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The road mileage user-fee: Level, intensity, and predictors of public support

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ABSTRACT

The road mileage user-fee is viewed as a promising alternative to the fuel tax, which in recent years has proven to be an inadequate means of financing road infrastructure. Public opposition is often thought to be a barrier to the political feasibility of the road mileage user-fee. We use a nationally representative public opinion survey to investigate the level and intensity of support for replacing the fuel tax with a general mileage user-fee and with three specific modes of administration of the fee. Our results confirm that public opposition to the adoption of mileage user-fees to address the growing revenue inadequacy of fuel taxes is high, with the number of opponents exceeding the number of supporters by a ratio of 4-1. Furthermore, public support is somewhat sensitive to respondents' belief in the user-pays principle and perceptions of the characteristics of the mode of administration. Additionally, relative to supporters, those who oppose the mileage user-fee are more likely to state that they are willing to take political action against the adoption of mileage user-fees.

1. Introduction

The fuel tax has grown increasingly inadequate as a means of financing road infrastructure in the United States. The annual tax revenue generated by the federal fuel tax is more than $20 billion lower than the $54 billion required each year to maintain highway performance at its current level (Kile, 2011). Similar shortfalls exist at the state level. For example, a panel of experts in Colorado found that the state would face a funding gap of $51 billion by 2030, even if the state settled for simply sustaining the current transportation system (Ungemah et al., 2013).[1]

There are two primary explanations for the inability of revenues to keep up with expenditure requirements: the gasoline tax rate is rarely adjusted for inflation in the cost of road construction, maintenance, and repairs, and it collects less revenue as cars become more fuel efficient (Wachs, 2007). The federal fuel tax rate was last changed in 1993. Although 10–12 states changed their tax rates in any given year between 1998 and 2011, only 27 of the 50 states changed their gasoline tax rates over this period, and those states that have changed the rate have typically done so only once. Since the unit cost of roadway construction and repairs has risen substantially during this period, the purchasing power of the revenues from the gasoline tax has been eroded (Wachs, 2007).[2]

The other growing source of revenue shortfall is the increase in fuel economy of new motor vehicles in response to stricter regulations. The federal government is raising passenger vehicle mileage standards from about 25 miles per gallon in 2005 to more than 50 miles per gallon by 2025 (Mitchell and Terlep, 2011). For the first time, new commercial trucks, including heavy-duty trucks, will also be required to achieve steady and significant gains in fuel economy (Harrington and Krupnick, 2012). Additionally, the state of California is requiring that at least 15% of all new passenger vehicles sold in the state run on electricity (or otherwise achieve zero emissions) by 2025 (CARB, 2013). As average vehicle fuel economy increases, the amount of fuel consumption and fuel tax revenues declines, even when an adjustment is made for the boost in miles of travel due to the lower marginal cost of traveling (CBO, 2012).[3]

With inflation adjusted revenues falling and construction, main-

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[1] Existing evidence points to similar funding shortages in other states: New York (Peters and Gordon, 2009), Alabama (Sisiopiku et al., 2006) and New Mexico (Cambridge Systematics, 2007).

[2] The national highway construction cost index increased rapidly between the first quarter of 2003 (baseline) and mid-2006. Although there was a significant decline during the recession (2007–2009), the index has resumed its upward trend since 2009. The data are available here: https://www.fhwa.dot.gov/policyinformation/nhcci.cfm.

[3] The fuel tax is almost always a per unit tax on the volume of fuel consumed instead of an ad-valorem tax on the value of fuel purchased.

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tenance, and repair costs increasing, governments across the country have been searching for solutions. One policy option is the use of a mileage user-fee, which – in its simplest form – is a charge for each mile of vehicle travel (Associated Press, 2009; Kost, 2009; Sorensen et al., 2010a, 2010b). Although there are concerns regarding perceived invasion of privacy, administrative costs, and reduced incentives for buying less fuel efficient vehicles, this solution is seen as promising by a number of transportation and public finance scholars because of its revenue-raising capability and its respect for the user-pays principle (Wachs, 2007; Kost, 2009; Duncan and Graham, 2013). In fact, twenty three states have commissioned mileage user-fee studies, and the single most important motivation for this increased attention given to mileage user-fees in US states is their ability to generate revenues in the face of a "dying" fuel tax.[4]

Although mileage user-fees appear to be gaining traction among policy makers in the US, a key determinant of adoption is public acceptability.[5] The objective of the current study, then, is to provide information on public opinion regarding the replacement of fuel taxes with mileage user-fees to address the growing revenue inadequacy of fuel taxes. Specifically, we address the following four research questions:

1. What is the overall level of support for or opposition to a mileage user-fee that is meant to replace existing gasoline taxes? Does it vary by administration mode and/or by level of government administering the fee?
2. Does support/opposition vary by respondent sociodemographic, political and driving characteristics?
3. Does support/opposition vary by respondent perceptions regarding characteristics of the technology used to collect mileage data (e.g., privacy, convenience, fairness) and/or the extent to which respondents support the user-pays principle?
4. What is the intensity of support for/opposition to replacing the gasoline tax with a mileage user-fee? Does the intensity vary by administration mode?

Our analysis focuses exclusively on the revenue motivation for adopting mileage user-fees so the results do not account for the ability of mileage user-fees to address congestion and emissions externalities. Nonetheless, we believe that the revenue motivation is important on its own given the current focus in the US on addressing the inadequacy of the fuel tax.[6]

The remainder of the paper is structured as follows. Section 2 describes road user-fees and highlights the importance of mileage collection technology. Section 3 provides a brief literature review, and the empirical approach including survey design, sample selection, and model specifications are described in Section 4. The results are presented in Section 5 and discussed in Section 6. We conclude in Section 7.

2. Road user-fees

Road user-fees are direct charges levied for the use of roads. These charges are assessed through different pricing strategies which include per-use, distance, and/or time-based fees (FHWA, 2016). The fees typically focus on congestion and peak-hour demand management, environmental externalities resulting from excessive road usage, and revenue generation for road construction and maintenance.

A key feature of distance-based road user-fees (mileage user-fee hereafter) is the mileage-collection technology. Collection technology can be classified into two broad categories: odometer and electronic monitoring. The mileage information recorded by the odometer can either be self-reported or recorded via inspection by a government official. Electronic monitoring devices have the option to transmit mileage information wirelessly, but differ greatly in the amount of information they collect and transmit; some devices collect number of miles only, while others also collect location and/or time-of-travel information. The choice of collection technology is crucial because it affects the characteristics of any proposed user-fee, including costs, convenience, privacy, fairness, compliance, and pricing flexibility (e.g., to account for inter-state travel and congestion pricing). For example, while the odometer readings raise few privacy concerns, there are concerns about compliance, and it does not facilitate pricing flexibility. In contrast, GPS-based systems allow for flexible pricing, but are subject to privacy concerns and are more expensive to implement. Therefore, the choice of mileage-collection technology might affect public support through its effect on the characteristics of the fee.

Although there is a very extensive literature on road user-charges, we are not aware of any study that identifies the effect of mileage-collection technology on public support (see Section 3). A key contribution of our paper is to identify the impact of mileage-collection technology on support for mileage user-fees. Our analysis focuses on three types of collection technology: self-reporting odometer readings; basic-GPS, which collects and transmits only the number of miles driven, and advanced-GPS, which collects and transmits miles driven as well as the time and location of each mile that is driven.

3. Literature review

Road user-charges is the subject of a vast academic literature including a substantial number of studies focusing on public attitudes (Jaensirisak et al., 2005; Dieplinger and Fürst, 2014). We classify this literature into two broad categories: one focusing on social and environmental *externalities* and the other on *revenue generation*. Studies in the former category tend to focus on the change in travel behavior across pricing strategies or on the determinants of acceptability of road pricing schemes often with little or no information about the collection technology. They find support in the range of 10% (Schlag and Schade, 2000) to 50% (Agrawal et al., 2009), and that acceptability depends on allocation of collected revenues (Harrington et al., 2001; Schuitema and Steg, 2008), belief about expected consequences of pricing policies on own car use (Guo et al., 2011; Whitty, 2013), financial costs (Kallbekken et al., 2013), and perceptions of equity and fairness (Jakobsson et al., 2000; Fujii et al., 2004; Hiramatsu, 2010).[7]

A similarly low level of support is found in studies that focus on replacing gasoline taxes. For example, Ellen et al. (2012) find support of 39% for a 1.6¢-*per*-mile tax in the state of Georgia, while HNTB Corporation (2012) finds that 23% of the US population supports a federal mileage user-fee. However, these studies do not specify the technology used to collect mileage data. Agrawal and Nixon (2014), in a study more closely related to ours, find that 19% of the US population support replacing the gas tax with a 1¢-*per*-mile tax administered with electronic meters that track mileage. They find that support increases to 43% if the mileage rate varies with vehicle emissions, thereby serving as an anti-pollution policy.

Our study makes several important contributions to the branch of the literature that focuses on *revenue generation* (e.g., Harrington

[4] Table A1 in the online appendix provides a list of the states that have given serious consideration to the adoption of mileage user-fees.

[5] Evidence that mileage user-fees are gaining traction in the US is presented in Table A1 of the online appendix where we document the studies that have been done on mileage user-fees across US states. There have been 6 pilot programs across 16 states so far. Additionally, Oregon began implementing a voluntary mileage user-fee in July of 2015.

[6] We acknowledge that efficiency and equity are other important factors to consider when deciding whether or not to adopt a mileage user-fees.

[7] See Zmud (2008) and Anas and Lindsey (2011) for a more detailed summary of this branch of the literature.

et al., 2001; Weinstein et al., 2006; Agrawal and Nixon, 2010; 2011; 2013; 2014; Hanley and Kuhl, 2011; Agrawal et al., 2012; Duncan et al., 2014a).[8] First, we are the first to provide public opinion on support for three administrative modes and a general mode of mileage user-fee in a nationally representative sample in order to address our first research question.[9] Existing studies either focus on a single mode (e.g., Agrawal and Nixon, 2014) or self-selected samples in pilot studies (e.g., Buxbaum, 2006; Whitty, 2007; Nevada DOT, 2010; Hanley and Kuhl, 2011).[10] Our study design allows us to comment on the extent to which administrative mode matters for support, which is important since there are competing technologies for administering mileage user-fees. Second, our study design allows us to understand (a) whether respondents with particular sociodemographic, political or driving characteristics are more or less likely to support mileage user-fees as a replacement for the gasoline tax (Research Question #2), and (b) whether respondent reactions to claims about the characteristics of each mode (e.g., convenience, fairness, privacy) are associated with opposition to mileage user-fees (Research Question #3). Unlike previous studies, we also collect data on the public's view of the user-pays principle, which allows us to say whether opposition is driven by a fundamental belief that roads should be financed from general fund revenue sources rather than dedicated user-charges. This collection of perception data is an important deviation from the existing literature (e.g., Ellen et al., 2012) because knowledge of respondents' perceptions allows policy makers to address specific areas that drive opposition.

Finally, we analyze four measures of the intensity with which people hold their views across administrative modes in order to answer our fourth research question. Variation in these measures across administrative modes provides useful information about how difficult it is likely to be for policy makers to convince opponents to support mileage user-fees as a replacement for fuel taxes.

4. Empirical strategy

This section begins with a description of the survey instrument before outlining the econometric specifications used to answer the research questions.

4.1. Survey data

The data are taken from a public opinion survey that was designed and sponsored by the Indiana University School of Public and Environmental Affairs (SPEA) and conducted in August and September 2013 by GfK Custom Research. Our research questions focus on the adoption of mileage user-fees as a solution to the revenue inadequacy of the fuel tax in the US. As a result, the survey is framed in the context of revenue generation for the sole purpose of road maintenance, repairs and construction. We achieve this context by presenting respondents with a series of prompts that highlight the current and future fuel tax revenue shortages facing federal and state governments.[11] Below is a description of the survey.

4.1.1. Description of administration modes

4.1.1.1. Mode design. We first ask respondents for their opinion about a generic mileage user-fee that provides no specific information about how the fee would be administered; we call this the *general* mode since it is designed to elicit a reaction to the concept of a mileage user fee. Respondents are then presented with three alternative modes of administering a mileage user-fee: an *odometer* mode that requires vehicle owners to report their own mileage; a *basic-GPS* mode that collects only information on the number of miles travelled; and an *advanced-GPS* mode that collects mileage, location, and time data. For each mode, survey respondents are informed that fee payments can be made monthly, quarterly, or annually. They are told that odometer readings can be submitted in person or online, and that the GPS readings will be transmitted wirelessly to their state department of motor vehicles.

We also inform respondents that 10% of drivers in their state will be randomly selected for auditing and that cheaters will be fined and possibly serve jail time if caught. Finally, half of the respondents (randomly selected) are told that they will have to pay $250 for the GPS device and its installation and half of the respondents are told that the government will pay $250 for the GPS device and its installation. This design was chosen based on pilot studies and features that are likely or expected to be implemented in actual mileage user-fees in order to create realistic conditions.

4.1.1.2. Mode characteristics. The modes vary with respect to start-up cost to vehicle owners, perceived invasion of privacy, opportunity to tamper with tracking and thereby evade taxes, and convenience of reporting. To get a sense of how observable these differences are to participants and whether or not the differences affect willingness to support, participants are asked whether they agree or disagree with several statements that characterize each mode.[12] One example statement is: “Most people will honestly report the mileage on the odometer in their cars.”.

4.1.1.3. Mode questions. After the statements about characteristics of the modes of administration, a question is posed as to whether the respondent would support replacing the gasoline tax in their state with the mileage user-fee mode they had just reviewed. The specific questions used for the *general* mode are:

> *Would you be in support of or opposed to **replacing** the gasoline tax with a mileage user-fee?*

This is followed by a three-part question meant to determine how the level of governmental administration matters in a very general sense:

> *Please indicate your degree of support for or opposition to the following options (strongly support, support, oppose, strongly oppose) (NOTE: Options were presented in randomized order.)*

- *Your **state replaces** its gasoline tax with a **state** mileage user-fee.*
- *The **federal** government **replaces** its gasoline tax with a **federal** mileage user-fee.*
- *The states and the federal government **replace** their gasoline taxes*

[8] This branch of the literature also includes a long list of public opinion polls, which are summarized in Zmud (2008) and Agrawal and Nixon (2014). Duncan et al. (2014a) employ the same survey as the present study, but focus explicitly on the impact of design features related to technology cost and privacy on public willingness to support mileage user-fees.

[9] We use the term *mode* to refer to the different technologies that can be used to collect mileage data and transfer this information to the government.

[10] Pilot programs are test runs of mileage user-fees that mainly seek to test the technology required for successful implementation. These are generally implemented with drivers who volunteer to participate for a specific time period. Six pilot programs covering 16 states have been implemented so far (Table A1 in the online appendix).

[11] The prompts that set up the context of the survey are shown in the questionnaire, which is available in Appendix F of the online appendix. The main prompts are on page 1 of the survey and the text that follows question 9 of the survey.

[12] The complete list of statements used for each mode is reported in Appendix B of the online appendix.

with mileage user-fees.

Similar questions are asked specifically for the *odometer*, *basic* GPS, and *advanced* GPS modes:

> *Would you be in support of or opposed to* ***replacing*** *the gasoline tax in your state with a mileage user-fee based on odometer/basic GPS/advanced GPS readings?*
> *For this question, please think about a federal level mileage user-fee. Would you be in support of or opposed to* ***replacing*** *the* ***federal*** *gasoline tax with a* ***federal*** *mileage user-fee based on odometer/basic GPS/advanced GPS readings?*

Every participant responds to questions about the *general* mode and then the *odometer* mode, before being randomly selected to answer questions about the *basic* GPS and then *advanced* GPS or the *advanced* GPS and then the *basic* GPS.

4.1.1.4. Intensity of support/opposition. In addition to measuring the level of support for mileage user-fees, we also measure the intensity of support in a way that allows us to quantify how intensity of support/opposition varies across modes. Intensity of support is captured in four ways that differ primarily in how much it would likely cost a participant to express support/opposition. First, participants respond to questions using a four-point Likert scale measuring self-reported intensity of support/opposition.[13] Second, participants indicate whether they would sign a petition supporting/opposing each mode. Third, participants indicate whether they would write a letter to or email their legislator to express support for or opposition to each mode.

Finally, participants report whether they would contribute $1, $5, $10, $20, $30, $40, $50, or more than $50 to a political campaign in support of or in opposition to a given user-fee mode, depending on whether they earlier indicated that they support or oppose each mode. Financial contribution was determined using a series of Yes/No items where each respondent was first asked whether she would give $10. If the respondent answered yes, this amount increased in $10 increments until she said no or $50 was reached, whichever came first. If the respondent answered no to $10, this amount decreased to $5 and then to $1. This series of questions allows us to determine how much participants are willing to spend in order to support candidates or groups who share their views on this issue. The four questions also allow us to determine if the intensity of support is stronger than the intensity of opposition, which then gives us a sense of how easy or difficult it would be to move public opinion, which tends to be an influential consideration in the formation of many tax policies.

4.1.2. Other questions

The survey also included a number of questions that are relevant to understanding mileage user-fee support/opposition. We ask participants whether they agree or disagree with four alternative revenue sources for road maintenance, construction, and repair: higher fuel tax rate, higher retail sales tax rate, higher personal income tax rate, and greater reliance on tolls. We also collect data on perceived quality of and need for roads, acceptability of benefit-based financing for roads, and driving-related characteristics, such as number of vehicles owned, fuel economy of vehicles, number of miles driven weekly, use of interstate highways, and use of public transportation.

Individual socioeconomic, demographic, and political characteristics are provided by GfK as part of their standard set of variables available for panel members. These include age, sex, marital status, household income, employment status, education, Census geographic region of residence, political party affiliation, and political ideology.

4.1.3. Representativeness of sample

The web survey was fielded to a nationally representative sample of 3325 US adults 18 years of age or older from GfK's KnowledgePanel®. The KnowledgePanel® is a probability-based online panel. Members are recruited using random-digit dialing and address-based sampling methods that include both households with and without internet access, thus providing nearly complete coverage of the US population.[14] Probability-based internet panels have advantages compared to random-digit dialing telephone surveys and other methods, including the potential for reduced measurement error, lower cost, and increased timeliness (Chang and Krosnick, 2009; Yeager et al., 2010).

The survey was fielded from August to September 2013. We obtained 2142 respondents, for an American Association for Public Opinion Research Completion Rate (COMR) of 64% among panel members. Approximately 2.5% of respondents (55 respondents) were removed from the sample due to short survey completion time, which leaves us with a sample of 2087 respondents.

Data are weighted to adjust for unequal probabilities of selection and to reflect Current Population Survey estimates of the US population on demographic characteristics, including age, sex, race/ethnicity, education, household income, home ownership status, internet access, Census region, and metropolitan area status. The weighted distribution of respondents in our sample, with the exception of age and employment status, is comparable to the 2013 estimates from the Current Population Survey (see Table C1 in the online appendix). Standard errors have been adjusted to account for weighting.

4.2. Econometric specifications

This section describes the econometric specifications used to address our research questions.

4.2.1. Level of support

We estimate the ordinary least squares model represented in Eq. (1) in order to determine whether level of support differs across the modes.

$$S_{im}=\alpha+\beta_{odometer}M_{odometer}+\beta_{basic}M_{basic}+\beta_{advanced}M_{advanced}+\varepsilon_i, \quad (1)$$

S is a dummy variable, which is equal to one if individual i supports mode m, and zero otherwise, M is a dummy variable for each of the respective modes, and ε is a random error term. The parameter α is the share of subjects who support the generic mileage user-fee and the betas tell us how support for each mode differs from the level of support for the generic mileage user-fee. The results from Eq. (1) are presented in Table 1.

Because we are interested in understanding the association between support for mileage user-fees and various individual-level and mode-specific characteristics, we estimate Eqs. (2) and (3) separately for each mode. The models are estimated using a logit regression, and the odds ratios from Eq. (2) are reported in Table 2, while those from Eq. (3) are presented in Tables 3 and 4.[15]

$$S_i=\theta+\gamma X_i+\xi_i, \quad (2)$$

$$S_i=\theta+\delta userfee1_i+\gamma X_i+\delta Y_{im}+\varsigma_i, \quad (3)$$

[13] We relied on a four-point scale because we wanted every participant to make a choice in favor of or against. Even those participants who are likely neutral on the issue are likely to be leaning one way or the other. Having a four-point scale forces these participants to express the direction in which they are leaning. There is also evidence that providing a neutral option may encourage respondents to short cut developing an accurate answer and instead they may select a middle response as an easy way to respond (a behavior known as "satisficing") (Krosnick and Presser, 2010).

[14] Although participants are recruited to the KnowledgePanel® using random-digit dialing and address-based sampling methods, all members of the panel participate in online surveys via the internet with their own computer or a laptop and ISP connection provided by GfK at no charge.

[15] The results are the same if a linear probability model is estimated instead of a logit model. We chose the logit specification for ease of interpretation via odds ratios.

Table 1
Support for mileage user-fees by mode of administration.

Modes	Share who support at state level	General mode	Odometer mode	Basic GPS mode	Share who support at federal level
General mode	0.211	–	–	–	0.221
	(0.011)	–	–	–	(0.011)
Odometer	0.216	0.005	–	–	0.189
	(0.011)	(0.009)	–	–	(0.011)
Basic GPS	0.152	−0.059***	−0.064***	–	0.144
	(0.01)	(0.011)	(0.01)	–	(0.01)
Advanced GPS	0.133	−0.078***	−0.083***	−0.019**	0.128
	(0.009)	(0.011)	(0.01)	(0.008)	(0.009)
N	2077	2077	2077	2077	2077

Notes: Standard errors – clustered on individuals – are in parentheses. The first column reports the share of participants who support each mode of the mileage user-fee at the state level. Columns 2–4 report how support for each mode (indicated in rows) differs from support for the mode indicated in the respective column titles (at the state level). The last column reports the share of respondents who support each mode of mileage user-fee at the federal level.
*** Significant at 1%.
** Significant at 5%.

S is the same as defined above and X is a vector of demographic, political, and socio-economic characteristics, including age, sex, marital status, household income, employment status, education, Census geographic region of residence, political party affiliation, number of vehicles owned, number of miles driven, and use of interstate roads. *Userfee1* is a dummy variable that takes a value of one if individual i agrees that those who use the road should pay more than those who do not use the road or only those who use the road should pay, and zero otherwise. Y is a vector of mode-specific characteristics that are described in Appendix B of the online appendix (e.g., Most people will honestly report the mileage on the odometer in their cars.), and ξ and ς are random error terms.

4.2.2. Intensity of support

We capture intensity in four ways: (a) four-point Likert-type scale, and willingness to (b) sign a petition, (c) write or send an email to a legislator and (d) contribute money to a political campaign for each mode. We check whether the willingness to take a given political action differs between supporters and opponents by estimating the linear probability model in Eq. (4), separately for each mode and political action.

$$P_i^a = \alpha + \beta S_i + \epsilon_i \quad (4)$$

P is a dummy variable equal to 1 if respondent i is willing to take political action a, and S is a dummy variable equal to 1 if respondent i supports the mileage user-fee, and ϵ is a random error term.[16] Results from this exercise are presented in Panels B–D of Table 5.

5. Findings

This section describes our findings beginning with a description of the level of support for the mileage user-fee across various modes of administration. We then describe the intensity of support/opposition by analyzing respondents' willingness to take political action in support

[16] It is possible that respondents overstated their willingness to take action in favor of their position on mileage user-fees. However, to the extent that supporters and opponents are equally likely to overstate their willingness to take action then the differences in intensity between supporters and opponents would be unbiased. Of course, one could argue that opponents are more likely to overstate willingness than supporters. If this is the case, then the differences are upper bounds.

Table 2
Association between individual characteristics and support for mileage user-fee.

Variables	**General mode**	**Odometer mode**	**Basic GPS mode**	**Advanced GPS mode**
Age	1.006	1.004	1.008	1.007
	(0.005)	(0.005)	(0.006)	(0.006)
Gender (ref=Female)	1.111	1.048	1.120	1.058
	(0.151)	(0.145)	(0.176)	(0.182)
Race (ref=White)				
Af. Am./black	1.103	1.100	1.264	1.475
	(0.278)	(0.280)	(0.338)	(0.421)
Hispanic	1.044	1.106	1.048	1.140
	(0.244)	(0.262)	(0.289)	(0.315)
Other/ multiracial	1.252	1.797**	2.192***	1.981**
	(0.365)	(0.527)	(0.650)	(0.629)
Education (ref=Less than HS)				
High school (HS)	0.973	1.481	0.679	0.775
	(0.254)	(0.395)	(0.185)	(0.215)
Some college/ associate's degree	1.039	1.242	0.723	0.723
	(0.269)	(0.331)	(0.202)	(0.212)
Bachelor's degree or higher	1.148	1.428	0.839	0.734
	(0.296)	(0.375)	(0.224)	(0.214)
Employed	1.039	0.999	0.870	0.778
	(0.164)	(0.149)	(0.157)	(0.157)
Head of household	1.072	1.025	1.067	1.008
	(0.238)	(0.219)	(0.262)	(0.262)
Region (ref=Northeast)				
Midwest	1.148	1.040	0.924	0.653
	(0.244)	(0.226)	(0.228)	(0.173)
South	1.297	1.361	1.092	1.144
	(0.253)	(0.274)	(0.243)	(0.265)
West	1.199	1.390	0.985	1.019
	(0.265)	(0.305)	(0.255)	(0.276)
Married	0.942	0.911	0.920	0.910
	(0.153)	(0.151)	(0.172)	(0.195)
Party affiliation (ref=Republican)				
Moderate	1.238	1.353*	1.204	1.087
	(0.205)	(0.234)	(0.252)	(0.245)
Democrat	1.447**	1.253	1.495*	1.373
	(0.260)	(0.237)	(0.328)	(0.320)
# of vehicles owned (ref=zero)				
One vehicle	0.728	0.879	0.903	1.340
	(0.267)	(0.344)	(0.437)	(0.640)
Two vehicles	0.817	1.080	0.666	1.251
	(0.303)	(0.432)	(0.335)	(0.624)
Three vehicles	0.844	1.290	0.817	1.116
	(0.322)	(0.527)	(0.406)	(0.566)
More than three vehicles	0.651	1.076	0.381	0.893
	(0.274)	(0.498)	(0.252)	(0.560)
Miles driven per week (ref=0 miles)				
1–49 miles	1.224	0.936	0.759	0.611
	(0.443)	(0.364)	(0.372)	(0.294)
50–99 miles	1.455	0.978	1.066	0.768
	(0.556)	(0.402)	(0.547)	(0.388)
100–199 miles	1.269	0.758	1.069	0.652
	(0.502)	(0.320)	(0.563)	(0.338)
200–299 miles	1.866	1.253	1.192	1.226
	(0.770)	(0.556)	(0.655)	(0.662)
300 or more miles	1.142	0.609	1.023	0.420
	(0.503)	(0.288)	(0.585)	(0.251)

(continued on next page)

Table 2 *(continued)*

Variables	General mode	Odometer mode	Basic GPS mode	Advanced GPS mode
Interstate usage (ref=once every 1–2 months or less)				
Couple of times a month	0.730*	0.835	0.978	0.812
	(0.130)	(0.151)	(0.215)	(0.179)
1–3 days a week	0.726	0.750	0.782	0.754
	(0.151)	(0.158)	(0.197)	(0.196)
4–7 days a week	0.768	0.747	0.717	0.561**
	(0.149)	(0.150)	(0.163)	(0.151)
Constant	0.126***	0.125***	0.170***	0.170***
	(0.057)	(0.058)	(0.081)	(0.080)
Log likelihood	−1014.24	−1018.56	−815.30	−740.49
N	2017	2017	2020	2018

Notes: Reported are the odds ratios from a logit regression. Dependent variables are dichotomous variables equal to 1 if the respondent supports replacing the gasoline tax with a mileage based user-fee under the *general*, *odometer*, *basic* GPS, and *advanced* GPS mode for columns 1 through 4, respectively, and 0 otherwise. *Party affiliation* is constructed from a 7-point Likert scale where the *Moderate group* includes individuals who '*Lean Republican*', '*Lean Democrat*' or are '*Undecided/Independent/Other*'. All models are estimated with sample weights and robust standard errors are in parentheses.

** Significant at 5%.

*** Significant at 1%.

* Significant at 10%.

Table 3
Determinants of support for general mileage user-fee.

Variables	Model 1	Model 2	Model 3	Model 4
Userfee1	2.824***	2.970***	1.621***	1.721***
	(0.384)	(0.417)	(0.277)	(0.304)
Need for road work (ref=urgent or significant need)				
Some need		0.858		0.797
		(0.140)		(0.152)
Little or no need		0.762		0.687
		(0.146)		(0.166)
Easy to calculate			2.484***	2.547***
			(0.486)	(0.514)
Accurate			5.140***	5.417***
			(0.989)	(1.090)
Unfair to rural drivers			0.868	0.910
			(0.193)	(0.202)
Unfair to drivers who drive a lot for work			0.473***	0.439***
			(0.095)	(0.090)
Invasion of privacy unless voluntary			0.440***	0.436***
			(0.081)	(0.081)
Unfair to fuel efficient vehicle owners			0.502***	0.465***
			(0.088)	(0.082)
Constant	0.174***	0.116***	0.217***	0.147***
	(0.017)	(0.057)	(0.057)	(0.096)
Covariates included	No	Yes	No	Yes
Log likelihood	−975.03	−957.72	−722.61	−705.45
N	2008	2004	2008	2004

Notes: Reported are the odds ratios from a logit regression. Dependent variable for models 1 through 4 is a dichotomous variable equal to 1 if the respondent supports replacing the gasoline tax with a *general* mileage based user-fee and 0 otherwise. Models 2 and 4 include controls for age, gender, race, region, employment, head of household, marital status, education, party affiliation, miles driven, number of vehicles owned, and use of interstate. *Userfee1* is a dummy variable that takes a value of one if individual *i* agrees that those who use the road should pay more than those who do not use the road or only those who use the road should pay, and zero otherwise. All models are estimated with sample weights and robust standard errors are in parentheses.

*** Significant at 1%.

of or in opposition to the mileage user-fee across various modes of administration.[17]

5.1. Level of support for mileage user-fee

The results presented in Table 1 indicate that approximately 21% of respondents support an effort to replace the gasoline tax with a state-level *general* mileage-based user-fee. We find a similar level of support for the *odometer-based* mileage user-fee. As shown in the second column, support is much lower for mileage collection technology that relies on the use of GPS. We also find no evidence that the level of government administering the mileage user-fee matters for support; support is weak for both state and federally administered mileage user-fees.

Next, we explore the association between support for mileage based user-fees and individual characteristics in Table 2 which reports odds ratios from Eq. (2). We find that support for mileage user-fees is not associated with most individual characteristics including age, gender, race, education, employment status, region of country, marital status, number of vehicles owned, and miles driven per week. While it may appear that support is higher among those who identify their race as other or multiracial, this group constitutes less than 10% of the total number of respondents. Thus, we are cautious in interpreting this finding. There is some evidence that self-described Republicans and individuals who use the interstate system extensively are less likely to support mileage user-fees.[18]

The analysis described above is extended to include respondents' perceptions of mode-specific characteristics in order to determine whether any of these characteristics are associated with opposition to the mileage user-fee.[19] The odds ratios from Eq. (3), which are presented in Table 3, indicate that respondents who agree with the user-pays principle of taxation as defined by *userfee1*, that is, they agree that those who use the road should pay more than those who do not use the road or only those who use the road should pay, are 2.8 times more likely to support a *general* mileage user-fee than respondents who do not.[20] This result is unchanged when we add the full set of covariates from Table 2 (see model 2 of Table 3). Importantly, model 2 also indicates that belief about the need for new or expanded roads is not associated with the likelihood of supporting mileage user-fees. We then include characteristics of the *general* mileage user-fee in model 3 and find that while respondents' perceptions of the ease of calculation and accuracy of administration are positively correlated with support for the mileage user-fee, privacy concerns, unfairness to individuals who have to drive a lot for work, and unfairness to those who drive fuel efficient cars are negatively correlated with support for the mileage user-fee. Model 4 of Table 3 shows that the results are robust to the inclusion of individual demographic, political, and driving behavior characteristics.

Results presented in Table 4 show that respondents' perceptions of mode-specific characteristics also matter for each administration mode. In particular, perceptions of invasion of privacy, high out-of-pocket costs, and increased inconvenience are associated with low

[17] In the interest of space, we describe the respondents' perceived quality of and need for roads, as well as the acceptability of the benefit principle as a means of distributing the cost of financing roads, in Appendix D of the online appendix. See Duncan et al. (2014b) for detailed analysis of the benefit principle in the context of road financing and Duncan et al. (2016) for a detailed analysis of support for alternatives to the mileage user-fee.

[18] The results presented in Table 2 continue to hold even if we add demographic, socioeconomic, and political variables in the model sequentially, which suggests that findings are not driven by multicollinearity.

[19] These include convenience of reporting, accuracy of mileage data, fairness, privacy, and cost of technology. In the interest of space, we provide a summary of respondents' perceptions of the characteristics of each mode in Appendix E of the online appendix.

[20] It is important to note that we are examining potential correlations using these models; we make no causal claims.

Table 4
Correlates of support for mileage user-fee across modes of administration.

Variables	Odometer	Variables	Basic GPS	Variables	Advanced GPS
Userfee1	2.602***	Userfee1	1.920***	Userfee1	2.257***
	(0.453)		(0.349)		(0.489)
Q17A: privacy	0.183***	Q26A: accurate	2.200***	Q34A: congestion pricing	1.866**
	(0.036)		(0.543)		(0.478)
Q17B: inconvenient	0.447***	Q26B: hard to tamper	1.318	Q34B: state pricing	8.230***
	(0.081)		(0.264)		(2.318)
Q17C: honest reporting	1.852***	Q26D: inconvenient	0.548**	Q34C: privacy (can track)	0.345***
	(0.329)		(0.134)		(0.079)
Q17E: audit effective	2.680***	Q26E: privacy (outside govt.)	0.971	Q34D: privacy (outside govt.)	1.430
	(0.519)		(0.211)		(0.389)
Q17F: easy to implement	4.982***	Q26F: privacy (cannot track)	3.414***	Q34E: errors with location data	0.497**
	(1.072)		(0.936)		(0.147)
		Q26H: waste of money	0.262***	Q34F: audit effective	2.560***
			(0.057)		(0.569)
		Q26I: $250 too much to pay	0.585*	Q34H: $250 too much to pay	0.667
			(0.165)		(0.193)
		Q26J: audit effective	2.547***	Q34I: monitor my cars	2.190***
			(0.539)		(0.526)
Log likelihood	−678.88		−618.37		−455.08
N	2005		1991		1996

Notes: Reported are the odds ratios from a logit regression. Dependent variables are indicators of support: 1 for support and 0 for oppose, for *odometer*, *basic* GPS, and *advanced* GPS, respectively. The exact statements used for each mode are reported in the online appendix. Each model includes the same set of controls as model 2 in Table 3, is estimated with sample weights, and robust standard errors are in parentheses.

*** Significant at 1%.

** Significant at 5%.

* Significant at 10%.

Table 5
Intensity of support/opposition by mode of administration.

	Panel A: four-point Likert scale			
	Strongly support	Support	Oppose	Strongly oppose
Odometer	0.024	0.192	0.391	0.393
Basic GPS	0.012	0.140	0.416	0.432
Advanced GPS	0.014	0.119	0.391	0.477
	Petition	Email	Financial contribution	Amount of contribution ($)
	Panel B: odometer			
Oppose	0.785	0.544	0.447	14.47
	(0.013)	(0.016)	(0.016)	(0.721)
Support	0.615	0.336	0.372	8.50
	(0.030)	(0.029)	(0.029)	(1.157)
P-value	0.000	0.000	0.025	0.001
	Panel C: basic GPS			
Oppose	0.726	0.507	0.388	16.15
	(0.014)	(0.015)	(0.015)	(0.764)
Support	0.633	0.318	0.416	8.146
	(0.036)	(0.034)	(0.036)	(0.948)
P-value	0.016	0.000	0.474	0.000
	Panel D: advanced GPS			
Oppose	0.725	0.517	0.395	17.533
	(0.014)	(0.015)	(0.015)	(0.797)
Support	0.652	0.354	0.452	9.166
	(0.036)	(0.037)	(0.038)	(0.997)
P-value	0.061	0.000	0.155	0.000
N	1939	1939	1939	*

Notes: Panel A reports the proportion of respondents who strongly support, support, oppose, or strongly oppose each mode of administering the mileage user-fee. Number of observations in panel A is 2077 for each mode. Panels B to D report the share of respondents who are willing to take the political action indicated in column titles conditional on whether they support or oppose the mode of mileage user-fee indicated in panel titles. "Amount of contribution" indicates the average of the minimum dollar amount that a respondent is willing to contribute to a political campaign; amount of contribution is top-coded to $50. Reported p-values are for the null hypothesis that the willingness to take political action is the same between supporters and opponents. Robust standard errors are in parentheses.

* Number of observations used to compute "amount of contribution" are 864, 794, and 806 for panels B, C, and D, respectively.

support. In contrast, support is higher among respondents who believe that implementation will be easy, motorists will report their mileage information honestly, and that the audit process will help prevent tampering or cheating. The results also indicate that design features of the *advanced* GPS mode that enable congestion pricing and state-specific pricing increase the likelihood of public support. The latter finding is especially interesting because the feature of the *advanced* GPS mode that facilitates congestion pricing and state-specific pricing also increases privacy concerns, which has been shown to reduce willingness to support mileage user-fees (Duncan et al., 2014a).

5.2. Intensity of support/opposition: willingness to take political action

The results presented in Panel A of Table 5 show that intensity of support is weaker than intensity of opposition across all modes of mileage user-fee administration. Approximately 1–2% of respondents strongly support each mode while 39%, 43%, and 48% strongly oppose the *odometer*, *basic* GPS, and *advanced* GPS modes, respectively.

Panels B–D of Table 5, which are based on Eq. (4), show several interesting results. First, the share of opponents willing to take political action is highest for signing a petition, which may be viewed as essentially costless, and lowest for contributing money to a political campaign, which may be viewed as the most costly form of political action. The share of supporters willing to take political action is again highest for signing a petition but supporters appear to be more willing to give money rather than write a letter or send emails to legislators; this is true across all modes, although the differences are not particularly large. Second, relative to supporters, we find that opponents are more willing to sign petitions and send emails for all modes, and more likely to make financial contributions to political campaigns for the odometer mode. Interestingly, there is no statistically significant difference in willingness to make financial contributions to political campaigns between supporters and opponents for the *basic* and *advanced* GPS modes. However, the average amount that opponents say they would be willing to contribute is higher, and statistically different, than that of supporters across all modes of administration.

6. Discussion

6.1. Contribution to literature

Our finding of low public support for mileage user-fees is consistent with previous work on road pricing (e.g., see Zmud (2008) for a review). Importantly, we find that mileage-collection technology matters and that the characteristics that matter extend beyond privacy and costs discussed in Duncan et al. (2014a). In particular, perceptions about convenience, evasion, fairness, and accuracy are strongly correlated with support for mileage user-fees. We are not aware of any direct comparisons for our results on intensity of support in the context of road mileage user-fees. However, our findings are consistent with the broader taxation literature in that people who oppose a tax policy generally do so with greater intensity than those who support the policy.

We must emphasize, though, that our findings are not directly comparable to many of the existing studies because of differences in survey design and sample of respondents. This is especially true for cross-country comparisons since there may be different political, cultural and sociodemographic factors that need to be considered in a non-US context.

6.2. Policy implications

Our results have important policy implications for the proponents of mileage-based road user-fees. First, our study adds to the list of design considerations policy makers must consider in designing a mileage user-fee. While previous works have shown that use of tax revenues and structure of user-fee rate to account for emissions matters for support, we show that designs that minimize perception of evasion opportunities, privacy concerns, and one-time technology costs, and maximize perception of convenience, accuracy, and fairness are likely to improve public acceptability of mileage user-fees. Interestingly, whereas we find that support ranges from 13% for GPS to 20% for odometer, Agrawal and Nixon (2014) find that support ranges from 19% for a flat fee to 43% for a fee that varies with emissions. This suggests that while mileage-collection technology matters, careful attention must be paid to the design of the rate structure as well.[21]

Second, policy makers might also target people's preferences for how the cost of roads ought to be distributed among the population in order to improve support for mileage user-fees. This implication flows from our finding of higher support for mileage user-fees among respondents who believe that roads should be paid for by people who benefit from roads.[22] The finding is particularly important because roughly two-thirds of respondents do not believe roads should be financed under the user-pays principle of taxation. Converting those people into supporters will likely require a fundamental shift in preferences for how the cost of publicly provided goods and services ought to be distributed among the population. Third, the political gamesmanship that often surrounds tax policy reforms is likely to favor policy makers who oppose the mileage user-fee. This follows from the fact that opponents are more willing to take political action than supporters. This pattern of opinion poses a major challenge for adoption of mileage user-fees because elected officials are more likely to side with voters who are more vocal about their stance on a particular policy issue.

Finally, the fact that up to 13% of respondents are willing to support an advanced GPS-based mileage user-fee that records location and time information suggests that a choice-based multi-mode approach may be a promising strategy for implementing mileage user-fees. Having multiple ways of measuring mileage allows drivers to select into the administrative mode of their choice and thus minimize privacy concerns. This is precisely the approach being used in the state of Oregon where a mileage user-fee was implemented in July 2015.[23]

7. Conclusions

We have explored the extent to which people in the United States support replacing fuel taxes with mileage user-fees to address the revenue inadequacy of fuel taxes. A novel feature of our analysis is that we explore the extent to which mileage collection technology (administrative mode) affects the support for mileage user-fees. Additionally, we examine the intensity of support or opposition as well as respondents' perceptions of the characteristics of each administrative mode. We did not test for how other collateral motivations for road user charges, such as emissions reductions or congestion mitigation, might lessen or intensify opposition to the charges. Nonetheless, we believe that our revenue-focused findings are important on their own given the current focus in the USA on addressing the revenue inadequacy of the fuel tax.

Based on our findings, we outline design features that policy makers should carefully consider as part of strategies aimed at increasing acceptance of the mileage user-fee. These include giving special attention to the design of the user-fee, including information campaigns aimed at increasing awareness of the ability of mileage user-fees to address concerns related to evasion, privacy, one-time technology costs, administrative costs, convenience, accuracy, and fairness. Our findings also suggest that policy makers can influence support by promoting the user-pays principle as the basis for how the cost of roads ought to be distributed among the population. Although we are able to identify strategies for improving support for mileage user-fees, the relative intensity with which opponents hold their views suggests that it will be quite difficult to generate public consensus in favor of adopting mileage user-fees in the near future.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.tranpol.2016.09.002.

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[21] The results in Agrawal and Nixon (2014) are based on survey data similar to ours. The key difference between our paper and theirs is that they focus on the effect of varying the mileage user-fee rate structure (flat fee versus fee that varies with fuel economy) while we focus on variation in mileage collection technology.

[22] Road beneficiaries are interpreted to mean those who drive on the roads (see Duncan et al. (2014b)).

[23] See http://www.myorego.org/about/vendor-options/ for more information on Oregon's mileage user-fee.

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