Transitioning From the Gasoline Tax to a Fee on Vehicle Miles Traveled

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TABLE OF CONTENTS

Appendices

EXECUTIVE SUMMARY

The transition from the gas tax to a user-fee based on miles driven has been a topic of debate for the past 30 years. A looming transportation fiscal cliff has led transportation engineers and many policy-makers alike to believe that, compared to taxing on gasoline consumption, charging drivers per mile using a vehicle-miles-traveled (VMT) fee would be the more sustainable way to the generate funds needed to retrofit our transportation infrastructure. The VMT fee is also known as a per-mile charge or road usage charge. New vehicle designs are more fuel-efficient and public transit ridership is increasing, leading to less gas consumed. Inflation has also eroded the purchasing power of the fuel tax, which is priced per gallon instead of per dollar. As these trends continue to create a dent in gas revenue, the vehicle-miles-traveled fee has been proposed as a way to mitigate revenue loss.

Previous research has focused on introducing a nationwide VMT fee to replace the current federal gas tax. Though a number of reports have revealed the technical and fiscal feasibility of using a mileage-based fee, few studies have examined the idea of implementing a VMT program in California. As such, this report synthesizes academic research and survey data and specifically analyzes the implementation of a VMT program in California.

Our key findings are as follows:

- We calculate that a 2.1 cents per mile VMT fee would raise enough revenue to cover the current gasoline tax.

- The fleet of California cars is rapidly changing. Our calculations show that, as old cars phase out of service and new cars become more fuel-efficient, the VMT fee will generate more income compared to the fuel tax. As fuel economy improves, a VMT fee set at the rate equivalent to today's gasoline tax could raise $3.65 billion to $5.7 billion more than the current gasoline tax.

- The public response to a VMT fee can be divided into four points: (1) The public prioritizes education and healthcare funding over transportation funding. (2) There is a lack of understanding of what a VMT fee is and how it might be implemented. (3) Individuals who are younger and those with less education are more concerned with the VMT costs. Males show the least concern. (4) Drivers have a higher preference for less invasive technology that does not track location.

- Implementation should consider these three factors: (1) the state must ensure that the public fully understands the problem with the current funding structure, (2) the choices by which the state or private companies collect VMT fees must be sensible and easily understood by the public, and (3) privacy concerns must be addressed, costs of implementation fully estimated, and mileage charge rates known and distributed.

TABLES AND FIGURES

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California Foundation for Commerce and Education

The California Foundation for Commerce and Education is a nonprofit (501(c)(3)) organization that serves as a "think tank" for the California business community. The Foundation is dedicated to preserving and strengthening the California business climate and private enterprise through accurate, impartial and objective research and analysis of public policy issues of interest to the California business and public policy communities. Affiliated with the California Chamber of Commerce, the Foundation is strictly non-partisan and takes no positions on pending legislation, ballot measures or other policy proposals.

INTRODUCTION

Road conditions in California are among the worst in the nation.[1] Despite being home to the highest gas tax in the country, the Golden State has experienced shrinking and unsteady funding sources for its transportation infrastructure. Within the state, 34 percent of major roads are in poor condition and 29 percent of bridges are deemed as operationally deficient.

Decrepit roads in California cost motorists $703 a year – this amounts to $17 billion statewide. In addition, traffic congestion in the state continues to grow. The state's network of roads, highways, and public transit lines provide the essential connections needed for the state economy to grow. Without further investment, the state's highways will continue to be overburdened with traffic congestion. The Texas Transportation Institute estimates that the cost of lost time and productivity caused by urban congestion ranges from $100 billion to $120 billion annually.[2]

California's transportation system is also facing a funding crisis because unstable sources fund the state's road infrastructure and operations. Fuel taxes generate most of the finances used for the construction, operation, and maintenance of the transportation infrastructure. However, the fuel tax is not linked to inflation and the revenue it generates is volatile to technological and social trends. The Bipartisan Policy Center (BPC) issued a report stating that there will be further federal funds cuts for state transportation projects.[3] The report also refers to California's reliance on federal funding as a major portion of its transportation budget.[4] As transportation revenue dwindles due to these trends, it is imperative that California legislatures consider implementing new sources of funding or increase the fees associated with current sources. As seen in Figure 1, these trends along with rising fuel prices have led to an overall decrease in fuel consumption and thus less fuel tax revenue.

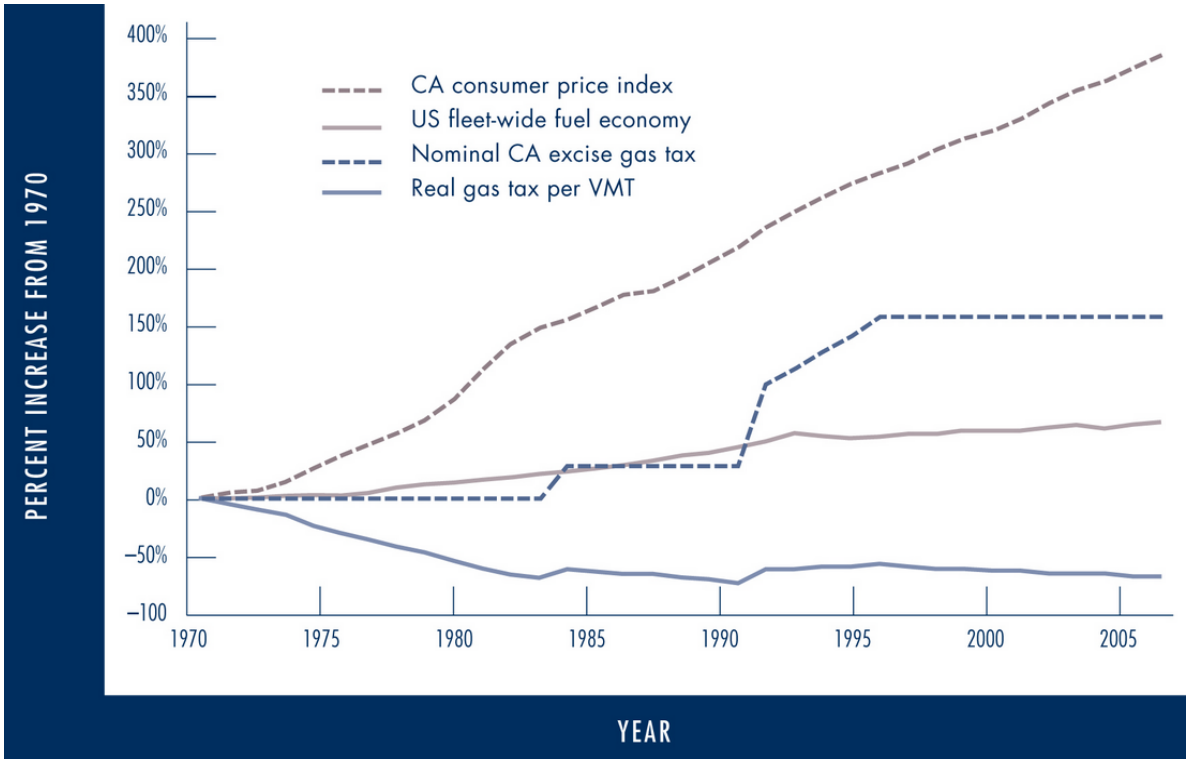
1 TRIP. (2009). Los Angeles news release. Retrieved on October 12, 2013 from http://www.tripnet.org/docs/Los_Angeles_PR_121709.pdf

2 O'Toole, Randal. (2012). Ending congestion by refinancing highways, Cato Institute. Retrieved on April 15th, 2014 from http://object.cato.org/sites/cato.org/files/pubs/pdf/PA695.pdf

3 Bipartisan Policy Center. (2012). The consequences of reduced federal transportation investment. Retrieved on October 12, 2013 from http://bipartisanpolicy.org/sites/default/files/BPC-Eno%20Transportation%20Report.pdf

4 Becker, T. A., Sidhu, I., & Tenderich, B. (2009). Electric vehicles in the United States: a new model with forecasts. to 2030. Center for Entrepreneurship and Technology, University of California, Berkeley. Retrieved from http://www.www.odpowiedzialnybiznes.pl/public/files/CET_Technical%20Brief_EconomicModel2030.pdf

Figure 1.
Real vs. Nominal Value of California Gas Tax since 1970



Source: Sorensen, P. (2009). Moving Los Angeles. http://www.uctc.net/access/35/access35_Moving_Los_Angeles.shtml

BACKGROUND & POLITICAL CONTEXT

Traditionally, stable funding for transportation infrastructure was due to small increases in the fuel tax. However, this method is no longer feasible because such increases must be much greater now to compensate for the improved fuel-efficiency of newer car models. Table 1 below shows a timeline of fuel taxes increases by the state and federal governments since its inception, and shows that in the last 25 years, the state fuel tax has only increased once. This is largely because state law requires every tax increase to achieve approval by a supermajority of the state legislature or approval by California voters. In general, the state legislature understands that California is home to the highest taxes in the country, and thus is reluctant to increase the gas tax as it often leads to complaints from constituents.[5]

Table 1.
A Historical Overview of the Fuel Tax in California[6]

1923	State imposes first gas excise tax of 2¢ a gallon.
1927	Tax rises 1¢ a gallon to pay for new road construction.
1932	1¢ federal gas tax is created.
1947	State raises tax to 4.5¢ a gallon.
1971	State imposes sales tax on gas to generate revenue for the general fund.
1983	Legislatures increase excise tax to 9¢ per gallon;
1983	Federal gas tax increases from 4 cents to 9¢.
1990	Federal gas tax rises to 14.1¢.
1990	Voters support Proposition 111, increasing the excise tax to 14¢
1993	Federal gas tax increases to 18.4¢ per gallon
2002	Sales tax moves out of general fund into transportation
2010	Sales tax on gasoline reduced, and excise tax set at 36¢ per gallon [1]
2013	Excise tax increase of 3.5¢ per gallon [1]
2014	Excise tax decrease of 3.5¢ per gallon

[1] Increases in 2010 and 2013 offset the elimination of the sales tax so there were no net increases for fuel consumers.

According to the California Business, Transportation, and Housing Agency, repaving failing roads would cost nearly $500 billion.[7] Increasing the fuel tax has been the traditional method of funding road repairs. However, such tax increases are infrequent and do not keep up with inflation.[8]

Two factors have led to problems in the current funding system: declining tax revenue and a dependence on voter-approved or legislative measures. Other factors such as Proposition 26 and the excise and sales tax structure are contextual matters unique to California.

5 Crabbe, A. E., Hiatt, R., Poliwka, S. D., & Wachs, M. (2005). Local transportation sales taxes: California's experiment in transportation finance. Public Budgeting & Finance, 25(3), 91-121.

6 Richards, G. (2013). State gas tax rises 3.5 cents Monday, giving California the highest in the nation. Mercury News. Retrieved on December 10 from http://www.mercurynews.com/traffic/ci_23563585/state-gas-tax-rises-3-5-cents-monday

7 Wachs, M. (2009). Financing transportation infrastructure in California. Rand Corporation. Retrieved on October 12, 2013 from http://www.rand.org/content/dam/rand/pubs/testimonies/2009/RAND_CT322.pdf

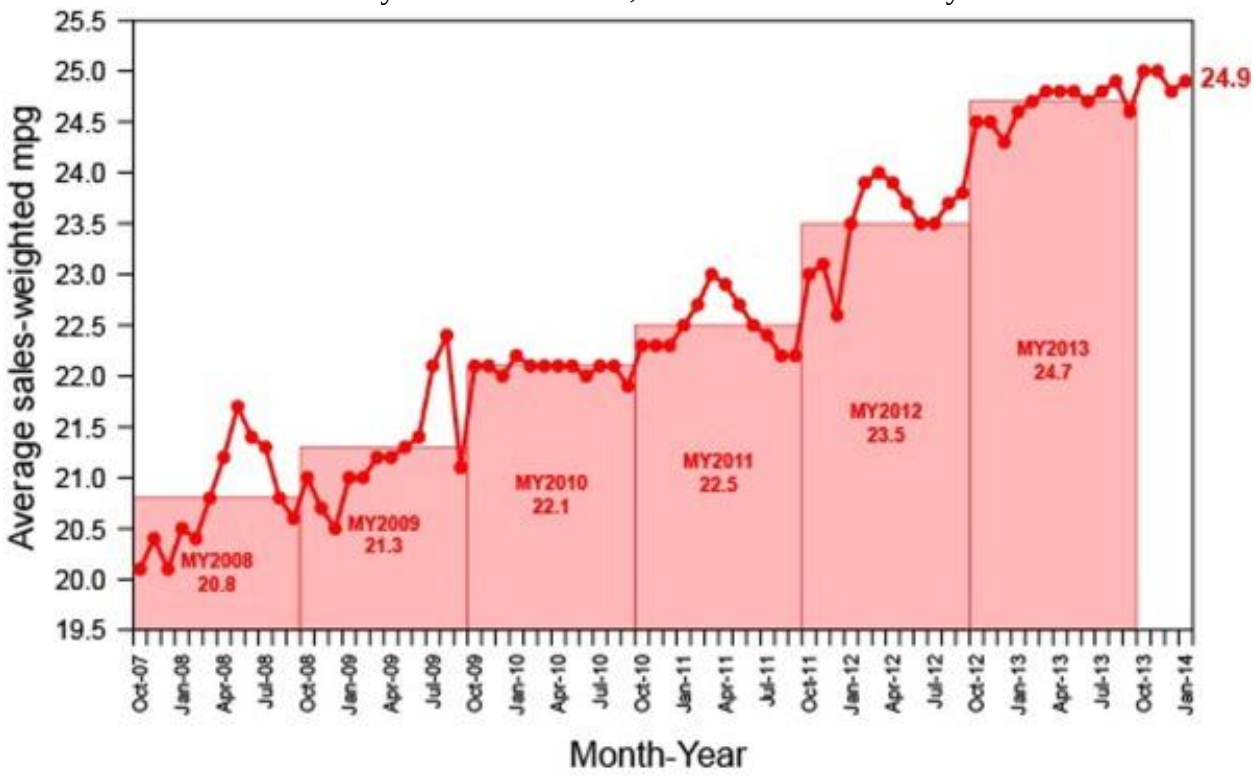
8 Ibid.

Shrinking Tax Revenue

California transportation funding has declined significantly over the last 50 years.[9] From 2006 to 2012, gas sales in the state fell from 15.9 to 14.6 billion gallons - which led to a $157 million shortfall in revenue.[10] Today's vehicles are exceedingly more fuel-efficient than those of the past, and this increase in fuel efficiency has stifled overall fuel consumption.[11] In fact, the Toyota Prius boasts a combined fuel economy of 50 miles per gallon (MPG).[12] A report released by the U.S. Energy Information Administration in April 2014 projects a decrease in energy consumption among light duty vehicles (See Appendix A). Further, the Obama administration has instituted fuel economy standards that will require new vehicles to run at 35.5 MPG by 2016.[13] Figure 2 below illustrates how fuel-efficiency is improving year-by-year.

Figure 2.

Fuel Economy for New Vehicles, October 2007 to January 2014



Source: Edmunds.com; http://www.edmunds.com/car-news/new-car-average-fuel-economy-reaches-24-9-mpg.html

The result is less gas sales, thus less fuel tax revenue. Compared to the past two decades, fuel

9 California Transportation Plan. (n.d.) Transportation revenues and expenditures. California Department of Transportation. Retrieved on November 14, 2013 from http://www.dot.ca.gov/hq/tpp/offices/osp/ctp2025_files/ctp07.pdf

10 Richards, op. cit. 5

11 Illinois State Transportation Plan. (2012). Transportation funding report. Retrieved on October 12, 2013 from http://www.illinoistransportationplan.org/pdfs/transportation_funding_090512_web.pdf

12 U.S. Department of Energy (2013). "2013 Most and Least Efficient Vehicles." Retrieved on October 12, 2013 from http://www.fueleconomy.gov/feg/best-worst.shtml

13 The White House (2009). President Obama announces national fuel efficiency policy. Retrieved on April 13, 2014 from http://www.whitehouse.gov/the-press-office/president-obama-announces-national-fuel-efficiency-policy

taxes today produce less than half as much compared to real revenue per mile driven.[14,15] Fuel efficiency will likely increase to 54 miles per gallon by 2025, and total fuel tax revenues would likewise decline as a result.[16] Therefore, the current funding mechanism based on fuel tax revenue will not generate stable revenue to maintain California's transportation infrastructure.

Voter Dependent Funding

Transportation planning is inherently a long-term endeavor; yet current transportation funding streams are unpredictable because its sources are entangled in politics. The gasoline tax is based on cents per gallon but is not adjusted periodically by inflation factors.[17] New transportation dollars are currently generated on a "pay-as-you-go" system that has been sustained continually through new legislation. This method is not reliable because it is doubtful that legislatures and voters alike support tax increases, especially during a time of recession.

Proposition 26

In 2010, California voters approved of Proposition 26. The ballot measure, which legally defined the definition of a tax versus a user fee, may create an opportunity for public agencies to charge fees without approval by voters, under the conditions that A) the individual paying fee directly benefits from the services or infrastructure provided by the fee, and B) the fee is reasonable. In this case, Proposition 26 may facilitate shifting the burden of paying for certain public services from general taxpayers to the users and beneficiaries of those services. In the context of introducing a VMT fee, the proposition may clarify the ability makes it easier to impose a road usage fee with only approval by the legislature.[18]

Sales Tax & Excise Tax

California is unique in that the state collects both an excise tax and a sales tax from gasoline sales. The total of these two taxes comes out to 49.9 cents per gallon, the highest of any state. These two taxes function similarly in that they provide funding to California's transportation system. Because both of these taxes depend on gasoline consumption, eliminating and replacing both would increase funding sustainability. However, our analysis dissects the total fuel tax into these two sub-taxes for the sake of analyzing alternatives that involve eliminating only one of taxes.

14 Poole, R. (2013). Tolling California's interstates. Reason Foundation. Retrieved on October 9, 2013 from http://reason.org/news/show/tolling-californias-interstates

15 California Transportation Plan, op. cit. 9

16 Poole, op. cit.14

17 Crabbe et al., op. cit. 5

18 League of California Cit.ies. (2011). Proposition 26: implementation guide. Retrieved on October 12, 2013 from http://www.cacit.ies.org/UploadedFiles/LeagueInternet/76/76adbe58-ba68-4aac-95a8-94ebcba43425.pdf

ALTERNATIVE FUNDING SOURCES

Inflation has eroded the value of the gas tax. That along with advancements in fuel efficiency and rising oil prices will lead to lower gas consumption and revenue generated from fuel taxes. Government-funded studies have cited concerns about the long-term durability of the gas tax and have recommended transitioning to a VMT-based funding system. However, before deciding to focus our study on a VMT fee, we examined several alternatives for generating revenue for transportation expenses including toll roads, vehicle registration fees, fuel taxes, and VMT fees. Table 2 below states our analysis of the different options.

Table 2.
Funding Sources and Pros and Cons

ALTERNATIVE	PROS	CONS
Toll Roads	• Voluntary participation • Reduced congestion	• Cannot be implemented statewide • Revenue based on usage
Vehicle Registration Fees	• Can be implemented statewide • Convenient collection • Low administration costs	• Fees are infrequently collected, which creates "sticker shock"
Fuel Tax	• Convenient collection method • Status quo • Low administration costs	• Has not kept up with inflation • Does not account for increasing fuel economy • Politically challenging
VMT Fee	• Accounts for increasing fuel economy • Will generate more revenue in the long-run • Can be implemented statewide	• Uncertainty in collection method • High administration costs • Privacy concerns • Public resistance to new tax

Source: Authors' Analysis

Toll Roads

Toll roads, also known as turnpikes or toll ways, charge a fee to drive on an alternative route based on the value of time saved from using that specific road. The fees collected are then used to cover road construction and maintenance expenses. Toll roads and bridges are prevalent in California; in northern California, payments are required for five major bridges and I-680 Express Lanes; Orange County is home to the SR-73, SR-241, SR-261, SR-133, and SR-91; Los

Angeles County has the I-10 and I-110 retrofitted to incorporate Metro Express Lanes.[19] Participation in toll roads is voluntarily so market forces often determine how much the toll should be priced.[20] When used in tandem with congestion pricing, toll roads are a desirable way to reduce congestion.[21] However, several driver advocacy groups oppose the idea and label the tolls as an additional tax levied by government.[22] In addition, because tolls are not mandatory, the revenue produced is dependent on whether or not the drivers choose to use the toll road. Another drawback to toll roads is that the effects of toll roads are localized and cannot be scaled to the state level.

Vehicle Registration Fee

State governments annually impose vehicle registration fees, typically through the Department of Motor Vehicles.[23] In California, examples of registration fees include vehicle license fees, weight fees, special plate fees, county/district fees and owner responsibility fees.[24] These fees constitute a small part of the transportation revenue source.[25] The advantages of registration fees include convenience in collection and statewide implementation. Since the state is already charging these fees, raising the vehicle registration fee would be simple and cost-effective. There are no hidden administration costs, as drivers would continue to be billed via mail. The caveat, however, is that the fee is collected once a year – so a large increase in the fee amount would signal a "sticker shock" to drivers who expect the fee to be much lower.

Fuel Tax

A fuel tax or gasoline tax charges a flat fee on a per gallon basis. For more than 50 years, fuel taxes in California have been the main source of revenue for transportation related projects. [26] Conventionally, the fuel tax is the easiest way to create revenue for transportation projects because the tax is collected as drivers purchase gas.[27] However, as mentioned earlier, improvements in the fuel economy of newer cars threatens the long-term viability of the gas tax.[28] In addition, the gas tax is not growing fast enough to keep up with inflation.[29] Highway construction costs in 2006 was ten times the amount compared to 1956, while in the same period the combined federal and average state tax for all states increased at around half that rate, from 8.4 cents to 47 cents per gallon[30].

19 FasTrak. Other California toll roads and bridge. Retrieved on April 13, 2014 from http://fastrak.511sd.com/san-diego-toll-roads/other-california-toll-roads-and-bridges-map

20 Joint Leadership Group of Coalition for Public Transportation. Possible revenue sources for public transit: toll roads. Retrieved on April 15, 2014 from http://www.valleyregionaltransit.org/Portals/0/CoalitionForPT/March06/factsheettollroads.pdf

21 Ibid.

22 Joint Leadership Group of Coalition for Public Transportation, op. cit.20

23 Vehicle Registration (2012). Retrieved on April 13, 2014 from http://dictionary.sensagent.com/vehicle%20registration/en-en/

24 California Department of Motor Vehicles (2011). Vehicle registration and title information. Retrieved on April 13, 2014 from http://www.dmv.ca.gov/vr/vr_info.html

25 California Department of Transportation. (2014). Transportation funding in California. Retrieved on April 12, 2014 from http://www.dot.ca.gov/hq/tpp/offices/eab/fundchrt_files/Transportation_Funding_in_CA_2014.pdf

26 California Department of Transportation (2007). California transportation plan 2025. Retrieved on April 12, 2014 from: http://www.dot.ca.gov/hq/tpp/offices/osp/ctp2025_files/ctp07.pdf

27 Dawid, I. (2014). Transportation chair endorses mileage fee -- why is that bad. Retrieved on April 6, 2014 from http://www.planetizen.com/node/67269

28 Spiller, E. B., & Stephens, H. M. (2012). The heterogeneous effects of gasoline taxes: Why where we live matters. Retrieved from: http://www.rff.org/RFF/Documents/RFF-DP-12-30.pdf

29 Crabbe et al., op. cit. 17

30 O'Toole, op. cit. 2

VMT Fee

A vehicle miles traveled (VMT) fee charges drivers for each mile they drive. It is one of the more sensible alternatives because it is directly associated with road use rather than the demand for gasoline. In 2007, the state of Oregon conducted a vehicle miles traveled fee pilot project and found that implementing such a policy is feasible.[31] Two years later the National Surface Transportation Infrastructure Financing Commission issued a recommendation for a VMT fee to replace the fuel tax in order to stabilize transportation funding. Estimates from studies have also shown that a VMT fee has the potential to generate more revenue than the gas tax. However, those advocating for privacy rights fear that the system will lead to unnecessary surveillance. Because an effective VMT program would require tracking devices to be placed in cars, some are concerned about the types of data collected and how long the data are kept. In addition, a VMT program presents some complications regarding which miles are tracked, including concerns about travel occurring out-of-state and on private roads.

31 Oregon Department of Transportation (2007). Oregon's mileage fee concept and road user fee pilot program. Retrieved on February 15, 2014 from http://www.oregon.gov/ODOT/HWY/RUFPP/docs/rufpp_finalreport.pdf

APPROACH

Our approach takes into consideration past recommendations to switch to a VMT fee and further analyzes its applicability and implementation, specifically in the state of California. We consider three main issues regarding the transition: revenue generation, public response, and implementation.

Research Questions

After analyzing different funding alternatives, we found that charging users per mile in the form of a VMT fee is the most viable funding option to implement on a statewide level. Toll roads would generate money to support road infrastructure, but the effects are scaled to a local level. An increase in vehicle registration fees can be applied on a statewide level. However, since the fee is only charged once per year, the fee will likely be extremely high, which prompts public concern about over-taxation. We decided to focus our research on the fiscal and political feasibility of the VMT fee, and invoke the following research questions:

1. At what level would a VMT fee need to be set to cover the current 48.5 cent per mile state gas tax, which consists of a 39.5 cent excise tax and an 9 cent sales tax?
2. How much revenue would be generated by incremental increases in the gas tax and VMT fee?
3. What are the equity concerns and public responses regarding a VMT fee?
4. What are the steps to implementing a VMT fee in California? What are the challenges?

Our research uses quantitative and qualitative methods. To answer our first question, we calculate how much the VMT fee would have to be to cover the gas tax. Because we want to compare the current tax on fuel with an equivalent VMT fee, we use a simple formula to convert between the two forms of taxation. The formula takes the gas tax and divides it by the vehicle's number of miles per gallon (MPG) - the number of miles traveled with one gallon of gas - to get a charge per mile that is equivalent to what would have been generated by the fuel tax.

$$\frac{Gas\ Tax/Gallon}{Miles\ per\ Gallon/Gallon} = \frac{Gax\ Tax}{Miles} = VMT\ fee$$

For the second question, we project the revenue generated from different price options for both the gas tax and the equivalent VMT fee. We propose six price options with the status quo as the first option, as seen in Table 3. The remaining five options reflect incremental increases in the VMT fee. Using option A, the status quo, as a baseline, the subsequent options characterize increases of 20, 40, 60, 80, and 100 percent. For each VMT fee option, we calculate the equivalent gas tax option using a conversion rate of 23.5 miles per gallon - the average MPG of a vehicle in the United States in 2012.

Table 3.
Price Options for VMT Fee and Equivalent California State Fuel Tax

Option	VMT fee (cents)	Fuel Tax (cents)	Change compared to Option A (%)
A	2.1	48.5	0
B	2.5	59.2	20
C	2.9	69.1	40
D	3.4	78.9	60
E	3.8	88.8	80
F	4.2	98.7	100

Source: Authors' proposal

The revenue generated from the gas tax and VMT fee result from the following formulas:

*Gas Tax * Gallons of Gas Consumed = Gas Tax Revenue*

*VMT Fee * Number of Miles Driven = VMT Revenue*

The status quo number of gallons of gas consumed derives from data in 2013.[32] As the price of the gas tax and equivalent VMT fee increases incrementally with each option, we expect the demand for driving to decrease slightly. A previous study[33] found that the elasticity of the price of gasoline to be - 0.22. In other words, a 1 percent increase in price would lead to a 0.22 percent decrease in demand for gas, suggesting that gas consumption is relatively inelastic. We use this same elasticity in our calculations and find that a 20, 40, 60, 80, and 100 percent increase in the gas tax would lead to a 1.4, 2.8, 4.2, 5.6, and 7.0 percent decrease in gas consumption respectively. A table with detailed calculations of gas consumptions and miles driven is located in Appendix B.

Under status quo conditions, we expect the gas tax and VMT fee to be revenue neutral. In other words, because fuel efficiency is assumed to be the same for both funding alternatives, the revenue generated from the gas tax should be roughly equal to what would be produced under the VMT fee. However, as seen in Figure 3 below, the number of electric and hybrid vehicles is expected to increase in the next few decades.[34] To account for future trends, we then use sensitivity analyses to observe how much revenue would be generated if we increased the

32 California Board of Equalization. (2013). Net taxable gasoline gallons. Retrieved on April 9 from http://www.boe.ca.gov/sptaxprog/reports/MVF_10_Year_Report.pdf.

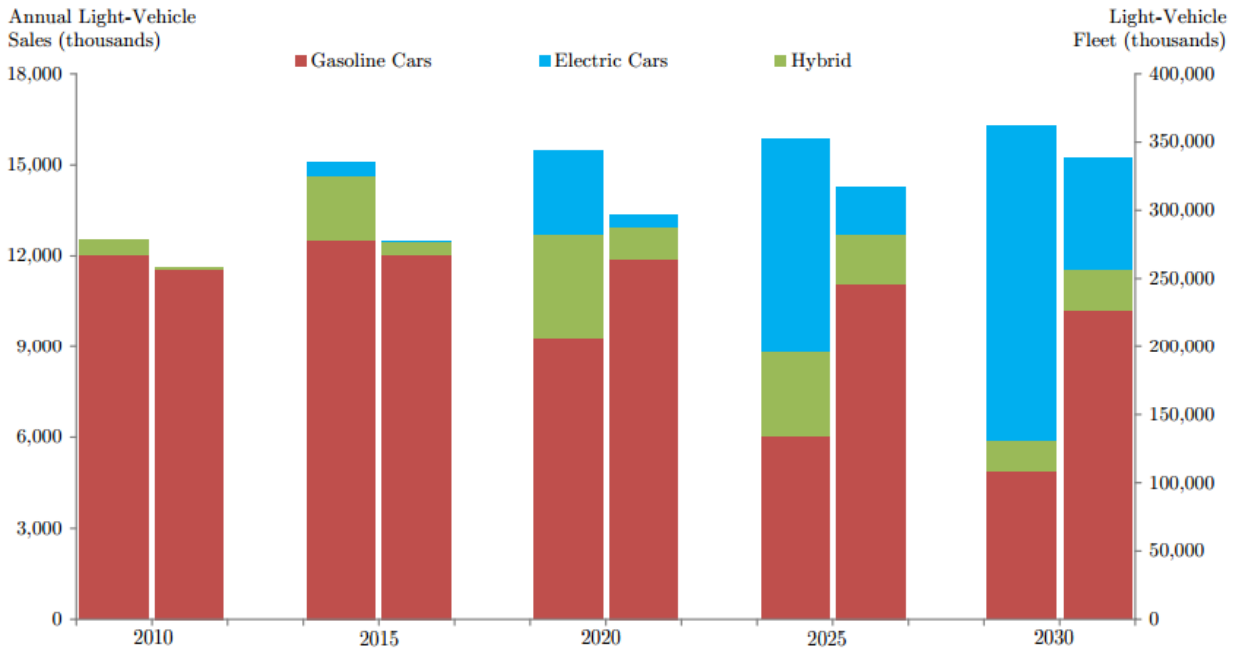
33 Gillingham, K. (2013). Identifying the elasticity of driving: evidence from a gasoline price shock in California. Regional Science and Urban Economics. Retrieved on April 15th, 2014 from http://www.yale.edu/gillingham/Gillingham_IdentifyingElasticityDriving.pdf

34 Becker et al., op. cit. 4

average fuel efficiency to 26 and 35.5 MPG while keeping number of miles travelled constant.[35]

For the third question, our methodology consisted of literature reviews and interviews with Professor Genevieve Guiliano and Michelle Godfrey.[36] Surveys for public responses in various states are used to illustrate potential reactions, public perceptions and preferences in California.

Figure 3.
Sales Forecast for Gasoline, Electric and Hybrid Vehicles



Source: Becker, T. A., Sidhu, I., & Tenderich, B. (2009). Electric vehicles in the United States: a new model with forecasts to 2030. *Center for Entrepreneurship and Technology, University of California, Berkeley*, (2009.1).

The methodology used to answer our fourth and final research question regarding implementation consisted of a meta-analysis of gathering both quantitative and qualitative data related to administering a VMT fee. A logic model, for which implementing a VMT fee would follow, provided a framework for answering this question. Using this model, we posited the expected impact of a VMT fee on equity and individual driving behavior. In addition, we analyzed the assumed and potential costs of administering a new transportation funding system. Two critical resources include the evaluation report for Oregon's pilot program and interviews with Oregon Department of Transportation personnel who were familiar with the execution of the program.

Assumptions and Limitations

The authors of this report acknowledge certain assumptions and limitations to the analysis presented. Estimating future revenue and predicting public response require certain assumptions - and those assumptions come with limitations. To calculate revenue from an increased gas tax,

35 The White House, op. cit. 13

36 Genevieve Guiliano is a transportation planning professor at the University of Southern California. Michelle Godfrey is the ODOT Office of Innovative Partnerships & Alternative Funding Public Information Officer and manages the public outreach effort for Oregon's Road Usage Charge Program.

we use a single elasticity value among many others that were available when, in reality, elasticities can shift according to a wide array of trip types, socio-economic statuses, travel conditions, and time periods.[37]

Assumptions about price elasticity

Price elasticity of demand measures how the willingness to purchase a product, in this case gasoline, changes because of price shifts. In calculating the revenue of our different options in Finding 2, we chose a single elasticity value of -0.22. This value, taken from a report that looked at the demand for gasoline specifically at California, represents the medium-term elasticity for new vehicles. Our analysis does not take into consideration the possible short-run and long-run elasticities. Our literature review finds that the demand for gas becomes more elastic over time, with short-run elasticities ranging from -0.10 to -0.16 in the short-run and -0.26 to -0.31 in the long run.[38] Although the elasticity value affects our revenue outcomes, the variability does not undermine our conclusion that the VMT fee is a more stable funding mechanism.

Assumptions about the status quo

In our revenue model, we assume 48.5 cents to account for the total price of the fuel tax and 23.5 miles per gallon as the average vehicle fuel efficiency in 2012. These numbers represent the status quo gas tax and national average fuel efficiency for the year 2013. However, by the time our research was complete, the excise tax had decreased by 3.5 cents from 39.5 to 36 cents. The fuel efficiency of new vehicles had also improved to 24.9 miles per gallon. As gas taxes changes or as fuel economy improves, our calculated outcomes for the first two research questions would shift. Table 4 below summarizes the status quo assumptions used in our quantitative analysis.

Table 4.
Status Quo Assumptions

Total California State Gas in 2013	48.5 cents per gallon
• Sales Tax on Gas	• 9 cents
• Excise Tax on Gas	• 39.5 cents*
Average Miles per Gallon in 2012	23.5 miles per gallon

*on July 1, 2014 the California Excise Tax on Gasoline will be reduced to 36 cents per gallon
Source: California Energy Commission. (2014). http://energyalmanac.ca.gov/gasoline/

Assumptions about survey data

All of the reports on the public perception of VMT fees surveyed drivers outside of California. Thus, our report utilizes survey data are from other states including Oregon, Texas and Nevada to infer public response in California. These inferences are prone to inaccuracies due to regional, demographic, and economic differences among the different states. For example, California has one of the highest state income taxes whereas Texas has no state income tax, so the overall consumer response to a VMT fee could be drastically different in both states. This presents huge limitations in our analysis of public perception.

37 Litman, T. (2013). Understanding transport demands and elasticities. How prices and other factors affect travel behavior.(Victoria Transport Policy Institute: Litman). Retrieved on November 22, 2013 from http://www. vtpi. org/elasticit.ies. pdf

38 Austin, D., (2008). Effects of gasoline prices on driving behavior and vehicle markets. Congressional Budget Office Report 2883, Washington, DC. Retrieved on April 15, 2014 from https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/88xx/doc8893/01-14-gasolineprices.pdf

RESULTS

Our main findings are as follows:

Finding 1: Under status quo conditions, the VMT Fee would need to be priced at 2.1 cents per mile to offset the loss in revenue after eliminating the state excise and sales tax all together. In 2013, the revenue from the gasoline tax (excluding diesel gas) amounted to $7,037,629,042[39]. Assuming the number of miles driven remains constant, a tax of 2.1 cents per mile will generate enough revenue to offset the loss in gas tax revenue.

Finding 2: As vehicles become more fuel efficient, a road-usage that charges per mile would provide a more sustainable source of revenue compared to the current tax on fuel.

Finding 3: The public response to a per-mile charge can be divided into four points: (1) The public prioritizes education and healthcare funding over transportation funding. (2) There is a lack of understanding of what a VMT fee is and how it is to be implemented. (3) Individuals who are younger and those with less education are more concerned with the VMT costs. Males show the least concern. (4) Drivers prefer less invasive technology that does not track location.

- Finding 4: There are three primary components that should be considered when implementing road usage charge: (1) the state must ensure that the public fully understands the problem with the current funding structure, (2) the choices by which the state or private companies collect VMT fees must be sensible and easily understood by the public, and (3) privacy concerns must be addressed, costs of implementation fully estimated, and mileage charge rates known and distributed.

Finding 1

The VMT should be priced 2.1 cents per mile to cover the current fuel tax of 48.5 cents per gallon. Of the total 2.1 cents per mile of fuel tax, 1.7 cents covers the excise tax and 0.4 cents covers the sales tax. This is based on a fuel efficiency of 23.5 miles per gallon[40] and assumes that there are no changes in the number miles driven when switching to a VMT funding stream. In this scenario, cars that operate at a fuel efficiency of over 23.5 MPG would be paying more than what is necessary to break even while cars operating at less than 23.5 MPG would be underpaying.

The breakeven point will differ for each vehicle depending on its fuel efficiency, measured in miles per gallon. Table 2 shows the different VMT price points needed cover the loss in both fuel and excise taxes. As with any price change, there are winners and losers. Choosing a single price point would be beneficial for those below a certain miles per gallon while disadvantageous for those above it. For example, if a fleet of cars traveled at a fuel efficiency of 15 MPG, to cover

39 For 14,498,502,840 gallons of taxable fuel

40 2010 Average MPG according to the United States Department of Transportation. Retrieved from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html

the California fuel sales tax of 9 cents those vehicles must pay 0.6 cents per mile. For another fleet of vehicles operating at 30 MPG, the price per mile would be 0.3 cents. If these two fleets operated on the same roads under a sales VMT fee of 0.4 cents, the cars travelling at 15 MPG would be underpaying by 0.2 cents per mile while those travelling at 30 MPG would be overpaying by 0.1 cents per mile. Motorists driving at 20 MPG would be indifferent to the VMT fee because they are paying an amount similar to what they would be paying under the gasoline excise and sales taxes.

Our findings iterate the fact that a VMT fee would be a greater burden for fuel-efficient vehicles, compared to the current tax framework based on gallons purchased. One solution to this discrepancy is to tier the VMT fee according to the individual fuel economy of each car, with more fuel-efficient vehicles paying a lower fee. Although this would decrease the amount of revenue collected from the VMT fee, it would also encourage people to choose fuel-efficient vehicles over gas-guzzlers. Another way to mitigate this disparity is to charge a VMT fee for fuel efficient vehicles while continuing to charge a fuel tax on inefficient vehicles. While this hybrid approach to charging vehicles based on fuel economy will generate the most revenue, there are complications concerning how such a strategy would be implemented.

Table 5.
Gas Tax and VMT Fee by Vehicle Fuel Efficiency

fuel economy *miles per gal*	**sales tax** *cents per mile*	**excise tax** *cents per mile*	**total fuel tax** *cents per mile*
15	0.6	2.7	3.2
20	0.4	2.0	2.4
25	0.3	1.6	1.9
30	0.3	1.3	1.6
35	0.2	1.1	1.4
40	0.2	1.0	1.2

Source: Author's Calculations

Finding 2

We examined six options, previously shown in Table 3, to find out the effect of incremental rate increases on the VMT fee and gasoline tax. We then conduct two sensitivity analyses to test how our outcomes would change in respect to an increase in fuel efficiency. All options use a fixed amount of 14,498,502,840 gallons of gasoline consumed. The first scenario in Figure 4 uses the current fuel efficiency of 23.5 MPG, which serves as the baseline fuel economy. The second and third scenarios in Figure 5 and 6 estimate a higher fuel economy of 26 and 35.5 MPG respectively. We chose our 26 MPG projections to model a small increase from the baseline and chose 35.5 MPG to model a larger increase. In addition, federal benchmarks set forth by the Obama administration require all new vehicles in 2016 to run at 35.5 MPG. Comparing the trend

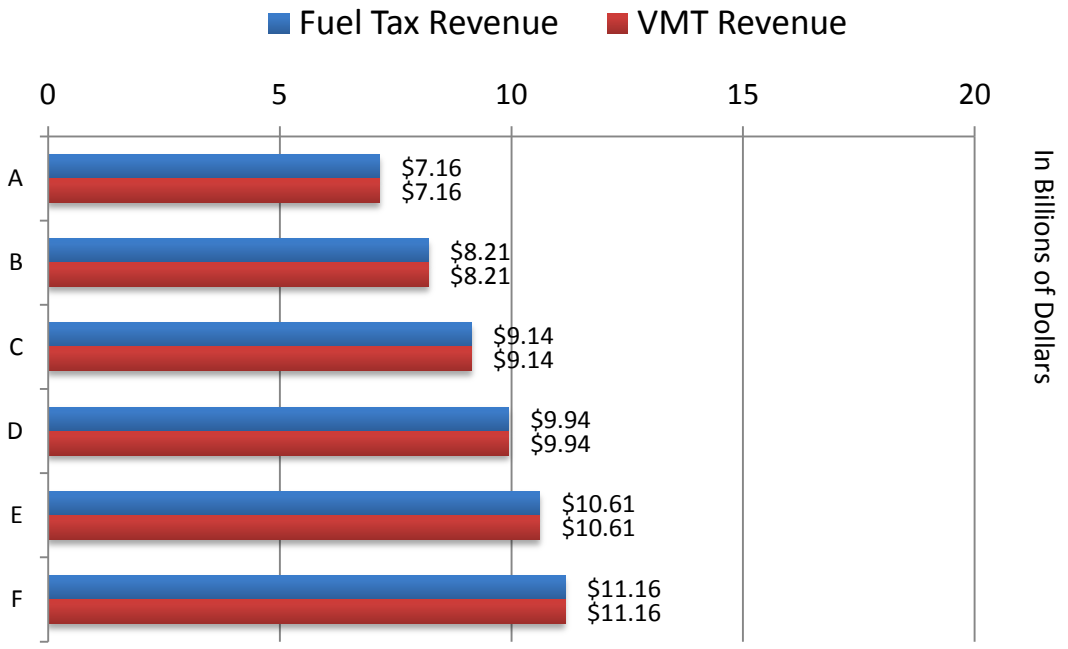
from Figure 4 to Figure 6, it is evident that as the overall fuel-efficiency of vehicles improves, the gas tax will bring in less and less revenue compared to the VMT fee. The shortcoming of the gasoline tax grows as the tax increases incrementally.

Figure 4 illustrates the revenue generated from our six options in terms of a gas tax and its equivalent VMT fee. The revenues shown represent a baseline amount that would be generated by both funding mechanisms. In all cases, the income generated will be nearly identical regardless of whether we are taxing fuel consumed or miles driven. We calculate that under the status quo fuel economy, switching from the gas tax to a VMT charge will be revenue-neutral.

Figure 5 models an overall increase in vehicle fuel efficiency of 2.5 miles per gallon. It conveys the same options but assumes that the average MPG is 26 instead of 23.5. The gap between the revenue produced by the VMT fee versus the fuel tax indicates the loss in revenue due to increased fuel economy. We calculate that VMT fees would raise an addition $760 million in annual revenue under option A. Under option F, which is priced twice as much as option A, we find that the VMT fee will raise $1.19 billion more than the gas tax.

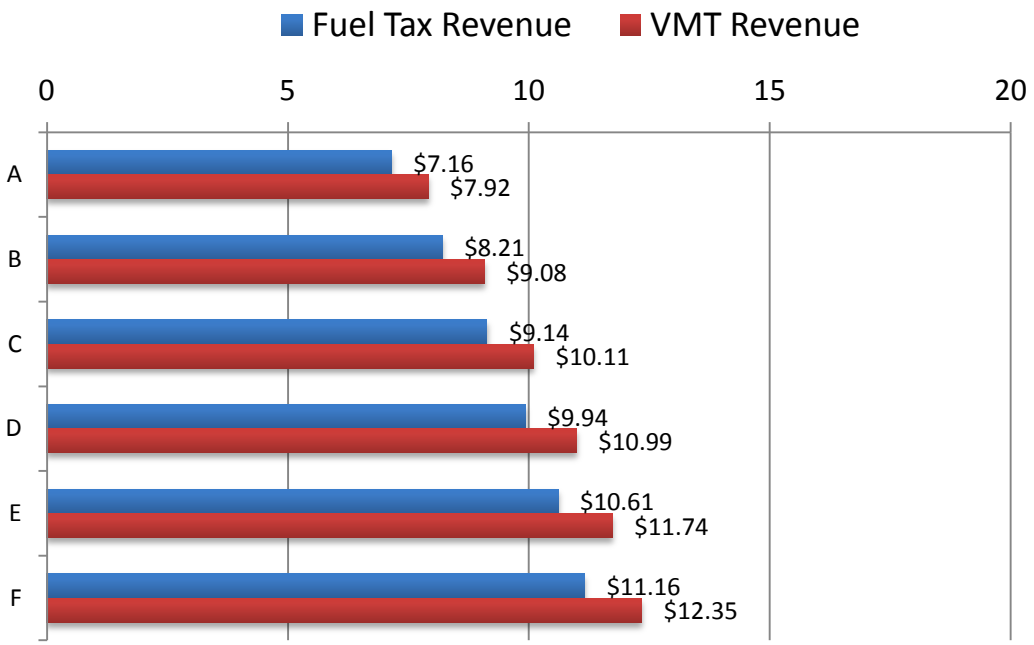
Figure 6 uses the standard of 35.5 MPG set out by the Obama administration as the benchmark MPG of new vehicle in 2016. This represents a 51 percent increase in fuel efficiency compared to the average fuel economy of 2012. We calculate that, as the fuel and VMT taxes increase with each option from A to F, the shortcoming of the fuel tax grows larger. Under option A, the difference between fuel tax and VMT revenue comes out to $3.65 billion whereas under option F, the gap between the two taxes grows to $5.7 billion.

Figure 4.
VMT and Fuel Tax Revenue, Average Fuel Efficiency 23.5 MPG



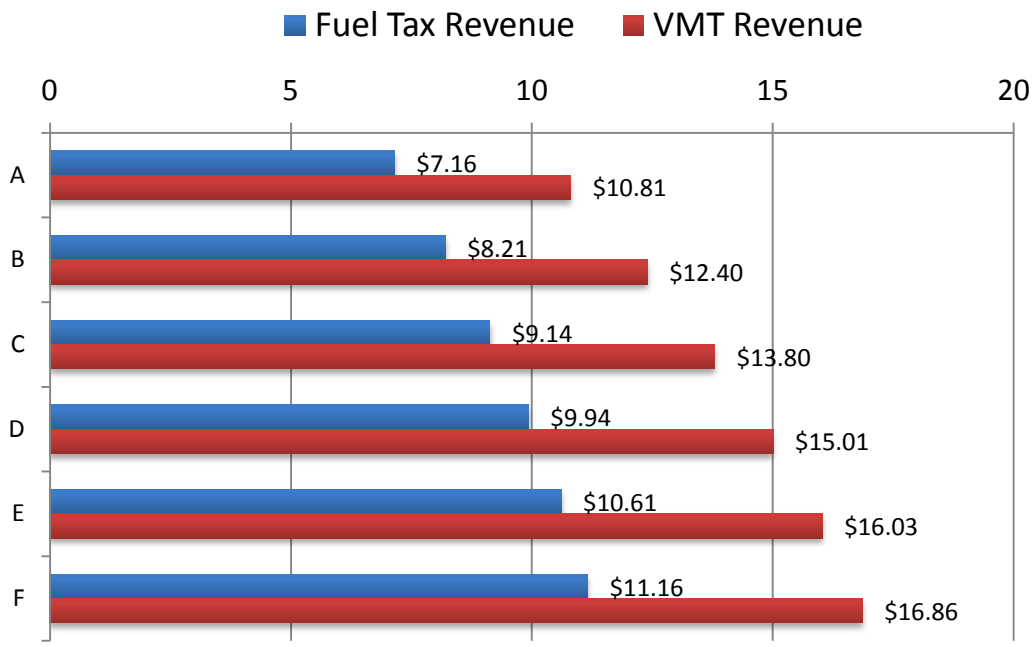
Source: Authors' Calculations

Figure 5.
VMT and Fuel Tax Revenue, Average Fuel Efficiency 26 MPG



Source: Authors' Calculations

Figure 6.
VMT and Fuel Tax Revenue, Average Fuel Efficiency 35.5 MPG



Source: Authors' Calculations

Finding 3

The main concerns of implementing a VMT boils down to four topics: the priority of other issues that are perceived more important than transportation funding, an understanding of the VMT funding structure, perceptions of cost will differ depending on age, sex, education, and familiarity with a VMT fee, and the invasiveness of technology used. We believe those findings may provide valuable information on predicting how drivers in California would react to new VMT fee.

Priority of Transportation Funding

Measuring the public perception to transportation funding as a whole could be a good predictor of how the public views a VMT fee. A long-standing public perception is that funding shortage in transportation is not a priority compared to the need for greater spending on healthcare and education.[41] Table 1 shows that of hybrid drivers, 64 percent are very concerned about the current funding allocated to education and 68 percent of them are similarly concerned about healthcare funding, Only 37 percent consider the shortage in transportation funding a pressing issue.[42] Although the level of concern for future transportation funding is slightly higher than for current funding, unease about education and healthcare funding is still much higher.

Table 6.
Survey of Funding Concern, by Car Type

41 The Dieringer Research Group (2009). Mileage-based user fee public opinion study-summary report phase III. Retrieved on February 15, 2014 from http://www.dot.state.mn.us/mileagebaseduserfee/pdf/09mbufphase3finalrpt.pdf

42 Ibid.

% Very concerned	Total base=734	Hybrid base=104	Non-hybrid base =714
Current Funding			
Education	54%	64%	55%
Healthcare	52%	68%	52%
Transportation	25%	37%	25%
Future Funding			
Education	57%	63%	57%
Healthcare	61%	66%	61%
Transportation	34%	43%	34%

Source: The Dieringer Research Group. (2009)
http://www.dot.state.mn.us/mileagebaseduserfee/pdf/09mbufphase3finalrpt.pdf

Understanding of VMT fees

We find that the public is prone to misperceptions and misinformation about the VMT tax. One misperception is that the VMT fee would be charged along with the gasoline tax, suggesting the idea of double taxation.[43] Although the VMT fee could hypothetically be levied in addition to the current fuel tax, we assume that the public would be more accepting of the fee if it replaced the gas tax. As seen in Table 7, 69 percent of drivers believe that the VMT fee will augment the fuel tax.[44] One possible reason for this misperception is the lack of clear knowledge of structure of the fuel tax, as people generally do not know the differences between the frameworks of the current gasoline tax versus a VMT user fee.[45] By educating the public on the matter, incomplete or biased knowledge of VMT could be mediated.[46]

Table 7.
Survey of VMT Understanding

Main Ideas Gathered	Total base=734	Support VMT base=170	Oppose VMT base=255
New funding solutions	69%	69%	67%
Funding shortfall	13%	18%	9%
Less gas is being used	7%	12%	5%
Raising/New taxes	5%	2%	10%
Underlying causes of a need for a solution	2%	4%	2%

43 RAND corporation (2009). Implementing strategies for shifting to direct usage-based charges for transportation funding. Retrieved on February 15, 2014 from http://www.rand.org/pubs/reprints/RP1395.html

44 The Dieringer Research Group. op. cit. 41

45 Nordland, A (2013). Public Perceptions and Preferences towards a VMT Fee 1 System in Nevada. Retrieved on April 06, 2014 from http://docs.trb.org/prp/13-2215.pdf

46 Oregon Department of Transportation. op. cit. 31

Source: The Dieringer Research Group. (2009).
http://www.dot.state.mn.us/mileagebaseduserfee/pdf/09mbufphase3finalrpt.pdf

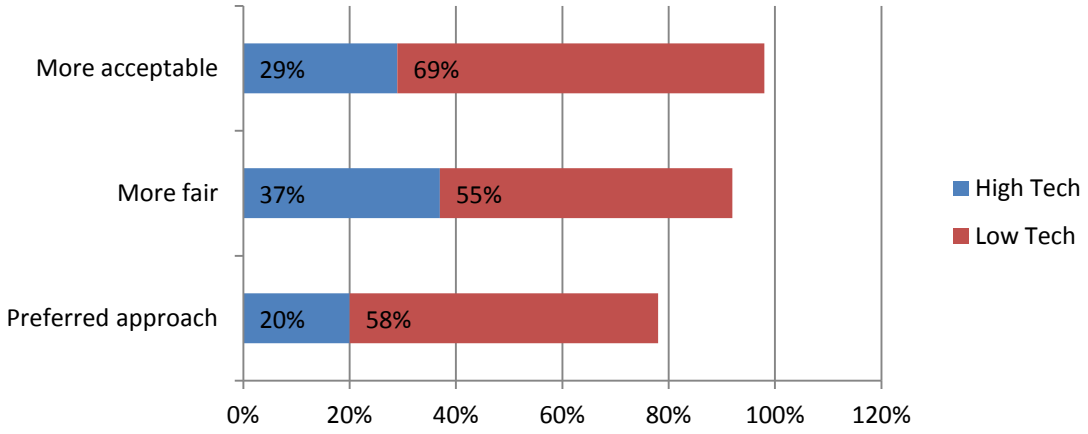
Costs Consideration

The costs of implementation are important to consider because if the costs are perceived as too high, public support of switching to a VMT funding structure will be stifled. A VMT fee study conducted in Nevada concluded that those without a bachelor's degree and younger responders are ambivalent about a VMT fee.[47] The survey also found that male population is the least worried. Overall, cost concerns of a VMT funding structure are correlated with the political will to implement such a system.[48]

Technology Preference

There is a trade-off between privacy and the sophistication of technology applied in a VMT program. Equipment used in a VMT program can be simplified to being either low technology or high technology. Low technology refers to a system where people report their odometer readings on a yearly basis, with the tax rate varying according to the size and type of vehicle.[49] High technology systems require drivers to install a Global Positioning System (GPS) device to record real-time travel along with mileage.[50] The rate charged may vary for more factors, such as time of travelling, road type and size or weight of the vehicle.[51] Figure 7 shows the results of a survey conducted in Minnesota: 69 percent of responders view low technology devices as a more acceptable option; and 55 percent believe that the use of low technology is more fair, and 58 percent explicitly express a higher preference for low technology.[52]

Figure 7.
Survey Results of Technology Preference



Source: The Dieringer Research Group. (2009).
http://www.dot.state.mn.us/mileagebaseduserfee/pdf/09mbufphase3finalrpt.pdf

47 Nordland, op. cit. 45

48 Norland, op. cit. 45

49 The Dieringer Research Group. op. cit. 41

50 The Dieringer Research Group. op. cit. 41

51 The Dieringer Research Group. op. cit. 41

52 The Dieringer Research Group. op. cit. 41

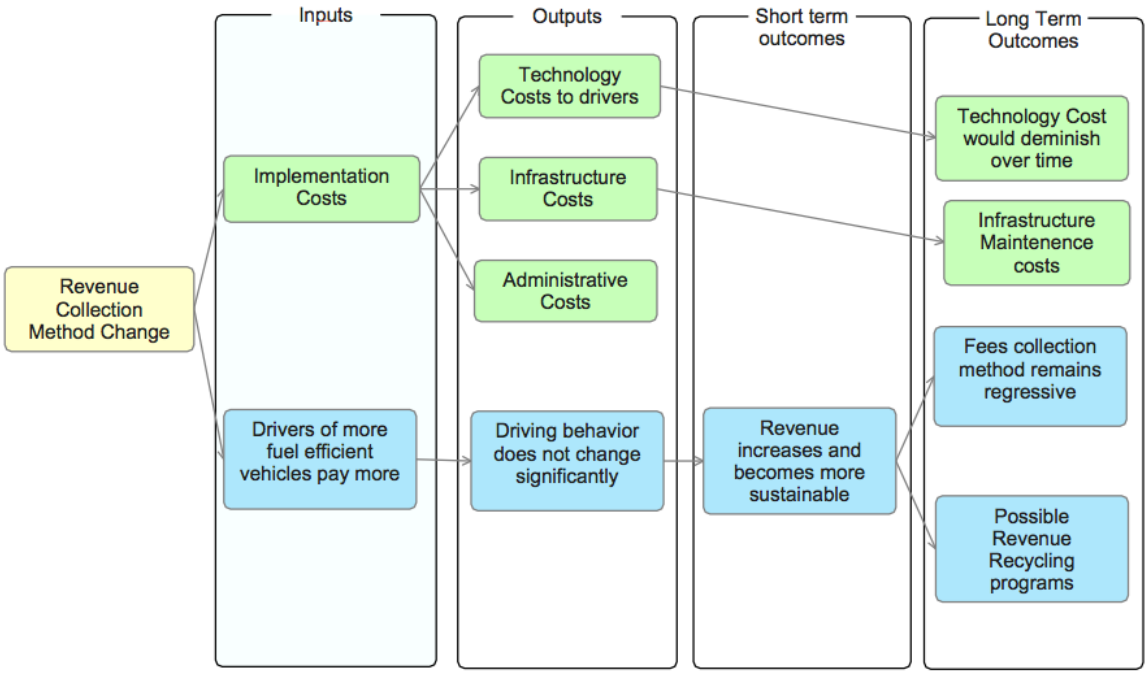
Finding 4

Our research finds that implementation of a VMT program is multifaceted and complex. Due to the uncertainty regarding the type of technology used and the political will to pay per mile, the actual steps will vary. However, several studies have distilled the process to executing a VMT funding system into the following topics: Technology, Transparency, and Equity. We use a logic model as a framework of explaining these topics.

Logic Model

The first step to understanding the implementation of a VMT funding system was to map the logic of the implementation into a model that could be dissected for further evaluation. The Logic Model in Figure 8 illustrates the steps in which implementation should follow. The key to a successful implementation, as demonstrated above, is transparency in the process. Ways to enhance the transparency include publishing information regarding the anticipated technology costs, infrastructure costs, administrative costs, and disclosing how these costs may change over time. Transparency should also extend to how a new funding mechanism would change revenue and how it would affect equity. Legislators may also consider ways to address the changes in equity by instituting revenue-recycling programs.

Figure 8.
Logic Model



Source: Authors' Proposal

Tracking systems can be seen as invasive, thus, offering a number of options to track miles traveled may reduce the opposition to the program regarding privacy concerns. A number of methods[53] can ease implementation of the program:

1. Odometer reading only: Requiring drivers to report mileage based on an odometer reading during various times (monthly, bimonthly, annually, or etc.) and charging them based on the number of miles changed from the previous reporting. There are however, more certified methods that California has implemented where vehicles are required to check for SMOG. These stations could be used as mileage verification as well.

2. Simple monitoring devices: A device that would track miles only, but would be installed in the vehicle so that reporting could be made without human inspection. This would require the device to be electronically connected to the government agency or billing agency but is more limited in privacy compared to other mechanisms.

3. Cellular locating device: A device that would use cellular towers to locate the drivers location based on jurisdiction. This would allow agencies to exclude charges for driving out-of-state or on private property.

4. GPS device: A device that would allow for tracking precise locations and indicate a specific route of travel. This device would possibly cause the most concern to privacy.

5. Smartphone Application: This may be a cheaper alternative for drivers who have the phone technology. They would simply download the application and this would report the mileage and any data that would also be provided by the GPS device. Most smart phones are already tracking this data[54]; therefore, the privacy issue may be avoided.

Possible steps for implementation would include ways to address all or most concerns with a new funding mechanism. Some possible methods include[55]:

1. Engage Stakeholders: The first step to a successful implementation is ensuring that all stakeholders are accounted and implementers understand the supporters and opposition. This would include groups like the Department of Transportation, auto clubs, business leaders, civil liberty advocates, and etc.

2. Collaborate with privacy advocates: Because privacy is a significant hurdle to the success of this new funding mechanism, implementers may consider cooperating with privacy groups who would be most concerned with civil liberties. This collaboration would help alleviate potential opposition from the public over the violation of privacy.

3. Start with odometer reading and/or give drivers a choice on technology: Odometer

53 Sorensen, P., Ecola, L., & Wachs, M. (2012). *Mileage-Based User Fees for Transportation Funding*. Rand Corporation

54 Jaffe, E. (2014) Your in-car navigation system is already watching you. The Atlantic. Retrieved on April 28, 2014 from http://www.theatlanticcities.com/commute/2014/01/your-car-navigation-system-already-watching-you/8045/

55 Sorensen et al., op. cit. 53

reading is the least intrusive collection method concerning privacy, and beginning the program using this method may offer greater acceptance. Implementers could also consider giving drivers the option of their preferred technology/collection method.

4. Develop a smartphone application: Given the technological age, there is a benefit to developing an application that allows mileage reporting directly from the phone. Most phones possess the ability to track locations using cellular signals and GPS, and the application may feel more user friendly and users are used to being tracked by GPS.

5. Certify many vendors and make market entry simple: In order to accomplish this, regulations/standards should be set so that private firms are able to develop technology that meets the criteria set in place. This open market would allow for many vendors which would increase the supply to offset the new demand. These multiple vendors can also add value to the minimum requirements by installing additional features to the devices that could potentially sync with parking meters or other features to enhance the usability.

6. Start a pilot program or make first phase voluntary: One key to a voluntary/pilot program is to rebate the fuel tax for those who volunteer or participate. This was the method used during the Oregon pilot program.[56] During the pilot program or voluntary period, it is unlikely that revenue would increase, but it may be a key piece to further understanding feasibility, public acceptance, and the initial infrastructure costs. This same method could be used to target specific groups in the initial phases, such as those who drive electric vehicles.

7. Collaborate with other states: Eventually it may be worthwhile to collaborate with neighboring states to make the system more user-friendly for those that frequently travel across state lines. This would also allow California to collect revenue for drivers visiting the state from other neighboring jurisdictions. States would also keep their sovereignty by administering and setting their own specific rates per mile.

According to the National Cooperative Highway Research and the CSG[57] there are three major factors that will determine the success of implementing a VMT fee:

1. The state must ensure that the public fully understands the problem with the current funding structure.
2. The process by which the state collects VMT fees must be sensible and easily understood by the public.
3. Have privacy concerns addressed, costs of implementation fully estimated, and mileage rates known and distributed.

Increasing Public Awareness of the Current Financing Problem

56 Personal Conversation, Michelle Godfrey

57 Council of State Governments. (2010). Vehicle miles traveled fees. Retrieved on February 10, 2014 from http://www.csg.org/policy/documents/TIA_VMTcharges.pdf

According to conversations with Michelle Godfrey, an administrator of ODOT's VMT implementation, it was explained that the more that people were aware of the growing problem of transportation funding shortfalls, the more they supported a strategy that mitigates that gap.[58] As stated previously in Finding 3, most of the public places a low priority on transportation funding, thus the public knows very little about the current challenges.[59] Changing the funding system will also include demonstrating why there is no solution within the current structure.[60] Research also suggests that the more the public understands the reason for a mileage fee, the more the public supports the change.[61]

Switching from fuel tax to VMT fee would mandate participation from the public. Thus, understanding the public response to such a fee is important in assessing its feasibility. According to previous studies, the issue of public acceptance can be delineated into privacy and equity concerns.

One major challenge with the current system of funding is the disassociation between the fuel tax and inflation. Switching to a VMT fee does not address the inflation issue. In order to remedy this issue, the legislature or voters would need to increase fees to adjust for the change of inflation.

The CSG also notes that no automobiles would be equipped with the proper technology for at least 20 years.[62] This is roughly how long it takes for all vehicles to cycle out of operation on public roads; however, this still does not account for antique and classic vehicles for nostalgic use.

Communicating Collection Methods

Understanding the invoice you receive can be important, and making the invoice as straightforward as possible will mitigate the number of individuals who do not pay.[63] Allowing drivers the option for billing method may also help alleviate any collection confusion. The Oregon Pilot offered 5 different methods for collection, all of which required different technology requirements, including self-reporting monthly and receiving an invoice, pre-paying a flat rate each month, and as sophisticated as a GPS devise that would monitor miles traveled.[64] Under each scenario, drivers were invoiced on a monthly basis to avoid any sticker shock from a once a year charge. RAND points out important invoicing issues, which include the regularity and method of payment, along with determining the roles of account managers, whether they should be public or private.[65] There are also a number of payment options that should be considered, including "automated debit accounts, monthly billing, annual payment with registration, or even payment with fuel purchases."[66]

58 Personal Conversation, Michelle Godfrey

59 Sorensen et al., op. cit. 53

60 Sorensen et al., op. cit. 53

61 Sorensen et al., op. cit. 53

62 Sorensen et al., op. cit. 53

63 Sorensen et al., op. cit. 53

64 Oregon's Road Usage Charge Program (2014). Choosing your plan: Plan option available to pilot participant. Received on May 7, 2014 from http://roadchargeoregon.org/choosing-your-plan/

65 Sorensen et al., op. cit. 53

66 Sorensen et al., op. cit. 53

Disclosing the Implementation Processes and Costs
The many concerns over cost, privacy, and equity should be addressed prior to the implementation of the VMT fee.

Administrative and Technology Costs
Administrative and technology costs represent the initial start-up costs to build required infrastructure, the costs to maintain the program – which includes staff, and costs on drivers to install monitoring devices. The largest immediate costs are related to planning, managing, and building the necessary infrastructure that is needed to effectively use a VMT system. The Council of State Governments (CSG) found that it would cost approximately $33 million for the initial set-up of necessary infrastructure in Oregon,[67] and we would expect this number to be larger in California given the geographic and demographic size differences. However, states may find compensation from the federal government to fund the start-up costs of implementation to alleviate the large price tag of the initial infrastructure.[68]

In addition to the initial costs, invoicing can become costly, especially since nearly 91 percent of the costs are attributed to labor.[69] Sutherland Global estimates that the average cost to process and deliver one invoice is roughly $9.38 but can be as high as $10 and as low as $2.[70] This is consistent with Fidesic Corporation's estimate, which states the average cost of producing paper invoices in 2002 was $8.44.[71] Electronic invoices, the most cost-efficient collection method, can be produced at little to no cost. The estimated administrative cost per vehicle ranges between $30 and $40,[72] and the total number of California registered vehicles in 2006 was 33,182,058.[73] Assuming the administration cost per vehicle is $35, the total administrative cost of the program would be $1,161,372,030 per year.

The costs to install devices that monitor the number of miles driven could range from $150 to $220. The Oregon Department of Transportation spent $209 per device plus an additional $55 for installation.[74] It is likely that overtime the cost of these devices would diminish as the production is scaled. A new VMT policy could involve the private sector as technology companies, telecommunication firms, and auto manufacturers develop cheaper, more effective and more efficient devices that will substantially decrease the cost of installation.

Privacy Concerns
Privacy concerns refer to public responses in accepting the new tracking system, that whether the

67 Council of State Governments, op. cit. 57

68 Transportation Research Board. (2006). The fuel tax and alternatives for transportation funding. Retrieved on April 10, 2014 from http://financecommission.dot.gov/Documents/Background%20Documents/sr285.pdf

69 Fidesic Corporation. (2002). The true cost of invoicing and payment. Retrieved on April 8, 2014 from http://www.enlivensoftware.com/Portals/0/docs/Cost%20of%20Invoicing.pdf

70 Velayudham, P. (2013). Invoice processing costs and challenges. Sutherland Global. Retrieved on April 8, 2014 from http://clarity.sutherlandglobal.com/blog/accounting-minute/invoice-processing-costs-and-challenges/

71 Jaffe, op. cit. 54

72 Harischandra, K; Isola, J; Rahman, L & Suen, A. (2011). Going forward: prospects for transitioning from gas taxes to vehicle-miles-traveled fees. Stanford University. Retrieved on March 1, 2014 from http://publicpolicy.stanford.edu/system/files/Carnegie_GasTaxes.pdf

73 Federal Highway Administration. (2007). State motor-vehicle registrations. Retrieved on April 13, 2014 from http://www.fhwa.dot.gov/policy/ohim/hs06/htm/mv1.htm

74 Counsel of State Governments, op. cit. 57

individuals' privacy rights can be protected by technology. Many members of the public as well as elected officials may be skeptical about distance-based charging systems due to the potential of government using devices to track individuals' movements and activities.[75] According to the Oregon pilot program study, there were options to have devices installed that only recorded mileage without collecting personal identifiable information such as the vehicle location.[76] The extent to which these the data provided by these devices after installation remains unclear. The wide variation among device capabilities determines the amount of privacy individuals will have, thus privacy disclosures should be outlined early on to ensure transparency.

Implementing a road usage charge will require increased government intrusion into the lives of citizens. However, the issue of privacy can be mitigated using technology.[77] Other tracking methods such as cell phones or credit cards could also provide detailed information about individual mileage traveled. Privacy rights advocates have two main concerns: data type and data storage.[78]

> Data Type: The type of data collected can vary depending on the precision and specificity of the data. GPS tracking devices allow for detailed records of travel location and time to be collected. Using odometer readings as a proxy of miles would involve less intrusion; however, odometers can be manipulated and do not distinguish travel on private roads versus public roads or out-of-state travel. In general, the more specific the data type, the more privacy concerns matter.[79] Oregon's pilot program study has noted that such privacy concerns can be eased by providing a wide array of choices in the type of data is collected.
>
> Data Collection: The manner in which data is collected and stored affects privacy concerns. Oregon's pilot study states that the information collected will be stored for no more than 30 days unless there is prior permission granted by the motorists. In regard to collection method, there is a choice between a centralized and decentralized system. Recent research has advocated for a decentralized collection system rather than a centralized repository. Under a centralized billing system, fees for vehicles are collected by transferring data from one sector to another, which means that an agency will track the location and travel time of vehicles and send an invoice at a later time. In a decentralized system, drivers pay for the fee directly at a pump when purchasing fuel. The data is transmitted automatically to the collection agency without having to go through an intermediate agency.[80] A centralized data collection system will result in cumbersome charging and increased costs. This method will likely impose financial pressure on governmental agencies. Certain inconveniences caused by a central system – such as the incapability of addressing payment failure and the possibility of double taxation with the

75 Nevada Department of Transportation (2010). Nevada vehicle miles traveled (VMT) fee study-phase 1. Retrieved on April 6, 2014 from http://www.nevadadot.com/uploadedFiles/NDOT/Documents/VMT%20FEE%20STUDY%20Bk.pdf

76 Oregon Department of Transportation, op. cit. 31

77 Transportation Research Board, op. cit. 68

78 Transportation Finance & Policy Commission (2012). Vehicle-miles-traveled revenue approaches policy issue paper. Retrieved on April 6, 2014 from http://www.dot.wisconsin.gov/about/tfp/docs/vmt-revenue.pdf

79 Transportation Finance & Policy Commission, op. cit. 78

80 Oregon Department of Transportation, op. cit. 31

fuel tax and VMT user fee – make a decentralized collection more appealing.[81]

Equity Concerns

The logic model also indicates equity issues in accepting this new funding system. Concerns about equity and fairness fall under two questions: Does the mileage-based user fee increase or decrease the disparity between (A) the users and payers; and (B) the rich and poor?

The VMT user fee is more equitable than the fuel tax because it establishes a nexus between the payer of the tax (drivers) and the benefits produced by the tax (road utilization). It would require drivers of electric vehicle, who are currently not paying their fair share of fuel taxes, to pay for their road usage. Drivers of less fuel-efficient vehicles, however, would pay less comparatively if they switch to the fee based on miles.

> Vertical Equity: Vertical equity refers to the concept that those who with greater capability to pay taxes should pay more. The VMT is a regressive tax,[82] where lower income groups pay a higher percentage of their income compared higher income groups. Revenue redistribution is a method to mitigate this greater burden on certain groups that are unequally affected by the fee structure. This could be done by investing in public transit for those who do not use automobiles as their form of transportation. Additional methods of altering the vertical equity could include providing exemptions, tax credits, or a preferential rate to lower income groups.[83]
>
> Regional Equity: Regional equity examines whether the motorists in certain area benefit more than others, as certain groups may be affected differently based on the geographic location. A VMT fee will have a greater negative effect for rural and suburban drivers compared to inner-city, urban drivers. Motorists in rural areas tend to own less-fuel efficient vehicles and drive less than their urban counterparts.[84] While urban and suburban drivers tend to own more fuel-efficient cars and have higher travelling demand then rural drivers, studies state that households with children are the most adversely affected.[85] Oregon's pilot program study reports that the total vehicle miles travelled among drivers in Eastern Oregon, a predominantly rural area, is 20 percent greater than those in Western Oregon, where metropolitans such as Portland and Eugene are located. This includes travel occurring out-of-state and on private roads. When comparing miles only travelled on in-state public roads, however, the difference between Eastern and Western Oregon drivers is 8 percent.[86]

81 Oregon Department of Transportation, op. cit. 31

82 Duncan, D; and Graham, J. (2013). Road user fees instead of fuel taxes: the quest for political acceptability. Retrieved on April 12, 2014 from http://onlinelibrary.wiley.com

83 Carroll, R; Joulfaian, D; & Mackie, J. (2011). Income versus consumption tax baselines for tax expenditures. National Tax Journal. Retrieved on April 10, 2014 from http://search.proquest.com.libproxy.usc.edu/docview/872087984

84 Weatherfor, B. A. (2012). Mileage-based user fee winners and losers. Retrieved on April 6, 2014 from http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2012/RAND_RGSD295.pdf

85 Zhang, L (2009). The short- and long-run impacts of vehicle mileage fee on income and spatial equity. University of Maryland, Maryland, United States. Retrieved on April 6, 2014 from http://wiki.umd.edu/lei/images/f/fe/Zhang2009b.pdf

86 Oregon Department of Transportation. (2013). Final Report on Impacts of Road User Charges in Rural, Urban, and Mixed Counties. Retrieved on April 10, 2014 from http://www.oregon.gov/ODOT/HWY/RUFPP/docs/FINAL_Report_Impacts_RoadUserCharges_Rural_Urban_Mixed_Counties_Jan_2013.pdf

Environmental Concerns

Some studies find that VMT fees could effectively reduce the total mileage traveled, which could be conductive to GHG emission mitigation.[87] However, other reports state that a VMT fee may actually lead to more congestion, and thus higher levels of pollution.[88] There is no consensus on whether a VMT fee will help or harm the environment, so estimating the costs and benefits for environmental effects may be trivial until further research is done. In addition, we acknowledge that issues such as equity concerns, potential risks to unknown stakeholders, fiscal uncertainties, and unforeseen implementation costs cannot be easily monetized. As such, we choose to exclude them from this report.

87 California Department of Transportation (2011). Transportation funding in California. Retrieved on October 12, 2013 from http://www.dot.ca.gov/hq/tpp/offices/eab/fundchrt_files/Transportation_Funding_in_California_2011_rev_050112.pdf#zoom=65

88 University of California, Los Angeles. (2009). Measuring vehicle greenhouse gas emissions for sb 375 implementation. Retrieved on October 12, 2013 from http://www.arb.ca.gov/cc/sb375/rtac/meetings/070709/commentaddendum.pdf

FUTURE DISCUSSION

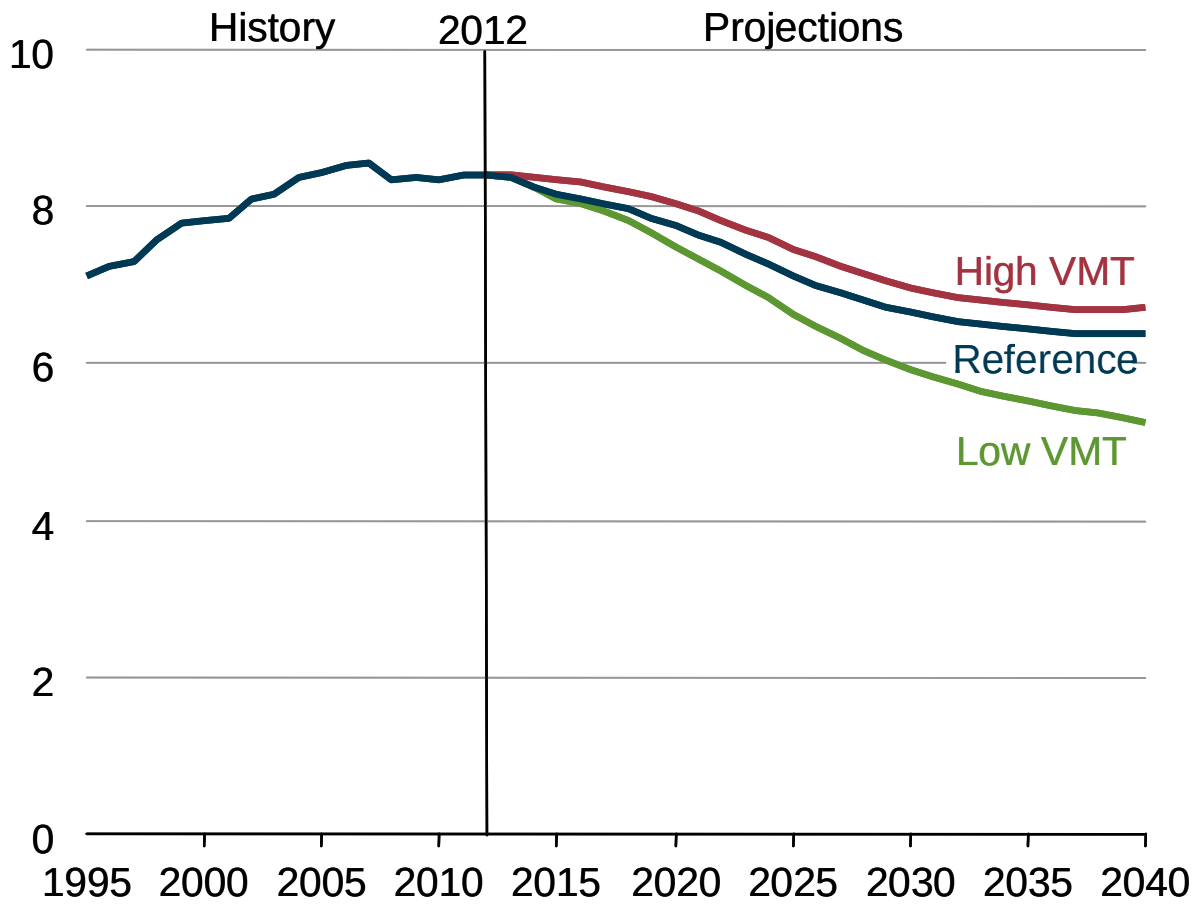
Our analysis, which presents a limited number of options and outcomes, is illustrative but not conclusive. While these findings may spur further dialogue on how to fund California's transportation system, caution should be taken when inferring policy decisions. Reactions to a VMT fee are based on stated preferences as opposed to revealed preferences. Because there is currently no state with a full-fledged VMT program, it is impossible to know whether and how drivers would react.

Replacing the fuel tax with VMT user fee in California is possible, but the state has a long way to go before mandating full participation in the VMT program. In order to implement a large-scale and fully functional VMT program with respect to the state, roads and vehicles involved, there is need for a pilot program and technical trials, as well a more detailed examination of how the program would be coordinated with federal of standards and policies. Initially, the program can be tested in a region instead of the entire state. Pilot programs also can help determine whether the program is publicly accepted.

Although there have been pilot programs in several states, due to regional and geographic factors driving patterns in California are different from those of other states. As aforementioned, our surveys on public response are based on other states, such as Oregon, Texas and Nevada. Because the political environment and demographics of these states differ tremendously, the opinions of Californians may differ in certain aspects regarding VMT implementation. Future studies and surveys should focus on exploring the perceptions of California drivers.

APPENDIX A

U.S. light-duty vehicle energy use in three cases, 1995-2040
(Millions of barrels oil equivalent per day)



Source: U.S. light-duty vehicle energy use in three cases, 1995-2040: History: U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey*, http://nhts.ornl.gov/download.shtml. Projections: AEO2014 National Energy Modeling System

APPENDIX B

Revenue from Fuel Tax and Equivalent VMT Tax, including State Sales and Excise Taxes
Analysis of 23.5 MPG, 26 MPG, and 35.5 MPG

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.021	0.4935			14,498,502,840	340,714,816,740	$ 7,155,011,152	$ 7,155,011,152
B	0.0252	0.5922	20.0%	4.4%	13,860,568,715	325,723,364,803	$ 8,208,228,793	$ 8,208,228,793
C	0.0294	0.6909	40.0%	8.8%	13,222,634,590	310,731,912,867	$ 9,135,518,238	$ 9,135,518,238
D	0.0336	0.7896	60.0%	13.2%	12,584,700,465	295,740,460,930	$ 9,936,879,487	$ 9,936,879,487
E	0.0378	0.8883	80.0%	17.6%	11,946,766,340	280,749,008,994	$ 10,612,312,540	$ 10,612,312,540
F	0.042	0.987	100.0%	22.0%	11,308,832,215	265,757,557,057	$ 11,161,817,396	$ 11,161,817,396

Price Elasticity 0.22 Fuel Efficiency 23.5

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.021	0.4935			14,498,502,840	376,961,073,840	$ 7,155,011,152	$ 7,916,182,551
B	0.0252	0.5922	20.0%	4.4%	13,860,568,715	360,374,786,591	$ 8,208,228,793	$ 9,081,444,622
C	0.0294	0.6909	40.0%	8.8%	13,222,634,590	343,788,499,342	$ 9,135,518,238	$ 10,107,381,881
D	0.0336	0.7896	60.0%	13.2%	12,584,700,465	327,202,212,093	$ 9,936,879,487	$ 10,993,994,326
E	0.0378	0.8883	80.0%	17.6%	11,946,766,340	310,615,924,844	$ 10,612,312,540	$ 11,741,281,959
F	0.042	0.987	100.0%	22.0%	11,308,832,215	294,029,637,595	$ 11,161,817,396	$ 12,349,244,779

Price Elasticity 0.22 Fuel Efficiency 26

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.021	0.4935			14,498,502,840	514,696,850,820	$ 7,155,011,152	$ 10,808,633,867
B	0.0252	0.5922	20.0%	4.4%	13,860,568,715	492,050,189,384	$ 8,208,228,793	$ 12,399,664,772
C	0.0294	0.6909	40.0%	8.8%	13,222,634,590	469,403,527,948	$ 9,135,518,238	$ 13,800,463,722
D	0.0336	0.7896	60.0%	13.2%	12,584,700,465	446,756,866,512	$ 9,936,879,487	$ 15,011,030,715
E	0.0378	0.8883	80.0%	17.6%	11,946,766,340	424,110,205,076	$ 10,612,312,540	$ 16,031,365,752
F	0.042	0.987	100.0%	22.0%	11,308,832,215	401,463,543,640	$ 11,161,817,396	$ 16,861,468,833

Price Elasticity 0.22 Fuel Efficiency 35.5

Revenue from Fuel Tax and Equivalent VMT Tax, Excise Taxes Only
Analysis of 23.5 MPG, 26 MPG, and 35.5 MPG

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.017	0.399			14,498,502,840	340,714,816,740	$ 5,784,902,633	$ 5,792,151,885
B	0.0204	0.4788	20.0%	4.4%	13,860,568,715	325,723,364,803	$ 6,636,440,301	$ 6,644,756,642
C	0.0238	0.5586	40.0%	8.8%	13,222,634,590	310,731,912,867	$ 7,386,163,682	$ 7,395,419,526
D	0.0272	0.6384	60.0%	13.2%	12,584,700,465	295,740,460,930	$ 8,034,072,777	$ 8,044,140,537
E	0.0306	0.7182	80.0%	17.6%	11,946,766,340	280,749,008,994	$ 8,580,167,586	$ 8,590,919,675
F	0.034	0.798	100.0%	22.0%	11,308,832,215	265,757,557,057	$ 9,024,448,108	$ 9,035,756,940

Price Elasticity	0.22	Fuel Efficiency	23.5

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.017	0.399			14,498,502,840	376,961,073,840	$ 5,784,902,633	$ 6,408,338,255
B	0.0204	0.4788	20.0%	4.4%	13,860,568,715	360,374,786,591	$ 6,636,440,301	$ 7,351,645,646
C	0.0238	0.5586	40.0%	8.8%	13,222,634,590	343,788,499,342	$ 7,386,163,682	$ 8,182,166,284
D	0.0272	0.6384	60.0%	13.2%	12,584,700,465	327,202,212,093	$ 8,034,072,777	$ 8,899,900,169
E	0.0306	0.7182	80.0%	17.6%	11,946,766,340	310,615,924,844	$ 8,580,167,586	$ 9,504,847,300
F	0.034	0.798	100.0%	22.0%	11,308,832,215	294,029,637,595	$ 9,024,448,108	$ 9,997,007,678

Price Elasticity	0.22	Fuel Efficiency	26

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.017	0.399			14,498,502,840	514,696,850,820	$ 5,784,902,633	$ 8,749,846,464
B	0.0204	0.4788	20.0%	4.4%	13,860,568,715	492,050,189,384	$ 6,636,440,301	$ 10,037,823,863
C	0.0238	0.5586	40.0%	8.8%	13,222,634,590	469,403,527,948	$ 7,386,163,682	$ 11,171,803,965
D	0.0272	0.6384	60.0%	13.2%	12,584,700,465	446,756,866,512	$ 8,034,072,777	$ 12,151,786,769
E	0.0306	0.7182	80.0%	17.6%	11,946,766,340	424,110,205,076	$ 8,580,167,586	$ 12,977,772,275
F	0.034	0.798	100.0%	22.0%	11,308,832,215	401,463,543,640	$ 9,024,448,108	$ 13,649,760,484

Price Elasticity	0.22	Fuel Efficiency	35.5

Revenue from Fuel Tax and Equivalent VMT Tax, State Sales Tax Only
Analysis of 23.5 MPG, 26 MPG, and 35.5 MPG

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.004	0.086			14,498,502,840	340,714,816,740	$ 1,246,871,244	$ 1,362,859,267
B	0.0048	0.1032	20.0%	4.4%	13,860,568,715	325,723,364,803	$ 1,430,410,691	$ 1,563,472,151
C	0.0056	0.1204	40.0%	8.8%	13,222,634,590	310,731,912,867	$ 1,592,005,205	$ 1,740,098,712
D	0.0064	0.1376	60.0%	13.2%	12,584,700,465	295,740,460,930	$ 1,731,654,784	$ 1,892,738,950
E	0.0072	0.1548	80.0%	17.6%	11,946,766,340	280,749,008,994	$ 1,849,359,429	$ 2,021,392,865
F	0.008	0.172	100.0%	22.0%	11,308,832,215	265,757,557,057	$ 1,945,119,141	$ 2,126,060,456

Price Elasticity	0.22	Fuel Efficiency	23.5

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.004	0.086			14,498,502,840	376,961,073,840	$ 1,246,871,244	$ 1,507,844,295
B	0.0048	0.1032	20.0%	4.4%	13,860,568,715	360,374,786,591	$ 1,430,410,691	$ 1,729,798,976
C	0.0056	0.1204	40.0%	8.8%	13,222,634,590	343,788,499,342	$ 1,592,005,205	$ 1,925,215,596
D	0.0064	0.1376	60.0%	13.2%	12,584,700,465	327,202,212,093	$ 1,731,654,784	$ 2,094,094,157
E	0.0072	0.1548	80.0%	17.6%	11,946,766,340	310,615,924,844	$ 1,849,359,429	$ 2,236,434,659
F	0.008	0.172	100.0%	22.0%	11,308,832,215	294,029,637,595	$ 1,945,119,141	$ 2,352,237,101

Price Elasticity	0.22	Fuel Efficiency	26

Option	VMT	Gas	Change in Price	Decrease in Gas Consumed	Gas Consumed (gal)	Vehicle Miles Travelled	Revenue Gas	Revenue VMT
A	0.004	0.086			14,498,502,840	514,696,850,820	$ 1,246,871,244	$ 2,058,787,403
B	0.0048	0.1032	20.0%	4.4%	13,860,568,715	492,050,189,384	$ 1,430,410,691	$ 2,361,840,909
C	0.0056	0.1204	40.0%	8.8%	13,222,634,590	469,403,527,948	$ 1,592,005,205	$ 2,628,659,757
D	0.0064	0.1376	60.0%	13.2%	12,584,700,465	446,756,866,512	$ 1,731,654,784	$ 2,859,243,946
E	0.0072	0.1548	80.0%	17.6%	11,946,766,340	424,110,205,076	$ 1,849,359,429	$ 3,053,593,477
F	0.008	0.172	100.0%	22.0%	11,308,832,215	401,463,543,640	$ 1,945,119,141	$ 3,211,708,349

Price Elasticity	0.22	Fuel Efficiency	35.5