Potential Federal Actions to Reduce Vehicle Travel

Dr. Susan Handy
University of California, Davis

I am a Professor in the Department of Environmental Science and Policy at the University of California, Davis. I hold a B.S.E. in Civil Engineering from Princeton University, an M.S. in Civil Engineering from Stanford University, and a Ph.D. in City and Regional Planning from the University of California at Berkeley.

I am internationally known for my research on the relationships between transportation and land use, particularly the impact of neighborhood design on travel behavior, and am one of the most widely cited researchers on this topic. My recent work focuses on the evaluation of strategies for reducing automobile dependence. I completed an in-depth review of the empirical literature on 23 strategies for reducing vehicle travel for the California Air Resources Board in 2013 and 2014. I have published several widely-cited review papers on the topic of vehicle travel and have given numerous invited talks in academic and professional forums on this topic.

In preparing this report, I relied heavily on the in-depth review of the empirical evidence completed for the California Air Resources Board in 2013 and 2014. For each topic I discuss, I searched academic databases for relevant studies published since these reviews and reviewed all such studies I identified. To document current federal policies, I searched the websites of the U.S. Department of Transportation and consulted the U.S. Code and other federal documents. I consulted other credible publications as needed to complete my report. Original analysis was limited to the application of estimated effect sizes from the literature and is described in the text.

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1. Introduction

The purpose of this report is to examine actions other than relaxing fuel economy standards that the federal government could potentially take to reduce vehicle miles of travel (VMT). In the Notice of Proposed Rule Making (NPRM) for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021-2026 Passenger Cars and Light Trucks, issued on August 24, 2018, the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) present several proposals to relax the greenhouse gas emissions and corporate average fuel economy (CAFE) standards for model years 2020-2026. The leading proposal in the NPRM is to roll back standards to the levels set for 2020, a significant relaxation of the existing fuel economy standards for model year 2021 and other standards. The Agencies assert that the proposed relaxation of CAFE standards will avoid an increase in driving that would result from higher standards, an effect known as the "rebound effect."[1] A substantial body of literature, not examined here, provides an economic explanation for the rebound effect and assesses the degree to which it occurs. This report instead focuses on actions the federal government could take to offset the rebound effect, i.e. to dampen any increase in VMT that might occur in response to an increase in fuel economy.

The federal government has many tools available, other than relaxing fuel economy standards, that it could use to reduce VMT and the safety concerns it generates. These tools include actions that directly affect drivers but also several indirect actions, that is, federal actions that influence the actions of state, regional, and local agencies that in turn affect drivers. The federal government is already using or has previously used these tools in an attempt to address transportation issues such as congestion. To offset the rebound effect, the federal government would need to expand their use of these tools. Some of these actions are within the control of the U.S. Department of Transportation, but some would require action on the part of Congress or in some cases other federal agencies; actions discussed here that have not previously been taken by the federal government have been taken by state governments. The actions discussed do not necessarily increase monetary costs to the public sector or to households, but they will change the decision making process for both, as discussed below.

The goal of reducing VMT merits careful consideration. Because travel contributes to economic activity (and vice versa), this report focuses on actions that discourage private vehicle travel without discouraging travel in general. This can be done in two general ways: reduce the distances that people must drive to get what they need, and increase the feasibility of using alternatives to driving, including transit and active travel modes (primarily walking and biking). Reducing VMT in these ways has many benefits beyond reducing car crashes, including reducing greenhouse gas (GHG) and air pollutant emissions, reducing harms to wildlife, improving water quality, improving physical and mental health, and reducing overall traffic delays (Fang and Volker, 2017). In addition, reducing VMT reduces financial

[1] 83 Fed.Reg.42,995-6, August 24, 2018.

costs to both households and public agencies in both direct and indirect ways. In other words, safety is just one reason why the federal government might want to consider policies that reduce VMT, and it is probably not the most important reason. At the same time, reducing VMT is just one way that the federal government can help to improve safety, and it is probably not the most effective approach. The combined benefits of reducing VMT nevertheless warrant a consideration of potential VMT-reducing actions at the federal level.

This report defines each of the possible actions (Table 1) and reviews evidence from the research on each action as to its potential effectiveness. It relies heavily on an in-depth review of the empirical evidence, focusing on studies from California and the U.S., on a wide variety of VMT-reduction strategies that my colleagues and I completed for CARB in 2013 and 2014.[2] This review provided estimates of the size of the effects on VMT of each of the strategies. However, the effect sizes (often taking the form of an elasticity) should not be applied in a simplistic way to project the magnitude of reductions in VMT that could be expected from the implementation of these strategies.[3] Many critical assumptions must be made to translate these effect sizes into a national projection (Boarnet and Handy, 2017). The effects on VMT of policies such as a gas tax increase or particular kinds of infrastructure investments are generally estimated at the regional level using sophisticated travel demand forecasting models that take into account the specific characteristics of each region, including its transportation system, its development patterns, and its population and economic characteristics; these models are described in the Appendix. Nevertheless, while I do not quantify the precise impact on VMT of possible federal actions in this report, I do find that the available empirical evidence strongly supports the conclusion that these federal actions are likely to be effective in reducing VMT to a measurable degree. I give a relative rating of the potential impact of each action based on my assessment of the empirical evidence as well as practical considerations in Table 1.

Table 1. Possible Federal Actions to Reduce VMT – Direct and Indirect

Direct Actions		**Indirect Actions**	
▪ Increase federal gas tax	Top	▪ Enable states to toll federal highways	High
▪ Give tax breaks to transit and biking but not driving benefits	High	▪ Increase flexible funding for transit and active modes	High
▪ Expand transportation Demand Management (TDM) programs for federal employees	High	▪ Require use of VMT as a performance measure	High
		▪ Update highway and street design guidelines	Moderate
▪ Increase dedicated funding for transit and active modes	High	▪ Provide guidance on evaluating VMT impacts of transportation projects under NEPA	Moderate
▪ Implement social marketing campaign on VMT	Moderate		
		▪ Provide leadership on accessibility-oriented planning approach	Moderate

[2]https://arb.ca.gov/cc/sb375/policies/policies.htm.

[3] This statement also applies to the estimated increase in VMT attributable to an increase in fuel efficiency standards that is presented in the notice of proposed rule-making (NPRM) for the *Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2012-20116 Passenger Cars and Light Trucks* (https://www.govinfo.gov/content/pkg/FR-2018-08-24/pdf/2018-16820.pdf).

In this report, I focus on the ways in which federal policies can influence individual choices about travel, in other words, VMT per person. VMT per person depends on socio-economic factors such as income distribution and workforce participation, with individuals who work and those with higher incomes driving more miles on average, for example. Auto ownership also influences VMT per person by increasing the likelihood that an individual drives; it may increase the number of trips the individual makes and the distances they travel as well. However, it is important to note that once auto ownership reaches a "saturation" level, with one vehicle available for every licensed driver, additional auto ownership has little effect on VMT per person (since it is currently impossible to drive more than one car at a time), at which point overall growth in VMT will match population growth, all else equal (Lave, 1991). In other words, it is not necessarily true that, as the Agencies state in the NPRM, "the overall size of the on-road fleet determines the total amount of VMT"[4] as the relationship between fleet size and the total amount of VMT is moderated by the ratio of drivers to vehicles; additional vehicles without additional drivers will have a limited effect on VMT. This point is illustrated by data from the 2017 National Household Travel Survey showing that the average annual VMT per vehicle drops from 11,129 for households with one vehicle to 8,749 for households with four vehicles; the pattern holds even when accounting for vehicle age.[5] As the Agencies acknowledge, "it is important to remember that not all vehicles are driven equally,"[6] but vehicle age is not the only important factor. VMT is ultimately a function of the demand for travel. How much each driver with a vehicle chooses to drive is not static, and these choices can be shaped by federal actions.

[4] 83 Fed.Reg.43,098, August 24, 2018.

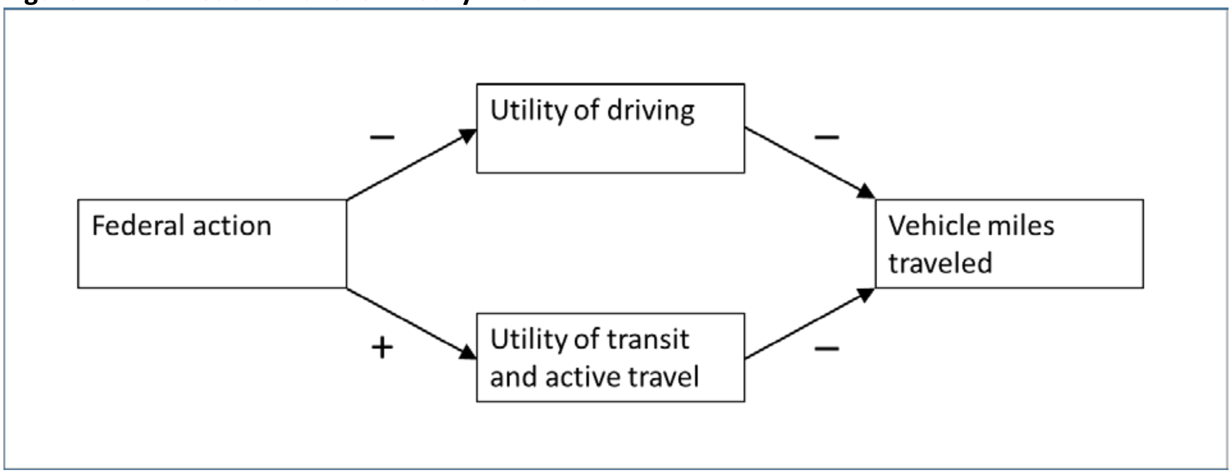
[5] Author's analysis using the "Explore NHTS Data – 2017 Table Designer" tool (available https://nhts.ornl.gov/) with "Average annual vehicle miles per vehicle (self-reported)" as the analysis variable and "Count of household vehicles" as the row variable and "Age of vehicle, based on model year" as the column variable, reported as Job Number 66166, 10/16/18.

[6] 83 Fed.Reg.43,099, August 24, 2018.

2. Direct Actions

The federal government has at its disposal several tools that directly affect driving, either by affecting the relative price of driving or by expanding or improving the alternatives to driving. Policies influence the choices that individuals make about their trips by influencing the relative utility (or net benefit to the individual) of the different options. Policies that decrease the utility of driving (e.g. by making it more expensive) and/or that increase the utility of alternatives to driving (e.g. by making them more convenient and comfortable) can nudge travelers to reduce their driving (Figure 1), thereby reducing total VMT. Policies can also reduce VMT by reducing the distances travelled for car trips.

Figure 1. How Federal Actions Directly Affect VMT



2.1 Gas tax: increase the federal gas tax

The federal gas tax is the most powerful tool available to the federal government for influencing VMT. Federal and state gas taxes are a component of the overall gas price that drivers pay at the pump; increases in gas taxes translate directly into increases in gas prices. Research shows that gas prices have a strong influence on vehicle miles of travel (Circella et al., 2014). One study using data from the U.S. estimated an elasticity for VMT with respect to gas prices of -0.03 in the short run, meaning that a 1 percent increase in the gas price is associated with a 0.03 percent decrease in VMT, and of -0.13 in the long run (Hymel et al., 2010). It appears that elasticities in the U.S. are lower than they are in other countries (Goodwin et al., 2004) and that responsiveness to prices is declining over time, i.e. that elasticities are moving closer to zero (Gillingham, 2014). A more recent study using data from California of VMT and gas prices from 2001 to 2009 found a higher elasticity of -0.22 for the medium-run for cars within the first six years of their lifespan, meaning that a 1 percent increase in the gas price would lead to a 0.22 percent decrease in VMT (Gillingham, 2014). A possible explanation for the larger elasticity in this study may be the sharp increase in prices that consumer experienced during the period of the study in comparison to more gradual and thus less notable increases as other times (Gillingham, 2014). The evidence thus suggests that a relatively large increase in gas price is needed to achieve a modest decrease in VMT but that a rapid change in price is likely to produce a larger effect than a gradual increase. The implementation of an increase in the gas tax could produce a sudden increase in the gas price at the pump, producing an effect on VMT at the higher end of these estimates.

A federal tax on motor fuel was first imposed in 1932 as a way to raise revenues to pay for a national system of highways. The creation of the Highway Trust Fund in the 1950s ensured that the revenues from this tax were dedicated to transportation. The federal tax currently stands at 18.4 cents per gallon,[7] a value set in 1993. Tax revenues are no longer keeping up with the needs of the highway system owing to increased vehicle fuel economy since 2005 (EPA, 2018), meaning that drivers pay less per mile than in the past, and the lack of any adjustment to the tax to reflect inflation, which has been higher in the construction sector than in the economy overall (Taylor, 2017). Congress has not acted on proposals to increase the gas tax (including a proposal endorsed by President Trump in 2018 to increase the tax to 25 cents per gallon), though several states, including California, have increased their state motor fuel taxes in recent years.

The effect on VMT of an increase in the gas tax can be estimated by multiplying the elasticities reported in the studies cited above by the proposed increase in the gas tax. For example, an increase in the federal gas tax of 6.6 cents (from 18.3 cents to 25 cents) translates to a 2.3 percent increase in gas price (given an average U.S. gas price as of 9/7/18 of $2.854 according to AAA). This increase is likely to produce at least a 0.07 percent decrease in VMT in the short-run (assuming an elasticity of -0.03 multiplied by 2.3 percent), and a 0.30 percent decrease in VMT in the long-run (assuming an elasticity of -0.13 multiplied by 2.3 percent).

The gas tax increase needed to offset a given increase in fuel economy can also be calculated. An increase in fuel economy is similar to a decrease in gas price, in that it reduces the per-mile cost of driving. The elasticities are not necessarily the same for the effect on VMT of increases in fuel economy and decreases in gas prices, however, as drivers may feel an increase in gas price more directly than they do an increase in fuel economy (Wang and Chen, 2014). Separating the effects has been challenging for researchers, but some evidence suggests that the effect of fuel economy is smaller than the effect of gas price (Greene, 2012) or may even be zero (Hymel and Small, 2015). Federal analysis has generally assumed a rebound effect of 10 percent,[8] translating to an elasticity of 0.1 for VMT relative to fuel economy. This is indeed smaller than the estimates of the mid-run and long-run gas price elasticities reported above. An upper-bound estimate of the increase in the gas tax needed to offset an increase in fuel economy could thus be generated by assuming that the two effects are the same. If they are, an increase in fuel economy of 25 percent (e.g. from 40 mpg models to 50 mpg) is equivalent to a 20 percent decrease in the price of driving per mile (assuming a price of $2.85). Offsetting this decrease would require a 20 percent increase in the price of driving, which could be achieved with an increase in the gas tax of $0.57. If indeed the effect for gas price is larger than the effect for fuel economy, a smaller increase in the gas tax would be needed.

The need for such a large increase in the gas tax would depend on the degree to which the rebound effect tapers off (i.e., the increase in VMT declines) as improvements in fuel economy increase, as some evidence suggests (Greene, 2012). This tapering effect makes sense given the limited hours in the day; evidence points to a relatively consistent "travel time budget" on average across the population (Mokhtarian and Chen, 2004), and if people have already reached the maximum amount of time they have available for traveling, additional decreases in the cost of travel will not lead to additional travel. In addition, to maintain the same overall level of VMT as without the increase in fuel economy, the increase in the gas tax could be implemented gradually depending on the rate at which average fuel

[7] 26 U.S.C. §4081 (2017).
[8] 75 Fed.Reg.25,490, May 7, 2010; 77 Fed. Reg. 62,716, October 15, 2012.

economy across the vehicle fleet increases over time. The average cost to households would remain stable, as the increase in gas tax simply offsets the savings stemming from the increase in fuel economy. Households could benefit indirectly as well: a greater share of the gas-pump price would flow to the public rather than the private sector, giving the public sector an opportunity to increase investments in the transportation system, for example, to improve alternatives to driving.

The federal government has previously considered the possibility of converting from a gas tax to a VMT tax, that is, a per mile fee rather than per gallon fee (Transportation Research Board, 2006). Such a switch could have a more direct impact on VMT. One study shows that in California a 10 percent increase in driving costs resulting from a VMT charge could result in a decrease in VMT of 2 to 2.5 percent (Deakin et al., 1996), suggesting a higher elasticity than some studies report for gas prices (e.g. Hymel et al., 2010). California conducted a pilot study of a VMT tax in 2016 in response to Senate Bill 1077 of 2014. Involving over 5000 vehicles for a period of nine months, the program garnered positive reviews from the participants (CalSTA, 2017). The evaluation of the program focused on the feasibility of implementing a VMT charge and did not assess whether the VMT charge led to less (or more) VMT than the gas tax for participants. The California program followed a similar pilot program in Oregon, which led to the establishment of OReGO, a voluntary program in which participants switch from a gas tax to a VMT charge (Oregon Department of Transportation, 2018).

2.2 Tax policy: give tax breaks to transit and bicycling benefits but not driving benefits

Tax policy on commuting benefits is another important tool for the federal government to manage VMT. Employers often provide employees with transportation benefits such as free transit passes or free parking. Such benefits make these modes more attractive to commuters by reducing their effective cost. Tax policy can influence the value and thus the effect of such benefits. Policy can target employers by allowing employers to take a tax deduction for the cost of the benefits they provide, making them more likely to provide such benefits. Policy can also target employees, in two ways: 1. by exempting employer-provided benefits from income taxes, which means that they retain their full value to employees, 2. by allowing employees to pay for transportation services (when not provided by employers) with pre-tax income, thereby effectively reducing the cost of transportation.

Federal policy on the taxing of transportation benefits could reduce VMT if tax breaks are implemented for transit and biking benefits but not for parking benefits. It is possible to estimate, at least roughly, the potential impact of these policies by looking at price elasticities for transit. Studies show that fare decreases have an elasticity of about 0.4, meaning that a 1 percent decrease in fares would lead to a 0.4 percent increase in transit ridership (Handy, Lovejoy et al., 2013). This does not directly translate into a 0.4 percent decrease in driving, however, as not all transit trips replace driving trips, and car travel is simply more abundant, so the percentage change in VMT would be smaller. One study suggests that the share of trips by car decreases by about 0.05 percent for every 1 percent decrease in transit fares, and the decrease in VMT might be similar (Paulley et al., 2006). Studies on price elasticities for parking also give an indication of the possible effect of tax policies (Spears, Boarnet, and Handy, 2014). One study shows that a $1 parking charge could produce a 1 percent decrease in VMT, with up to a 2.6 percent decrease for a $3 parking charge (Deakin et al., 1996). Tax policies that effectively reduced the cost of riding transit or increased the cost of parking could have an effect on VMT similar to those reported in these studies.

The first federal tax policy on transportation benefits was adopted in 1984, setting a modest cap of $15 per month for subsidized parking or transit passes (meaning that $15 was the most that employers could deduct and that employees could receive tax free). Congress increased the caps over time, but parking caps were almost always higher than transit caps (American Public Transit Association, n.d.). Starting in 2016, tax policy treated transit and parking benefits equally with caps of $255 for pre-tax expenses or subsidies to employees. This policy also allowed up to $20 per employee per month out of pre-tax income for biking-related expenses; businesses could deduct their contributions to employees of up to the same amount. The 2017 tax legislation eliminated deductions (for employers and employees) for transportation benefits starting in 2018. Reinstating deductions for transit and biking benefits while not reinstating deductions for parking benefits could help to reduce VMT and would have less impact on federal tax revenues than the previous policy of granting tax deductions for both types of benefits.

2.3 Transportation Demand Management (TDM): expand programs for federal employees

Transportation demand management (TDM) programs can influence VMT by giving employees more flexibility in their travel and encouraging alternatives to driving through non-monetary means. These programs, often adopted by large employers and sometimes known as employer-based trip reduction programs, aim to shift commuters from driving-alone to other modes, to shift commuting out of peak travel times, or to eliminate at least some commute trips altogether. The first category includes free or discounted transit passes, carpool and vanpool programs, facilities for bicycle commuters such as showers and protected bike parking, and other strategies that make the alternatives to driving more attractive. The second category includes flexible and alternative work schedules that enable employees to commute outside of peak hours but do not generally discourage driving. The last category includes compressed work weeks (e.g. employees work 9 rather than 10 days in a two-week period) and telecommuting, defined as working at home by employees who have a regular work place.

Employer-based trip reduction programs can reduce VMT by appreciable amounts, according to the available studies conducted in the U.S.: a region that adopts a requirement for employers with 50 or more employees to adopt such a program might expect to see a 4 to 6 percent reduction for employees at participating worksites, and a 1.3 percent VMT reduction for the region as a whole (Boarnet, Hsu et al., 2014). Parking cash-out programs, in which employees receive a cash benefit in place of a parking subsidy, can produce a 12 percent reduction in VMT for the employees who take it, according to a study in Southern California (Shoup, 1997). Telecommuting studies also show substantial declines in VMT: employees who telecommute reduce their commute VMT by 90 percent on telecommuting days, their total VMT by 43 to 77 percent, and their household VMT by as much as 48 percent, according to studies from California and Washington (Handy, Tal et al., 2013). If 1.5 percent of a region's workforce telecommutes on any given day, the net reduction could be 1.1 percent of household VMT for the region.

Expanding transportation demand management programs for federal employees, now numbering over 2 million, could have a measurable impact on VMT. Federal agencies have had TDM policies in place for over two decades, and Congress passed a mandate for agencies to provide telework (I.e. telecommuting) opportunities for federal employees in 2000. It is up to each participating agency to develop criteria for their program as to which employees are eligible, how frequently, with what training, and other policies (U.S. Office of Personnel Management, 2011). The latest telework report to Congress (as required annually) states that 44 percent of federal employees are eligible to telework, and that 46 to 51 percent of eligible employees participate; the report discusses ways that agencies could further expand participation in telework programs (U.S. Office of Personnel Management, 2017). Federal policy allows agencies to implement flexible work schedules and compressed work schedules; a handbook on alternative work schedules was published in 1996. An expanded federal TDM program could serve as a model for other large employers and could even lead to a federal requirement for large private employers to adopt TDM programs. TDM programs impose modest administrative costs on employers, but research shows that the availability of such programs can increase employee satisfaction, thereby reducing turnover, and improve productivity, with net benefits to the employer.

2.4 Dedicated funding: increase dedicated funding for transit and active travel

The federal government wields significant influence over the transportation system through its funding programs. Federal law vests much of the power for decision making about federally-funded transportation investments with state departments of transportation, Metropolitan Planning Organizations (MPOs), and transit agencies.[9] The structure of the federal transportation program, averaging over $56 billion per year for 5 years,[10] has an important influence on these decisions, however. It establishes specific categories of funding, sets the amount of funding for each category, and specifies what kinds or projects are and are not eligible for that funding. The program has two general types of categories: mode-specific categories, for which only projects for the specified mode are eligible, and flexible categories, for which a wider range of project types are eligible. The mode-specific categories focus on highways (about 52 percent of funding) and to a lesser degree transit (about 21 percent of funding). Because needs exceed the amounts provided for these modes, the federal government can be virtually certain that all of the funds in these categories will get spent on these modes even if decisions about specific projects are made by state DOTs, MPOs, and transit agencies. This is not true for the flexible categories (about 27 percent of funding), where the spending for each mode is not guaranteed, as discussed further in Section 3.2. Increasing funding in transit-specific categories and creating one or more categories specific to active travel would thus be likely to increase investments in these modes.

Investments in projects that improve transit and active travel are likely to reduce VMT. Research from the U.S. shows that such investments could have a substantial impact on VMT. Studies of the impact of expanded transit service, for example, show that a 1 percent increase in transit vehicle hours means a 1.1 percent increase in total ridership, while a 1 percent increase in service frequency is associated with a 0.5 percent increase in total ridership (Handy, Lovejoy et al., 2013). Investments in bike infrastructure also impact travel behavior: a 1 percent increase in miles of bike lanes means 0.3 percent increase in the share of commuters bicycling and could mean a 0.01 percent decrease in share of commuters driving (Handy, Tal, et al., 2014). The effects for pedestrian infrastructure are similar: a 1 percent increase in proportion of route with sidewalks is associated with a 0.3 to 1.2 percent increase in walk mode share (Handy, Sciara, et al. 2014). It is important to note that these increases do not directly translate into decreases in VMT, as not all transit, biking, or walking trips replace driving trips, but available evidence suggests that a sizable share of trips do (Handy and Clifton, 2001; Matute, et al., 2018).

Although federal funding for highway projects dates back to the 1910s, federal funding for transit projects began in the 1960s. Active travel projects were not eligible for federal funding until the 1990s, following the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA)[11] of 1991, which

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[9] 23 U.S.C. § 135 (2017); 23 U.S.C. § 134 (2017).

[10] Public Law 114-94-Dec. 4, 2015; available: https://www.gpo.gov/fdsys/pkg/PLAW-114publ94/pdf/PLAW-114publ94.pdf. See also this summary of funding authorizations from the Eno Foundation: https://www.enotrans.org/wp-content/uploads/FASTActAuths.pdf?x43122.

[11] Public law 102-240-Dec. 18, 1991. Available: https://www.gpo.gov/fdsys/pkg/STATUTE-105/pdf/STATUTE-105-Pg1914.pdf .

established flexible categories for the first time. The latest transportation bill, the Fixing America's Surface Transportation Act (FAST-Act) of 2015, largely maintained the uneven funding split between highways and transit and continued to allow funding from flexible categories to be used for active travel projects (as discussed in Section 3.2).[12] Within the Surface Transportation Block Grant Program,[13] which was authorized at $11.7 billion per year on average, the legislation requires U.S. DOT to set aside $830 million per year, or about 7 percent, for Transportation Alternatives, including bicycle and pedestrian projects. It is important to note that although state DOTs, MPOs, and transit agencies have considerable discretion in choosing how to invest federal funds, all projects using federal funds must have U.S. DOT sign-off in the form of a project agreement. In addition, much of the transit funding is allocated through a competitive process in which U.S. DOT selects projects for the Capital Investment Grants program from those proposed by transit agencies. In recent months, transit agencies have complained about a slowdown in the process for approving funding for transit projects (Schmitt, 2018), a situation that works against the goal of reducing VMT (and improving safety). Ensuring speedy approval of these projects would help to reduce VMT at little cost to the federal government.

A strategy that directly shifts funding from highway categories to categories specific to transit and active travel would also help to reduce VMT by reducing investments in highways. When a highway expansion project results in a decrease in travel times, it in effect produces a reduction in cost for travelers, since time is an important component of the generalized cost of travel (Handy and Boarnet, 2014). Economic theory suggests that when cost goes down, consumption will go up for most goods, and in this way, highway expansion projects lead to an increase in VMT, an effect called "induced travel." Studies from the U.S. show that a 1 percent increase in highway capacity in a region can lead to a 1 percent increase in VMT over a period of time (Handy and Boarnet, 2014). Shifting funds out of highway categories would reduce the percentage increase in highway capacity and avert the increase in VMT that would have resulted.

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2.5. Social marketing: implement campaigns focused on VMT

Social marketing is another potential action for the federal government to reduce VMT. This strategy is widely used in the public health field to encourage healthier behaviors, such as smoking cessation, more exercise, and healthier eating. Social marketing campaigns in transportation have generally targeted behaviors related to safety, including seat-belt use and drunken driving. Studies show that such campaigns have been successful in changing behavior. A review of studies of the effectiveness of mass media campaigns for reducing drinking and driving found that the median decrease across the available studies was 13 percent (Elder et al. 2004). Another review also found strong evidence for the effectiveness of these campaigns (Wakefield, et al. 2010).

The federal government has played a prominent role in transportation safety campaigns for some time. In 2014, the U.S. Department of Transportation launched a national distracted driving campaign, investing $8.5 million in TV, radio, and digital advertisements (U.S. DOT, 2014). This campaign followed successful pilot programs in California and Delaware which produced a 30 percent drop in observed hand-held cell phone use. The National Highway Traffic Safety Administration (NHTSA) hosts a "risky driving" website that provides information about distracted driving, drunk driving, drug-impaired

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[12] The FAST-ACT defines specific categories for safety projects: the Highway Safety Improvement Program (HSIP) at $2.3 billion (in 2018) and the Railway-Highway Crossings Program at $235 million. Together these programs account for 6 percent of the funding for highway projects.

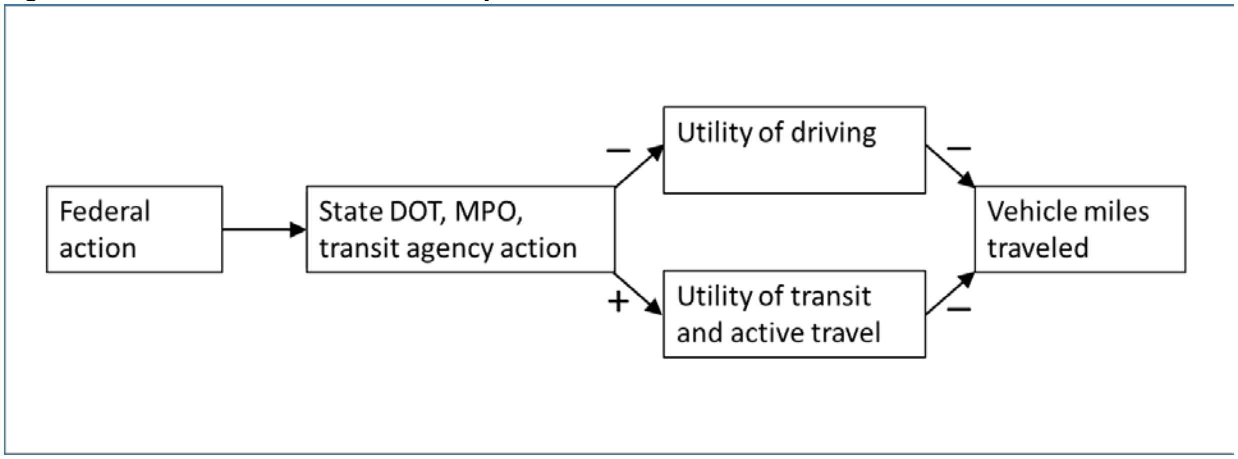
[13] 23 U.S.C. § 133 (2017).

driving, drowsy driving, speeding, and seat belts (NHTSA, 2018). It is important to note that these safety campaigns are often paired with regulation of behavior (e.g. seat-belt laws, drunk driving laws), as well as enforcement of these regulations. Their success cannot be attributed to social marketing campaigns alone. Nevertheless, a federal campaign on the safety (and other) benefits of driving less could have some impact on VMT. The cost of such a campaign would be small in comparison to the cost of expanding highways.

3. Indirect Actions

Federal policy indirectly impacts VMT in many different ways. State departments of transportation, metropolitan planning organizations (MPOs), and transit agencies[14] have primary responsibility for building and operating the transportation system as well as setting various policies about the system (Sciara and Handy, 2017). These actions directly influence the choices that travelers make about travel mode, destinations, and trip frequency, choices which together determine VMT. The federal government indirectly influences these choices by influencing the actions of agencies at lower levels of government. Several federal actions could push state DOTs, MPOs, and transit agencies towards investments that would help to reduce VMT.

Figure 2. How Federal Actions Indirectly Affect VMT



3.1 Tolls: Enable states to toll federal highways

Loosening federal policy on the use of tolls on federally-funded highways could substantially reduce VMT. Highway tolls have been used by some states for over a century as a way to pay for the cost of building and maintaining the highway. These tolls add to the cost of travel and thus would be expected to reduce vehicle travel (just as increases in the gas tax would, as discussed in Section 2.1). According to studies done in the U.S., a 1 percent increase in tolls on a given highway leads to a 0.1 to 0.45 percent decrease in traffic volume, which might translate into a comparable decrease in VMT (Boarnet, Spears et al., 2014). An Oregon study found VMT reductions of 11 to 15 percent when drivers were charged a per-mile rate in place of a gas tax (Rufolo and Kimpel, 2008); tolls imposed at a per-mile rate could have a similar effect, especially if the tolls are paid in a visible way.

In recent years a growing number of states have turned to highway tolls as a way of raising revenues to pay for highway construction and maintenance. Some areas have moved toward congestion pricing programs in which tolls are higher during peak periods; examples include the bridges in the Bay Area. But the federal government limits the ability of states to add tolls to federal-aid highways (defined as those that are eligible federal funds). In 1956, Congress explicitly established the Interstate Highway system as a tax-supported rather than toll-supported system. States are now allowed to pass toll road legislation that would impose tolls on new roads, and a variety of federal programs enable and support

[14] Local governments are responsible for the local street system, projects on which are generally not eligible for federal funding. Bicycle and pedestrian projects are an exception, but this funding flows from U.S. DOT through state DOTs or MPOs rather than directly to local governments.

tolling in specific situations. Otherwise, tolls are not allowed on existing highways that do not already have tolls (U.S. Department of Transportation, 2017)[15] meaning that the toll-free status of existing lanes on the Interstate system remains protected (Kirk, 2013). Enabling states to toll these facilities would help to reduce VMT. The administrative costs of implementing a tolling system could be offset by the tolls, and, as discussed for a gas tax increase in Section 2.1, tolls could be set to balance the effects of an increase in fuel economy to hold costs to households constant.

3.2 Flexible funding: increase flexible funding for transit and active travel

The federal government could expand the flexibility to spend federal funds on transit and active travel projects. As discussed in Section 2.4, the federal surface transportation program, as shaped by the FAST-Act,[16] consists of two types of funding categories: mode-specific and flexible. For the flexible categories, state DOTs and MPOs have the flexibility to spend funds on transit, active travel, or other kinds of projects that could reduce VMT. The primary flexible categories are the CMAQ (Congestion Management and Air Quality) program, at $2.4 billion per year, and the Surface Transportation Block Grant Program, at $11.7 billion per year; these flexible programs represent about one-third of the total highway program.

Different states and regions use this flexibility to different degrees, but the flexibility has meant more funding for transit and active travel than if the funding were in highway-specific categories (Handy and McCann, 2011). Shifting more funding from highway-specific to flexible categories would help to increase investments in transit and active travel; these investments would help to decrease VMT, as discussed in Section 2.4, at little cost to the federal government or to households.

3.3 Performance measures: require use of VMT as a performance measure

Federal requirements for performance-based planning offer another opportunity for the federal government to indirectly influence VMT. Performance-based planning requires the setting of goals and the measurement of progress towards those goals (Handy, 2008). The Moving Ahead for Progress in the 21st Century Act (MAP-21),[17] the predecessor to the FAST-Act that was signed into law in 2012, directed U.S. DOT to implement a performance management system for the federal surface transportation system. The program has six elements: national goals are set by Congress, measures are developed by FHWA to assess the performance of the transportation system relative to these goals, targets are set by recipients of federal funds (e.g. state DOTs, MPOs, transit agencies), plans are developed by federal funds recipients that outline strategies and investments to meet these goals, reports are made by funds recipients on their progress, and accountability and transparency requirements are developed by FHWA for funding recipients to use (FHWA, 2018a).

U.S. DOT has issued rules on performance measures for: pavement and bridge condition, system reliability, freight, congestion, air pollutant emissions, safety, public transportation safety, asset management, transit asset management, and planning. FHWA published the final rule on the performance measure for greenhouse gas emissions in May, 2018, repealing an earlier rule that

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[15] 23 U.S.C. § 129 (2017).

[16] Public Law 114-94-Dec. 4, 2015; available: https://www.gpo.gov/fdsys/pkg/PLAW-114publ94/pdf/PLAW-114publ94.pdf. s

[17] Public Law 112-141-Jul. 6, 2012. Available: https://www.gpo.gov/fdsys/pkg/PLAW-112publ141/pdf/PLAW-112publ141.pdf

required state DOTs and MPOs to establish targets for GHG reductions.[18] Given the strong connection between GHG emissions and VMT, the final rule on GHG measures is a set-back for efforts to reduce sVMT. When combined with more dedicated and/or flexible funding for transit and active travel projects, a requirement for a VMT performance measure could push state DOTs and MPOs toward VMT-reducing programs.

Implementing a VMT performance measure in state-wide or regional transportation planning would not be difficult. MPOs use travel demand forecasting models to predict future traffic levels given assumptions about population, land development patterns, and the transportation system (see Appendix). These models, which follow a relatively standardized approach, have traditionally been used to assess level-of-service (LOS) for passenger vehicles. LOS is determined based on the speed of vehicle travel, with higher speeds (or conversely smaller delays) assigned a higher LOS; speeds depend on the volume of vehicles relative to the capacity of a particular stretch of roadway. Forecasts of VMT are thus a component of forecasting LOS and a standard output of the travel demand forecasting models used in transportation planning.

3.4 Design guidelines: update highway and street design guidelines

The federal government can influence VMT through its influence on highway and street design guidelines. Street design influences the quality of walking and bicycling environment, affecting active travelers as well as transit users who often use active modes to access bus stops and train stations. Important design characteristics for these travelers include sidewalk and bike lane widths, separation of sidewalks and bike lanes from car traffic, shade from trees, the availability of benches, and other features. The design of the spaces for cars, including the number of lanes, lane widths, and parking spaces, influence the speed and volume of car traffic, which in turn influence the environment for active travelers. Studies in the U.S. show that walking trips are substantially higher and VMT is lower in areas with a good walking environment (Sciara et al. 2014). Projects that convert car lanes to bike lanes, sometimes known as "road diets," can increase bicycling without slowing car travel, as shown in a California study (Gudz, et al. 2016).

The FHWA influences the design of highways and streets through the standards and guidelines it issues, largely based on *A Policy on Geometric Design of Highways and Streets*, published by the American Association of State Highway and Transportation Officials (AASHTO). In issuing these guidelines, FHWA encourages "the use of flexibility and a context-sensitive approach… These adopted design standards provide a range of acceptable values for highway features, and FHWA encourages the use of this flexibility to achieve a design that best suits the desires of the community while satisfying the purpose for the project and needs of its users."[19] To improve the environment for active travelers, FHWA could go farther in requiring designs that ensure a safe and comfortable environment for active travelers and transit users, thereby helping to reduce VMT (see Section 2.4 for a review of the evidence). This could be done a little cost to the federal government and would not necessarily increase the cost of building or rebuilding roads.

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[18] Federal Register, Vol. 83, No. 105, Thursday, May 31, 2018, pp. 24920.
[19] Federal Register, Vol. 80, No. 197, Tuesday, October 13, 2015, pp. 61303; 23 CFR Part 625.

3.5 NEPA guidance: provide guidance on evaluating VMT impacts of highway projects

The federal government indirectly influences decisions about highway investments and thus VMT through the National Environmental Protection Act (NEPA). Under NEPA,[20] state DOTs must prepare environmental impact statements (EISs) for federally-funded highway projects.[21] The EIS must take a "hard look" at the potential environment impacts of the proposed project as an input to the decision making process. Accepted practices for evaluating environmental impacts for highway projects – what to evaluate and how – are shaped by federal rules issued by the Council on Environmental Quality and the FHWA but also by court decisions.

One of the issues with standard EIS practice is the evaluation (or lack thereof) of the potential increase in VMT resulting from proposed highway projects, an effect called "induced travel." As discussed in Section 2.4, induced travel occurs when a highway expansion project results in a decrease in travel times, producing in effect a reduction in cost for travelers; the reduction in cost leads to an increase in consumption, in this case VMT (Handy and Boarnet, 2014). Ignoring induced travel in environmental impact assessments leads to underestimation of the environmental costs of the project along with overestimation of its benefits in terms of congestion reduction (Litman, 2011). Under FHWA guidance on environmental impacts, induced travel would fall into the category of "indirect" impacts. Indirect impacts are "later in time or rather removed in distance, but are still reasonably foreseeable." They may include "growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects…" (FHWA, 2018b). FHWA does not provide guidance on the need or methods for estimating induced travel effects specifically, though they do provide general guidance in evaluating indirect effects (e.g. Louis Berger & Associates, Inc., 1998). Providing such guidance could ensure that the VMT-inducing potential of highway projects is taken into account by state DOTs and MPOs in deciding which projects to fund. Because VMT is a standard output of travel demand forecasting models, as discussed in Section 3.3 and the Appendix, which are also used to assess environmental impacts for highway projects, the additional cost of evaluating induced travel effects would be minimal, though some regions would need to invest in improvements to their models to conduct this analysis

A related problem is the wide-spread focus on level-of-service (LOS) as a measure of environmental impacts rather than VMT. LOS is determined based on the speed of vehicle travel, with higher speeds (or conversely smaller delays) assigned a higher LOS. The traditional focus on LOS impacts has contributed to the use of capacity expansion as an environmental mitigation strategy, despite the negative environmental impacts of such expansions. Some cities and states are moving to include VMT as a performance measure alongside LOS; California is going farther in requiring the use of VMT rather than LOS. California's Senate Bill 743 of 2013[22] explicitly recognized the limitations of using LOS as a measure of environmental impacts and required the adoption of a more appropriate measure. Under the direction of Governor's Office of Planning and Research, the state is shifting to VMT as a key measure of environmental impact given its direct contribution to air pollutant and GHG emissions. Senate Bill 743 also requires the analysis of induced vehicle travel for state highway system projects; OPR has issued technical advisory on this need as well as a simple method for calculating such impacts (OPR, 2018). Caltrans has not yet updated its own CEQA guidance (Caltrans, 2005).

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[20] 42 U.S.C. § 4321-4335 (2017).

[21] 23 C.F.R. § 771-772 (2017).

[22] Available: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB743 .

3.6 Leadership: provide leadership on an accessibility-oriented planning approach

The federal government also influences the transportation system and thus VMT through the leadership it provides over transportation planning throughout the U.S. The prevailing approach to transportation planning has been slowly shifting towards a focus on the needs of people to access to jobs and services, an "accessibility-oriented" approach, rather than a focus on cars and the speed of their movement, a "mobility-oriented" approach (Handy, 2006). An accessibility-oriented approach acknowledges that societal needs for transportation can be met with less VMT and thus less economic and environmental cost. Strategies include investments in transit and active modes but also land use policies that reduce distances to destinations. Studies from the U.S. show that land use policies that increase density, land-use mix, and proximity to regional centers have the potential to reduce VMT (Boarnet and Handy, 2014; Spears, Boarnet, Handy, and Rodier, 2014; Handy, Tal, and Boarnet, 2013b).

The federal government can play a leadership role in encouraging and facilitating this shift. The Intermodal Surface Transportation Efficiency Act of 1991,[23] for example, emphasized a new way of thinking about the transportation system (Sciara and Handy, 2017), enabling funding for active travel for as well as more flexible funding categories for the first time, as discussed earlier. Subsequent transportation bills have maintained these principles, though other priorities have recently come to the fore. U.S. DOT can play a leadership role in furthering this shift through its rules and guidance on transportation planning. A shift from mobility-oriented measures to accessibility-oriented measures, for example, as a part of the performance management system discussed in Section 3.3, could have a substantial effect on the plans and investment decisions of state DOTs and MPOs. Under the previous administration, U.S. DOT elevated "livability" as a top priority, a concept consistent with an accessibility-oriented approach. The cost to the federal government as well as state DOTs and MPOs would be minimal, given that the travel demand forecasting models already in use can produce measures of accessibility (as well as VMT) with relatively little work. The benefits to households, who would be able to meet their needs with less driving, could be substantial.

[23] Public law 102-240-Dec. 18, 1991. Available: https://www.gpo.gov/fdsys/pkg/STATUTE-105/pdf/STATUTE-105-Pg1914.pdf .

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Appendix: Projecting the Effect of Federal Policies on VMT

A variety of possible federal actions have the potential to reduce vehicle miles of travel (VMT), as summarized in this report. The potential VMT effects of each strategy can be estimated in two general ways: based on estimated effects sizes derived from empirical studies, or using travel demand forecasting models. Each approach has important limitations.

Empirical studies of the type cited in this report provide estimates of the effect of a strategy on VMT based on observations of the real world. These observations are often cross-sectional, meaning that the VMT in different places with or without the strategy (or with varying degrees of the strategy) are compared. Stronger evidence comes from longitudinal studies in which changes in VMT are linked to changes in the strategy over time in a given place. For example, Gillingham (2014) estimated the elasticity of VMT with respect to gas prices using data on gas prices and VMT from California for the period 2001 to 2009. For strategies that affect the price of travel, the effect size is reported as an elasticity, that is, the percent change in VMT that occurs in response to a 1 percent change in price.

Using estimated effect sizes to forecast total effects for a given area, whether a region, a state, or the nation, is not straightforward for several reasons (Boarnet and Handy 2017):

1. Effect sizes are likely to depend on the particular context; effect sizes estimated for a particular time and place may not be applicable to other times and/or places. For most of the strategies discussed here, the number of available studies is too small to be able to estimate how the effect size varies by context.
2. Effect sizes are calculated based on a specific range of that strategy, for example, a particular range of gas prices. If the proposed strategy is beyond this range, the estimated effect size may no longer apply. Thus the estimated effects of a strategy that produces a large change in the factor that affects VMT (e.g. gas prices) are more uncertain than those of one that produces a small change.
3. The overall impact of a strategy will depend not just on the effect size but also on the extent of the strategy, including the geographic area for which it is implemented, the population to which it applies, and/or the degree to which that population adopts it. The effect of a telecommuting program, for example, depends on how many employees choose to telecommute and how often.
4. For many strategies, the effect measured in the available studies is not the effect on VMT but the effect on another outcome that has some connection to VMT. In these cases, additional assumptions must be made as to the degree to which the first effect translates into a VMT effect. For example, as noted in the report, studies of bicycling facilities and transit investments generally report their effect on the use of these modes rather than VMT, and other studies show that not all of the increase in these modes translates into a decrease in VMT.

For these reasons and others, it is not possible to quantify the precise impact on VMT of possible federal actions (including changes in fuel efficiency) using effect sizes derived from the empirical literature. Projections based on this approach are generally used as an indication of the possible magnitude of the effect of the strategy rather than as a forecast of the likely effect. This is a “back of the envelope” approach.

Instead, state DOTs and metropolitan planning organizations (MPOs) rely on sophisticated travel demand forecasting models to assess the potential impact on VMT of proposed strategies, particularly highway and transit investments as well as pricing policies. Federal law requires “valid forecasts of future demand for transportation services” but does not specify the method for producing those forecasts (except for regions in non-attainment for air quality standards, in which case minimum specifications for travel models must be met). The Federal Highway Administration (FHWA, 2018) explains that “these forecasts are frequently made using travel demand models, which allocate estimates of regional population, employment and land use to person-trips and vehicle-trips by travel mode, route, and time period. The outputs of travel demand models are used to estimate regional vehicle activity for use in motor vehicle emissions models…. And to evaluate the impacts of alternative transportation investments being considered in the transportation plan.”

The type of travel demand forecasting model traditionally used by state DOTs and MPOs is called a “four-step model” and is usually developed at the scale of a metropolitan region. In the first step, “trip generation,” the model forecasts the number of trips produced in or attracted to each geographic zone based on forecasts of population characteristics and the number and type of jobs, respectively. In the second step, “trip distribution,” the model forecasts the flow of trips from each geographic zone to every other geographic zone as a function of the number of productions and attractions for each zone and the travel time between zones given an assumed roadway network. In the third step, “mode split,” the flow of trips between each pair of geographic zones is divided among the different transportation modes (usually driving alone, carpooling, and transit) based on relative travel costs (including the time cost) for each mode. In the fourth step, “trip assignment,” each car trip is assigned to the roadway network based on the estimated travel time along the possible routes between the starting zone and the ending zone, taking into account the route assignments of all the other car trips. The output of the model is a forecast of the traffic volume on each segment of the road network for a specified period of time, usually the morning or evening rush hour. Traffic volumes are generally converted to measures of level-of-service (reflecting the ratio of volume to capacity) but the model can also produce an estimate of VMT for the network. The method is explained in more detail in a two-hour webinar produced by FHWA (2010).

These models represent a far more sophisticated approach to forecasting the impacts of possible strategies than the effect-size method described above. Most important, they take into account the characteristics of the region (its population and economy, its patterns of development, and its transportation system) that will influence the effect of the strategy. In addition, they account at least to some degree for interactions within a metropolitan system and may capture secondary effects of the strategy. That said, these models have important limitations. They do not account for all interactions or capture all secondary effects. They do not provide a way to represent all of the strategies reviewed in this report and thus cannot provide forecasts for these strategies, including bicycle and pedestrian improvements and travel demand management strategies. The models are best suited for forecasting the effect of an increase in the gas tax and relatively effective in forecasting the effects of other strategies that change the cost of travel. Significantly, the models assume that the behavior of travelers will remain fundamentally the same in the future as it was at the time the data used to develop the model were collected, for example, that the importance of cost to travelers remains the same in the future, even if the cost itself changes. Some of the larger metropolitan regions have adopted more sophisticated modeling approaches, such as activity-based models, that address some of these limitations, but these models still assume some consistency in the fundamentals of travel behavior.

Although travel demand forecasting models are clearly superior to the effect-size approach for estimating the effects on VMT of proposed strategies for metropolitan regions, their usefulness at larger scales is more limited. Some states, California, for example, have developed state-wide models that enable an analysis of the effects of state-wide policies. A nation-wide model does not exist, not surprising given the complexity and computational demands of such models. A forecast of the effect of possible federal actions on VMT nationwide could in theory be generated by forecasting the effects in a sample of metropolitan regions using their travel demand forecasting models and extrapolating these results to the nation as a whole.

Appendix References

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