Public Perceptions and Preferences towards a VMT Fee System in Nevada

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ABSTRACT

A number of barriers are associated with the implementation and deployment of a Vehicle Miles of Travel (VMT) Fee system ranging from technology issues to public acceptance. Technologically related barriers are easier to address compared to public related barriers. In addition, addressing technological barriers requires explicit consideration of the public attitudes and preferences towards various technological options. This paper studies public perceptions and preferences towards a VMT Fee system in Nevada. A survey questionnaire was developed to capture these perceptions and preferences. A series of discrete choice models – including ordered, probit, and logit models – were tested to determine the best model to use for evaluating the results of the survey. Multinomial logit models provided the best explanatory power. Modeling assumptions were tested to ensure adequate results. The model provided a number of interesting insights about public perceptions and preferences regarding the VMT system. Based on these insights, some policy recommendations are provided.
INTRODUCTION
A Vehicle Miles Traveled (VMT) Fee is a potential mechanism to replace the existing gas tax. Several states, including Iowa and Oregon, have conducted field tests to access the feasibility of a VMT Fee system. Both Iowa and Oregon recruited participants to evaluate technology developed for collecting miles traveled. These studies evaluated the accuracy and reliability of the technology, the practicality of a VMT Fee system, and the level of comfort the participants have with the system.

Some of the most important barriers for the implementation of a VMT Fee system include:

- The selection of the technological options for collecting mileage,
- Cost and time associated with deploying the system,
- Public perceptions about the existing problems with current gas tax system,
- Public acceptance towards the VMT system, and
- The level of comfort with the technology used as part of the VMT system.

Technological Options
Several options exist for the collection of mileage and the VMT Fee. They include both invasive and non-invasive technologies. Invasive technologies use global positioning systems (GPS) or similar to track vehicle trajectories. Although potentially highly effective, invasive systems raise privacy concerns.

In a 12-month VMT field study, Oregon used GPS as part of its mileage collection system. An algorithm, developed to minimize privacy concerns (1), used data from the GPS to calculate the corresponding VMT fee. The GPS data was only received by the participant vehicles, and only the total VMT fee was stored. No GPS data was transmitted from the vehicles. Hence, it was impossible to track the vehicles’ locations (2).

A very similar system was used in a national study conducted by the University of Iowa (3). This system used the vehicle’s On-Board Diagnostic (OBD) unit, which exists in most vehicles produced after 2003, to determine the mileage. A GPS was used to determine the vehicles’ location so as to apply the corresponding jurisdictional fee. The
vehicles’ locations were used to calculate the fee. Only the aggregated mileage charge was transmitted to the operation center (2).

A less invasive device, Davis Car Chip®, was used in a field test study in Las Vegas in the summer of 2011. The device used the vehicles’ OBD to collect miles traveled without keeping track of the vehicles’ trajectories. Hence, the VMT data were collected without creating privacy concerns. The Davis Car Chip used a wireless connection to transmit VMT to a computer located at a participant pump station where the VMT Fee was calculated.

Other options to collect the VMT Fee include audits and receiving a bill on a periodic basis. Either of these options would require an initial physical reading of the odometer and a subsequent reading at the end of the period; the driver would either be charged on site or would receive a bill in the mail (4). These types of options are especially necessary for electric and other alternative fuel vehicles that do not require refueling at a pump station (5).

**Deployment Costs**
Replacing the gas tax with a VMT Fee undoubtedly would require significant initial expenses. For example, installing the device used in the Oregon study (6) into all of the vehicles in the state would require over $1 billion. This does not include costs associated with upgrading gas stations. Upgrading the fuel pumps and software for every station in Oregon would cost a total of $28.6 million and $2.7 million, respectively. New computers would cost another $1.7 million, and operating costs would total $2.4 million per year. An idea to reduce these costs was proposed only to require the device in new vehicles for mileage collection; existing vehicles would continue to pay the gas tax. However, analysis based on new vehicle purchase and scrap rates indicated that it would take an estimated 20 years for 95% of vehicles on the road to have the VMT device installed (7).

Estimates for the State of New York with a 1 cent/mile fee indicated that after full implementation, the annual operating costs would be 17.87% of the collected revenue. These estimates assumed a six-year deployment period. The capital costs to fully deploy the system in one year would require $1.337 billion for the onboard units and $104.5 million for the equipment required at gas stations.
Public Perception

Public perception focuses on how the public feels about the problems associated with the existing gas tax, and their concerns with the VMT Fee. Focus groups in Texas (8) revealed a lack of knowledge about the gas tax. Participants noted that VMT fees would adversely affect high-mileage drivers compared to low-mileage drivers. These participants did not consider that with the existing gas tax, high-mileage drivers are likely to pay more in taxes because they likely purchase more fuel than low-mileage drivers.

A study in Minnesota, using a focus group, found similar problems (9). Overall, participants felt they had been using roads for free, and that a VMT Fee would change that. Lack of trust in the government also was common in this group. The mediators felt that the participants did not believe funding problems existed that are associated with the current gas tax system for revenue collection. In general, the participants believed that the funding crisis is not real. Previous studies involving public opinion in Minnesota showed a lack of knowledge about the current gas tax (10). Few members of the study group knew the actual value of the state’s gas tax, 38.4 cents/gallon, guessing anywhere between 9¢/gallon to $1.00/gallon. The annual tax paid was estimated between $50/vehicle to $10,000/vehicle by the members of the study group. The actual tax paid was around $600 and $700 per vehicle.

Public Acceptance

Public acceptance towards the VMT system is critical to prevent opposition and additional deployment costs. Several studies have considered various options and the corresponding public acceptance towards them. For example, five focus groups in Texas discussed various options, including a system with a fixed fee using an odometer reading based system, a cellular-/zone-based system that applies a rate according to location, and a GPS-based system that applies a rate according to location (1). Focus group members were asked to give their level of acceptance for each system. Privacy was a primary concern with regard to the cellular- and GPS-based systems. Many participants felt that regardless of the system design, the use of either of these systems would allow the government to keep detailed travel information. Cost of both of these systems also was a major concern. Either system would
require an in-vehicle device and periodic uploads to a central database, which would require installation and incur high initial costs as well as operating and maintenance costs.

Participants thought that all three systems would require more administration compared with the current gas tax system. To address this, different options were presented to the groups including installment plans, online payment, paying with vehicle registration, or allowing the payment to occur with fuel purchases. It was widely suggested that a payment that would happen annually would not be advised because households are unlikely to budget for this. Surprisingly, most participants stated that they would be more accepting of the cellular- or GPS-based systems, as long as they are allowed to pay at the pump (1).

A study from the University of Iowa (4) found that a simple collection system would face less resistance from users. Anticipated privacy concerns from road users prompted the need for a simple system, one that would transmit only the total mileage fee.

Level of Comfort
The level of comfort of the users with the technology use to collect mileage data and the VMT Fee is another important barrier. Overall, support for the Oregon field study was high among the participants (11). At the end of the study, 71% of the participants were comfortable with the ease and convenience of the in-vehicle device. The accuracy of the device, within ±2% of actual mileage (12), was acceptable to 70% of the participants. Finally, if the study were expanded to allow participants to refuel at every gas station in the state, 91% of the study participants were willing to continue paying the VMT Fee.

The device used by the University of Iowa also received a high level of approval. Over 71% of the participants had positive views, and only 17% had negative views (6). Payment of the fee was managed through a monthly bill. Over 60% of the participants favored the auditable bill, which provided the daily miles traveled, the location of the vehicle, and the corresponding VMT Fee.

Challenging Barriers
Among all the above barriers, public perceptions and acceptance towards the VMT Fee system probably are the most challenging barriers to address, because they involve users’ behaviors and attitudes. In addition, technological options and costs are highly dependent on the approaches
used to address issues associated with public perceptions and acceptance. Hence, this study focused on analyzing public perceptions and acceptance towards the VMT Fee system. In particular, this study considered some of the main aspects of concern for implementing a VMT Fee, including deployment costs, comfort with the car chip device, and preference for billing period. A survey questionnaire was used to capture public perceptions and acceptance towards these aspects.

This paper proposes a methodology for capturing public perceptions and acceptance towards a VMT Fee system in Nevada. The paper analyzes the collected data as well as the proposed models, using a discrete-choice modeling framework. Finally, conclusions and recommendations are provided.

**METHODOLOGY**

The proposed methodology involves the development of a survey questionnaire, data collection, and model development.

**Survey Questionnaire**

Considering the focus of this study, questions related to deployment costs, comfort, and preferred billing period were developed to capture the corresponding perceptions and preferences towards a VMT Fee system in Nevada. These questions represent various aspects emphasized in this study.

Previous analyses noted the high cost of fully implementing a pay-at-the pump VMT system. However, retaining a pay-at-the pump system is highly desirable, at least initially, to provide a smooth transition between the existing gas tax system and the VMT Fee system. In order to capture public perceptions survey responders were asked what their concern was about the implementation costs associated with deploying the VMT Fee system. The available responses were:

1. Very Concerned
2. Somewhat Concerned
3. Neutral
4. Somewhat Unconcerned
5. Very Unconcerned

With many options available to collect mileage information from drivers, public opinion about their comfort with a device used to collect
their mileage is required to facilitate the selection of an adequate device. In the survey, a brief description of the device used in Nevada for a field test was provided. It stated that the system recorded the change in odometer miles at each pump visit, and then applied an established rate without tracking vehicle location. Responders to the survey were asked about their level of comfort with such a device. The available responses were:

i. Very Uncomfortable
ii. Somewhat Uncomfortable
iii. Neutral
iv. Somewhat Unconcerned
v. Very Concerned

Various billing periods could be used to charge the VMT Fee. Survey responders were asked how frequently they would prefer to pay their fee. The available responses were:

i. Monthly
ii. Quarterly
iii. Bi-Annually (Twice a year)
iv. Annually
v. None (Continue to pay at the pump during every refuel)

Public perceptions about the cost of deploying a VMT Fee system, comfort with the device used to collect mileage, and billing period preference are interdependent. Discomfort with the device or concern with the cost of deploying a VMT Fee system will greatly influence the need for a billing option. If there are high levels of concern with the initial costs or strong discomfort with having a mileage collection device installed, billing users by using an alternative approach will be the most practical way to implement a VMT Fee system. Understanding the preferences for different billing periods will help decide whether one fixed period is best or if different options are weighted equally and individuals should be able to choose from a set of alternatives. Conversely, preferring not to receive a bill will influence the need to maintain the current pay at the pump system.

Although not an inherent trait of a VMT Fee system, a change in transit use also was considered because of the potential effect a change in
a major transportation tax structure might have on transit ridership. In a metropolitan area such as Las Vegas, where transit is available, users may choose to substitute methods of transportation other than driving vehicles to keep their total VMT cost low. It is important to know if, and how often, users would change modes in order to ensure that there is both sufficient transit availability and that revenue from the VMT Fee is sufficient. As a result, responders were asked if a VMT Fee would affect their transit use. The available responses were:

- i. Significantly Less Use
- ii. Somewhat Less Use
- iii. Neutral
- iv. Somewhat More Use
- v. Significantly More Use

Socioeconomic information about the responder also was collected. This information was used to draw connections between the responders and their choices about VMT characteristics. Some specific demographics included gender, age, level of education, and household income.

**Data Collection**

A total of 173 survey responses were collected. Data was collected from the general population at public locations near the main campus of the University of Nevada, Las Vegas (UNLV). These locations included local grocery stores, local shopping centers, and the student union. To attract people to take the survey, UNLV articulated pens were offered for completing the survey. Participants from the Las Vegas field test were not included in this survey because their responses might be adversely affected by their experiences. No racial information was collected.

Responders first read the front page of the survey. This page contained information detailing the basics of what a VMT Fee would involve, why the Nevada Department of Transportation (NDOT) was interested in a VMT Fee system, and the purpose for collecting the surveys. If still interested, the responder filled out the remainder of the survey. For questions specific to VMT, additional supporting information was provided about the technology used in the field study and cost estimates from previous studies.
Regarding gender, responders were 55% male and 45% female.

Figure 1 shows the age distribution in the sample data. Nearly 70% of the responders were between the ages of 18 and 34, with only 2% of the responders 65 or older. This data does not accurately represent the age of the population in Las Vegas or the United States. However, implementing a VMT Fee system would take many years, and the large skew of young responders may be beneficial, as younger people would be most affected by a change.

![Figure 1 Age distribution in the sample data.](image)

Considering the potential benefits of this study as well as the potential issues associated with a non-representative sample, the results and conclusions provided by this study could be seen as initial insights. Although the results of this study may not be general, they provide a better understanding of the public perception and preferences towards the VMT system. Additional data collection and analysis is required to corroborate the results from this study, using a more representative sample.

**Model Development**

Discrete choice modeling was used in this study to analyze people’s perceptions and preferences towards a VMT Fee system in Nevada. Various aspects of the system can be designed each in a different
manner, many of them involving a discrete choice. Therefore, models for three aspects of a VMT Fee system were developed to analyze and understand their effects in Nevada. These models were developed to study 1) the costs of implementing a VMT Fee system, 2) the level of comfort with the device, and 3) the preferred billing period.

Although transit changes also were initially considered, preliminary results indicated that a VMT Fee system will not create significant changes in transit ridership. Of the 173 responses, only 17 people currently used transit, representing less than 10% of the total sample. With a VMT Fee, only 19 people responded that they would use transit more, while 38 responded they would use transit less. These low values before and after a hypothetical VMT Fee is implemented imply that developing a model would be impractical, and would probably provide very minimal insights.

Costs Concerns
The information was collected using the survey questionnaire about how the public feels with respect to the costs of implementing a VMT Fee; this information was used to analyze the corresponding perceptions and attitudes. Considering the ordered characteristics of the associated possible responses, as described before, initially ordered discrete choice models were developed. The dependent variable in these models is the feeling of the public towards these costs.

Ordered models are not always appropriate, as they sometimes lack the flexibility necessary to control interior choice probabilities (14). For example, with the neutral response included, the ordered models showed very little explanatory power. Both ordered logit and ordered probit models provided similar results. Each of these models had an adjusted $\rho^2$ value of 0.012. In addition, neither model was able to predict results for the Somewhat Unconcerned and Very Unconcerned choices. Furthermore, each model estimated 113 neutral responses in contrast to only 53 actual neutral responses.

In seeking opportunities to improve the estimates and the explanatory power of the models, the dependent variable was modeled as a binary choice that included only those who either have a concern with costs or do not have concern. Similar results were obtained. Both the probit and logit models were unable to estimate results for being unconcerned about cost, and provided an even lower adjusted $\rho^2$ value, 0.0038.
Poor results provided by ordered models motivated the use of
multinomial models. The Neutral response implies that the responders
either do not know about the potential costs of implementing a VMT
Fee, or the costs are not important for them. Hence, the Neutral
responses were not considered for model development.

The best model specification using a multinomial logit
specification is described by Equation 1. It has an adjusted $\rho^2$ value of
0.171.

$$U(Very \ Concerned) = 0.965 - 1.962 \times SMALL - 0.773 \times YOUNG$$

$$U(Somewhat \ Concerned) = 1.033 - 1.625 \times SMALL - 1.433 \times GENDER + 0.866 \times LOWEDU$$

$$U(Somewhat \ Unconcerned) = -1.625 \times SMALL - 0.999 \times KNOW$$

$$U(Very \ Unconcerned) = -2.605$$

Everything else being equal, and considering only the constants,
people are most likely Somewhat Concerned with the cost of VMT
followed by being Very Concerned, Somewhat Unconcerned, and Very
Unconcerned. Factors causing a decrease in utility included:

i. SMALL = small households, less than 3 people;
ii. YOUNG = responders under the age of 35;
iii. KNOW = people with previous knowledge of a VMT Fee
    system; and
iv. MALE = male.

Only people without a college degree (LOWEDU) showed an increase in
their utility for being Somewhat Concerned. Comparatively, people with
a high level of education had a higher probability for being Very
Concerned. Previous knowledge of a VMT Fee decreased the utility for
being Somewhat Unconcerned. Although potentially contradictory, it
showed that people with knowledge of VMT Fee were aware of the
implementation costs, thus increasing the probability of being somewhat
or very concerned with the cost.
Comfort Level
Ordered logit and ordered probit models were developed to capture the comfort level associated with having a device in the vehicle for collecting mileage. Both models were only able to estimate Neutral and Somewhat Concerned choices, with 143 and 30 estimated choices compared with 51 and 43 actual choices, respectively. These models also had questionable goodness-of-fits, with adjusted $\rho^2$ values of 0.0046 for logit and 0.0041 for probit.

Seeking to improve the models, the Neutral responses were not considered. This provided only marginally better models. The respective adjusted $\rho^2$ values were 0.01085 for logit and 0.0078 for probit.

Considering the relatively low explanatory power of the ordered models, a multinomial logit model was tested. The adjusted $\rho^2$ of 0.0298 for this model is slightly better than the ordered models. The model specification is described in Equation 2.

\begin{align*}
U(\text{Very Comfortable}) &= -1.481 + 1.022 \times \text{LOWINC} \\
U(\text{Somewhat Comfortable}) &= 0 \\
U(\text{Somewhat Uncomfortable}) &= -0.868 \times \text{SMALL} + 0.861 \times \text{PRIVACY} + 0.884 \times \text{KNOW} \\
U(\text{Very Uncomfortable}) &= -0.392 - 0.868 \times \text{SMALL} + 0.861 \times \text{PRIVACY} + 0.884 \times \text{KNOW}
\end{align*}

Everything else equal, and considering only the constants, the model indicated that people are Somewhat Uncomfortable with a device collecting their mileage. Having a high preference for privacy protection and previous knowledge of the VMT Fee increased the probability for being Somewhat Uncomfortable and Very Uncomfortable with the device. Previous knowledge of a VMT Fee system might imply knowledge of previous studies using GPS devices to track mileage. This may explain why people who are familiar with the concept of a VMT Fee may feel uncomfortable about the system.

Billing Period
A model was developed for analyzing the preferred billing period. In order to consider only the pertinent choices, the choice of None was removed from the choice set. These choices followed an ordered nature,
because each option represented a certain number of bills per year: 12 for Monthly, 4 for Quarterly, 2 for Bi-Annually, and 1 for Annually. Hence, both ordered and unordered multinomial logit and probit models were considered.

The best model was obtained using a multinomial logit specification with an adjusted $\rho^2$ value of 0.1205. The model is described with Equation 3:

$$U(Monthly) = 1.165 - 1.44 \times SMALL - 0.945 \times LOWEDU + 0.838 \times HM$$

$$U(Quarterly) = -0.95 \times SMALL - 1.58 \times LOWEDU + 0.506 \times LOWINC$$  \hspace{1cm} (3)

$$U(Bi-Annually) = -1.15 - 0.95 \times SMALL - 0.945 \times LOWEDU + 1.08 \times LOWINC$$

$$U(Annually) = -0.853 + 1.08 \times LOWINC$$

Everything else the same, the alternative specific constants indicate that the Monthly billing period is the most attractive. With most bills been paid on a monthly basis, it is not a surprise that the Monthly option is the most attractive choice. Small households (SMALL) and people with less than a college degree (LOWEDU) prefer to pay their bills on an annually basis. Small households are likely to have fewer expenses, making it easier for them to pay once a year. The same can be said about households with low levels of education. Households driving more than 40 miles/day (HM) have a stronger preference for a monthly bill. Low income households (LOWINC) do not like a monthly billing cycle. Although difficult to budget for, it may appear to be easier for low income households to save and pay fewer bills a year.

**ANALYSES OF RESULTS**

Each model was analyzed to determine the appropriateness of the proposed modeling framework, the relative significance of the variables in the model, and the model’s explanatory power. The appropriateness of using the multinomial logit framework was checked by testing for the property of Independence of Irrelevant Alternatives (IIA).

The IIA property can be tested by estimating a model for a subset of the alternatives. A ratio of probabilities estimated using the
subset of alternatives can be compared to the ratio of probabilities for the
same alternatives when all alternatives are considered. Failure of the IIA
property occurs when these ratios are different.

The relative significance of variables is estimated using
elasticities. Direct-elasticities could give misleading results for the
models developed in this study, given that many of the explanatory
variables are binary. Hence, direct pseudo-elasticities were calculated to
determine the percent change in the utility of an alternative when the
variable changed from 0 to 1. Direct pseudo-elasticities were calculated
as:

\[
E_{Xk} = \frac{P(X_k=1) - P(X_k=0)}{P(X_k=0)}, \quad (4)
\]

where \(X_k\) represents variable \(X\) in the utility for alternative \(k\).

The explanatory power of the models is determined by
comparing the estimated versus the stated choices. The estimated number
of times that an alternative is chosen was calculated as the product of the
choice probability and the expected number of choices, as illustrated by
Equation 5:

\[
\text{Estimated Number of Times than an Alternative is Chosen} = \frac{e^{U_k}}{\sum_{k=1}^{K} e^{U_k}} \times \text{(Total Number of Choices)} \quad (5)
\]

The explanatory power of the model is given by Equation 6:

\[
\text{Explanatory Power} = \frac{\text{Total} - \sum \text{Abs(Stated - Estimated)}}{\text{Total}} \times 100 \quad (6)
\]

**Cost Concern**

**Appropriateness**

For the cost concern, a model was developed with Somewhat Concerned
and Somewhat Unconcerned as a subset of alternatives. The probability
ratio in the model with just those two choices was 2.38, while the ratio in
the full model was 2.55. Given that these ratios are very similar, and the
ordering between the two did not change, a logit model was considered
to be appropriate for this data.
Significance of the Variables

Table 1 shows the pseudo-elasticities for the variables in the model that were used to evaluate the concern of the public with the VMT Fee. Positive values indicate an increase in the probability for choosing an alternative, and negative values indicate a decrease. Small households showed a strong (infinite) increase in being Very Unconcerned, resulting from zero responses for non-small households.

TABLE 1 Elasticities for the Model, Used to Evaluate the Costs Concerns

<table>
<thead>
<tr>
<th>Variable</th>
<th>Very Concerned</th>
<th>Somewhat Concerned</th>
<th>Somewhat Unconcerned</th>
<th>Very Unconcerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small household</td>
<td>-17.1%</td>
<td>-7.9%</td>
<td>-1.68%</td>
<td>INF (P(0)=0)</td>
</tr>
<tr>
<td>Young person</td>
<td>-38.6%</td>
<td>23.3%</td>
<td>57.9%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Male</td>
<td>63.6%</td>
<td>-49.5%</td>
<td>96.3%</td>
<td>309.7%</td>
</tr>
<tr>
<td>Without college degree</td>
<td>-27.56%</td>
<td>12.2%</td>
<td>63.0%</td>
<td>-27.53%</td>
</tr>
<tr>
<td>Familiar with VMT</td>
<td>59.2%</td>
<td>-13.8%</td>
<td>-58.7%</td>
<td>-3.7%</td>
</tr>
</tbody>
</table>

Young responders showed a propensity for approaching the middle of the range. In general, the same could be concluded for responders with a low level of education. This indicates uncertainty about the potential cost. Additional information and knowledge about the subject might reduce some of the uncertainty.

Prior knowledge about the VMT Fee created a significant increase for being Very Concerned with respect to cost. Increasing the information about what the cost of VMT would entail, as stated for young and low educated households, would likely show further concerns about cost.

Explanatory Power

Figure 2 shows a comparison between the stated and estimated choices about the public concerns with respect to the cost of implementing a VMT Fee system. The extremes were modeled very well, with little or no difference. Overall, the model had an accuracy of 93%.
FIGURE 2 Concern about the cost of a VMT Fee system.

**Level of Comfort**

**Appropriateness**

The IIA property for the model – used to evaluate the level of comfort with the device used to collect mileage – was tested using a model that included the choices Somewhat Comfortable and Somewhat Uncomfortable. The probability ratio for this model was 1.1, while the corresponding ratio for the model with all choices was 1.2. These ratios are similar, and the ordering did not change. Hence, the logit specification was considered to be appropriate.

**Significance of the Variables**

The pseudo-elasticity values for the model – used to evaluate the public level of comfort with the device used to collect mileage – are shown in Table 2. Small households showed a significant increase in their level of comfort compared to large households. Smaller households were more likely to drive fewer miles. This could explain the increase in their level of comfort, because they did not get that much impacted by the device.

The significant increase for being Very Comfortable for low income families is not surprising. Low income households have, on average, vehicles with low fuel efficiency, and would benefit from a VMT Fee.

Responders who indicated that privacy was one of their top two important characteristics for a VMT Fee system showed an increase in...
being uncomfortable with the device. Previous knowledge of a VMT Fee also led to an increase in discomfort with the device. Additional information about the device or a demonstration to show what information the device collects could help shift responses to being more comfortable.

### TABLE 2 Elasticity for the Model, Used to Evaluate the Level of Comfort

<table>
<thead>
<tr>
<th>Variable</th>
<th>Very Comfortable</th>
<th>Somewhat Comfortable</th>
<th>Somewhat Uncomfortable</th>
<th>Very Uncomfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small household</td>
<td>85.7%</td>
<td>48.6%</td>
<td>-25.7%</td>
<td>-25.7%</td>
</tr>
<tr>
<td>Low income</td>
<td>163.0%</td>
<td>-19.7%</td>
<td>-5.5%</td>
<td>-4.2%</td>
</tr>
<tr>
<td>Prefer Privacy</td>
<td>-4.2%</td>
<td>-28.2%</td>
<td>25.7%</td>
<td>11.0%</td>
</tr>
<tr>
<td>Familiar with VMT</td>
<td>-18.0%</td>
<td>-41.4%</td>
<td>29.1%</td>
<td>32.7%</td>
</tr>
</tbody>
</table>

**Explanatory Power**

Figure 3 illustrates the difference between stated and estimated values for the choices about the level of comfort with the device. This model is 96% accurate. Only the Very Uncomfortable response was estimated with a difference of greater than 1. However, the model provides a marginal goodness of fit. Although the model may represent the data set well, it may have problems with assessing other data.

**Billing Period**

*Appropriateness*

To test for the IIA property, a model was developed with only billing choice alternatives for Monthly and Annually. The probability ratio of Monthly to Annually for this model was 2.02, while the corresponding ratio for the full model was 1.58. Under Luce’s choice axiom, logit would not be an appropriate fit because of the significant difference in the ratios (15). However, the ordering of the alternatives is not effected. Hence, under Gul’s choice axiom, a logit model is appropriate (16).
Significance of the Variables
The pseudo-elasticities for the model that were used to evaluate the preferences about the billing period are shown in Table 3. Small households had a very large increase in the probability for Annual bills, more than double the probability of large households. This increase indicates a preference for fewer bills, which is supported by the changes in Monthly, -35%, and Bi-Annually, -23.4%; however, Quarterly increases.

**TABLE 3 Elasticities for the Model Used to Evaluate the Billing Period**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Monthly</th>
<th>Quarterly</th>
<th>Bi-Annually</th>
<th>Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small household</td>
<td>-35.0%</td>
<td>16.6%</td>
<td>-23.3%</td>
<td>104.4%</td>
</tr>
<tr>
<td>Without college degree</td>
<td>-4.1%</td>
<td>-56.6%</td>
<td>-1.0%</td>
<td>57.436%</td>
</tr>
<tr>
<td>High mileage</td>
<td>46.4%</td>
<td>-37.3%</td>
<td>1.3%</td>
<td>-42.2%</td>
</tr>
<tr>
<td>Low income</td>
<td>-42.3%</td>
<td>8.7%</td>
<td>70.7%</td>
<td>100.6%</td>
</tr>
</tbody>
</table>

Low-education households had a decrease in every alternative except preferring an annual bill, which increased by 57%. This is likely due to the correlation between having a low level of education and having low income. Low-income households had a decrease in Monthly
bills, and increases in all other choices. The progression of the increases indicated an increased preference for fewer bills.

The high increase in Monthly bills for high-mileage households indicated the effect that a VMT Fee might have. Intuitively, higher mileage means a greater VMT Fee to be paid. Although a monthly bill would not change the total annual cost, it would be easier to budget and control.

Explanatory Power

A comparison between the estimated and stated preferences for the billing period is shown in Figure 4. The choices with the fewest responses, Quarterly and Bi-Annually, are modeled most accurately. There is crossover between Annually and Monthly, with the model estimating more responses for Annually and fewer for Monthly. At the aggregate level, the model for the billing period is almost 89% accurate.

The Annual billing period was estimated to be chosen about 20% more times than the stated number of times it was chosen. All other choices were estimated to be within roughly ±10% of the stated value. Overall, the model did not perfectly estimate the stated information. However, the overall percent difference was small enough for the model to be useful.

FIGURE 4 Preference for billing period.
CONCLUSIONS

This paper estimates and analyzes the behavior of the public regarding a VMT Fee system. A survey questionnaire was used to collect the state choices with respect to various important aspects of the VMT system. A multinomial logit modeling framework was used to capture the choice behavior of the responders. This model included some strong assumptions, most notably regarding the IIA property. Tests were conducted to evaluate the impact of this property. The results indicated that the IIA assumption was not a problem.

Analysis of the pseudo-elasticities showed drastic impacts for some of the variables in the models. Large percent changes for a particular alternative showed the need to address the associated reason, as these large changes potentially represent isolated or uninformed groups. For example, in the model used to capture the public preferences for a billing period, two of the variables showed greater than a 100% increase in the probability for choosing Annually as the preferred billing period. This makes apparent that both a Monthly and Annual billing period should be available, initially.

The model also was used to capture concerns about the cost of implementing a VMT system; the majority of the responses were in the middle of the choice set, namely, Somewhat Unconcerned and Somewhat Concerned. More information about the components, upgrades needed for gas stations, and operating costs will help people make a better informed decision.

Finally, for the model used to evaluate the level of comfort with the device used to collect mileage, there was a significant preference for the extremes, Very Comfortable and Very Uncomfortable. Demonstrations of a working device as well as information about how the data will be collected will likely increase the overall level of comfort.

Initially, only a monthly bill is recommended. Although both monthly and annually were the most popular responses, one bill per year could be extremely difficult to control, especially for low-income and high-mileage households. A monthly bill could be implemented to allow drivers to move to a VMT Fee system and stop paying the fuel tax. It would also decrease initial costs, eliminating the need to retrofit the technology at the fuel stations. This will allow more time to develop an efficient and reliable collection system as well as time to disseminate more information to the public to increase the overall level of comfort.
REFERENCES


