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16. Abstract

The Texas Department of Transportation is facing a severe shortfall in funds needed to address the state's growing transportation requirements. In response, the Texas Transportation Plan is exploring various funding alternatives, including toll roads. A statewide survey undertaken for this project reveals that toll roads are seen as an acceptable alternative to increasing motor fuel taxes. Adjusting the results to account for gender bias, the survey reveals that 61.7 percent of Texans favor toll roads over motor fuel tax increases to address transportation needs. Support for toll roads comes primarily from urban areas. Rural areas support toll roads over motor fuel tax increases, principally because residents oppose any increases in taxes. The survey results also indicate that a larger percentage, though not a majority, would accept tolls on existing non-tolled roads and the use of toll revenues for non-tolled roads. These findings have important implications for the development of a comprehensive toll road policy.

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TEXAS PUBLIC OPINION REGARDING TOLL ROADS

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Research Report 1322-1

Research Study 1322
"An Evaluation of the Status, Effectiveness, and
Future of Toll Roads in Texas"

conducted for the

Texas Department of Transportation

in cooperation with the

U.S. Department of Transportation
Federal Highway Administration

by the
Center for Transportation Research
Bureau of Engineering Research
The University of Texas at Austin

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IMPLEMENTATION STATEMENT

The Texas Transportation Plan has identified a number of action items related to the development of a statewide system of toll roads. As Texas moves in this direction, it is important to realize that Texas' experience with toll roads has been limited primarily to urban areas, where comparable alternate routes are available. Thus, rural areas and existing non-tolled highways have no experience with such systems. As a result, it is difficult to determine how Texans would respond to the development of a toll road network. This report presents the results of a statewide survey on Texas attitudes towards tolling. This information should assist policy makers and planners in developing effective strategies for toll road development. The survey clearly indicates that it is possible to develop support for tolling when clear transportation needs and benefits are identified.

Prepared in cooperation with the Texas Department of Transportation
and the U.S. Department of Transportation,
Federal Highway Administration

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented within. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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BIDDING, OR PERMIT PURPOSES

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PREFACE

The Texas Transportation Plan forecasts a 45 percent increase in vehicle miles of travel over the state highway system between 1995 and 2014. Alarmingly, the Texas Department of Transportation forecasts revenues sufficient to fund only 44 percent of the projects necessary to address this increase. This funding gap has forced the state to explore a variety of approaches to fund highways efficiently and economically. The result of this exploration has been a renewed interest in toll roads, not only as a source of new funds, but also as a method of promoting greater efficiency within the highway system. Thus, this report examines public attitudes towards tolling; Report 1322-2 summarizes electronic toll collection (ETC) methods; and Report 1322-3F identifies the issues that must be addressed in developing a comprehensive toll policy.

ABSTRACT

The Texas Department of Transportation is facing a severe shortage of funds to address growing transportation needs. *The Texas Transportation Plan* calls for a number of actions to explore various funding alternatives, including toll roads. A statewide survey has revealed that toll roads are seen as an acceptable alternative to increasing motor fuel taxes. Adjusting the results to account for gender bias, the survey reveals that 61.7 percent of Texans favor toll roads over motor fuel tax increases to address transportation needs. Support for toll roads comes primarily from urban areas. Rural areas support toll roads over motor fuel tax increases, principally because residents oppose any increases in taxes. The survey results also indicate that a larger percentage, though not a majority, would accept tolls on existing non-tolled roads, as well as the use of toll revenues for non-tolled roads. These findings have important implications for the development of a comprehensive toll road policy.

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SUMMARY

Texas must revise the old method of funding or develop a new source of funding to meet the growing list of transportation needs in the state. *The Texas Transportation Plan* reports a significant gap between transportation needs and available funds. To address this crisis, *The Texas Transportation Plan* outlines a number of strategies and policies, among them the development of a statewide network of toll roads. Central to this development is an assessment of the political feasibility, a marketing plan, an estimation of demand, and a consideration of network effects. Surveying Texas attitudes concerning toll roads can assist the Texas Department of Transportation (TxDOT) in addressing these issues.

The Center for Transportation Research conducted a comprehensive statewide survey of public attitudes towards tolling. The questionnaire presented the Texas funding dilemma to the respondents and asked whether the funding gap should be addressed by using toll roads or increasing motor fuel taxes. Additionally, the survey explored in great detail the factors leading to this decision. The results are somewhat surprising.

Nearly 40 percent of the 6,011 surveyed households responded, a figure that enhances the statistical validity of the results. The researchers were able to adjust results to account for geographical and gender bias. With great confidence, the researchers are able to present the findings of the survey. Importantly, however, the survey method is a stated preference, which does not always accurately measure how persons will actually respond. Nevertheless, the survey results do gauge how the public feels about tolling, which is essential to the development of an effective toll road policy.

Adjusting for gender bias, overall, 61.7 percent of Texans favor toll roads over increases in motor fuel taxes. This support holds for both urban and rural areas. However, urban areas tend to support toll roads because they more accurately relate transportation costs to transportation use. Rural areas, on the other hand, tend to support toll roads over motor fuel tax increases because residents oppose "any" increases in motor fuel taxes. The rural perspective represents more of a protest vote, rather than an affirmative statement in support of a statewide system of toll roads.

CHAPTER 1: BACKGROUND AND OBJECTIVES

INTRODUCTION

The Texas Transportation Plan forecasts a 45 percent increase in vehicle miles of travel over the state highway system between 1995 and 2014. This is particularly alarming when one realizes that the Texas Department of Transportation (TxDOT) has only 44 percent of the funds necessary to support the transportation improvements aimed at meeting this growing demand. Texas is faced with significant increases in congestion costs, lost productivity, higher vehicle operating costs, and ever-worsening air quality. Unquestionably, Texas is faced with a crisis in addressing its highway transportation needs.

In order to meet these transportation needs, new financial resources are required. Unfortunately, in terms of dollars per vehicle mile traveled (VMT), state and federal transportation budgets have been shrinking for the past two decades. Constant dollar transportation expenditures have dropped by more than half since 1960 (Ref 1). At the state and local levels, "traditional" sources of transportation funding such as fuel taxes and vehicle registration fees are being redirected to fund non-transportation-related programs like schools and social services (Ref 2). In Texas, for example, nearly one-half of all highway transportation-related taxes and fees are used for non-transportation purposes (Ref 3). This funding situation is exacerbated by non-transportation federal funding priorities and budget deficit reduction efforts. The most important example can be found in ISTEA, which has changed the federal/state intergovernmental relationship, placing the onus of meeting transportation needs squarely on the states (Ref 4).

With transportation needs outpacing available funds from traditional transportation funding sources, state and local governments are searching in ever-increasing numbers for new transportation funding sources. The age-old toll road is making a comeback as one of these "new" funding sources. The popularization of toll financing was observed as early as 1988 in an study sponsored by *The Urban Transportation Monitor*. Eighty percent of the transportation professionals surveyed indicated that they were "either actively planning toll roads or would be doing so in the foreseeable future" (Ref 5). These words have been backed up with State and private sector action around the country. California, Colorado, Florida, Georgia, and Virginia have all begun the construction or operation of toll facilities in the past three years (Ref 6). The federal government is assisting in this effort by funding up to 50 percent of non-interstate system toll road construction, rehabilitation, and feasibility assessment through the States' annual apportionments from the Federal Highway Trust Fund.

Like many other states, Texas has been active in exploring new toll road opportunities. *The Texas Transportation Plan* calls for a number of toll-related actions. Toll roads are specifically mentioned in the following action items:

- •Action 9.1.3 - Conduct a study, including a benefit-cost analysis, of the feasibility and potential impact of creating a statewide system of toll roads and of selling existing toll facilities to private investors, and develop a statewide toll facility plan.
- •Action 24.1.2 - Develop a statewide toll road and bridge system and back bonds with system-wide toll revenues rather than project-level revenues.
- •Action 24.1.3 - Optimize and expand the use of public-private partnerships and require an evaluation of the potential for such partnerships for each turnpike or toll bridge development project.
- •Action 25.1.1 - Develop public-private partnerships and toll financing at the state level for international and NAFTA-related projects (Ref 7).

At this time, tolls are being considered as a funding mechanism for at least four highway projects. Three of these facilities would provide users with the ability to bypass congested links. The Camino Columbia would link the Camino Columbia International Bridge west of Laredo with IH-35; the Trinity Parkway and Santa Fe Bypass would provide an outer bypass around southeastern Dallas; the Mo-Kan Expressway would provide a high-speed bypass east of Austin. The fourth facility under consideration would provide an Interstate class highway connecting IH-10 at Abilene with IH-44 in Wichita Falls. These facilities are in addition to the three toll highways already operating in the State. These roads, totaling 63.8 miles in length, all serve heavily urbanized areas. Two of the facilities, the Hardy Street Toll Road and the Dallas North Tollway, provide alternative radial routes to heavily congested non-tolled highway links in Houston and Dallas respectively. The third facility, the Sam Houston Tollway, provides an outer loop that allows traffic to bypass congested highways leading into the Houston central business district (CBD). It is important to note the Dallas North Tollway recently underwent a 4.9-mile, $168 million dollar extension, and a 29.5-mile extension is planned for the Sam Houston Toll Road. Based on Texas' relatively limited experience with tolling and new federal support, new funding opportunities offered by highway tolls must be seriously explored.

As Texas moves forward with a toll financing program, it is important to realize the limitations of the Texas tolling experience. Tolls have been used to fund facilities only in urban areas where comparable (Interstate class) alternate routes are available. Tolls have not been imposed on rural areas, nor have they been imposed on existing non-tolled highways in urban areas. In addition, tolling policy has never been used to address societal goals such as trip reduction through congestion pricing. As a result, comparatively little is known about how Texans will respond to the increasing use of tolls on highways, especially in the contexts described above.

This lack of knowledge raises critical questions of how users as well as the general public would accept the expanded use of toll facilities in Texas. From the facility operator's standpoint, whether a public agency or a private concessionaire, knowing how potential road users perceive being tolled is essential in determining what types of toll facilities (rural vs. urban, existing vs. new, etc.) would be most viable in the Texas market. In addition, knowing these perceptions allows the operator to determine the market segments that are most likely to use the facility. If data concerning potential users' price sensitivity is determined as well, such data can be extrapolated into rough estimates of usage, which is itself a predictor of financial feasibility. From the standpoint of a policy maker, knowing the general public's attitudes and feelings about toll roads will enable him/her to identify potential political obstacles to toll road implementation and to design policy accordingly.

REPORT OBJECTIVES

With the value of toll financing thus established, attention is turned towards the public and political acceptability issues that will, by and large, dictate the feasibility of adopting widespread highway tolling. The following chapter begins by addressing the relationship between public acceptability and toll road feasibility. Next, Chapter 3 presents a stated preference survey instrument designed to: (1) determine the general toll facility operational and institutional arrangements that would be most palatable to Texas citizens and (2) analyze how Texans' value three likely toll road benefits. This information can help enable state policy makers to market toll facilities efficiently.

Chapter 4 analyzes the sampling validity of the survey responses. Chapter 5 presents the general survey results concerning Texas attitudes towards tolling. Chapter 6 provides important information concerning valuation of toll road benefits which is important in examining and predicting toll road utilization. Finally, this report is concluded in Chapter 7.

CHAPTER 2: PUBLIC ATTITUDES AND TOLL ROAD FEASIBILITY

The attitudes and feelings held by individuals play key roles in determining individuals' behavior. This section defines four broad areas in which survey data can prove useful in assessing and enhancing toll road feasibility. These four areas are (1) political feasibility assessment, (2) marketing plan development, (3) demand/usage model determination, and (4) network effects prediction. This particular study focuses primarily on the first two areas and attempts to develop preliminary conclusions about the third area. It is hoped that the progress made in these three areas will lead to further exploration of network effects resulting from addition of toll links to a transportation system. With this disclaimer stated, attention can be turned to the four areas themselves.

POLITICAL FEASIBILITY ASSESSMENT

Imposing any new type of user charging mechanism on highways is inevitably a highly charged political exercise. A cursory examination of Texas legislation reveals that Texas is no exception to this rule. As recently as 1991, the Texas legislature intensely debated the authorization of private toll road corporations. House Bill 749, passed in 1991, repealed earlier acts which authorized the foundation of independent, private highway corporations--which would be, in most cases, private toll road providers. In addition, the Texas Turnpike Authority (TTA), the State organization charged with administration of all State toll facilities, has been scheduled for "sunset" in 1998. Current plans are for TTA to be folded into the Texas Department of Transportation (TxDOT).

At the same time as the legislature seems to be shying away from toll roads, fiscal realities are forcing both county highway departments and TxDOT to consider expanding the use of tolls. The rift separating legislative priorities and financial realities threatens to undermine the extensive road network the state has constructed and threatens to grow larger if corrective action is not taken. To this end, a survey of popular opinion regarding expanded toll use can prove extremely valuable. Such a survey will be able to provide factual evidence about whether or not tolls are an acceptable highway funding option. In addition, an exploration of public attitudes concerning different toll road operational and institutional arrangements can identify politically acceptable implementation strategies.

MARKETING PLAN DEVELOPMENT

Obtaining toll facility marketing information is closely related to the assessment of political feasibility. Rather than pursuing the goal of "selling" toll roads to policy makers, however, market-related survey information seeks to identify the most efficient ways to sell toll roads to potential users. Marketers have traditionally used surveys to judge product characteristics that are most important to consumers. In transportation, market data has been collected to determine markets for programs as varied as traffic demand management (TDM), telecommuting, and high speed rail. (For information on the TDM market research, refer to Koppleman et al. Mahmassani et al. examined the factors influencing the telecommuting market. Gunn et al. present survey-based research on market projections for high speed rail services.)

At the heart of all of these studies is the concept that the user of any transportation service (or non-service in the case of telecommuting) makes a choice whether or not to utilize the service on the basis of cost, service characteristics, socioeconomic factors, and attitudes.

Toll roads, which represent an additional transportation choice, should also be judged, at least partially, on the basis of consumer response to the choice. Consumer response, as well as the toll choice itself, can be examined in a number of ways, but in all cases reflects the essential question, "Why would drivers choose to use a toll road?" Underlying this choice is the fact that, in comparison to non-tolled facilities, toll roads impose an additional cost on users. Assuming that drivers are utility maximizers, toll road users must derive some benefit from toll road use that justifies paying the additional fee. Otherwise, toll road users would be considered irrational. This observation implies that the best way to examine potential toll road markets is to focus on the possible benefits that toll roads can provide to users.

Some examples of toll road benefits are: (1) reductions in travel time due to more direct routing, reductions in congestion, or grade-separation; (2) improvements to road maintenance and safety due to the additional funds available from tolls; and (3) reductions in travel time variance due to improved incident detection, reduction in congestion, and grade separation. Examining the way in which these benefits are perceived by potential toll road users is critical to assessing the market penetration achievable by toll facilities. Survey methods provide an ideal way to obtain this benefit valuation data.

DETERMINING DEMAND/USAGE MODELS

The revenue generation potential and corresponding profitability of toll facilities is of critical importance to toll road developers and operators. The revenue generated by a toll facility is directly proportional to the amount of traffic utilizing the toll facility. Thus, to assess the financial feasibility of a toll project, it is critical that accurate forecasts of toll facility traffic demand are available. Individual route choice behavior collected via survey instruments can provide some insight into these demand forecasts (Ref 8). In addition, the analysis of survey-provided data can provide estimates of how much route characteristics affect users' route choice decisions. Such analysis can prove a valuable tool for enhancing the attractiveness of toll facilities to potential users. By "understanding the customer's needs, attitudes, and perceptions and taking them into account," toll operators can maximize their revenue potential by maximizing customer demand for their services (Ref 9). Thus, the use of survey data to determine facility demand circles back to the marketing of toll road benefits.

PREDICTING NETWORK EFFECTS

From the transportation analyst's perspective, a key goal of toll road demand forecasts is to assess the effect that new or converted toll facilities will have on the transportation network as a whole. The need for such assessment is driven by the goal of mobility improvement that underlies the addition of any transportation service to a network. Survey data about the demand for toll facilities can aid the analyst in answering questions such as "Will the toll road help or worsen congestion in other parts of the network?"

From a system perspective, such questions become particularly important as highway agencies consider placing tolls on non-tolled highways or raising tolls on toll facilities. Such changes to road pricing structures and the resulting traffic diversion can seriously affect demand patterns throughout the rest of the highway network. For example, assume that a $1.00 toll was imposed on an eight-lane freeway through a metropolitan area. Furthermore, assume that the previously non-tolled road carried 2,000 vehicles per lane per hour during peak periods. Finally, assume that drivers, on average, currently pay $0.50 per trip in operating costs. If only a mere 5 percent of the drivers are priced off of the road (implying a linear arc price elasticity of -0.025), 800 trips per hour would have to be foregone or absorbed by other parts of the network. (Average linear arc price elasticity has been defined as $(\Delta X/X)/(\Delta V/V)$ where X is trip demand and V is the cost of travel.) Survey data can help in assessing users' price sensitivities, providing some insight into the network effects of tolling strategies.

CHAPTER 3: SURVEY DESIGN AND GOALS

To determine how the public will react to the expanding use of tolls on Texas highways, a stated preference (SP) survey instrument has been designed with two goals in mind: (1) to determine the general operational and institutional arrangements that would be most palatable to Texas citizens, and (2) to analyze how Texans value three likely toll road benefits. This information will allow state policy makers to market toll facilities efficiently and will also provide preliminary estimates of toll facility feasibility in several areas of the State. This chapter presents the goals and design of this SP survey.

This chapter begins by explaining the need to utilize a SP approach and by exploring some of the limitations of the SP approach. This discussion is followed by some comments on survey data validity that are especially important in a SP context. Next, the survey's goals are enumerated and potential implementation strategies are evaluated. The design of the survey instrument itself is then described. This chapter concludes with a consideration of survey sampling and implementation details.

THE STATED PREFERENCE FRAMEWORK

Survey data can be classified into two distinct categories, (1) revealed preference (RP) data, and (2) SP data. RP data can be obtained only after choices are made in the real world. Thus, RP data truly reflects choice behavior because it relies on choices and decisions that have actually been made in the marketplace. SP techniques, on the other hand, rely on obtaining choice behavior in response to hypothetical situations. SP methods are "a family of techniques which use individual respondents' statements about their preferences in a set of transport options to estimate utility functions" (Ref 10). These utility functions' specifications can be used to predict demand levels for transportation services under potential operating conditions.

In addition to the demand predictions that can be made on the basis of estimated utility functions, SP data can also be used to determine the public's willingness to pay for potential public goods. Such an approach has important applications in a toll road context. As mentioned above, toll facilities must provide users with tangible incentives before users will consider toll facilities as an alternative to non-tolled routes. From a marketing standpoint, willingness-to-pay data can be used to determine which incentives would be most attractive to consumers. In addition, such data can also be used to calculate a value for user benefits that can subsequently be used to determine aggregate toll facility benefits.

From the standpoint of data validity, RP data is preferable to SP data for the simple reason that RP data is directly connected to actual choice behavior. Despite this fact, RP techniques are confronted by some significant methodological problems. As Bates states:

> There are practical limitations [on RP techniques], largely connected with survey costs and the difficulty of distinguishing the effect of attributes which for many reasons are hardly "traded" in the marketplace. Very often, these attributes relate to notions like quality or convenience.

This sentiment is echoed by Kroes and Sheldon, who note the following disadvantages to RP studies:

- Difficulty in obtaining sufficient variation in RP data to examine all variables of interest.
- The existence of strong correlations among measurable explanatory variables.
- The requirement that explanatory variables be objectively measurable.
- The inability of RP methods to address conditions that are not presently in existence.

For this study's purposes, the last two points are most important. Texas' toll road experiences are limited to three facilities in two urban areas. Perceptions of rural toll facilities as well as non-traditional implementation schemes such as imposing tolls on non-tolled roads are not known. In other words, this study is concerned with "addressing conditions that are not presently in existence." In addition, there are explanatory variables such as maintenance and safety that may not have objective measures that would be understood or measured by survey respondents. (Note that some attempts have been made to quantify maintenance levels, but these measures often rely on characteristics unobservable or unmeasurable by the road user. An example of such a measure is crack density.) On the basis of these factors, an SP approach is required for this study.

Before addressing the design of the SP instrument, some comments must be made about some methodological problems confronting an SP approach. The significant disadvantage to SP methods is that individuals' stated preferences may not be indicative of their true choice behavior. Wardman enumerates the following two reasons why SP behavior differs from RP behavior: "[SP and RP behaviors] may diverge because of systematic bias in SP responses or because of the difficulty in carrying out the SP task" (Ref 11). Although Wardman's observation that the effect of this divergence may be less serious because its effects are of a random nature, it remains important to consider possible sources of systematic bias as well as whether or not SP instruments can be designed to yield valid preference data.

In terms of systematic bias, respondents to SP surveys tend to overstate their responses under hypothetical situations (Ref 10). In a toll road context, this phenomenon would manifest itself as respondents' overstatement of their willingness to pay for toll road benefits. The biasing effect of this overstatement can be countered by relying on relative valuation of toll road benefits and utility functions, rather than on absolute valuations. (Relative utility weights would be estimated as $\beta(x_{2m}-x_{1m})$ where β is the "relative utility weight" and x_{1m} and x_{2m} are the values of the m^{th} attribute for the first and second "choices" in the choice set. By contrast, absolute utility weights would evolve from the following formulation: βx_{1m}). Thus, utility functions estimated from SP data should rely on the differences in attribute levels among alternatives in the choice set, rather than relying solely on the values of attribute levels themselves. Similarly, the benefits to be valued should take relative forms such as time *savings*, travel time reliability *improvements*, etc.

Additional problems can be caused by what Mitchell and Carson term "strategic bias" (Ref 12). This occurs when respondents deliberately shape their answers to influence the study's outcome or conclusions. In the toll road context, it is likely that individuals who feel a certain way about whether or not tolls should be used more widely in Texas will taint with this preference any valuation of toll road benefits. Individuals who prefer highway tolling will tend to overstate the value of toll benefits, and those opposed to tolls will understate the value of benefits. Complicating the situation further is the fact that negative perceptions affect valuation levels much more considerably than positive perceptions (Ref 12). Protest responses indicating that respondents will not pay to use a toll facility under any circumstance probably belie the users' true route choice/benefit valuation behavior. Thus, steps must be taken to exclude or correct for protest voters in the study's sample. These steps include the exclusion of protest responses altogether.

RESPONSE VALIDITY

One of the most important concerns during the questionnaire design process was the generation of valid and reliable data. Consideration of the validity issues associated with SP methods has already been discussed. This section focuses instead on general methods that can be used to insure the validity of any survey instrument. Wentland and Smith recently published the results of an extensive study that examined the validity of survey responses. The researchers report that there are three broad causes of response error in survey contexts. The first of these, inaccessibility of the information to the respondent, refers to the inability of respondents to recall and report behavior accurately. As Wentland states, "a respondent simply may not have the requested information or be unable to remember it, particularly if the recall period is long and if the behavior or event in question was not significant to the respondent" (Ref 13). The frequency, significance, and "currentness" of events are the primary factors influencing informational inaccessibility.

Problems of communication, the second cause, refers to the inability of questions to convey meaningful information to respondents. This cause is particularly insidious because "it is likely that respondents do not wish to appear uninformed, uncooperative, or unable to supply information. Therefore, responses will probably be provided without requests for clarification" (Ref 14). The final source, motivational factors, deals with the respondents' perceived value of the information requested. If the value of the information is not perceived by respondents, survey responses will tend to be inaccurate, if they are provided at all.

Several methods can be used to minimize the response error effects described above. The provision of contextual cues, reliance on common behavior patterns, and the ability of the questionnaire to establish a "rapport" with the respondents are all cited as factors that can reduce response error. Avoiding sensitive questions (such as detailed income information), obtaining respondent commitment to the survey, and reducing the amount of specificity required by questions will also reduce response error. A final conclusion reported by Wentland is that binary response questions elicit more accurate data than questions that have more than two response categories. In fact, response validity is inversely proportional to the number of response categories. A possible explanation for this finding is that the informational requirements needed to distinguish among scale alternatives are much greater than those necessary to make a binary decision. However, such a realization also requires the recognition that questions with multiple response categories, such as ordinal scales, provide much richer data for analysis. Thus, there is a tradeoff between response validity and information "richness" when designing the survey instrument.

With the above observations in mind, several measures were undertaken to ensure that valid data was obtained from the survey instrument. First, the questionnaire was kept as short as possible without losing useful information. Second, attitude questions were posed in a binary format wherever possible to heighten the validity of the responses. Considerable pre-testing, both in the form of formal mail-outs and as informal interviews, was undertaken to establish that respondents could comprehend and answer the survey questions. Finally, a conscious effort was undertaken to establish a rapport with the respondents through survey and cover letter language. The specific ways in which these tasks were performed is reported in the question design sections below.

COMPARISON OF IMPLEMENTATION STRATEGIES

Conventional survey design literature lists three ways SP surveys can be implemented: face-to-face interviews, phone interviews, and mail questionnaires. (Dillman's seminal work examines the issues related to the implementation of phone and mail surveys. The more classical face-to-face approach, along with a more general coverage of phone and mail methods, is covered in Fowler's text.) The amount of resources available to the project team coupled with the statewide focus of the survey goals eliminated the face-to-face approach. After this initial conclusion, however, both the phone and mail options seemed feasible. Phone administration of the questionnaire offered the significant benefit of interviewer/respondent interaction and high potential response rates (after valid phone numbers had been reached), but had the disadvantage of requiring large amounts of implementation time. In contrast, the time and effort required to implement a mail survey was minimal compared to the phone option. However, because the mail survey lacked any interviewer/respondent interaction until after survey completion, the design and testing of a mail survey instrument needed to be more rigorous and robust. Additionally, the mail option was confronted by a serious and endemic problem of non-response bias that can be difficult to correct (Ref 12).

A priori, implementing the toll financing study as a phone survey was appealing. A pilot study was conducted in Austin, Texas, to determine the feasibility of implementing the survey on a statewide basis. A random sample of Austin residents was selected from the local telephone directory. Because respondents' attention spans during a phone interview were thought to be short, a simple twelve-question survey instrument was used. A sample of the pilot phone questionnaire can be found in Appendix A. In addition to identifying numerous problems related to respondents' comprehension of the questions, a high level of non-response was encountered. (For the purposes of this analysis, there were several types of activities that were deemed "non-response," respondent refusal and no answers being the obvious cases. However, because of resource constraints, phone calls that contacted Spanish speakers or encountered busy signals were also deemed "non-response," as were no answers, disconnected numbers, and outright refusals.) To compensate for this unexpectedly high non-response rate--which was about 80 percent overall--replacement strategies were used to achieve the desired sample size. In the end, 158 individuals were surveyed. The pilot survey demonstrated that: (1) conducting a statewide telephone survey without specialized equipment and additional personnel would be unfeasible, and (2) the survey instrument itself required considerable reworking.

As a result of the pilot phone survey experience, the mail survey format was selected for the study. Implementing the toll financing study as a mail survey yielded several advantages. First, random population samples of addresses were readily available from several commercial providers. In addition, since less time is required to implement the survey (once the survey instrument is designed), more time can be spent on data analysis. Third, the mail format allows questions with long or complex response categories to be posed and batteries of similar questions to be asked (Ref 14). Finally, validity problems associated with recall time--the amount of time required for respondents to remember information--are eliminated because the survey is self-administered without a perceived time limit for response (Ref 13). Despite these advantages, anticipated low mail survey response rates remained a significant disadvantage.

SURVEY GOALS

First, the survey seeks to determine the institutional and operational arrangements under which highway tolling is acceptable to the public. Next, the survey elicits respondents' willingness to pay for possible toll road benefits. As stated above, this data will enable toll operators to market toll facilities more effectively and allow policy makers to identify conditions under which toll roads are considered a feasible transportation alternative to non-tolled roads. Finally, survey data will be utilized to estimate potential user demand for toll facilities under varied operating conditions.

To achieve these goals, the survey instrument must obtain (1) respondents' attitudes concerning toll facilities and Texas' road system; (2) respondents' past and present experiences with the Texas highway system; (3) respondents' valuation, in terms of acceptable toll levels, of hypothetical toll facilities; and (4) respondents' socioeconomic and geographic characteristics. Figure 3-1 illustrates the conceptual relationship of this data to the survey goals. As can be seen from the diagram, past experience influences both current behavior and attitudes. In turn, attitudes and current behavior, coupled with socioeconomic and geographic characteristics, affect individuals' perceptions of toll roads. These perceptions determine the public acceptability of tolling in general and individuals' willingness to pay in specific.

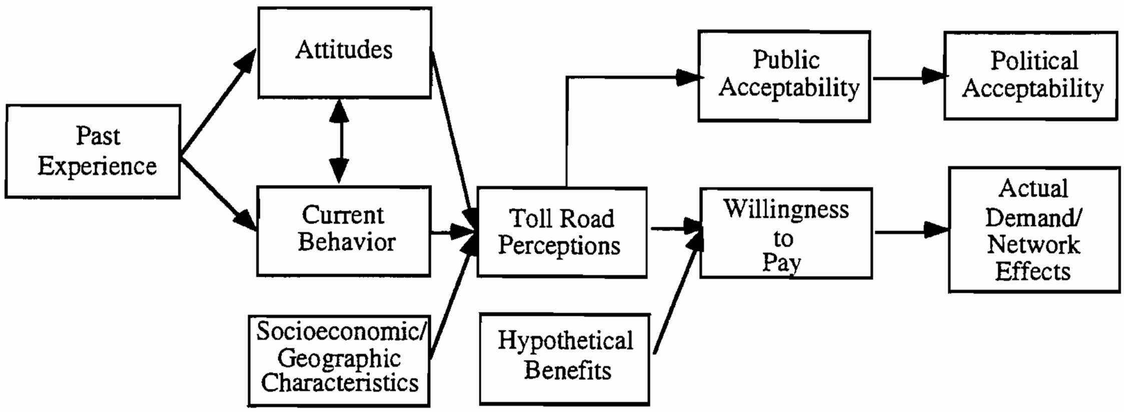

Figure 3-1: Conceptual Framework of Toll Financing Study

Based on this conceptual framework, the survey instrument is divided into four parts. The first section of the survey, Section A, focuses on obtaining the public's general perception of highway tolling as an alternative highway funding source. In addition, Section A measures the public acceptance of various institutional and operational schemes under which highway tolling could be utilized in Texas. Section B obtains information about individuals' current trip-making characteristics, as well as individuals' past experience with toll facilities in Texas. Section C forms the backbone of the survey instrument's benefit valuation data collection effort. In this section, respondents are asked to select the highest toll they are willing to pay to use hypothetical toll facilities. The data collected from Section C will also be used to make inferences about respondents' choice behavior. The implicit choices indicated by Section C are critical to modeling the disaggregate toll facility demand. Finally, Section D obtains socioeconomic data critical to modeling respondent behavior and assessing the survey sample validity. The mail survey questionnaire is shown in Appendix B. With the overview of the survey instrument thus presented, attention is turned to the design of the four survey sections.

OPERATIONAL/INSTITUTIONAL ARRANGEMENTS SECTION (SECTION A)

Section A begins with two questions designed to gauge respondents' current perceptions of Texas' highway system. By asking how well the current highway system meets their needs, Question A1 directs respondents' thoughts toward a rational evaluation of Texas roads. In addition to providing this cognitive cue, the first question elicits a possible explanatory variable. It is expected that the better the current highway system is rated, the lower acceptance of toll facilities would be. Question A2 is also intended to provide respondents with a cognitive cue, and, in addition, provides a basis for data segmentation.

Beginning with Question A3, the questionnaire addresses the expanded use of tolls directly. In this question, individuals indicate their highway funding source preference--either increased fuel taxes or expanded tolling. The choice set is limited to these two funding sources for four primary reasons. First, experience has shown that both sources can provide sufficient funding for large-scale, interstate-class facilities. Second, fuel taxes and tolls are relatively easy for respondents to understand. Third, both fuel taxes and tolls represent user fees and are therefore directly comparable. Funding sources such as general sales taxes, property taxes, or lotteries--which are not tied to highway usage- lack this element of comparability. Finally, as was noted above, binary response categories enhance response validity enabling more reliable conclusions to be drawn.

To further illuminate funding source preferences, the respondents are asked to list the reason for their preference. The data collected by the two "reason" questions, A4 and A5, spotlight specific user-perceived strengths and weaknesses of tolling. The identification of such reasons can aid in the marketing and design of toll facilities. The response, "I don't want to stop to pay the toll," illustrates this point. Large numbers of responses in this category would indicate the potential for electronic toll collection (ETC) to influence toll road acceptance.

The final three questions ask respondents to evaluate three different toll road operational policies. Questions similar to these have been used by Colorado and Ohio to determine publicly acceptable tolling policies in those states (Refs 15 and 16). As stated previously, public acceptance is a key determinant of political acceptability. Question A6 concerns the acceptability of congestion pricing, phrased in this survey as a peak period pricing scheme, as a general policy. This issue is extremely important to realizing the travel time savings and travel time reliability improvements proposed by Section C, especially in urban contexts. Question A7 involves the public's acceptance of imposing tolls on existing non-tolled highways to pay for the maintenance and upgrade of these facilities. Considering that Texas' network of interstate-class facilities is largely already in place as non-tolled highways, the responses to this question will determine the systemwide applicability of tolling. Finally, Question A8 examines whether or not Texans want toll generated revenues to subsidize non-tolled facilities. This last issue addresses the sufficiency and equity of toll financing for the transportation system as a whole.

CURRENT BEHAVIOR/PAST EXPERIENCE SECTION (SECTION B)

Section B, as mentioned above, captures current travel behavior which could be used to predict an individual's propensity to accept tolling. Thus, the design of Section B focuses on trip characteristics that could be closely associated with: (1) trip value, (2) current travel conditions, (3) current toll road experience, and (4) geographic factors. Before these factors can be addressed, however, a standard basis defining a trip needs to be defined. In the interests of enhancing respondents' comprehension and recall of their travel behavior, all of the questions in Section B reference the respondents' "most frequent trip" defined as "the regular route traveled during your most typical activities." This general approach is mandated by the heterogeneous nature of the statewide sample. In such a sample, asking individuals about trips with reference to pre-conceived trip purposes such as home-to-work would result in poor-quality data.

With the concept of the "most frequent trip" thus defined, respondents are asked about their trip purpose, mode of travel, frequency, length, and average travel time (Questions B1-B5). These trip characteristics are hypothesized to have great influence over toll road valuation. For example, common sense indicates that individuals making a 45-minute commute to work, 5 days a week, would tend to value more highly a toll road that saves 15 minutes in travel time than would individuals whose most frequent trip is a 15-minute trip to the grocery store once a week.

The questionnaire then asks the respondents to rate the maintenance and congestion levels on the roads they use to make their trip. Additionally, an objective measure of congestion is elicited by asking respondents how often their travel time exceeds their average reported travel time due to traffic flow problems. These questions (B6-B8) are asked to identify benefits individuals currently receive from the highway system. Like trip characteristics, these route conditions are assumed to be strong toll facility valuation indicators.

Geographic factors also have the potential to influence toll road preference and benefit perception. Rural households might value road maintenance more than travel time, whereas urban dwellers facing long congested commutes may do the opposite. Individuals' home location is only half the story, however. To accurately classify individuals' trip types, both home and destination locations must be known. Question B9 attempts to arrive at such a classification.

A final trip-related explanatory variable involves the functional classification of the roads individuals use during their most frequent trip. There are several reasons for this assumption. The choice of a facility type is closely linked to a trip's length and purpose. As stated above, these factors can be important determinants of toll road acceptance and benefit valuation. One would expect current toll road users to make the most rational valuations of possible toll road benefits, followed by users of interstate-class freeways. It is hypothesized that the less exposure an individual has had to high-volume expressways, the less likely he/she will be to accept possible toll road benefits. Of course, this hypothesis may be in error; individuals with extensive negative toll experiences may refuse to accept toll road benefits. In either case, however, cause and effect is indicated. Thus, respondents are asked to estimate the frequency with which they use four broad functional classes of roads (Question B10). Since toll road experiences have the greatest potential to influence respondents' perceptions, Questions B11 through B16 ask for detailed information concerning frequent toll users' experiences. Before concluding this section, it is important to note that the data collected in Section B of the questionnaire will be used to segment the Section A responses. Thus, hypotheses such as "Frequent toll road users support tolling more than infrequent users" can be tested.

BENEFIT VALUATION SECTION (SECTION C)

In designing Section C, the first task was to select benefits around which hypothetical toll facilities would be designed. As stated above, rational decision makers must derive some increased utility from these benefits before they will pay an additional amount to use a toll road. Toll roads have the capability to provide several benefits--more direct routing, higher speeds, better road quality, and more frequent service/rest areas, to name a few. However, fully enumerating possible toll facility benefits in terms of hypothetical situations would be impossible due to the extremely large number of situations that would be required. As Kroes and Sheldon state, "respondents can only evaluate a fairly limited number of alternatives at a time" (Ref 10). Thus, Section C was designed around three benefits: (1) improved maintenance, (2) reduced travel time, and (3) improved travel time reliability.

These three benefits have been found to be significant determinants of route choice in other SP studies (Refs 8 and 17). In addition, these three benefits were found to be positively valued by pre-test respondents. A final reason for the choice of these three benefits was that all three benefits have the potential to be realized on tolled facilities. Travel time improvements can be realized either by providing more direct routes or by reducing congestion through congestion pricing strategies. Likewise, toll-related congestion reduction can result in improved travel time reliability. Technological improvements that reduce the time needed to detect and clear incidents can also improve travel time reliability. These improvements are likely to be offered on toll facilities because they improve the throughput and therefore the profitability of high-volume toll roads. Finally, the additional funds highway tolling can generate can be used to improve facility maintenance.

To determine the range of variation for these three benefit attributes, control conditions had to be designed. In this way, benefit valuation data could be collected relative to the control conditions. As stated above, such relative valuation is essential to the validity of SP data. The specification of this control condition dictates the design of the hypothetical benefit situations. Therefore, to get high-quality valuation data, it was extremely important that the control condition be "realistic and relevant to individual respondents" (Ref 18). Meeting this goal was complicated both by the study's heterogeneous sample and the mail survey format. The heterogeneous sample implied that realistic and relevant travel situations would vary considerably across the sample. The mail format meant that hypothetical situations could not be adapted to the respondents' experiences and thus reflect the sample's variance. With these constraints in mind, the following control conditions were used:

Control Conditions	
Trip Distance	**15 miles**
Average Trip Time	**30 minutes**
Maximum Trip Time	**50 minutes**

The maximum trip time was indicated to set a control condition for travel time reliability. This was due to the operationalization of travel time reliability as the maximum travel time experienced on a route. According to Prashker, there are many possible dimensions to travel time reliability including maximum delay length, average delay, and delay frequency. In this study, however, average delays are captured by the "average travel time" of 30 minutes in the control conditions. The survey pre-tested both measures of delay frequency and delay length and found that the presentation of both factors proved confusing to respondents. Delay length was ultimately chosen because the author believed delay length reductions would be a more achievable benefit than delay frequency reductions.

Maintenance levels were not explicitly stated as a control condition because maintenance benefits were operationalized in relative terms rather than absolute terms.

Respondent valuation of the three benefits is obtained by asking respondents the maximum toll they would pay for the benefit level proposed by the scenario. In this way, benefit valuation data is measured directly. Binary discrete choice data concerning toll road usage can be inferred from this direct valuation data. This can be accomplished by "exploding" the valuation data, which is in essence an ordinal scale, into a set of use/not use decisions. For example, if an individual indicates the highest toll he/she will pay for a 15-minute time savings is $1.50, consistency implies that same individual would choose to use the toll facility if the toll were $0.50 and $1.00. Of course, exploding the valuation data in this manner assumes that individuals act consistently.

However, justifying this assumption is the rationality upon which the utility maximizing framework of discrete choice analysis rests.

The six scenarios individuals are asked to value have been designed by varying each benefit between high and low benefit levels with all other benefits held constant at a zero relative provision level. Such treatment may not be realistic, as positive correlations among the benefits are likely in practice (i.e. maintenance improvements can result in reduced travel times). In addition, such a design means respondent valuation data will not be available for benefit combinations. However, to collect full information about the interactions among benefits, a factorial design that included 27 hypothetical situations would be required. Pre-testing revealed that even 9 hypothetical valuation scenarios resulted in high non-response levels. In addition, many respondents who did answer the valuation questions did so inconsistently, indicating a significant confusion level. As a result, data validity and respondent comprehension constraints mandated the use of the reduced scenario set.

As stated in the goals above, the primary concern of Section C is to obtain valuations of possible toll facility benefits to determine which benefits should be promoted by toll road providers. Accomplishing this goal is not undermined by use of the reduced scenario set. Since the values of all hypothetical benefits are measured directly in dollars, each of the benefit questions is comparable to the others. The only drawback of the reduced scenario set, in the benefit valuation context, is the inability to accurately assess the value of benefit combinations. However, the ordinal rankings of benefit importance asked in Section C (Questions C1, C4, and C7) provide a basis for the individual benefits to be weighted, combined additively, and normalized.

The secondary goal of developing discrete choice models to predict toll facility demand is more seriously affected by the reduced scenario approach. In fact, reducing the scenario set implies that three choice models will have to be estimated independently, one for each benefit. This modeling strategy will still provide an opportunity to compare the three models and to analyze the effects of the explanatory variables on each of the three benefits. However, models of demand for a given set of toll road characteristics cannot be estimated on the basis of the survey data.

SOCIOECONOMIC CHARACTERISTICS SECTION (SECTION D)

Section D, as indicated previously, is tasked with obtaining socioeconomic characteristics that can help classify and stratify the survey sample. In addition, socioeconomic characteristics are vital explanatory variables to the eventual econometric modeling. The selection of these characteristics was driven largely by "common sense" assumptions about socioeconomic factors affecting an individual's propensity to accept toll facilities, as well as by a literature review.

To illustrate the selection process, income can be considered. *A priori*, individuals with high household incomes are expected to be more willing to accept tolling than individuals with low incomes simply because the toll represents a much smaller income fraction than for low-income respondents. In addition, income serves as a rough proxy for individuals' values of time. These findings have been confirmed in several mode choice studies (Refs 11 and 19). It is hoped that household income data, possibly divided by household size, will prove a significant explanatory variable in this toll road study as well.

The number of vehicles divided by the number of drivers has also been assumed to have explanatory power. This measure is indicative of individuals' mobility--the higher the vehicle-to-person ratio, the greater the importance of mobility. However, this need for mobility may have conflicting effects on individual propensities to accept tolls. On one hand, the benefits new toll facilities can offer indicate their status as mobility enhancers. Such a perception would result in a positive correlation between toll acceptance and vehicles per person. In contrast, if tolls are perceived as mobility-restrictive (due both to existing methods of toll collection that impede mobility and increased travel costs), a negative correlation can result.

The three other explanatory socioeconomic factors--county of residence, age, and gender-were chosen for use in this study primarily to validate sample representitiveness. However, these variables have been found to have significant explanatory power in some studies. Such effects may be caused by these variables serving as proxies for trip-making and income characteristics. Note, for example, the likely correlation between age and income. With the explanation of the questionnaire design completed, steps required to effectively implement the survey can be described.

SAMPLING AND IMPLEMENTATION DETAILS

Selecting a sampling strategy was somewhat difficult because the design team had little information about the variation of toll road attitudes across Texas. In the absence of such data, it was impossible to condition the sampling on any exogenous demographic or geographic factors with a high degree of confidence. Adding to this constraint was the desire of the organization funding the study to determine Texans' attitudes about toll roads on a statewide basis. Because of these two constraints, a simple random sample, chosen on the basis of population density alone, was chosen for use in this study. Such samples are commercially available; for this study a 6,011-member sample was purchased from TRW Target Marketing Services in Dallas, Texas.

Despite this sample design, common sense indicates that there will be significant bases for segmenting the data set after the data is collected. For example, geographic characteristics have the potential to be significant indicators of toll road preference. This conclusion is based on the assumption that one's proximity to a toll facility (as well as one's experience with such a facility) will have a great influence on toll facility perception. In addition, it seems that individuals living in urban areas, where delay from congestion and road deterioration are common, would perceive the benefits of toll facilities more than individuals living in uncongested rural areas. (There are possible exceptions to these assumptions. For example, rural areas without interstate-class highways nearby may value toll benefits highly because time savings could be realized with the addition of a more direct, higher-speed toll facility.) For this reason, significant steps will be taken to identify homogenous population segments after the survey data is collected. Possible bases for this segmentation include current trip frequency, current trip length, current trip conditions, home location, work location, and income.

The next important implementation consideration is sample size. In this study, the determination of sample size was driven largely by financial constraints. Resources available to the study allowed an initial mailing to approximately 6,000 potential respondents. Assuming a response rate of 15 percent implies that 900 completed surveys will be received. For binary response questions, assuming a 50/50 response split, it can be expected at a 95 percent confidence level that the sampled data will be representative of the population response to within 4 percent (Ref 14). Although the confidence intervals will likely be larger for questions with more response categories, the initial mailing size of 6,000 seems suitably accurate for study purposes.

The accuracy of sampled data stated above was determined for a simple random sample. If systematic biases are present in the collected data, validity drops dramatically. Assuming the survey instrument itself is not the biasing factor, the primary source of bias in a mail survey is non-response bias. This is because non-response is often non-random. In particular, certain populations tend to have higher rates of non-response than others. In this study, for example, rural populations may have a higher level of non-response because they figure toll roads are an urban phenomenon that does not and cannot affect them.

Although non-response bias can rarely be eliminated entirely, its effects can be minimized. Dillman recommends several steps that can be taken to enhance survey response rates. In fact, mail surveys that have used Dillman's method have achieved response rates upward of 70 percent (Ref 20). Many of Dillman's techniques would be prohibitively expensive to implement. An example is sending three separate follow-up mailings, with the last follow-up being sent via certified mail. However, simple measures such as carefully crafting the cover letter, sending one follow-up mailing, and including incentives with the survey can improve response rates dramatically (Refs 20 and 21).

On the basis of these findings, the toll financing study implemented a two-stage mailing. In the first stage, the respondents were sent a questionnaire, a cover letter, and a non-monetary incentive in the form of an *Official Texas Highways Travel Map*. The cover letter in the first stage of the mailing conveyed three basic ideas: (1) the importance of the study, (2) the importance of the participant in determining the study's outcome, and (3) the confidentiality of the participant's response. A sample of this cover letter can be found in Appendix C. The incentive was chosen for its low cost and its pertinence to the study. The second stage, or follow-up, mailing was sent only to first-stage non-respondents and consisted of a replacement questionnaire and a cover letter. In this mailing, the cover letter took a more insistent tone, reminding participants that their response has not yet been received and again expressing the importance of the study. A sample of the follow-up cover letter can be found in Appendix D. The use of this two-stage approach with an incentive should minimize non-response bias, allowing accurate conclusions about Texans' response to toll roads to be drawn.

CHAPTER 4: GENERAL SURVEY VALIDITY

This chapter evaluates the validity of the survey. First, results and issues related to the survey response rate are discussed. Next, demographic and trip-making characteristics of the collected sample are presented. This presentation includes data concerning current toll road usage. Finally, statistical tests are performed on the sample to determine its validity.

RESPONSE RATE INFORMATION

As stated in Chapter 3, the survey was mailed out in two stages. The first-stage consisted of 6,011 individuals randomly selected from across Texas. The second, or follow-up, stage was mailed to individuals from the first-stage who had failed to respond one month after the first-stage had been mailed. The first-stage was mailed during the week of April 4-8, 1994. By May 8, the cutoff date for initial mailing receipts, 1,703 responses had been received. In the week following the cutoff date, eighteen additional responses from the first-stage mailing were received. The resulting 1,721 first-stage responses amounted to a 28.6 percent first-stage response rate.

The follow-up mailing was sent on May 8, 1994. This second-stage mailing elicited over 667 additional responses, resulting in an overall response rate of 39.7 percent. The satisfaction with the response rates reported above must be tempered with the realization that not all respondents returned completed surveys. Partial responses were common. Even so, many partially completed surveys do contain useful data and therefore have been entered as received. Where possible, inferences have been made concerning questions that did not receive a response. These inferences are limited to data available from the mailing list itself, most notably the respondents' county of residence and gender. In some cases, the surveys themselves reveal answers to previous questions. This situation is most commonly observed in Question A3, where respondents' decisions to answer either Question A4 or A5 indicates a funding method preference, tolls or fuel taxes. Despite these inferences, some item non-response remains. As a result, the exact number of respondents to each question is noted in the results tables contained in Appendices E-H.

DEMOGRAPHIC AND TRIP-MAKING CHARACTERISTICS

Demographic and trip-making characteristics, collected in Sections D and B of the survey respectively, serve similar purposes in the survey data analysis. Their primary use is to provide a basis for data segmentation--the division of attitude data into homogenous groupings. As noted in Chapter 2, such segmentation enables policy makers to identify the most promising locations for toll facilities and the most likely user groups. In addition, demographic characteristics enable the validity of the sample to be verified. This section presents demographic and trip-making results, and, wherever possible, includes comments about the effects the characteristics are expected to have on the attitude and benefit valuation data.

Only the demographic and trip data most important to the segmentation analysis and sample validity verification performed later in this report are presented. If not explicitly presented below, full summaries of the demographic data, including proportion confidence ranges, are included in Appendix E. Full summaries of the trip data can be found in Appendix F.

Figure 4-1 shows the sample gender distribution, and Figure 4-2 shows the sample.

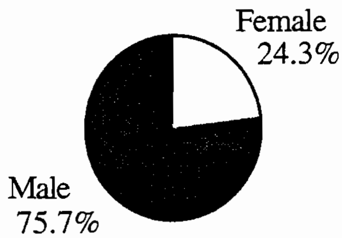

Figure 4-1: Survey Response by Gender

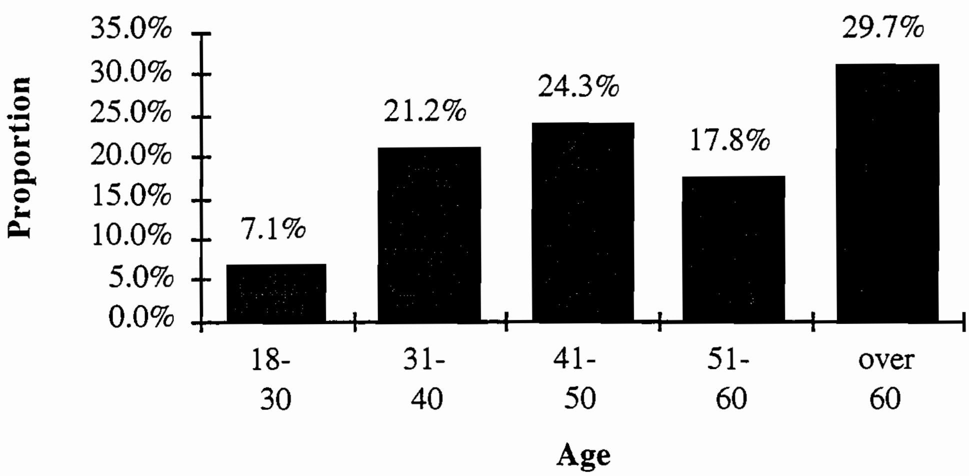

Figure 4-2: Survey Response by Age

The regional classification of respondents according to their county of residence is important to assessing regional differences concerning toll acceptability, as well as to verify sample validity. Unfortunately, county level data obtained from Question D1 is widely dispersed because of the large number of counties sampled. For this reason, three aggregate measures of county classification have been compiled from the responses to Question D1. Two of these schemes are based on county population density calculated from census data. The first of these, County Class 1, is defined as follows: (1) large urban counties with population densities greater than 250 persons per square mile; (2) small urban counties with population densities less than or equal to 250 persons per square mile and greater than 100 persons per square mile; (3) rural counties with population densities less than or equal to 100 persons per square mile. The survey results based on County Class 1 are shown in Figure 4-3. The second county classification scheme, County Class 2, is identical to County Class 1 except that counties within 10 miles of a toll facility are placed in a new category, toll-proximate. The distribution of County Class 2 appears in Figure 4-4.

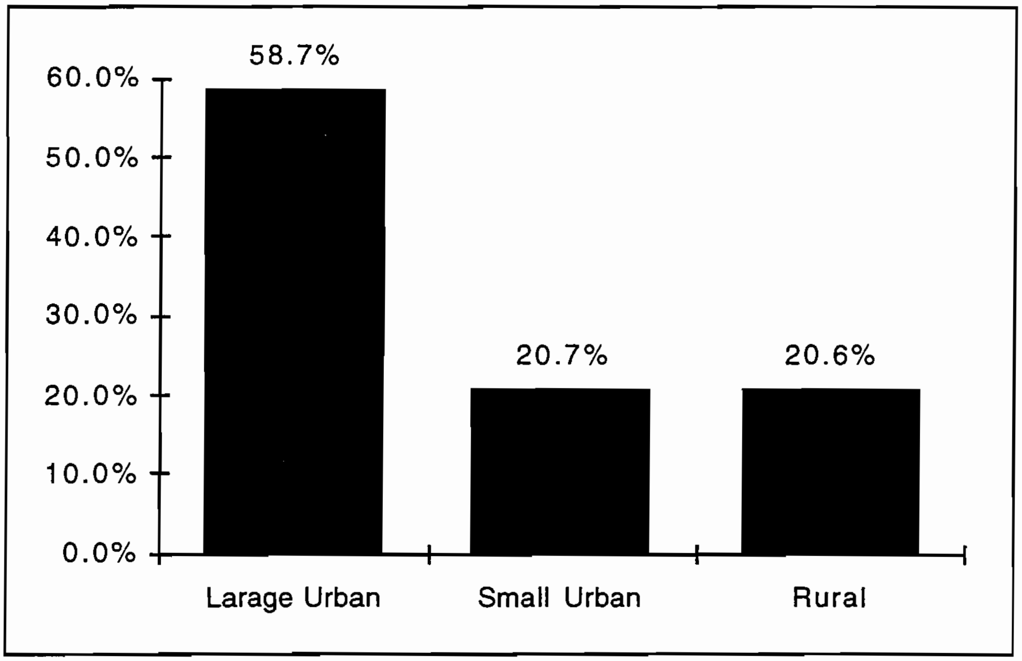

Figure 4-3: Survey Response by County Class 1

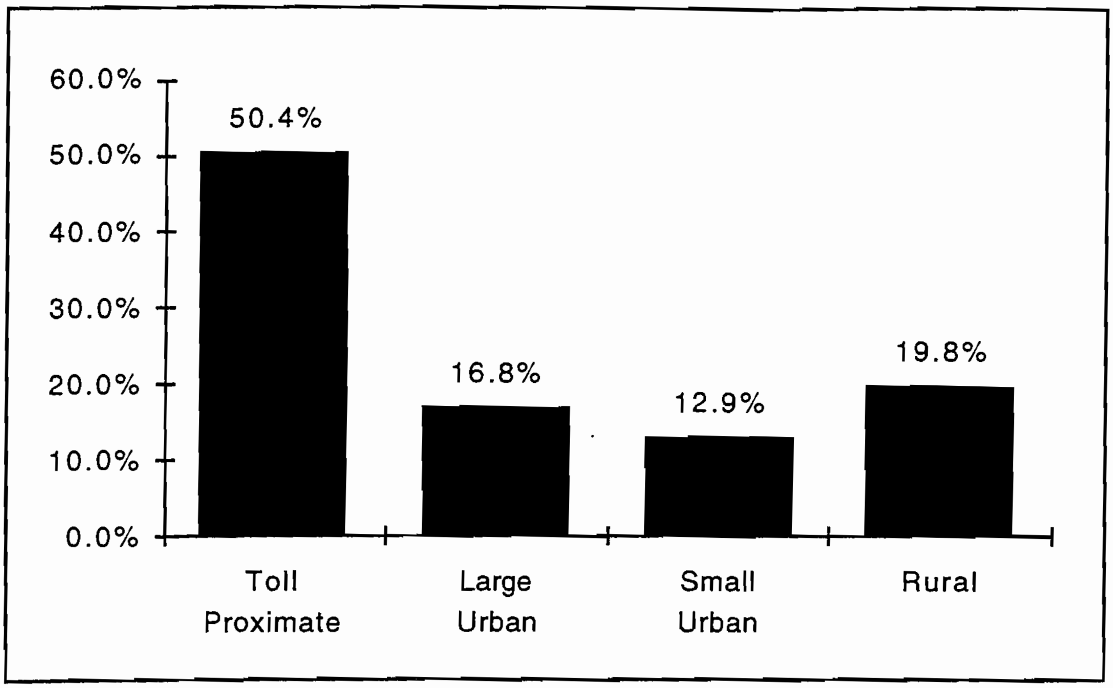

Figure 4-4: Survey Response by County Class 2

An additional county classification scheme, geographic class, is based on a regional segmentation of Texas performed by Andersen et al (Ref 22). This segmentation scheme divides the state into six economic regions. The distribution by the geographic class is presented in Figure 4-5.

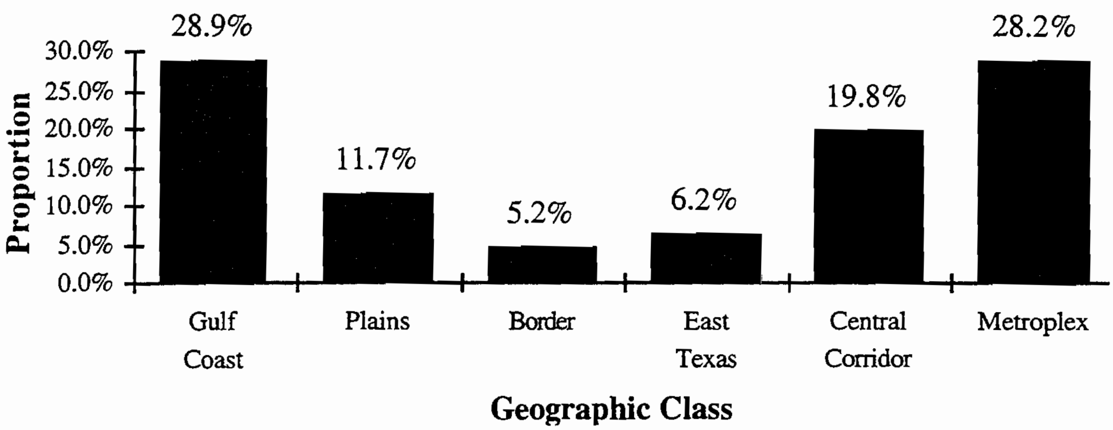

Figure 4-5: Geographic Class Distribution

Turning attention to respondents' most frequent trip characteristics, 70.9 percent report their most frequent trip is work/school-related. Shopping is the next most popular response--

accounting for 19.9 percent of the responses. Other trip purpose categories account for minimal response percentages. Based on these observations, trip purpose can be aggregated into work and non-work categories for use in the analysis of toll road acceptability. Respondents' trip frequencies mirror their trip purposes, with 71.7 percent of respondents making their most frequent trip at least five times a week. On 5-point scales, respondents report the roads they use to make their trip are well-maintained (median rating, 4), but somewhat congested (median rating, 3). As expected, individuals living in large urban counties have significantly lower travel speeds and significantly greater problems with traffic congestion and travel delay than their rural counterparts. This finding supports the *a priori* hypothesis that urban dwellers are more amenable to highway tolling than rural dwellers, especially when the toll facility provides travel-time-related benefits.

Verification of Sample Validity

Chi-square goodness of fit tests can be applied to determine if the demographic characteristics of the sample differ significantly from 1990 census values. Table 4-1 shows the results of these tests. The sample's gender and age distributions exhibit significant deviations from the Texas population distributions. Geographic Class also shows a significant deviation from the census distribution, although its chi-squared statistic is approximately an order of magnitude less than the gender and age cases. The two population-density-based measures, County Class 1 and County Class 2, show less deviation from the Texas population than the other variables, as exhibited by these variables' smaller chi-square statistics and p-levels. (The p-level is the probability of making a type I error and rejecting H_0 when H_0 is true. The higher the p-level, the greater the chances the conclusions from the hypothesis test will be incorrect.)

Table 4-1: Chi-Square Goodness of Fit Between Sample and Census

Variable	χ^2 computed	p-level	df
Gender	14.9	<<0.005	1
Age	21.5	<<0.005	5
Geographic Class	3.152	>>0.25	5
County Class 1	1.043	>>0.25	2
County Class 2	1.307	>>0.25	3

These chi-squared tests are only the first step in identifying potential sampling biases. The next step involves examining the practical effect of the sample's deviation from census data. In the cases of gender and age, the effects are believed to be practically significant. In the case of gender, males are significantly over-represented in the sample; they compose 75.7 percent of the sample as opposed to 49.3 percent of Texas' population. If males exhibit different toll road attitudes than women then this oversampling will have a significant biasing effect on the attitude data. Likewise, individuals over 60 have been oversampled, while individuals under 31 have been undersampled. This biased age distribution also has potential to bias attitude data.

For the county-based classifiers, County Class 1, County Class 2, and Geographic Class, the situation is not as clear. Fortunately, chi-squared tests show, based on population density, that the survey sample is similar to Texas' actual population distribution. The regional distribution, based on Geographic Class, matches state population distributions as well as density-based measures. However, some of this variable's deviation from the actual population distribution is caused by undersampling of the border region (5.2 percent of the sample compared to 9.8 percent in the census). This undersampling is expected primarily because of the large proportion of exclusively Spanish-speaking individuals in the region. However, the practical effects of this undersampling, including the potential biasing of attitude and valuation data, are expected to be low because the undersampling resulted in only a 5 percent deviation from the population totals. This small percentage is unlikely to significantly skew valuation and attitude results. The effect of the border area undersampling is even more muted when the 95 percentile confidence intervals for the Geographic Class proportions are considered. The upper bound of this interval for the border region is 6.1 percent, a mere 3.7 percent difference from the census value. Census proportions fall within most of the other Geographic Class proportions' confidence ranges. As a result of the small potential for bias, the geographic distribution of the sample will henceforth be treated as representative of Texas.

CHAPTER 5: TEXAS ATTITUDES TOWARDS TOLLING

The express purpose of Section A is to determine Texans' general acceptance or rejection of highway tolling. The survey responses indicate that tolls are viewed in a surprisingly positive light in contrast to fuel tax increases. This chapter first presents the response of the full sample to Section A questions. After this presentation, the attitude results are segmented by a select set of demographic and most frequent trip characteristics. This segmentation reveals that gender and toll proximity have a significant influence on toll road attitudes. In addition, the segmentation analysis reveals the geographic regions in which tolls are most acceptable. Note that Section A's results, including 95 percentile confidence ranges, appear in Appendix G.

AGGREGATE ATTITUDE RESULTS

The first two questions, intended to determine Texans' current perception of the Texas highway system, produced expected positive responses. Nearly 74 percent of the respondents rate the Texas highway system excellent or above average. This opinion, as well as a probable reluctance to pay increased taxes and fees, caused the majority of respondents (67.0 percent) to indicate that Texas is spending the right amount of money on its highway system. In spite of the increased funding it will require, a significant proportion of respondents (29.3 percent) want more money spent on Texas roads.

Question A3 determined that tolls are a surprisingly acceptable method of funding highway improvements. Figure 5-1 shows the proportions of response to Question A3. As the figure shows, a statistically significant 58.7 percent majority of respondents chose tolling over fuel tax increases. However, despite the statistical significance of this finding, its practical significance is questionable because of the binary format of the question which puts tolls in direct contrast with fuel taxes. This situation can result in a respondent's choice of tolls, not because of his/her true preference for tolls, but because of the his/her dislike of fuel taxes. Such a situation does not imply toll acceptability, but rather indicates a strong resistance to fuel tax increases.

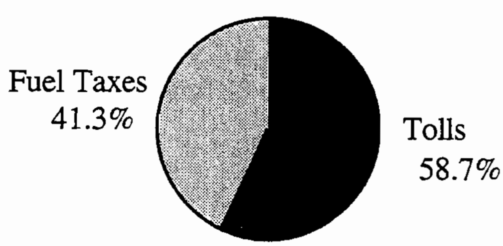

Figure 5-1: Preferences for New Highway Funding

To verify the validity of the toll preference noted above and reject the idea that the toll option is chosen only by default, the responses to Questions A4 and A5 are analyzed. The aggregate results of Question A4 are shown in Figure 5-2. These results reveal that 52.0 percent of the individuals choosing tolls did so because they believe tolls to be a more direct way to charge drivers for their road use than fuel taxes. An additional 8.7 percent indicate good past experiences with toll facilities as their reason for favoring tolls. These responses show that tolling was not a default choice for the majority of those choosing tolls. However, 29.5 percent of the respondents do explicitly note that their toll choice is driven by their reluctance to see fuel taxes raised.

The responses to Question A4 are consistent with results obtained from a similar study in Colorado, although Texas' anti-tax sentiments are more pronounced (Ref 15). In Colorado, 62 percent of Coloradians favoring tolls did so because the tolls charge users directly. Anti-fuel tax sentiments comprise the second most popular reason for favoring tolls in the Colorado study, garnering 12 percent of the responses.

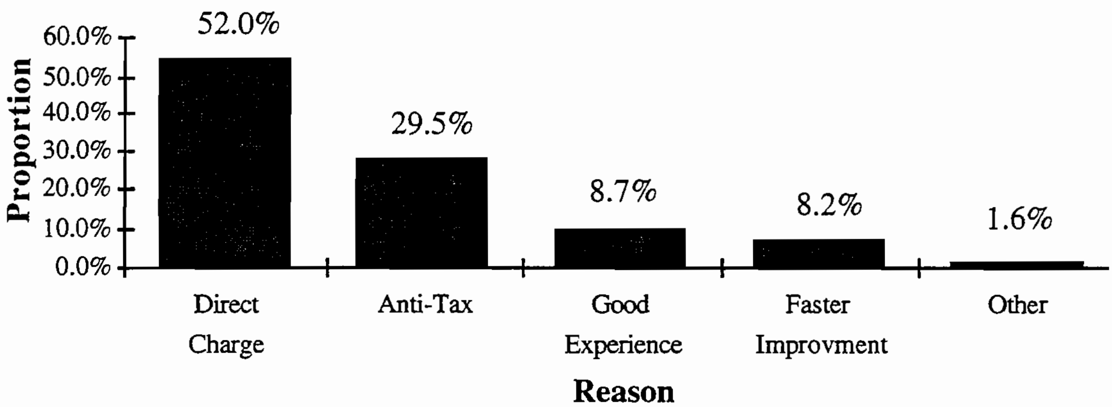

Figure 5-2: Toll Preference Reason

Individuals preferring fuel taxes are much more divided on the reasons for their preference than those who preferred tolls. The most popular reason for fuel tax preference is, "I shouldn't have to pay to use the roads," getting 28.0 percent of the responses to Question A5. Among further analysis of the "other" response, it was found that 17.8 percent of the survey respondents felt that all persons, users and nonusers, should pay for roads. These responses provide strong evidence that fuel taxes are not perceived as road use charges by large numbers of Texans. This finding confirms the assertion that fuel taxes in the United States have not been charged at a rate high enough to significantly affect driver perceptions, let alone charged at a rate high enough to influence trip-making behavior. As noted previously, being able to affect user behavior through pricing mechanisms is critical to enhancing individual mobility in congested transportation networks. Thus, fuel taxes, by road users' own admissions, may not be capable of such a task.

The next most popular reason for fuel tax preference is, "I don't want to stop to pay the toll," which gained 17.6 percent. When combined with another time-related reason, "I want to avoid traffic congestion at the toll booth," the proportion of individuals choosing fuel taxes for reasons of travel time convenience rises to 28.4 percent. This high number of convenience/delay-related choices confirms the potential of convenience-enhancing, delay-reducing electronic toll collection (ETC) and automatic vehicle identification (AVI) systems to enhance toll road acceptability. Nearly 14.4 percent of respondents cite toll roads as being too expensive in relation to fuel taxes. As with the "Shouldn't have to pay" category above, this response provides more evidence that fuel taxes are not high enough to significantly affect user trip-making behavior.

The responses to the last three questions in Section A are not surprising. A large majority of respondents, 80.0 percent, are opposed to congestion pricing. This majority, which cuts across all demographic lines, confirms the findings of other studies in both the U.S. and Great Britain that have found congestion pricing to be publicly and politically unacceptable. (For evidence of drivers' resistance to congestion pricing, see Goodwin and Jones, pp. 34-36, or Giuliano, pp. 343-349.) Most Texans (63.6 percent) feel that tolls should be imposed on new facilities only. This finding also reflects political sentiments long held by state and Federal legislators and is driven by the perception that existing facilities have already been paid for with tax dollars so tolling such facilities would constitute double taxation. Finally, a small majority of respondents (55.5 percent) want to limit the use of toll revenues to the toll road itself, rather than using toll revenues to fund non-tolled highways. Even though a majority support traditional views on toll roads, there are large numbers who support broader application of tolls. Nearly 36 percent of the respondents felt it appropriate to toll existing roads; likewise, 44.5 percent felt tolls could be used for nontoll road improvements. These responses have important implications for developing state toll road policies.

SEGMENTATION ANALYSIS OF ATTITUDE DATA

The most important goal of the segmentation analysis is to determine how responses to Question A3 are affected by explanatory variables. This segmentation scheme's efficacy can be confirmed by investigating the reasons behind the funding source choices (Questions A4 and A5). The primary method for verifying response homogeneity is the chi-square goodness of fit test. This test is chosen because it is especially effective in dealing with categorical and proportional data.

The first step in the segmentation analysis involves cross-tabulation of Question A3's response categories, tolls and fuel taxes, by demographic response categories that were expected to have an effect on Question A3. Chi-square statistics are calculated from these cross-tabulation tables and used to test the following hypotheses:

•Null hypothesis (H_0): Distributions are the same among population segments.

•Alternative hypothesis (H_a): H_0 is not true, i.e., distributions are not the same.

This test procedure finds only two explanatory variables for which the null hypothesis can be rejected at a 90 percent confidence level. These variables, in order of increasing p-levels, are: (1) gender (p-level < 0.0001) and (2) geographic class (p-level = 0.0015). These two variables are thus selected for further consideration in the segmentation analysis. Importantly, age does not have a significant effect on the choice of a highway funding method (p-level = 0.6776).

With the variables having a significant effect on funding source choice identified, the cross-tabulation tables themselves are examined. With respect to gender, women are significantly more amenable to tolling than men. In fact, 67.2 percent of women chose tolling over fuel taxes as compared to 56.2 percent for men. Chi-square tests performed on the cross-tabulation tables reveal no significant differences between the sexes for both "reason" questions, Question A4 and Question A5 (p-levels of 0.7586 and 0.4211 respectively). Since geographic class, the only other variable found to have a significant effect on funding preference, is not correlated with gender (p-level = 0.6033) individuals' funding choices, women's increased preference for tolls (or men's increased preference for fuel taxes) is likely a result of unobserved demographic characteristics. Regardless of the response, survey results definitely indicate that significantly more women prefer tolls than men. Since women have been significantly undersampled, the implications of this fact are that the funding choice proportions obtained directly from Question A3 are biased in favor of fuel taxes. The effect of this bias can be approximated by multiplying gender-segmented funding choice proportions by gender proportion distributions. Performing this task results in a 61.7 percent toll road acceptance proportion, up 3 percent from the directly observed proportions.

The effect of geographic class on funding choice is not as directly assessable as the gender effect. The cross-tabulation table for geographic class reveals that the state can be broken into two roughly homogenous groups on the basis of highway funding preference alone. The first group, consisting of the Plains and Metroplex regions, shows heightened toll road acceptance, respondents preferring tolls 65.8 percent of the time. The second group, which included the other 4 regions, registers a 55.4 percent toll road preference.

Despite these differences, the regions respond differently to the two "reason" questions, even within these homogenous groups. In fact, the grouping of the Plains and Metroplex proves erroneous when the reasons behind indicated funding preferences are examined. For the Metroplex, a highly urbanized group of counties, 56.5 percent of the respondents indicate the direct relationship of toll charges to road use as their reason for toll road preference, while only 24.8 percent indicate that their funding preference is driven by anti-tax sentiments. In contrast, the largely rural Plains region exhibits anti-tax sentiments in 42.5 percent of responses, while tolling's directness is noted in 44.3 percent of the responses. On the basis of tolling reasons, a better segmentation scheme can be obtained by dividing the geographic classifications into urban and rural groupings. This scheme reveals that urban counties are more likely to support tolls for reasons positively linked to the toll roads themselves. These reasons include tolling's direct relationship to road use, tolling's contribution to faster highway improvements, and good past experiences with tolls. Anti-tax sentiments are voiced only 25.3 percent of the time in the urban counties. On the other hand, rural counties' toll road preferences are driven by anti-tax sentiments 42.2 percent of the time.

As noted above, these tax-negative responses are detrimental to toll road acceptability because they indicate that tolls have been chosen solely to reject fuel tax increases. Unfortunately, toll roads are only part of the solution to Texas' transportation funding dilemma. Fuel taxes, most likely imposed at higher levels, are another critical solution component. In such a situation, when both fuel tax increases and tolling are used to increase transportation revenues, the support of rural regions cannot be assured. On the plus side, however, urban regions' support of tolling is based on the positive characteristics toll roads offer. Thus, the observed support of tolling in these regions can be considered reliable.

Texas Experience With Toll Facilities

Section B of the survey collects information about current toll facility experience. Approximately 18 percent of the 2,388 respondents to these questions provided information concerning their toll road experiences. In order of frequency, the Sam Houston Tollway, Dallas North Tollway, and Hardy Toll Road are the facilities respondents report using most. When asked why they use the toll facility, most respondents cite that the toll road saves time or is less congested than alternate non-tolled roads (35.7 and 23.7 percent of the responses to Question B16, respectively). Additionally, 20.1 percent of the respondents note that the toll road provides better travel time reliability than other routes. These responses indicate that toll facilities are already providing significant travel time benefits to Texans and that travel time is an important factor in their decision to use the toll roads. Despite these conclusions, only 11.1 percent of the 440 toll road users report that they are currently using ETC. This low usage rate of delay-reducing technology illustrates that ETC systems still have a long way to go in achieving market penetration.

Toll users' perceived time savings resulting from toll road use is another important piece of data collected by the survey. This data, in conjunction with user-reported travel distances and toll levels, enables the estimation of users' values of time and distance. These revealed values provide essential bases for verifying the stated valuations obtained in Section C of the survey. These revealed values of distance and time are 7.0¢ per mile and 6.0¢ per minute respectively.

Comparisons of these values to stated preference values are performed in the discussion of the benefit valuation results, the focus of the next chapter.

CHAPTER 6: BENEFIT VALUATION RESULTS

Section C of the highway financing survey gathered data concerning respondents' perceptions and values of three potential toll facility benefits, (1) improved maintenance, (2) reduced travel time, and (3) improved travel time reliability. However, before presenting this data, it is important to explain the procedure used to mitigate effects of strategic bias on the sample. Following this discussion, we present the analysis of the benefit importance data, concluding that Texans consider highway maintenance most important, followed by travel time reliability, and finally travel time savings. Next, the benefit valuation data itself is presented. The analysis of this data reveals that travel time savings are the most valued benefit, followed by maintenance, and travel time reliability. The reasons behind the discrepancy between the importance ranking and valuation ranking of the benefits are briefly discussed. The chapter concludes with a detailed analysis of travel time values computed from Section C's stated preference (SP) data. These travel time values are compared to the revealed travel time values from current toll users that were computed above to confirm the valuation data's validity.

STRATEGIC BIAS EFFECTS AND MITIGATION PROCEDURES

As stated in Chapter 3, strategic bias occurs when respondents deliberately shape their answers to influence the study's outcome or conclusions. In this survey, the effects of strategic bias are assumed to be most prevalent in Section C because, by the time respondents reach Section C, Section A has already exposed them to the survey's purpose--evaluating the acceptability of tolls on Texas highways. With this knowledge, respondents have the potential to taint benefit valuations with their previously expressed toll road attitudes.

Theoretically, strategic bias can either increase or decrease reported valuation data. In this survey, however, few cases of positive strategic bias have been observed--the number of respondents indicating high toll values after indicating support for toll roads is practically nonexistent. On the other hand, many cases of negative bias are apparent. In these cases, respondents indicate zero values for all six of the benefit situations after stating strong anti-toll sentiments. In flagrant cases, individuals actually note their unresponsiveness to toll road benefits at any provision level. However, most cases of potential strategic bias are not obvious, making the identification of cases of strategic bias extremely difficult. Without a direct indication of strategic bias in the sample, a second-best approach was utilized. "Protest voters," respondents causing negative strategic bias, are defined as individuals who indicated a preference for fuel taxes in Question A3 and then indicated $0.00 for all six benefit valuation questions (C2, C3, C5, C6, C8, and C9). Respondents meeting this criterion account for 8.7 percent of the total respondents.

To verify the definition's efficacy, the reasons for fuel tax preference between protest and non-protest voters can be compared. The comparison, by way of a chi-squared goodness of fit tests, reveals the protest group cites reasons such as "I shouldn't have to pay to use a road" and "I've had bad past experiences with toll roads" significantly more often than their non-protest counterparts. Note that these reasons indicate a fundamental opposition to tolling. In contrast, the non-protest group cites "I don't want to stop to pay the toll" and "I want to avoid traffic jams at the toll booths" significantly more often than the protest group. These reasons are not fundamentally opposed to tolling, but rather are convenience-related. As a result of these findings, the protest definition above seems justified.

Additional segmentation analysis reveals that the most frequent trip purpose, geographic class, and age are highly significant determinants of protest status, with chi-squared tests showing p-levels less than 0.005. Respondents over 60, from a region without toll facilities, or making non-work trips, are most likely to account for protest votes. Two of these findings have positive implications for toll road acceptability. This is because individuals over age 60 or those making non-work trips are not market segments for which toll facilities are designed in the first place. Thus, these individuals' effect on toll road feasibility is likely to be small. The effect of geographic class on protest voting is somewhat more disturbing, as it shows that a region's inexperience with toll facilities drives people to vehemently oppose tolling. (The Gulf Coast and Metroplex regions have toll experience and report protest proportions of 7.8 percent and 5.5 percent respectively. The remaining four regions without toll proximity average approximately 11 percent protest response.) This finding implies that extensive information programs may be needed to mitigate public opposition to tolling when tolls are imposed in regions that do not currently have toll facilities. On the plus side, the reduced protest proportions in toll proximate regions indicates that the prospects for long-term acceptance of toll facilities, once initial opposition can be overcome, is likely to be high.

VALUATION DATA

As noted in Chapter 3, Section C asks respondents two types of questions. The first type obtains respondents' perceived importance of benefits, rated on a 5-point ordinal scale; the second type obtains respondents' willingness to pay for hypothetical benefits. The results of the benefit importance rankings appear in Table H-1 and Table H-2 in Appendix H. Note that results in Table H-1 have been compiled from the protest-included data set, whereas results in Table H-2 have been compiled from the protest-excluded data set. A comparison of Tables H-1 and H-2 shows that both data sets' importance proportions lie within the 95 percentile confidence interval ranges of one another. Thus, the hypothesis that the benefit importance data has been tainted by strategic bias can be rejected.

In contrast, a comparison of the three benefits on the basis of their importance ratings reveals interesting differences. This comparison, presented graphically in Figure 6-1, reveals that the greatest importance is attached to road maintenance, with 84.8 percent of the protest-included sample indicating that road maintenance is above average in importance. Of this 84.8 percent, 54.1 percent rate highway maintenance very important. Travel time reliability is the second most important benefit, rating more important than average 66.3 percent of the time. Finally, travel time savings were found to be more important than average by 59.3 percent of respondents.

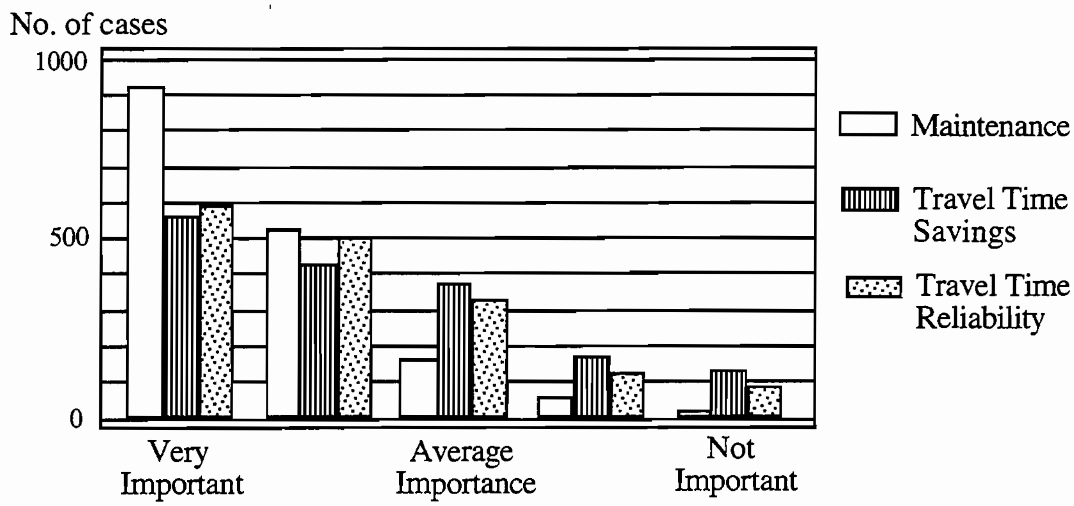

Figure 6-1: Protest-Included Sample Benefit Importance

Despite the direct comparability of the benefit importance ratings, this data does not reveal respondents' choice behavior in reaction to benefit provision. To obtain this behavior, the benefit valuation questions themselves must to be analyzed.

The results from the benefit valuation questions are presented in Appendix H in terms of their descriptive statistics, rather than as categorical proportions. This is because the benefit valuation data, although collected categorically, can be measured on a continuous scale. This fact, coupled with the large sample size present in the survey, implies that valuation data can indeed be treated as continuous with an underlying normal distribution. Viewing the data in such a manner enables the collection of descriptive statistics such as means and variances, thus compressing data and simplifying the analysis. In addition, treating the valuation data as continuous allows arithmetic transformations to be performed. These transformations permit the computation of travel time values.

Tables H-3 and H-4 in Appendix H present descriptive statistics of the benefit valuation data for the protest-included sample and protest-excluded sample respectively. Unlike the importance ratings, the benefit valuation data does exhibit significant differences between the protest-excluded and protest-included data sets. Two-sample t tests used to compare the means of the valuation questions between the protest-included and protest-excluded data sets show significantly higher valuation estimates for the protest-excluded data in all six hypothetical benefit situations (p-level < 0.05). In monetary terms, the protest-excluded valuation estimates increase by 4¢ to 9¢ over their protest-excluded counterparts. The significance of the differences between the two data sets provides the needed justification to segment the data set between protest and non-protest voters to eliminate strategic bias. As a result, subsequent analysis of the benefit valuation data is performed on the protest-excluded data set.

Cursory examination of the protest-excluded valuation results reveals the expected consistency between the two benefit levels, moderate and substantial, for each of the three benefits. This means that the substantial benefit level is valued more than the moderate benefit level for all three benefits. Paired t tests confirm that the substantial benefit value means are significantly higher than the moderate benefit level means (p-level < 0.001).

A comparison among the three benefits at moderate provision levels reveals that maintenance improvements are most highly valued at 59¢, followed by 5-minute travel time savings at 54¢ and 45-minute maximum travel time at 49¢. Using a paired t test, differences among these values are all significant at a 99 percent confidence level. At substantial provision levels, order of valuation changes, with 15-minute travel time savings valued at 92¢, substantial maintenance improvements valued at 84¢, and 35-minute maximum travel times valued at 74¢. Again, paired t tests show that the three values are significantly different from each other (p-level < 0.001).

Before conclusions can be drawn from these comparisons, two caveats must be stated. First, the direct comparability of the three benefits cannot be assured. For example, 15-minute time savings may be perceived at a higher benefit level than "substantial" maintenance improvements. For this reason, the comparisons of the importance proportions are a more reliable indicator of benefits' comparative values in the eyes of highway users. Second, it was hypothesized that, at moderate provision levels, respondents seemed to overvalue hypothetical benefits because no value categories between $0.00 and $0.50 were allowed. As a result, responses clustered around $0.50 for all three moderate benefit situations--biasing moderate valuations upward. Specific evidence confirming this hypothesis for the travel time benefit is presented below.

Unlike the maintenance and reliability benefits, the travel time savings benefit can be transformed into a travel time value. This value can be compared to the revealed value of travel time of current toll road users obtained in this survey. Values of travel time can be obtained for both benefit provision levels. Table 6-1 shows these values, as well as the revealed value of travel time from Section B of the survey.

Table 6-1: Travel Time Values

Source	Value
Stated Preference, 5-Minute Travel Time Savings	12.0¢ per minute
Stated Preference, 15-Minute Travel Time Savings	5.6¢ per minute
Revealed Preference	7.3¢ per minute

Note that revealed travel time values are determined from a choice-based sample--revealed values are available only from individuals who have chosen to use a toll facility. Rational consumers who have decided not to use the toll road because their value of travel time is too low to justify the toll have no effect on the revealed value. Thus, with the assumption that road users are rational consumers, the revealed travel time value should be higher than the general population's valuation. On this basis, the 5.6¢ per minute value of travel time obtained from the 15-minute travel time savings situation is plausible.

On the other hand, the 12¢ value of travel time estimated from 5-minute time savings data appears inflated. Additional evidence that the 5-minute time savings is overvalued comes from a comparison of toll road users' revealed and stated travel time values. Table 6-2 shows the travel time values estimated for respondents who provided information about their toll road use.

Table 6-2: Frequent Toll Users' Travel Time Values

Source	Value
Stated Preference, 5-Minute Travel Time Savings	16.0¢ per minute
Stated Preference, 15-Minute Travel Time Savings	7.1¢ per minute
Revealed Preference	7.3¢ per minute

A paired t test reveals that toll users' 5-minute stated preference and revealed preference travel time values are significantly different ($p\text{-level} < 0.001$). This finding proves the 5-minute travel time benefit is overvalued. As stated above, the most probable cause of this overvaluation is the fact that the response categories provided to respondents were not fine enough to capture reliable benefit values. The overvaluation phenomenon affecting travel time savings is hypothesized to affect values estimated for moderate maintenance and travel time reliability benefits in a similar manner. Unfortunately, revealed preference information is not available for the other two benefits to confirm this hypothesis. (Note that the overvaluation of the 5-minute travel time benefit undermines the reliable estimation of travel time arc elasticity. Thus, the planned calculation of arc elasticity will not be performed.)

On the other hand, a paired t test comparing 15-minute stated preference travel time values to revealed preference travel time values shows that the two values are not significantly different from each other (p-level > 0.10). Thus the reliability of the stated preference travel time valuation data at substantial benefit levels can be deemed reliable. This reliability is assumed to carry over to the other two benefits' at the substantial benefit provision level.

BENEFITS' EFFECT ON ATTITUDE

In addition to providing respondents' perceived benefit values, Section C data reveals how respondents' attitudes are affected by benefit provision. An analysis of respondents' decisions to use/not use a toll road for the six different hypothetical situations provides a measure of potential toll road usage. Respondents' use/not-use decisions can also be compared to the original funding preference data obtained in Question A3. This comparison illustrates which benefits have the greatest potential to increase toll road acceptability.

To convert the benefit valuation data into a binary use/not-use choice, respondents are divided into two groups. The first group indicates a value of $0.00 for the benefit in question; the second group indicates a value of $0.50 or greater. For this part of the analysis, protest respondents are included in the sample. Table 6-3 presents the use proportions for each of the six hypothetical situations. (Note that the not-use proportions can be computed by subtracting the use proportion from 100%.)

Table 6-3: Toll Road Use/Not-Use Proportions

Benefit	Use Proportion	Sample Size
Moderate Maintenance (C2)	66.4%	2289
Substantial Maintenance (C3)	79.6%	2288
5-Minute Time Savings (C5)	58.5%	2299
15-Minute Time Savings (C6)	81.9%	2296
5-Minute Reliability Improvement (C8)	53.5%	2306
15-Minute Reliability Improvement (C9)	72.8%	2298

The use proportions above are consistent with the benefit valuation rankings previously stated. At moderate provision levels, a facility providing moderate maintenance improvements gains the highest level of use, followed by 5-minute time savings and, finally, 5-minute reliability improvements. At substantial provision levels, greatest levels of usage result from time savings, followed by maintenance and reliability benefits.

The use proportions for moderate and substantial maintenance improvements, 15-minute time savings, and a 35-minute maximum trip time (representing the substantial provision level of reliability) are all significantly greater than the toll road funding preference proportion of 58.7% determined in Question A3 (p-level < 0.001 for all four cases). Although the direct comparability of the use/not-use decision to Question A3 may not be assured, these findings do show that toll road usage, especially in the presence of user benefits, should be higher than implied solely by the toll road funding preference proportion.

CHAPTER 7: CONCLUSIONS

As indicated in *The Texas Transportation Plan*, Texas faces a serious shortage of financial resources to address the growing list of transportation improvement projects. The consequences of this shortage are significant and require strategic action by TxDOT. While toll roads are not the answer to Texas' funding dilemma, they can be a vital component of the Texas transportation network. Ultimately, however, the future of toll roads in Texas depends on the public willingness to support them. The survey findings in this study reveal that tolling is an acceptable approach to addressing the highway funding dilemma in various areas and situations around the state. At the most basic level, individual support for tolling is directly linked to perceived benefit. Successful marketing of toll roads in Texas requires the identification of tangible benefits.

Adjusting for gender bias, overall, Texans favor toll roads over increases in motor fuel taxes 61.7 percent of the time. Moreover, increased education about the benefits of electronic toll collection (ETC) systems should increase this number, since 28.4 percent of the persons favoring motor fuel tax increases over tolling did so because of anticipated toll-collection bottlenecks. If these bottlenecks can be eliminated, then support for toll roads in lieu of increases in motor fuel taxes could be as high as 72.6 percent. Because of this potential, the research team has explored ETC systems in greater detail in Report 1322-2.

The survey results also clearly demonstrated greater support for tolling in urban areas. Rural respondents favored toll roads, but only because they were strongly opposed to increases in motor fuel taxes. Logic suggests that they favor toll roads because they will be constructed in areas outside respondents' usual operations. This lack of rural support for tolling does have important negative implications for intercity toll facilities. On the other hand, the stronger urban support for toll roads will be helpful in developing strategies for responding to urban congestion problems.

Finally, the survey revealed interesting findings on the application and use of toll collections. While a majority of the respondents believed toll revenues should be used only on the toll road, 45 percent of the respondents felt it appropriate to use toll revenues on non-tolled facilities. Similarly, 36 percent of the respondents believed that it was appropriate to toll a road that is currently non-tolled. The implications of these findings are important to the development of toll road programs in various areas of the state.

Toll roads are not a panacea for Texas funding problems. However, with public support, they can become an important component of the Texas transportation system. The findings of this report are consistent with the new policies concerning toll roads in *The Texas Transportation Plan*.

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Appendix A: Pilot Phone Survey Instrument

Zip Code ___ ___ ___ ___ ___ Sex: M ___ F ___

Phone (__ __ __) __ __ __ - __ __ __ __

TOLL ROAD SURVEY

Hello, my name is _________, and I'm with the University of Texas at Austin. We are conducting interviews with Texas residents to determine their opinions about government highway spending and finance. This interview is entirely voluntary and will take about 5 minutes. Is now a good time for me to interview you? [ARRANGE CALLBACK IF NOW IS NOT A GOOD TIME.]

Now, I would like to confirm...

A) That you are over 18 years old and live in Texas. [If yes, skip to 1 below; otherwise ask B.]

B) Is there someone in the house older than 18 with whom I can speak? [If no, end Interview]

First, I need to inform you that presently available public funds will soon be insufficient to maintain and upgrade Texas' highway system so alternatives to present funding sources must be found. Toll roads are one funding alternative that could provide sufficient funding for future highway needs without requiring general tax increases.

Before we begin, I would like to assure you that this interview is confidential and completely voluntary.

1) Do you use toll roads more than once a month?

___ Yes ___ No

2) Would you prefer the State of Texas pay for road maintenance and new highway construction with increased gasoline taxes charged to all road users or with tolls charged to the users of highways needing funds?

___ Gas Tax ___ Tolls ___ Don't Know/Not Sure

3) If converting some free roads to toll roads could relieve congestion onboth free and toll roads, would you favor some free highways becoming toll roads?

___ Yes ___ No ___ Don't Know/Not Sure

4A) Do you work outside your home? [IF YES ASK 4C, IF NO ASK 4B.]

___ Yes ___ No

4B) Do you make any regular trips, or commutes, from your home to another location? [IF YES ASK 4C, IF NO SKIP TO QUESTION 6.]

___ Yes ___ No

4C) On a typical day, how many minutes do you spend on your commute to this location?

5) Would you pay a toll between 25 cents and a dollar to use a road that would reduce your commute time by 30%? [DON'T READ 30%, CALCULATE ACTUAL TIME FROM QUESTION 4C INSTEAD.]

___ Yes ___ No ___ Don't Know/Not Sure

6) Would you pay a toll between 25 cents and a dollar to use a road that was maintained better than alternate free roads?

___ Yes ___ No ___ Don't Know/Not Sure

7) Would you pay a toll between 25 cents and a dollar to use a road that would guarantee that you could arrive at your destination within 5 minutes of when you wanted to arrive there?

___ Yes ___ No ___ Don't Know/Not Sure

The last few questions are about you and your family. These answers will help us to classify the results we obtain.

8) What range does your age fall under?

___ 18-21 ___ 22-34 ___ 35-60 ___ over 60

9) What type of housing do you live in?

___ single family ___ apartment ___ condo ___ townhouse/duplex ___ other

10) How many licensed drivers are there in your household?

___ none ___ one ___ two ___ three ___ four ___ five ___ six or more

11) How many vehicles are there in the household?

___ none ___ one ___ two ___ three ___ four or more

12) Finally, which of the following income groups includes your family's total annual income from all sources in1992? [**DO NOT** READ THE "REFUSED" CATEGORY]

Under $20,000 .... ______
$20,000 to $50,000 .... ______
Over $50,000 .... ______
Refused [DO NOT READ] .... ______

Thank you very much for participating in our survey. Your answers were extremely helpful.

Appendix B: Mail Survey Questionaire

Center for Transportation Research
Highway Financing Study

SECTION A

The first section of the survey concerns your opinions about how the government should pay for road maintenance and construction.

A1) On a scale of 1 to 5, how would you rate Texas' highway system in meeting your needs? (Circle one)

1	2	3	4	5
Poor				Excellent

A2) Currently the State Legislature spends about 8 cents of every government dollar on transportation-related programs. In your opinion, should Texas be spending more, less, or about the same amount of funds on the State's highway system? (Circle one)

1. More
2. Same Amount
3. Less

A3) Currently, most Texas transportation funding comes from motor vehicle fuel taxes. However, current transportation funding sources will soon be insufficient to provide current levels of highway service. To supplement these funding sources, Texas could raise the fuel taxes charged to all road users. Alternatively Texas could supplement highway funding by charging tolls only to the users of roads needing additional funds. Which type of funding would you prefer Texas to use? (Circle one)

1. Tolls — Please answer question A4
2. Fuel Taxes — Please answer question A5

A4) If you favor tolls, what is your **number one reason** for doing so? (Circle one)

1. Tolls charge users directly for road use.
2. I don't want fuel taxes raised.
3. Tolls will lead to faster highway improvements.
4. I've had good past experiences with toll roads.
5. Other (specify)____________________.

A5) If you favor fuel taxes, what is your **number one reason** for doing so? (Circle one)

1. I don't want to stop to pay the toll.
2. I want to avoid traffic jams at toll booths.
3. Toll roads are expensive.
4. I shouldn't have to pay to use a road.
5. I've had bad past experiences with toll roads.
6. Other (specify)____________________________.

A6) If tolls were put on Texas roads, these tolls could be raised during rush hours to discourage unnecessary trips during the rush hour. This policy could relieve rush hour traffic congestion on the toll road. Are you in favor of such a policy? (Circle one)

1. Yes, tolls should be higher during rush hours on congested highways to relieve congestion.

2. No, if tolls are imposed they should be the same all day.

A7) Historically in Texas, tolls have been imposed only on newly-constructed roads. Some people have suggested tolls should also be imposed on existing roads to pay for improvements and maintenance on these roads. **If Texas decides to use tolls, which policy would you prefer?** (Circle one)

1. Toll new roads only.
2. Toll existing roads and new roads.
3. Toll existing roads only.

A8) Some believe that tolls should be used to fund improvements only on the highway where they are collected. Others believe that tolls should be used to fund improvements on non-tolled roads as well. **If Texas decides to use tolls, which policy would you prefer?** (Circle one)

1. Use tolls only to fund improvements on the toll road.
2. Use tolls to fund non-tolled roads' improvements.

SECTION B

The following questions concern the condition of your local and regional transportation system. Your "most frequent trip" refers to the regular route that you travel during your most typical activities.

B1) What is the **primary purpose** of your **most frequent trip** from home? (Circle one)

1. Work/School.
2. Child care/Dropping children off at school.
3. Shopping/Other Errands.
4. Recreation/Leisure.
5. Other (specify).

B2) How do you travel during your **most frequent trip**? (Circle one)

1. Car(drive alone).
2. Carpool.
3. Transit(bus, rail, tram).
4. Other(bicycle, walk, taxi, etc.).
5. Combination of modes(driving to a bus stop, etc.)

B3) How often do you make this round-trip? (Circle one)

1. 5 or more days a week.
2. 2-4 days a week.
3. 1 day a week.
4. Less than once a week but at least once a month.
5. Less than once a month.

B4) How long is your most frequent trip, **one-way**? _____**miles**

B5) On average, how much time does this trip take, **one-way**? **____minutes**

B6) Thinking about your most frequent round trip, how often does your travel time exceed the average travel time you reported on question B5 because of problems with traffic flow (i.e. congestion, accidents, etc.)?

(Answer appropriate response)

____ times per week

OR

____ times per month

B7) On a scale of 1 to 5, how would you rate the maintenance on the roads you use to make your most frequent trip? (Circle one)

1	2	3	4	5
Poor				Excellent

B8) On a scale of 1 to 5, how much traffic congestion do you experience on your most frequent trip? (Circle one)

1	2	3	4	5
Gridlock				No Congestion

B9) Please check the boxes on the following page that best describes the area around your home and the area around your most frequent destination. Please check one box for your home location and one box for your destination location.

	B9 a	B9b
Description	**Location of Home**	**Location of Destination**
1. Large Metropolitan Area: City of 500,000 or more, many suburbs, little open country.		
2. Medium Metropolitan Area: City of 150,000 to 499,999, several suburbs, some open country.		
3. Small Metropolitan Area: City of 50,000 to 149,999, few smaller towns in the area, much open country.		
4. Semi-Urban: City of 10,000 to 49,999, few smaller towns in the area, much open country.		
5. Semi-Rural: City of 2,500 to 9,999, one or two other towns in the area, mostly open country.		
6. Rural: Town of less than 2,500 or entirely open country.		

B10) How frequently do you use the following types of roads?

	Less than once month	At least once a month but less than once a week	At least once a week but not every day	Everyday
Tollway	1	2	3	4
Expressway/IH	1	2	3	4
City/Local Streets		1	2	3
	4			
Other Types	1	2	3	4

If you use a toll road more than once a month, please answer the following questions. Otherwise go to SECTION C on page 7.

B11) What is the name of the tollway you use most? ___________

B12) How much do you pay for one-way use of this toll road? ______

B13) How long is the segment of the toll road that you use (in miles)?. ____miles

B14) How much time (in minutes) do you save over other routes by using the toll road? ________ minutes

B15) Do you use devices that let you pay your toll without stopping (toll tags, etc.)? (Circle one)

1. Yes.
2. No.

B16) Why do you currently use toll roads? (circle up to three reasons)

1. No alternate routes to the toll road.
2. Toll road saves time.
3. Toll road is better maintained than other roads.
4. Toll road has better travel time reliability than other roads.
5. Toll road is safer than other roads.
6. Toll road is less congested than other roads.
7. Other (specify). ____________________

SECTION C

Tolling roads would generate new funds that could be used to provide a variety of roadway improvements. Several of these possible benefits are listed below.

The first benefit toll-generated funds could provide is **improved highway maintenance**. The next three questions examine how much you value road maintenance.

C1) On a scale of 1 to 5, how important is **roadway maintenance** to you? (Circle one)

1	2	3	4	5
Poor				Excellent

C2) Suppose that you had to make a 15 mile trip that takes, on average, 30 minutes to make. What is the highest toll you would pay to use a toll road that was maintained **moderately** better than alternate routes? This means the toll road would have fewer potholes, more signs, and somewhat better lighting than the roads you use today. (Please circle the highest toll you would pay to use this road.)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

C3) Suppose that you had to make the same 15 mile trip, but this time the toll road was maintained **substantially** better than alternate routes. This means the toll road would have no potholes, a many more signs, much better lighting, and many fewer bumps than the roads you use today. What is the highest toll you would pay to use this road? (Please circle the highest toll you would pay to use this road.)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

Additional funds generated by tolls could also be used to **reduce travel times** by providing more direct routes, more lanes, and discouraging unnecessary trips. The next three questions examine how much you value travel time savings.

C4) On a scale of 1 to 5, how important is **travel time** to you during the most frequent trip you mentioned in section B above? (circle one)

1	2	3	4	5
Poor				Excellent

C5) Suppose on average, **a 15 mile trip takes 30 minutes** on an existing non-tolled road. Suppose a toll road allows you to make the trip in **25 minutes (you save 5 minutes)** by providing a more direct and congestion-free route. What is the highest toll you would pay to use this road? (circle one)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

C6) Suppose the toll road allows you to make the 30 minute trip in **15 minutes (you save 15 minutes).** What is the highest toll you would pay to use this road? (circle one)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

A final benefit toll-generated funds could provide is **improved reliability.** Good reliability means that you would arrive at your destination close to the time you planned your arrival. Bad reliability means that you could arrive at your destination much later than you planned to arrive at the destination.

C7) On a scale of 1 to 5, how important is **reliability** to you during the most frequent trip you mentioned in section B? (circle one)

1	2	3	4	5
Poor				Excellent

C8) Suppose, on average, a 15 mile trip takes 30 minutes on an existing non-tolled road. However, the trip on this **free roads has a maximum travel time of 50 minutes** (20 minutes longer than expected). Suppose a toll road has the same average travel time as the free roads (30 minutes), but **the toll road has a maximum travel time of only 45 minutes**. What is the highest toll you would pay to use the toll road? (circle one)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

C9) Now, suppose the toll road has the same average travel time as the free road (30 minutes), but has a **maximum travel time of only 35 minutes**. What is the highest toll you would pay to use the toll road? (circle one)

1. $2.5 or more
2. $2.0
3. $1.5
4. $1.0
5. $0.5
6. Would not pay toll

SECTION D

Finally, we would like to know a little about you and your household. Your accurate responses to these questions will help us classify the results we obtain.

D1) What county do you live in?

____

D2) What is your gender? (circle one)

1. Female
2. Male

D3) What is your age? (circle one)

1. Under 21	2. 21-30
3. 31-40	4. 41-50
5. 51-60	6. over 60

D4) How many passenger vehicles do you have in your household? (including pickups and motorcycles) ___________

D5) How many people live in your household? _____________

D6) How many people have a driver's license in your household?

____

D7) Finally, which of the following categories describes your household's gross (before taxes) annual income? (circle one)

1. under $20,000
2. $20,000-40,000
3. $40,000-60,000
4. $60,000-80,000
5. over $80,000

Thank you for participating in this important study.
Please feel free to add any additional comments below.

Appendix C: Initial Mailing Cover Letter

COLLEGE OF ENGINEERING

THE UNIVERSITY OF TEXAS AT AUSTIN

Center for Transportation Research · Suite 200
3208 Red River · Austin, Texas 78705-2650 · (512) 472-8875 · FAX (512) 480-0235

April 3, 1994

Dear Texas Resident:

One of the most important challenges Texas faces in the coming century is funding its highway network. Growth in both rural and urban areas of the state is forcing state and local officials to consider new transportation funding sources to meet the transportation needs of Texas residents like yourself. The Center for Transportation Research at the University of Texas at Austin has been examining several promising methods including highway tolling.

Knowing what individuals like yourself think about tolls is extremely important to state policy makers and will influence the outcome of highway funding decisions. Your household is one of a small number which has been randomly selected from all Texas residents to give your opinions about these matters. To truly represent the thinking of the community, it is important that we receive your completed questionnaire.

The enclosed questionnaire should take about 15 minutes to complete. In appreciation of your time and effort, we have enclosed a *Texas Official Highways Travel Map.* We hope you find it useful. When you are finished with the questionnaire please place it in the pre-addressed postage-paid envelope and drop it in the mail. Your responses will be kept completely confidential.

Christopher Oswald, the survey team leader, would be happy to answer any questions you might have. His telephone number is (512) 471-8270.

Thank you very much for your assistance.

Sincerely,

C. Michael Walton, P.E.
Ernest H. Cockrell Centennial Chair
in Engineering and Chairman

Appendix D: Follow-Up Mailing Cover Letter

COLLEGE OF ENGINEERING
THE UNIVERSITY OF TEXAS AT AUSTIN

Center for Transportation Research • Suite 200
3208 Red River • Austin, Texas 78705-2650 • (512) 472-8875 • FAX (512) 480-0235

May 8, 1994

Dear Texas Resident:

About four weeks ago we solicited your opinion about funding options for Texas highways. Our records indicate that we have not yet heard from you. We are writing you again so that your input can be included in our study.

The Center for Transportation Research at the University of Texas at Austin has undertaken this study because of the belief that Texas citizens' opinions should be taken into account in the formation of state highway policy.

Each completed questionnaire is significant to the usefulness of this study. Your name was drawn through a scientific sampling process in which every household in Texas had an equal chance of being selected. This means that only about one out of every 2,800 people in Texas are being asked to complete this questionnaire. Knowing what individuals like yourself think about highway funding, particularly tolls, is extremely important to state policy makers and will influence the outcome of highway funding decisions. Please make your opinion count.

A replacement questionnaire is enclosed in case your original questionnaire has been misplaced. Let me reassure you that your responses will be kept completely confidential. To back up this claim, identification numbers have been deleted from the replacement questionnaire. Christopher Oswald, the survey team leader, is still available to answer any questions you might have. His telephone number is (512) 471-8270.

Thank you very much for your assistance.

Sincerely,

C. Michael Walton
Ernest H. Cockrell Centennial Chair
in Engineering and Chairman

P.S. If your name was not the one on the envelope, we still appreciate your opinion. If you are over 18, you can fill out the questionnaire yourself. If you have already sent your first questionnaire back, there is no need to reply to this letter.

Appendix E: Demographic Results

Table E-1 presents the compiled results from the categorical questions from Section D of the survey. These questions include D2, D3, and D7. In addition, three aggregate measures based on respondents' counties of residence (Question D1) have been computed. The methodology for computing these measures, County Class 1, County Class 2, and Geographic Class, are described in Chapter 4.

The first two columns of Table E-1 categorize the results by question and answer category respectively. The frequency of response and the corresponding sample proportion it represents are contained in the next two columns. These numbers are totaled in the rows labeled "TOTAL." Note that the percentages in the "TOTAL" rows do not equal 100 because they represent the proportion of individuals from the entire 2,388 member sample that responded to the specific question. The fourth and fifth columns contain the lower and upper bounds of the 95th percentile confidence interval for the measured proportions. Finally, the last column contains the actual Texas population proportions from the 1990 U.S. census. (Note that census figures are only included when available.)

Table E-1: Demographic Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval Lower Bound	Upper Bound	1990 Census Values
County Class 1	Large Urban	1372	**58.7%**	56.7%	60.7%	54.7%
	Small Urban	485	**20.7%**	19.1%	22.3%	18.8%
	Rural	482	**20.6%**	19.0%	22.2%	26.5%
	TOTAL	2339	**97.9%**			
County Class 2	Tolled Urban	1180	**50.4%**	48.4%	52.4%	50.8%
	Lg.Non-Toll Urban	393	**16.8%**	15.3%	18.3%	12.8%
	Small Urban	302	**12.9%**	11.5%	14.3%	11.2%
	Rural	464	**19.8%**	18.2%	21.4%	25.2%
	TOTAL	2339	**97.9%**			
Geographic Class	Gulf Coast	676	**28.9%**	27.1%	30.7%	30.8%
	Plains	274	**11.7%**	10.4%	13.0%	11.1%
	Border	122	**5.2%**	4.3%	6.1%	9.8%
	East Texas	145	**6.2%**	5.2%	7.2%	7.9%
	Central Corridor	462	**19.8%**	18.2%	21.4%	12.9%
	Metroplex	660	**28.2%**	26.4%	30.0%	27.5%
	TOTAL	2339	**97.9%**			
D2 Gender	Female	571	**24.3%**	22.6%	26.0%	50.70%
	Male	1784	**75.7%**	74.0%	77.4%	49.30%
	TOTAL	2355	**98.6%**			
D3 Age	Under 21	5	**0.2%**	0.0%	0.3%	6.90%
	21 to 30	159	**6.8%**	6.3%	7.3%	23.80%
	31 to 40	498	**21.2%**	19.5%	22.9%	23.40%
	41 to 50	571	**24.3%**	22.6%	26.0%	16.40%
	51 to 60	419	**17.8%**	16.3%	19.3%	11.20%
	over 60	698	**29.7%**	27.9%	31.5%	18.30%
	TOTAL	2350	**98.4%**			

Table E-1 continued

D7 Income	Under $20,000	283	**12.8%**	11.4%	14.2%	N/A
	$20,001 to $40,000	634	**28.6%**	26.7%	30.5%	N/A
	$40,001 to $60,000	582	**26.2%**	24.4%	28.0%	N/A
	$60,001 to $80,000	344	**15.5%**	14.0%	17.0%	N/A
	Over $80,000	374	**16.9%**	15.3%	18.5%	N/A
	TOTAL	2217	**92.8%**			

Table E-2 presents the descriptive statistics for continuous (non-categorical) demographic data. These statistics include the mean and standard deviation of the measured variables as well as the number of observations recorded. Note the first column which indicates the source of the data. "Calculated" in the last row refers to the fact that the row was calculated rather than obtained directly from the returned surveys. "Vehicles per License" values were generated by simply dividing individuals' responses to Question D4 by their responses to Question D6.

Table E-2: Demographic Means

Question		**Sample Size**	**Min.**	**Max.**	**Mean**	**Standard Deviation**
D4	**# of Vehicles in Household**	2347	0	10	**2.2**	1.0
D5	**# of People in Household**	2348	1	11	**2.7**	1.3
D6	**# Driver's Licenses**	2341	0	7	**2.1**	0.8
Calculated	**Vehicles per License**	2332	0	6	**1.1**	0.4

Appendix F: Most Frequent Trip Characteristics

Table F-1 presents results from the categorical response questions in Section B of the survey that pertained to the sample population as a whole. Table F-2 presents the descriptive statistics from the non-categorical questions in the same section. Tables F-3 and F-4 present current toll road usage information. This information, collected only from individuals who are frequent toll road users, has been tabulated in the same fashion as the whole sample information; Table F-3 contains categorical data and Table F-4 contains statistics compiled from non-categorical data.

A few of the items in the tables below require some explanation. Average travel speed was computed by dividing trip distance (Question B4) by average travel time (Question B5). The results from Questions B10c and B10d have not been presented due to a confounding of the responses between the two categories. Revealed per mile cost was computed by dividing toll road user's reported toll (Question B12) by the length of toll road used (Question B13). Likewise, revealed travel time value was computed by dividing the toll by reported time savings (Question B14). Finally, respondents were permitted up to three responses to Question B16. As a result, the sample size for Question B16 is much higher than the response rate to the other toll road usage questions. Proportions of response were computed relative to the total number of responses (up to three per survey) to Question B16.

Table F-1: Most Frequent Trip Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval	
				Lower Bound	Upper Bound
B1 Trip Purpose	Work	1678	**70.9%**	69.1%	72.7%
	Child Care	29	**1.2%**	0.8%	1.6%
	Shopping	471	**19.9%**	18.3%	21.5%
	Recreation	127	**5.4%**	4.5%	6.3%
	Other	61	**2.6%**	2.0%	3.2%
	TOTAL	2366	**99.1%**		
B2 Mode	Car	2208	**93.4%**	92.4%	94.4%
	Carpool	112	**4.7%**	3.8%	5.6%
	Transit	18	**0.8%**	0.4%	1.2%
	Other	8	**0.3%**	0.0%	0.5%
	Combination	19	**0.8%**	0.4%	1.2%
	TOTAL	2365	**99.0%**		
B3 Round Trip Frequency					
	5 or more per week	1675	**71.7%**	69.9%	73.5%
	2 to 4 per week	458	**19.6%**	18.0%	21.2%
	1 per week	79	**3.4%**	2.7%	4.1%
	More than 1 per month	82	**3.5%**	2.8%	4.2%
	Less than 1 per month	42	**1.8%**	1.3%	2.3%
	TOTAL	2336	**97.8%**		
B7 Maintenance Rating	Poor	91	**3.9%**	3.1%	4.7%
		215	**9.2%**	8.0%	10.4%
	Average	701	**29.9%**	28.0%	31.8%
		947	**40.3%**	38.3%	42.3%
	Excellent	393	**16.7%**	15.2%	18.2%
	TOTAL	2347	**98.3%**		
B8 Congestion Rating	Gridlock	43	**1.8%**	1.3%	2.3%
		311	**13.3%**	11.9%	14.7%
	Average	837	**35.7%**	33.8%	37.6%
		706	**30.1%**	28.2%	32.0%
	None	448	**19.1%**	17.5%	20.7%
	TOTAL	2343	**98.1%**		

Table F-1 continued

B9a Home Location	Large Metro.	820	**35.4%**	33.5%	37.3%
	Medium Metro.	374	**16.2%**	14.7%	17.7%
	Small Metro.	367	**15.8%**	14.3%	17.3%
	Semi-Urban	332	**14.3%**	12.9%	15.7%
	Semi-Rural	222	**9.6%**	8.4%	10.8%
	Rural	202	**8.7%**	7.6%	9.8%
	TOTAL	2317	**97.0%**		
B9a Destination Location	Large Metro.	1019	**44.5%**	42.5%	46.5%
	Medium Metro.	377	**16.4%**	14.9%	17.9%
	Small Metro.	372	**16.2%**	14.7%	17.7%
	Semi-Urban	235	**10.2%**	9.0%	11.4%
	Semi-Rural	157	**6.9%**	5.9%	7.9%
	Rural	132	**5.8%**	4.8%	6.8%
	TOTAL	2292	**96.0%**		
B10a Toll Road Frequency	Less than 1 per month	1838	**80.7%**	7901%	82.3%
	Less than 1 per week	228	**10.0%**	8.8%	11.2%
	1 per week to evrday	140	**6.2%**	5.2%	7.2%
	Everyday	70	**3.1%**	2.4%	3.8%
	TOTAL	2276	**95.3%**		
B10b Expressway Frequency	Less than 1 per month	352	**15.7%**	14.2%	17.2%
	Less than 1 per week	244	**10.9%**	9.6%	12.2%
	1 per week to evrday	679	**30.2%**	29.3%	32.1%
	Everyday	969	**43.2%**	41.2%	45.2%
	TOTAL	2244	**94.0%**		

Table F-2: Most Frequent Trip Descriptive Statistics

Question		Sample Size	Min.	Max.	Mean	Standard Deviation
B4	Trip Distance	2322	0.2	1500	**26.4**	73.0
B5	Average Travel Time	2303	1	10140	**39.6**	224.8
Calculated	Average Speed	2290	0.8	85.7	**36.8**	17.0
B6	Delay Frequency	2206	0	10	**1.25**	1.51

Table F-3: Toll Road Use Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
B11 Toll Road Used	Sam Houston	206	**46.7%**	42.0%	51.4%
	Hardy	55	**12.5%**	9.4%	15.6%
	Dallas North	158	**35.8%**	31.3%	40.3%
	Other	22	**5.0%**	3.0%	7.0%
	TOTAL	441	**18.5%**		
B15 Toll Tag Use	Use	49	**11.2%**	8.2%	14.2%
	Don't Use	389	**88.8%**	85.8%	91.8%
	TOTAL	438	**18.3%**		
B16 Toll Use Reason	No Alternative	17	**1.7%**	0.9%	2.5%
	Saves Time	366	**35.7%**	32.8%	38.6%
	Better Maintained	106	**10.4%**	8.5%	12.3%
	More Reliable	206	**20.1%**	17.6%	22.6%
	Safer	76	**7.4%**	5.8%	9.0%
	Less Congested	243	**23.7%**	21.1%	26.3%
	Other	10	**1.0%**	0.4%	1.6%
	TOTAL	1024	**42.9%**		

Table F-4: Toll Road Use Descriptive Statistics

Question		Sample Size	Min.	Max.	Mean	Standard Deviation
B12	**Toll Charged**	438	$0.00	$7.50	**$1.1**	$0.83
B13	**Toll Segment Length (miles)**	409	0.5	215	**14.0**	17.5
Calculated	**Value per Mile**	390	$0.00	$0.75	**$0.07**	$0.064
B14	**Toll Road Time Savings (minutes)**	421	0	180	**18.8**	14.0
Calculated	**Value per Minute**	364	$0.00	$0.75	**$0.073**	$0.062

Appendix G: Attitude Results

Table G-1 contains the aggregate responses to Section A of the survey. It was compiled indentically to the demographic proportions in Appendix F.

Table G-1: Attitude Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval	
				Lower Bound	Upper Bound
A1 Highway Rating	Poor	20	**0.8%**	0.4%	1.2%
		68	**2.9%**	2.2%	3.6%
	Average	528	**22.3%**	20.6%	24.0%
		1251	**52.8%**	50.8%	54.8%
	Excellent	502	**21.2%**	19.6%	22.8%
	TOTAL	2369	**99.2%**		
A2 Amount to Spend	More	689	**29.3%**	27.5%	31.1%
	Same	1575	**67.0%**	65.1%	68.9%
	Less	86	**3.7%**	2.9%	4.5%
	TOTAL	2350	**98.4%**		
A3 Funding Preference	Toll	1334	**58.7%**	56.7%	60.7%
	Fuel Tax	940	**41.3%**	39.3%	43.3%
	TOTAL	2274	**95.2%**		
A4 Toll Reason	Direct Charge	709	**52.0%**	49.3%	54.7%
	Anti-Tax	402	**29.5%**	27.1%	31.9%
	Faster Improvment	111	**8.2%**	6.7%	9.7%
	Good Experience	118	**8.7%**	7.2%	10.2%
	Other	22	**1.6%**	0.9%	2.3%
	TOTAL	1362	**57.0%**		

Table G-1 continued

A5 Fuel Tax Reason	Don't Want to Stop	169	**17.6%**	15.2%	20.0%
	Traffic at Booth	104	**10.8%**	8.8%	12.8%
	Expensive	139	**14.4%**	12.2%	16.6%
	Shouldn't Have to Pay	270	**28.0%**	25.2%	30.8%
	Bad Experience	47	**4.9%**	3.5%	6.3%
	Other	131	**13.6%**	11.4%	15.8%
	All Pay	71	**7.4%**	5.7%	9.1%
	Tax More Fair	32	**3.3%**	2.2%	4.4%
	TOTAL	963	**40.3%**		
A6 Congestion Price	Pricing	463	**20.0%**	18.5%	21.7%
	No Pricing	1843	**80.0%**	78.3%	81.5%
	TOTAL	2306	**96.6%**		
A7 Toll Applicability	New Roads	1452	**63.6%**	61.6%	65.6%
	Both	767	**33.6%**	31.7%	35.5%
	Existing Roads	63	**2.8%**	2.1%	3.5%
	TOTAL	2282	**95.6%**		
A8 Toll Transfer	Toll Road Only	1266	**55.5%**	53.5%	57.5%
	Both Toll & Non-Toll	1017	**44.5%**	42.5%	46.5%
	TOTAL	2283	**95.6%**		

Appendix H: Valuation Data

Tables H-1 and H-2 contain the aggregate responses to the three categorical benefit importance questions from Section C of the survey for the protest-included and protest-excluded data sets respectively. They were compiled in an identical manner to the demographic proportions presented in Appendix F. Table H-3 presents the descriptive statistics from the six benefit valuation questions themselves. In addition to the data obtained directly from the survey, Table H-3 displays the values of travel time that correspond to the two levels of travel time savings. These values were obtained by dividing the values indicated in Questions A5 and A6 by their respective time savings (5 minutes for A5 and 15 minutes for A6). Table H-4 is identical to Table H-3 except that it excludes "protest voters" in an attempt to mitigate strategic bias. Protest voters were defined in Chapter 6 as respondents that preferred fuel taxes in Question A3 and selected a value of $0.00 for all six hypothetical toll road benefit situations (Questions C2, C3, C5, C6, C8, and C9).

Table H-1: Protest-Included Benefit Importance Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval	
				Lower Bound	Upper Bound
C1	Very Important	1266	**54.1%**	52.1%	56.1%
Maintenance		718	**30.7%**	28.8%	32.6%
Importance	Average	243	**10.4%**	19.2%	11.6%
		77	**3.3%**	2.6%	4.0%
	Not Important	35	**1.5%**	1.0%	2.0%
	TOTAL	2339	**97.9%**		
C4	Very Important	771	**33.6%**	31.7%	35.5%
Travel Time		590	**25.7%**	23.9%	27.5%
Importance	Average	500	**21.8%**	20.1%	23.5%
		249	**10.9%**	9.6%	12.2%
	Not Important	182	**7.9%**	6.8%	9.0%
	TOTAL	2292	**96.0%**		

Table H-1 continued

C7 Reliability Importance	Very Important	816	**35.6%**	33.6%	37.6%
		703	**30.7%**	28.8%	32.6%
	Average	467	**20.4%**	18.8%	22.0%
		183	**8.0%**	6.9%	9.1%
	Not Important	124	**5.4%**	4.5%	6.3%
	TOTAL	2293	**96.0%**		

Table H-2: Protest-Excluded Benefit Importance Proportions

Question	Answer	Freq.	Percent	95% Confidence Interval Lower Bound	Upper Bound
C1 Maintenance Importance	Very Important	1171	**54.9%**	52.8%	57.0%
		653	**30.6%**	28.6%	32.6%
	Average	211	**9.9%**	8.6%	11.2%
		69	**3.2%**	2.5%	3.9%
	Not Important	29	**1.4%**	0.9%	1.9%
	TOTAL	2133	**89.3%**		
C4 Travel Time Importance	Very Important	740	**35.5%**	33.4%	37.6%
		550	**26.4%**	24.5%	28.3%
	Average	446	**21.4%**	19.6%	23.2%
		214	**10.3%**	9.0%	11.6%
	Not Important	135	**6.4%**	5.3%	7.5%
	TOTAL	2085	**87.3%**		
C7 Reliability Importance	Very Important	790	**37.8%**	35.7%	39.9%
		652	**31.2%**	29.2%	33.2%
	Average	402	**19.3%**	17.6%	21.0%
		153	**7.3%**	6.2%	8.4%
	Not Important	91	**4.4%**	3.5%	5.3%
	TOTAL	2088	**87.4%**		

Table H-3: Protest-Included Benefit Valuation Descriptive Statistics

Question		Sample Size	Min.	Max.	Mean	Standard Deviation
C2	Moderate Maintenance Improvement	2289	$0.00	$2.50	**$0.53**	$0.51
C3	Substantial Maintenance Improvement	2288	$0.00	$2.50	**$0.77**	$0.60
C5	5 Minute Time Savings	2289	$0.00	$2.50	**$0.49**	$0.54
C6	15 Minute Time Savings	2288	$0.00	$2.50	**$0.83**	$0.63
Calculated	5 Minute Value of Time	2289	$0.000	$0.500	**$0.11**	$0.103
Calculated	15 Minute Value of Time	2288	$0.000	$0.167	**$0.051**	$0.040
C8	45 Minute Maximum Travel Time	2295	$0.00	$2.50	**$0.45**	$0.54
C9	35 Minute Maximum Travel Time	2295	$0.00	$2.50	**$0.67**	$0.59

Table H-4: Protest-Excluded Benefit Valuation Descriptive Statistics

Question		Sample Size	Min.	Max.	Mean	Standard Deviation
C2	Moderate Maintenance Improvement	2076	$0.00	$2.50	**$0.59**	$0.51
C3	Substantial Maintenance Improvement	2076	$0.00	$2.50	**$0.84**	$0.58
C5	5 Minute Time Savings	2081	$0.00	$2.50	**$0.54**	$0.55
C6	15 Minute Time Savings	2080	$0.00	$2.50	**$0.92**	$0.60
Calculated	5 Minute Value of Time	2081	$0.000	$0.500	**$0.12**	$0.102
Calculated	15 Minute Value of Time	2080	$0.000	$0.167	**$0.056**	$0.038
C8	45 Minute Maximum Travel Time	2087	$0.00	$2.50	**$0.49**	$0.54
C9	35 Minute Maximum Travel Time	2087	$0.00	$2.50	**$0.74**	$0.58