations to 1341. Contrary to expectations, the sign of the variable representing household income was negative, implying that wealthy households drove less. Their findings also suggest that households with fuel-efficient vehicles drive less.

Paz et al. *(Paz et al. 2013)* consider two VMT fees: 3.3 cent/mile and 2.91 cent/mile. The higher VMT fee resulted in a "greater number of households with an increased tax burden … In the case of the 2.91 cent/mile fee, although overall less revenue is collected, the average household still sees an increased cost" *(Paz et al. 2013)*. However, this could simply be due to the number of households with fuel inefficient vehicles contained in the sample. Due to the small sample size, it was difficult for Paz et al. *(Paz et al. 2013)* to arrive at any consistent conclusions regarding the impact VMT fees may play on various income groups. The authors conclude that further research is needed to determine the exact impact of a VMT fee on income groups. Similarly, the urban versus rural household location impact was difficult to determine due to the weak Nevada-only model. The existing evidence suggests that while both urban and rural households would drive less with a VMT fee, rural households would incur slightly higher annual costs compared to their urban counterparts.

The Paz et al. *(Paz et al. 2013)* study focused on comparing various demographic groups. Asian households were found to be the most affected demographic group with a change in annual cost of more than 50% compared to the next closest demographic group when examining the 1341 observation model *(Paz et al. 2013)*. This is likely because Asian households were more likely to own fuel efficient vehicles *(Paz et al. 2013)*. For the NV dataset, African-Americans were the most affected. “Single parent households had the largest loss in mobility... but a smaller change in annual cost” *(Paz et al. 2013)*. As one would expect, hybrid vehicle owners would end up paying more with a VMT than a fuel tax.

Weatherford *(Weatherford 2011)* analyzes the distributional implications of charging a VMT federal fee of 0.98 cent/mile, the equivalent of the current per-gallon federal fuel tax, using data from the 2001 National Household Travel Survey. Of the roughly 26,000 households in the NHTS, households without vehicles were omitted as well as those with incomplete household income data, leaving 19043 observations. Weatherford *(Weatherford 2011)* created a regression model based on McMullen et al. *(McMullen et al. 2010)* with the additional variables denoting household demographics, state of residence, and vehicle substitutability. The demand elasticities with respect to price range from .51 to 2.84, with a mean of 1.48, which is a relatively high finding. Weatherford attributes the high elasticity findings with the short-term nature of the data, as fuel prices do not vary over short time periods, and is consistent with other studies that evaluate elasticity using the NHTS dataset.

Unlike the Oregon studies, Weatherford *(Weatherford 2011)* finds that a flat, approximately revenue-neutral VMT fee, is *less* regressive than gas taxes at the federal level and the burden of the tax shifts from low income households to high income households. This may be due in part to the fact that Weatherford uses a national sample that may include regions in which driving response behavior differs from that of Oregon. Similar to the Zhang et al. *(Zhang et al. 2009)* and McMullen et al. *(McMullen et al. 2010)* studies, he finds that the impacts of the change in fee structure are negligible. Weatherford (2011) notes that “a revenue neutral VMT fee would change the annual tax burden of 98% of the population by less than $20,”*(Weatherford 2011)* and concludes that equity concerns surrounding a VMT are less important than administration costs, evasion, and privacy concerns.

Larsen et al. *(Larsen et al. 2012)* used the Texas data from the 2009 NHTS to evaluate equity implications from four possible VMT fee schemes suggested to replace the existing state gas tax. The Texas NHTS data set is large because Texas has 20,000 add-on households (for which the state pays extra) of which 14,595 households and 29,162 vehicles were left after the data cleaning and filtering. These households were weighted to reflect 2008 vehicle owning Texan households. Each of the four VMT fee scenarios were subjected to a static model in which no change in travel behavior occurred, and a dynamic model that reflected travel behavior changes because of changes to the cost of travel. The following scenarios were devised: 1) a flat VMT fee that collected the same amount of revenue as the state gas tax, 2) a flat VMT fee for additional revenue generation in order to meet infrastructure goals established by the Texas 2030 Committee, 3) a three tiered VMT schedule to encourage adoption of vehicles with better fuel economies, 4) and a flat VMT fee that distinguished between driving on urban and rural roadways. The study used research from Ojah *(Ojah unpublished, Texas Transportation Institute, March 4, 2011)* to arrive at two possible estimates of vehicle mile disaggregation—a 80/20 split (in which 80% of urban household travel was on urban roads and 20% of rural household travel would be on urban roads), and a 70/30 split.

Unlike previously discussed studies, the Larsen et al. *(Larsen et al. 2012)* study does not conduct a regression analysis to estimate the dynamic effects of a change in price caused by conversion from a fuel tax to a VMT fee *(Larsen et al. 2012)*. Rather, they assume that gas price elasticities are similar to VMT fee elasticities, and use Wadud et al.'s *(Wadud et al. 2009)* gas price elasticities, disaggregated by household income level and geographic location, which is not done specifically for Texas *(Larsen et al. 2012)*.

The results found that quantitatively, "vertical equity of all proposed VMT-fee scenarios and that of the current state gas tax were similar" *(Larsen et al. 2012)*. Under the third scenario (a three tiered VMT schedule) low-income households paid the smallest percentage of the revenue generated by either VMT fees or state gas tax, which was attributed to how the tiered stratum was set up: "high-income households drive more miles in vehicles that fall under the VMT fee categories that are assessed either the high or medium rate than their less wealthy counterparts do" *(Larsen et al. 2012)*. The static case of a three-tiered VMT schedule was found to be the most progressive while a dynamic scenario involving an 80/20 split (the fourth case) was found to be the most regressive. However, when the tax burden as a percentage of total household income was considered, in absolute terms the VMT fees were as regressive as the gas tax. The Larsen study made use of a Gini coefficient (or Suits Index) to compare the regressivity of the various fee structures.

2.5 IMPORTANCE OF LOCATIONS AND URBAN/RURAL DEFINITION

Overall, Kastrouni et al. *(Kastrouni et al. 2012)* found that households located in states with low gas taxes and that use vehicles with lower fuel efficiency shoulder a larger tax burden. Households owning vehicles with higher gas efficiencies and those with higher average incomes tend to drive more often and have higher VMT. The authors also show that despite initial similarities between national data and data for the state of Iowa, the development of distinct local models are necessary statistically. Iowan VMT at the household level shows patterns that are inconsistent with the national data, specifically the variables concerned with location and geography. They recommend using more disaggregate data sets to evaluate equity impacts of VMT fee structures.

One problem with the NHTS data set is that the exact location of a household is not known and the researcher must rely on the classification of Urban or Rural household as made by the NHTS. Distinguishing urban from rural is a nontrivial task with important policy implications. The Willamette Valley is densely populated; Eastern Oregon is typically less so. While the extremes of urban (e.g. downtown Portland) and rural (e.g. Steens Mountain) can be easily classified, other places are more ambiguous.

The NHTS follows the Census Bureau classifying urban and rural locations. The algorithm used by the Census Bureau has census blocks and block groups; urban areas contain a block group with a population density of 1,000 persons per square mile and adjacent blocks and block groups with densities of at least 500 persons per square mile. If the sum people for this agglomerated area are at least 2,500 persons, then the area is marked urban. Urbanized areas contain 50,000 or more people, and urban clusters contain between 2,500-10,000 people. Areas that do not fit these characteristics are labeled rural. The advantage to this method is that it has been in use for a very long time, allowing for time series analysis. The two category definition is also easy to picture. However, because census data is not reported by rural/urban classifications, data has to be aggregated from block level if one wishes to compare demographic traits. Additionally, because there are only two categories, the "diversity of place is lost" as residents of large cities like Portland and residents of smaller places like Ontario are in the same category *(Crandall and Weber 2005)*.

Crandall and Weber *(Crandall and Weber 2005)* suggest mapping Oregon using a classification system that better reflects "how the demographic profile of rural Oregon changes as definitions of rural change" *(Crandall and Weber 2005)*. Their suggested system would apply the urban classification to communities with at least 50,000 people and the surrounding area within 10 miles of these communities. Portland, Eugene, Salem, Medford, Bend, and Corvallis would be classified as urban. Rural areas would be either urban rural (at least 10 miles by road from an urban community), rural (at least 30 miles by road from an urban community), isolated rural (at least 100 miles by road from a community of at least 3000), or frontier rural (at least 75 miles by road from a community of less than 2000). This obviously would tell us more about household behavior by region but it also requires more data than is available from the NHTS.

Given the very generic classification of households in the NHTS, it would be desirable to better identify households by geographic regions for assessing the impact of a per-mile fee. For instance, there may be significant differences in behavior between Portland and Eugene and Bend even if all three are classified as "Urban".

2.6 VMT FEE STRUCTURE CONSIDERATIONS

A flat fee has been a VMT fee structure used in every one of the equity evaluations of VMT fees to date. The main question is how to set the flat rate and typically a "revenue neutral" rate is attempted, which means that the total revenues collected from the per-mile fee would be the same as the revenues generated under the current fuel tax. In the McMullen et al. *(McMullen et al. 2008)* study a flat VMT fee of 1.2 cents per mile was set to be approximately a revenue neutral fee since the fuel tax at the time was 24 cents per gallon and average fuel efficiency was estimated to be 20 miles per gallon (24/20=1.2 cents per mile.) However, in the NHTS samples used for the McMullen et al. *(McMullen et al. 2008)*, Zhang et al. *(Zhang et al. 2009)*, and McMullen et al. *(McMullen et al. 2010)* studies, the1.2 cents per mile VMT fee turned out to actually produce more revenue than the fuel tax---mostly due to the fact that the average fuel economy of vehicles in the sample was greater than 20 miles per gallon.

Similarly, the RUC of 1.5 cents per mile used in the Oregon per-mile fee volunteer program that started in July 2015 could be viewed as an approximately revenue neutral fee to replace the 30 cent per gallon fuel tax, if it were true that the average fuel economy for vehicles in Oregon was 20 mpg. To the extent that the overall average fuel economy of the Oregon vehicle fleet exceeds 20 miles per gallon, this 1.5 cent per mile rate will produce more revenue than the existing fuel tax. For the OHAS data, this 1.5 cents per mile is not approximately revenue neutral. Follow-on analysis based on an approximately revenue neutral fee for this data set is documented in Appendix C. Distributional impacts occur depending on the actual distribution of fuel-efficient vehicles across income and geographic groups.

Another concern for policymakers in implementing a RUC (per-mile fee) is how to determine the structure of the rate. A flat rate structure is the easiest to apply but assumes that every passenger vehicle impacts the road system equally and thus imposes the exact same cost on the system.

This assumption is not unreasonable when considering light passenger vehicles as there is negligible difference in road damage between passenger vehicles, but there is a much greater difference between passenger vehicles and heavy trucks. The Oregon weight distance tax for heavy trucks (those over 26,000 pounds) takes this into account by setting different mileage rates to heavy trucks of differing weights and by equivalent single axle loads (ESALs)

In the Texas *(Larsen et al. 2012)* and Nevada *(Paz et al 2013)* studies, alternative flat fees were considered so as to meet future revenue objectives such as projected highway expenditures at a level that could not be financed with a revenue neutral fee. To meet higher revenue goals a higher flat VMT fee or a higher fuel tax would be required.

Fee structures have been also suggested to meet goals other than strict highway finance/revenue generation. For instance, fee structures have been proposed to deal with environmental or energy concerns *(Larsen et al. 2012)*. Larsen et al. *(Larsen et al. 2012)* examined a fee that would differ for urban and rural roads. McMullen et al. *(McMullen et al. 2010)* considered fees that are higher for less fuel efficient vehicles, including a hybrid user fee structure where some vehicles pay a gasoline tax and others a per-mile charge. Other possible fee structures include those designed deal with social equity considerations.

3.0 METHODOLOGY

The methodology used in this analysis closely follows that developed in Zhang et al (2009) and McMullen et al. *(McMullen et al. 2010)* for Oregon and subsequently used in UC studies in other geographic regions of the U.S. *(Paz et al. 2013; Weatherford 2011)*. In those studies, both static and dynamic methods were used but, as McMullen et al. *(McMullen et al. 2010)* note, the resulting impacts on Oregon households were not significantly different but the dynamic models required more data. Given the fact that the two methods yield similar results combined with the additional data required for the dynamic analysis that is difficult to obtain for the disaggregated regions considered in this study, the results reported here use only the static model methodology.

The static model assumes households drive the same vehicles for the same distances both before and after a per-mile RUC is imposed. Thus, the results reported here will *over*estimate the impact on households since these results ignore the change in household driving (VMT) that will result as the change in fee structure causes the price they pay per mile to change. For instance, if the change from a fuel tax to a RUC increases the household price per mile of driving (which it will for households with vehicles that get greater than average fuel economy) and the household responds by reducing VMT, the increase in household expenditures shown below for the static model will be greater than the true impact. Similarly, if the change in fee structure reduces the household price per mile of driving and the household responds by increasing VMT, the decrease in household expenditures would be less than that shown below for the static model. Thus, the results presented below show the maximum impact on households and the actual impact is most likely slightly less.

3.1 CALCULATION OF THE CHANGE IN HOUSEHOLD EXPENDITURES

The static model used in this research is calculated by dividing household daily VMT (HHVMT) by the average household fuel efficiency rating (HHMPG), to obtain the number of gallons of gasoline consumed by the household for travel purposes.

$$\boldsymbol{Gallons = \frac{HHVMT}{HHMPG}} \qquad \textbf{(3.1)}$$

HHVMT = household’s total vehicle miles traveled

HHMPG = household’s weighted miles per gallon fuel (mpg) efficiency rating which was calculated by weighing each vehicle’s mpg by the percent of total VMT driven on that vehicle. See Appendix A for details.

The price of fuel on the day of the survey was reported in the OHAS for each household so that total household expenditures on fuel under the fuel tax could be calculated simply by multiplying the price of fuel per gallon by the number of gallons consumed.

$$\boldsymbol{Exp_{gas} = Gallons * Price_{gas}} \quad \textbf{(3.2)}$$

In order to calculate the price of traveling the same mileage under a per-mile RUC, we calculate how much each household would pay for fuel net of the fuel tax, and then add the per-mile RUC for each mile traveled.

$$\boldsymbol{Exp_{RUC} = Gallons * \left(Price_{gas} - Tax_{gas}\right) + HHVMT * Tax_{RUC}} \quad \textbf{(3.3)}$$

The net change in household expenditures is the difference in household expenditures under the two fee structures.

$$\Delta_{static} = Exp_{RUC} - Exp_{gas} \quad \textbf{\textit{(3.4)}}$$

3.2 MEASURING REGRESSIVITY: THE SUITS INDEX

A regressive tax is one that takes a greater percent of income from those in lower income groups; a progressive tax takes a greater percent of income from those in higher income groups and a proportional tax takes the same percent of income from all income groups. The Suits Index is a way of measuring the regressivity of taxes by comparing the percent of income paid for each tax by income group. In the RUC context, we compare the regressivity of the fuel tax to the RUC fee. The Suits Index is convenient in that it provides one number that can be compared across tax regimes. This makes it easier to compare alternative RUC fees and fee structures

See Appendix B for the formal definition of the Suits Index.

4.0 OHAS DATA

The data used for this study is the 2013 Oregon Households Activity Survey (OHAS) dataset collected by Oregon Department of Transportation (ODOT) between 2009 and 2011. The OHAS was designed to help state and local planners deal with a diverse set of transportation related issues. It contains responses from 19,932 households, including over forty thousand individuals (considerably more Oregon households than the NHTS data set.)

4.1 DATA FILTERING

First, the data was filtered to remove non-Oregon households, households that did not own any vehicles, oversampled households, and non-driving vehicle owning households. Because it was conducted for transportation planning, commuters from Clark County, Washington were included in the survey. As this research is only concerned with a change in the price of driving for Oregonian households, these 1,667 Washington households were removed. Further examination of the dataset revealed one household in California that was subsequently removed from the dataset.

For the most part, households were randomly chosen to participate in the OHAS survey. There were 826 Oregonian households surveyed that reported not owning a vehicle. Since this research seeks to explore the impact of a change in the price of driving caused by the change from a fuel tax to a RUC and households without vehicles would be unaffected, they were removed from the dataset.

Intentional oversampling of certain locations (e.g. Portland metro, with respect to bicycle miles traveled) occurred in order to give policy makers a better picture of what specific situations looked like. This research excludes the 272 oversampled households.

After removing the intentionally oversampled households, the amended OHAS dataset contains 17,166 households that own at least one vehicle. Of these, the 1,765 households that reported zero vehicle miles traveled (VMT) were deleted from the dataset, leaving a remaining sample of 15,401 households. The 1,012 households that declined to report their incomes were filtered out, allowing for a dataset of 14,389 households in the final analysis.

During the verification of vehicle VMT numbers, two vehicles had over 1,500 miles reported for the survey day. These were classified as outliers or possible data entry errors and removed from the study sample. The maximum daily vehicle miles travelled range was set at 1,500 miles because it is barely feasible if a person spent an entire day driving on an interstate highway.

4.2 GEOGRAPHIC REGIONS AND MPOS

The remaining Oregon households were divided into either metropolitan planning organizations (MPOs) or regions. As shown in on Map 1, Figure 4.1, the state was divided into seven regions: Coast, Deschutes, East, Mid-Willamette Valley, North Central, North Willamette Valley, Southern Willamette Valley, and South Central. The regions were identified by the Technical Advisory Committee (TAC) for this project as a way to divide the state into sub-regions that are more meaningful rather than simply using an East Oregon-West Oregon or urban/rural bifurcation system. For instance, Deschutes county households may behave differently from other households due to their distance to Bend MPO. Households may behave differently if they are part of an isolated coastal community rather than a town along the I-84 corridor. It is important to note that these ODOT regions do not strictly follow county lines. The nine state-recognized MPOs are also marked on the map. These include Albany, Bend, Corvallis, Eugene-Springfield, Portland, Rogue, Middle Rogue, Salem-Keizer, and the Walla Walla Valley. All households were assigned regions. Thus, Portland MPO households belong to North Willamette Valley. Households in Albany, Corvallis, Salem/Keizer, and Eugene Springfield MPOs are also in the Mid-Willamette Valley region. Likewise, households in the Medford and Middle Rogue MPOs are tagged as being in Southern Valley, and all households in Bend MPO are in Deschutes region as well. Households that do belong to any MPOs are given NA values for their respective MPO variable.

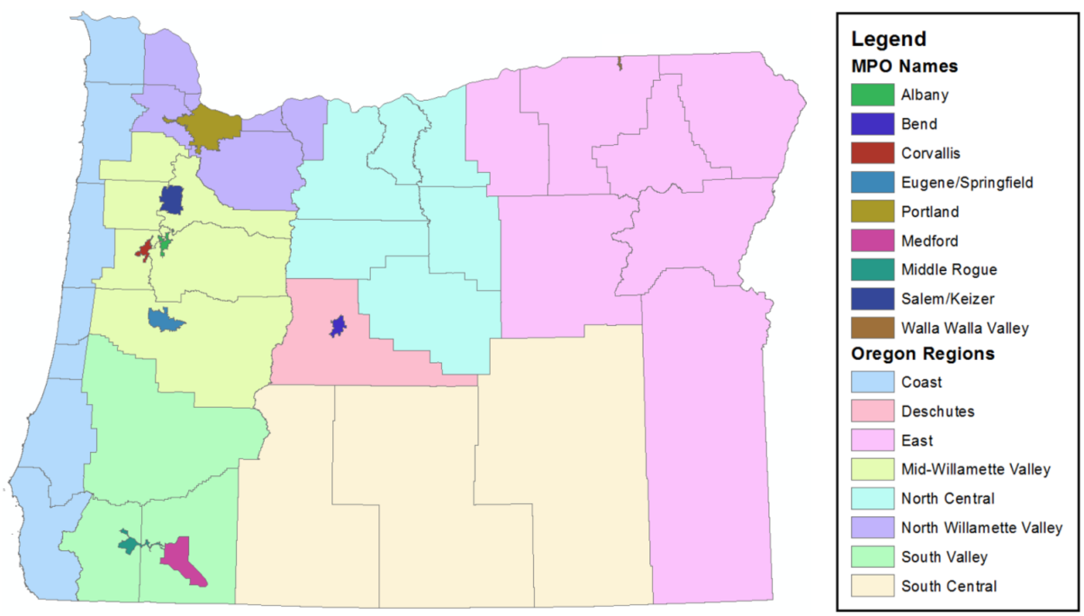

Figure 4.1: Oregon Regions and MPOs

In the OHAS data set, each household was assigned a location type variable based on proximity to population density criteria. These location types are similar to the Oregon specific rural-urban spectrum proposed by Crandall and Weber *(Crandall and Weber 2005)*. This location type classification allows for households that reside within MPO jurisdictional boundaries to receive a location type that is not MPO, particularly if they are located on the MPO's outskirts. Likewise, households may receive a location type code of MPO despite not belonging to an actual MPO.

The five location types used in the OHAS are derived from the 2010 US Census' data on census block population. Households were assigned location type codes as follows:

- LT1: “Rural,” greater than 2 miles to accumulate 2,500 people and greater than 15 miles to accumulate 50,000 people.

- LT2: "Isolated City," less than 2 miles to accumulate 2,500 people but greater than 15 miles to accumulate 50,000 people.

- LT3: "Rural Near Major Center," greater than 1 mile to accumulate 2,500 people but less than 15 miles to accumulate 50,000 people.

- LT4: "City Near Major Center," less than 1 mile to accumulate 2,500 people and less than 15 miles to accumulate 50,000 people.

- LT5: "MPO," less than 1 mile to accumulate 2,500 people and less than 5 miles to accumulate 50,000 people.

The following Figure 4.2 provides a visual guide to this data.

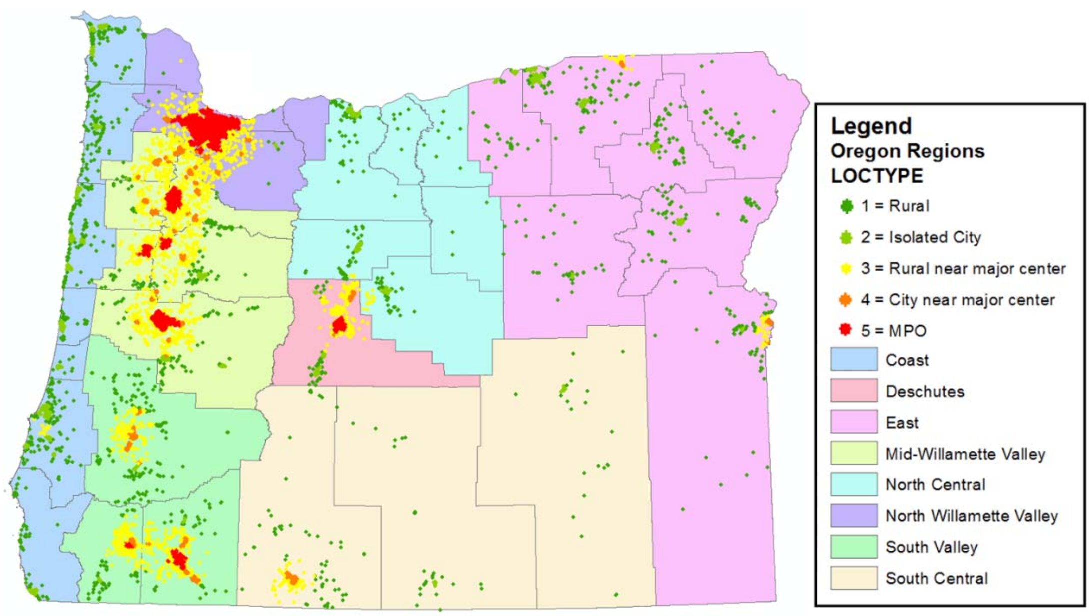

Figure 4.2: OHAS Households in Different Location Types and Regions

The red and yellow dots in Figure 4.2, denoting households that have a location type of MPO or city near major center, mostly line up with MPO boundaries in the first map. Notable exceptions are the large clusters of dots where the towns of Roseburg, Klamath Falls, and Ontario lie.

4.3 TIME DIMENSION OF DATA

The OHAS dataset is cross sectional in nature, and captures only the VMT demand for the day of the survey. While other datasets including the NHTS provides estimates for annual VMT by households, the OHAS dataset lacks additional information required to do so.

Seasonal variability in travel behaviors within a household was not captured. As the surveys were administered solely on weekdays, weekend travel behavior was not recorded. Discussions with ODOT and others indicate that annualizing VMT is beyond the limits of the data *(Bettinardi, personal communication, December 12, 2014)*. Therefore, daily VMT estimates were used in this research.

One of the concerns with this type of dataset is that it may not be evenly spread across days of the week. Kuhnimhof and Gringmuth *(Kuhnimhof and Gringmuth 2009)* find that day-to-day variation in travel behavior within a household makes up for most of the variation in VMT demand models. Table 4.1 shows that statewide; the OHAS data were evenly distributed across days of the week within each survey area. There was only a percentage point or two in differences between days. The largest percentage point difference was the seven percentage points between Tuesday and Friday survey numbers in Bend; however, as the total number of surveys is only 789, this is not a large difference in numbers. Overall, it seems that Fridays in general suffered from a lack of household responses. There appears to be no other systemic misdistribution of survey responses.

Table 4.1: Distribution of all survey responses by day surveyed (shown in percentages)

	Monday	Tuesday	Wednesday	Thursday	Friday	Total Number of Responses
Oregon Statewide	21%	21%	20%	19%	19%	17,166
Coast	20	20	20	20	19	1,387
Deschutes	20	23	19	20	18	1,134
East	21	21	19	19	20	1,143
Mid-Willamette Valley	20	20	21	20	20	6,071
North Central	18	24	19%	22	17	382
North Willamette Valley	22	22	20	19	18	4,268
South Central	22	17	19	20	22	501
Southern Valley	21	21	22	18	18	2,280

As previously stated, seasonal variability in travel behavior within a household was not captured. However, if the dataset were large enough and evenly distributed between seasons within survey areas, inferences could still be made regarding seasonal travel variation. Tables 4.2 and 4.3 show the number of surveys conducted by year and season, respectively, for all households.

Table 4.2: Distribution of all survey responses by year (shown in percentages)

	2009	2010	2011
Oregon Statewide	48%	17%	35%
Coast	100%	-	-
Deschutes	30%	-	70%
East	-	100%	-
Mid-Willamette Valley	72%	28%	-
North Central	100%	-	-
North Willamette Valley	1%	-	99%
South Central	90%	10%	-
Southern Valley	55%	-	45%

Table 4.3: Distribution of all survey responses by season (shown in percentages)

	Winter	Spring	Summer	Fall
Oregon Statewide	6%	43%	10%	41%
Coast	41	46	8	7
Deschutes	-	75	25	-
East	-	31	-	69
Mid-Willamette Valley	58	31	2	9
North Central	-	83	17	-
North Willamette Valley	53	44	-	3
South Central	-	80	14	6
Southern Valley	32	46	9	13

While Table 4.1 indicates that the dataset may be robust enough to show day-to-day variability in VMT, longer term seasonal or annual daily VMT analyses cannot be made. Tables 4.2 and 4.3 indicate that the OHAS was primarily conducted in years 2009 and 2011; most households responded in the spring and fall months. This was intentional as the goal was to collect data on average weekday travel behavior for travel demand models. Possible bad road conditions in the winter months could make overall travel different from other times of the year. Summer months may have been avoided if vacation travel behaviors were seen to be a departure from normal or ordinary travel decisions. Furthermore, enumerators may have been constrained by budgetary or logistical considerations from being able to conduct the OHAS in a temporally consistent manner across all survey regions. Regardless, only weak inferences can be made regarding seasonal variability of travel behaviors.

4.4 SUMMARY STATISTICS FOR OHAS DATA SET

In its original form, the OHAS dataset was a relational database consisting of ten separate files indexed by SAMPN, each household's unique identification number. These files included data on household demographics, current and past vehicle ownership, trip and route data, and additional spatial data on the household. One of the preliminary tasks was to create a dataset from the raw data. Trip and route data were used to calculate VMT by vehicle. The raw dataset included all trips by all household members during the day of the survey. In order to avoid over-counting household trips due to carpooling, only the subset of trips with drivers were evaluated. In this context, a trip was defined as going from a point of origin to a destination via a light-duty vehicle; public transit use, walking, and biking are intentionally omitted. This data was collected in feet. As a result, some small rounding errors may have occurred during the feet to mile conversion. Vehicle VMTs were summed by household to calculate household VMT variable, the primary unit of analysis. Table 4.4 provides summary statistics for daily VMT reported by the households included in the OHAS data set.

Table 4.4: Average Daily Household VMT by Region and Income Group

	Average	**$0 - $14,999**	**$15,000 - $24,999**	**$25,000 - $34,999**	**$35,000 - $49,999**	**$50,000 - $74,999**	**$75,000 - $99,999**	**$100,000 - $149,000**	**$150,000 or more**
Oregon Statewide	44.41	**25.44**	**31.03**	**34.68**	**40.25**	**43.39**	**52.27**	**54.26**	**62.84**
Coast	49.32	29.96	29.16	34.18	51.78	49.49	66.79	67.03	87.67
Deschutes	39.33	23.57	29.81	38.9	36.33	37.37	43.37	45.28	45.88
East	48.12	23.63	27.25	33.2	47.93	49.67	51.28	67.67	95.56
Mid Wil Valley	44.6	24.36	31.5	35.4	38.86	43.74	51.38	53.85	68.9
N Central	59.5	45.27	42.14	35.18	57.32	66.94	57.75	82.77	114.8
N Wil Valley	40.42	22.21	23.75	26.28	33.1	36.62	48.06	48.59	52.84
S Central	48.28	35.22	38.23	42.51	43.88	45.87	56.18	73.64	98.44
S Valley	44.89	22.47	35.01	39.91	40.86	44.31	59.93	57.2	68.71

Table 4.5 shows more detail on how those miles are distributed by region. As previously mentioned, because these are household miles traveled rather than individual's miles traveled, households with multiple drivers and vehicles may accrue large total VMT

figures: therefore, the maximum miles driven by household column contains large numbers such as 1,179 miles and 1,110 miles, for the North Willamette Valley and Deschutes, respectively. While the average daily miles driven by households in the North Central Region was 56 miles, those households make up less than 3% of the overall OHAS sample. Average daily miles driven by households in the Coast, East, North Central, and South Central regions are generally much larger than the statewide average. This is consistent with previous research suggesting that households in rural areas must travel further to access the same services compared to urban households *(ODOT 2013)*.

Table 4.5: Daily Household VMT (in Miles) by Region

	25% of all households drove no more than	50% of all households drove no more than	75% of all households drove no more than	Maximum miles driven by households	Average miles driven by households
Oregon Statewide	8	23	50	905	39
Coast	7	20	50	1,024	45
Deschutes	9	22	46	1,110	37
East	6	19	53	553	43
Mid-Willamette Valley	8	23	51	852	40
North Central	10	34	76	905	56
North Willamette Valley	8	25	48	1,179	35
South Central	8	19	49	769	44
South Valley	9	24	49	552	40

Table 4.6 contains summary statistics for the household weighted mpg ratings used in this analysis by region and income group.

Table 4.6: Average Household Weighted Fuel Efficiency by Region and Income Group

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	23.37	23.44	23.34	23.43	23.36	23.49	23.37	23.21	23.21
Coast	22.40	23.32	22.56	22.06	22.17	22.79	21.91	21.89	22.62
Deschutes	22.42	22.65	22.03	22.96	22.05	22.58	22.45	22.23	22.36
East	21.36	21.38	22.10	21.00	21.31	21.56	21.35	21.02	20.18
Mid Wil Val	23.78	23.88	24.00	24.19	23.90	23.96	23.66	23.47	22.77
N Central	21.41	21.94	21.57	21.18	21.91	21.29	21.21	21.82	19.88
N Wil Val	24.44	24.02	24.42	24.62	24.56	24.67	24.59	24.02	24.33
S Central	21.38	22.84	21.56	22.97	21.24	20.71	20.93	20.09	21.73
S Valley	23.28	23.65	23.32	23.13	23.36	23.29	23.34	23.16	22.49

The statewide average fuel efficiency for this data set is 23.37 mpg. Households in the North Willamette Valley have vehicles with the highest average fuel economy of 24.02 mpg whereas the East has the lowest average fuel economy of 21.38. Although 23.37 mpg was the average statewide household vehicle fuel economy, rural regions tended to have a higher percentage of fuel inefficient vehicles. For North Central, South Central, and Eastern Oregon, at least half of households tended to own vehicles with below average fuel economies, while a little more than a quarter owned vehicles with above average fuel efficiency. In contrast, regions with urban centers such as the North Willamette Valley, the South Valley, and Mid-Willamette Valley had much lower rates of fuel inefficient vehicles. Nearly one third of households in those areas owned above average fuel efficiency vehicles. Despite including the Bend MPO, only 22% of households in Deschutes owned above-average fuel-efficient vehicles. This may be due to that urban area's remoteness—households living in Bend MPO may still have to navigate rough roads that favor fuel inefficient vehicle types such as pickup trucks. Bend may also exhibit certain intangible effects different from the MPOs in the Willamette Valley.

Respondents to the OHAS survey selected one of the following eight annual income category ranges or declined to answer:

Group 1: $0-14,999
Group 2: $15,000-24,999

Group 3: $25,000-34,999
Group 4: $35,000-49,999
Group 5: $50,000-74,999
Group 6: $75,000-99,999
Group 7: $100,000-149,999
Group 8: >$150,000.

The median income of each range was assigned to households for this analysis except for the upper category, $150,000 or more. According to the 2011-2013 American Community Survey (ACS) from the Census Bureau, the median income of Oregon households with $150,000 or more was $201,000. Therefore, this research assumes that the OHAS data reflects census data, and assigns the 931 Oregon households that belong to this income tier a median income of $201,000.

Table 4.7 shows summary statistics by region of the mean household incomes.

Table 4.7: Mean Household Incomes, by Region

	Mean	Declined to respond
Oregon Statewide	$69,410	1,172
Coast	$59,470	58
Deschutes	$77,780	61
East	$65,350	61
Mid-Willamette Valley	$71,410	282
North Central	$64,220	14
North Willamette Valley	$84,740	303
South Central	$56,920	15
Southern Valley	$59,840	219

Consistent with literature, average incomes for rural regions lag behind urban regions (Crandall and Weber 2005). North Willamette Valley and Deschutes have the highest mean incomes, perhaps reflecting both better job opportunities as well as wages reflecting higher costs of living in Portland and Bend, respectively. The lowest mean incomes were found in South Central Oregon. Some regions have relative few households in certain categories, such as only 11 households with income over 150,000 (Income group 8) for the South Central Region as shown in Table 4.8.

Table 4.8: Household Income Category Counts by Region

	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	850	1,615	1,604	2,366	3,787	2,903	2,038	931
Coast	95	163	137	202	292	180	107	42
Deschutes	44	53	78	110	254	193	136	85
East	41	94	106	152	256	171	116	29
Mid-Wil Valley	199	451	485	780	1266	966	718	279
North Central	18	44	40	45	91	68	35	13
N Wil Valley	103	205	249	425	757	666	632	367
South Central	32	0	59	61	107	66	36	11
South Valley	132	253	220	311	433	303	165	62

The North Willamette Valley, which includes the Portland metropolitan area, and the Mid-Willamette Valley, which includes the MPOs of Albany, Bend, Corvallis, Eugene/Springfield, and Salem/Keizer, had the highest number of households reporting an income of less than $15,000. The 103 sub-$15,000 income households in North Willamette Valley may seem large when compared to other parts of the state however the population in the North Willamette Valley is large and those 103 households comprise only 3 % of households in that region that reported an income. Comparatively, the 18 sub-$15,000 income households in North Central is representative of 5.1% of that region's income reporting households, while South Central's 132 lowest income households make up 6.7% of that region's total number of income reporting households. The North Willamette Valley also had the largest number of households that earned more than $150,000, which comprised 39.4% of the state's wealthiest households.

4.5 COMPARISON OF OHAS LOCATION TYPE AND NHTS

The purpose of this section is to explain how the OHAS five tiered classification system is similar, and how it differs, from the Urban/Rural NHTS definitions. By doing so, we can compare our final results with those that would have been obtained from the NHTS categories and show how the OHAS classification system reveals more differences between regions in the state than can be seen just using the NHTS location types. These differences provide information to policymakers who can use results to better assess how policies may differentially impact households in different locations in Oregon.

Which of the five OHAS household location types, LT1-LT5, applies to a household based on their location and a five-tiered rural-urban scale based on population density. The NHTS uses a single dummy variable to distinguish between rural and urban location types based on the 2000 US Census designations.

Table 4.9 compares the OHAS location types with the NHTS urban/rural designation. To stay consistent with the most recent NHTS dataset, the 2000 US Census urban/rural definitions were applied to OHAS households. Thus, the differences between the OHAS location types and the NHTS classification schemes may be partially due to the NHTS definitions relying on older population density data while the OHAS used 2010 data to determine household location types. Using NHTS standards, 97% of OHAS LT 5 MPOs and 96% of LT4 Urban near Major City type households are "urban." Additionally, 83% of LT 2 Isolated City households are classified as "urban" by the NHTS. 97% of LT 1 Rural households coincide with the NHTS definition of a "rural" household, while 83% of LT 3 Rural near Major City households would also be classified as "rural."

Table 4.9: Statewide number of households in geospatial classification systems

Location Types	OHAS	Urban (NHTS)	Rural (NHTS)
Rural	1,574	51	1,523
Isolated City	1,636	1,365	271
Rural near Major City	2,379	406	1,973
Urban near Major City	2,004	1,895	109
MPO	7,809	7,577	232
Total HHs	15,402	11,294	4,108

4.6 SUMMARY

Summary statistics presented here show that the conventional wisdom that rural areas lag behind urban areas in household income holds true. The data also shows that the more detailed locational classification system contained in the OHAS illustrates differences even within the urban/rural categories used by the NHTS. Households in regions without urban centers tend to have a greater percentage of vehicles below average fuel economy, which may help offset a mileage-based road usage charge. The next section will seek to evaluate both of these factors in the face of a RUC by presenting results from the static model.

5.0 RESULTS

The static model as described above was used to determine the impacts of changing from a fuel tax of $.30 per gallon to three alternative RUC fee structures:

1. A 1.5 cent per mile fee applied to all vehicles.
2. A fee of 1.5 cents per mile applied to only vehicles with ≥30, ≥40 or ≥50 MPG while retaining the fuel tax for all others.
3. A fee of 1.5 cents per mile applied only to vehicles in the OHAS data set that are considered new (2009, 2010, 2011 or 2012 model year vehicles)

These three fee structure scenarios will be applied by geographic areas, starting with a statewide overview, using alternative measures of Urban/Rural, followed by an inter-regional examination (with regions specified in the previous section), and finally considering the impact of the change in fee structure in the identified individual MPOs.

5.1 FLAT RATE OF 1.5 CENTS PER MILE

In this analysis the per-mile RUC of 1.5 cents was used as it is the rate specified in SB 810. Note that if everyone drove identical vehicles, the 1.5 cents per mile RUC would produce an equivalent amount of revenue to the $.30/gallon fuel tax only if every vehicle got 20 mpg. However, since the average vehicle fleet mpg for the OHAS households that are the sample for this analysis is greater than 20 mpg, on average there will be a slight increase in revenue. Thus, in the following results most groups pay more under the 1.5 cent per mile RUC so that the impact question in most cases becomes which regions end up having their taxes go up more than others. Accordingly, the impacts reported below for individual regions and locations show how much they deviate from the statewide average household impact.

For comparison, a follow-up analysis of the impact statewide and by location type of a revenue neutral rate (one that has an average impact of zero on the households in our OHAS sample) is provided in Appendix C.

5.1.1 Impact by Geographic Region and Location

Table 5.1 disaggregates the static model results from a statewide level into the eight regional definitions specified by ODOT as relevant for this study (Coast, Deschutes, East, Mid-Willamette, North Central, North Willamette (which includes the Portland Metro area), South Central, South Willamette) and compares average household daily expenditures between households in different geospatial location types. NAs indicate that a particular geospatial category did not exist within the specified region (e.g. there were no Type 5 households in Coast); “0” values indicate that the change in daily expenditures for households in this category would not differ from the statewide average impact of 5 cents per day. In all of the following tables, numbers in black font indicate values either equal to or greater than zero; red numbers in parentheses indicate negative values. Figures in these tables have been rounded off to the nearest hundredth of a cent.

Note that the statewide results show that the average household pays 5 cents more per day with the RUC because the 1.5 cents per-mile is not a revenue neutral fee (see Appendix C for analysis of a revenue neutral fee.) What is interesting is that while some regions pay exactly the statewide average, most do not—some end up paying more and others less. Thus, just looking at the average statewide impact masks differences across regions in the state. The regional results differ from paying 5 cents less than the statewide average in daily expenditures in the South Central Region to an average of 2 cents per day more than the statewide average in the North Willamette Valley (which includes the Portland Metro).

Table 5.1: Average Daily Impact (cents) by Region and NHTS Urban/Rural Definition of a Change to a Non-Revenue Neutral 1.5 cent per mile RUC

(Deviation from Statewide Average Impact of +5 cents per day-red numbers in parentheses indicate negative values)

	Average	Urban	Rural
Oregon Statewide	$0.00	$0.00	$0.00
Coast	($0.03)	($0.04)	($0.03)
Deschutes	($0.02)	($0.02)	($0.03)
East	($0.04)	($0.03)	($0.05)
Mid Wil. Val.	$0.01	$0.01	$0.03
N. Central	($0.02)	$0.00	($0.04)
N. Wil Val.	$0.02	$0.02	$0.04
S. Central	($0.05)	($0.05)	($0.05)
S. Valley	$0.00	($0.01)	$0.02

These results are not too surprising given the OHAS data summary above that shows the North Willamette Valley (which includes Portland) has the most fuel-efficient vehicles whereas the East and the North Central have the least fuel-efficient vehicles, on average. Note that when using the NHTS urban/rural definitions to classify the OHAS households there does not appear to be a difference in the impact of the RUC as both the average NHTS urban and rural households pay about the same as the statewide average. However, rural households in the East and South Central pay 5 cents *less* per day and rural households in the North Willamette Valley pay 4 cents per day *more* than the average statewide household.

To delve into these differences, Table 5.2 shows the average daily net change in household expenditures per income as deviations from the statewide average household impact of 5 cents per day. This table presents geographic results in more detail using the five location categories and the MPO/non-MPO definitions from the OHAS data set. Table 5.2 shows that even in the North Willamette Valley that includes the Portland Metro, there is a large variation in impact depending on the location type. In particular, households in rural and isolated city locations in the north Willamette Valley are adversely impacted more than any other region with average households paying between 18 and 27 cents more per day than the statewide household average of 5 cents per day. The fact that households in this region usually have higher mpg vehicles also contributes to the impact on those households. Coastal households seem to be less affected than the state average with type LT3 (Rural near Major City) households actually paying an average 17 cents ***less*** than the statewide average household per day under the RUC.

Table 5.2: Change in Average Household Daily Expenditures (in cents) by Regions and Location Type of a Change to a Non-Revenue Neutral 1.5 cent per mile RUC

(Deviation from Statewide Average Impact of +5 cents per day -red numbers in parentheses indicate negative values)

		MPO / Non-MPO		NHTS Urban/Rural		Location Types				
	Regional Average	Non-MPO	MPO	Rural	Urban	Rural	Isol. City	Rural M.C.	City M.C.	MPO
Statewide	$0.00	($0.01)	$0.01	$0.00	$0.00	($0.02)	($0.02)	$0.01	$0.00	$0.01
Coast	($0.03)	($0.03)	NA	($0.03)	($0.04)	($0.03)	($0.03)	($0.17)	($0.02)	NA
Deschutes	($0.02)	($0.03)	($0.01)	($0.03)	($0.02)	$0.02	($0.03)	($0.04)	($0.02)	($0.02)
East	($0.04)	($0.04)	$0.00	($0.05)	($0.03)	($0.04)	($0.04)	($0.06)	($0.05)	NA
Mid Wil Val	$0.01	$0.03	$0.01	$0.03	$0.01	$0.03	$0.05	$0.03	$0.02	$0.01
N Central	($0.02)	($0.03)	NA	($0.04)	$0.00	($0.05)	$0.00	($0.13)	NA	NA
N Wil Val	$0.02	$0.04	$0.02	$0.04	$0.02	$0.27	$0.18	$0.04	$0.02	$0.02
S Central	($0.05)	($0.05)	NA	($0.05)	($0.05)	($0.07)	($0.07)	($0.06)	($0.04)	NA
S Wil Val	$0.00	$0.01	($0.01)	$0.02	($0.01)	$0.02	$0.12	$0.01	$0.00	($0.02)

5.1.2 Impact by Income and Geographic Region

To delve into whether the impacts above depend on income groups, we look at the income distributional impacts in Table 5.3 that shows the average daily net change in household expenditures per income category as a *deviation* from the statewide average household impact of 5 cents per day in cents.

Table 5.3: RUC Impact by Income Group and Region (cents per day)

(Deviation from Statewide Average Household Impact of +5 cents per day-red numbers in parentheses indicate negative values)

	Reg. Avg.	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	($0.01)	($0.01)	$0.00	($0.01)	$0.00	$0.02	$0.01	($0.01)
Coast	($0.03)	($0.02)	($0.01)	($0.03)	($0.07)	($0.01)	($0.04)	($0.05)	($0.14)
Deschutes	($0.02)	($0.04)	($0.03)	$0.00	($0.03)	($0.02)	($0.02)	($0.02)	($0.03)
East	($0.04)	($0.05)	($0.05)	($0.05)	($0.02)	($0.04)	($0.03)	($0.02)	($0.18)
Mid Wil Val	$0.01	($0.01)	$0.00	$0.01	$0.00	$0.20	$0.03	$0.02	$0.00
N Central	($0.02)	$0.05	($0.04)	($0.05)	$0.00	($0.05)	$0.00	($0.01)	($0.07)
N Wil Val	$0.02	$0.00	$0.00	$0.01	$0.01	$0.00	$0.04	$0.04	$0.04
S Central	($0.05)	$0.00	($0.03)	($0.04)	($0.02)	($0.08)	($0.03)	($0.09)	($0.23)
S Wil Val	$0.00	($0.02)	$0.01	$0.00	$0.00	$0.00	$0.03	$0.02	($0.03)

Table 5.3 results show that households in the Coast, Deschutes, East and South Central regions pay *less* than the statewide average of 5 cents more per day for all income groups. In the Coast, East, and South Central regions, the income group that ends up paying the least is the highest income group---indicating that the change to the 1.5 cent per mile RUC benefits the highest income group more than the others. For instance, the highest income group in the South Central region ends up paying $.23 less than the daily statewide average of 5 cents per day, or 18 cents less per day. However, the lowest income group in the South Central ends up paying 5 cents less than the statewide average of 5 cents per day, resulting in no change in daily household expenditures. Again the change from a fuel tax to a RUC of 1.5 cent s per mile results in the largest increases in daily expenditures for the North Willamette Valley with the average household daily expense ranging from 5 cents per day (0 deviation from the statewide average impact of 5 cents per day) for the lowest two income groups to 9 cents per day for the top three income groups.

Thus, the regions experiencing the largest impact from the change to the RUC (biggest increase in daily expense) are those located in the Willamette Valley, especially the North Willamette Valley that includes Portland. Households outside the Willamette Valley experience the smallest increase—often a decrease in daily expenditures—from the change to the RUC. To further assess the impact of the change in fee structure on the regressiveness of the fee structures, the following section presents Suits index results for each fee structure.

5.1.3 The Suits Index for a Per-Mile Charge of 1.5 Cents

The Suits Index was calculated for both the fuel tax and the RUC of 1.5 cents per-mile. As seen in Table 5.4, both the fuel tax of 30 cents per gallon and the RUC of 1.5 cents per mile are regressive overall (see statewide numbers). The main reason the RUC appears more regressive (with a Suits Index of -0.23 as compared to an Index of -0.29 for the RUC) is because the RUC of 1.5 cents per mile is not revenue neutral as it actually produces more revenue than the 30 cent per mile fuel tax for this OHAS sample. However, what is notable is that for all regions, the Suits Index is similar for both highway revenue sources. Of particular interest is that the region that experiences the greatest increase in daily household costs by the switch to a RUC (as shown above in Table 5.2), the North Willamette Valley, is the region in which both forms of revenue are the *least* regressive with a Suits Index of only about -0.06, less regressive than statewide averages for both revenue sources. This suggests that the people most impacted by the switch in fees in the North Willamette Valley are those in higher income groups. As shown in the OHAS data summary tables, this region contains 39.4% of the OHAS data set's wealthiest households statewide and those with the most fuel-efficient vehicles—as this region has the highest average fuel economy of any region in the state.

Table 5.4: Suits Index: Comparison of Fuel Tax and RUC of 1.5 cents per mile

Region	Fuel Tax Suits Index	RUC Fee Suits Index
Statewide	-0.23333	-0.29146
Coast	-0.33762	-0.34929
Deschutes	-0.20936	-0.21325
East	-0.27497	-0.28042
Mid Wil Valley	-0.22607	-0.23334
North Central	-0.30332	-0.30638
North Wil Valley	-0.06273	-0.06761
S Valley	-0.36689	-0.37391
South Central	-0.38051	-0.39802

5.2 ALTERNATIVE RUC SCENARIOS

Two alternative scenarios were considered.

1. A fee of 1.5 cents per mile applied to only vehicles with ≥30, ≥40 or ≥50 MPG while retaining the fuel tax for all others; and,

2. A fee of 1.5 cents per mile applied only to new vehicles in the OHAS data set (defined to be 2009, 2010, 2011 or 2012 model year vehicles) while retaining the fuel tax for all others.

5.2.1 Impacts by Region and Income Groups

The vehicles and households to which these alternative fee structures would apply represent a much smaller number of households than the entire OHAS data set as shown in Table 5.5.

Table 5.5: Number of Households Statewide Under Different RUC Structures

Alternative Fee Structure	# Household Statewide
Flat RUC Fee of 1.5 cents/mile	14,389
≥ 30 MPG	2,443
≥ 40 MPG	867
≥ 50 MPG	349
Model year 2009 or later	933

The following tables show the regional static model results by household income category if only vehicles that receive greater than a 30 mpg, 40 mpg, or 50 mpg fuel efficiency rating are charged the RUC of 1.5 cents per mile and the rest of the households still pay the fuel tax of 30 cents per gallon. Thus, the deviations from the statewide household average values in these tables are smaller than the original scenario where 100% of households pay the RUC. The smaller impact results are because fewer households own and operate these vehicles (as shown above in Table 5.5); household expense changes in these household subsets (those that have these specified vehicles) are spread across all households for each analysis category. Households that do not own or operate vehicles with mpg ≥ 30 would continue to pay the fuel tax and thus their expenditures would not change (Table 5.6). This is why these average impacts are smaller than those for a 1.5 cent per-mile RUC applied to all vehicles as in the previous section.

Table 5.6: Average Net Change in Household Expenditures by Region and Income Category; ≥30 MPG (cents per day)

(Deviation from Average Household Statewide Impact of +4 cents per day-red numbers in parentheses indicate negative values)

	Average	**$0 - $14,999**	**$15,000 - $24,999**	**$25,000 - $34,999**	**$35,000 - $49,999**	**$50,000 - $74,999**	**$75,000 - $99,999**	**$100,000 - $149,000**	**$150,000 or more**
Statewide	$0.00	$0.00	($0.01)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Coast	($0.01)	($0.02)	($0.03)	$0.00	($0.01)	$0.00	$0.00	$0.00	($0.03)
Deschutes	($0.02)	($0.02)	$0.00	$0.00	($0.01)	($0.01)	$0.00	($0.01)	$0.00
East	($0.01)	$0.02	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01
Mid Wil Val	$0.00	($0.02)	$0.00	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.02
N Central	$0.00	$0.01	($0.03)	($0.01)	($0.02)	($0.01)	($0.03)	($0.02)	($0.02)
N Wil Val	$0.00	($0.02)	$0.00	$0.04	$0.01	($0.01)	($0.01)	($0.01)	($0.02)
S Central	($0.01)	$0.00	$0.02	$0.00	($0.01)	($0.01)	$0.00	$0.00	$0.03
S Valley	$0.00	$0.00	$0.00	$0.00	$0.04	$0.01	($0.01)	($0.02)	($0.03)

Table 5.6 shows that overall trends between charging per-mile for 30 mpg or better fuel efficiency vehicles and the complete vehicle fleet are similar at statewide and regional levels.

Rather than charging 30 mpg or better vehicles, an alternative cut-off point could be set at 40 mpg or better. The following two tables show the average net change in household expenditures as the deviation from the average household statewide impact reported for each region and household income categories. Within the OHAS data, only 867 household had vehicles that got over the 40 mpg to which the 1.5 cent per-mile RUC would apply (Table 5.7). Zero values mean that the impact was not significantly different from the statewide household average impact.

Table 5.7: Average Net Change in Household Expenditures by Region and Income Category; ≥40 MPG (cents per day) (Deviation from Statewide Average Household Impact of 2 cents per day-red numbers in parentheses indicate negative values)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	$0.00	$0.00	$0.00	($0.01)	$0.00	$0.00	($0.01)	$0.00
Coast	($0.01)	$0.00	($0.02)	$0.00	($0.01)	($0.01)	$0.00	$0.01	($0.02)
Deschutes	($0.01)	($0.02)	($0.02)	$0.01	$0.00	$0.00	($0.01)	($0.01)	($0.02)
East	($0.01)	$0.00	$0.00	$0.00	$0.02	$0.00	$0.00	($0.02)	($0.02)
Mid Wil Val	$0.00	$0.01	$0.00	$0.00	($0.01)	$0.00	$0.00	($0.01)	$0.01
N Central	($0.01)	($0.02)	($0.02)	($0.01)	($0.01)	$0.00	($0.02)	($0.01)	($0.02)
N Wil Val	$0.00	($0.02)	$0.00	($0.01)	($0.01)	$0.00	$0.01	($0.01)	$0.00
S Central	($0.01)	($0.01)	$0.01	$0.00	($0.01)	($0.01)	$0.00	$0.01	$0.05
S Valley	$0.00	($0.01)	$0.00	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.02

Table 5.7 results display trends similar to the 30 mpg or more fuel efficiency vehicle scenario although the size of the impacts are smaller as fewer households are affected.

Finally, the RUC of 1.5 cents per mile is charged only to vehicles with fuel efficiencies of 50 mpg or better. Table 5.8 shows the average net change in household expenditures when only vehicles with 50 or more mpg ratings are assessed the RUC. Within the OHAS data, 349 households were charged the RUC. Because so few households are charged, the average values in the tables below are much smaller than those found in the previous two transition scenarios.

Table 5.8: Average Net Change in Household Expenditures by Region and Income Category; ≥50 MPG (cents per day; deviation from statewide average household impact of 1 cent per day)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Coast	$0.00	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.01	$0.00	($0.01)
Deschutes	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.00	($0.01)	($0.01)	($0.01)
East	$0.00	$0.00	$0.00	$0.00	$0.02	$0.00	$0.01	($0.01)	($0.01)
Mid Wil Val	$0.00	$0.01	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
N Central	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	$0.00	($0.01)
N Wil Val	$0.00	($0.01)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01
S Central	$0.00	$0.00	$0.00	($0.01)	$0.00	$0.00	$0.01	$0.01	$0.02
S Valley	$0.00	$0.00	$0.00	($0.01)	$0.00	$0.00	$0.00	($0.01)	$0.00

As Table 5.6 shows, it is the Coast, Deschutes, East and South Central households that experience a 1-2 cent per day lower impact from having the per-mile change applied to fuel efficient vehicles (those with mpg ≥ 30mpg) relative to the statewide average household impact. Over time as more households acquire more fuel-efficient vehicles, the impacts will become larger as more households will face the RUC of 1.5 cents per mile that will increase daily expense for vehicles with fuel economies above the statewide average.

The other approach analyzed is to charge all new vehicles the VMT fee while older vehicles remain under the current gas tax. Because the OHAS dataset was collected from 2009-2011, vehicles made in 2009 and later are considered new vehicles and are assessed the VMT fee. Table 5.9 shows the average net change in household expenditures in this scenario. Of the 14,389 households examined, only 1,322 households owned at least one vehicle made in 2009 or later. As the tables show average changes, the values are lower than previous static model tables depicting participation in a VMT fee program by all households.

Table 5.9: Average Net Change in Household Expenditures, by Region and Income Category; New Vehicles Only (cents per day)

(Deviation from statewide average household impact of 1 cent per day-red numbers in parentheses indicate negative values)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	$0.00	($0.01)	$0.00	($0.01)	($0.01)	$0.00	$0.00	$0.00
Coast	($0.01)	($0.01)	($0.01)	($0.01)	($0.02)	($0.01)	($0.01)	$0.00	($0.01)
Deschutes	($0.01)	($0.01)	($0.01)	($0.01)	$0.00	($0.01)	($0.01)	($0.01)	($0.01)
East	$0.00	($0.01)	($0.03)	($0.01)	($0.01)	($0.01)	($0.01)	$0.01	($0.01)
Mid Wil Val	($0.01)	$0.00	($0.01)	$0.00	($0.01)	($0.01)	$0.00	($0.01)	($0.01)
N Central	($0.01)	$0.02	($0.01)	($0.01)	($0.01)	$0.00	$0.00	($0.01)	($0.03)
N Wil Val	$0.00	($0.01)	$0.00	$0.00	$0.00	($0.01)	$0.00	$0.00	$0.00
S Central	($0.01)	($0.01)	$0.01	$0.00	($0.01)	$0.01	$0.03	$0.02	$0.04
S Valley	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

5.2.2 Suits Index for Alternative Scenarios

All of the alternative scenarios involve charging 1.5 cents per mile only to vehicles that are either new or are more fuel-efficient. The latter, more fuel-efficient vehicles pay less per mile under a fuel tax for driving on the highway than vehicles with only average fuel economy. Households owning those vehicles will be the most impacted by the change in highway revenue structure. The question addressed here is how these alternative RUC fee structures compare with respect to regressivity. Table 5.10 compares each of the RUC structures we have considered by looking at their Suits Index. Full Suits Index results are in Appendix B.

Table 5.10: Alternative RUC Suits Index

Fee Structure	Suits Index
$0.30 Gas Tax	-0.23333
RUC of 1.5 cent per mile for all HH	-0.29146
≥ 30 MPG	-0.25859
≥ 40 MPG	-0.14610
≥ 50 MPG	-0.13166
New Vehicles	-0.17731

Table 5.10 shows that the alternative scenarios that charge a RUC of 1.5 cents per mile only to more fuel-efficient vehicles are less regressive than charging all households and vehicles this per-mile charge. Charging the RUC only to vehicles with fuel economies of greater than 40 mpg actually is less regressive than the current situation where everyone pays the fuel tax. Similarly, charging the RUC of 1.5 cents per mile only to new vehicles and letting the rest continue to pay the fuel tax, would produce a less regressive structure than the current fuel tax (a Suits Index of -.18 as opposed to one of -.23 for the current fuel tax).

These results suggest that charging only new vehicles or more fuel-efficient vehicles a 1.5 cent per mile RUC would actually be less regressive highway revenue system than the current fuel tax in Oregon of 30 cents per gallon of fuel for light vehicles at the present time. However, this is likely to provide only a short run advantage. As noted above, these alternative scenario results reflect a very small number of vehicles. Over time as more fuel-efficient vehicles enter the vehicle fleet and vehicles that are new now make it into the used vehicle markets and are purchased by lower income households, the impacts are likely to grow larger and the regressivity is likely to increase.

Note that this entire analysis used, a RUC of 1.5 cents per mile, which is the one specified in SB 810. This is NOT a revenue neutral RUC. Appendix C illustrates the impacts of charging an approximately revenue neutral RUC.

6.0 CONCLUSIONS

The purpose of this research was to provide ODOT with up to date information on the economic impact of various RUC alternatives on the stakeholders in the state of Oregon. Of particular concern to policymakers are perceived differences that the implementation of a RUC might have on different regions of the state.

Previous work in the area was limited by the small Oregon sample of households included in the NHTS data set. The newly available OHAS data set opened the opportunity to explore the impacts on Oregon households and geographic regions with much greater precision.

A key result from this research is that there are large differences in the impact of implementing a RUC depending on geographic regions and even different location types within the standard NHTS categories of urban/rural. In the case of Oregon, it is not just the east or west of Oregon, but the impact differs considerably depending on geographic regions identified by ODOT as well as the locations classification systems for households based on population density.

Even in the North Willamette Valley that includes the Portland Metro, there is variation in impact depending on the location type. In particular, households in rural and isolated city locations in the north Willamette Valley end up paying ***more*** than the statewide average whereas the average rural households in Oregon's South Central Region would pay an average of 7 cents ***less*** than the statewide average per day with the same 1.5 cents per mile RUC. The fact that households in this region usually have higher mpg vehicles also contributes to the impact on those households.

As far as impacts on income groups, the result of a change from a fuel tax to a (non-neutral) flat RUC of 1.5 cents per mile as specified in SB 810 was found to have different results in different regions. The impact of the per-mile RUC—as well as the fuel tax—was found to be least regressive in the North Willamette Valley--the region also the most impacted by the change in fee structure. This is because this region has the greatest percentage of households with incomes greater than $150,000 and that own vehicles that, on average, have the highest fuel efficiency.

Consideration of alternative per-mile fee structures that charged households a RUC of 1.5 cents per mile only on fuel-efficient vehicles (those with ≥30, ≥40, or ≥50 mpg) resulted in less regressive impacts than a flat RUC of 1.5 cents per mile applied to all vehicles. Applying the RUC of 1.5 cents per-mile to vehicles with ≥40 or ≥50 mpg or just to new vehicles resulted in even less regressive impacts overall that were less than the current fuel tax of 30 cents per gallon. This suggests that applying a RUC to those fuel-efficient vehicles who are now paying less under the fuel tax, would actually make the entire highway revenue structure less regressive than it is today. However as explained above, this impact is not likely to persist in the long run as more new vehicles enter the fleet and vehicles become more fuel-efficient.

The analysis of a revenue neutral per-mile RUC of approximately 1.38 cents per-mile (Appendix C) shows that while the overall statewide average household would pay the same under the fuel tax and the per mile RUC, households in some urban locations may pay slightly more (less than $20/year) and households in some rural locations would pay slightly less (less than $20/year). In all cases, the impacts of the change in fee structure to a RUC of the sizes considered in this report are minimal, and, as McMullen et al (2010) argue, certainly less than the impacts caused by changes in the price of fuel.

The long run impact of changing to the RUC will depend on how households respond to the change in the price of driving that, in turn, depends on differences in the price elasticities of demand for driving in the different regions. To do this would require more in depth analysis of the different determinants of driving (and VMT) in the different geographical and locations types identified in the OHAS to better understand the factors that drive the results found here. The impacts also depend on the exact RUC charged. These are fruitful directions for future research.

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APPENDIX A

WEIGHTED AVERAGE HOUSEHOLD MPG

APPENDIX A: WEIGHTED AVERAGE HOUSEHOLD MPG

To calculate the weighted average fuel economy for a household we used combined fuel efficiency ratings for city and highway mpg (cmb_i) for each vehicle. To calculate average household fuel efficiency, households with a single vehicle were given that vehicle's combined mpg rating. Households with multiple vehicles were assigned a weighted mean of the combined mpg ratings for each driven vehicle where weights for each vehicle were the percent of household vehicle miles driven on that vehicle:

$$\boldsymbol{HHMPG = \sum_{i=1}^{HHVEH} \frac{cmb_i * vmt_i}{HHVMT}} \qquad \textbf{(A-1)}$$

cmb_i = the EPA estimated combined city/highway mileage of vehicle *i*
vmt_i = Vehicle miles travelled by vehicle *i*
$HHVMT$ = total household VMT

APPENDIX B

THE SUITS INDEX

APPENDIX B: The Suits Index

The Suits Index is a way of measuring the regressivity of a tax by comparing the changes in regressivity because of a structural change. In the RUC context, we compare the regressivity of the gas tax to the VMT fee. The Suits Index is convenient in that it provides one number to compare across multiple tax regimes.

The Suits Index is computed as:

$$\boldsymbol{S = 1 - \frac{1}{5000}\int_0^{100} T(Y)dy} \tag{B-1}$$

The area is multiplied by $\frac{1}{5000}$ to keep the Suits Index bounded by -1 and 1, since the area of the upper or lower triangle will be 5000. A value of -1 suggests a perfectly regressive tax where the lowest income group bears the entire tax burden. On the other extreme, a value of 1 suggests the highest income group bears the entire tax burden. A Suits Index equal to 0 implies we are on the 45-degree line and the burden of the tax is exactly proportional to income. Thus, we are calculating the area between the curve and the 45-degree line. Since we only have eight income groups and thus eight discrete points, the integral is approximated as:

$$\int_0^{100} T(Y)dy \approx \frac{1}{2}\sum_{i=0}^{8}\{[T(y_i) + T(y_{i-1})](y_i - y_{i-1})\} \tag{B-2}$$

Graphically it can be depicted in a similar fashion to the Gini Coefficient (see figure), where the 45-degree line represents the points where the proportion of the tax paid by each income group exactly equals the proportion of the population. Points above the 45-degree line suggest lower income groups pay more than their proportion of total income, suggesting a regressive tax.

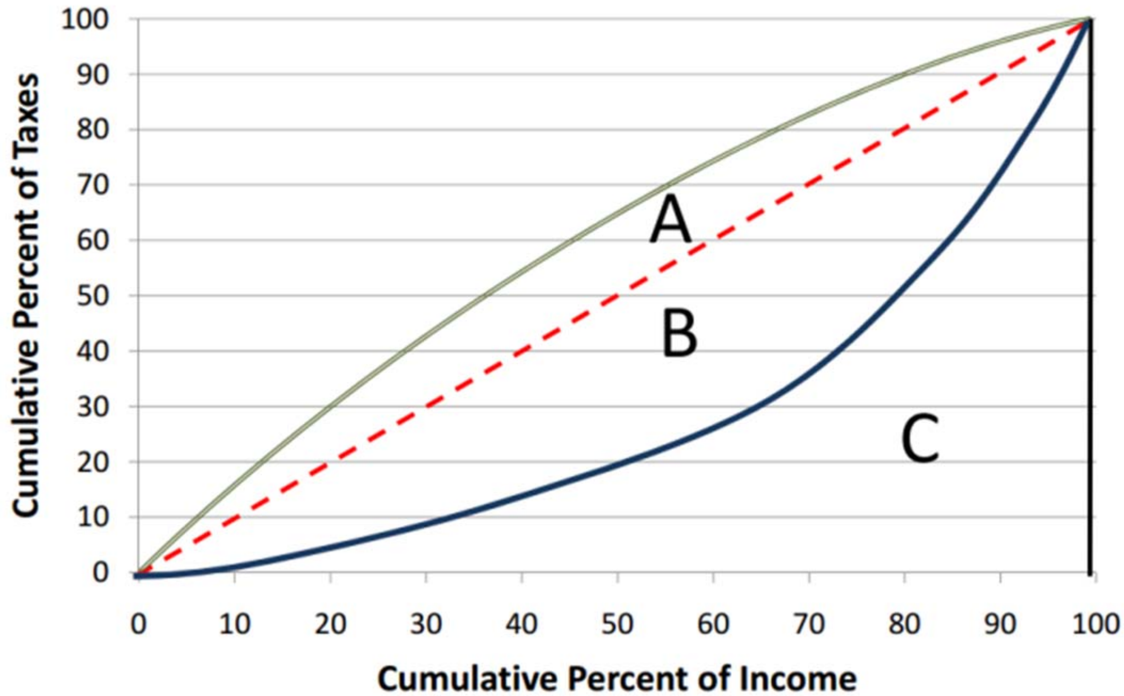


Image source: Roach, 2010

Similarly, points below the 45-degree line would suggest lower income families pay a lower proportion of a tax than their proportion of income, suggesting a progressive tax.

45° (dotted) line: S = 0
Progressive tax (blue): S = B / (B + C)
Regressive tax (olive): S = -A / (B + C)

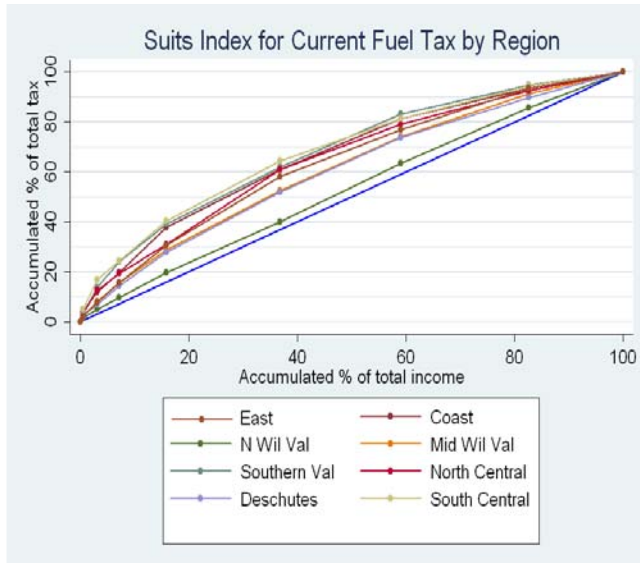
The following table puts Suits Index values into context. Index values that are larger than zero indicate progressive taxes; these include the federal income and corporate taxes, as well as the Oregon state tax system as a whole, without adjusting for federal tax offsets. Values close to zero are associated with a proportional tax, while negative index values represent regressive taxes; the Oregon fuel tax is an example of a regressive tax.

Tax Component	Suits Index	Data Source, Year
Federal Income	+0.42	CBO, 2007
Federal Social Sec.	-0.20	CBO, 2007
Federal Corporate	+0.51	CBO, 2007
Entire US Tax System	+0.06	Citizens for Tax Justice, 2009
Oregon State Tax System	+0.02* -0.02**	Institute on Taxation and Economic Policy, 2014
Oregon $0.30 Fuel Tax	-0.23	OHAS, 2011

**Without adjusting for federal tax offset; **Adjusting for federal offset*

As indicated in the table, the current fuel tax has an overall Suits Index of -0.23. This value can be broken down into individual Suits indices for the eight regions in the state.

Region:	Suits Index:
Statewide	-0.23333
Coast	-0.33762
North Wil Valley	-0.06273
Mid Wil Valley	-0.22607
S. Valley	-0.36689
North Central	-0.30332
Deschutes	-0.20936
South Central	-0.38051
East	-0.27497

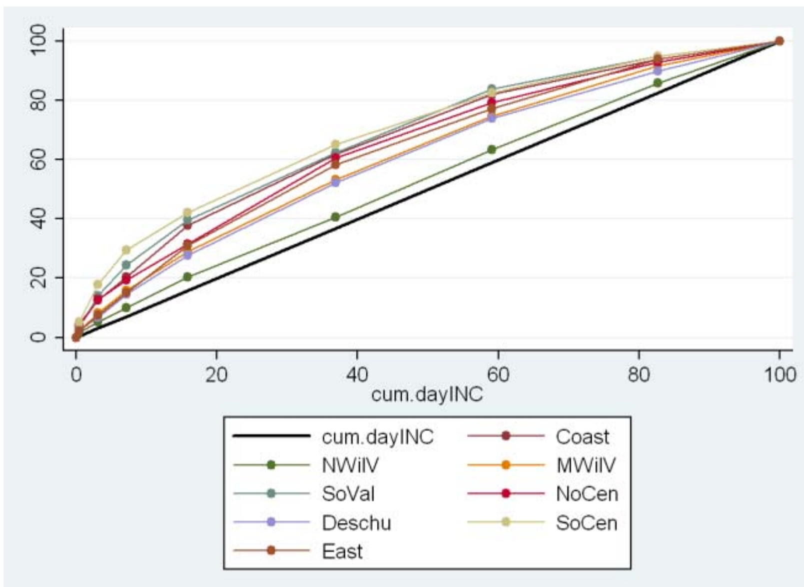


Alternative scenarios considered included charging a flat 1.5 cents per mile road use charge for all motorists, applying the road use charge to vehicles with >30, >40, and >50 mpg fuel efficiencies, and to vehicles made after 2009. The following graphs and tables illustrate the regional Suits Index score breakdowns for these additional fee structures.

Alternative Fee Structure	# Households Statewide
Flat RUC Fee	14,389
≥30 MPG	2,443
≥40 MPG	867
≥50 MPG	349
Yr 2009 or later	933

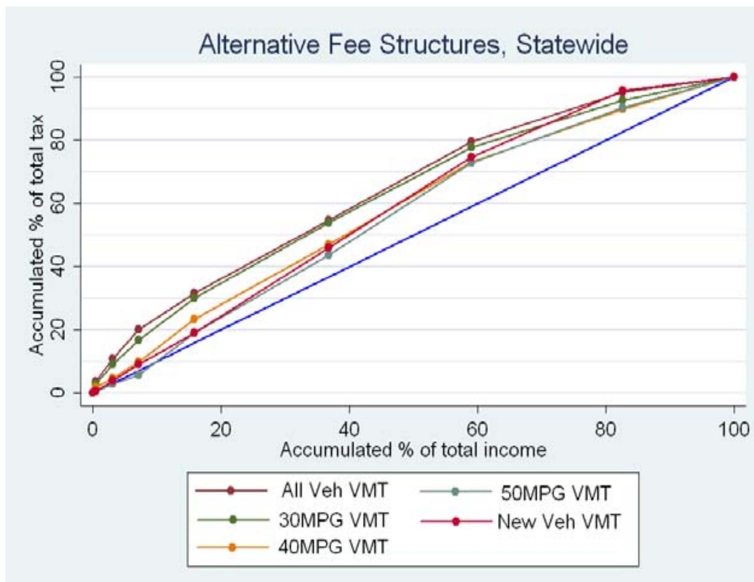
All Vehicles Assessed a 1.5 cents per mile Fee, By Regions

Region:	Suits Index:
Statewide	-0.29146
Coast	-0.34929
North Wil Valley	-0.06761
Mid Wil Valley	-0.23334
S. Valley	-0.37391
North Central	-0.30638
Deschutes	-0.21325
South Central	-0.39802
East	-0.28042



Alternative Charging Schemes, Statewide

Statewide Scenarios	Suits Index
0) RUC for all vehicles	-0.29146
1) >30 mpg vehicles	-0.25859
2) >40 mpg vehicles	-0.14610
3) >50 mpg vehicles	-0.13166
4) New vehicles	-0.17731



Recap: Statewide Suits Index with Different Fee Structures

Alternative RUC Structures' Impacts	
Fee Structure	Suits Index
$0.30 Gas Tax	-0.23333
State Baseline	-0.29146
≥30 MPG	-0.25859
≥40 MPG	-0.14610
≥50 MPG	-0.13166
New Vehicles	-0.17731

APPENDIX C

IMPACTS OF A REVENUE NEUTRAL RUC

APPENDIX C: IMPACTS OF A REVENUE NEUTRAL RUC

The original analysis reported in the main body of this document was based on the RUC of 1.5 cents per mile specified in SB 810. At the time that rate was selected, it was thought that it was approximately revenue neutral. However, revenue neutrality varies not only over time as the vehicle fleet changes, but across data sets as well. As seen in the main body of this report, the 1.5 cent per mile RUC was not revenue neutral for the OHAS sample used for this study. The additional information presented here identifies and analyzes a revenue neutral RUC rate specific to the OHAS data set to provide analysis consistent with this base policy assumption.

The revenue neutral RUC is defined here as the as the per mile charge that when applied to our OHAS sample of households, brings in revenue exactly equivalent to the revenue produced by the $0.30/gallon fuel tax. This is derived by performing the following calculation:

$$RUC = \frac{\$0.30 * Total\ Statewide\ Gallons\ Used}{Total\ Statewide\ VMT} \quad \textbf{(C-1)}$$

According to the filtered OHAS data used in this analysis (as described in Section 4 above), the total statewide gallons used was 29,462.56 and total statewide VMT was 638,949.7. Thus, the revenue neutral RUC rate is $0.01383328. It is important to note, however, that this is revenue neutral only for the average household at the statewide level using the households included in this specific OHAS data set. This RUC may not be revenue neutral for households in different regions and income groups. As seen below, it is also not revenue neutral for the alternative scenarios in which the RUC applies only to a subset of vehicles while the rest of the vehicle fleet still pays the fuel tax.

Tables C.1-C.3 present the actual daily impact in cents per household—which in the case of the revenue neutral RUC applied to the full OHAS data sample is equivalent to the deviations from the mean shown in the main report. This is because the statewide mean for the revenue neutral RUC is equal to zero so deviations from the mean are simply the daily impact minus zero.

Using NHTS Urban and Rural definitions, the following table shows the average daily household change in expenditures in shifting from the current fuel tax to the revenue neutral RUC. Since the overall statewide impact is by definition zero for a revenue neutral RUC, the results in Tables C.1-C.3 also can also be interpreted as deviations from the mean impact, which in this case is zero.

Table C. 1: Average Daily Household Impact (cents) by Region and NTHS Urban/Rural Definition of a Change to a Revenue Neutral RUC

(Red numbers in parentheses indicate negative values)

Regions	Average	Urban	Rural
Statewide	0.00	0.01	(0.03)
Coast	(0.04)	(0.03)	(0.05)
Deschutes	(0.02)	0.00	(0.04)
East	(0.04)	(0.02)	(0.07)
Mid-Wil Val	0.01	0.02	0.00
N Central	(0.04)	0.00	(0.09)
N. Wil Valley	0.03	0.03	0.01
S Central	(0.06)	(0.05)	(0.08)
S Valley	0.00	0.00	0.00

Table C.1 indicates that while the statewide average change in household expenditure is $0.00, urban households will pay slightly more, while rural households pay slightly less than they currently do. The North Willamette Valley region will pay an average of $0.03 more daily, while Mid-Willamette Valley households will on average pay an additional $0.01 daily. Other regions in the state will either pay the same as they currently do or less; the region that seems to benefit the most from a RUC is South Central, where the average household will pay an average of $0.06 less daily under the RUC and rural households in that region pay 8 cents less per day than under the current fuel tax of $.30/gallon.

The following tables break down the changes in daily household expenditure changes by regions, location types, and income groups.

Table C. 2: Change in Average Household Daily Expenditures (in cents) by Regions and Location Type from a Change to a Revenue Neutral RUC

(Red numbers in parentheses indicate negative values)

		MPO/Non		NHTS Rural/Urban		Location Types (5)				
	Reg. Avg.	Non-MPO	MPO	Rural	Urban+	Rural	Isol City	Rural MC	City MC	MPO
Statewide	0.00	(0.02)	0.02	(0.03)	0.01	(0.05)	(0.02)	(0.01)	0.00	0.02
Coast	(0.04)	(0.04)	NA	0.05	(0.03)	(0.05)	(0.03)	(0.21)	(0.01)	NA
Deschutes	(0.02)	(0.04)	(0.00)	(0.04)	$0.00	0.01	(0.05)	(0.05)	(0.01)	(0.01)
East	(0.04)	(0.05)	0.01	(0.07)	(0.02)	(0.06)	(0.03)	(0.04)	(0.03)	NA
Mid Wil Val	0.01	0.00	0.02	(0.00)	0.02	(0.03)	0.03	0.00	0.01	0.02
N Central	(0.04)	(0.04)	NA	(0.09)	0.00	(0.09)	0.01	(0.18)	NA	NA
N Wil Val	0.03	0.01	0.03	0.01	0.03	0.12	0.12	0.01	0.03	0.03
S Central	(0.06)	(0.06)	NA	(0.08)	(0.05)	(0.11)	(0.06)	(0.06)	(0.03)	NA
S Wil Val	0.00	(0.01)	0.01	$0.00	0.00	(0.02)	0.09	$0.00	0.00	$0.00

Table C.2 shows that while the statewide the average household experiences ***no*** change in daily expenditure, households in the rural location type pay an average of 5 cents ***less*** per day whereas households in MPOs would pay an average of 2 cents more per day when changing from a 30 cent per gallon fuel tax to a revenue neutral per-mile RUC of just over 1.38 cents per-mile. Note this is different from the urban/rural impacts found when using the NHTS Rural/Urban definition for which the rural households pay 3 cents less per day and urban households pay 1 cent more per day. Results also differ between regions and location types and the North Willamette Valley is the only region where the change to the RUC increases average household daily expenses for all locations—given the driving habits (VMT) and vehicle ownership patterns of households in the OHAS sample set used in this analysis.

Table C.3 shows the impact of a change to a revenue neutral RUC by income group. Statewide the average household impact is close to zero with only households in the Mid and North Willamette Valley regions paying more on average per day under the revenue neutral rate. Households in the North Willamette Valley region pay on average 3 cents more per day—or $10.95 more per year (assuming they drive the same vehicles and mileages for 365 days per year). Households in the Coast, Deschutes, East, North Central, and South Central regions pay less on average per day under a revenue neutral rate—up to $21.90 less per year on average in the South Central region (assuming 365 days per year at the daily rates shown in Table C.3).

Table C. 3: Change in Average Household Daily Expenditures (in cents) by Income Group and Region from a Change to a Revenue Neutral RUC

(Red numbers in parentheses indicate negative values)

	Reg. Avg.	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,999	$150,000 or more
Statewide	0.00	0.01	0.01	0.00	$0.00	0.00	0.01	0.00	(0.03)
Coast	(0.04)	(0.00)	0.01	(0.02)	(0.08)	(0.02)	(0.07)	(0.07)	(0.19)
Deschutes	(0.02)	(0.02)	(0.02)	0.01	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
East	(0.04)	(0.03)	(0.03)	(0.04)	(0.02)	(0.05)	(0.04)	(0.04)	(0.24)
Mid Wil Val	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.01	(0.03)
N Central	(0.04)	0.05	(0.04)	(0.04)	(0.01)	(0.08)	(0.02)	(0.06)	(0.15)
N Wil Val	0.03	0.03	0.02	0.03	0.02	0.02	0.03	0.03	0.03
S Central	(0.06)	0.01	(0.03)	(0.04)	(0.02)	(0.09)	(0.04)	(0.13)	(0.29)
S Wil Val	0.00	$0.00	0.02	$0.00	0.00	$0.00	0.01	(0.01)	(0.06)

Results for the alternate RUC scenarios are presented in the following tables. These scenarios are the same as included in the main analysis where the revenue neutral RUC is applied only to vehicles with mpg ≥30, ≥40, or ≥50 and then only to new vehicles, defined as post-2009. In these tables all other vehicles still pay the fuel tax on $.30/gallon. Thus, while the 1.38 cent per mile RUC is revenue neutral if applied to the entire OHAS dataset used in this report, since these alternate scenarios are applied to a subset of vehicles and households while all others still pay the fuel tax, this is no longer a revenue neutral impact (unless the statewide average impact is 0). Thus, the following results are presented as deviations from the mean statewide impact, which varies between scenarios.

Table C. 4:Average Net Change in Household Expenditures by Region and Income Category; ≥30 MPG (cents per day) (Deviation from Average Household Statewide Impact of +3cents per day-red numbers in parentheses indicate negative values)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.00	$0.01	$0.00	$0.01
Coast	($0.01)	($0.01)	($0.01)	($0.02)	($0.02)	$0.00	$0.01	$0.00	$0.01
Deschutes	($0.01)	($0.02)	($0.02)	($0.01)	($0.02)	$0.00	($0.01)	($0.01)	$0.01
East	($0.01)	($0.03)	($0.03)	($0.02)	$0.02	($0.01)	($0.01)	$0.01	($0.01)
Mid Wil Val	$0.01	($0.01)	($0.01)	$0.00	$0.00	$0.01	$0.01	$0.01	$0.00
N Central	$0.01	$0.02	($0.01)	($0.02)	$0.00	($0.01)	$0.02	$0.05	$0.07
N Wil Val	$0.00	($0.02)	($0.02)	$0.00	$0.00	$0.00	$0.01	$0.00	$0.01
S Central	($0.01)	$0.02	$0.00	($0.01)	($0.02)	($0.02)	$0.01	($0.02)	$0.01
S Valley	$0.00	($0.02)	($0.01)	$0.00	$0.00	$0.01	$0.02	$0.01	($0.01)

Table C. 5: Average Net Change in Household Expenditures by Region and Income Category; ≥40 MPG (cents per day) (Deviation from Statewide Average Household Impact of 1 cents per day-red numbers in parentheses indicate negative values)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	$0.00	($0.01)	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01
Coast	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.01	$0.00	$0.01	($0.01)
Deschutes	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	$0.01	$0.00	$0.00	($0.01)
East	$0.00	($0.01)	($0.01)	($0.01)	$0.03	($0.01)	($0.01)	($0.01)	($0.01)
Mid Wil Val	$0.01	$0.00	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01
N Central	$0.00	($0.01)	($0.01)	($0.01)	$0.01	$0.00	($0.01)	$0.01	($0.01)
N Wil Val	$0.01	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.01	$0.01	$0.02
S Central	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	$0.02	$0.00	$0.00

Table C. 6: Average Net Change in Household Expenditures by Region and Income Category; ≥50 MPG (cents per day; deviation from statewide average household impact of 1 cent per day)

	Average	$0 - $14,999	$15,000 - $24,999	$25,000 - $34,999	$35,000 - $49,999	$50,000 - $74,999	$75,000 - $99,999	$100,000 - $149,000	$150,000 or more
Statewide	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.00	$0.00
Coast	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	$0.00	($0.01)	$0.00	($0.01)
Deschutes	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	$0.01	($0.01)	($0.01)	($0.01)
East	$0.00	($0.01)	($0.01)	($0.01)	$0.02	($0.01)	($0.01)	($0.01)	($0.01)
Mid Wil Val	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.00	$0.00
N Central	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	$0.01	($0.01)	($0.01)
N Wil Val	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	$0.00	$0.00	$0.00	$0.01
S Central	$0.00	($0.01)	($0.01)	($0.01)	($0.01)	($0.01)	$0.02	$0.00	($0.01)
S Valley	$0.00	($0.01)	($0.01)	($0.01)	$0.00	$0.00	$0.01	($0.01)	$0.00

Table C. 7: Average Net Change in Household Expenditures, by Region and Income Category; New Vehicles Only (cents per day)

(Deviation from statewide average household impact of 0 cents per day-red numbers in parentheses indicate negative values)

	Average	**$0 - $14,999**	**$15,000 - $24,999**	**$25,000 - $34,999**	**$35,000 - $49,999**	**$50,000 - $74,999**	**$75,000 - $99,999**	**$100,000 - $149,000**	**$150,000 or more**
Statewide	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Coast	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Deschutes	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
East	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.00
Mid Wil Val	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
N Central	$0.00	$0.00	$0.01	$0.00	$0.00	$0.00	$0.00	$0.00	($0.10)
N Wil Val	$0.01	$0.00	$0.00	$0.00	$0.01	$0.00	$0.01	$0.01	$0.00
S Central	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	($0.03)	$0.00
S Valley	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.00	($0.01)

Findings in this revenue neutral analysis are consistent with and support the same conclusions drawn in the main report. In summary, a change to a RUC would have a very small impact on households in Oregon. While the overall statewide the average household would pay the same under the $.30/gallon fuel tax and the revenue neutral RUC, households in some urban locations may pay slightly more (less than $20/year) and households in some rural locations would pay slightly less (a maximum of just over $20/year less).