MODAL EQUITY CONSIDERATIONS

We examine existing literature on the costs different modes of transportation impose on the transportation system as well as the charges they pay to cover these costs. Direct and indirect costs are considered. Direct costs are those related to the use of roadway facilities and their deterioration, and external costs are costs imposed by users of the transportation system on other users and non-users such as congestion and environmental costs. In terms of charges paid, we consider user fees. We limit our assessment to “user fees”, in particular motor fuel taxes, as they are levied directly to the use of the road, just as a distance-based fee would. Additionally, distance-based fees are likely to replace the motor fuel tax in the future. Much of the existing research is presented either in terms of costs to the system or in terms of revenues generated by a particular mode. There is little research linking the costs imposed by different modes with the revenue they generate through taxes or fees.

The transportation modes are divided into individual mobility and shared mobility. Individual mobility considers passenger vehicles (cars, SUVs, passenger trucks/vans) and trucks (single and combo units, and light- and heavy-duty vehicles). Shared mobility includes carpooling and vanpooling as well as ridesourcing services provided by Transportation Network Companies (TNCs) -such as Uber and Lyft-, and carsharing services that provide their customers either one-way trips (Car2Go) or two-way trips (Zipcar and Hourcar). Conversations related to fuel internal combustion engine (ICE) passenger vehicles and electric vehicles (EVs) are included for all transportation modes.

General Findings

- Transportation costs include direct costs for the use of the transportation system as well as indirect costs imposed on other users and non-users of the system, such as congestion and environmental costs.
- Proceeds from user fees -such as the motor fuel tax- have diminished over time are not sufficient to cover all the direct costs associated with the use of the transportation infrastructure.
- User fees do not account for external costs associated with congestion and environmental damages. Dynamic pricing tries to account for these costs.

Individual Mobility

- Heavier vehicles impose higher costs on the transportation infrastructure, but it is unclear whether they contribute correspondingly to the cost they impose.
- EVs contribute to transportation infrastructure funding through sales taxes and registration taxes.
- EVs contribute relatively less than ICE vehicles in terms of the motor fuel tax, although EVs and ICE vehicles generate comparable road damage. Some states have implemented additional registration fees for EVs to cover the costs they impose on the transportation infrastructure.

- EVs are expected to impose lower environmental costs compared to ICE vehicles, but there are still some costs associated with the source of energy used to power electric vehicles when considering the entire life cycle of the vehicle. Depending on the energy source, the external costs imposed by EVs could be higher.

Shared Mobility

- Empty trips (trips made to cruising for passengers by ridesourcing services) are likely to increase the use of transportation infrastructure and congestion. The costs imposed are not fully covered by the current charges. Some states are now levying taxes or fees on ridesourcing services.
- Shared mobility has the potential to increase vehicle occupancy, and reduce vehicle ownership, and thus has the potential to reduce road deterioration, congestion, and environmental damages. Some states have a lower tax or fee levied on shared TNC trips in order to encourage this type of use.
- Round-trip and one-way carsharing have both been found to contribute to a reduction in vehicle miles traveled, which can in turn reduce societal costs imposed by private mobility.

In this section, we examine existing literature on the costs that different modes of transportation impose on the transportation system as well as the charges they pay to cover these costs. In terms of the costs, we consider direct costs, related to the use of roadway facilities and their deterioration, and external costs, which are costs imposed by users of the transportation system on other users and non-users such as congestion and environmental costs. In terms of charges paid, we consider user fees. We limit our assessment to "user fees", in particular motor fuel taxes, as they are levied directly to the use of the road, just as a distance-based fee would. Additionally, distance-based fees are likely to replace the motor fuel tax in the future. We do not include other transportation revenues generated through vehicle sales, registration, or lease, since fees and taxes are related to the transaction, ownership or usage right, not to the use of the road. It is important to note that much of the existing research is presented either in terms of costs to the system or in terms of revenues generated by a particular mode. There is little research linking the costs imposed by different modes with the revenue they generate through taxes or fees.

The transportation modes included in this report are divided into individual mobility and shared mobility. Individual mobility refers to passenger vehicles (cars, SUVs, passenger trucks/vans) and trucks (single and combo units, and light- and heavy-duty vehicles). Shared mobility includes carpooling and vanpooling as well as ridesourcing services provided by Transportation Network Companies (TNCs) -such as Uber and Lyft-, and carsharing services that provide their customers either one-way trips (Car2Go) or two-way trips (Zipcar and Hourcar). For all transportation modes, we include conversations related to fuel internal combustion engine (ICE) passenger vehicles and electric vehicles, which are divided into two categories: plug-in hybrid electric vehicles (PHEVs) and battery-electric vehicles (BEVs).

Costs Imposed on the Transportation System

Transportation modes impose costs on the transportation system including direct and external costs. Direct costs are those costs directly related to the use of road facilities and road deterioration; while external costs are those costs imposed by users of the transportation system on other users and non-users such as congestion and environmental costs. Private costs such as maintenance and repairs, and depreciation costs are excluded.

One of the most comprehensive reports on transportation costs and benefits is developed by the Victoria Transport Policy Institute (Litman, 2011). Litman estimated twenty-three transportation costs for eleven transportation modes and concluded that the price structure is both inefficient and inequitable. The price structure is inefficient as there is no incentive to limit driving and it does not mitigate/avoid problems such as traffic congestion and pollution, among others. It is inequitable as people must bear significant costs imposed by others.

Table 1 presents Litman's estimated costs per vehicle mile for different transportation modes. Included costs are related to roadway facilities, congestion, and environmental costs for urban (peak and off-peak travel) and rural travel. Roadway facilities refers to road construction and operating expenses not paid by user fees, congestion includes congestion costs imposed on other road users, and environmental costs include air pollution, greenhouse gas (GHG) pollution, and water pollution.

Table 1: Per Vehicle Mile Cost Estimates (2007 US Dollar)

Transportation Mode	Average Occupancy	Road Facilities		Congestion		Environmental Costs	
		Urban Peak	Urban Off Peak	Urban Peak	Urban Off-Peak	Urban Peak	Urban Off-Peak
Average Car	1.1	0.026	0.026	0.130	0.020	0.095	0.083
Compact Car	1.1	0.026	0.026	0.130	0.020	0.079	0.069
Electric Car	1.1	0.064	0.064	0.130	0.020	0.028	0.024
Van or Pickup	1.1	0.035	0.035	0.130	0.020	0.152	0.132
Rideshare Passenger	1	0.000	0.000	0.000	0.000	0.002	0.002
Diesel Bus	25	0.048	0.048	0.270	0.040	0.293	0.260
Electric Trolley	30	0.048	0.048	0.270	0.040	0.116	0.100
Motor-cycle	1	0.014	0.014	0.130	0.020	0.129	0.109

Note: *Rideshare passenger costs are defined as the incremental cost of an additional passenger, assuming that the vehicle will be driving anyway.* ***Source:*** *Data from Litman (2011).*

According to the estimates, all transportation modes impose a higher cost on roadway facilities than what is paid through user fees. Roadway facility costs for electric vehicles are higher as they do not pay fuel taxes. Average, compact, electric cars, vans, and light trucks impose about the same congestion costs. Buses and trolleys are considered to impose twice that cost. Per vehicle costs are higher for transit modes, but when comparing passenger costs, personally owned vehicles impose higher costs. Overall, ridesharing tends to have the lowest costs.

Deterioration of the Roadway System

The deterioration of the roadway system, which includes pavements and bridges, is caused by many factors including traffic, pavement materials, the environment, and excessive vehicle weight (Wilde, 2014). Most of the studies on this topic agree road impacts vary with the type of vehicle and its used capacity, the weight distribution per axle, and the type of road.

In terms of private mobility, it is documented that heavy-duty vehicles can cause several times the damage to roads than light-duty vehicles. Wilde summarized that heavier private mobility options, such as vans and pick-up trucks can cause 7 times the amount of damage to roads than private mobility options that are lighter, like sedans and compact cars (see Table 2).

Table 2: Road Impact by Vehicle Type

Vehicle Type	Number of Axles	ESAL Factor	Passenger Car Equivalents
Cars	2	0.0008	1
Vans/Pickups	2	0.0052	7
Large Pickups/Delivery vans	3	0.0122	15
Large Delivery Trucks	3	0.1303	163
Local Delivery Trucks	2	0.1890	236
Residential Recycling Trucks	2	0.2190	274
Buses	2 or 3	0.6806	851
Residential Trash Trucks	3	1.0230	1,279
Long Haul Semi-Trailers	3-5+	1.1264	1,408

Source: *Data from Wilde (2014)*

Gibby, Kitamura and Zhao (1990) estimated that, on a typical roadway, the average annual maintenance cost per heavy truck is $7.60 per mile per year, and the corresponding cost per passenger car is $0.08. Furthermore, each additional heavy truck will cost an additional $3.73 per mile per year for pavement maintenance, while each additional passenger car increases costs by $0.04 (see Table 3). Similarly, Zhao and Wang (2015) estimated that the unit pavement damage costs induced by trucks are in the range of $0.005-$0.04 per ESAL-mile for the Interstate highways and $0.05-$0.61 per ESAL-mile for minor roads. These values depend on the discount rate, pavement structure, and rehabilitation strategy (full reconstruction and milling & overlay). Additionally, heavy trucks can cause even more pavement damage when they are loaded beyond the legal limit. Pais, Amorim and Minhoto (2013) explored the impact of overloaded vehicles on pavement and concluded that overloaded vehicles can increase costs by 100 percent compared to those vehicles loaded at the legal limit.

Table 3: Maintenance Costs per Mile of Roadway

	Average Annual Maintenance Cost per mile	Marginal Annual Maintenance Cost per mile (1)
Passenger Car	$0.08	$0.04
Heavy Truck	$7.60	$3.73

Note: *(1) The marginal annual maintenance cost per mile is the maintenance cost imposed by each additional vehicle. S**ource:** Data from Gibby, Kitamura and Zhao* (1990).

The deterioration of the roadway system caused by shared mobility varies depending on the type of service. Recent literature recognizes that ridesourcing services are more likely to increase vehicle miles traveled (VMT) (Rayle, Dai, Chan, & Cervero, 2016; Schaller, 2017; Henao, 2017; Clewlow & Mishra, 2017). These services contribute to VMT growth by diverting users from walking and biking into a driving mode, as well as by drivers cruising for passengers. Regarding carsharing services, Martin and Shaheen (2016) found that the use of free floating carshare had two types of impact on customers driving behavior and amount of driving. First, a majority of the members used the service for incidental mobility, which increases driving. Second, a smaller number of members used the carsharing service in place of a personal vehicle and/or sold or suppressed purchase of a private auto. The reduction in VMT seen when users delayed or suppressed the purchase of a car far outweighed the addition of VMT by users who used the service for incidental mobility. These authors also found that round trip carsharing leads to a reduction of 28 and 43 percent in VMT per year per household (Shaheen & Cohen, 2018). The changes in VMT observed as a result of shared mobility use are important as roadway damage caused by light-duty vehicles is directly related to the number of miles driven by those vehicles (McMullen, Zhang, & Nakahara, 2010).

It should be noted that these outcomes in VMT reduction and behavior change resulted from both free-floating and a two-way carsharing models. These two types of carsharing serve different purposes and different use cases, but both contribute to a reduction in the negative externalities of privately-owned vehicles. There are currently no free-floating car-share operators in Minnesota, though the City of Saint Paul, along with HOURCAR have proposed a one-way, stationed-based, all-electric service (City of St. Paul, 2019).

Automation and electrification of the shared mobility fleet could also have some impacts on vehicle weight, which impacts transportation infrastructure. According to the Alliance to save energy, automation could add some weight to vehicles due to the equipment required for operations (Information Communication Technologies, Shared Mobility and Automation Technical Committee, 2018). But it can also eliminate the need for vehicle components (such as steering wheels, foot pedals, and transmission control among others) which could reduce vehicle weight. More research in this area is needed to determine the real impact.

Congestion

Congestion costs are a continuing topic of debate in the US. One of the most critical congestion costs is the increased time of travel, that is, time spent in travel that could be devoted to other pursuits, such as earning income or engaging in leisure activities (Federal Highway Administration, 2008). Other costs include the increase in travel time unreliability; excess fuel usage; increased emissions and environmental damage; higher accident rates and safety costs; higher inventory, maintenance, and operating costs; and loss of productivity (HDR, 2009).

Private mobility is a large contributor to congestion. As Thomson & Bull (2006) describe, different vehicles cause different amounts of congestion. Vehicles receive Passenger Car Units (PCU) ratings based on their disruption to traffic and the amount of road they occupy relative to a passenger vehicle.

For instance, a passenger car has a PCU rating of 1, while a bus has a PCU of 3. The congestion caused by a bus is higher than congestion caused by a passenger vehicle, however, when considering the congestion caused per occupant (50 for the bus and 1.5 for the passenger vehicle, on average) each passenger vehicle occupant causes 11 times as much congestion as each bus passenger.

When it comes to shared mobility and congestion, a study in San Francisco found that ridesourcing services increased three factors indicative of congestion: delay, VMT, and speed (San Francisco County Transportation Authority, 2018). Population and employment growth in the area also contributed to an increase in congestion but about 50 percent of the increase can be attributed to ridesourcing services (San Francisco County Transportation Authority, 2018). Another study found that many types of shared mobility, including peer-to-peer, carsharing, and ridesourcing do not contribute to reductions in congestion or carbon emissions (Santos, 2018). In addition, this study suggests that ridesourced vehicles where multiple passengers share a ride with people headed in the same direction have the potential to reduce congestion and carbon emissions. Unfortunately, this mode of shared mobility is the least appealing to customers.

Environmental Costs

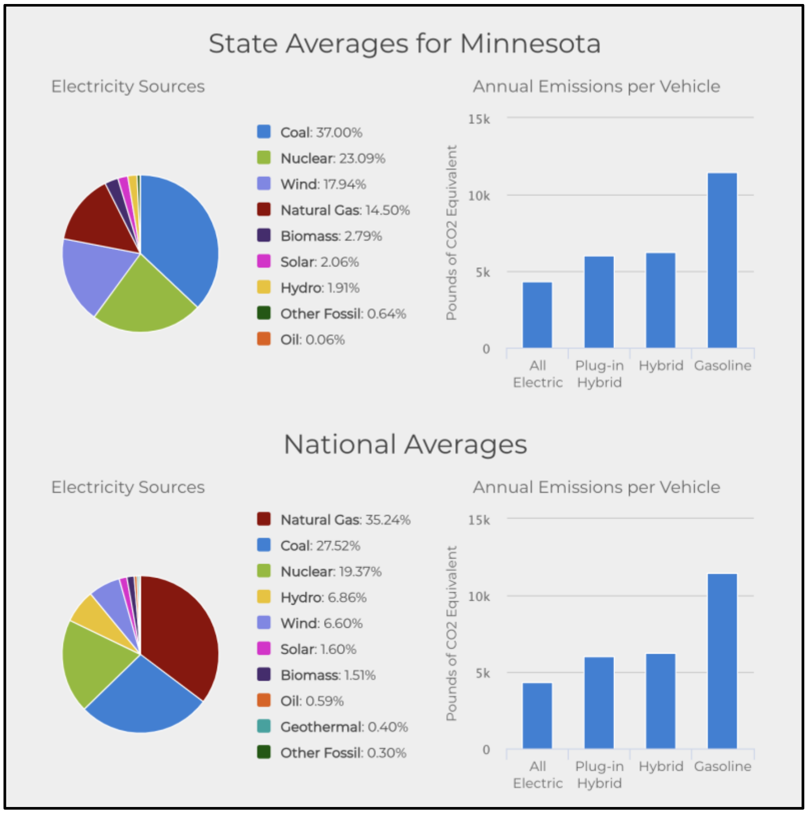
Environmental costs include air pollution, greenhouse gas (GHG) emissions, water pollution, and hydrologic impacts, etc. Air pollution refers to emissions from vehicles that can impact human health such as fine particulates, carbon monoxide, and methane among others. GHG emissions such as carbon dioxide and monoxide contribute to climate change. Pollution of water systems comes from run-off that washes lubricants, road salt, automotive chemicals, and particles from tires. Additionally, impervious paved surfaces like roads and parking lots can cause increased runoff and flooding, among other impacts (Litman, 2011).

According to the U.S. Environmental Protection Agency (2019) light-duty vehicles are the largest emitters of GHGs followed by heavy-duty trucks. In 2017, these types of vehicles accounted for 82 percent of total GHG emissions (59 and 23 percent, respectively). Buses and rail together accounted for only 3.15 percent. Per vehicle, those powered by diesel contribute more GHG emissions. Monahan & Friedman (2004) point out that burning a gallon of diesel leads to the release of 17 percent more GHG than does burning a gallon of gasoline. For instance, an average 40-passenger diesel bus must carry a minimum of 7 passengers on board to be more efficient than the average single-occupancy vehicle (U.S. Department of Transportation, 2010).

Among transportation modes, it is estimated that an automobile that gets 20 miles per gallon contributes $0.006 per mile of greenhouse gas externalities (Harford, 2006). When comparing ICE with EVs, EVs are seen as a “greener” transportation choice. The environmental friendliness of BEVs and PHEVs depends on the method used to generate the electricity that fuels the vehicle. For example, in Minnesota, 37 percent of electricity is still generated from coal (

Figure 1). This is important considering all types of coal emit more carbon dioxide per million British Thermal Units of energy produced than gasoline does (U.S. Energy Information Administration, 2019). In

Minnesota, an EV accounts for 4,303 pounds of carbon dioxide emissions per year, on average, while an ICE vehicle accounts for 11,435 pounds of carbon dioxide emissions per year, on average.



Source: *U.S. Department of Energy (2019)*

Figure 1: Summary of Electricity Sources

Additionally, while EVs on the roadway can produce less carbon emissions than ICE vehicles, EVs still have a cradle to grave (C2G) carbon footprint. A cradle to grave carbon footprint refers to the GHG emissions produced from the production, operation, fuel pathways (source and production of fuel), and disposal of vehicles. The literature highlights that the manufacturing impact of EVs is higher compared to the one of ICE vehicles. For Amgad Elgowainy, et al. (2018), there are 26 percent more GHG emissions associated with the manufacturing of BEVs compared to ICE vehicles. According to Del Pero, Delogu, & Pierini (2018), the manufacturing impact of BEVs is higher with respect to the one of ICE vehicles due to the high contribution from the production of battery and electric motor as well as other powertrain components which present a high content of aluminum. EVs appear to involve higher life cycle impacts than ICEs for acidification, human toxicity, particulate matter, photochemical ozone formation and resource depletion. This greater load in the production of BEV is largely compensated by the lower use stage impact, which leads to a 36 percent reduction of total life cycle impact with respect to ICEs. The reason for this is the absence of exhaust emissions during operations as well as the lower environmental burdens involved in the production of electricity compared to the fuel supply chain.

BEVs have the potential to reduce the impact on climate change in comparison with ICEs, but this is true only if the electricity consumed by car is produced from non-fossil energy sources (Del Pero, Delogu, & Pierini, 2018). On the contrary, the use of fossil energy carriers for electricity production can strongly reduce the environmental benefit of BEVs and even lead to an increase in GHG emissions. According to Asaithambi, Treiber, & Kanagaraj (2019), EVs in China produce more CO2 emissions compared to ordinary ICE vehicles whereas than in Germany, the US, and Japan produce less emissions. Current ICE vehicles produce C2G emissions of approximately 450 grams of carbon dioxide equivalents per mile (*gCO2e/*mi) while C2G emissions from HEVs, PHEVs, Hydrogen EVs, and BEVs range from 300-350 gCO2e/mi. In the future, with improvements in vehicle efficiency, ICE vehicles are expected to produce C2G emissions of around 350 gCO2/mi while EVs are anticipated to generate around 250 gCO2e/mi (Amgad Elgowainy, et al., 2018). Overall, the impacts of EVs are highly dependent on vehicle operation energy consumption and the electricity mix used for charging.

Regarding shared mobility, Shaheen and Cohen (2018) found that roundtrip car sharing leads to a reduction of 34-41 percent of GHG emissions. In addition, the electrification and automation of the shared mobility fleet are expected to minimize energy consumption and associated emissions. Greenblatt and Saxena (2015) found that integrating shared and automated technologies could result in decreased U.S. per-mile GHG emissions in 2030 per vehicle deployed of 87–94 percent below current conventionally driven vehicles. These technologies can enable GHG reductions even with an increase in total VMT, average speed, and vehicle size.

When it comes to carpooling, a potential conflict exists between congestion reduction offered by carpooling and vanpooling and the increased emissions these modes might lead to. Concas and Winters (2007) suggest that carpooling dissuades people from combining maintenance and discretionary trips with commuting trips, or trip-chaining. A departure from trip-chaining leads to maintenance and discretionary trips being made outside of the commuting schedule. This discontinuity of trips leads to more “cold starts” of vehicles, which is ultimately more polluting than engaging in the same trip when the vehicle is already warm. A “cold start” is when a vehicle is started after having not run for an hour or more. Trips made under a cold start condition can lead to up to 5 times more pollution.

Charges to cover the Costs Imposed on the Transportation System

Proceeds from user fees are not sufficient to cover transportation costs and are supplemented through appropriations from the general fund. Bishop-Henchman (2013) found that fuel taxes, tolls, and other local user fees and taxes covered 32 percent of total spending on state and local roads in 2010.[1] This share varied from 59.3 percent in Delaware to 5.2 percent in Alaska. In Minnesota, these transportation

[1] The author defines road spending as motor fuel tax revenue and highway revenue divided by highway spending.

special revenues covered 23.6 percent of road spending.[2] Of the total highway funding in the U.S., 23.4 percent comes from general fund appropriations.[3] At the federal level, general funds appropriations make up to 37.5 percent of total highway funding, while at the state level they represent 7.9 percent. In Minnesota, general appropriations to supplement highway funding began in 2018 and accounted for 4 percent of the revenues of the Highway User Tax Distribution Fund (MnDOT, 2020) – the other 96 percent corresponds mainly to revenues from the motor fuel tax, registration tax, and the vehicle sales tax.

Proceeds from the motor fuel tax are projected to continue to decline, due to inflation, improved fuel efficiency and stagnation in driving (Dutzik & Weissman, 2015). Projected increases in fuel efficiency due to technological advances in ICE vehicles and the addition of hybrid electric vehicles will reduce the per-mile fuel tax paid by 25 percent (before inflation) from 2010 to 2030 (Weatherford, 2011). Because of this degradation in revenue-raising capacity of the fuel tax, the Highway Trust Fund is, and will continue to be, underfunded unless the fuel tax is regularly increased, or a different solution is put in place. As Coyle et al (2011) note, the fuel tax is an inefficient revenue-generating system as it provides weak price signals to users by not charging for the full costs their road use imposes on society. This underpricing leads to over-use of the road, inefficient transportation investments by the government, and sprawling land uses due to the perceived low costs of commuting. In addition, fuel taxes have little impact on demand for vehicle travel as they often go unnoticed by users and do not account for the higher costs imposed by road use during times or within zones of high congestion.

Regarding trucks, the Federal Highway Administration (2000) reported that combination trucks (more than 50,000 and less than 100,000 pounds) paid only 80 percent of the federal-scale costs they imposed on highways via user fees in 2000, with the largest trucks paying only half of their responsibility.

Regarding passenger cars, it is noted that hybrid and electric vehicles contribute less in tax revenue than ICE vehicles. Jenn, Azevedo and Fischbeck (2015) estimated that, under the current funding structure, midsize and compact vehicles (e.g., Toyota Camry and Honda Civic) generate between $2,000 to $4,000 in tax revenue over their lifetime, and half of which are accrued from fuel taxes. For less fuel-efficient vehicles (e.g., F-150) revenue generation is between $3,000 to $6,000 over the lifetime of the vehicle. PHEVs (e.g., Chevrolet Volt) and BEVs (e.g., Nissan Leaf) generate substantially less at $1,500-$2,700 and $400–$1,300, respectively.

Some states have adopted an additional registration fee that applies to hybrid and electric vehicles to make up for lost gas tax revenues. This fee typically applies in addition to the standard motor vehicle registration fee. As of October 2018, 20 states have enacted legislation requiring a special registration fee for electric vehicles (see Figure 2). Further research is needed to assess the capacity of the fee to

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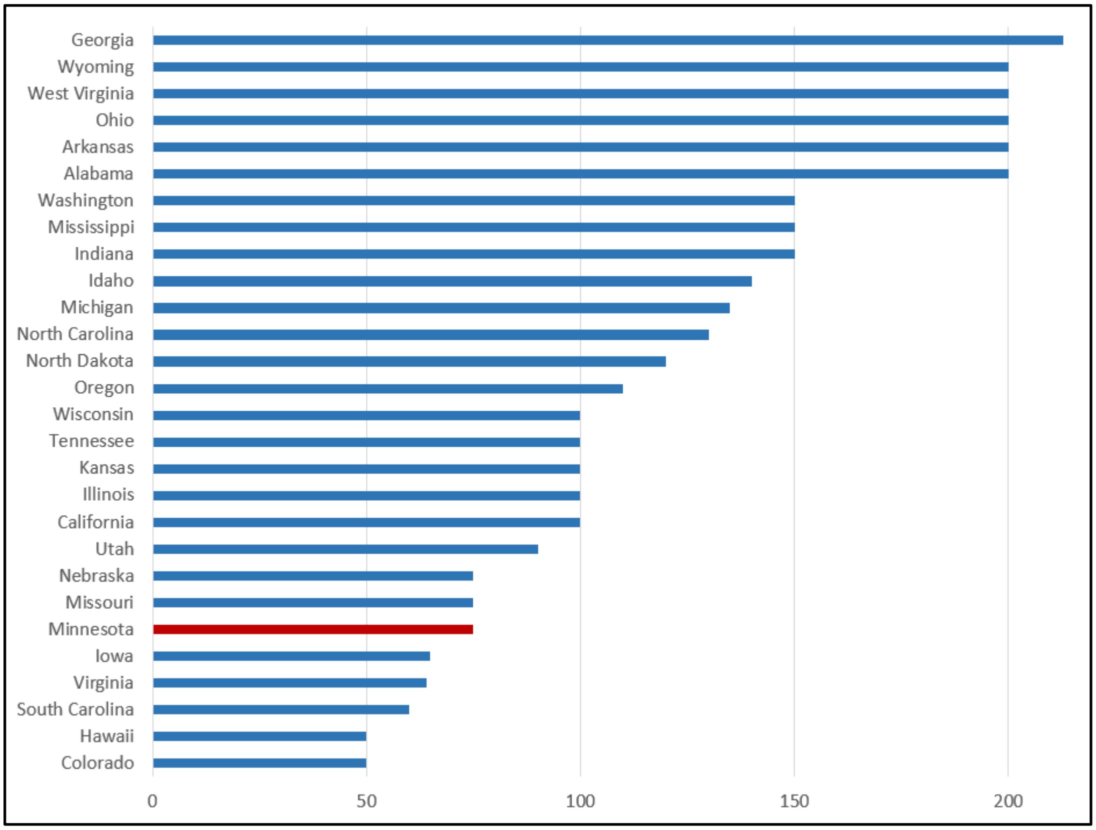
[2] Other sources of roadway funding are from local efforts, mainly through the levy of local property taxes (Zhao, Lari, & Fonseca, 2018).
[3] Information from Batic Institute and AASHTO Center for Excellence. "Transportation Funding and Financing" retrieved from http://www.financingtransportation.org/funding_financing/funding/

cover the costs for the use of the transportation infrastructure. These fees are typically flat fees that do not provide a direct price signal to the users about their road use and other indirect costs. Additionally, these fees need to be adjusted by the legislature to cover the increasing costs of transportation, which has generated resistance in several states. The state of Washington, for instance, attempted to pass legislation in 2019 that would cap vehicle registration fees at $30.[4] This limit on registration fees would cost the state six billion dollars in revenue used for transportation projects over the next six years.



Source: *National Conference of State Legislatures (2018). New Fees on Hybrid and Electric Vehicles.*

Figure 2: Fees on Electric Vehicles in Different States

In addition to these fees, states like Virginia, California, Florida, Minnesota, and Texas have implemented a form of congestion pricing including high occupancy travel (HOT) lanes and express toll lanes. Studies in these states have found that congestion pricing strategies are successful in changing

[4] There is an ongoing legal case in the state of Washington on the implementation of Initiative 976 - which would cap the registration fee at $30. News article from The Oregonian "Washington's $30 car tab measure blocked by judge" (Nov 27, 2019) retrieved from https://www.oregonlive.com/news/2019/11/washingtons-30-car-tab-measure-blocked-by-judge.html

driving behavior. In Minnesota, in particular, it is found that MnPASS users travel approximately 25 mph faster during peak periods than non-users, with a 3-4 mph speed gain for non-users (Federal Highway Administration, 2017; Virginia Department of Transportation, 2019). Proceeds from this pricing strategy pay for MnPASS operations and maintenance in the corridor (up to $1 million or 75 percent of the revenue, whichever is less). The remaining proceeds are split between MnDOT costs associated with the operation of the program and infrastructure improvements in the corridor (25 percent), and for bus transit improvements in the corridor (75 percent) (MnDOT, 2019).

Most heavy-duty vehicles are fueled with diesel. At the state level, some states imposed a higher tax on a gallon of diesel than on a gallon of gasoline, some impose the same amount per gallon. At the federal level, the motor fuel tax is higher for diesel than for gasoline (U.S. Energy Information Administration, 2019). The difference in charges could account for (i) higher damage to the transportation infrastructure (heavier vehicles tend to use diesel), and (ii) higher environmental costs imposed by the use of diesel. In Minnesota, particularly, vehicles powered with diesel pay the same amount per gallon in state motor fuel tax than vehicles powered with gasoline.

Lastly, in terms of shared mobility, some states have started to levy fees and taxes on ridesourcing trips (Zhao, Fonseca, & Zeerak, 2019). Although the majority of localities use these strategies to cover regulatory costs or fill budgets, a few are using the proceeds to improve transportation infrastructure such as Massachusetts, Nevada, and Maryland. In New York (in NYC the fee is part of a congestion pricing strategy) and the District of Columbia, proceeds are used to support transit services. In New Jersey and New York, the fee varies for solo- and shared-trips, and typically shared-trips pay a lower charge. Given the recent adoption of these measures, more research is needed to determine how much of the costs imposed on the systems are recovered through these fees as well as their modal equity implications.

Conclusions

Transportation modes impose direct costs related to the use of the transportation infrastructure, as well as indirect costs by contributing to congestion and pollution. User fees, such as the motor fuel tax, are applied to different transportation modes to generate revenue intended to cover the costs they impose on the system. The proceeds generated from these fees, however, are generally insufficient to cover the direct costs, and rarely account for the indirect costs. Highway user taxes and fees nationwide, for instance, made up just 32 percent of total spending on state and local roads in 2010. In Minnesota, user fees only covered 23.6 percent of spending on roads in the same year.

Two major vehicle characteristics differentiate the costs imposed and the proceeds generated by individual mobility: vehicle type and source of power. Cost impacts of individual mobility modes on road infrastructure vary by vehicle type. In particular, studies agree heavier vehicles impose higher costs on the transportation infrastructure. Often, heavy vehicles are fueled with diesel, which tends to be taxed at a higher rate, but it is more likely that they do not contribute correspondingly to the infrastructure costs they impose. Large trucks only paid 80 percent of the federal costs imposed on the system, while the largest trucks only contributed 50 percent. In terms of the power source, electric vehicles cause comparable road damage as their ICE counterparts since there is little difference in weights between the two types of vehicles. However, EVs contribute little or nothing through the motor fuel tax to cover the costs they impose on transportation infrastructure.[5] Electric vehicles provide an opportunity to reduce the environmental impacts of individual mobility, but the full environmental impact reduction of EVs depends on the source of electricity. In Minnesota, 37 percent of our electricity is still derived from coal which produces up to 71 more pounds of carbon per million British Thermal Units of energy produced than gasoline.

Much of the infrastructure and congestion impacts from shared mobility are caused by TNC drivers circulating and moving between customer pick-ups (empty trips). Currently, the tax and fee structure for TNCs does not cover the costs imposed by the modes, but some municipalities have imposed specific fees for these services. Shared mobility has the potential to increase riders per vehicle and reduce vehicle ownership, which reduces VMT. To encourage shared trips in ridesourcing services, some states have lowered the fee imposed on these trips.

[5] Electric and hybrid vehicles contribute through the motor vehicle sales tax and registration fees.

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