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ABSTRACT

This report focuses on selected issues associated with alternative sources of transportation funding. In particular, this report: presents a list of funding options, discusses the advantages and disadvantages of each option, explores public attitudes towards selected options, and investigates how certain funding option might alter transportation behavior. A relatively comprehensive list of transportation funding options is presented, and the advantages and disadvantages of each are discussed. The public's acceptability of a few of these options is then explored, first, through a review of existing public opinion surveys of funding alternative, and second, by a large opinion survey that was conducted in Georgia. The report then explores how some of the revenue options might alter transportation behavior. First, a review of existing studies of the effect of revenue sources on transportation behavior is presented, including both surveys of what individuals say they would do in the face of changes in transportation taxes and fees and econometric studies of how individuals react. Second, the results of Georgia survey questions regarding how the respondent would alter his or her transportation behavior if certain transportation taxes and fees were increased are presented. Third, the results of a laboratory experiment that explores the transportation choices of the subjects when confronted with different level of congestion fees are discussed.

Key Words: transportation funding; fuel taxes; congestion pricing; vehicle miles travel tax; tolls; cordon fees; behavioral responses to transportation taxes and tolls; public attitude; revenue sources; transportation studies; Georgia survey questions.

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EXECUTIVE SUMMARY

Fuel taxes and transit fares are two key revenue sources for transportation. But with fuel tax revenue lagging and with strong voter resistance to increased fuel taxes, governments are searching for alternative revenue sources. In addition, rather than address the problem of congestion by continuously increasing the supply of transportation infrastructure, there is increasing interest in finding revenue sources that provide incentives that would alter travel behavior. This report addresses four question related to funding transportation:

- What are the feasible alternative revenue sources?
- What are the advantages and disadvantages of these sources?
- What is the public's level of acceptability of alternative revenue options?
- What effects might these alternatives revenue sources have on the transportation choices?

Revenue Alternatives

There are a substantial number of revenue options for funding transportation; the report identified 36 and evaluated them on criteria that included: economic efficiency, equity, administrative feasibility, public acceptance, and the level and stability of the revenue. Most of these options would provide only marginal increases in revenue. Furthermore, most of the available options would not provide incentives for individuals to alter their transportation behavior, such as the use of the transportation system during periods of congestion. Some options, for example, a dedicated sales tax, would generate substantial revenue but would have no effect on transportation behavior. Sales taxes, or any general fund revenue, would also break the historic link between taxes (or fees) paid and the use of the transportation system.

Fuel taxes generate substantial revenue and are tied to the number of miles driven. However, because of increases in fuel efficiency the revenue generated per mile driven by a pennies-per-gallon fuel tax has decreased. Furthermore, because of differences in fuel efficiency across motor vehicles there is substantial variation across motorists in what is paid per mile driven. In addition, there is sizable resistance to increasing fuel taxes. Use of fuel taxes as a local option is limited by the ability to purchase fuel in neighboring jurisdictions in response to tax rate differential across jurisdictions.

Tolls can generate significant revenue, but that depends on the nature of the facility and the demand for use of the particular facility. Tolls provide an incentive to reduce the use of the facility relative to the usage if its use were free. But this means that tolls will also shift usage to alternative, non-tolled facilities. Tolls can vary by time of day, but generally do not vary with the level of congestion; HOT lanes are an exception.

A vehicle miles traveled (VMT) tax could generate substantial revenue, would not be dependent on fuel efficiency, and could vary with the level of congestion. The major concerns with a VMT relate to privacy issues, to which technology to adopt in order to allow for a national VMT system, the high initial cost, and the feasibility of fully implementing such a tax. Finally, at this time, there is a lack of voter understanding of how such a tax would work and, perhaps for that reason, a lack of voter support for such a tax.

A review of existing public opinion surveys was conducted and yielded several overarching patterns.

- Tolls appear to be the most favored alternative for transportation finance.
- Fuel taxes are supported generally by only about 25 percent of the public.
- Approval of any tax is higher when the proposals are specific and respondents are provided additional information.
- Alternatives such as HOT lanes and variable tolling are not very intuitive to respondents, and that may impact the response to general questions about such revenue options.
- Respondents who are users (potential and current) of an option such as HOT lanes are more likely to support a particular option than nonusers.
- Many surveys find more public support when the revenues are linked to specific transportation purposes.
- Many polls find that support depends on whether the public perceives an option as fair.

There have been a few surveys and substantial empirical studies of the effect of tolls, fees, and taxes on transportation-related behavior. Generally, surveys find that individuals say they will change transportation-related behavior in response to a toll, fee or tax, and the empirical studies find that individuals actually do change their behavior. However, respondents to surveys generally report much larger responses than what the statistical research finds. The existing empirical studies imply that responses will be modest, that is, the percentage change in measured behavior such as miles driven will be smaller than the percentage change in the toll, fee, or tax.

Public Opinion Survey

To explore the level of public support for various transportation funding options and the likely response of drivers to increases in transportation taxes or fees, we conducted a survey of 2,000 Georgia drivers. The survey considered five alternative revenue sources: an increase in the state per-gallon gas tax, replacing the per-gallon gas tax with a per-mile tax (VMT), a new employee-parking lot tax, expansion of managed lanes, and expansion of toll roads. Respondents were asked about their level of support for each option in isolation and were also asked to pick the more and less appealing options from among a list of options. The various alternatives were presented as hypothetical options and only in general terms.

Table ES-1 on page ix presents the level of support for four of the alternatives when considered in isolation. Drivers indicated greater support or appeal for toll roads, statewide employee-parking lot fees, and managed lanes as compared to an increase in the gasoline tax or implementation of a VMT tax, respectively. Toll roads and managed lanes provide greater choice and a known benefit for a given cost. Importantly, their support of this option does not indicate intent to use the alternative, just their preference as a means for raising transportation revenues. Employee-parking lot fees are a flat fee and, as presented, represent a much lower annual cost alternative than the gasoline or VMT taxes. Given that more than 93 percent do not currently pay anything to park at work, the fees may seem relatively small or they may assume their employer will pay the fees.

TABLE ES-1
Support and Opposition Levels for Four Revenue Options
(Percentages are the sum of those who said they "strongly" or "somewhat" support/oppose each option.)

Revenue Option	Support (%)	Oppose (%)	Don't know (%)
10¢ gas tax increase	31%	66%	3%
15¢ gas tax increase	23%	74%	3%
25¢ gas tax increase	21%	75%	3%
1.35¢ VMT (mileage tax)	33%	60%	7%
1.60¢ VMT (mileage tax)	39%	55%	6%
2.10¢ VMT (mileage tax)	36%	57%	7%
$2 per month parking fee	45%	45%	10%
$4 per month parking fee	39%	50%	12%
Toll roads	51%	42%	7%

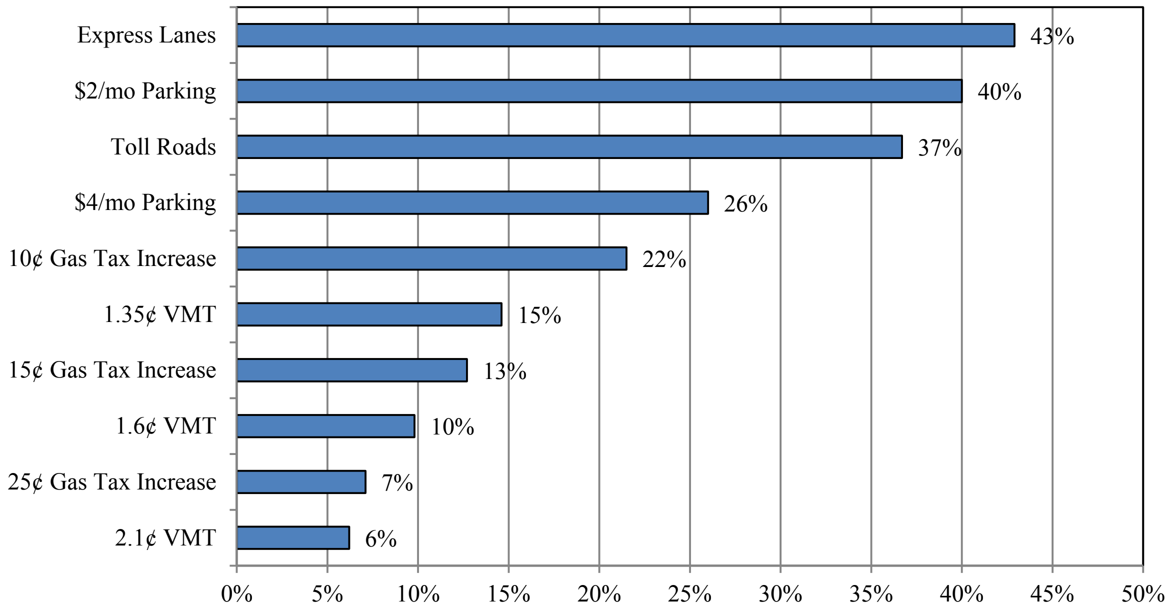
Note:
Managed lanes were not addressed in this form.
Some row percentages do not sum to 100 due to rounding.

Regarding managed lane tolls, the survey asked respondents what is the most they would be willing to pay in tolls to reduce trip time by 35 minutes for a 10-mile trip. Half of respondents were willing to pay $3.00 or less, regardless of trip type or duration of the trip in regular traffic. However, some were willing to pay more, as indicated by willingness to pay an average toll of $5.85 across all trip types. Given no difference in their willingness to pay across scenarios, this suggests that the choice to pay the toll may be more of a function of an individual's time value than trip characteristics. Forty percent were willing to pay $1.00 more and 31 percent were willing to pay $2.00 more than the toll they had stated.

The managed lane question implied that the respondent had a choice between driving the 10 miles at about 13 miles per hour versus 60 miles per hour. A $3.00 toll, which half of the respondents said they would pay, is 30 cents per mile, and implies a value of time of $5.14 per hour. However, 30 percent said they were willing to pay a toll of at least $10.00, or $1.00 per mile. This suggests that if a highway is very congested, a large percentage of the drivers would shift to a HOT lane even if the toll was $1.00 per mile.

Each respondent was also presented with 10 revenue alternatives, three cost combinations for gasoline and VMT taxes and two employee-parking lot fees, as well as the options of variable-rate managed lanes and toll roads. Figure ES-1 on page xi shows the percentage of respondents who found each of the ten revenue options appealing, ordered from highest to lowest appeal. None of the options received a majority share of appeal. Three options had appeal to about 40 percent of respondents: variable rate managed lanes (43 percent), $2 per month employee parking fee (40 percent) and building toll roads (37 percent). The three least appealing were all "pay at the pump" options - the 1.6 cents vehicle mileage tax (VMT) (appealing to 10 percent), the 25 cents per gallon increase in the gasoline tax (7 percent) and the 2.1 cents vehicle mileage tax (VMT) (6 percent).

FIGURE ES-1
Relative Appeal of Different Revenue Options
(% Who Found Each Option Appealing)



The gasoline tax increase was the least supported alternative in initial questioning yet preferred over the equivalent-cost VMT tax in the tradeoff task. A likely explanation is that the gasoline tax is currently in place and therefore known to drivers, whereas the VMT tax and how it would be implemented is more uncertain. However, the rankings indicate that drivers consistently preferred the lower cost alternatives whether a gasoline or VMT tax.

Transportation Behavior Response

We explored how taxes or fees might alter transportation behavior in two ways, by a survey and a laboratory experiment. As part of the opinion survey, respondents were asked how they would respond if a particular revenue alternative was implemented. If the gasoline tax was increased, over 60 percent of respondents said they would drive a little or a lot less. This percentage was lower (39 percent) for a VMT tax, perhaps because the fuel efficiency of their vehicle would be less of a factor or it would only affect miles driven in Georgia. Over one-third said they would car pool or ride share a little or a lot more, while 19 percent said they'd take public transportation more often. Importantly, over one-third indicated that it would be extremely or very difficult for them to make such changes.

Respondents were also asked how much a change from a gasoline tax to a VMT would affect their behavior. Forty-nine percent (49 percent) said it would dramatically (22 percent) or moderately (27 percent) affect their behavior.

While great care was taken to frame the survey questions regarding how respondents might alter behavior as a result of increased taxes and fees, there is still the concern that responses to the survey may differ from actual behavior when full information and implications are known. Furthermore, the statistical analysis of behavior may not adequately control for other factors that might have affected transportation behavior. Thus, a laboratory experiment was conducted that controls the environment in which decisions are being made yet confronts the subjects with choices that have real financial consequences for the participants.

The experiment attempted to indirectly elicit individuals' preferences between travelling a standard route to get to one's destination and paying a toll in order to arrive at the destination in less time. The experiments also elicited the subjects' preferences toward reducing the uncertainty about how long a trip would take.

In the experiment subjects choose between waiting 30 minutes to receive payment and giving up some money in order to reduce the wait time by 15 minutes. We found that the subjects were not willing to pay much to reduce waiting time. The implication of the experiment is that most individuals are not willing to pay much to avoid congestion. For example, suppose that the choice is between traveling 15 miles at 30 miles per hour or at 60 miles per hour. The former would take 30 minutes while the later would take 15 minutes. The experiment suggests that only 6 percent of drivers would pay at least 40 cents per mile to travel at 60 miles per hour rather than 30 miles per hour. These results suggest a much lower willingness to pay than what was reported in the survey.

The experiment also found the most individuals are not willing to pay very much to eliminate uncertainty about the time it takes to make a short trip. For example, suppose there are two routes to go the 15 miles from point A to point B. Suppose that Route 1 is free flowing at 30 miles per hour while Route 2 is faster (60 miles per hour) half of the time or slower (20 miles per hour) half of the time. The results of the experiment suggest that only about 20 percent of drivers would pay a toll of $5.00 (or 33 cents per mile) to use Route 1.

Given the results of the laboratory experiment, there appears to be a very low willingness to pay tolls to save time or reduce uncertainty. This suggests that tolls would have to be low—or time savings very high—to induce them to pay to travel in toll lanes.

CHAPTER 1
INTRODUCTION

Current revenue sources are proving to be inadequate to fund needed transportation projects and operations. As a consequence, alternative revenue sources, such as the vehicle miles traveled (VMT) tax, sales tax, energy tax, parking tax, tolls, and others, are being used or discussed around the United States in order to provide financing of transportation (both improvements and operations). In addition, some of these revenue sources are also designed in part to affect travel behaviors through the internalizing of travel costs. There are several questions that need to be addressed in considering these alternatives, and that are the subject of this research project.

- What are the feasible alternative revenue sources?
- What are the advantages and disadvantages of these sources?
- What is the public's level of acceptability of alternative revenue options?
- What effects might these alternative revenue sources have on the transportation choices that individuals make?

This research project had four primary objectives:

1. Develop a list of alternative revenue sources that could be used to finance transportation, both at the state and local level.
2. Present the pros and cons, advantages and disadvantages of each option.
3. Determine the extent of public support for and attitudes towards the various options.

4. Determine how the various alternative revenue sources might alter transportation behaviors such as mode choice, number of trips, and vehicle miles traveled.

The first two objectives are addressed through a review of existing literature. The third objective is based on a review of existing opinion surveys conducted in other states and on a scientific opinion survey of a large random sample of Georgia adults that we conducted. The fourth objective is addressed by a review of the literature that addresses how individuals respond to taxes and transportation fees, through the survey of Georgia adults that we conducted, and by a laboratory experiment that we conducted.

While not the only source of revenue, fuel taxes and transit fares are two key revenue sources for transportation. The construction and maintenance of roads and bridges rely heavily on fuel taxes and the construction and operation of transit systems have been funded from fares, and both are also funded by federal grants that are funded by fuel taxes. But with fuel tax revenue lagging and with strong voter resistance to increased fuel taxes, state and local governments are searching for alternative revenue sources. In addition, rather than address the problem of congestion by continuously increasing the supply of transportation infrastructure, there is increasing interest in attempting to reduce congestion by reducing demand through pricing schemes or user charges.

There is a long list of potential revenue options for transportation. Chapter 2 contains a list of 36 potential revenue sources for transportation. These are not new options in the sense that governments have used them or at least experimented with them. The chapter describes each of the alternatives, and for several options discusses how they are used by certain jurisdictions. To evaluate the advantages and disadvantages of each alternative, a set of criteria was proposed. These criteria include: economic efficiency, equity, administrative feasibility, public acceptance, and the level and stability of the revenue. Each of the revenue options is then evaluated against these criteria.

The public's acceptability of any transportation revenue option is an important factor in considering the choice of an alternative revenue source. Chapter 3 presents a review of publically available surveys of public opinion regarding alternative transportation revenue sources.

Given the desire to reduce congestion by reducing travel, particularly at peak times, the literature on the responsiveness of travel to taxes, tolls, or fees that vary with the distance traveled or with the level of congestion was surveyed. Chapter 4 contains the results of that literature review. The review includes a discussion of existing surveys that asked how travelers would respond to changes in certain fees or taxes. In addition, statistical studies that use actual behaviors to estimate the responsiveness of changes in fees or taxes on transportation behavior are presented.

Chapter 5 contains the results of a large scientific survey of 2,000 Georgia adults. The survey explored, in several different ways, the level of support for four alternative revenue sources, namely, an increase in the fuel tax, a VMT tax, a parking tax, and tolls. In addition, the survey asked how the respondent would change transportation behavior in the face of alternatives.

While surveys that explore how respondents might change behavior in response to changes in transportation fees and taxes are informative, they have a limitation. There is a concern that what individuals say they will do in response to a change in fee or tax may not match what they would do when actually faced with a change in a specific transportation fee or tax. To further explore how individuals might actually respond, a laboratory experiment was conducted in which the subjects were presented options for which there are real (financial) consequences of the choices that are made. The results of the experiment are presented in chapter 6. Chapter 7 contains conclusions and possible implications for policy.

CHAPTER 2
TRANSPORTATION REVENUE OPTIONS

This chapter presents a comprehensive list of revenue options that a state could adopt to fund transportation, an explanation of each option, and the advantages and disadvantages of each option.

2.1 List of Revenue Options

This section presents an alphabetized list of 36 revenue options that potentially could be adopted by a state or by local governments, if they were so authorized. We also provide a very brief description of each option. The list of options was drawn mainly from Dierkers and Mattingly (2009), Sundeen and Reed (2006), and Weinstein et al. (2006). We have attempted to be as comprehensive as possible in developing the list of options. Being included on the list does not imply anything about the desirability or feasibility of the revenue option.

We focus on revenue options and not financing options. For example, bonds are a means for financing a project, but at some point the state would need to raise the revenue to pay off the bonds. Nor do we include a discussion of federal transportation funding since the state has no discretionary control over that revenue source**.** Public-Private Partnerships are a way to finance a project. However, since they frequently involve imposing tolls as a way to generate the revenue, we include them in our list.

- ***Advertising Revenue***

  Changes for the lease of spaces to firms for advertising purposes.

- ***Alternative Fuel Tax***

  This is a tax for the use of electricity, natural gas, hydrogen and similar fuels in alternative fuel vehicles.

- ***Assessment (or Benefit or Improvement) District Tax or Fee***

  In a defined area that benefits from some transportation infrastructure a property tax or fee is levied on businesses to finance the construction or operation of the transportation infrastructure.

- ***Battery Tax***

  An excise tax that is imposed on batteries.

- ***Bicycle Registration Tax or Fee***

  Similar to car registration or license, it is an annual or one-time fee paid to register a bicycle.

- ***Container Charges***

  Fees levied on containers used on ships and railroads.

- ***Drive-Through Service Fee***

  A fee charged for the presence of drive-through service at retail establishments.

- ***Driver's License Fee***

  Fees associated with obtaining or renewing a driver's license.

- ***Emissions Fees***

  A fee on motorists for the amount of pollution their vehicles emit.

- ***Excise Tax on Automobile-Related Goods and Services***

  A tax applied to the purchase of vehicles and vehicle parts.

- ***Fuel Excise Tax—Fixed***

  This is a fixed per gallon tax on fuel.

- ***Fuel Tax—Indexed***

  This is a variant of the fuel tax under which the tax rate per gallon is indexed for inflation, using a price index such as the Consumer Price Index or a construction cost index, or for fleet fuel efficiency increases.

- ***General Fund Revenue***

  Some portion of a state's general revenue would be appropriated to fund transportation.

- ***Local Fuel Taxes***

  These are fuel taxes that are levied by local governments for their use.

- ***Local Option Sales or Income (Payroll) Tax***

  This is a local add-on to the state sales tax or a tax on payrolls paid by the employer or the earnings of employees in a given jurisdiction.

- ***Naming Rights***

  Rather than naming a section of a road, bridge, rest area, transit station, etc. to honor someone, the state would sell the right to name the facility.

- ***Parking Tax or Fee***

  This is a flat fee per parking space or a percentage tax on the charge for parking.

- ***Privatization of Rest Area /Concessions***

  The state would lease public rest stops and allow the lessee to install commercial facilities.

- ***Public-Private Partnerships***

  This is a contractual agreement between a public agency and a private firm or consortium to collaborate on a transportation project.

- ***Road Utility Fees***

  This option is a charge based on a property's access to and derived use of the road system.

- ***Safety Violation Fee***

  Increased fine for drivers who are convicted of traffic safety offenses.

- ***Sales Tax on Fuel***

  A tax based on the price of fuel rather than just the volume of fuel purchased.

- ***Special License Plate Fees***

  These are increased fees for special license plates.

- ***Title Fee***

  A fee imposed when a vehicle is purchased or the title changes hands.

- ***Tire Tax***

  An excise tax on the sale of tires.

- ***Toll—Fixed***

  This is a fixed, direct charge on a user for access to a highway, bridge, tunnel, etc.

- ***Toll—Variable***

  This is a toll that varies with the time of day, type or weight of vehicle, or level of congestion.

- ***Transit Fare***

  Fees charged for riding a public transit vehicle.

- ***Transportation Impact Fee***

  A fee that is imposed on a developer in order to fund the transportation infrastructure needed to support the development.

- ***Truck Weight-Distance Fee***

  A fee based on the weight of a commercial truck and the distance traveled.

- ***Value-Based Tax on Vehicles***

  A property tax applied to vehicles.

- ***Vehicle Impact Fee (Transportation Access Fee)***

  A one-time charge placed on a vehicle when the vehicle is titled or registered in the state for the first time.

- ***Vehicle Mile Traveled (or Mileage) Fee***

  A tax based on the number of vehicle miles traveled.

- ***Vehicle Registration Fees***

  A fixed fee paid annually in association for registering a vehicle.

- ***Vehicle Rental Tax***

  This is a tax that is levied on vehicle rental agreements.

- ***Vehicle Weight Fee***

  A state fee based on the weight of a noncommercial vehicle.

2.2 General Criteria for Evaluating Revenue Options

There are general criteria that can be used to evaluate alternative revenue sources for transportation infrastructure. These criteria are: economic efficiency, equity, administrative feasibility, public acceptance, and the level and stability of the revenue.

2.2.1 Economic Efficiency

Prices are one means for rationing limited resources. Without prices, consumers would not be constrained in the amount they consumer, with the result that they will consume more than is economically efficient. If the cost of producing one more unit exceeds the benefits of that unit of output, society is not being economically efficient in its use of its limited resources. In a competitive market system, prices lead to an allocation of resources to their highest and best use. This maximizes net benefits since the allocation occurs where marginal benefits equal marginal cost. In the public realm, user taxes and fees can play the role of prices. If properly set, tolls and fuel taxes signal the marginal cost of using the transportation infrastructure, and thus lead to the economically efficient use of the infrastructure.

The costs of using the transportation infrastructure include the cost of building and maintaining it, environmental damage, and congestion. When roads are congested, adding another car results in time delays for other drivers, as well as environmental damage. If drivers do not bear the congestion cost imposed on others, the result is that costs exceed the benefits, and thus economic inefficiency from too many drivers. To the extent that tolls and taxes reflect all of these costs, the use of the transportation infrastructure will be more economically efficient.

Taxes and fees affect behavior. If taxes and fees reduce congestion or the cost of maintaining roadway, then that would be generally thought of as a good thing. But, the taxes could lead drivers to shift purchases to other jurisdictions, or simply use other roadways and increase the congestion on them. This would reduce economic efficiency.

2.2.2 Equity

When it comes to financing public services, a distinction can be made between horizontal equity and vertical equity. Horizontal equity, or fairness, means that equals should be treated the same. Vertical equity refers to how non-equals are treated. Equity can be based on the principle of ability to pay or the benefit principle. In terms of the ability to pay principle, vertical equity means that someone with a greater ability to pay should pay more taxes or fees. While for the benefit principle it means that the tax or fee should be based on the benefit received.

Transportation has traditionally been financed by user taxes, like fuel taxes. These are benefit taxes, i.e., those who benefit more from a road, that is, use the road more or impose more cost on the system, will pay more.

2.2.3 Administrative Feasibility

Funding alternatives should be evaluated in terms of the cost of administering the revenue source relative to the revenue collected. Part of this is the compliance cost, both on the part of the user and the government.

2.2.4 Public Acceptance

While no one wants to pay taxes or be charged fees, some revenue sources are more acceptable to the public than others. If the public is strongly opposed to some revenue source, it will be difficult to get elected officials to impose it. And, if imposed, the public will strongly resist paying it, which increases the cost of collecting it.

2.2.5 Level and Stability

A revenue source should produce sufficient revenue to make it worthwhile imposing the tax or fee. Sufficient revenue, however, might be considered relative to what the funds will be used for. A source that will be dedicated to funding bike lanes does not have to generate the same revenue as a source that will be used to build new roads. And of course, one or two revenue sources do not have to fund the entire transportation system; even revenue sources that generate relatively small revenues do contribute to the total.

It should be noted that some fees are not designed to necessarily raise revenue. For example, fees that are designed to reduce congestion may generate revenue, but the evaluation of such fees would be largely based on how well they allocate the roadway.

A revenue source that is stable and predictable is better than one that is not. While it is possible to maintain large balances that can be used in time of low revenue, stable revenue makes planning and budgeting easier.

2.3 An Evaluation of Traditional Revenue Sources

In this section we provide a discussion of what some authors refer to as "traditional" or common revenue sources. Since several of the revenue sources listed above are variations of one revenue source, for example, fuel taxes indexed for inflation are still fuel taxes, we combine some of the options and discuss them together. In section 2.4 we discuss tolling or pricing options, while in section 2.5 we discuss other, less traditional revenue sources.

- ***Fuel Excise Tax***

The fuel excise tax is a fixed pennies per gallon tax on gasoline and other motor fuels, and is the main funding source for highways and for Federal grants for transit. The average state motor fuel excise tax in 2009 was 21.72 cents per gallon for gasoline, 22.62 cents per gallon for diesel, and 21.54 cents per gallon for ethanol (Dierkers and Mattingly, 2009). The majority of state excise taxes fall between 18 cents and 24 cents per gallon, although the complete range is from 7 to 32 cents per gallon (Dierkers and Mattingly, 2009). In 2008, state fuel excise taxes generated $36.6 billion in revenue across the U.S., approximately one-third of state transportation revenue.

Fuel excise taxes have been the key funding source for highways for a very long time. One of their biggest advantages is their significant revenue yield, coupled with low administrative and compliance costs. A small increase in the fuel tax generates substantial revenue. Another advantage is the direct link between the tax and the use of the revenue. Overall, in the past the excise tax has been a good proxy for a user charge since gas usage is related to the number of miles driven. However, with changes in fuel efficiency and the development of alternative fuel vehicles, this relationship has weakened and will continue to do so in the future.

One of the main disadvantages of the fuel excise tax is that it is not indexed to increases in the cost of building and maintaining transportation facilities, with the exception of a few states,[1] and therefore the revenues do not increase automatically with some measure of inflation. With higher gas prices, voters have been unwilling to support increases in fuel taxes, so revenue in real terms has not been able to keep up with transportation financing needs. One revenue option would be to adopt legislation that

[1] Florida, Kentucky, Maine, Nebraska, North Carolina, and West Virginia (Dierkers and Mattingly, 2009).

would index fuel taxes for inflation. This would allow fuel tax rates to adjust quickly to cost increases rather than waiting for the legislature to act, which has been a politically acrimonious task in most states. Indexing, however, does take the approval of a tax increase out of the control of the legislature.

Another disadvantage related to revenue adequacy is that with improving fuel efficiency this source of revenue is expected to decline in real term further in the next couple of decades. To deal with this trend, the fuel tax could be indexed for improvements in fleet fuel efficiency. This would protect the fuel tax revenue from decreases in revenue per mile driven due to the reduce fuel used per mile driven. An alternative way of dealing with the effect of increases in fuel efficiency is to shift to a vehicle miles driven tax; this option is discussed below.

In terms of economic efficiency, fuel taxes paid do relate to road usage, but do not vary much with the level of congestion, so fuel taxes are not as efficient as would be a variable tax or fee that depends on road congestion. Generally, any tax increase would be perceived as an increase in the price of gas and therefore will reduce the amount of driving. Studies of the price elasticity of gas estimate that a one percent increase in the price of gas reduces demand by 0.43 percent (Sjoquist et al., 2007). Further, fuel tax increases may influence the purchase of more efficient vehicles, carpooling, and demand for public transportation.

Finally, most taxes on consumption, either excise or percentage taxes, are considered to be regressive, that is, individuals with lower incomes pay a larger share of their income in taxes. According to a study for the Colorado DOT, low income families (income less than $20,000) pay about 0.8 percent of their income in fuel taxes, while high income families (income between $80,000 and $100,000) pay 0.34 percent of their income in fuel taxes in Colorado (Carter and Burgess Inc., 2007). To the extent that funding of the transportation system should be based on benefit taxes, inequities arise due to differences in fuel efficiency across vehicles.

Public support for tax increases is difficult to garner, as illustrated by the failure of the only two ballot initiatives (in Missouri and Washington in 2002) over the past decade for statewide fuel tax increases (Coussan and Hicks, 2009).[2] However, there were legislative increases of the motor fuel tax ranging from 3 cents per gallon in Kansas in 2002 to 6 cents per gallon in Oregon in 2009. Washington implemented a 5-cent increase in 2003 and gradual increases from 2005 to 2008, for a total of 9.5 cents per gallon.

Recent poll results confirm that fuel tax increases are very unpopular with voters. A national poll conducted by HNTB (2010), showed that Americans prefer toll financing (41 percent) to gas tax increases (18 percent) for new roads, and they would rather have no new roads (41 percent) and keep their taxes low. In Virginia, two-thirds of poll respondents opposed a gas tax increase, and one-third was in favor (Meola and Whitley, 2011). An Idaho survey in 2008 revealed that voters are strongly against fuel taxes and tolls, and are more likely to favor impact fees, registration fees, and a local option tax (Idaho Highway Users, 2008).

- ***Vehicle Registration Fees***

Vehicle registration fees are another revenue source used by all states. The cumulative revenue from such fees in 2008 was $20 billion (Dierkers and Mattingly, 2009). Registration fees are levied annually and are either flat or depend on the vehicle value, weight, year, and horsepower. Twenty-seven states have flat fees, eight states

[2] These proposals were for multiple tax increases, including the fuel excise tax and the sales tax.

have a weight-based fee, and the remaining states use a more complex fee structure. In Colorado, the registration fee depends on the weight and year of the car. For example, the registration fee for a small car that is 10 years old is $16 (Carter and Burgess Inc., 2007).

Some states allow local governments to impose an annual transportation benefit district tax on each vehicle beyond the annual registration fee. For example, Wisconsin allows municipal and county governments to add an additional fee (called a wheel tax) with the revenue earmarked for transportation. Seattle and Olympia, Washington and Milwaukee, Wisconsin impose a tax of $20.

Registration fees are a fairly stable source of revenue, but due to low vehicle ownership turnover they do not have a high revenue potential unless value-based fees are introduced in place of flat fees. Flat fees are not related to the amount of driving and any fee increase is not expected to significantly influence driving behavior. Fees that vary with the vehicle type and value may influence the purchase of particular vehicles, but are not likely to influence driving behavior. There is an indirect link to the cost of transportation infrastructure in the cases where fees are based on weight and value, assuming that heavier cars cause more damage to the roads, and that more expensive new cars are driven more.

Flat fees are regressive, since they represent a larger share of the income for low-income individuals. However, registration fees based on the car value are probably progressive. The administrative costs of registration fees would depend on the extent of the change, but are not expected to be prohibitive since most states collect some form of a registration fee.

In the past decade, states have increased a mix of vehicle fees, including registration fees. Specifically, Colorado increased registration fees by $31 in 2009, and Kansas increased the registration rate by $4 in 2008 (Coussan and Hicks, 2009). Poll results released by the Pennsylvania Governor's Office indicate that close to a majority of residents (48 percent in favor, 45 percent against) are willing to support inflation adjustments to vehicle fees for infrastructure spending (Pennsylvania Office of the Governor, 2010).

- ***General Fund Revenue***

Thirty-two states use general fund revenues to fund transportation projects, for a total amount of $8 billion in 2008 (Dierkers and Mattingly, 2009). General funds are a combination of sales taxes, income taxes, property taxes, and other fees and charges. General fund revenues are more important at the local level, where almost half of highway expenditures came from general fund appropriations in 2004 (Cambridge Systematics Inc. et al., 2006).

The general fund revenues are a large potential source of revenue. It is based on a large tax base and has good growth potential. Using general fund revenues to finance transportation means that all taxpayers are required to "contribute" to transportation funding, which can be justified on the basis that transportation infrastructure is a public good and everyone benefits from its development, not just users. To the extent that revenues are from a mix of taxes, this is a less regressive approach because income taxes are generally progressive. In most states fuel tax revenues can only be used on roads and bridges. General fund revenues do not have that restriction and thus can be used to fund transit and other non-highway transportation.

General fund revenues are not as stable a revenue source for transportation as fuel taxes because general fund revenues fluctuate more with the economic cycle than do fuel taxes. In addition, appropriations for transportation must compete each year with demands to fund other public service. Using general fund revenue does break the link between what a person "contributes" to the funding for transportation and that person's use of the road system. Furthermore, the revenue is not linked to the cost of providing and maintaining transportation, and increases in the use of this revenue source are not expected to have any impact on driving behavior.

- ***Driver's License Fees***

Driver license fees are a small revenue source due to their relatively low rates and the fact that licenses are renewed only periodically, anywhere from four to 10 years. Overall, the revenue from driver license fees has been used for administrative expenses. Increases in license fees are not costly to implement but are not expected to influence driving behavior.

- ***Vehicle Rental Tax***

The rental car tax is a tax on the rental or lease of a vehicle. It is similar to a sales tax, but the rate may be greater than for the state or local sales tax. Rental car taxes are imposed in 30 states (Sundeen and Reed, 2006). In Colorado, the rental car tax is equal to the state sales tax,[3] while in Minnesota it is a separate tax, which was increased from 3 percent to 5 percent in 2008 (Coussan and Hicks, 2009; Carter and Burgess Inc., 2007). Arkansas, Florida, and Pennsylvania dedicate some of their rental car tax revenue for public transportation, while New York uses the revenue for highways (Cambridge

[3] Colorado also imposed a $2 per day fee on rental cars in 2009 (Coussan and Hicks, 2009).

Systematics Inc. et al., 2006). Indiana, Kentucky, North Carolina and Wisconsin have local rental car taxes that support transit.

The adequacy of this revenue source depends on the extent of leisure travel in the state and any seasonal fluctuations. If the tax needs to be accounted for separately and earmarked for transportation, it will be associated with some additional compliance and administrative costs. To the extent that people who rent cars are not state or local residents this revenue source is more equitable since visitors are not paying other state and local taxes that are paid by residents. Also, to the extent that higher income individuals have more leisure time and are more likely to travel, this sales tax is expected to be less regressive than a regular sales tax. It is not very likely that a rental car tax would have a significant impact on miles driven, but it may impact the decision on what type of car to rent.

- ***Transit Fares***

Fare box revenue is mostly used to fund public transit operations and maintenance, while capital projects are funded by other transportation revenues. Notably, Chicago Metra has dedicated 5 percent of its fare increases since 1989 to capital projects (Cambridge Systematics Inc. et al., 2006).

Fare box revenue is directly linked to the use of public transportation and to the cost of operation and maintenance. And, it is generally desirable for the beneficiary of transit to pay the cost. However, the socially appropriate pricing of transit is complicated.

Mass transit ridership is price inelastic. In a meta-analysis of public transportation studies, Johan Holmgren (2007) reports that the long-run price-elasticity of public transportation in the United States -0.75, i.e., a one percent increase in fares is expected to reduce ridership by 0.75 percent. This means that an increase in fares will result in an increase in revenue. However, it also means that increased fares will reduce ridership. If the transit system was used to capacity, then raising fares would be socially desirable. But if there is excess transit capacity, such a decrease in usage would not be socially desirable since increasing ridership will have little effect on cost but will generate benefits for the rider. Furthermore, reduced ridership may exacerbate road congestion problems in some areas. To the extent that the use of roads is inappropriately priced too low, shifting transit riders to driving would not be socially desirable.

When there is congestion on the transit system, transportation studies report that transit systems can improve their peak-time performance by introducing rates that vary over the day and day of the week. Flat fares per ride do not reflect the additional cost of longer trips. Since low income individuals are more likely to rely on transit, transit fares are likely to be regressive.

2.4 Tolling or Pricing Options

The basic foundation for the financing of transportation systems in the U.S. has been to use benefit taxes. Fuel taxes has been the principal method, under the premise that the more one drives the more fuel will be consumed. Fuel taxes are considered an indirect user fee. But there are other, more direct ways of pricing transportation. In this section we consider various forms of tolling, or pricing, road facilities or networks.

Many of the revenue options involve tolling, or direct pricing. (Fares for the use of public transit are a form of a pricing, but we considered that option above.) Tolling has a long history of being employed to fund transportation projects. But there are many variations in how transportation can be priced. More generally, pricing options differ in terms of what the driver is paying access to and what factors determine the price or toll. Tolls can vary with the distance travelled, the weight of a truck (usually measured by the number of axles), time of day, and level of congestion. In what follows, we first list the various transportation infrastructures that could be priced and give some examples. We then turn to a discussion of the advantages and disadvantages of tolls in general, and then to specific types of tolls or pricing. Finally, we discuss the use of congestion pricing, i.e., varying tolls by the level of congestion on a road or road network.

2.4.1 Types of Facilities that can be Priced

- ***Access to a Specific Road, Bridge or Tunnel***

The most common application of tolls is as a flat charge imposed for access to a transportation facility such as a bridge or a segment of a road. Tolls could be fixed amounts, but frequently vary with the distance travelled or the weight of a truck (usually measured by the number of axles). Tolls can be allowed to vary by time of day or day of the week, generally to reflect the expected level of congestion during peak periods. Tolls are collected at a toll station, either directly or through automated mechanism such as E-Z Pass. The development of automated mechanisms such as E-Z Pass has reduced the transaction cost of collecting the tolls, regardless of the transportation facilities.

- ***Car Access to an Express Lane, or HOT Lanes***

A toll can be imposed for the use of a particular lane of a freeway, i.e., High Occupancy Toll (HOT) lanes; these are also called managed lanes. A toll on a HOT lane can be a fixed amount to enter the lane or a fixed amount per mile, and can vary by time of day and by traffic volume. With HOT lanes there is usually a zero toll for car pools of, say, three or more passengers per car. Some HOT lanes attempt to keep usage of a lane to a level that ensures free flow in that lane for anyone willing to pay to use the lane. Thus, the price (or toll) varies continuously as the demand changes.

The first HOT lane appears to be the Riverside Freeway (state route 91) in California. For that road two HOV lanes were converted to HOT lanes. The toll varies by time of day (highest is $10.25 per trip Friday afternoons). A transponder is used to record road usages. Interstate 15 in San Diego has eight miles of two reversible HOT lanes. Toll varies in real time from $.50 to $4.00 depending on the level of congestion. A transponder deducts the payment from a prepaid account.

In Toronto, the Express Toll Road fee varies by time of day and distance. It is set at $0.10 (Canadian) per kilometer during peak period, $0.07 during other weekday times, and $0.04 on weekends. The system uses a vehicle identification system (VIS). For those without a VIS, the system photographs license plates and sends bill to the registered driver. In Minneapolis the toll for using the HOT lane is 25 cents during rush hour, regardless of the distance driven.

Variations of HOT lanes are FAIR (fast and intertwined regular) lanes for which everyone pays including car pools.

- ***Truck Access to a Specific Lane, or TOT Lanes***

A toll can be imposed on the use of a lane devoted to truck use. The use of the lane can be voluntary or mandatory. We were unable to identify any existing TOT (truck-only toll) lanes. Meyers (no date) provides an extensive discussion of the issues associated with implementing TOT lanes in the Atlanta area.

- ***Cordon Pricing***

Under a cordon price policy the central area of a city is cordoned off and a charge or toll is levied if a driver crosses the cordon boundary. For the cordon pricing schemes that are in place the toll is a form of congestion pricing in that the charge varies by time-of-day and day-of-the-week, but not by the level of congestion.

There are a few examples of cordon pricing. Singapore adopted cordon pricing, called the Area Licensing Scheme (ALS), in 1975, which was the world's first comprehensive road pricing scheme.[4] It was adopted because of increased car ownership and the concern that more land could not be allocated to roads. Singapore sought a market-based way to reduce the number of passenger cars and taxis coming into the Central Business District. They instituted a manual system of toll collection at 22 entry points. All non-exempt vehicles were required to buy and display a decal, which cost S$3 per day (about US$2.30 at today's exchange rate), if the driver wanted to enter the restricted zone between 7:30 a.m. to 9:30 p.m. Monday through Saturday. It was thought that restricting entry in the morning would be mirrored in the evening. Police simply looked at each car as it entered the cordoned area to see if it has the required decal. Cars with four or more passengers were exempt, as were public service vehicles, motorcycles, buses, and delivery vehicles. Singapore also increased its parking fees in the restricted area by almost 100 percent and implemented a park-and-ride program. Over time, the daily fee changed as did the peak-toll hours. By 1989, the peak-toll hours were set at 7:30 a.m. to 10:15 a.m. and from 4:30 p.m. to 7:00 p.m.

[4] This description was drawn from Phang and Toh (2004).

London adopted a cordon pricing scheme in 2003. Cars entering central London on weekdays between 7:00 a.m. and 6:30 p.m. are required to pay £8.[5] There are some exemptions such as motorcycles, taxis, buses, and emergency vehicles. Area residents receive a 90 percent discount for their vehicles. Payments can be made at selected retail outlets, at payment machines located in the area, by Internet, and by cellular telephone messaging. Passes for up to a year can also be purchased. A network of video cameras records the license plate numbers of vehicles and matches it with the paid list. The fine for not paying is £80.

In 2006, the Swedish national government sponsored a full-scale congestion pricing experiment in Stockholm.[6] The congestion pricing program was put in place for six months, and was combined with short-term increases in public transit capacity. At the time the experiment was approved it was decided to hold a referendum after 6 months to see if there was support for implying the congestion program on a permanent basis. The referendum passed with 52 percent of the voters approving the plan.

The congestion charges were for entering a 30 square miles cordon area of inner city Stockholm. Vehicles were identified by a transponder or a photograph of the license plate. There are four different rates for travel into and out of the condoned area that vary by time of day and days of the week: zero charge at night and on weekends, 10 Swedish crowns (SEK) for off-peak, 15 SEK for early and late peak periods, and 20 SEK for peak-hour travel, with a maximum charge of 60 SEK per day.[7] Cordon pricing is also used in the cities of Trondheim, Oslo, and Bergen in Norway.

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[5] This description is drawn from Litman (2006).
[6] This description is drawn from Hårsman and Quigley (2010).
[7] 10 SEK is about $1.45 as of January 2011.

- ***Access to a Road Network, Electronic Road Pricing***

Charges can be levied for use of a set of roads or a road network. Hong Kong experimented with electronic road pricing (ERP) in the mid-1980s, but dropped it. In part there was concern with privacy issues, since vehicle owners received a bill indicating where they went and when.

Over time Singapore's ALS became more complex and the visual enforcement by the police had become more difficult.[8] So, in 1998, Singapore shifted to an electronic road pricing (ERP) system at a cost of about S$300 vehicle. Transponders, known as In-vehicle Units (IUs) were installed in each vehicle. Motorists have to insert a debit card into the IU before making any trip that includes an ERP charge. Visitors have the option of renting a temporary IU.

The ERP relies on a pair of gantries. The first checks the debit card and then debits the card. The second gantry determines the location and identifies the vehicle type. With every transaction, the driver is notified by a beep, and the balance on the debit card is displayed. In case the vehicle does not have a debit card, a photo of the license plate is taken.

Initially the gantries were set up at the existing entry points into the cordon area. Over time other locations were added. As of January 2003, there were 45 points being covered by gantries that included the restricted zone as well as four expressways and four major arterial roads. Charges are changed every quarter based on travel speed reviews. The charge varies by vehicle type, time of day, and location. The charge by vehicle is based on the road space the vehicle occupies.

[8] This discussion is based on Phang and Toh (2004).

There were other policies that were combined with ERP in Singapore, including a motor vehicle quota scheme, parking fee increases, and increases in public transit.

Singapore is an island city-state about the size of Seattle, with a population of 4.2 million. It is largely isolated from foreign motorists, and has a law-abiding citizenry. This provides an advantage in using an ERP system.

- ***Access to the Entire Road Network (Vehicle Miles Traveled)***

Vehicle miles traveled (VMT) taxes are similar to fuel taxes, but rather than the tax being dependent on fuel consumption, VMT taxes are based on miles traveled. And, rather than be dependent on the miles traveled on a particular road or lane as with HOT or ERP, VMT taxes apply to all roads.

There is no known example of a fully operational VMT tax. However, there have been two demonstration or test programs in the U.S. The first was conducted in the Portland, Oregon area beginning in 2006. In that program 299 motorists participated. Devices were installed in each car that determined the number of miles driven in the test area. Mileage data and fee collection occurred at the gas pumps at two filling stations that were equipped with special readers. When the driver purchased fuel, the gas pump would download the miles driven, calculate the tax, and charge the tax as part of the purchase price of the fuel. The regular fuel tax was not imposed.

The reports of the experiment concluded that the concept is viable. "The pilot program showed that, using existing technology in new ways, a mileage fee could be implemented to replace the gas tax as the principal revenue source for road funding." (Whitty, 2007, vi.) Ninety-one percent of participants said they would agree to continue paying the mileage fee. The experiment showed that paying at the pump works, and that the mileage fee can be phased in so that integration with current system can be achieved.

A second experiment was the Puget Sound (Seattle) pilot project that was conducted between 2005 and 2007, and in which 275 households participated.[9] Each household received a GPS device. Drivers were given a travel budget account based on their expected VMT tax payment; drivers could keep any positive account balance at the end of the experiment. Unlike the Oregon program, the Puget Sound pilot included a test of congestion pricing. Congestion charges based on prevailing congestion levels were establish for each part of a tolled network of roads at different times of the day. The analysis of the program led to the conclusion that this was a dramatic opportunity to significantly reduce congestion and to raise revenue. However, it was also concluded that installing in-vehicle tolling devices is a costly logistical challenge ($665 million).

The University of Iowa is testing the feasibility and public acceptance of a mileage-based charging system. The objective of the study is to determine how the public responds to the new VMT road user charge system. It was a multi-state study in which participants have an on-board computer installed in their car. The computer stored a record of charges due from road use, which was then uploaded to a processing center. However, no actual fees are being collected. The results of the study are due out soon.

There is strong support for VMT taxes among those who have studied transportation funding. For example, the following is a conclusion from a recent transportation policy conference: "Many proponents of transportation reform have concluded that the best approach to ensure adequate funding and re-align incentives for road use is to return to a pay-as-you-go system. This means taxing road use (instead of

[9] Puget Sound Regional Council (2008).

fuel consumption) via a vehicle-miles-traveled (VMT) tax. As discussed at greater length in subsequent sections, the technology exists to implement such a tax in ways that also address privacy and regional equity concerns. Moreover, a VMT-based system could be designed to advance other public policy goals, such as incentivizing travel at different times of day or differentiating among types of vehicles based on their emissions performance or the amount of wear they impose on highways. In short, the technology exists to design funding mechanisms that are not only more rational, but that also create the market signals needed to address important transportation externalities." Miller Center of Public Affairs (2010, 26).

Sorensen and Taylor (2006) provide a detailed discussion of 20 electronic tolling case studies that they believed to be the most relevant to the concept of distance-based user fees. They also provide a briefer review of 68 facility congestion toll projects and cordon toll projects. For the 20 projects, they identify where the projects are located, how they were structured, and what factors have affected their implementation.

2.4.2 Advantages and Disadvantages of Pricing

We now turn to a discussion of the advantages and disadvantages of pricing transportation facilities. We then discuss the use of pricing to address congestion.[10]

- ***Revenue***

Tolls provide a source of revenue that is very stable and can generate substantial revenue, but do not need to cover the entire cost of constructing and operating a transportation facility. Increasing tolls during peak travel periods would increase revenue.

[10] This section is drawn heavily from the Final Report of the National Surface Transportation Policy and Revenue Study Commission (2007).

VMT fees could be set to yield any level of desired revenues, but unless indexed to inflation their purchasing power would erode over time, as the fuel tax currently does.

- ***Feasibility***

Imposing tolls on existing interstate highways is restricted, but pilot programs have allowed tolls on some interstates, particularly for the reconstruction of existing roads. Tolls for new interstate highways are a much greater opportunity, particularly in the longer run. Calculating the real time price required to maintain free flow of traffic is complicated and expensive. Sorensen et al. (2009) provide a discussion of potential technical system options for implementing a VMT tax system and conclude that there are many potential VMT metering and charging systems that could be implemented within a few years. However, they note that there are one or more significant drawbacks for each option.

- ***Efficiency***

Traditionally, road tolls vary directly with the number of miles traveled and the size of trucks. Thus, they are more economically efficient than fuel taxes, given that fuel efficiency varies across vehicles. However, traditional tolls do not vary with congestion levels. VMT fees, especially if applied as congestion pricing fees or weight-distance taxes can send strong pricing signals to users. Tolls, if appropriately set, can result in a congestion-free trip. Among other advantages of tolling include: 1) they encourage the use of transit and carpooling; 2) HOT and TOT lanes reduce accidents between heavy trucks and light-duty vehicles; 3) TOT lanes increase speed and the reliability for deliveries.

There are disadvantages to tolling. Tolling specific roads leads to shifts to non-tolled roads, increasing congestion on those roads. Cordon pricing, or any system in which tolls vary by time of day, causes behavioral changes in an effort to avoid the toll. So, cordon pricing projects have led drivers to change work hours (leading to inconvenience), to speed up in order to cross the boundary before the charge increases or to wait on the shoulder of the road until the toll decreases, to drive around the cordon area rather than through (which increases congestion on those roads), and to shift to exempt vehicles (like delivery trucks).

- ***Flexibility***

Changing tolls can usually be done without approval of elected officials. While tolls are typically used to finance a separate facility, it is possible to use toll revenue to fund new roads or transit facilities. However, there is political resistance to using toll revenue from one to fund other projects.

- ***Administration***

Collecting tolls at traditional toll booths is expensive to administer and results in significant traffic delays. Electronic tolling is much less costly. However, unless all cars have transponders or a driver can be billed based on a photo of the car license, then it is still necessary to use toll booths. If the toll is small, then the cost of billing a driver based on a license photo may not be cost effective. Administration and compliance costs for tolling are greater than for motor fuel taxes, although electronic toll collection reduces these costs. Enforcement can be difficult.

If VMT taxes are allocated to local areas or individual states, it is necessary to be able to identify the geographic district in which one drives so that fees can be apportioned to different jurisdictions. It is believed that the potential for evasion is minimal since, for example, tampering with on-vehicle device would result in default payment of the gas tax. VMT taxes that are collected at the fuel pump do not address the problem of taxing drivers of alternative fuel vehicle that, for example, charge their electric cars at home. VMT fees would be more costly to collect and administer than fuel taxes, but long term costs are uncertain. VMT fees or congestion pricing fees require the technology to collect those fees reliably. A significant issue that would arise with a VMT tax imposed in one area is dealing with visitors to the area. However, it is possible to get an E-Z Pass tag for most states on line before visiting. And, E-Z Pass tags could be sold at welcome stations, although that would not handle visitors who do not use interstates or major roads into the state or region. Enforcement of out-of-state drivers would be difficult.

Significant investment of capital ($100 per vehicle) is required, which is major hurdle to implementing a VMT program. There is also the issue of how information is transmitted to the tax collection agency and how to deal with equipment failures (malfunction or tampering).

- ***Equity***

Tolls can be set so that drivers pay in proportion to the cost they impose on the road, for example, miles driven and weight of the vehicle. As a form of benefit tax, this is more equitable than fuel taxes in which the tax per mile varies with fuel economy. There are concerns that tolls are a regressive tax. Tolling existing lanes is widely perceived as inequitable; drivers claim that they are “paying twice” for the road. This is not true to the extent that the revenue is used to maintain and operate the facilities. Equity is strongly influenced by the availability of good alternatives to driving on the priced highways. Rebate programs have been suggested as one way to reduce adverse impacts on lower income groups. Good transit alternatives also must be available for those who cannot afford the congestion toll and cannot change their trip destination or time of day they travel.

- ***Acceptability***

There is opposition to tolling existing lanes. There appears to be more opposition the more lanes of a road that are tolled. Thus, HOT lanes are supported while fully tolled roads are not. TOT lane face opposition from the trucking industry as burdensome and costly unless use of the lanes is voluntary. There are concerns regarding privacy issues with VMT taxes; Oregon officials did not record where and when people travelled in that experiment. Implementing a VMT will require substantial political will, given that it is a dramatic departure from current practice. The HOT lane and managed lane applications have generally been well accepted since they provide drivers the choice of whether to pay to avoid congestion or not; however, acceptance of pricing entire facilities or entire areas of a city is more controversial. In a poll conducted in 2010, 33 percent of Americans stated that tolls should be a primary source of transportation revenue, while 16 percent believe toll should never be used (HNTB 2010).

- ***Other Issues***

VMT tax are unaffected by changes in fuel efficiency, which gives that option an advantage over fuel taxes. However, that also means that the incentive that fuel taxes have to increase fuel efficiency does not exist with VMT taxes. But, the VMT tax could be made to vary with fuel efficiency, and even the pollution level of the vehicle. A concern with cordon pricing is that it could reduce local retail business.

2.4.3 Congestion Pricing

Congestion pricing is a means to ration available road capacity by setting prices that reduce traffic to a socially desirable level. The concept of using pricing to regulate demand has a long history, but the modern theory of optimal road pricing is more recent and is attributed to Vickery (1963).

The basic theory goes as follows. The economically optimal level of road capacity is the point where the marginal cost of additional capacity equals the marginal benefit that stems from that capacity. Drivers will utilize the road until the marginal benefit equals the private marginal cost of travel. If drivers are not charged for the capacity cost, then utilization of the road will exceed the design capacity, and congestion will occur. So, drivers should be charged a price (or tax) that is equal to the cost of providing and maintaining the capacity. Fuel taxes partially serve that role, but the tax does not vary with the level of congestion and differences in fuel efficiency across cars means that the charge per mile driven varies.

But the demand for road usage varies by time-of-day and day-of-the-week. It would not be economically efficient to provide road capacity equal to the peak demand. Rather, capacity should be expanded based on the weighted average of the marginal benefits of peak and off-peak times, where the weights are equal to the fraction of time that is peak and off-peak. (The problem of calculating the optimal capacity is obviously much more complicated given that demand for road usage varies continuous over time and the investment in capacity must reflect demand over a long period of time.) The result is that, even if road capacity is optimal, there will be congestion, i.e., an economically inefficient level of drivers trying to use the road. The result is that travel time increases for everyone.

The congestion arises because each individual driver considers only his private cost and not the social cost of the delay imposed on other drivers. This marginal social cost increases as the number of drivers using the road during peak period increases, which increases congestion. To maintain economic efficiency, a charge or price should be imposed on each driver equal to a level that reduces the amount of road usage to the optimal level. This congestion charge would be levied during the peak period.

If road capacity is less than optimal, then a charge would have to be levied during more than peak periods. In this case, the revenue from the congestion charge should be used to expand capacity, either of the road system or public transit.

To be fully implemented, the congestion prices charged would vary with the demand for road usage. Thus, the congestion price would vary as the demand for road usage changed. The price would be higher during peak periods of the day, but could vary from day-to-day or hour-to-hour or minute-to-minute depending on what demand was at that time. Furthermore, the price would vary across roads based on the demand for the use of each road.

The congestion pricing scheme implied by the previous paragraph is very complex and would be hard to implement. The only congestion pricing scheme that comes even remotely close to this is in Singapore. The congestion pricing schemes that have been more widely implemented are cordon pricing, road and bridge tolls that vary by time of day and day of the week, and HOT lanes.

The advantages and disadvantages of tolling discussed above also apply to congestion pricing, so we do not discuss these here. The principal advantage of congestion prices follows from the theory, namely, that if appropriately applied, congestion pricing will achieve an economically efficient level of road usage. In other cases, it will reduce congestion. (This, of course assumes that drivers are responsive to prices on driving. In a subsequent section we explore the empirical evidence.) Reducing congestion increases social benefits that result from reducing the trips that have little value to the driver but that result in reduced trip time for other drivers. These social costs have been estimated to be quite high.

The second advantage of congestion pricing is that it generates revenue that can be used to expand the road network or alternative transportation systems, such as public transit.

There are several disadvantages of congestion pricing. First, there is the cost of installing and operating a congestion pricing system. Before the advent of electronic metering systems, a complete congestion pricing system was simply not feasible.

A second concern is posting of the prices. If the objective is to discourage drivers when traffic gets heavy, either at a particular time or on a particular road, drivers need to know what the price is so they can make a decision to delay the trip, cut the trip short, take an alternative route, or not drive at all. For HOT lanes, prices can be posted a few minutes before they go into effect and in time for a driver to decide whether to get in the HOT lane or get out of the lane. That is much more difficult to do for a network of roads.

When congestion pricing is used on a more limited basis, for example just one or two roads, the benefits of congestion pricing are reduced. When the price for driving on one road goes up, many drivers will shift to alternative routes. This means that the congestion is shifted to other roads. Some of that shifting is desirable since it reduces congestion on the most congested facility and increases it on the less congested facility. The result should still be an increase in social benefit. What is lost are the benefits of the trips that are delayed or cancelled. There is some evidence that 2nd best congestion pricing schemes obtain nearly as much social benefit as a full congestion pricing scheme. It this is correct, than it may be desirable to adopt a less than optimal system given the administrative cost of an optimal system.

2.5 Less Traditional Revenue Alternatives

- ***Public–Private Partnership (PPP)***

There are three categories of private financing of transportation infrastructure**:**

- *Contracting out*. This is a situation in which the private sector provides the service, but not the capital. For example, the state could contract with a private firm to collect tolls.
- *Privatization*. Privatization involves the transfers (sale or long-term lease) of ownership rights to a transportation facility to the private sector. The lease of the Chicago Skyway and the lease of the Indiana Toll Road are examples. The public sector may retain some regulatory role.
- *Concession scheme*, also known as Public-Private Partnership. Under a PPP the private sector provides the capital (all or a large percentage of it) and maintains and operates the road.

In this section we consider just PPPs. PPPs are seen as a way of generating financing for a new transportation infrastructure, but we discuss PPPs because they typically, but not always, involve tolls. The advantages and disadvantages of tolls, as discussed above, apply here as well. But with private sector involvement, there are other factors to consider.

The U.S. Department of Transportation defines a PPP as follows. "A public-private partnership is a contractual agreement formed between public and private sector partners which allows more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system." (U.S. Department of Transportation, 2004).

Typically, the public sector contracts with a project company to develop, finance, construct, maintain and/or operate the transportation infrastructure for the contracted period. The project company typically assumes a substantial financial, technical and operational risk in the project. The project company's revenue typically involves tolls, but the public sector may provide part of the cost of building the infrastructure and/or some guaranteed annual revenues for a fixed period. At the end of the contract the public sector acquires the infrastructure. The project company is responsible for the agreements with the contractors and lenders. Standards for service are defined in the contract, with penalties specified for substandard service. Projects are not usually completely self-supporting.

PPPs are commonly used in Europe but are not yet widely used in the United States. It is reported that in the past 20 years more than 80 transportation PPPs have completed in the U.S. (Public Works Financing, 2010) However, over the past two decades more than 1,400 PPP deals were signed in the European Union (Kappeler and Nemoz, 2010).

There are several potential benefits and concerns with PPPs, including the following:[11]

- The private capital can overcome public sector fiscal constraints, leading to the delivery of projects that otherwise might have been delayed or not built.
- The responsibility for multiple project phases of a project gives the project company an incentive to reduce costs across a facility's entire lifecycle. It also allows the project company to incorporate state-of-the-art technologies and techniques.
- PPPs allow the transfer of certain project risks from the public to the private sector.
- Some stakeholders express concern about how default by a private partner could affect the public sector, especially for long-term lease agreements.
- Non-compete clauses are not unique to PPPs, but they do impose constraints on the development of future transportation infrastructure.

Issues regarding tolls imposed by the public sector also apply to tolls on roads developed through PPPs. But for PPP projects there is also the concern regarding what the role of the public sector will be in setting the tolls, which is spelled out in the contract. The project company will want to set toll at a level that will maximize its return on its investment, while the government will want tolls that are socially optimal or at least politically acceptable. But once the contract has been signed, the public sector loses

[11] This discussion is drawn from Rall, Reed, and Farber (2010), which contains a much longer list of concerns.

control over the level of the tolls. Given the long-term nature of the contract and the uncertainties that arise, there is substantial uncertainty that future tolls will be set at the economically efficient level.

- ***Local Option Sales and Income (Payroll) Taxes***

Local option sales and income taxes have been widely used in many states to support highway and transit. In the 1970s, local option sales and income (or payroll) taxes were adopted to fund transit. For example, Atlanta, San Francisco, and Denver adopted sales taxes while Portland and Cincinnati adopted payroll taxes to fund transit. Beginning in the 1980s, states begin to allow local governments to adopt time-limited local option taxes to fund infrastructure, including transportation projects. More recently, local option sales taxes have been adopted in metropolitan areas to fund a mix of transit and transportation projects. Regional sales tax increases have been successfully passed, with nine out of 13 proposals approved in the past decade or so. The majority of proposals were focused on transit funding (Coussan and Hicks, 2009).

Significant revenue can be generated from a one percent local sales or income tax, particularly in urban areas. Local sales taxes tend to receive stronger support than other local option taxes. If the local option tax is temporary, the revenue can be used to support capital investments, but that means that funding operations, particularly for transit, has to be addressed in the future. If the collection of local sales and income taxes can be tied to state taxes, the costs of administering the taxes are small.

Local option sales tax will cause border shopping. Studies have found that if there is a sales tax rate differential among communities, consumers will shift some of their shopping to the jurisdiction with the lower sales tax rate. Likewise, a jurisdiction with a higher local payroll tax rate will likely see a reduction in employment, while a jurisdiction with a higher local income tax rate will likely see migration of families to the lower tax jurisdiction.

- ***Local Fuel Taxes***

At least 15 states allow local governments to assess an additional gas tax, including Alabama, Florida, and Mississippi. In addition to the advantages and disadvantages of state fuel taxes, a local option gas tax allows a community to address transportation issues that are specific to the community but are not statewide issues. Thus, using local fuel taxes to address the community's transportation issue does not require the rest of the state to support a statewide fuel tax increase, which they may be reluctant to do. Allowing the use of a local fuel tax also means that the principle that transportation systems should be financed by user charges is retained.

The major disadvantage of a local fuel tax is that the fuel tax rates, and thus fuel prices, will likely differ from jurisdiction to jurisdiction. This will result in some drivers shifting their purchase of fuel to communities with lower fuel tax rates. This cross-border shopping imposes a practical limit on the fuel tax rate that a local community can impose without significant decreases in fuel sales in the community.

- ***Sales Tax on Fuel***

A sales tax is a percentage tax imposed on the purchase of a very board array of good and some services. Ten states include fuel as part of its sales tax, including California (6 percent), Georgia (4 percent), Hawaii (4 percent), Illinois (6.25 percent), Indiana (6 percent), Michigan (6 percent), Nebraska (5 percent) and New York (4 percent) (Cambridge Systematics Inc. et al., 2006; Dierkers and Mattingly, 2009;

Coussan and Hicks, 2009). Taxes may be collected from retail purchases, or at the wholesale level, as in Connecticut, Georgia, Hawaii, and New Jersey.

A sales tax on fuel, or a percentage (or ad valorem) excise tax, is better than the per unit excise tax in keeping up with inflation since revenue increases as the price of fuel increases. However, it is also more volatile as a result and it is difficult to predict the revenue stream given the significant volatility in fuel prices. The fuel sales tax also links directly the source of the revenue to its use. The fuel sales tax may not be as costly to administer if it is collected at the wholesale level, together with the per unit excise tax. However, if it will be collected from consumers by the retailer, it will require reprogramming of the gas pumps and additional state administrative costs for accounting of the revenues (Carter and Burgess Inc., 2007). It is necessary to assess the total fuel tax rates and compare them to neighboring states in order to determine whether there may be any revenue loss from border purchases, particularly from commercial vehicles. Even though revenues from sales taxes would increase with higher gas prices, this option does not address the expected revenue loss from fuel efficiency.

Sales taxes on fuel have the same economic efficiency limitations as per unit excise fuel taxes since they do not vary by the level of congestion. Tax increases would increase the regressivity of this funding source. It is expected to have the same effect as any price increase on miles driven, and possibly demand for more efficient vehicles, carpooling, and public transportation.

Statewide changes in the sales taxes have been few in the last decade, but notably include a one-percentage point increase of the retail sales and use tax on gasoline from 6 percent to 7 percent in Indiana in 2008, and a new 5 percent tax on the average price of wholesale gasoline in Nebraska[12] (Coussan and Hicks, 2009). The same study finds that there were 99 ballot initiatives for local sales tax increases between 2000 and 2009, with 58 of these approved by voters.

- ***Privatized Rest Areas/Concessions***

The concession rights to rest areas, as well as transit stations, that attract a high volume of travelers could be sold or leased. The concessionaire could provide drivers with new amenities such as restaurants and other retailing.

Such concessions should be popular with drivers, and to the extent that such rest areas allowed drivers to rest a bit longer, it should reduce the number of accidents. The concession would generate some revenue, but only a small increase relative to total transportation expenditures. There is likely to be opposition from business owners and local governments in the area.

- ***Truck Weight-Distance Tolls***

Tolls on trucks can be imposed that are based on distance driven and the weight of the truck (using size and number of axles as surrogates for weight). Such tolls are commonly used in Europe, but not in the U.S. The toll has to reflect the direct capital and operating costs imposed by the truck. Payment for infrequent users is by manual declaration, with payment at roadside stations or through the internet. For regular users an automated electronic system that uses on-board GPS equipment is used. Charges are calculated and transmitted to the toll collect center, which sends out an invoice.

The German Toll Collect truck toll system was initiated in January 2005. Per European Union directive, the fee system applies only to vehicles over 12 tons and only to use of the motorways—other roads are exempt. The price varies by distance traveled,

[12] However, Nebraska lowered the excise tax from 10 to 2.5 cents per gallon.

by the number of axles, and by the emissions class of the vehicle. The overall fee structure, which is governed by an EU directive, is designed to recoup direct capital and operating costs to the motorway system imposed by truck traffic. For infrequent users, there is a manual declaration and payment method that can be accessed via roadside toll stations or the Internet. For others, an on-board GPS system determines entry to and exit from the motorway network and distance traveled, and a GSM system determines the fee and communicates that to billing office. Toll collect is administered by a private consortium. The revenue is spent on road maintenance and improvement. For a more detail discussion see Sorensen and Taylor (2005)

One advantage of such a toll is that it results in vehicles paying in proportion to costs imposed on system. The opposition to such tolls is likely to be very strong. Opponents have argued that such tolls unfairly targets trucking. It is likely that the toll would be reflected in the cost of shipping and thus passed on to consumers. The tolls would provide incentive for shippers to use trains and for truckers to reduce deadheading. Collecting the toll would likely require a new system in order to measure distance travelled in the state and to invoice and collect the tolls.

- ***Transportation Impact Fee (System Development Charges) or Benefit Districts***

Transportation impact fees are one time charges levied against developers based on the road improvements required to accommodate the increased traffic flow related to the development, and are based on the number of vehicle trips each class of property generates. Impact fee legislation exists in about half the states, with impact fees heavily used for transportation improvements in California and Florida.

Impact fees are usually imposed by local governments, but can be imposed at the state level. They would likely produce only an incremental amount of transportation funding, and are typically dedicated to transportation improvements that would serve the new development. Transportation impact fee revenue obviously depends on the volume of development.

These charges can be designed to target those who impose cost (both capital and operating) on the road network, and therefore are considered relatively equitable. Transportation impact fees provide an incentive that encourages better transportation and land use integration.

Transportation impact fees are opposed by developers, and competition among local governments for development will limit the use of impact fees. Numerous lawsuits have been filed claiming that the charge or fee is not properly associated with cost or that the revenue is not used for the intended purposes.

- ***Container Charges***

Container charges are seen as a means to fund freight-specific transportation improvements that are required because of the rapid growth in international and domestic freight volumes. There would be a fee on every inbound loaded container.

Container fees represent a potentially large source of revenue. Cambridge Systematics Inc. et al. (2006) cite an estimate of $2.2 billion in revenue through 2017 from a $30/TEU fee applied at all U.S. ports. Container fees provide a revenue source to fund non-highway freight improvements. To the extent that container fees are used to fund freight handling improvements, than these fees would seem to be a desirable benefit tax.

Given competition for business among ports, it would be difficult for one port or state to impose a very heavy container charge without losing port activity. To be financially successful it would be necessary to obtain agreement among competing jurisdictions on whether to impose a container charge and if so, at what level. Furthermore, reaching agreement among jurisdictions and other stakeholders on the types and locations of projects to be developed with the revenue will also be very difficult.

- ***Value-Based Tax on Vehicles (Property Tax)***

At least 16 states, including Georgia, impose a property tax on motor vehicles. The property tax revenue is largely local revenue, although some states do impose a state property tax.

Property taxes on motor vehicles can generate significant revenue for transportation, particularly for local roads, although the revenue is not generally earmarked for transportation. Property taxes depend on ownership and value of the vehicle, and are therefore not user fees. Property taxes provide an incentive to own less expensive cars, which means either smaller or older cars. However, there is no incentive on vehicle use. In several states, property taxes on vehicles have proven to be politically unpopular, and the number of states that do not impose a property tax on motor vehicles has increased over time.

- ***Safety Violation Fee***

States could increase the fines for traffic safety offenses. Revenue from such increased fines could be significant, but still small relative to total revenue needs. Fines are related to the potential costs imposed on the system from safety violations since the penalties target the drivers who are the greatest safety threat. Larger fines could reduce traffic violations or could result in the highway patrol writing fewer citations. An across the board increase in fines for any traffic violation is not likely to be politically popular. However, targeting those violations that have a high probability of resulting in an accident, for example, drunk driving and excessive speeding, may be generally supported by citizens.

- ***Excise Tax on Transportation-Related Goods and Services***

Battery and tire fees or excise taxes are discussed below, but sales taxes or charges on transportation-related goods such as auto parts and auto repairs are a possible source of transportation funding. Earmarked non-fuel taxes include sales taxes on purchases of cars and auto parts, as well as on auto services, with the revenue set aside for transportation funding. Twelve states have an excise sales tax on cars, with the revenue dedicated to transportation funding.[13] The revenue from the vehicle sales tax in Nebraska was $143 million in 2005. The total revenue is dedicated to transportation and roughly divided in half between the state and local governments. Missouri allocates only half of the revenues from a vehicle sales tax to transportation, with two-thirds for the Missouri DOT and the rest for cities and counties (Cambridge Systematics Inc. et al., 2006).

The revenues from these taxes would be cyclical, but with an overall growth potential. According to the Colorado DOT study (Carter and Burgess Inc., 2007), the national annual growth rate for cars and auto parts sales was 5.75 percent for the period 1993-2006. However, during the early 2000s, the sales growth dropped to 2 percent. Earmarked sales taxes would require separate accounting from vendors and the state for

[13] These states are Connecticut, Iowa, Kansas, Maryland, Michigan, Minnesota, Missouri, North Carolina, Nebraska, Oklahoma, South Dakota, and Virginia (Cambridge Systematics Inc. et al., 2006).

the funds that should be dedicated to transportation. Sales taxes on parts and repairs are more likely to impact low income families who cannot afford to buy a new car, so they will be more regressive than a general sales tax. Sales taxes on new cars are less regressive to the extent that higher income households buy new cars more often. Earmarked taxes are more likely to be approved by voters than general tax increases.

While excise taxes on parts and auto repairs maybe weakly and very indirectly linked to transportation, it is hard to justify such taxes as being transportation related. It is not likely that such excise taxes would affect the amount of driving. Annual expenditures on auto parts and repairs are significant, so the revenue from such an excise tax would be sizable. Since the sales tax already applies to the parts components of auto repair, the cost of collection would be negligible.

- ***Special License Plate Fees***

States, including Georgia, charge a fee above and beyond the regular registration fees for special license plates that are either personalized or identify an organization or activity. States could enhance transportation funding by increasing fees for special plates. Harrington and Krynski (1989) find that the demand for "vanity plates" is price inelastic and thus states could increase revenue by increasing the price of such plates. But the amount of revenue collected would be modest compared to total spending on transportation.

An increased fee on special license plates is a convenient revenue source, and one that would be easy to collect. The fees are tied to transportation, but only very indirectly and certainly would not affect driving patterns. Special plates are very popular, but there may be resistance to the government generating significant net revenue from selling them.

- ***Tire or Battery Tax***

Some states impose an excise tax on the sale of tires and batteries, either a percentage of the sales price or a flat fee, in addition to the general sales tax. Typically the revenue from these excise taxes is used to fund the cost of disposing of the tires or the battery. But such a tax could be used to fund transportation. A tire tax, and to a lesser extent a battery tax, can be seen as a user fee since the more a person drives the more frequently he will need to buy tires and a new battery. But, the need to replace tires will depend on the quality of the tires, how well the owner cares for the tires, and the road conditions and speed. And battery replacement is more tied to the life of the battery than the amount of driving.

- ***Title Fee/Vehicle Impact Fee***

States, including Georgia, charge a small fee for titling motor vehicles. The issues associated with increasing the annual registration fee would also apply to an increase in the title fee. In particular, title fees are not associated with road use.

An alternative version is a Vehicle Impact Fee (or Transportation Access Fee). For this option a one-time charge is levied when a vehicle is titled or registered in the state, but only for the first time. Title transfers would not be subject to the fee. This is not a user fee and does not depend on actual vehicle use. Such fees have been justified on the basis that new vehicles are tied to the need for capacity. This fee would be in addition to the sales tax on newly registered vehicles.

- ***Alternative Fuel Tax***

Vehicles that rely on alternative fuels do not pay the traditional fuel taxes on gasoline and diesel. To bring these vehicles into the transportation financing system, taxes equivalent to current fuel taxes would need to be imposed on the alternative sources, including electricity, natural gas, hydrogen, and similar fuels.

Taxing these alternative fuels would reflect use of the highway system by motorists who pay little through gas taxes. Thus, they fit the user fee scheme. Because the fleet of alternative fuel vehicle is still small, such a tax would not generate substantial revenues.

A significant difficulty is the ability to impose the tax on the purchase of these energy sources when they are used by motor vehicles but not when the purchase is for other uses. For example, to impose a charge on wattage generated by an electric or hybrid electric vehicle it would be necessary to either have a special meter on the plug-in for the vehicle or estimate the wattage used based on self-reported miles driven or on an annual inspection.

These alternative fuel taxes would reduce the incentive to use alternative fuel vehicles; thus environmental groups are likely to oppose such taxes.

- ***Emissions Fees***

A fee could be imposed that is based on the amount of pollution an owner's vehicles emits. Such a fee would provide an incentive to reduce emissions. However, administering such a tax would be difficult, the biggest problem being measuring the amount of emissions. Emissions are largely related to the amount and type of fuel used.

So, an emission fee would, in effect, be either a fee based on the fuel efficiency, type of fuel, and miles driven.

- ***Road Utility Fees***

A road or transportation utility fee is a monthly fee, levied by local governments, that is based on use of the road system generated by the land use. This option is for local governments and is currently used in various communities in Montana, Oregon, and Florida. The fee is imposed across the entire jurisdiction and continues indefinitely. Some property types, for example, undeveloped land, are exempt. See Ewing (1994) for a discussion of this option.

Typically the fee is based upon measures such as motor vehicle trip generation estimates, the number of parking spaces, the number of employees, or front footage. It is designed to be a fee rather than a tax, since local governments are usually allowed to impose a fee but not a tax. The advantage of the road utility fee over using property taxes to fund road construction and maintenance is that road utility fees are more closely aligned with road usage of an individual or business than are property taxes. Furthermore, the fee is also collected from property owners who are exempt from property taxes, for example, non-profits. However, given that the fee is calculated as an average for a class of property, there are inequities.

In Oregon City, Oregon residential households are charged for maintaining local streets while non-residential facilities are charged for maintaining arterials. The costs of collectors are shared equally.

While the fee is based on use of the road system, but it is not likely to have a large effect on use of the road system. To the extent that the fee is based on average road use, there will be little effect on the fee a property owner pays if that owner changes his driving pattern. However, if the fee is based on something like the number of parking spaces a retail store has, it provides some incentive to reduce the number of slots and encourage alternative modes to get to the store. To the extent that a city ordinances mandate the number of parking spots, the fee will not have much effect.

Collection of the road utility fee can be combined with payments of other utility charges such as for water. Thus, the administration of such a fee should be relatively easy once the fee is designed.

- ***Bicycle Registration Tax or Fee***

Imposing an excise tax on bicycle sales or a one-time fee for bicycle registrations could generate revenue to be used, for example, to fund bike paths. Only a handful of states and some localities currently tax or impose fees on bicycle sales or registrations.

Such a tax or fee would not generate substantial amounts of revenue. The need or desire for bike paths is likely to be much higher in more urban areas, and thus if the revenue is used to finance bike paths the fee is likely to be supported. However, there likely will be opposition to such a tax or fee in less urban areas of the state. This suggests that such a tax or fee should not be statewide. Environmental groups and bicycle advocacy organizations may be opposed to such a tax or fee. However, if the revenue is dedicated to bike paths, the opposition should not be very strong.

- ***Drive-Through Service Fee***

This option envisions a transaction fee on drive-up service at any retail establishment. It could either be based on whether an establishment has a drive-up service or a fee for each customer using the drive-up service. The revenue potential of this approach is unknown.

The drive-through window is a symbol of the car-oriented society, and the intent for such a fee would be to reduce reliance on cars. However, the effect of such a fee on driving is apt to be negligible. It would most likely force customers to go inside the establishment rather than use the drive-through service. It would be very difficult to enforce the fee if it was based on the number of users. It is likely to be very unpopular.

- ***Advertising Revenue***

Transit agencies have for a long time leased interior and exterior spaces for advertising purposes. State transportation departments might consider the same option. However, the opportunities for state transportation agencies to lease space seem rather limited; leasing advertisement space at rest areas being the one obvious possibility. If so, then the potential revenue is small. The main concern is that too many advertisements can be seen as a blight.

- ***Naming Rights***

Like the sale of naming rights for sports stadiums, transportation officials could sell naming rights to transportation infrastructure, such highways, rest areas, rail and transit stations, toll plazas, etc. Several states—including Massachusetts and Virginia—have explored these options.

Revenue generate is not likely to be substantial. One concern with selling naming rights is that it might overly commercialize public venues, particularly historic or popular transportation facilities. In addition, voters might object to the name put on the facility.

- ***Parking Tax or Fee***

Imposing a tax or fee on parking is frequently proposed. The fee could be a tax on the payment to park or a fee on each commercial parking space, depending on whether the owner charges for parking. A parking tax or fee is not seen as a significant revenue generator. A fee on parking would provide an incentive to use alternative transportation or to car pool. If imposed on retail shopping centers based on the number of parking places, it will provide an incentive to reduce the area devoted to parking, and possibly lead to charging for parking. A parking tax or fee is seen as an option for local government. If the community does not have transit, there is much less of a rationale for imposing a parking tax or fee. There is likely to be strong opposition from commercial parking lot and garage owners. If the fee is imposed on retail shopping centers, there will be strong opposition.

Collecting a parking tax from a commercial parking facility will be as difficult as imposing a sales tax on other service vendors that operate businesses in which payment is mostly by cash. Imposing a fee on parking spots provided to workers or shoppers will require defining what a parking spot is and measuring each facility.

CHAPTER 3
A REVIEW OF OPINION SURVEY LITERATURE

This chapter contains the results of a search of public opinion surveys that focus on the level of support for various transportation funding alternatives. We focus on surveys conducted since 2000. To conduct this review we first searched the database of the Roper Center for Public Opinion Research for relevant public opinion questions. The Roper Center provides the responses to public opinion questions asked by most polling firms for their various clients such a CNN, New York Times, TIME, etc. The Roper Center allowed us to identify the individual questions asked and the responses. However, no analyses of the questions are provided, for example how the responses differ by age, income, etc. In addition to the Roper Center, we searched the literature for published articles and reports that address public opinion toward alternative transportation funding sources, although there are only a few published studies that we were able to identify. In addition to surveys regarding attitudes towards transportation taxes and fees, we also identified a few surveys that asked about how the interviewee would respond to increases in taxes or fees. These surveys are considered in the next chapter.

The majority of surveys and polls have focused on the key transportation funding alternatives – fuel taxes, sales taxes, and tolls. The results from the surveys that have been identified are discussed for each category, with key findings and explanations of observed differences.

There are several overarching patterns that can be identified from all of the surveys. First, it appears that tolls are the most favored alternative for transportation finance. This pattern is even more pronounced when tolls are explicitly compared to taxes in survey questions. Another global finding is that approval is higher when the proposals are specific and respondents are provided additional information, versus when they are asked general questions concerning their support for a funding source. Some of the alternatives that have been developed more recently, such as HOT lanes and variable tolling, are not very intuitive to respondents who have not been exposed to these alternatives, and that may impact the response for general questions about such revenue options. Third, respondents who are users (potential and current) of an option such as HOT lanes are more likely to support a particular option than nonusers. Also, many surveys find more public support when the revenues are linked to specific purposes related to transportation. Finally, many polls find general concern with fairness, and support depends on whether the public perceives an option as fair or unfair.

3.1 Fuel Excise Tax

Fuel tax increases are not usually supported by a majority of respondents in most instances, with a very few exceptions as noted below. A national survey of public attitudes towards different federal funding options conducted in 2010 found that 42 percent of respondents would support a 10 cent increase in the motor fuel tax if the revenues were dedicated to projects that reduce global warming. Thirty-nine percent expressed support for a phased increase of the gas tax of 2 cents per year over 5 years, and 32 percent supported an increase when the respondents were provided information about their annual cost of the tax increase would be (Agrawal and Nixon, 2010). The percentage of respondents supporting the first two modified options almost doubled when compared to the general question about a 10-cent gas tax increase, where only 23 percent of respondents were in favor.

A California survey conducted in 2006 confirms that there is more support for a phased increase of the gas tax. The question asked whether respondents would support a 1 cent per year increase in the state gas tax over 10 years, with 40 percent being in favor of this option (Dill and Weinstein, 2006). Far fewer respondents in the survey supported indexing the gas tax to inflation; about 27 percent expressed support when they were provided information that with 3 percent inflation would result in a half-cent increase in the gas tax.

Other national polls conducted from 2000 to 2010 generally find that only about one-third of respondents are in favor of higher gas taxes, regardless of question wording (Roper Center, 2011). For example, a 2009 survey asked whether individuals were willing to pay a gas tax of 40 cents per gallon, with the revenue dedicated to road improvement. Thirty-eight percent of respondents were strongly against, while only 14 percent were strongly in favor, and another 24 percent were somewhat in favor. Only 27 percent of respondents voice support for a 15-cent fuel tax increase for road improvement in a 2010 Associated Press survey. Another survey asked whether higher fuel taxes should be used as a way to reduce driving and global warming; only 28 percent supported such an alternative (Stanford University, 2010). A 2007 CNN poll reports that 33 percent would favor an increase in the federal gas tax to fund inspection and repair of the transportation infrastructure.

However, when respondents were asked a more general question about paying more taxes and not specifying that it is the fuel tax, 56 percent responded that they were willing to pay more taxes to improve roads and bridges. Another survey, in 2006, by Fox News, also found majority support, by 58 percent of respondents, for paying more taxes rather than seeing cuts in funding for roads. Finally, a survey that asked respondents whether they would be willing to pay 9 cents more per day for road and bridge repairs found that 69 percent said they were willing to do so (Tarrance Group, 2003). The same survey also asked respondents whether they agreed that "America is facing a transportation crisis," after which respondents were asked whether they were willing to pay up to 5 cents more in federal fuel taxes to be used for transportation improvements. A majority of respondents were willing to pay more taxes, with 57 percent in favor and 38 percent against.

Also, when the survey question asks about specific amount of a tax increase, it appears that there is more support for a tax increase, although the support varies with the proposed fuel tax increase. An ABC poll from 2005 reports that 12 percent were willing to pay 1 to 4 cents per gallon more in taxes to fund transportation, another 11 percent agreed to 5 cents, and 19 percent agreed to more than 5 cents.

Surveys conducted in specific states or metropolitan areas find mixed support for tax increases. In Atlanta, a survey by the Applied Research Center in 2002 found that only one-third of the respondents were willing to support a gas tax increase, and the majority of those supported a 10-cent increase. In the state of Washington, support for a transportation funding measure that included a 9-cent gas tax increase varied from 64 percent to 40 percent in three different counties. A statewide poll found that 63 percent were willing to support the proposed legislation calling for a gas tax increase conditional on there being a higher priority for public transportation funding. Polls about a ballot measure in Oklahoma in 2005 also showed a significant majority opposing gas tax increases; however, the timing of the measure coincided with rising gas prices.

3.2 Sales Tax

Sales taxes appear to be the most favored of all tax options, although even the sales tax option falls short of majority support at the national level. The surveys we were able to identify asked about sales tax of less than 1 percent; we found no surveys that asked about one percent sales taxes. A national survey in 2010 found that 43 percent of respondents approved of a new half-cent federal sales tax for transportation funding (Agrawal and Nixon, 2010). In California, about the same proportion were in favor of a half-cent increase in the state sales tax (Dill and Weinstein, 2006). Regional surveys identify higher support for sales tax increases, especially when there are specific transportation projects and measures to be financed by the proposed tax increases. In North Carolina, a survey for the Triangle Transportation Authority found that 58 percent of respondents said they were willing to vote for a half-cent increase in the sales tax dedicated to public transportation (Fallon Research, 2010). Two other metropolitan surveys found majority support for sales tax increases, again with the funds dedicated to specific transportation projects. A 2010 survey for Metropolitan Denver and Boulder County in Colorado found that 56 percent of respondents were willing to vote in favor of a 0.4 cents sales tax increase with the revenue dedicated to specific identified projects (The Kenney Group, 2010). In Los Angeles, 56 percent of respondents express support for a 0.5 cents county sales tax increase to fund projects that were listed and explained in the survey (Fairbank, Maullin and Associates, 2007).

3.3 Vehicle-Miles Traveled (VMT) Tax

Replacing the gas tax with a mileage tax, i.e., a VMT tax, does not appear to have a lot of support based on the few studies that have examined public opinion of this option. Support increases somewhat when the mileage fee varies with vehicle type and pollution levels. A national survey about federal funding options in 2010 found that a mileage tax of one cent per mile was the least popular alternative from the options that they examined, with only 21 percent in favor of such a tax. But 33 percent of the respondents said they would support a mileage tax that varies with the vehicle's pollution level (Agrawal and Nixon, 2010). The results from a 2006 California survey are similar, with only 22 percent supporting a 1-cent per mile tax to replace the gas tax (Dill and Weinstein, 2006). However, a more recent survey of California residents found that 50 percent of respondents would support a mileage fee that varies with the vehicle's emissions (Agrawal et al., 2009).

Focus group interviews for the Minnesota DOT illuminate some of the reasons behind the lack of support for a mileage fee (Fichtner and Riggleman, 2007). Although most participants considered the mileage fee fair, they thought that it would be expensive to implement and they were concerned with privacy due to the electronic monitoring. Respondents were more supportive of a mileage fee that varies by vehicle weight and type. Many respondents, after hearing why the gas tax has become an inadequate source of revenue, stated that it would be easier to just increase the gas tax rather than implement a new type of tax.

Oregon conducted a pilot VMT program. Oregon found that 91 percent of participants said they would have been willing to keep the on-vehicle equipment in their vehicles and continue paying the mileage fee rather than the gas tax if the system were extended to allow them to buy gasoline at any service station statewide (Whitty, 2007).

Baker and Goodin (2011) conducted five focus group sessions in various cities in Texas regarding various aspects of VMT fees. They explored various aspects of a VMT fee program, including the effect on miles traveled, administrative issues, and fairness. Baker and Goodin found that there are barriers to public acceptance of VMT fees. The principal conclusions from the Texas focus group sessions were:

- There is strong lack of understanding how the transportation system is currently funded and the issues affecting its long-term health.
- There was a strong anti-tax sentiment but it is not universal. Upon receiving information on the fuel tax, information that the majority of participants previously had no knowledge of, many participants indicated that fuel taxes were still too high while others indicated that they were too low.
- Most focus group participants believed that they are essentially driving for free since the fuel tax is effectively hidden.
- All five groups expressed some opposition to mileage fees in general. When pressed, the participants chose the simpler approach, i.e., an odometer reading-based model.
- Privacy, enforcement, and costs of operating a VMT system were concerns of participants.

3.4 Fees and Tolls

It appears that the public is somewhat more supportive of increasing vehicle registration fees relative to the tax alternatives, although the source of this information is from just two surveys conducted in California. As with the mileage fee, variable environmental fees are more attractive rather than flat fees. The 2006 California survey reports that 32 percent favored a flat fee increase, while about 44 percent favored a fee increase that varies with the vehicles emissions (Dill and Weinstein, 2006). Support in 2009 increased to 41 percent and 63 percent, respectively (Agrawal et al., 2009).

Tolls overall are the only funding option that usually commands a majority support from respondents in a variety of surveys. However, attitudes towards different types of tolls vary significantly. Generally, traditional and express toll lanes are favored more than the congestion-targeting tolls. The public tends to support tolls for new roads, but strongly opposes tolls on existing roads. This section discusses traditional tolls, while the following section discusses express toll lanes, HOT lanes and variable tolls as part of congestion pricing.

Generally, surveys find majority support for traditional tolls, but this is conditional on several factors. First, voters tend to express support for tolls more when they are presented with several options to raise revenue and have to choose among them. Respondents express a preference for tolls over tax increases. Second, voters support tolls only when they are imposed on new roads and the revenue is proposed to be used to repay the cost for building and maintaining the roads. Lastly, strong positive support for tolls is most likely when the toll is for a specific project, versus a general question about tolls. Annual surveys between 2001 and 2006 in Orange County, California, consistently found more than 50 percent of respondents support the completion of a local toll road (Zmud and Arce, 2008, 11-7). The same review of surveys reports that 55 percent of respondents in Central Florida favored an extension of an existing regional toll road.

A statewide survey in Utah provides additional insight about how people may change their support for toll roads depending on the question that they are asked. The

2006 poll found that 55 percent of Utah residents were willing to pay tolls if the toll would ensure that roads can be built faster, specifically within the next three years rather than the next 20 years (Zmud and Arce, 2008, 17).

More general questions about tolls have received somewhat lower support, although some of the surveys do report support near 50 percent. A North Carolina statewide poll in 2000 found that 52 percent of respondents support tolls as a way of financing new construction (Zmud and Arce, 2008, 11). A California survey in 2006 found that 44 percent supported tolls as an alternative to higher taxes as a means for financing new road construction (Dill and Weinstein, 2006). When potential users of toll roads in central Texas were surveyed in 2005 about their general attitudes towards tolls, only 45 percent believed that tolls are needed. However, 51 percent approved of the toll roads under construction in the area at that time (Zmud and Arce, 2008, 16).

Podgorski and Kockelman (2006) conducted a study for the Texas DOT in 2006 with a focus on opinions towards tolling issues. They found that a large percentage of respondents (70 percent or more) believed that they should not pay tolls for existing roads, that revenues should be used within the region where they were generated, and that tolls should be reduced after construction expenses have been repaid (p. 894). The study found that residents outside of metropolitan areas were more supportive of tolling existing roads, but were also more concerned about equity. Fewer people were in favor of tolling existing roads when they were provided information about the average cost of driving a car, versus being provided with information about the cost of maintaining roads. Older individuals, new residents, and those who were using toll roads regularly were more likely to support tolls for new and existing roads.

3.5 Congestion Pricing

3.5.1 Cordon Tolls

As noted in chapter 2, several cities in other countries, for example, London, Singapore, and Stockholm, have imposed cordon tolls, which are charges for entering the central area of the city. There are relatively few surveys in the United States that explore public attitudes towards cordon tolls. Overall, there is no majority support for cordon pricing, with some exceptions noted below. A national poll in 2007 found that two-thirds of respondents opposed a congestion tax similar to the congestion pricing for central London (Zmud and Arce, 2008, 32). The other known polls deal with the proposal by New York City Mayor Bloomberg to introduce a cordon toll for Manhattan. Two of the polls conducted in 2007 in the New York area found that the majority of respondents opposed the proposal by 57 percent to 36 percent in August, and by 52 percent to 41 percent in July. Only Manhattan residents supported congestion pricing, but respondents were more likely to support the proposal if the revenue would be used to prevent increases in public transportation fares and other tolls (Quinnipiac University Polling Institute, 2007). A 2006 survey of New York residents found that people were more likely to support the Manhattan cordon toll proposal if they believed that congestion pricing would be effective at reducing congestion. An online poll in 2007 found that 53 percent supported the cordon pricing proposal and 47 percent opposed it, with the majority of those against stating that it would be unfair to small business owners and residents in Manhattan (Zmud and Arce, 2008, 31-2).

In 2006, the Swedish national government sponsored a full-scale congestion pricing experiment in Stockholm (Hårsman and Quigley, 2010). The congestion pricing program was put in place for six months, and was combined with short-term increases in public transit capacity. At the time the experiment was approved, it was decided to hold a referendum after 6 months to see if there was support for implementing the congestion program on a permanent basis. The referendum passed with 52 percent of the voters approving the plan.

How individuals vote is perhaps a stronger or better measure of the voter position on a cordon pricing scheme and allows for discovery of some additional insight for who supports cordon pricing. Hårsman and Quigley (2010) conducted an analysis of the results of the referendum. They report that support of the congestion plan was stronger inside the cordon than outside, although after controlling for other factors, the difference was about 2.5 percentage points. They found that what motivated voters was more subtle than whether voters were transit riders or a car user, but rather depended on the effect on time saving and cost. Based on residential location, Hårsman and Quigley (2010) estimated the change in time savings due to the effect of the toll and out-of-pocket costs. They found a clear positive relationship between the likelihood of voting in favor of the pricing program and time savings, where trip times were estimated for each residential zone using a traffic-engineering model. They find that a one minute saving in commuting time per trip is associated with an increase in support of the pricing program of about 7 percentage points. In residential zones in which the average congestion toll was larger (the difference being due to differences in the mix of transit and non-transit riders) the voters were less likely to support the congestion pricing program. Given other factors, they found that support for the congestion pricing was higher in residential area with higher levels of education, smaller levels of foreign-born residents, and a larger percentage of females.

3.5.2 Express Toll Lanes

Express toll lanes are built alongside existing highways and drivers can access these if they prefer to avoid traffic in the regular lanes. Toll collection is automatic and tolls may increase with traffic in the express lanes. Generally, express toll lanes are supported because they do not reduce the existing lanes, but the variable tolls to manage congestion in those lanes are not supported as strongly. A series of surveys of Orange and Los Angeles Counties found that approval of the toll lanes increased as the toll was opened and used. However, the highest support came from users of the toll lanes, with support ranging from 60 percent to 80 percent. Also, support for variable tolls ranged from 50 percent to 70 percent in 1996, just after the lanes were opened, up from 40 percent when the lanes were still under construction. A follow-up survey in 1999 found that higher income individuals expressed greater support for the variable tolls and toll financing in general (Zmud and Arce, 2008, 18-9). A statewide poll in Minnesota also found fairly strong support for tolls on new lanes, with 69 percent of respondents in favor of having the option to use a toll lane (Zmud and Arce, 2008, 20). A 2006 survey of Denver residents living close to toll roads found that 78 percent considered express lanes a good way to manage congestion.

3.5.3 High-Occupancy Toll (HOT) Lanes

HOT lanes provide the opportunity to low-occupancy vehicles to use HOV lanes if they pay a toll. As in the above discussion of express toll lanes, support for HOT lanes is highest among users and when the actual lanes are already operating. However, concerns with HOT lanes have focused on their ability to resolve congestion issues. A series of surveys and focus groups in San Diego during the late 1990s find that support among the general public is close to two-thirds of respondents, but support among users is 80 percent or more. Also, respondents generally approve using some of the toll revenues for public transit improvements (Zmud and Arce, 2008, 21-3). Another local California survey in 2003 found that support for HOT lanes increased after voters were provided more information about the project, increasing from 58 percent to 67 percent. The survey identified three key factors associated with support of the HOT lanes – no cost to carpools, electronic tolling, and revenues used for both construction and public transportation (Zmud and Arce, 2008, 24).

A focus group study in Denver revealed that people wanted the public discussion of the HOT lane proposal to focus on how the funds were going to be used. Respondents who approved of HOT lanes believed that they would be beneficial in reducing congestion in the other lanes (Zmud and Arce, 2008, 24). Minnesota DOT conducted a series of surveys between 2004 and 2006 that found high support for HOT lanes, even among carpoolers. Support was lowest among public transit users.

Surveys in Atlanta in 2006 reveal split opinions about HOT lanes, with people opposed to them because they do not believe that HOT lanes would resolve congestion problems in the area, and that HOT lanes are not fair (Zmud and Arce, 2008, 27). Another exception to the general support for HOT lanes was revealed in a survey of residents of Salt Lake County, Utah; in that survey respondents expressed strong opposition to HOT lanes. Sixty-one percent were against the toll lanes and individual accounts indicated that respondents were concerned with fairness.

3.5.4 Variable Tolls

HOT lanes for which tolls are adjusted by time of travel and are higher during peak hours are probably the least acceptable of all tolls. The attitudes of New York metro residents were studied in several different surveys and focus groups in 2003, with the results indicating strong opposition to congestion tolls (Zmud and Arce, 2008, 14). Respondents did not believe that the variable tolls have addressed congestion problems in the area and considered the discounts for off-peak travel insignificant to be able to change their behavior. Residents in Southern California were equally strongly opposed to congestion tolls on existing roadways, with 58 percent against a variable fee of 5 to 10 cents per mile, depending on traffic conditions. However, opposition decreases somewhat if part of the revenue from the toll roads is used to reduce other taxes, with opposition falling to 46 percent under that condition (Harrington et al., 2001).

3.5.5 Additional Comments

As noted, there is a general lack of support for pricing of the use of roads. Some authors have attempted to explain this general opposition. Frey (2003) suggests that there are four major reasons why people tend to oppose road pricing schemes. First, Frey argues that people consider prices as being associated with goods but do not understand that road pricing is a way of allocating scarcity, i.e., limited road capacity. They view road pricing as a reduction in income and not as means of reducing the use of the road. Second, Frey suggests that people have an aversion to using prices to allocate scarce resources. He cites a survey he undertook in which 76 percent of the respondents said that "first come, first serve" was the fairest way to allocate a scarce good, while only 27 percent said that prices were the fairest way. Third, Frey suggests that there is a general aversion to government intervention and taxes. Fourth, people express concern over the winners and losers of road pricing. A common expression of this view is the statement that "the rich just pay" and thus are affected very little, while those with little choice lose.

The findings that there is limited support in the U.S. for increases in fuel taxes or road pricing is also reflected in surveys that have been conducted in European countries. Jones (2003) and Schade (2003) note that public opinion surveys in European countries find low levels of support for road pricing schemes. Jones cites a survey conducted in London that asked what the respondent thought was the single most effective way of reducing London's traffic level. Over 50 percent mentioned public transit, while only 5 percent suggested a road user charge in central London (i.e., cordon pricing). Schade reports on the extent to which various approaches to congestion relief are acceptable. He reports that 96 percent find improved public transportation acceptable, while less than 15 percent say that increasing parking costs, cordon pricing, congestion pricing, or distance base pricing are acceptable.

3.6 Public-Private Partnerships

Surveys of attitudes towards public-private partnerships, also known as concessions, focus on specific projects in several states. Among those are Indiana, New Jersey, Pennsylvania, and Texas. Initial surveys conducted in March 2007 and May 2007 in Pennsylvania found public support for leasing the Pennsylvania Turnpike, 49 percent and 44 percent in favor, respectively. However, in August 2007 support had fallen to 40 percent, and those who opposed the plan increased to 47 percent (Zmud and Arce, 2008, 34). The wording of the question noted that the state would have control over toll increases and maintenance schedules. Toll increases under the control of private companies is one of the major reasons for opposing public-private partnerships.

In Indiana, the lease of the Indiana Toll Road was opposed by a significant majority of respondents – 55 percent and 60 percent in two polls conducted in 2006. Respondents were mainly concerned about the foreign ownership of the company, but also with the potential of toll increases (Zmud and Arce, 2008, 33).

New Jersey residents were asked in two different polls in 2007 whether they would approve the sale or lease of the New Jersey Turnpike and Garden State Parkway. The polls find little support for this proposal, with 56 percent and 61 percent responding as being against the proposal in each poll, although the question wording in one of the polls says that the money will be used to pay off state debt. A separate question finds that residents would support the idea if the money would be used for transportation investments (Zmud and Arce, 2008, 33).

Dallas and San Antonio in Texas surveyed residents about their support for private toll roads. In Dallas, opposition increased from 41 percent in 2005 to 61 percent in 2007. Zmud and Arce (2008) note that the legislature was considering a bill banning private tolls for two years in the state at the time that the 2007 survey was being conducted. An opt-in survey in San Antonio finds even stronger opposition to private contracts, with 74 percent against and 22 percent in favor.

CHAPTER 4
LITERATURE MEASURING BEHAVIORAL RESPONSES

In this chapter we turn to the evidence of the behavioral responses to transportation taxes and fees. Economic theory suggests that increases in fuel taxes will lead to a reduction in fuel consumption, which could be the result of driving less, using more fuel efficient cars, or shifting to alternative modes (car pool or transit). Congestion pricing aims to alter traffic patterns by making it more expensive to drive when roads might be more congested. Economic theory implies that road pricing will have the same effect as an increase in fuel prices, but in addition shift the time that some trips are taken to periods when the road charge is less. Theory suggests that increases in the cost of parking will reduce the likelihood that a commuter will drive or drive solo.

There are two general ways of exploring the effect of increases in taxes and fees on the behavior of individuals. One method is to ask them how they would respond and the other is to measure how individuals' behavior actually changed. We consider the first method in section 4.1 while the statistical approach is covered in section 4.2.

4.1 Measurement of Responses Using Surveys

There is a good deal of skepticism regarding the use of surveys to measure the likely effect on behavior from some change. How people say they will respond to a price or tax change may differ from what they will do when confronted with the actual change in non-hypothetical situations. Nonetheless, we provide a review of the few surveys that have been conducted that attempt to elicit how individuals will respond to increases in fuel taxes and tolls.

Although we were not able to identify surveys that ask how people would change their driving behavior in response to higher gas taxes, surveys related to gas prices can provide an indication of the possible effect of higher taxes on driving. A 2006 national poll found that 48 percent of respondents claimed they were driving less as a result of higher gas prices, and among those with incomes lower than $50,000 it was 59 percent (Saad, 2006). Also, a majority of respondents said that they were going to consider hybrid models when replacing the car they currently owned. Another national survey in 2007 asked at what prices people would be start using public transit instead of their cars. 56 percent of respondents said that they would use public transit if gas prices were $4 or more, and another 19 percent said they would switch if prices were between $5 and $8 (Roper Center, 2011).

A focus group study in Miami-Dade County in 2005 asked area residents how they would use the express lanes at different prices; specifically, $1, $2, $3, and $5 more per trip than they currently pay in tolls. The majority of respondents said that their use of the lanes would decrease at $3 and $5 to only few trips (Zmud and Arce, 2008, 21).

Baldassare, Ryan and Katz (1998) conducted a phone survey of solo drivers in Orange County, California about the likelihood that they would shift from being solo drivers if certain programs were put in place. They tested the effect of imposing three different fees, a parking fee at the person's workplace, a snog fee based on amount driven and the amount their car pollutes, and a congestion fee for driving on busy road during rush hour. A little more than 50 percent of the respondents said that they would not change from being a solo driver. On the other hand, 20 percent said they would change in response to a parking fee, 17 percent said they would change if a smog fee was imposed, and 16 percent responded positively for a congestion fee. The survey did not provide any dollar magnitude for the fees. The percentage who responded positively was smaller for drivers with more education, who had higher income, who were older, and who had longer commutes.

Albert and Mahalel (2006) report on the results of a survey of employees of Technion-Israel Institute of Technology that explored the likely response of drivers to a parking fee and to a congestion toll for arriving on campus during rush hour. Interviewees were asked to choose between paying the fee or alternative means of avoiding the fee. For example, for the parking fee the alternatives were to use the shuttle service (or public transit) or to park outside the campus. 54 percent of the respondents said they would choose an alternative in order to avoid the parking fee, while 72 percent said they would choose an alternative in order to avoid the congestion fee. These responses are much larger than estimates based on actual behavior.

Although perhaps not the most appropriate method to raise revenue, parking policy is an effective way to influence transportation behavior. A study by Newmark and Shiftan (2007) examined the stated willingness of shoppers to pay for surface parking at four major suburban shopping centers in Prague. They also used multivariate regression models to analyze the factors that affect the change in behavior from the parking fees. Their analysis suggests that income, engine size, and number of passengers in the car are positively correlated with the willingness to pay for parking. The authors also find that grocery shoppers and age are both significantly negatively correlated with willingness to pay for parking at these malls. Overall, their findings suggest that people are willing to pay for parking at suburban malls, but the demand curve is logarithmic with a price elasticity of demand that is inelastic for lower parking fees.

Another group of researchers investigated behavior responses to different parking fees in downtown Beijing during morning peak hours (Li, et al, 2008). Using stated preference surveys, they obtained a sample of 572 responses. Using a multinomial logit model they estimate a demand elasticity of -1.4. They conclude that increasing parking fees in downtown Beijing can affect the volume of automobile traffic entering and exciting the central district. Higher parking fees also induce different modes of travel (public transportation to the central district), but extremely high parking fees may restrain traffic flow excessively, which could lead to negative economic impacts (Li, et al, 2008).

4.2 Measuring Behavioral Responses Using Statistical Analysis

We turn to a review of the statistical evidence of the effect of taxes and fees on transportation related behavior. Some of the evidence is simple comparisons of behavior before and after the implementation of some pricing scheme, for example the adoption of cordon pricing. Such analysis does not control for other factors that may have changed at the same time and which also had an effect on behavior. For example, if a city imposes a cordon price scheme while at the same time increasing transit service, then it is not possible to attribute any change in travel patterns to just the cordon pricing scheme. Other evidence is based on sophisticated econometric analysis that yields some measure of the responsiveness of behavior to the change in tax or fee. Generally, this measure is an elasticity, that is, the expected percentage change in the measure of behavior as a result of a one percent change in the tax or fee.

Elasticities are a common and easy way to summarize the response to some change in price or other factor. They make comparisons across studies much easier, although they are a somewhat crude measure of market response. It is common to estimate a regression equation in which the variables are measured as logs because in such equations the coefficient on, say the fuel price, is the fuel price elasticity. In such cases, the elasticity does not vary with the value of the fuel price. If the variables are measured in levels, then the coefficient on, say fuel price, measures the quantitative change in the behavior for a one unit change in fuel price. In this case, the elasticity varies with the value of fuel price, but the reported elasticity is the value typically calculated at the mean of the values of the variables. Demand is said to be inelastic if the absolute value of the elasticity is less than one, that is, the percentage change in the response is less than the percentage change in the price of fuel.

We consider the results of empirical studies classified by the tax or fee. We first consider the effects associated with automobiles and then turn to transit.

4.2.1 Automobile Transportation

- ***Changes in Fuel Price***

In this section, we focus on the effect on travel of changes in fuel prices. In particular, we focus on the price elasticity of the demand for vehicle travel. In most of the studies, price is measured by fuel price. We were unable to identify any study that considered fuel taxes directly. But since fuel taxes are part of the fuel price, the effect of changing fuel taxes can be inferred by estimates of the fuel price elasticity of travel. These studies typically measure transportation demand by number of trips, miles traveled, or traffic levels.

There are two general approaches to estimating demand for travel. One approach uses data on individual behavior, usually obtained from a survey. These data reflect behavior at some point in time, i.e., the data are cross sectional. The second approach uses aggregate, or market, data. While aggregate data could be cross sectional, for example, the units of observation could be states, aggregate data are frequently available as times series, or as panel data (i.e., cross section-time series data.) Time series data allow estimation of short-term and long-term elasticities.

We begin by discussing two papers, one that uses information on the behavior of individuals for one year, and one that uses a panel of state aggregate data. We do this to illustrate the two approaches for measuring the effect of changes in fuel prices on travel behavior, and to provide some detail about how estimates are generated. Consider first a paper by Ficklin (2010) that uses household survey data to estimate the effect of fuel prices on daily automobile trips and vehicle miles traveled. The data used are from the 2001 and the 2009 National Household Travel Survey (NHTS), which are large national cross sectional surveys. For 2001, 49,646 observations are used, while for 2009, 219,438 observations are used.

The principal variable of interest for Ficklin is the fuel price, which is measured by the average monthly gasoline price by state. In the regression equation he includes the fuel price for both the current and the previous month, and includes as other explanatory variables a set of demographic variables such as age, gender, education, and income. He also includes whether the individual lives in an urban area, whether the individual has access to rail transit, and a measure of the fuel economy of the individual's primary vehicle. He also includes dummy variables to control for seasonal differences in weather and driving patterns.

Ficklin first estimates a probit model to predict the probability that an individual takes an automobile trip on a given day.[14] He then estimates a regression for each of the two measures of daily automobile use (number of trips and VMT), conditional on an individual choosing to take at least one trip.

For the 2001 survey data, Ficklin finds that gas prices have no significant effect on the decision to take at least one trip on a given day. However, for those who do take a trip, the estimated fuel price elasticity of the number of trips is -0.078. So, a 10 percent higher price of fuel is associated with about 0.8 percent fewer trips on a given day. (Note that if the retail price of gas is $3.50, a 10 cent increase in fuel taxes would increase the price of fuel by about 2.8 percent.) The estimated elasticity of Vehicle Miles Traveled (VMT) is -0.44. The results from the 2009 survey are inconclusive in that the relevant coefficients are statistically insignificant. (Puller and Greening (1999) also use the NHTS and estimate a fuel price elasticity of VMT of -0.69. However, they consider only non-work miles traveled, which would be expected to be more responsive to fuel price changes.)

A study that uses aggregate panel data is the one by Small and Van Dender (2007). The focus of their study is the "rebound effect", but in the process of estimating the rebound effect, they estimate the price elasticity of VMT. The rebound effect is the difference between what fuel consumption would have been in the face of an increase in

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[14] A probit model is a type of regression model that is used when the dependent variable can be either zero (e.g., did not take a trip) or one (e.g., did take a trip).

fuel efficiency holding VMT constant and fuel consumption given that the increase in fuel efficiency leads to greater VMT.

Small and Van Dender build a model that allows for the simultaneous determination of aggregate demand for VMT, vehicle stock, and fuel efficiency. Thus, increases in fuel efficiency are allowed to be set within the structure of the model, for example, due to increases in fuel prices, individuals may purchase more efficient cars or drive in ways that increase fuel economy. The model is comprised of three simultaneous equations. The actual model is quite complicated and estimating the model requires rather sophisticated econometric technique; an explanation of the model and empirical technique used is beyond the scope of this report. The equation for VMT includes as one of the explanatory variables the lagged value of VMT. This is based on the assumption that the change in VMT due to a change in, say fuel price, occurs over time, i.e., through a lagged adjustment process. The model is dynamic in the sense that the response to a change in fuel price occurs over time. Thus, there is a difference in the short-term and long-term response to a change in fuel prices.

The data Small and Van Dender use is a panel data set consisting of observations for each year from 1966 to 2001 for each U.S. state. The variable we are most interested in is measured as VMT divided by the state's adult population. The price of gasoline is deflated by the consumer price index and is measured as fuel cost per mile. Small and Van Dender include several control variables such as per capita income, adults per road mileage, family size, percent urban, and access to rail transit. The estimated elasticities, at the sample average, of VMT with respect to fuel cost per mile are -0.045 for the short term and -0.222 for the long term. In other words, the response is very small.

There have been many surveys, including some that are relatively current, of the literature that estimates elasticity of transportation. We rely on those surveys to summarize the estimates of the fuel price elasticities of travel.

Two of the earlier survey were conducted by Goodwin (1992) and Oum, Waters, and Yong (1992). These companion reviews considered some 150 cited references, although there was little duplication in the two reports. They found similar average values; Goodwin reports the average short-term price elasticity was -0.15 and the average long-term price elasticity was -0.31. Oum, Waters, and Yong (1992) reported average elasticities for the U.S. of -0.23 (short-term) and -0.28 (long term).

Graham and Glaister (2004) report the finding of surveys conducted by TRACE (1998), de Jong and Gunn (2001), and Graham and Glaister (2002), These are reviews that summarize numerous recent (1985 and later) international studies that estimate fuel price elasticities for both short and long-run responses. These reviews indicate that in the short run, fuel price elasticity was -0.16 for both car trips and car-km. In the long-run, the elasticity estimate for car-km to fuel prices substantially increases to -0.26. However, the long-run elasticity estimate for car trips increases marginally to -0.19. These results are consistent with previous survey reviews, as noted above.

Similar average elasticities are reported by Hanly, Dargay and Goodwin (2002) in their review of the literature. They find that a persistent 10 percent increase in real fuel price decreases the volume of traffic by approximately 1 percent within a year (short-run) and approximately 3 percent within five years (long-run).

There is also an extensive literature analyzing fuel price demand elasticity. Averaging the estimates of 377 studies of the effect of fuel price on fuel demand, Graham and Glaister (2004) find a short-run fuel price elasticity of demand of -0.25. Similarly, after averaging the estimates of 213 studies, they find a long-run fuel price elasticity of demand of -0.77. These findings are consistent with estimates summarized by Hanly, Dargay and Goodwin (2002). Their analysis of sixty-nine different studies conducted worldwide suggests that a real fuel price increase (persistent) of 10 percent will decrease fuel demand by approximately 2.5 percent within a year (short-run) and approximately 6 percent in the long-run (Hanly, Dargay and Goodwin, 2002).

Hanly, Dargay and Goodwin (2002) also find evidence of other behavioral responses from an increase in fuel price. Their analysis suggests that an increase in fuel price of 10 percent would lead to an increase of fuel use efficiency of approximately 1.5 percent in the short-run and approximately 4 percent in the long run. They also find evidence that the same price increase would lead to a decrease in the total number of vehicles owned by less than 1 percent in the short-run and approximately 2.5 percent in the long-run.

There are some general findings from the various surveys, despite the argument by Oum, Waters, and Yong (1992) that across-the-board generalizations about the estimates are not feasible. First, elasticities are similar across countries, although the response to fuel price is somewhat less in the U.S. (Hanly, Dargay, and Goodwin, 2002). Second, the long-term elasticity is about twice the short-term elasticity. The obvious reason for this is that drivers can make more adjustments to behavior over time, such as moving closer to work. Third, there is no strong evidence that elasticities have increased over time (Hanly, Dargay, and Goodwin, 2002).

The various surveys report average elasticities across several studies. However, there are wide differences in the elasticities estimated in the various individual studies. There are several factors that have been identified that explain some of the differences in the reported elasticities. Response to a change in fuel prices will differ depending on the nature of the alternative modes or routes that are available. If public transit is very limited, then the ability to reduce vehicle miles driven or car trips is very constrained. Thus, there will be differences in the elasticity by geography. Studies that do not, or cannot, account for differences in intermodal competition estimate elasticities that are either relevant to just one jurisdiction or are misestimated (biased) because the appropriate control variables are not included in the regression model.

Estimates differ by the nature of the data. Some studies use data on individual drivers at some point in time, while others use aggregate data. Significant differences in estimated elasticities are found between these two types of studies.

Another difference is the time period considered in the various studies, and this leads to differences in estimated elasticities. For example, some studies might have monthly travel information while other might have annual values, and some studies might have data for a five-year period, while other have a longer times series. Annual data produces lower price elasticities than monthly data (Hanly, Dargay, and Goodwin, 2002).

There are differences across studies in the specification of the model and the treatment of various econometric issues. These differences can result in substantially different estimates of elasticities.

Some studies use cross sectional data, while others use times series or panel data. Dynamic models, i.e., those that use times series data and thus allow for adjustment over time to changes in fuel prices, allow estimates of short-term and long-term elasticities. On the other hand, cross sectional data produce static estimates, which tend to be smaller, or more similar to short-term elasticities. With cross sectional data, one does not know the extent to which drivers have adjusted their behavior to changes in fuel prices. Thus, it is not clear whether the elasticities reflect short-term responses or long-term responses.

- ***Tolls***

There is little published research on the demand elasticity of tolled roads, in part due to the limited number of tolled roads. Matas and Raymond (2003) provide a summary of published studies of toll elasticity. They identified five studies of toll roads conducted within the past 20 years or so, all of which found elasticities of less than -0.4, with most falling around -0.2 and -0.3.

Matas and Raymond conducted a study of the effect of tolls on traffic volume on various segments of toll roads in Spain, using the variation in tolls on various road segments and over time to identify the effect of tolls on traffic volumes. They used 72 road segments over an 18-year period. In addition to tolls, they include several other explanatory variables in their regression model, including alternative routes and modes, gasoline prices, and dummy variables reflecting major changes in the road network. They found that the elasticities varied across road segments and thus they categorized the road segments into four groups. Table 4.1 on page 82 reports the short-term and long-term elasticities for the four road segments.

Table 4.1
Toll Elasticities for Four Road Segments

Road segment	Short-term elasticity	Long-term elasticity
Group 1	-0.209	-0.330
Group 2	-0.371	-0.585
Group 3	-0.445	-0.702
Group 4	-0.828	-1.307

Source: Matas and Raymond (2003).

Matas and Raymond then explore factors that might explain the variation in the elasticities. What they found was that the elasticity is greater the higher the speed on the alternative road and smaller the greater the percentage of heavy vehicles on the alternative road. They also found that demand was more inelastic on those segments that served tourism, consistent with the premise that tourists are less likely to use alternative routes.

- ***Cordon Pricing***

Under a cordon price policy the central area of a city is cordoned off and a charge or toll is levied if a driver crosses the cordon boundary. For nearly all of the cordon pricing schemes that are in place the toll is a form of congestion pricing in that the charge varies by time-of-day and day-of-the-week, although not by the level of congestion.

There are a few examples of cordon pricing. Singapore adopted cordon pricing, called the Area Licensing Scheme (ALS), in 1975, which was the world's first comprehensive road pricing scheme. In order to reduce the number of passenger cars and taxis coming into the Central Business District, Singapore imposed a fee on all non-exempt vehicles. Initially the fee was S$3 per day (about US$2.30 at today's exchange rate) if the driver wanted to enter the restricted zone between 7:30 a.m. to 9:30 p.m. Monday through Saturday. It was thought that restricting entry in the morning would be mirrored in the evening. Cars with four or more passengers were exempt, as were public service vehicles, motorcycles, buses, and delivery vehicles. Singapore also increased its parking fees in the restricted area by almost 100 percent and implemented a park-and-ride program. Over time, the daily fee changed, as did the peak-toll hours. By 1989, the peak-toll hours were set at 7:30 a.m. to 10:15 a.m. and from 4:30 p.m. to 7:00 p.m.

The effects of the 1975 program were significant. The number of vehicles entering the restricted area between 7:30 a.m. and 10:15 a.m. decreased from 74.0 thousand to 41.2 thousand. The share of commuters in cars with less than four passengers entering the restricted zone dropped from 48 percent to 27 percent, while the share of commuters using carpool and buses increased from 41 percent to 62 percent (Small and Gomez-Ibañez, 1998). With the changes enacted in 1989, the number of vehicles entering the restricted area between 7:30 a.m. and 10:15 a.m. decreased from 51.8 thousand to 44.8 thousand, and the number entering between 4:30 p.m. and 6:30 p.m. decreased from 51.5 thousand to 23.8 thousand (Small and Gomez-Ibañez, 1998).

Three cities in Norway adopted cordon pricing, Bergen in 1986, Oslo in 1990, and Trondheim in 1991. Given that the cordon pricing scheme in the three Norwegian cities were designed principally to generate revenue and not reduce congestion, it is not surprising that the effect of the cordon pricing schemes had only small effects on behavior.

In Bergen most vehicles entering the toll area between 6:00 a.m. and 10:00 p.m. on weekdays paid a fee of 5 NOK.[15] It is not apparent that the cordon had much of an effect on traffic, largely because most of the revenues from the toll were directed towards the expansion of traffic infrastructure, so that it is hard to identify the net effect from the

[15] In 1992, NOK 1 was equal to $0.16.

toll collection. There was a very slight drop in recorded traffic, less than 10 percent, at the initial implementation of the scheme (Ieromonachou, et. al., 2006).

The cordon pricing scheme in Oslo was clearly designed to generate revenue since the fee, which in 1998 was 11 NOK, was collected all day, every day. As reported by Small and Gomez-Ibañez (1998), the number of vehicles crossing the cordon boundary decreased by no more than 5 to 10 percent. Ramjerid (1995) reports that there were no noticeable changes in mode in Oslo as a result of the cordon system.

In 1998, the cordon fee in Trondheim was 10 NOK and was collected from 6:00 a.m. to 5:00 p.m. weekdays. In Trondheim, it is reported that the system seems to have induced some people to delay afternoon trips until the end of the charging period, and thus spreading out of the afternoon peak period. Tretvik (2003) reports that in Trondheim there was a 10 percent decrease in inbound car traffic during the hours that the cordon price was imposed, but an eight to nine percent increase during the uncharged periods. So, there was a shift in the timing of inbound trips but not much change in the number of inbound trips. But the growth in inbound trips crossing the cordon was slower than in the rest of Trondheim, but a greater increase in inbound trips during the charged hours than the uncharged hours. There is evidence that there was also some shifting of trips from weekdays to weekends. The congestion pricing scheme in Trondheim was terminated in 2005, as originally planned. Since then, there has been a traffic shift back to the first and last hours of the cordon period (Amdal, 2006).

As noted above, in 2006 the Swedish national government sponsored a full-scale congestion pricing experiment in Stockholm (Hårsman and Quigley, 2010). The congestion pricing program was put in place for six months, and was combined with short-term increases in public transit capacity. The congestion charges were for entering a cordon area that included inner city Stockholm, and amounted to 30 square miles. There are four different rates for travel into and out of the condoned area that varied by time of day and days of the week: zero charge at night and on weekends, 10 Swedish crowns (SEK) for off-peak, 15 SEK for early and late peak periods, and 20 SEK for peak-hour travel, with a maximum charge of 60 SEK per day.[16]

During the trial, there was a decrease of 22 percent in the number of vehicles crossing the cordon boundary. There was also a reduction of wait times for drivers on the approach roads and a 16 percent decrease in driving in the inner city (Eliasson, 2009).

In 2002, congestion charges were introduced for the city of Durham. A £2 charge is imposed on vehicles using Saddle Street and the Market Place payable between 10:00 a.m. and 4:00 p.m. Monday through Saturday. The primary objective of the congestion charges was to reduce parking and traffic in this area, and to make it more attractive for customers and users of the area to walk around (Ieromonachou, et al., 2006). The scheme appears to have brought about a reduction in traffic by 50 to 80 percent, depending on the traffic count used as the base, compared to immediately before its introduction (Santos and Fraser, 2006). There has been a considerable substitution effect by delivery vehicles, which now make sure that they have completed their deliveries by early morning, or undertake them later in the evening (Harland, 2003).

London adopted a cordon pricing scheme in 2003, referred to as the London Congestion Charging System (LCCS). Cars entering or leaving central London (the area inside the Inner Ring Road) on weekdays between 7:00 a.m. and 6:30 p.m. are required to

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[16] 10 SEK is about $1.45 as of January 2011.

pay £8 (an increase from £5 in 2005).[17] There are some exemptions such as motorcycles, taxis, buses, and emergency vehicles. Area residents receive a 90 percent discount for their vehicles. Payments can be made at selected retail outlets, at payment machines located in the area, by Internet, and by cellular telephone messaging. Passes for up to a year can also be purchased. A network of video cameras records the license plate numbers of vehicles and matches it with the paid list. The fine for not paying is £80.

Transport for London (TfL) and various academic organizations established a five-year monitoring program to evaluate the various impacts of congestion charging (www.tfl.gov.uk/tfl/cclondon/cc_monitoring.shtml). Santos and Fraser (2006) report the following effects on transportation as a result of the cordon pricing scheme and other associated changes:

- The average travel rate in the charging zone during the first year of the scheme the average speed increased from 14 km per hour to between 16 and 17 km per hour, an increase of between 14 percent and 21 percent.
- The total number of vehicles with four or more wheels entering the zone during the charging hours was reduced by 18 percent, or about 20,000 vehicles per day. The number of cars entering the restricted zone decreased by 33 percent between 2002 and 2003, but the number was essentially unchanged between 2003 and 2004.
- There is no congestion charge for using the Inner Ring Road. As would be expected, some traffic was diverted to the Inner Ring Road, resulting in an increase in traffic of 4 percent. However, because of improved traffic management arrangements there was no increase in congestion.

[17] This description is drawn from Litman (2006) and Santos and Fraser (2006).

- It was also expected that traffic would be diverted to nearby roads. That did occur; there was a 10 percent increase in traffic on the peripheral roads. However, the effect on congestion appears to be too small to measure, in part because traffic signal systems on these roads were adjusted in anticipation of these traffic shifts.
- There was about a 38 percent increase in the number of inbound bus passengers in the morning peak period between 2002 and 2003. There was a further increase between 2003 and 2004. This increase is due in part to the LCCS, but also to the large-scale London-wide improvements to the bus network.

Using the changes in speed and trips registered after the LCCS was implemented, Santos and Fraser (2006) estimated an elasticity of demand for trips with respect to the congestion charge. They first estimated a generalized cost (GC) elasticity of demand rather than a congestion charge elasticity of demand since the charge increased from zero (before the LCCS was implemented) to £5, an infinite percentage change.

Multiplying the GC elasticity by the congestion charge share, which represents 28 percent of the GC of a trip by car, yields an estimates of the congestion charge elasticity of demand. The estimated congestion charge elasticity is -0.27 for cars. Santos and Fraser suggest that the reason for the high elasticity is the availability of public transport in London.

Cordon pricing projects have led drivers to shift the time of boundary crossing to just before the charge in fee goes into place (which leads to congestion), to change work hours (leading to inconvenience), to speed up to cross before the charge increased or to wait on the shoulder until the toll decreased, to drive around the CBD rather than through (which increases congestion on those roads), and to shift to exempt vehicles (like delivery trucks).

4.2.2 Changes in Vehicle Cost or Price

Several international studies have attempted to estimate the elasticities of vehicle ownership with respect to changes in vehicle cost/price. One major difficulty in comparing such studies arises from the definitional inconsistencies surrounding vehicle price and vehicle cost. Graham and Glaister (2004) review three studies that use data from three different European countries (Norway, Denmark, and Holland). The studies analyze elasticities of car ownership with respect to both fixed and variable costs. For fixed costs (depreciation, annual ownership tax, and insurance), elasticity estimates range from -0.80 to -2.65. For variable costs (fuel, replacement, repairs and maintenance), elasticity estimates range from -0.41 to -1.33. Graham and Glaister (2004) also review various other studies that try to measure both short and long-run elasticities with respect to vehicle price or cost. Their analysis suggests that on average, in the short-run the price elasticity of car ownership is approximately -0.2 (ranging from -0.09 to -0.35), while in the long-run the average estimate is approximately -0.9 (ranging from -0.24 to -2.65). As mentioned before, these studies suffer from definitional issues regarding price and cost that make the comparisons less precise.

4.2.3 Changes in Freight Service Price

Graham and Glaister (2004) review and summarize 143 price elasticity estimates of the demand for road freight. The price elasticity estimates range from -7.92 to 1.72 with a mean of -1.07. Although the range of the estimates seems quite large, the majority of the estimates (66 percent) fall between -0.5 and -1.3. The underlying reason for the broad range of estimates stems mainly from the analysis of various different commodities in various countries. Overall, it seems that the price elasticity of demand for freight is negative and relatively elastic. However, generalizations may be presumptuous due to the large range of estimates that arise in the literature from differing commodity groups, trip types, market coverage, and nationalities.

4.2.4 Vehicle Miles Traveled Tax/Fee and Congestion Pricing

A possible contender for replacing the gasoline tax is a vehicle-based mileage fee. Although full systems have not been implemented yet, some pilot programs and tests have been conducted to analyze potential behavioral responses. One such test was implemented in Oregon by the Oregon Department of Transportation and researched by Rufolo and Kimpel (2008). Their study recorded mileage from three distinct groups: the control group which continued paying the gas tax of the state, a VMT group which was charged a flat fee per mile traveled that approximated the amount of the state gas tax (and were credited for the actual gas tax paid at the pump), and a peak hour group which was charged a higher mileage fee during peak periods and given discount on the mileage fee outside the peak times (and gas tax credits). Rufolo and Kimpel regressed the change in peak hour miles per weekday on various demographic and attitude characteristics and found a statistically significant 22 percent reduction in miles per vehicle of peak-period travel for the peak hour group relative to the VMT group. Their results also indicate that households with more vehicles reduced their peak hour driving per vehicle by less than did other households, and that households with transit access less than four blocks away reduced their peak hour travel by more than other households. The researchers warn that results may be biased due to the nature of being in an experiment and that the estimates may be imprecise due to the small number of observations.

The Minnesota Department of Transportation (Abou-Zeid et al., 2008) carried out a similar field experiment where a treatment group was subjected to a per-mile travel cost. Their aggregate analysis suggests that participants reduced their mileage when charge on a per-mile basis, particularly during the summer period. Disaggregate analysis suggests that the price elasticity of peak-period mileage is negative. However, in both aggregate and disaggregate analysis, the price effects are statistically insignificant largely due to the small samples analyzed in the experiment.

4.2.5 Surface Parking Fees

There is not a substantial literature that estimates the effect of parking fees on mode choice. However, Feeney (1989) provides a review of the older literature and concludes that parking subsidies are an important determinant of model choice.

Shoup and Brown (1998) report the results of the case studies of eight firms (amounting to 1,694 employees) that voluntary complied with a parking cash-out program. Under such a program, the firm started charging employees for the actual cost of parking. The result was a reduction of 17 percent in the number of solo drivers, an increase of 64 percent in the number of carpoolers, a 50 percent increase in transit riders, and a 39 percent increase in the number who walked or biked. Vehicle miles traveled fell by 12 percent.

Peng, Dueker, and Strathman (1996) used travel-activity data from Portland, OR to estimate the effect of parking fees on commuters' mode choice, and found that parking fees have a significant effect. They find that drivers who are suburban residents are less responsive to parking price changes than drivers who live in the central city.

Hess (2001) estimated a multinomial logit model to estimate the effect of free parking on mode choice for individuals who work in the central city of Portland, OR. With free parking, the model predicts that 62 percent of commuter will drive alone, 16 percent will commute in carpools, and 22 percent will ride transit. For workers who are charged a parking fee of $6 per day the model predicts that 46 percent will drive alone, 4 percent will carpool, and 50 percent will take transit.

Wilson (1991) estimated a multinomial model using a sample consisting of 5,060 employees and 118 employers in the Los Angeles central business district. In addition to the price of parking (which for some would be zero if their employer provided free parking), the models included several other variables that might affect the likelihood that a commuter would drive. These variables included income, occupation, vehicle availability, travel time, and rideshare incentives.

The estimated model predicts that 72 percent of commuters would drive solo if free parking was provided, while only 41 percent would drive solo if the commuter had to pay to park. The percentage that were predicted to carpool increased from 13 percent to 28 percent, while the percentage taking transit increased from 15 percent to 31 percent. In an alternative formulation of the model, Wilson allows the price of parking to vary, rather than comparing free and not free parking. His results for this model are consistent with the prior findings. In particular, the percentage who drive solo is predicted to fall from 70 percent when parking is free to 39 percent when parking is $6.00 per day. Wilson provides estimates of the parking price elasticity for mode choice. Given the nature of this model, the elasticity varies with the parking price, ranging from -0.03 when the parking price is $1.00 to -0.70 when the parking price is $6.00.

Six case studies of parking fees were reviewed by Wilson and Shoup (1990). Five of the case studies pertain to Los Angeles, while the sixth occurred in Ottawa, Canada. The studies compare mode choice in a mix of before-and-after studies (i.e., cases in which parking subsidies were eliminated) and with-and-without studies (cases in which some commuters where provided parking subsidies while other did not). The smallest reduction in the percentage of solo drivers of either eliminating or not providing free parking was a 19 percent reduction, while the largest change was 81 percent; the average across the studies was 66 percent reduction. Wilson and Shoup also report on four parking pricing experiments, all of which imply a substantial effect of parking price on mode choice.

4.2.6 Transit

There are various ways to approach the estimation of transit demand elasticities. The most common in the literature is to use aggregated data, for example, total number of trips over some period of time. A second approach is to derive estimates from computer models of travel behavior. A third approach is to use expressed travel behavioral response to changes based on market research. The research reported on below generally relies on the first method.

The American Public Transportation Association published bus fare elasticities that reflect the estimated the short-run effects of bus fare changes in 52 U.S. transit systems during the 1980s (Pham and Linsalata, 1991). One of the principal objectives of the study was to determine whether the value of the fare elasticity that was being used by transit authorities, namely the fare elasticity of -0.33 implied by the Simpson-Curtin formula, was still accurate. Pham and Linsalata found that the bus fare elasticity was closer to -0.4.

To estimate the elasticity, Pham and Linsalata surveyed U.S. transit authorities and obtained usable data from 52 transit systems. The data included ridership data 24 months before and 24 months after each fare change. Six of the systems used peak period fares systems, which the authors accounted for. Pham and Linsalata used the Autroregressive Integrated Moving Average (ARIMA) model, which is an advanced econometric model. This econometric model is appropriate for analyzing time series data since it eliminates autocorrelation and multicollinearity, which are problems when using OLS regression with times series data. In addition to the fare, they included monthly information on other factors in the model. These variables included gasoline prices, transit service level, and employment level in the area. Separate elasticities are estimated for each of the 52 transit systems.

The estimated all-hour fare elasticity for all systems averaged -0.4, which suggests a higher responsiveness than implied by the Simpson-Curtin formula. However, the estimated elasticities varied widely across the sample, from -0.12 for Riverside, CA to -0.85 for Toledo, OH. Table 4.2 on page 94 summarizes the average elasticities. Demand is more elastic for smaller systems and for off-peak periods.

Table 4.2
Estimated Transit Fare Elasticities

	Cities/Areas with: More than 1 million population	Cities/Areas with: Less than 1 million population
Average for all hours	-0.36	-0.43
Peak hour average	-0.23	
Off-peak average	-0.42	
Peak hours	-0.18	-0.27
Off-peak hours	-0.39	-0.46

Source: Pham and Linsalata (1991).

They also provided estimates of the responsiveness of ridership to local gas prices, although they were not reported for all systems. These fuel price elasticities varied from 0.10 to 0.78, with a simple average of 0.32.

Goodwin (1992) conducted a survey of published estimates of fare elasticities conducted in the 1980s. He found that the overall average of the 50 elasticities to be -0.4, which is the average of the elasticities estimated by Pham and Linsalata (1991). The studies that Goodwin reviewed were a mix of short-run and long-run estimates. As expected, demand was more elastic in the long-run. Studies that had a time frame of less than 6 months had an average fare elasticity of -0.28, while those studies that consider a one year time frame, which was nearly half of the reported elasticities, had an average fare elasticity of -0.37. Studies that considered the response over a four-plus year period had an average fare elasticity of -0.55.

Goodwin (1992) found three studies that provide an estimate of the fuel price elasticity of transit ridership. The average fuel price elasticity is reported by Goodwin to be 0.34, but with a range from 0.08 to 0.8.

Oum, Waters, and Yong (1992) report the findings of 12 studies that provide estimates of the fare elasticity of public transit. These studies appeared in the late 1970s and 1980s and are generally from the academic journals. Oum, Waters, and Yong (1992) give the range of elasticity values for each of the studies, but do not provide any discussion of the strengths and weaknesses of the individual studies. Across the studies, most of the elasticity estimates fall in the range of -0.1 to -0.6.

Dargay and Hanly (2002) conducted a study similar to that of Pham and Linsalata (1991), except it was for England and ridership was measured over 10 years. Dargay and Hanly obtained annual ridership data for nearly all counties in England for 1987 to 1996; their data covered 93 percent of passenger journeys in England. Ridership was measured in per capita terms. In addition to a fare variable, they included income per capita, public transit service level, motoring cost, and percent pensioners.

The model they estimated was a dynamic adjustment model, which allows them to estimate a short-run and a long-run elasticity. They estimated the model assuming a constant elasticity and one in which the elasticity varies by fare level. They also estimated the model assuming that the elasticity was the same for all counties and a model that allows the elasticity to differ by county. We report only the results for the former.

When the elasticity is assumed to be constant, Dargay and Hanly estimate a fare elasticity of -0.33. But when they allow the elasticity to vary by fare level, the estimated fare elasticity for the average fare is -0.31, but is -0.74 for the maximum fare. These are the short-run elasticities. The long-run elasticities are -0.68 for the constant elasticity and -0.86 for the variable elasticity at the average fare level. The short-run constant elasticity is smaller than that estimated by Pham and Linsalata (1991), suggesting that the English are less sensitive to a change in fare. The estimated motoring cost elasticity is 0.32 in the short run and 0.66 in the long run.

Nijkamp and Pepping (1998) conducted a meta-analysis of public transit demand elasticities in an attempt to explain the differences in the estimated elasticities. They consider 12 studies conducted in various European countries. The estimated fare elasticities range from -0.15 to -0.77. There are many potential reasons why estimated elasticities can vary across studies. There are differences across studies in the transit modes that are considered (bus, subway, rail), the nature of the data (cross section, times series, or panel data), the measure of demand (trips or distance), and estimation methods, including functional form of the regression. Nijkamp and Pepping conclude that the principal factors that explain the difference in estimated elasticities are the country from which the data comes, the number of competing modes of transit, and the type of data collected (times series versus cross section).

Holmgren (2007) summarized the elasticities of transit demand found in other studies and attempts to account for the large variation in the estimates across studies. He considers only direct demand models of local bus patronage. He identified 81 estimates of the fare elasticity. The estimates ranged from -0.009 to -1.32, with a mean of -0.38. He also considered the fuel price elasticity. The range of estimated elasticities for fuel cost is from 0 to 1.04, with a mean of 0.38.

Holmgren then attempts to explain the differences in the estimates. He finds that the estimated demand is more elastic, i.e., a more negative number, if the study considered the long term, if it used monthly times series data, and if a non-linear regression equation is estimated. Based on his analysis he reports a short-run fare elasticity of -0.59, and a fuel price elasticity of 0.4.

Litman (2011) identified seven recent studies that explored the effect of changes in fuel prices on transit ridership in the U.S. These studies find elasticities that are generally around 0.12, but are as large as 0.24.

CHAPTER 5

GEORGIA DRIVERS' PREFERENCES FOR ALTERNATIVE REVENUE SOURCES FOR TRANSPORTATION[18]

5.1. Introduction

To determine public opinion about potential alternatives for generating transportation revenue, a survey of 2,000 adult Georgia drivers was conducted in August 2011. The survey was conducted in conjunction with Booth Research Services, Inc. The survey presented respondents with five different means by which additional transportation revenues might be raised. They were asked the degree to which they would support or be willing to pay for each.

The specific taxes and fees tested were an increase in the state per-gallon gas tax, replacing the per-gallon gas tax with a per-mile tax (or Vehicle Miles Traveled (VMT) tax) a new employee-parking lot tax, expansion of toll roads, and expansion of managed lanes. For all except toll roads, two or three price or tax levels were tested. In addition to measuring the support for the gasoline tax increase or substitution of a VMT tax, likely behavioral impact was measured to gauge potential increases or reductions in transportation modes. Standard socio-demographic data were also collected.

Two different approaches were used to determine preferences. In the first, direct questioning about an option allowed the respondent to consider the option in isolation. It also allowed follow-up questions about how the respondent would likely react behaviorally. The second method required respondents to choose more and less

[18] This chapter benefited from the assistance of Michael Ellers.

appealing options from among the set of options, generating relative preferences across types and costs.

Respondents were asked to provide their opinions under the assumption that at least one of the revenue options would be implemented. The various alternatives were presented as hypothetical and only in general terms. All were presented as providing funds only for transportation needs. Thus, the survey results represent the public's general preferences but do not necessarily indicate actual support if options were presented on a ballot or with greater detail.

5.2. Survey Design and Administration

5.2.1 Revenue-Generation Options

The survey tested public support for five alternatives to raise revenues for transportation:

- An increase in the state gas tax;
- A new state mileage tax (VMT);
- A new tax on employee parking;
- New toll roads;
- Variable rate managed lanes.

A toll road refers to a road for which the driver pays a fixed toll, although the toll may vary by distance or time of day. For a managed lane the driver pays a toll that varies with the level of congestion, with the objective of maintaining free flow in the lane. Georgia 400 is an example of a toll road, while I-85 has a managed lane.

The options were examined through two types of questions. The first type were direct questions about the option. Focusing on each alternative in isolation allowed follow-up questions such as how the respondent would react behaviorally to that option. Only the first four options were included in the direct questions.

The second type of question was a choice task in which respondents saw random sets of all combinations of alternatives (i.e., type of tax at various tax rates). Specifically, a respondent saw eight sets of four randomly-generated options. For each set, respondents were asked which option was most appealing and which was least appealing, followed by whether all of the choices were appealing, none of them were appealing or only some of them were appealing. This set of questions allowed the determination of relative preferences among the set of options.

To help the respondents understand both the method of raising revenues and the implications for them personally, descriptions included who would be taxed and how, along with specific costs for three of the five options (all except toll roads and managed lanes). Respondents saw one of three possible costs for the gas tax increase and for the VMT tax, and one of two different costs for employee parking.

Following is a more detailed description of each option presented.

- ***Gas Tax Increase***

An increase in the state per-gallon gas tax was described both at 1) a per-gallon increase, and 2) an annual cost for a person who "drives a car that gets 20 miles per gallon (MPG) for 10,000 miles per year"). Each person saw one of the following three variations of the gas tax:

  - A 10 cent per gallon increase in the gas tax for "$50 more per year in gas taxes, for a total of $135."

- A 15 cent per gallon increase in the gas tax for "$75 more in gas taxes, for a total of $160."
- A 25 cent per gallon increase in the gas tax for "$125 more in gas taxes for a total of $210."

Respondents were asked whether they would strongly support, somewhat support, somewhat oppose or strongly oppose the option. In addition, they were asked how their own driving behavior might change if this option were implemented and how difficult such a change would be.

- ***Vehicle Miles Traveled (VMT) Tax***

The VMT was described as a replacement for the current gas tax without describing the mechanism by which miles would be determined. Respondents were asked to imagine that, instead of paying a state gas tax, they could pay at the gas pump a tax based solely on the number of miles the vehicle was driven in Georgia since it was last refueled. Respondents were told that "everyone who drives 10,000 miles a year in Georgia would pay the same tax, regardless of the fuel efficiency of the vehicle they drove."

Importantly, the estimated cost increase for a respondent was held constant across the gas and VMT tax. If the respondent was randomly selected to see the 15 cent per gallon increase in the state gas tax, they saw the 1.60 cents per mile VMT tax, which was equivalent to the estimated annual increase of $160. Thus, corresponding to the gas tax increase they had previously seen, the respondent saw one of the following three variations of the VMT tax:

- ○ A 1.35 cent per mile tax, meaning "a person who drives a car 10,000 miles per year will pay $135 in taxes."
- ○ A 1.60 cent per mile tax, meaning "a person who drives a car 10,000 miles per year will pay $160 in taxes."
- ○ A 2.10 cent per mile tax, meaning "a person who drives a car 10,000 miles per year will pay $210 in taxes."

Respondents were asked whether they would strongly support, somewhat support, somewhat oppose or strongly oppose the option. In addition, they were asked how their own driving behavior might change if this option was implemented and how difficult such a change would be.

- ***Employee Parking Fee or Tax***

This option described a new statewide fee for employee-parking lots. The option was described as an increase for those currently paying to park or a new fee for those who did not. Respondents saw one of the following variations of the parking fee:

- ○ $2 per month
- ○ $4 per month

Respondents were asked whether they would strongly support, somewhat support, somewhat oppose or strongly oppose the option.

- ***New Roads Built as Toll Roads***

For this option, respondents were asked about building roads sooner as a toll road rather than waiting for public funds to be available for a non-toll road. Respondents were asked whether they would strongly support, somewhat support, somewhat oppose or strongly oppose the option. No specific toll amount was specified.

- ***Variable Rate Managed Lane***

In this alternative, solo drivers could use the high-occupancy managed lane by paying a variable toll "determined by the number of cars that can use the managed lane and keep it flowing at a constant 45 miles per hour or faster." If drivers chose to pay the posted toll, "they simply move into the lane at designated spots" with tolls deducted electronically from their Peach Pass account.

Because the managed lane toll is variable, rather than fixed as with the other options, respondents were asked what they were willing to pay rather than their degree of support. Specifically, they were asked how much they would pay under a given scenario in which they had adequate time to make their trip but a managed lane option was available that would save them 35 minutes for a 10-mile trip. The respondent saw one of the following variations, which manipulated both the type of trip (i.e., regular commute or important appointment) and estimated time of the trip in regular traffic lanes (i.e., 45 or 60 minutes) while keeping the total miles and the time savings constant.

  - Regular commute will take 45 minutes; that is, you can make 10-mile trip in 10 minutes
  - Regular commute will take 60 minutes; that is, you can make 10-mile trip in 25 minutes
  - Trip for important appointment will take 45 minutes; that is, you can make 10-mile trip in 10 minutes
  - Trip for important appointment will take 60 minutes; that is, you can make 10-mile trip in 25 minutes

After providing the amount they were willing to pay, a respondent saw one of two follow-up questions, asking them how likely they would pay that much more than the price they had just indicated they would be willing to pay:

- $1 more, or
- $2 more

5.2.2 Method

An online survey was conducted among 2,000 adult, Georgia drivers. An online survey provides advantages over other methods such as phone or intercept surveys in terms of:

- Lower cost;
- Faster data collection;
- More representative sampling (reaching more young respondents and fewer respondents older than 65).

In addition, online surveys allow for completion of complex tasks, such as ranking or choice methods, than does using a phone survey. It also allowed for random assignment of respondents to each option and customization of questions to the respondents' previous answer.

The complete survey is found in Appendix 5.1.

5.2.3 Sampling

The survey used the Survey Sampling International (SSI) consumer panel for internet research. These panel members are interested in survey research and have agreed to participate in SSI surveys for which they are qualified (according to the Survey Spot method). Respondents earn points as an incentive for completing surveys, which they may redeem for cash or merchandise in the future.

All respondents were qualified as adult (18+) residents of Georgia who drive at least one mile per day. To account for differences in both population densities and transportation needs, samples were drawn from three Georgia areas based on zip code of residence as follows:

- 1,000 in the Atlanta DMA (a map of the included counties is in Appendix 5.2.);
- 500 in other Georgia DMAs, including Albany, Augusta, Columbus, Macon and Savannah;
- 500 in all other Georgia areas excluding the above groups.

A sample size of 2,000 provided an overall maximum sampling error of ± 2.2 percent at the 95 percent confidence level. Maximum sampling errors for the geographic breakouts were:

- 1,000 yields a maximum sampling error of ± 3.1 percent at a 95 percent confidence level;
- 500 yields a maximum sampling error of ± 4.4 percent at a 95 percent confidence level.

5.2.4 Timing

All surveys were completed between August 10, 2011 and August 21, 2011 under the supervision of Booth Research Services.

5.2.5 Confidentiality

Booth Research Services recognizes the confidential nature of this project. No aspect of this study or information regarding its execution will be disclosed to persons other than those whose work on it. All products of this project, including survey answers and results, will be the exclusive property of the client, including title to copyright in all copyrightable material and will be considered "work for hire" in accordance with the copyright statute. Booth Research conducted this project in accordance with normally applicable professional and ethical standards.

5.3 Survey Respondents

Following a description of the survey respondents, the overall support or preferences for the tax options are provided in subsequent sections.

Table 5.1 on page 107 compares the 2,000 survey respondents to the Georgia adult population, according to the 2010 U.S. Census Bureau. As noted, the percentage of all Georgia adults (18+ years of age) that live in the Atlanta DMA is slightly higher than represented in the survey. In the survey sample, more people identified their race as "white" and fewer as "Black, African-American" than in the Census. The sample also included more people with some college or with college degrees than in the Georgia population. In terms of income, there were fewer respondents in households with incomes of $100,000 or more per year and more middle income respondents.

In terms of driving behavior,

- 57 percent typically drive alone to work or school (see Figure A5.1 in Appendix 5.3);
- 63 percent drive 25 miles or less on a typical weekday (see Figure A5.2 in Appendix 5.3);

TABLE 5.1
Comparison of Survey Respondents with Those of the Adult Population of Georgia[1]

Socio-Demographic Category	Survey Respondents	Georgia Adults (18+)[1]
Georgia		
Atlanta DMA	50%	56%
Other Georgia DMAs	25%	23%
All Other Georgia	25%	21%
Gender		
Male	37%	49%
Female	63%	51%
Race		
White	76%	60%
Black	18%	30%
Other (Including Hispanic)	6%	10%
Education		
Less than high school graduate	2%	16%
High school graduate	24%	29%
Some college	36%	28%
College graduate	24%	18%
Some graduate school	4%	NA
Graduate degree	10%	10%
Employment Status		
Employed	52%	57%
Not Employed/Student/Homemaker/Retired	48%	43%
Annual Household Income		
Less than $25,000	22%	27%
$25,000 to $34,999	16%	11%
$35,000 to $49,999	19%	15%
$50,000 to $74,999	22%	18%
$75,000 to $99,999	12%	12%
$100,000 or more	9%	18%
Age		
18 to 24 years	10%	13%
25 to 34 years	19%	19%
35 to 44 years	18%	19%
45 to 54 years	21%	19%
55 years and Older	31%	29%

Notes: Some percentages do not sum to 100 due to rounding.
[1] Source: 2010 U.S. Census Bureau.
All census data are for adults 18 years and older except for household income, which is for all Georgia households, and employment data, which is for the civilian non-institutional population 18 to 64 years of age.
Significantly higher than the other group (column) at 95% confidence level.

- Only 6.7 percent of respondents currently pay for parking at work;
- 36 percent drive a car getting 18-22 MPG and 27 percent drive one getting 23-27 MPG (see Figure A5.3 in Appendix 5.3);
- 36 percent drive a 2004-2008 model car while 26 percent drive a 2000-2003 model (see Figure A5.4 in Appendix 5.3).

5.4 Support or Appeal for the Alternative Revenue Sources

5.4.1 Direct Questioning about Revenue Options

As described previously, respondents were asked about each of the revenue options separately.

- ***Gasoline Tax Increase, Vehicle Miles Traveled, Employee-Parking Lot Fee, Toll Roads***

For the first four revenue options, respondents were asked their degree of support or opposition. (For managed lanes, they were asked the toll they were willing to pay; this is discussed below.)

Table 5.2 on page 109 provides the summary results for these direct questions about each option. (NOTE: Within a revenue option, a given respondent saw only one of the hypothetical costs. Thus, it is more appropriate to compare across options than necessarily within.)

In interpreting the preferences from direct questioning, one must keep in mind that state gasoline taxes are currently in place and increasing these taxes was the first option presented. Thus, it is a known and easy to imagine option while the other options are more hypothetical.

Respondents reported greatest levels of support for toll roads (51 percent) and employee-parking lot fees (45 percent for $2 and 39 percent for $4), options that may provide drivers more choice and fixed fee per use. There was greater support for VMT (range from 33 percent to 39 percent) than for gasoline taxes (21 percent to 31 percent). The greater support for VMT may be attributed to the fact that VMTs tax only road use (i.e., miles driven) whereas gasoline taxes are based on road use and fuel efficiency, facts presented to respondents.

TABLE 5.2
Support and Opposition Levels for Four Revenue Options
(Percentages are the sum of those who said they "strongly" or "somewhat" support/oppose each option.)

Revenue Option	Support (%)	Oppose (%)	Don't know (%)
10¢ gas tax increase	31%	66%	3%
15¢ gas tax increase	23%	74%	3%
25¢ gas tax increase	21%	75%	3%
1.35¢ VMT (mileage tax)	33%	60%	7%
1.60¢ VMT (mileage tax)	39%	55%	6%
2.10¢ VMT (mileage tax)	36%	57%	7%
$2 per month parking fee	45%	45%	10%
$4 per month parking fee	39%	50%	12%
Toll roads	51%	42%	7%

Notes:
Managed lanes were not addressed in this form.
Some row percentages do not sum to 100 due to rounding.

Table 5.3 on pages 110-11 shows the level of support by different socio-demographic groups. There are consistent and significant differences in support for a particular option across education, income and age groups. The highest educated, highest income and oldest groups tended to be more supportive of more measures. Men tended to be more supportive of all measures than women, with significantly higher support for some higher cost measures. Interestingly, there was little difference based on miles driven in a typical day.

TABLE 5.3
Support for the Revenue Options for Different Socio-Demographic Groups
(Percentages are the sum of those who said they "strongly" or "somewhat" support each option.)

	------------------Revenue Options Tested------------------					
Socio-Demographic Category	10¢ Gas tax incr.	15¢ Gas tax incr.	25¢ Gas tax incr.	1.35¢/ mile VMT	1.60¢/ mile VMT	2.10¢/ mile VMT
All Respondents	31.0%	23.0%	21.0%	33.0%	39.0%	36.0%
Georgia						
Atlanta	(35.7%)	23.9%	23.1%	(38.5%)	40.1%	37.3%
Other Georgia DMAs	24.4%	23.5%	23.5%	25.6%	39.2%	38.8%
Other Georgia	28.2%	19.6%	16.6%	27.6%	35.1%	29.0%
Gender						
Male	33.1%	(31.5%)	(32.4%)	35.1%	42.7%	(40.5%)
Female	30.2%	18.1%	14.7%	31.6%	36.5%	32.6%
Miles Driven						
15 or less	29.7%	21.5%	23.1%	36.1%	39.9%	40.8%
16-25	34.2%	19.0%	24.5%	30.8%	41.6%	32.9%
26 or more	31.1%	26.2%	17.4%	30.7%	35.5%	31.1%
Education						
High school or less	24.0%	19.6%	18.9%	26.3%	29.9%	29.0%
Some college	26.2%	18.5%	14.3%	31.6%	38.2%	37.0%
College graduate +	(40.6%)	(29.3%)	(29.8%)	(38.3%)	(45.9%)	(38.7%)
Employment status						
Employed	(36.8%)	24.7%	21.1%	32.4%	41.6%	32.3%
Not employed	24.8%	20.5%	21.6%	33.4%	35.3%	38.9%
Annual household income						
Less than $50,000	24.7%	19.6%	19.5%	31.7%	33.2%	37.8%
$50,000 to $99,999	(38.8%)	23.2%	20.7%	35.8%	42.3%	32.9%
$100,000 or more	(38.2%)	(43.6%)	(36.2%)	28.9%	(63.6%)	31.0%
Age						
18 to 34 years	28.7%	22.3%	21.5%	(37.3%)	35.0%	(40.1%)
35 to 54 years	28.3%	19.0%	15.7%	26.0%	39.8%	29.5%
55 years and older	(37.6%)	(28.5%)	(27.9%)	(37.1%)	40.9%	(39.2%)

Note:
( ) Significantly higher at 95% confidence level than at least one other group on that characteristic within that revenue option. (Example: For the 10¢ gas tax increases, the percentage strongly or somewhat supporting is higher among those in Atlanta than at least one other region.)

TABLE 5.3 (continued)
Support for the Revenue Options for Different Socio-Demographic Groups
(Percentages are the sum of those who said they "strongly" or "somewhat" support/oppose each option.)

Socio-Demographic Category	-----Revenue Options Tested---- $2 Employee Parking	$4 Employee Parking	Toll Roads
All Respondents	45.0%	39.0%	51.0%
Georgia			
Atlanta	45.7%	38.3%	51.1%
Other Georgia DMAs	43.4%	37.6%	52.6%
Other Georgia	45.8%	40.1%	51.1%
Gender			
Male	44.3%	40.4%	55.9%
Female	45.6%	37.6%	48.9%
Miles Driven			
15 or less	49.6%	37.5%	51.2%
16-25	41.4%	43.0%	54.7%
26 or more	42.0%	37.2%	49.9%
Education			
High school or less	39.3%	34.3%	45.5%
Some college	45.3%	40.6%	51.0%
College graduate +	49.1%	39.8%	56.0%
Employment status			
Employed	46.1%	35.5%	52.1%
Not employed	44.1%	42.0%	50.7%
Annual household income			
Less than $50,000	41.8%	38.2%	47.5%
$50,000 to $99,999	51.8%	39.2%	55.9%
$100,000 or more	41.5%	38.9%	59.3%
Age			
18 to 34 years	43.1%	40.8%	48.0%
35 to 54 years	45.5%	36.3%	48.8%
55 years and older	46.6%	39.6%	58.1%

Note:
(oval) Significantly higher at 95% confidence level than at least one other group on that characteristic within that revenue option. (Example: For toll roads, the percentage strongly or somewhat supporting is higher among men than women.)

- ***Variable-Rate Managed Lanes***

Because the fees on tolls for a managed lane are variable, rather than fixed, respondents were asked how much they would be willing to pay rather than their degree of support. As described previously, the survey asked the toll amount that the respondent would be willing to pay to save 35 minutes on one of four scenarios: a regular commute or important appointment, each with two different trip lengths in regular traffic (45 minutes or 60 minutes).

The respondent provided an actual dollar value, and some respondents provided extreme answers that suggest a possible misunderstanding of the question (i.e., a monthly or annual, rather than per trip, rate). Specifically, three to four percent gave answers of $40 or more (i.e., more than four times the estimated $9.00 maximum for a 10-mile drive based on rates for the new I-85 managed lanes in North Atlanta) and as high as $999.[19] To account for the distortion created by a small number of extreme values, medians and trimmed means (i.e., eliminating those answering $40 or more) are reported below. Table 5.4 shows that half of respondents would be willing to pay $3.00 or less for a 35-minute savings, regardless of scenario.

TABLE 5.4
Toll Willing To Pay To Save 35 Minutes

		------Regular Commute-----		---Important Appointment----	
	Overall	10 miles/ 10 minutes	10 miles/ 25 minutes	10 miles/ 10 minutes	10 miles/ 25 minutes
Median	$3.00	$3.00	$2.00	$3.00	$3.00
Trimmed Mean	$5.85	$6.18	$6.03	$5.45	$5.73

[19] The maximum toll on the I-85 managed lanes is 90 cents per mile. The actual toll is determined by a computer algorithm that weights various factors. After the lanes opened, SRTA made various modifications to the algorithm that resulted in lower actual tolls per mile. However, the maximum toll remains at 90 cents per mile.

The only significant difference in the willingness to pay by socio-demographics was for age. For the four scenarios, younger respondents (18-34) were willing to pay a higher average (trimmed mean) fee ($7.11-$8.21) compared to 35-54 year olds ($5.31-$6.63). Those who were 55 years or older were willing to pay the least ($3.12-$4.59). Thus, on average, there is about a $1.50 decline in toll they were willing to pay between each of the groups as age increased.

After indicating the toll they would be willing to pay, respondents were asked how willing they would be to pay either $1 or $2 more. As shown in Table 5.5, 40 percent or more were willing to pay an additional $1 for all scenarios. Respondents were more willing to pay $1 more for the longer trip when it was an important appointment than a regular commute.

The percentage willing to pay $2 more was lower (31 percent). Here, respondents were more willing to pay $2 more for a shorter, regular commute than a longer trip for an important appointment.

TABLE 5.5
Percentage Who Were Willing to Pay $X More
(Percentages are the sum of those who said they "definitely" or "probably" would pay more)

		------Regular Commute-----		---Important Appointment---	
	Overall	10 miles/ 10 minutes	10 miles/ 25 minutes	10 miles/ 10 minutes	10 miles/ 25 minutes
$1 more	44.3%	43.5%	40.0%	44.1%	(50.2%)
$2 more	31.0%	(37.2%)	30.1%	30.3%	26.6%

Note:
(oval) Significantly higher than at least one other group in the same row at 95% confidence level.

5.4.2 Choice Task

As described previously, the choice task showed each respondent 10 revenue-generating alternatives. That is, they saw three cost combinations for gasoline and VMT taxes and two employee-parking lot fees, as well as the options of variable-rate managed lanes and toll roads. Because comparing 10 options to each other was too difficult, a respondent was presented instead with eight different combinations of four randomly-selected revenue options from the set of 10. They then indicated which option was most and least appealing. The resulting data show the appeal of a given option among the set as a whole as well as based on cost differences. (Note that a given list did not include the same option but with different tax levels.)

Figure 5.1 on page 115 shows the percentage of respondents who found each of the 10 revenue options appealing, ordered from highest to lowest appeal. Not surprisingly, none of the options received a majority share of appeal.[20] These are increases in driving-related costs without any foreseeable benefit during a time of economic uncertainty and higher fuel costs.

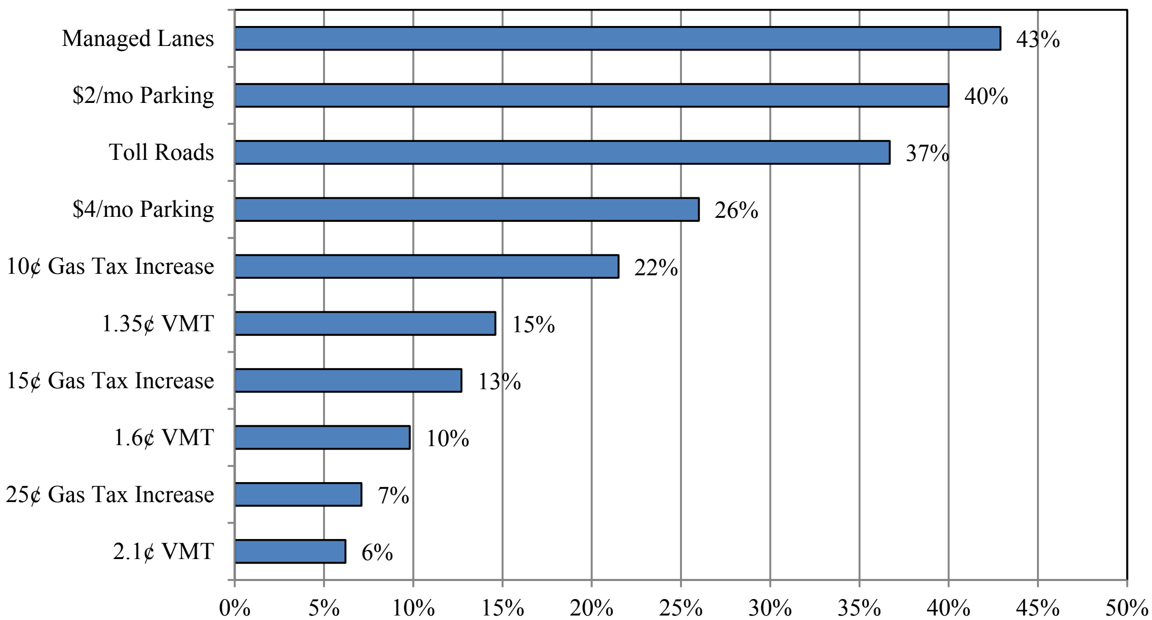
Three options had appeal to about 40 percent of respondents: variable rate managed lanes (43 percent), $2 per month employee parking fee (40 percent) and building toll roads (37 percent). The three least appealing were all "pay at the pump" options—the 1.6 cent vehicle mileage tax (VMT) (appealing to 10 percent), the 25 cent per gallon increase in the gasoline tax (7 percent) and the 2.1 cent vehicle mileage tax (VMT) (6 percent).

As expected, lower cost options were consistently more appealing than higher cost options of the same type. The four more appealing options in the choice task included the three most supported options in the direct questioning (i.e., toll roads and employee-parking lot fees). Like tolls roads, variable rate managed lanes may be more

[20] Similar results are found in the experiment described in the next chapter. As can be seen in Table 6.2 on page 165, no option received a majority support.

appealing because drivers have a choice as to whether to incur the additional costs and they are able to quantify the value they receive.

FIGURE 5.1
Relative Appeal of Different Revenue Options
(% Who Found Each Option Appealing)



In this tradeoff task, respondents consistently preferred the gasoline tax option to the VMT option at the same cost. In the direct question, they preferred the VMT to the gasoline tax. The gasoline tax increase was the first alternative presented in the direct questioning, which occurred at a time when the national retail average for a gallon of gas was $3.60 or higher,[21] thus any increase in gasoline prices were likely to be viewed negatively. When the VMT was presented as an alternative, it may have been viewed initially as a fairer alternative – one which taxed drivers only on their miles driven rather than mileage plus fuel efficiency. In the choice task, respondent saw all possible options at all possible costs, encouraging them to scrutinize the tradeoffs with each. The gasoline

[21]http://www.bts.gov/publications/key_transportation_indicators/august_2011/html/highway_retail_gasoline_price_table.html.

tax was a known alternative while the full implications of a VMT tax were not known, such as the means by which miles driven would be assessed. Given the uncertainty of the VMT tax implementation, drivers may have preferred the known option.

- ***Comparison of Choice Task Results Across Respondent Groups***

Table 5.6 on pages 117-18 shows the level of appeal of the 10 options for various groups of respondents. Specifically, the top row repeats the overall appeal for the 10 options, followed by the appeal within each respondent group.

Appeal did not vary significantly by geographic regions, miles driven, employment, or age. Some significant differences existed within gender, education, and annual household income groups (as indicated by the circles). Men were generally more supportive than women of the gasoline tax increases and the two lower VMT rates. Those with higher education and income were more likely to support toll roads, managed lanes, and an employee-parking lot fee.

TABLE 5.6
Appeal of the Revenue Options for Different Socio-Demographic Groups
(% Who Found Option Appealing)

Socio-Demographic Category	10¢ Gas tax incr.	15¢ Gas tax incr.	25¢ Gas tax incr.	1.35¢/ mile VMT	1.60¢/ mile VMT	2.10¢/ mile VMT
	------------------Revenue Options Tested------------------					
All Respondents	22%	13%	7%	15%	10%	6%
Georgia						
Atlanta	21%	13%	8%	15%	10%	7%
Other Georgia DMAs	24%	14%	7%	15%	10%	7%
Other Georgia	20%	10%	6%	14%	9%	5%
Gender						
Male	(25%)	(16%)	(9%)	(18%)	(12%)	8%
Female	19%	11%	6%	13%	8%	5%
Miles Driven						
15 or less	21%	11%	6%	16%	10%	6%
16-25	22%	14%	7%	15%	11%	7%
26 or more	22%	14%	6%	13%	10%	6%
Education						
High school or less	21%	13%	7%	13%	9%	6%
Some college	21%	13%	7%	14%	9%	5%
College graduate +	22%	12%	7%	16%	11%	7%
Employment status						
Employed	22%	12%	7%	15%	10%	7%
Not employed	21%	14%	8%	14%	9%	6%
Annual household income						
Less than $50,000	22%	13%	7%	15%	11%	7%
$50,000 to $99,999	19%	10%	6%	13%	8%	5%
$100,000 or more	23%	(16%)	9%	14%	10%	6%
Age						
18 to 34 years	22%	15%	8%	(18%)	13%	8%
35 to 54 years	21%	11%	6%	13%	9%	6%
55 years and older	22%	12%	4%	12%	8%	4%

Note:
(circled) Significantly higher at 95% confidence level than at least one other group on that characteristic within that revenue option. (Example: For the 10¢ gas tax increases, the percentage strongly or somewhat supporting is higher among males than females.)

TABLE 5.6 (continued)
Appeal of the Revenue Options for Different Socio-Demographic Groups
(% Who Found Option Appealing)

Socio-Demographic Category	-----------Revenue Options Tested----------- $2 Employee Parking	$4 Employee Parking	Toll Roads	Managed Lanes
All Respondents	40%	26%	37%	43%
Georgia				
Atlanta	40%	25%	37%	45%
Other Georgia DMAs	37%	26%	37%	42%
Other Georgia	42%	28%	37%	40%
Gender				
Male	40%	27%	38%	41%
Female	40%	26%	36%	44%
Miles Driven				
15 or less	41%	26%	37%	41%
16-25	36%	24%	38%	42%
26 or more	42%	27%	36%	46%
Education				
High school or less	37%	24%	32%	36%
Some college	39%	26%	35%	43%
College graduate +	43%	27%	41%	49%
Employment status				
Employed	41%	26%	37%	45%
Not employed	39%	26%	36%	40%
Annual household income				
Less than $50,000	39%	26%	35%	40%
$50,000 to $99,999	45%	27%	37%	43%
$100,000 or more	39%	26%	41%	51%
Age				
18 to 34 years	42%	26%	38%	45%
35 to 54 years	38%	26%	34%	41%
55 years and older	39%	26%	38%	43%

Notes:
○ Significantly higher at 95% confidence level than at least one other group on that characteristic within that revenue option. (Example: For the $2 employee parking fee, the percentage strongly or somewhat supporting is higher among college graduates than at least one other education level.)

5.4.3 Detailed Findings for Gasoline and VMT taxes

In addition to stated preferences for gasoline tax increases and the VMT tax, respondents were asked how they would respond if each of the alternatives were implemented.

- ***Gasoline Tax Increase***

Asked how much an increase in the gasoline tax would affect their behavior, 61 percent said it would dramatically (28 percent) or moderately (33 percent) affect their behavior. Thirty-six percent (36 percent) said such a change would be very or extremely difficult to make. When asked how much it would affect their behavior, 74 percent said they would drive a little less (33 percent) or much less (41 percent).

Some respondents would consider a change in their method of transportation either a little more or much more:

- ○ 40 percent would carpool or ride share;
- ○ 32 percent would walk, bike or cycle;
- ○ 23 percent would replace their car sooner; and
- ○ 19 percent would take public transportation.

When asked how their support might change if the gas tax increase was phased in over five years, 39 percent said it would somewhat or significantly increase their support while 40 percent said it would make no difference.

- ***Vehicle Miles Traveled (VMT)***

Respondents were asked how much a change from a gasoline tax to a VMT would affect their behavior. Forty-nine percent (49 percent) said it would dramatically (22 percent) or moderately (27 percent) affect their behavior.

When asked how it would affect their behavior, 67 percent said they would drive a little less (31 percent) or much less (36 percent).

Some respondents would consider a change in their transportation method either a little more or much more:

- 36 percent would carpool or ride share;
- 32 percent would walk, bike or cycle;
- 21 percent would replace their car sooner; and
- 19 percent would take public transportation.

5.5 Summary

A survey of 2,000 Georgia drivers provided their preferences among five revenue-generating alternative for transportation. Using both direct questioning about each option as well as a choice among all 10 alternatives, drivers indicated greater support or appeal for toll roads, statewide employee-parking lot fees and managed lanes as compared to an increase in the gasoline tax or implementation of a VMT tax. (This preference for tolls rather than gasoline tax and VMT is consistent with other surveys reviewed in chapter 3.) Toll roads and managed lanes provide greater choice and a known benefit for a given cost. Importantly, their support of this option does not indicate intent to use the alternative, just their preference as a means for raising transportation revenues. Employee-parking lot fees are a flat fee and, as presented, represent a much lower annual cost alternative than the gasoline or VMT taxes. Given that more than 93 percent do not currently pay anything to park at work, the fees may seem relatively small or they may assume their employer will pay the fees.

Solo use of managed lanes was the more appealing option in the choice task (43 percent). Half of respondents were willing to pay at most $3, regardless of trip type or length of trip in regular traffic. However, some were willing to pay more, as indicated by willingness to pay an average toll (trimmed mean) of $5.85 across all trip types. Given no difference in their willingness to pay across scenarios, this suggests that the choice to pay the toll may be more of a function of an individual's time value than trip characteristics. Forty percent were likely to be willing to pay $1 more and 31 percent were likely to be willing to pay $2 more than the toll they had stated.

The gasoline tax increase was the least supported alternative in initial questioning yet preferred over the equivalent-cost VMT tax in a tradeoff task. A likely explanation is that the gasoline tax is currently in place and therefore known to drivers whereas the VMT tax and how it would be implemented is more uncertain. However, the rankings indicate that drivers consistently chose the lower cost alternatives whether a gasoline or VMT tax.

If the gasoline tax was increased, over 60 percent of respondents said they would drive a little or a lot less. This percentage was lower (39 percent) for a VMT tax, perhaps because the fuel efficiency of their vehicle would be less of a factor or it would only affect miles driven in Georgia. Over one-third said they would car pool or ride share a little or a lot more while 19 percent said they'd take public transportation more often.

Importantly, over one-third indicated that it would be extremely or very difficult for them to make such changes. Asked if phasing-in a gas tax increase would affect their support, 39 percent said it would significantly or somewhat increase their support while 40 percent it would make no difference.

The degree of support or appeal of the revenue alternatives did not vary across the three geographic areas even though the areas varied in population density and transportation needs. The number of miles driven in a typical weekday also did not affect support or appeal. Some demographic trends were observed. Particularly in direct questioning, there tended to be greater support across the alternatives among men, the more highly educated and those with higher income.

APPENDIX 5.1
Questionnaire

Respondents prescreened for 18 years or older and current driver

2. On a typical weekday, about how many miles do you personally drive? If your job is driving, do NOT include miles you drive on the job.

Don't drive --> Terminate

1-5 miles

6-15 miles

16-25 miles

26-40 miles

41-60 miles

61-75 miles

76-100 miles

More than 100 miles

We, as faculty at Georgia State University, are interested in your opinions about ways in which states try to address their transportation needs.

Georgia's population continues to grow causing more wear-and-tear on roads and bridges. This means more costs for maintenance and repairs.

There are also calls for Georgia to develop its road system and improve public transportation to relieve congestion and improve economic growth.

Meeting the demands within existing budgets is often challenging. Like many states, Georgia may, in the future, implement ways to fund transportation needs.

(New Screen)

If implemented, this means that the costs to some, or all, Georgia drivers could increase. And we know such increases may not be desirable.

However, it is important to understand how Georgia citizens, like you, feel about the alternative methods to increase funding for transportation. That is the purpose of this survey.

We will present you with hypothetical situations and ask your opinion about them. In forming yo ur opinion, we ask you to imagine that at least one of these alternatives might be implemented. Imagining that, we are asking your preferences about the funding alternatives themselves.

(New Screen)

Right now, the primary source of state transportation funds is a gas tax. The price at the pump of each gallon of gas includes a per gallon gas tax.

The total amount of tax paid by an individual depends on the number of miles driven and the car's miles per gallon (MPG).

(This paragraph is paired with 3rd paragraph after Q9. 1/4 of respondents see both or neither; 1/4 see one but not the other) Georgia's gas tax is the 8th lowest in the nation. That is, 42 states have higher gas taxes than Georgia.

3. (Randomly assigned to 1/3 of respondents) One option that states have is to increase the state gas tax by 10 cents per gallon. This means a person who drives a car that gets 20 miles per gallon (MPG) for 10,000 miles per year will pay $50 more per year in gas taxes, for a total of $135.

The actual amount a person would pay would depend on the number of miles they drive and the miles per gallon their car gets.

Would you ...

Strongly support the increase

Somewhat support the increase

Somewhat oppose the increase

Strongly oppose the increase

No opinion

4. (Randomly assigned to 1/3 of respondents) One option that states have is to increase the state gas tax by 15 cents per gallon. This means a person who drives a car that gets 20 miles per gallon (MPG) for 10,000 miles per year will pay $75 more in gas taxes, for a total of $160.

The actual amount a person would pay depends on the number of miles they drive and the miles per gallon their car gets.

Would you ...

Strongly support the increase

Somewhat support the increase

Somewhat oppose the increase

Strongly oppose the increase

No opinion

5. (Randomly assigned to 1/3 of respondents) One option that states have is to increase the state gas tax by 25 cents per gallon. This means a person who drives a car that gets 20 miles per gallon (MPG) for 10,000 miles per year will pay $125 more in gas taxes for a total of $210.

The actual amount a person would pay depends on the number of miles they drive and the miles per gallon their car gets.

Would you ...

Strongly support the increase

Somewhat support the increase

Somewhat oppose the increase

Strongly oppose the increase

No opinion

6. If the gas tax was increased as described, how much would it affect your own behavior as a driver?

Not at all

Slightly

Moderately

Dramatically

7. (If answer slightly, moderately, or dramatically to above) How would the change affect your driving behavior? Would you ...

	Much less	A little less	About same	A little more	Much more
Drive					
Take public transportation					
Car pool or share rides					
Walk, bike or cycle					
Replace your car sooner					

8. How difficult would it be for you to change your driving behavior?

Extremely difficult

Very difficult

Somewhat difficult

Not very difficult

Not at all difficult

9. Rather than implement a gas tax increase all at once, an increase could be phased in over time. If the tax were gradually increased over five

years, how would this affect your support?

Would it ...

Significantly increase your support

Somewhat increase your support

Slightly increase your support

Would make no difference

(Screen 1 Intro Q10-12) The amount a person pays in gas taxes is determined both by the number of miles they drive and the miles per gallon their car gets.

Some people choose to drive more fuel efficient vehicles while other people choose to drive less fuel efficient vehicles.

(Seen only by some respondents - This paragraph paired with paragraph before Q1. informs respondent of potential inequities for lower income citizens in current gas tax system.)

For others, the car they drive is based on what they can afford to buy rather than its gas mileage. Many lower income drivers pay more gas taxes because they are unable to afford newer, more fuel efficient vehicles. Instead they buy older, used vehicles that get lower fuel mileage because they cost less.

(Screen 2 Intro Q10-12) One idea is to eliminate the state gas tax altogether and replace it with a tax based only on the number of miles you drive. In other words, this matches taxes to actual roa d usage. This is called a Vehicle Miles Traveled (VMT) tax.

(Screen 3 Intro Q10-12) Imagine that the current state gas tax was eliminated and replaced by a t ax that was based only on the number of miles the car was driven in Georgia.

Imagine that it was possible to pay this tax at the gas pump just like the current gas tax. So when a driver refueled their car, the total cost would include the cost of the gas plus tax based on how many miles the car had been driven in Georgia since the last gas purchase.

In this proposal, everyone who drives 10,000 miles a year in Georgia would pay the same tax, reg ardless of the fuel efficiency of the vehicle they drove.

10. (Assigned to same respondents as Q1)

To create the same revenue for transportation, the new miles-based tax would be 1.35 cents per mile. This means a person who drives a car 10,000 miles per year will pay $135 in taxes.

Would you ...

Strongly support this change in how the gas tax is determined

Somewhat support this change in how the gas tax is determined

Somewhat oppose this change in how the gas tax is determined

Strongly oppose this change in how the gas tax is determined

No opinion

11. (Assigned to same respondents as Q2)

To create the same revenue for transportation, the new miles-based tax would be 1.6 cents per mile. This means a person who drives a car 10,000 miles per year will pay $160 in taxes.

Would you ...

Strongly support this change in how the gas tax is determined

Somewhat support this change in how the gas tax is determined

Somewhat oppose this change in how the gas tax is determined

Strongly oppose this change in how the gas tax is determined

No opinion

12. (Assigned to same respondents as Q3)

To create the same revenue for transportation, the new miles-based tax would be 2.1 cents per mile. This means a person who drives a car 10,000 miles per year will pay $210 in taxes.

Would you ...

Strongly support this change in how the gas tax is determined

Somewhat support this change in how the gas tax is determined

Somewhat oppose this change in how the gas tax is determined

Strongly oppose this change in how the gas tax is determined

No opinion

13. If the gas tax was replaced by such a tax, how much would it affect your own behavior as a driver?

Not at all

Slightly

Moderately

Dramatically

14. (If answer slightly, moderately, or dramatically to above) How would the change affect your driving behavior? Would you ...

	Much less	A little less	About same	A little more	Much more
Drive					
Take public transportation					
Car pool or share rides					
Walk, bike or cycle					
Replace your car sooner					

15. (Randomly assigned to 1/2 of respondents) Another proposed option is to add or increase fees on employee parking in lots at work statewide. The option would increase the cost of current employee parking by $2 per month statewide.

If an employee currently pays $50 a month to park, the new fee would be $52. If employees do not currently pay to park, a new $2 monthly fee would be charged.

Would you ...

Strongly support the increase

Somewhat support the increase

Somewhat oppose the increase

Strongly oppose the increase

No opinion

16. (Randomly assigned to 1/2 of respondents) Another proposed option is to increase fees on employee parking in lots at work statewide. The option would increase the cost of current employee parking by $4 per month statewide.

If an employee currently pays $50 a month to park, the new fee would be $54. If employees do not currently pay to park, a new $4 monthly fee would be charged.

Would you ...

Strongly support the increase

Somewhat support the increase

Somewhat oppose the increase

Strongly oppose the increase

No opinion

Toll roads already exist in some parts of Georgia. For example, Georgia 400 in Atlanta is a toll road.

A toll road (or tollway, turnpike, toll highway or an express toll route) is a privately or publicly built road for which each driver pays a specific toll or fee to use the road.

Building a toll road may allow certain highways to be built sooner. If public funds are unavailable for the whole project, tolls may provide the extra funding.

Users pay the toll in cash or use a pre-paid electronic pass attached to their windshield.

17. If a new road could be built sooner as a toll road rather than waiting to build a non-toll road, would you ...

Strongly support using tolls

Somewhat support using tolls

Somewhat oppose using tolls

Strongly oppose using tolls

No opinion

(Screen 1 Intro Q17-20) Express Lanes already exist in some parts of Georgia. These lanes are free for carpools and buses. In the Fall of 2011, some express lanes will be opened to solo drivers wh o choose to pay a toll for a faster, more reliable trip when they want it. These lanes are in addition to the existing general purpose traffic lanes.

The toll to use the express lanes varies with the amount of traffic. The toll is set to keep the traffi c in these lanes moving consistently at 45 miles per hour or faster. This means drivers have more reliable trip times.

(Screen 2 Intro Q17-20) How Do Express Lanes Work?

The toll to use the express lane to a particular destination is clearly displayed on signs overhead.

Before using an express lane, a driver would first register for a PeachPass, a prepaid account ($20 minimum), and place the PeachPass electronic card on their windshield.

If a driver decides to pay the toll to use the lane, they simply move into the lane at designated spots. The PeachPass sticker is detected electronically and the toll is automatically deducted from their account.

The actual toll price will be determined by the number of cars that can use the Express Lane and keep it flowing at a constant 45 miles per hour or faster.

18. (Randomly assigned to 1/4 of respondents) Imagine you are driving as part of your regular commute and you have a 10-mile drive on the interstate. With the current congestion, you see it's going to take you 45 minutes. You have time to get there without being late.

Imagine you have a PeachPass and can move into an Express Lane and drive the 10 miles in only 10 minutes.

What is the most you would pay in total to save the 35 minutes in traffic?

$

19. (Randomly assigned to 1/4 of respondents) Imagine you are driving as part of your regular commute and you have a 10-mile drive on the interstate. With the current congestion, you see it's going to take you 60 minutes. You have time to get there without being late.

Imagine you have a PeachPass and can move into an Express Lane and drive the 10 miles in only 25 minutes.

What is the most you would pay in total to save the 35 minutes in traffic?

$

20. (Randomly assigned to 1/4 of respondents) Imagine you are driving to an important appointment and you have a 10-mile drive on the interstate. With the current congestion, you see it's going to take you 45 minutes. You have time to get there without being late.

Imagine you have a PeachPass and can move into an Express Lane and drive the 10 miles in only 10 minutes.

What is the most you would pay in total to save the 35 minutes in traffic?

$

21. (Randomly assigned to 1/4 of respondents) Imagine you are driving to an important appointment and you have a 10-mile drive on the interstate. With the current congestion, you see it's going to take you 60 minutes. You have time to get there without being late.

Imagine you have a PeachPass and can move into an Express Lane and drive the 10 miles in only 25 minutes

What is the most you would pay in total to save the 35 minutes in traffic?

$

22. (Randomly assigned to 1/2 of respondents) Suppose the toll was actually $(answer to previous question + $1). How likely would you be to pay the toll to use the Express Lane?

Definitely would

Probably would

Might or might not

Probably would not

Definitely would not

23. (Randomly assigned to 1/2 of respondents) Suppose the toll was actually $(answer to previous question + $2). How likely would you be to pay the toll to use the Express Lane?

Definitely would

Probably would

Might or might not

Probably would not

Definitely would not

24. All of the options we've shown you mean more costs to some or all Georgians. We want to understand better how you would make these decisions by asking you to evaluate a series of tradeoff scenarios.

(Max Diff Exercise – New Screen)

24_1a. Considering only these four options, which is the Most Appealing, and which is the Least Appealing?

	Most Appealing	Least Appealing
Option 1	1	2
Option 2	1	2
Option 3	1	2
Option 4	1	2

24_1b. Are all of these options appealing, none of them appealing, or are only some of them appealing?

All are appealing……………1

None are appealing……….2

Some are appealing ……. 3

(Max Diff exercise will randomly choose four of the following to show on each screen. Each respondent will see all Options a-j at least once.)

<u>**24 Options**</u>

a) Increase the state gas tax by 10 cents per gallon

b) Increase the state gas tax by 15 cents per gallon

c) Increase the state gas tax by 25 cents per gallon

d) Replace the current per-gallon gas tax with a 1.35 cents per mile tax

e) Replace the current per-gallon gas tax with a 1.60 cents per mile tax

f) Replace the current per-gallon gas tax with a 2.10 cents per mile tax

g) Add employee parking fee of $2 per month

h) Add employee parking fee of $4 per month

i) Build toll roads when public funds are not available

j) Create special express lanes where you pay for each mile used

The following questions are about your own driving patterns.

26. On a typical day, how do you get to your workplace or school?

Drive alone Bike

Carpool Rail or MARTA train

Walk Work from home

Bus Retired/not currently working

Other (please explain)

27. (Skip if not working or work from home) Do you currently pay to park at work?

Yes

No

Don't Know

28. On average, how many miles per gallon (MPG) does the car you drive most often get?

Less than 13 mpg

13 - 17 mpg

18 - 22 mpg

23 - 27 mpg

28 - 75 mpg

Don't know

29. What is the model year of the vehicle you drive most often?

Before 1985

1985-1993

1994-1999

2000-2003

2004-2008

2009 or later

Don't know

The final questions are about you and your household. Your answers are strictly confidential and will be combined with those of other respondents for statistical analysis purposes.

1. Which of the following describes your age?

Under 18 --> (Not allowed to participate in survey)

18-24

25-34

35-44

45-54

55-64

65 or older

30. What is your home zip code?

31. What is your highest level of education?

Less than high school

Completed high school

Some college

Completed college

Some graduate school

Completed graduate school

32. Which of the following describes your current employment status?

Employed full time

Employed part time

Retired

Student

Not currently employed

Other (please explain)

33. How many licensed drivers currently reside in your home?

1

2

3

4

5 or more

34. Which of the following describes your total household income?

Less than $24,999

$25,000 to $34,999

$35,000 to $49,999

$50,000 to $74,999

$75,000 to $99,999

$100,000 to $149,999

$150,000 or more

35. What is your gender?

Male

Female

36. What race or ethnicity do you consider yourself? (Select as many as apply)

White/Caucasian (not Hispanic/Latino background)

Hispanic, Latino, Mexican-American

Asian, Pacific Islander, East Indian

Black, African American

Native American

Multi-racial

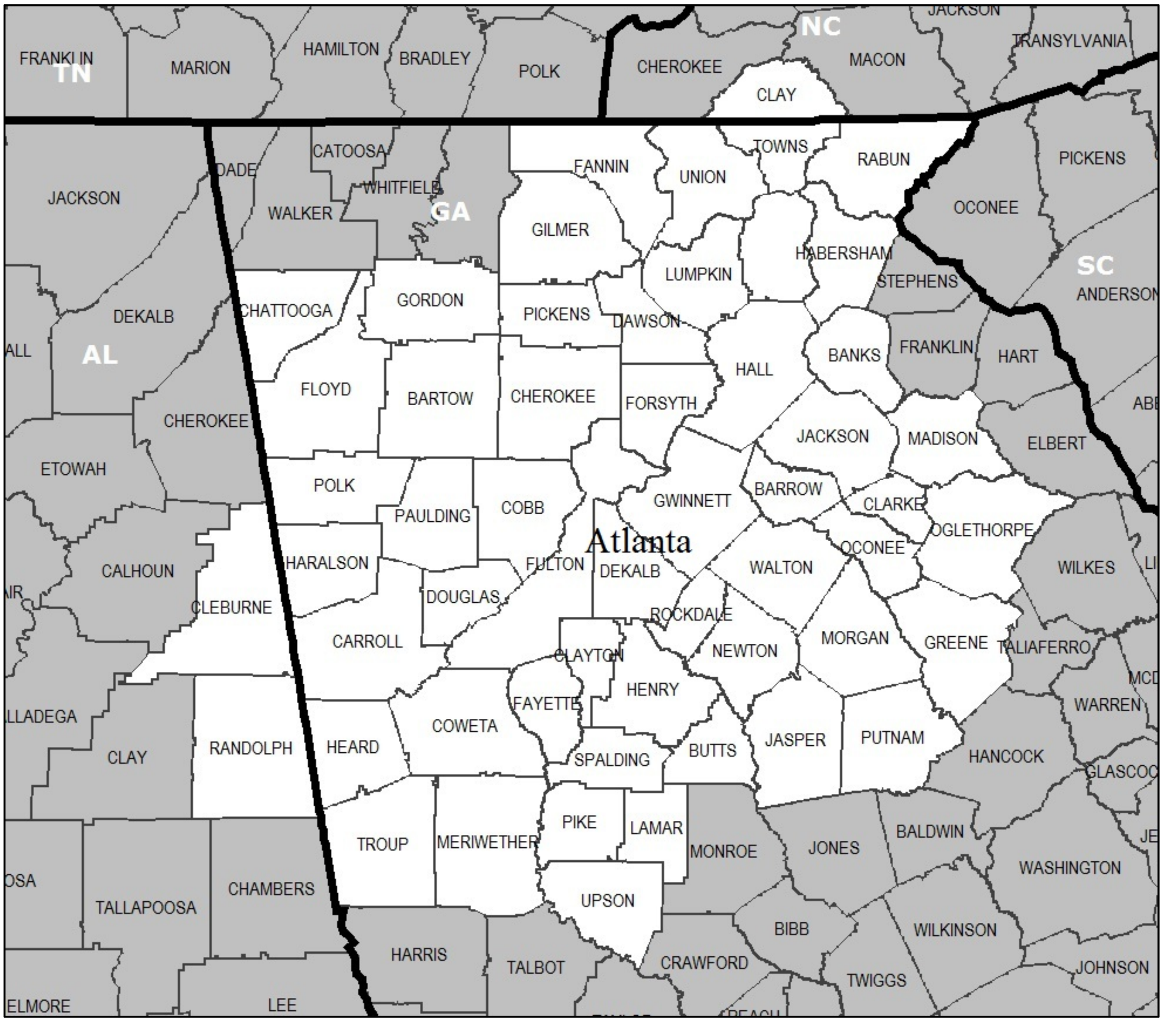
Other (please specify)

37. As you know, many people are so busy these days they can't find time to register to vote, or they move around so often they don't get a chance to re-register. Are you now registered to vote in your precinct, or haven't you been able to register for one reason or another?

Currently registered to vote

Not currently registered

APPENDIX 5.2
Atlanta DMA Counties (in white)[21]



[21] Residents of Alabama and North Carolina counties in Atlanta DMA were excluded from the survey sample.

APPENDIX 5.3
Driving Behavior of Respondents: Frequency Distributions

FIGURE A5.1. ON A TYPICAL DAY, HOW DO YOU GET TO YOUR WORKPLACE OR SCHOOL?

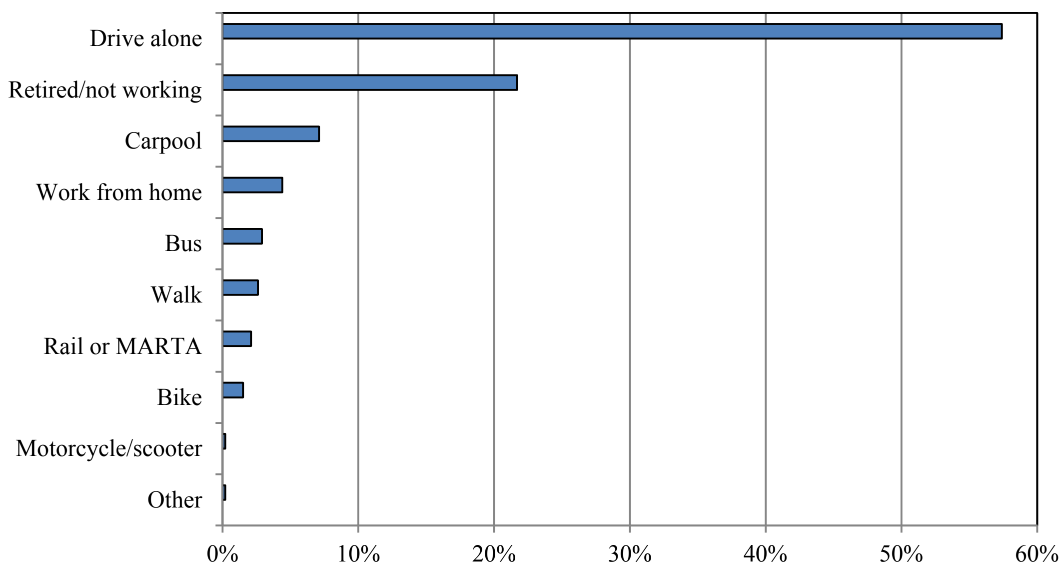


FIGURE A5.2. MILES DRIVEN ON TYPICAL WEEKDAY

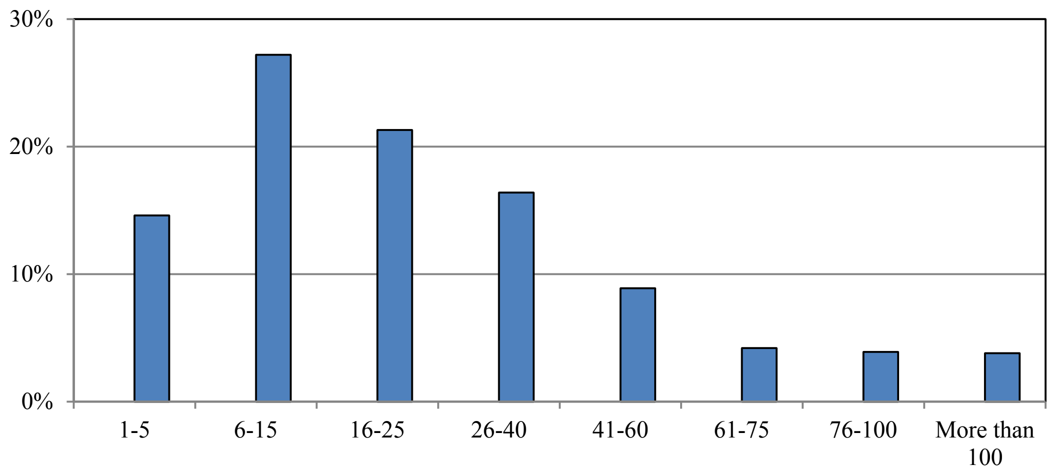


FIGURE A5.3. MILES PER GALLON OF VEHICLE YOU DRIVE MOST

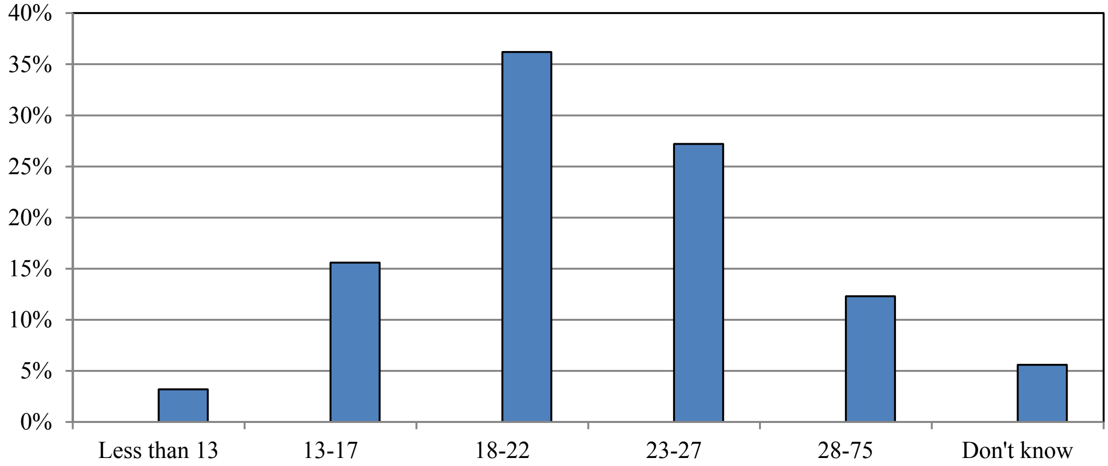
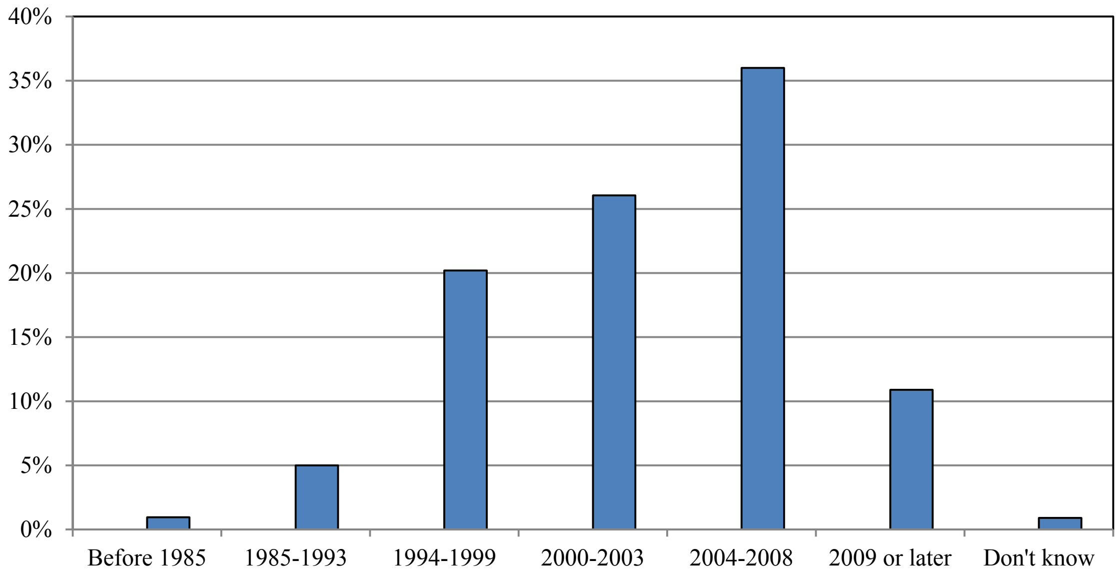


FIGURE A5.4. WHAT IS THE MODEL YEAR OF THE VEHICLE YOU DRIVE MOST OFTEN?



CHAPTER 6
RESULTS OF A LABORATORY EXPERIMENT

6.1 Introduction to the Laboratory Experiment

When subjects are given a survey, they may consider their choices carefully and try to imagine what they might do in various situations. However, in many circumstances what one *actually* does when confronted with a situation is different than what the same person imagines he or she might do in that same situation. Thus, there is a complementary role for experiments in the analysis of policy-relevant issues. In an experiment, subjects are asked to make choices in which they (typically) face real consequences that depend on the choices that they make.

For example, a survey might ask which of the following two gambles a person prefers:

Gamble A	Gamble B
Heads: Earn $5 Tails: Earn $1	$2 for sure

If the same question were posed in an experiment, the subject would be paid based on the choice he made. If he said he preferred Gamble B, he would be paid $2. If he said he preferred gamble A, the experimenter would toss a coin and the subject would be paid $5 or $1 depending on whether the outcome was heads or tails.

The advantage of the experiment over the same question presented in a survey is that in an experiment a participant makes a choice, then faces a <u>*real*</u> (typically monetary) consequence that is directly based on the participant's choice.

The experimental portion of this study attempts to elicit individuals' preferences between travelling a standard route to get to one's destination and paying a toll in order to arrive at one's destination in less time. As in the gambling example above, in our experiment subjects will make choices and face real consequences as a result of their choices. These consequences involve both the amount of monetary payment that they will receive for participation in the experiment, and how long they must wait to receive this payment.

It's also useful to note a tradeoff that exists between experimental and survey data. Most often, survey questions (such as those used in this project) use a lot of context. If the issue of interest is funding alternatives for transportation, then the questions are framed to ask about this context. For example, survey respondents are asked how their support for various levels of gas taxes and how this would affect their behavior. In another survey question, they are asked about the highest level of toll they would be willing to pay in order to save 35 minutes in traffic.

In experimental studies, a more neutral context is typically used. For example, instead of using the terms "toll" and "traffic" in one treatment we presented participants with a choice between receiving a sum of money after waiting for 30 minutes, and receiving a smaller sum of money after 15 minutes. For example, a subject might be given a choice between receiving $25 after waiting 30 minutes and receiving $23 after waiting 15 minutes. This is equivalent to paying $2 in order to reduce waiting time by 15 minutes.

Clearly, these two approaches are complementary. Survey answers can be directly interpreted in the context of interest. However, the experiment places participants into a situation in which they face real consequences that depend on their decisions.

The experimental design is discussed in detail below.

6.2 Experiment Design

Participants in this experiment completed four tasks:

- Task 1 – Elicitation of Long-Term Time Preference;
- Task 2 – Elicitation of Short-Term Time Preference;
- Task 3 – Elicitation of Preference for Certainty; and
- Complete a survey similar to the one in Appendix 5.1.

At the start of each experimental session, participants were told that they would participate in four decision-making tasks, and that three of these tasks would involve the potential to earn money (in addition to a participation payment).

As described below, Task 1 involved the chance to earn money either two- or nine-weeks after the date of the experiment. Task 2 and Task 3 involved decisions about earning money on the day of the experiment. Subjects were told that they had to complete all tasks in order to earn any money other than their participation payment.

Specifically, they were told:

> "Any additional earnings will be determined after all three tasks are completed.
>
> "After you have completed all three decision-making tasks (but before you complete the survey) I will randomly choose ONE of these three tasks that will count for payment. I will throw a 6-sided die.
>
> - If I throw a one or a two: Task 1 will be used to determine any additional earnings;
> - If I throw a three or a four: Task 2 will be used to determine any additional earnings; and

- If I throw a five or a six: Task 3 will be used to determine any additional earnings.

"So, if I throw the die and the four comes up, I will look at your answers in Task 2 to determine any of your additional earnings. In this case, your answers in Task 1 and Task 3 would have NO effect on your earnings. I will throw the die at the front of the room and the same task will be chosen for each person.

"However, it is important that you know that you will not receive any earnings, other than your participation payments, unless you complete all decision-making tasks and stay until the end of today's session (which will last no more than two hours)."

When subjects complete more than one decision-making task in an experiment, the standard practice is to pay subjects for only one of these tasks (with the determination of the paid-task made at the end of the experiment). This avoids potential wealth effects and also so-called portfolio effects. Wealth effects are problematic when subjects earn money for all tasks because they have higher earnings at the time of the last task than the first. If these higher accumulated earnings affect decisions, then the results from the experiment are less reliable. Portfolio effects arise when subjects make decisions that spread out the risks associated with any decisions. So subjects might choose a sooner payment option in one task and a later payment option in another so that they receive money in both time periods.

In the current study, it would not have been possible to pay subjects for both Task 2 and Task 3, since both involved waiting a period of time in the lab before being paid.

The actual choice-situations are described below, but to illustrate: if in Task 2 the subject was to be paid after waiting for 30 minutes and in Task 3 the subject was to be paid after waiting for just 15 minutes – the 30 minute wait time in Task 2 would make the Task 3 outcome irrelevant.

6.2.1 Eliciting Time Preferences—Background

There is a large literature addressing how to elicit individual time preferences in a laboratory experiment. It is assumed that most individuals prefer to receive an immediate benefit rather than having to wait to receive that same benefit. The goal of this experimental task is to measure *how much* the individual prefers receiving the benefit (typically a monetary payment, although other types of rewards have been studied) sooner rather than later.

For example, assume that the benefit in question is receiving $100. Given a choice between receiving $100 today and $100 in one month, most people would choose to receive $100 today. While this tells us that receiving $100 now is preferred over receiving the same amount of money in one month, it does not tell us how strong this preference is. Continuing with this example, we could measure the strength of the preference for receiving the money now by eliciting how much more money this individual would have to receive in order to be willing to wait one month to receive it. A person who requires a payment of $120 in one month in order to forego receiving $100 today would be said to have a strong preference for the current benefit relative to one who requires only a $102 payment in one month.

While time preferences are sometimes measured over real goods, most experiments use monetary payments. The problem associated with using goods (rather than money) is that there may be substantial differences in how people value a given good—and these differences cannot be observed or controlled by the experimenter. Using transportation as an example, two people may view a 15-minute delay in arriving at one's destination very differently depending upon how one feels about driving, where one is going, and the importance of arriving at one's destination at a given time. On the other hand, there is likely to be much less variation in how individuals value a sum of money, especially when restricting attention to those with similar levels of wealth (in our case, college students). Thus, we used monetary payments to measure time preferences in this experiment.

There have also been differences in how the question is framed. In some studies subjects have been directly asked the minimum amount of money they would require in order to delay receiving payment. However, when the question is posed in this way subjects often over-state this amount of money. For example, they might state that they require at least $130, but if the same person was later offered $120 they might very well agree to this amount.

Therefore, most researchers prefer to give subjects a menu of choices between receiving money sooner rather than later, and then using the point at which they indicate they are willing to delay payment to determine the individual's time preference. For example, consider the following five decision-problems:

Question 1: $100 now or $102 in one month

Question 2: $100 now or $104 in one month

Question 3: $100 now or $106 in one month

Question 4: $100 now or $108 in one month

Question 5: $100 now or $110 in one month

A person who chooses $100 now for the first four questions and then switches to later payment shows that they have a stronger preference for current payment than one who switches to the latter option prior to question 5.

Each of our three decision-making tasks involves a series of choices between two options, with the point at which a participant switches from one option to the other used to determine their preference toward the issue in question. Each task is described in detail below.

6.2.2 Elicitation of Long-Term Time Preferences

In recent years, economists have pointed out a problem with offering subjects a choice between a sum of money now and a larger sum of money in the future—because one likely values changes in income at various levels, asking questions such as those posed in the section above have been shown to over-estimate the extent to which one prefers a current benefit. Thus, we use a slightly different method to elicit the long-term time preferences of subjects in this experiment.

Instead of giving participants a choice between a sum of money now and larger sum later, the payment at either time period is the same amount of money. However, earning the money is no longer certain, and the chance of earning the money increases if the subject waits to receive payment. We still use the point at which the subject switches from payment sooner to later to infer the time preference, but now the results can be used to directly measure time preference without concern that the elicitation method has biased the results.

The decision-sheet that each participant filled out for Task 1 is shown in Appendix 6.1. In this decision-making task, each participant made 14 choices between a chance of receiving $100 in two weeks ("Option A") and a (typically) larger chance of receiving $100 in nine weeks ("Option B"). It is notable that both time periods at which payment make take place occur on a future date, which is the most typical way in which time preferences are elicited.

Even someone with a relatively low preference for current earnings may choose to receive money today rather than wait so that they don't have to return a second time to receive payment, and to reduce uncertainty about whether the money will actually be paid in the future. By making both payment periods at a later date, we hold these considerations equal between payment periods. Thus, their choices should reflect their time preference and not these other factors.

In this decision-making task, Option A always involved a 50 percent probability of receiving $100 in two weeks. For Option B, the probability of receiving $100 in nine weeks started at 50 percent, and increased as the participant worked down the rows. For example, in Decision 1, the subject was asked to choose between a 50 percent chance of $100 in two weeks and a 50 percent chance of $100 in nine weeks. In Decision 2, the subject was asked to choose between a 50 percent chance of receiving $100 in two weeks and a 50.07 percent chance of receiving $100 in nine weeks. While this is a small increase in probability, it corresponds to a one percent annual percentage rate (APR) if interest (the increase in probability) is compounded daily from two weeks to nine weeks after the experiment. By Decision 14, the subject is asked to choose between a 50 percent chance of receiving $100 in two weeks and a 55.29 percent chance of receiving $100 in nine weeks (a 75 percent APR).

The point at which a subject switches from Option A (payment in two weeks) to Option B (payment in nine weeks) reveals the rate of interest required to forego payment for an extra seven weeks. For example, a subject who chooses Option A for the first four decision rows, and then switches to Option B at row 5 (when there is a 50.4 percent chance of receiving $100 in nine weeks) shows that he requires a 6 percent APR to wait the extra seven weeks to receive payment.

Subjects were told that if Task 1 was the one task that was selected for payment, just one of their 14 decisions would be used to determine whether or not they received $100 in two or nine weeks. A 20-sided die was used to determine which one decision row would be used (if a 15-20 was thrown, the die was thrown again until a number in the 1-14 range was thrown). For example, if the die roll was an 8, we would look at their choice (A or B) for Decision 8 only. At this point, a second set of die rolls was used to determine whether the subject received $100. Continuing with this example Table 6-1 shows the outcomes from Decision 8 of Task 1, based on the participant's choice (A or B) and the die throw:

Table 6.1
Outcomes from Decision 8 of Task 1

Die Throw	Outcome if Participant Chose -------------Option A-------------	Outcome if Participant Chose ------------Option B--------------
0001-5000	$100 in 2 weeks	$100 in 9 weeks
5001-5081	$0	$100 in 9 weeks
5081-0000	$0	$0

The four-digit die throw was determined by throwing four 10-sided die: one red, one white, one blue, and one black. The four numbers thrown determined the four-digit number (ordered as red number, white number, blue number, and black number). For example, given the following die throws:

- Red: 3
- White: 8
- Blue: 6
- Black: 1

The resulting 4-digit number would be recorded as 3861. However, if the die throws were:

- Red: 6
- White: 3
- Blue: 1
- Black: 8

The resulting 4-digit number would be recorded as 6318.

Continuing with the example above where Row 8 (see Appendix 6.1) is used to determine payment in Task 1, if the 4-digit die throw was between 1 and 5000, then the subject would earn $100 in either two or nine weeks, depending on whether the subject chose Option A or Option B. If the number thrown was between 5001 and 5081, the subject would receive nothing if he chose Option A, but would receive $100 in nine weeks if he chose Option B. If the number thrown was greater than 5081, then the subject earned nothing from this Task.

To summarize, in this task:

- The subject made 14 choices between Option A (a 50 percent chance to earn $100 in two weeks) and Option B (a chance greater than or equal to 50 percent to earn $100 in nine weeks).
- After all three decision-making tasks were completed, the one used for payment was selected at random.

If Task 1 was determined to be used for payment:

- A 20-sided die was used to determine which one of the 14 decisions would count for payment (throwing a 15-20 resulted in another die throw until a number between 1 and 14 was thrown).
- Four colored 10-sided die were used to determine a random 4-digit number.
- The randomly-determined 4-digit number and the participant's choice of A or B determined whether the subject earned nothing, $100 in two weeks, or $100 in nine weeks.

6.2.3 Elicitation of Short-Term Time Preferences

While the longer-term elicitation task follows methods that are widely used to elicit time preferences, we also wish to study preferences over a time period that more closely corresponds to that faced by most drivers. When making a choice between routes of travel, or whether to pay a toll in order to travel on a faster road, the choice doesn't involve a period of weeks. Thus, the last two decision-making tasks involved choices that related to a delay in payment of less than one hour.

As in Task 1, the decision was framed in terms of monetary payments (the ultimate outcome is earning a sum of money), but in this Task participants were asked to choose between waiting in the lab for 30 minutes to receive a $25 payment or giving up a portion of this $25 in order to leave the lab after only 15 minutes. This corresponds to a driver choosing whether to pay a toll in order to reduce travel time.

The decision-sheet that each participant filled out for Task 2 is shown in Appendix 6.2. Each participant made 10 choices between receiving $25 in 30 minutes ("Option A") and receiving a smaller sum of money after waiting for only 15 minutes ("Option B").

The point at which a subject switches from Option B (payment in 15 minutes) to Option A (payment in 30 minutes) reveals the strength of one's preference to reduce time waiting. For example, a participant who chooses Option B for the first three decision-rows reveals that he is willing to give up $3 of earnings to reduce time waiting from 30 to 15 minutes. On the other hand, a person who chooses Option B for the first seven rows shows a stronger preference to avoid waiting – this person is willing to give up $7 to reduce waiting time from 30 to 15 minutes.

Subjects were told that if this task was the one task that was selected for payment, just one of the 10 decision rows would be used to determine their payment and how long they had to wait for payment. A single 10-sided die was used to determine (for each individual) which decision-row would be used. For example, if the die roll was an 8, we would look at their choice (A or B) for Decision 8 only. If the subject chose A in Decision 8, he had to wait 30 minutes before receiving $25. If the subject chose B, he had to wait 15 minutes to receive $17.

It was important to limit the options of what participants could do while waiting for payment. Most people view sitting in traffic as an unpleasant experience with little chance for entertainment or relaxation. Given this, subjects were told in the instructions (prior to making their decisions):

> "After the task that will be used for payment (Task 1, 2, or 3) is determined, I will give you a survey to complete. If this task is chosen for payment, the time you must wait will start after you complete the survey and turn it in. While you wait, you must sit quietly in your seat. You cannot read, talk to anyone else, use a computer or any other device. You must sit quietly until the specified amount of time (15 or 30 minutes) has passed. If this Task is chosen for payment and you want to leave early, you will receive your participation payment but not any additional money."

To summarize, in this task:

- The subject made 10 choices between Option A (waiting 30 minutes to receive $25) and Option B (waiting 15 minutes to earn an amount of money less than $25).
- After all three decision-making tasks were completed, the one used for payment was selected at random.

If the short-term time preference task was the one used for payment:

- A 10-sided die was used to determine which one of the 10 decisions would count for payment.
- The subjects choice for this one decision (A or B) determined their earnings and how long they had to wait to receive earnings.

6.2.4 Elicitation of Preferences to Reduce Uncertainty about Waiting Time

Often driving decisions don't involve a choice between two driving times that are known with certainty. Instead, when one makes a decision the person must choose between a relatively certain delay and an alternate route that may be faster or slower depending on a variety of factors. This part of the experiment elicited subjects' preferences toward reducing uncertainty about the time they had to wait to receive payment.

The decision-sheet that each participant filled out for Task 3 is shown in Appendix 6.3. Each participant made 10 choices between receiving $25 after waiting for either 15 or 45 minutes (Option A) and receiving a smaller sum of money after waiting for 30 minutes for sure (Option B). In Option A, there was an equal probability of receiving $25 in either 15 or 45 minutes.

The point at which a subject switches from Option B (payment in 30 minutes for sure) to Option A (50-50 chance of waiting 15 or 45 minutes to receive $25) reveals the strength of one's preference to reduce uncertainty about wait times. For example, a participant who chooses Option B for the first three decision-rows reveals that he is willing to give up $3 of earnings to know with certainty that payment will be received in 30 minutes. On the other hand, a person who chooses Option B for the first seven rows shows a stronger preference to avoid uncertainty – this person is willing to give up $7 to know the wait time is 30 minutes for sure.

As before, subjects were told that if this task was the one task that was selected for payment, just one of the 10 decision rows would be used to determine their payment and how long they had to wait for payment. A single 10-sided die was used to determine (for each individual) which decision-row would be used. If a subject chose Option A (uncertain wait time) in the binding decision, then a second die throw was used to determine whether the wait time would be 15 or 45 minutes. If the subject chose Option B the subject waited 30 minutes to receive payment (with the amount of payment depending on the decision-row chosen).

For example, if Decision 6 was the one used for payment. A subject who chose Option A waited 15 minutes to receive $25 if the second die roll was 1-5, and 45 minutes if the second die roll was 6-10. If the subject chose Option B, he waited 30 minutes to receive $19.

As in the short-term time treatment, subjects were told that they had to spend the time waiting, sitting quietly until the time was over.

To summarize, in this task:

- The subject made 10 choices between Option A (waiting either 15 or 45 minutes to receive $25) and Option B (waiting 30 minutes to earn an amount of money less than $25).
- After all three decision-making tasks were completed, the one used for payment was selected at random.

If the uncertain time preference task was the one used for payment:

- A 10-sided die was used to determine which one of the 10 decisions would count for payment.
- If the subject chose Option A, a second die throw determined whether they waited 15 or 45 minutes to be paid $45. If the subject chose Option B, the subject waited 30 minutes to be paid an amount of money less than $25.

6.2.5 Survey

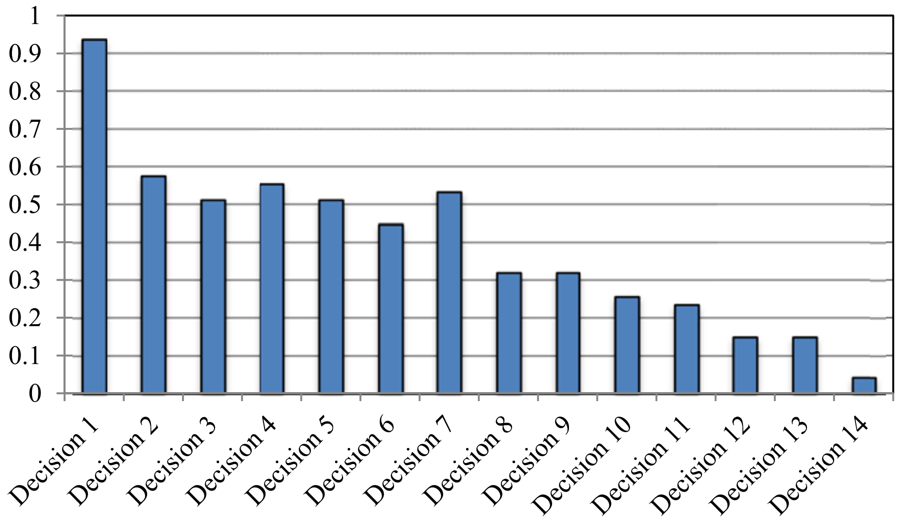
After completing all three experimental tasks, and before the waiting time to receive payment began, subjects completed a survey to elicit opinions about various funding options for transportation services. Subjects were asked for basic demographic information and also about their opinions on various options from gas taxes, to mileage-based taxes, to toll roads. Most of the questions reflected those that were given in the survey to the general public (see Appendix 5.1).

6.3 Experiment Results

A total of 47 subjects participated in experimental sessions at Georgia State University. Subjects were students at Georgia State, aged 18 and older. About 40 percent of subjects were male. The average age was 21.7 (ranging from 18 to 33). About 43 percent of subjects reported they were African American, 19 percent Asian, 21 percent white, and the remaining participants were multi-racial, Hispanic, or did not report their racial background. Most participants reported that they drive, with almost 40 percent of subjects reporting that they drive 15 or fewer miles on a typical day (about 2/3 of subjects report driving 40 or fewer miles on a typical day).

Figure 6.1 on page 158 shows the proportion of subjects who chose in Task 1 to receive payment in two weeks (Option A) instead of nine weeks (Option B). The data from this treatment are consistent with those obtained in similar studies using this experimental design (a choice between a 50 percent chance of earning money sooner and a higher probability later). Over 40 percent of subjects are willing to wait an extra seven weeks to receive payment (nine weeks instead of two) in the second Decision, where the probability of receiving payment is just 0.07 percentage points higher than at the earlier time period (a one percent annual percentage rate).

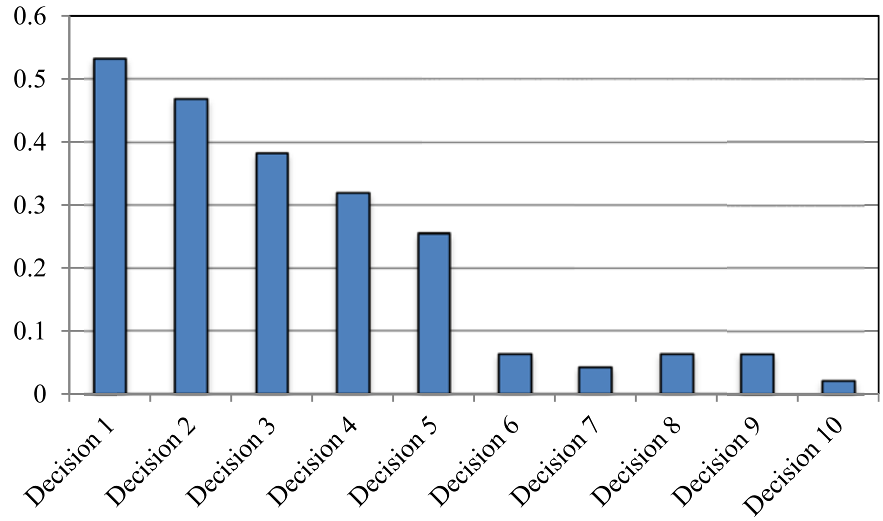
Figure 6.1
Long-Term: Proportion "Sooner"



This shows a remarkable degree of patience over this time period. (It is also notable that about 5 percent of subjects always wait nine weeks to receive payment. It's not clear whether this reflects confusion about the decision-making task among these subjects or a preference for enforced savings—akin to those who do not reduce withholdings on income taxes even when receiving large refunds each year.) There are certainly some participants who have a strong preference to receive payment sooner—for about 20 percent of participant, an annual percentage rate of interest on the probability of receiving payment exceeding 25 percent is required to forgo payment for an additional seven weeks. However, the majority of subjects are willing to wait with a relatively small increase in the probability of receiving payment.

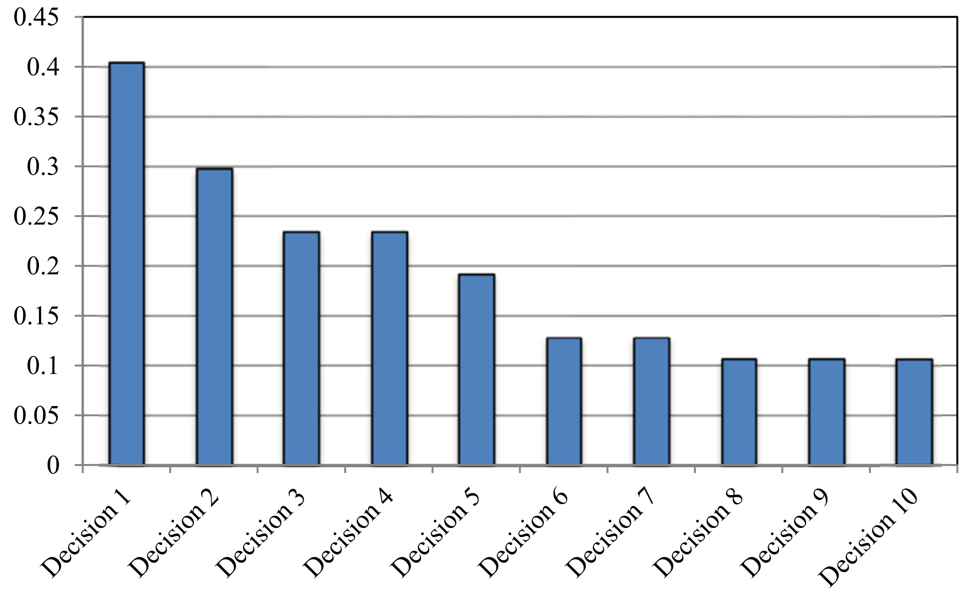
This result is similar to that obtained in the short-term time preference elicitation task (see Figure 6.2 on page 159). While the decision-rows are not directly comparable, data from this treatment also show a high degree of patience over this relatively short period of time. Almost 50 percent of subjects are willing to wait 30 minutes to receive payment rather than give up $1 to reduce the wait time by 15 minutes (Decision 1). Almost 94 percent of subjects would rather wait 30 minutes to receive payment rather than give up $6 of earnings (Decision 6).

Figure 6.2
Short-Term: Proportion "Sooner"



The final treatment explores a different facet of behavior – willingness to pay to eliminate uncertainty about a short-term waiting time. Results for Task 3 are shown in Figure 6.3 on page 160. This figure shows the proportion of subjects who chose to receive payment (of less than $25) after 30 minutes rather than a 50-50 chance of waiting 15 or 45 minutes to receive $25.

Figure 6.3
Uncertainty: Proportion in 30 Minutes



In Decision 1, we see that about 60 percent of subjects prefer to receive $25 in either 15 or 45 minutes rather than give up $1 and receive $24 in a certain 30 minutes. By Decision 5, fewer than 20 percent of subjects are willing to give up $5 to eliminate the uncertainty associated with when they will be paid.

Taken as a whole, these results indicate that subjects are willing to wait to receive payment, even when the wait time is uncertain.

One characteristic of the data (as well as much experimental data that measure both risk and time preferences using a menu of choices as in this case), is that some subjects don't have a single switch-point between Option A and Option B. The short-term time preference task can be used to illustrate this pattern of behavior. Subject 8 chose Option B (payment in 15 minutes) for the first six decisions, then chose Option A for decisions seven and eight, Option B for decision 9 and then Option A for decision 10. By switching initially at Decision 7, this subject revealed that he was not willing to give up $6 to receive payment in 15 minutes (instead of 30), but not willing to give up $7 to receive payment sooner. But in Decision 9, the subject indicated that he preferred to give up $9 rather than wait to receive payment for 30 minutes. If preferences are consistent, we would expect to see the subject choose Option B for a period of time, but once the subject switches to Option A we do not expect to see a switch back to Option B. (In other words, once a subject decides to wait to receive payment, the subject should not then go back and be willing to give up more to receive payment sooner.)

In the long-term time preference task the intuition is similar, except that we expect that once a subject switches to Option B (willing to wait nine weeks to receive payment) they would not switch back to Option A. About 1/3 of participants exhibit this type of "multi-switching" behavior in at least one of the three decision-making tasks. This is largely consistent with results from other experiments of this type. For the remaining analysis, we focus only on those subjects who exhibit a single switch-point. Thus we can more readily interpret the point at which they switch from one option to another as their willingness to pay to either receive payment sooner or to avoid uncertainty (depending on the task).

Figure 6.4 on page 162 shows the proportion of subjects who choose in Task 1 to receive payment in two weeks (the "sooner" option) for various numbers of decisions. About an equal number of subjects (just over 5 percent) either always choose to receive payment in two weeks (14 "sooner" choices) or to always receive payment in nine weeks (0 "sooner" choices). Over one-third of subjects (35.5 percent) choose to receive their money in two weeks only in Decision 1 when the probability of receiving $100 is the same in both two- and nine-weeks. For these subjects, any increase in probability over 50 percent is enough to induce them to wait an additional nine weeks to receive payment. As noted earlier, this reflects a remarkable degree of patience among these participants. Except for this large group of subjects, most other choice-patterns are spread out among the various options, with about 20 percent of subjects choosing the sooner option for 11 or more Decision rows.

Figure 6.4
Long-Term: Number of "Sooner" Choices

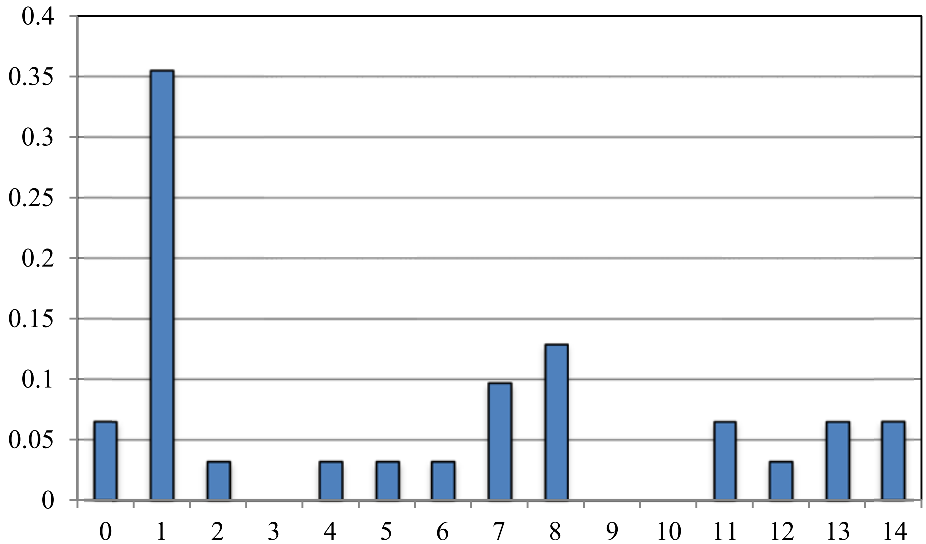


Figure 6.5 on page 163 displays similar data for the short-term time preference task (Task 2). Unlike the long-term time preference task there is no decision-row in which the payment is the same in both 15 and 30 minutes. Here, over half of all subjects indicate that they are willing to wait 30 minutes, even when the cost of receiving the money sooner is just $1 (as in Decision 1). Only one subject is willing to give up more than $5 to have the waiting time reduced from 30 to 15 minutes (this subject was willing to give up $9 to leave after just 15 minutes).

Figure 6.5
Short-Term: Number of "Sooner" Choices

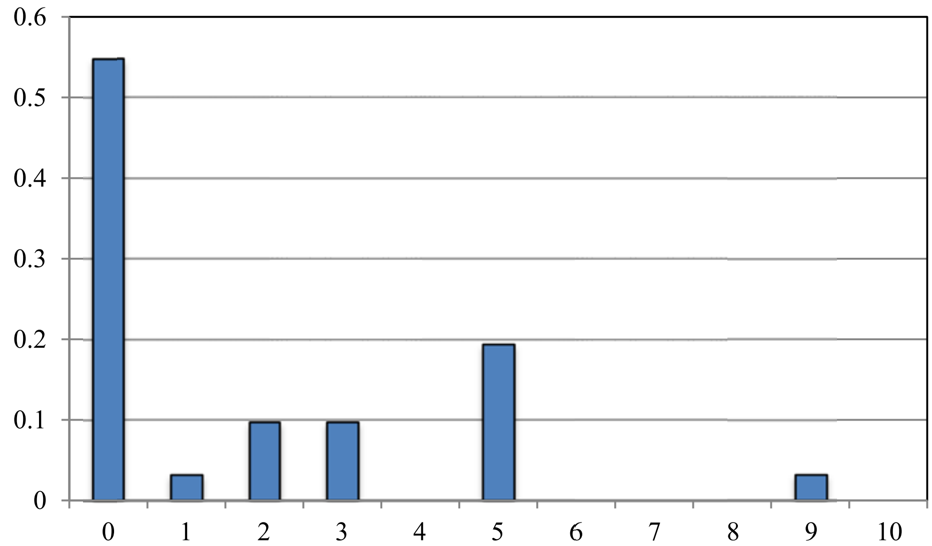
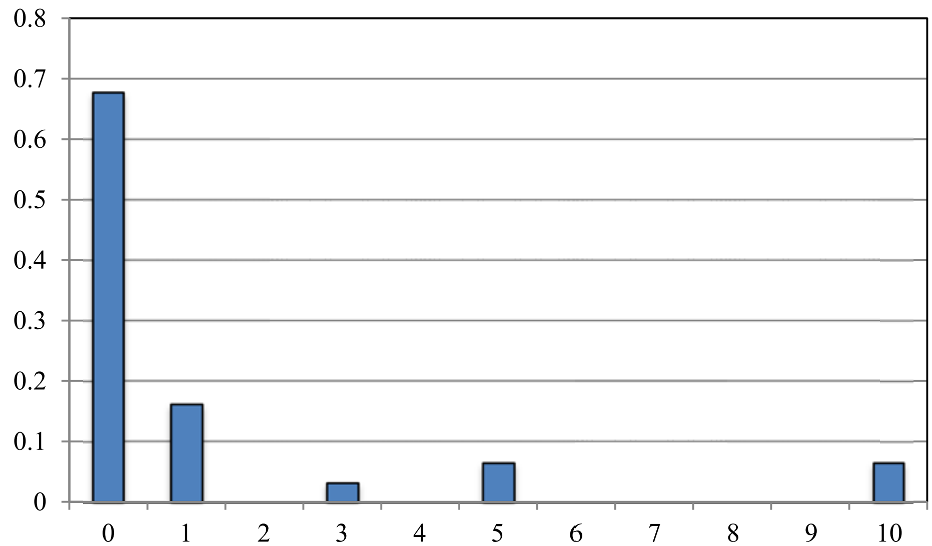


Figure 6.6
Uncertain Time: Number of Certain Choices



The data for the uncertain time treatment (Task 3) is shown in Figure 6.6. and are even more dramatic. Over 2/3rds of these participants would rather face an uncertain 50-50 chance of waiting 15 or 45 minutes rather than give up even $1 to reduce the wait to 30 minutes. (These subjects never choose the certain outcome, even in Decision 1 where the cost is just $1 to do so.) In fact, fewer than 20 percent of subjects are willing to give up more than $2 (Decision 2) to reduce uncertainty about waiting time in this treatment.

Given that all participants made decisions in all three tasks, it is worthwhile to consider the correlation of individual choices between decision-making tasks. In all cases, the correlation was low. The correlation between the number of “sooner” choices in the short-term and long-term time preference tasks (Tasks 2 and 1) was just 9 percent for those subjects who exhibited a single switch-point. The correlation between the number of “sooner” choices in the short-term time preference task (Task 2) and the number of “certain” choices in the uncertain time task (Task 3) was similar: 11.6 percent. It is interesting to note that there is a negative correlation between the number of “sooner” choices in the long-term time preference task and the number of “certain” choices in the uncertain time task: the correlation is -22.2 percent.

Finally, we had hoped to compare results from the survey question that asked subjects how much they would be willing to pay for a Peach Pass Managed Lane trip in order to save 35 minutes in traffic with results from the experimental choice tasks. Unfortunately, many subjects in these experiments seemed to misinterpret this question – some explicitly stating a monthly fee they would be willing to pay (they stated $20 per month as an example) and others reported dollar amounts that suggested that they had interpreted the question in this way). The range of responses was from $0 to $100. Even the median response, which is less sensitive to outliers, was $5 or $10 depending on the question that was asked, and so the responses to this question are not useful.

Participants did, however, seem to answer other questions in a reasonable manner. For example, for the questions about funding of transportation projects by a gasoline or mileage based tax, responses were in a reasonable range (compared with the survey results) and responded in a predictable manner to a change in tax rate. Responses to these two questions are summarized in Table 6.2.

Table 6.2
Responses to Survey Questions Regarding Support for Two Tax Options

Support for Gasoline Tax (Support or Strongly Support)

Tax Rate	Percentage Supporting
$0.22 per gallon	46.8%
$0.27 per gallon	25.5%
$0.37 per gallon	10.6%

Support for Vehicle Miles Travelled Tax (Support or Strongly Support)

Tax Rate	Percentage Supporting
1.35¢ per mile	46.8%
1.60¢ per mile	25.5%
2.10¢ per mile	8.5%

6.4 Summary

Overall, results across our three experimental tasks were very consistent – subjects showed a high degree of patience, and demonstrated a willingness to wait to receive payment – whether that payment involved a long wait (nine weeks compared to two weeks) or a relatively short wait (30 minutes compared to 15). Results are economically reasonable in the sense that as the cost of waiting increases, fewer participants are willing to wait to receive payment. Similarly, subjects respond in a predictable manner to questions about funding alternatives for transportation – the higher the cost of the option, the lower the level of support. Participants in lab experiments seemed largely indifferent between support for a gasoline tax compared with a vehicle miles travelled tax.

Given these results, there appears to be a very low willingness to pay for tolls to save time (or reduce uncertainty) about travel time. When asked to choose between receiving payment after waiting for 15 versus 30 minutes, fewer than half of the participants in the laboratory experiments were willing to pay even $1 to reduce waiting time by 15 minutes. This suggests that tolls would have to be very low – or time savings very high – to induce them to pay to travel in toll lanes.

These participants were even less likely to pay to reduce uncertainty about travel time. Two-thirds of all participants preferred an uncertain wait time (15 or 45 minutes) compared with paying only $1 to face a certain wait of 30 minutes. Thus, if the goal is to induce drivers to take advantage of managed lanes, the better strategy is to demonstrate time saved, as opposed to decreased uncertainty regarding travel time.

Of course the sample in this study was made up of college students, who likely have lower income than the general public. But the qualitative results are strong: participants are generally patient; however they are more willing to pay to avoid a certain delay than to reduce uncertainty about their waiting time.

APPENDIX 6.1

Task 1 – Long Term Time Preference

Decision	Option A (Pays $100 in 14 days)		Option B (Pays $100 in 63 days)		Preferred Option (Circle A or B)
	Winning Numbers for Option A	Chances of winning	Winning Numbers for Option B	Chances of winning	
1	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	A B
2	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 0 7.	50.07%	A B
3	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 1 3.	50.13%	A B
4	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 2 7.	50.27%	A B
5	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 4 0.	50.40%	A B
6	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 5 4.	50.54%	A B
7	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 6 8.	50.68%	A B

Appendix 6.1 continues next page…

APPENDIX 6.1 (continued)
Task 1 – Long Term Time Preference

Decision	Option A (Pays $100 in 14 days)		Option B (Pays $100 in 63 days)		Preferred Option (Circle A or B)
	Winning Numbers for Option A	Chances of winning	Winning Numbers for Option B	Chances of winning	
8	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 0 8 1.	50.81%	A B
9	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 1 0 9.	51.09%	A B
10	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 1 3 6.	51.36%	A B
11	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 1 7 1.	51.71%	A B
12	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 2 0 5.	52.05%	A B
13	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 2 7 6.	52.76%	A B
14	You receive $100 in 14 days if the # rolled is between 0 0 0 1 and 5 0 0 0.	50.00%	You receive $100 in 63 days if the # rolled is between 0 0 0 1 and 5 5 2 9.	55.29%	A B

APPENDIX 6.2
Task 2 – Short-Term Time Preference

Decision	Option A	Option B	Circle Your Choice
1	Receive $25 in 30 minutes	Receive $24 in 15 minutes	A B
2	Receive $25 in 30 minutes	Receive $23 in 15 minutes	A B
3	Receive $25 in 30 minutes	Receive $22 in 15 minutes	A B
4	Receive $25 in 30 minutes	Receive $21 in 15 minutes	A B
5	Receive $25 in 30 minutes	Receive $20 in 15 minutes	A B
6	Receive $25 in 30 minutes	Receive $19 in 15 minutes	A B
7	Receive $25 in 30 minutes	Receive $18 in 15 minutes	A B
8	Receive $25 in 30 minutes	Receive $17 in 15 minutes	A B
9	Receive $25 in 30 minutes	Receive $16 in 15 minutes	A B
10	Receive $25 in 30 minutes	Receive $15 in 15 minutes	A B

APPENDIX 6.3
Task 3 – Uncertain Wait Time

Decision	Option A	Option B	Circle Your Choice
1	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $24 in 30 minutes	A B
2	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $23 in 30 minutes	A B
3	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $22 in 30 minutes	A B
4	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $21 in 30 minutes	A B
5	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $20 in 30 minutes	A B
6	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $19 in 30minutes	A B
7	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $18 in 30 minutes	A B
8	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $17 in 30 minutes	A B
9	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $16 in 30 minutes	A B
10	Receive $25 in 15 minutes if die roll is 1-5 Receive $25 in 45 minutes if die roll is 6-10	Receive $15 in 30 minutes	A B

CHAPTER 7
CONCLUSIONS

A substantial number of revenue options for funding transportation are available. However, most of these options would provide only marginal increases in the current level of revenue. Furthermore, most of the available options would not provide incentives for individuals to alter their transportation behavior, that is, the options would not reduce the extent to which the transportation system is used or the use of the system during periods of congestion. Some options, for example, a dedicated sales tax, would generate substantial revenue but would have no effect on transportation behavior. Sales taxes, or any general fund revenue, also break the historic link between taxes (or fees) paid and the use of the transportation system.

Fuel taxes generate substantial revenue and are tied to the number of miles driven, and thus should reduce the extent to which drivers use the transportation system. However, there are several issues with the use of fuel taxes. First, because of increases in fuel efficiency the revenue generated per mile driven by a pennies-per-gallon fuel tax has decreased. Second, there is sizable citizen resistance to increasing fuel taxes. Third, because of differences in fuel efficiency across vehicles there is substantial variation across motorists in what is paid per mile driven. And, in the case of alternative energy vehicles, the tax paid could be zero. Third, although Florida allows local option fuel taxes, the ability to use local option fuel taxes is limited because the ability to purchase fuel in neighboring jurisdictions restricts the feasible tax rate differential across jurisdictions.

The revenue that tolls generate depends on the nature of the facility and the demand for particular facility. Because of improvements in technology, the use of tolls is now less costly and thus more feasible. Tolls should reduce the use of the facility relative to it usage if it were free. Tolls will also shift usage from the tolled facility to alternative, non-tolled facilities. Tolls can vary by time of day, which would encourage shifting between the period when the toll is higher to when it is lower. Generally, toll systems do not allow the toll to vary with the level of congestion, but HOT lanes are an exception. There is also support for toll, particularly to finance new facilities.

A vehicle miles traveled (VMT) tax has some advantages over the fuel tax. A VMT tax would equalize tax per mile driven since it would not be dependent on fuel efficiency, and the available technology would allow a VMT tax to vary with the level of congestion. The major concerns with a VMT relate to privacy issues, to how to build a national system for collecting the tax, and to the sizable initial cost. Furthermore, while there has been one demonstration project that proved successful, there remain concerns regarding the ability to fully implement such a tax. Finally, at this time there is a lack of voter understanding of how such a tax would work and, perhaps for that reason, a lack of voter support for such a tax.

A review of existing U.S. public opinion surveys highlights several overarching patterns of public opinion. First, it appears that tolls are the most favored alternative for transportation finance. This pattern is even more pronounced when tolls are explicitly compared to taxes in survey questions. Across the various surveys, fuel taxes are supported generally by only about 25 percent, although some surveys report 45 percent support. A second global finding is that approval is higher when the proposals are specific and respondents are provided additional information versus when they are asked general questions concerning their support for a funding source. This implies that context in which the tax revenue will be used is important in gaging public support for a transportation funding alternative. Some of the alternatives that have been developed more recently, such as HOT lanes, variable toll, managed lanes, and a VMT tax, are not very intuitive to respondents who have not been exposed to these alternatives, and that may impact the response for general questions about such revenue options. Third, respondents who are users (potential and current) of an option such as HOT lanes are more likely to support a particular option than nonusers. Also, many surveys find more public support when the revenues are linked to specific purposes related to transportation. Finally, many polls find general concern with fairness, and support depends on whether the public perceives an option as fair or unfair.

We were able to identify only a few surveys that asked how individuals would respond to increases in transportation taxes and fees such as fuel taxes, toll, and parking fees. Generally, respondents expressed the view that their responses would be sizable. For example, 56 percent of the respondents in one survey stated they would use public transit if gas prices reached $4 per gallon, while in another survey 20 percent of respondents said they would car pool in response to a parking fee.

There are two concerns regarding the use of surveys to illicit how individuals will respond to incentives from taxes and tolls. First, frequently, the size of the tax or fee is not stated. Second, and more important, is that individuals face no consequences from their responses. Thus, how individual would respond in reality could be very different from how they respond to a survey. Therefore, we also reviewed the rather sizable literature on empirical studies of how individuals respond to changes in transportation taxes or fees.

Generally, the research supports the economic theory that individuals do respond to changes in effective prices. These studies generally find that the respond to tax or fee increases are smaller than those implied by responses to surveys. In particular, the research suggests that the response is inelastic. This implies that increases in tax rates or fees will result in an increase in revenue. However, the size of the elasticity depends on the ability of the traveler to substitute away from the behavior that is being taxed. For example, an increase in a toll will elicit a very large response in the number of travelers using the tolled facility if there are several alternative non-tolled routes available.

To explore the issues of the level of public support for various transportation funding options and the likely response of drivers to increases in transportation taxes or fees, we conducted a survey of 2,000 Georgia drivers. The survey considered five alternative revenue sources: an increase in the state per-gallon gas tax, replacing the per-gallon gas tax with a per-mile tax (VMT), a new employee-parking lot tax, expansion of managed lanes, and expansion of toll roads. Respondents were asked about their level of support for each option in isolation and were asked to pick the more and less appealing options from among the list of options. The various alternatives were presented as hypothetical options and only in general terms. Thus, the survey results represent the public's general preferences but do not necessarily indicate actual support if options were presented on a ballot or with greater detail.

The results are consistent with the findings of the other opinion surveys from other states that we were able to identify. In particular, there is little support for an increase in fuel taxes. VMT taxes actually polled stronger, but with more undecided respondents. Support for parking fees was somewhat higher, but with a sizable percentage of respondents undecided. Toll roads were marginally supported. The principal implication is that before any of the proposed revenue options could be adopted, a substantial campaign would be necessary to overcome current opposition. The level of support for any revenue options did not vary much across the state.

Respondents to the survey suggested that they would substantially alter their transportation behavior in response to an increase in any of the taxes or tolls. For example, 61 percent said that an increase in fuel taxes would dramatically or moderately alter their behavior. Forty percent said they would carpool. These results imply that increases in these taxes or fees would have a substantial effect on the extent to which people drive. The stated responses are consistent with other surveys, but much higher than found in empirical studies.

The survey asked respondents what is the most they would be willing to pay in tolls to reduce trip time by 35 minutes for a 10 mile trip. This would be the reduction in time from driving 10 miles at about 13 miles per hour versus 60 miles per hour. Thirty-five percent of the respondents said they would pay no more than $1.00 to save 35 minutes, while 53 percent would pay no more than $3.00. A $3.00 toll is 30 cents per mile, and implies a value of time of $5.14 per hour. However, 30 percent were willing to pay a toll of at least $10.00, or $1.00 per mile. This suggests that if a highway is very congested, a large percentage of the drivers would shift to a managed lane even if the toll was $1.00 per mile.

While we took great care to frame the questions regarding how respondents might alter behavior as a result of increased taxes and fees, there is still the concern that surveys may not yield reported behavioral changes that correspond with actual behavior.

Furthermore, the statistical analysis of traveler behavior may not adequately control for other factors that might have altered behavior, and thus incorrectly measured the size of the effect of taxes and tolls on behavior. Thus, we conducted an experiment in a laboratory that allows us to control the environment in which decisions are being made yet confronts the subject with making choices that have real financial consequences for the participants.

The experiment attempted to elicit individuals' preferences between travelling a standard route to get to one's destination and paying a toll in order to arrive at one's destination in less time. Surveys questions use a lot of context. For example, survey respondents might be asked how various levels of gas taxes would affect their behavior. In the experiment, we used a more neutral context. Thus, instead of using the terms "toll" and "traffic," participants had to make a choice between receiving a sum of money after waiting for 30 minutes, and receiving a smaller sum of money after 15 minutes. This allows us to determine what a person would be willing to pay to save 15 minutes, which corresponds to a driver choosing whether to pay a toll in order to reduce travel time.

Often driving decisions don't involve a choice between two driving times that are known with certainty. Instead, when one makes a decision the person must choose between a relatively certain delay and an alternate route that may be faster or slower depending on a variety of factors. Thus, we also elicited the subjects' preferences toward reducing uncertainty about the time they had to wait to receive payment.

In the experiment in which subjects choose between waiting 30 minutes to receive payment rather than give up some money in order to reduce the wait time by 15 minutes, we found that the subjects were very patient. For example, almost 50 percent of subjects are willing to wait 30 minutes to receive payment rather than give up $1 in order to reduce the wait time by 15 minutes. Almost 94 percent of subjects would rather wait 30 minutes to receive payment rather than give up $6 of earnings.

The implication of the latter decision is that most individuals are not willing to pay much to avoid congestion. For example, suppose that the choice is between traveling 15 miles at 30 miles per hour or at 60 miles per hour. The former would take 30 minutes while the later would take 15 minutes. The experiment suggests that only 6 percent of drivers would pay at least 40 cents per mile to travel at 60 miles per hour rather than 30 miles per hour. These results suggest a much lower willingness to pay than what was reported in the survey.

We also investigated what individuals would be willing to pay to eliminate uncertainty about a short-term waiting time. For example, we found that about 60 percent of subjects prefer the option in which they receive $25 but have a 50-50 chance of waiting 15 or 45 minutes rather than give up $1 and receive $24 in a certain 30 minutes. Fewer than 20 percent of subjects are willing to give up $5 to eliminate the uncertainty associated with when they will be paid.

These results have implications for transportation systems. Suppose there are two routes to go from point A to point B, which are 15 miles apart. Assume Route 1 is free flowing at 30 miles per hour while Route 2 may be fast (60 miles per hour) half of the time or slow (20 miles per hour) half of the time depending on traffic; the expected travel time is the same for two routes. The results of the experiment suggest that about 20 percent of drivers would pay a toll of $5.00 (or 33 cents per mile) to use Route 1.

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