PANEL SURVEY EVALUATION OF ATTITUDES AND WILLINGNESS TO PAY FOR TOLLED FACILITIES

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Submission Date: August 6, 2006

Word Count: 7,357

ABSTRACT

This paper presents results of an evaluation study of the behavioral impacts of a high occupancy toll (HOT) lane project in Minnesota. The I-394 MnPASS Express Lane Project is the fifth HOT lane project in the U.S. Although other HOT lanes exist, they remain a new enough concept that there is little empirical information on their evaluation methods and their impacts on travel behavior for transportation planners and policy makers to use when making decisions about future facilities. The MnPASS evaluation study is significant not only because it uses a panel design, but also because it involved multiple waves of stated preferences experiments. These waves were conducted "before and after" the project implementation. This paper uses information from the evaluation study to examine two significant issues:

- How applicable is a panel design to evaluating road pricing projects?
- How does willingness to pay vary based on "before and after" iterations of the stated preference experiments?

INTRODUCTION

A number of new road pricing projects have emerged in the U.S. over the past decade. Currently, 35 of the 50 states have some sort of road pricing project in the planning or implementation stage. One promising approach to implementing road pricing is to convert existing and under-utilized high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes. The development of HOT lanes can bring new revenues and pricing incentives to road use by essentially auctioning off space on existing HOV lanes. HOT lanes have operated in two parts of California (San Diego and Orange Counties) and in Houston, Texas, and additional projects are currently in early implementation or development in eight other states. Are HOT lanes the future for Minnesota drivers? The answer to this question depends, in part, on the results of the I-394 MnPASS Evaluation Attitudinal Panel Survey (hereafter, the Attitudinal Panel Survey).

MnPASS is the first of its kind in Minnesota, and is a new and significant change in highway management for the state. To evaluate public acceptance and use, the Minnesota Department of Transportation (MnDOT) commissioned the University of Minnesota's Hubert H. Humphrey Institute of Public Affair to conduct before-and-after project implementation surveys. NuStats designed and conducted these surveys under contract to the University of Minnesota, and Mark Bradley consulting was commissioned to design and analyze the stated preference (SP) experiments.

The Attitudinal Panel Survey used a longitudinal panel design to collect opinion, travel behavior, and willingness to pay information from users and potential users of the MnPASS Express Lane (Zmud, 2006). Although panel designs have enjoyed widespread use in transportation studies in other countries, and in work in other fields, they have rarely been adopted in transportation surveys in the United States. This is despite the fact that previous research studies have argued effectively about the advantages of panel surveys (Moser and Kalton, 1979; Duncan, et al., 1987; Golob et al., 1997; Dennis and Lee, 2003). One advantage that research panels have for longitudinal research is that costs of the initial recruitment can be spread out over multiple waves of data collection. Also the statistical power for detecting differences in experimental designs and for improving the predictive reliability is enhanced by repeated same-subject measurements. Given the increase in interest in road pricing projects, this paper uses information from the Attitudinal Panel Survey to examine two significant issues:

- How applicable is a panel design to evaluating road pricing projects?
- How does willingness to pay vary based on "before and after" iterations of the stated preference experiments?

This paper presents information about MnPASS Express Lane Project, followed by information on the Attitudinal Panel Survey design and respondent participation patterns across the three waves of data collection. This information is followed by a description of the SP design, the SP analysis and

its findings. Finally, the paper concludes with comments on the research questions above.

MNPASS EXPRESS LANE PROJECT

The I-394 MnPASS Express Lane project began allowing solo drivers to pay a fee to use an 11-mile stretch of carpool lanes between downtown Minneapolis and the western suburbs in May 2005. While solo drivers pay to use the MnPASS lanes, carpoolers, bus riders, and motorcyclists may use the lanes free of charge. Dynamic pricing ensures continued free flow in the lanes at about 50 to 55 miles per hour by adjusting the toll up or down depending upon the amount of traffic in the lanes. The variable, per-trip fee is always charged for single-occupancy vehicle (SOV) use in a reversible section, while fees are only charged in the peak direction during rush hours in the "diamond lane" section. The per-trip fee depends on where users enter and exit the MnPASS Express Lanes. Separate tolls are charged for use of each section. The fee is posted on message signs, adjusted as often as every three minutes, located just before entrances to MnPASS lanes. The tolls range from 25 cents to $8 and average $1 to $4 during rush hour.

Solo drivers who subscribe to the MnPASS program are issued windshield-mounted transponders for automatic vehicle identification. Each time subscribers use the lanes; their accounts are automatically debited the per-trip fee. MnPASS subscribers also pay a $1.50 monthly fee for leasing the MnPASS transponder. The transponders are read by antennae stationed at the access points in the lanes. Enforcement is carried out by local law enforcement that patrol the MnPASS lane. Readers in their vehicles can determine whether a vehicle has a "working" transponder or not. This technology plus visual determination of vehicle occupancy is used for enforcement. Violation of the MnPASS lane is subject to a $142 fine. As for actual usage, there are currently (July 2006) over 9,500 transponders leased to over 7,700 account holders. The lanes are averaging between 18,000 and 20,000 trips a week and are bringing in about $18,000 a week in toll revenue (Douma, 2006).

ATTITUDINAL PANEL SURVEY DESIGN

The Attitudinal Panel Survey measured the attitudes, perceptions, and reported travel behaviors of a scientific sample of residents of the study area. It covered issues of acceptance, equity, effectiveness in congestion management, toll system performance, as well as changes in travel behavior, mode choice, and route choice and willingness to pay for the priced lane before-and-after the project implementation. As depicted in Figure 1, the survey waves took place in Fall 2004, Fall 2005, and Spring 2006.

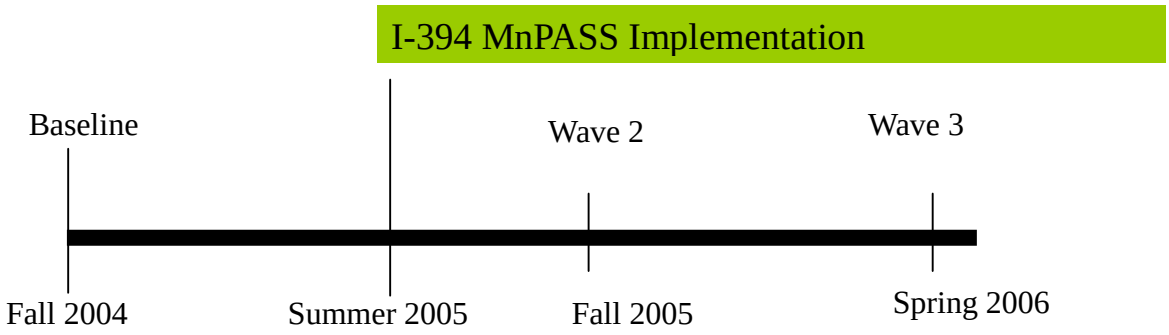

FIGURE 1 Attitudinal panel survey timeline

Baseline (Wave 1) Survey

Data collection for the Baseline Survey was completed in November/ December 2004, prior to the opening of the I-394 MnPASS Express Lane. The design included the use of a treatment sample and control sample. The treatment sample consisted of households selected from the I-394 corridor, and the control sample consisted of households in the I-35W corridor. I-35W was selected as the control because it was the only other facility with carpool lanes in the study area

The population under study consisted of those individuals 18 years of age or older, residing within the target travel sheds, who had traveled the target segments of I-394 and I-35W corridors between 6am and 9pm at least once in the five weekdays prior to the day of interview. To efficiently sample this population, specific areas were pre-identified as being the likely residential locations for I-394 or I-35w users based on origin and destination data from the Household Travel Diary Survey, conducted by NuStats as one element of the Twin Cities Metropolitan Area Travel Behavior Inventory (TBI). These data were used to identify the areas that generated the highest proportions of target trips. Random digit dial (RDD) sample was then proportionally allocated to those areas.

The survey materials consisted of an advance letter and a computer-assisted telephone interview (CATI) questionnaire. The questionnaire was developed based upon the objectives and research questions identified by a team that included MnDOT and other representatives from the I-394 MnPASS team. In addition, the Baseline Survey questionnaire drew from instruments used to evaluate predecessor projects, SR91 and I-15 in California. The Baseline Survey questionnaire contained six sections: (1) eligibility screening, (2) attitude/ opinion, (3) information about travel during the assigned travel week, (4) reference trip information, (5) stated preference questions, and (6) demographics. The questionnaire also contained a script to recruit respondents into the panel. Approval from the Institutional Review Board (IRB) of the University of Minnesota was obtained prior to administering these materials.

A total of 750 users of the I-394 corridor and 250 users of the control corridor (I-35W) were interviewed. An overall response rate of 66% was achieved. Nearly all of the 1,000 respondents (980) agreed to participate in future waves, thus forming the base panel sample for Wave 2 of the

Attitudinal Panel Survey. In March of 2005, postcards were sent to these persons reminding them of their prior consent to being interviewed in the Wave 2 Survey.

Wave 2 Survey

In addition to the 980 Baseline Survey respondents who agreed to participate in the panel, NuStats targeted two supplementary sample types for inclusion in the Wave 2 Survey – transit users and MnPASS subscribers (e.g., transponder owners). Both of these sub-groups were targeted to ensure a sufficient sample size for analytical purposes. Transit users were sampled from a list of individuals known to use the local public transportation system supplied by Metro Transit in Minneapolis. The list contained name, address and contact information for 8,600 regional transit users. NuStats randomly selected 1,076 individuals from this list for inclusion in the survey. MnPASS subscribers were sampled from a list of 650 transponder owners supplied by MnDOT. The list contained name, address, contact information and date of account opening.

The survey materials included an advance packet that contained a letter and travel log. The travel log was used by respondents to record general travel information for an assigned travel week as well as information about a specific reference trip. The reference trip characteristics were pulled from the Baseline data and attached to the Travel Log via a mail-merge label. The CATI instrument was a slightly modified version of the Baseline questionnaire.

Data collection for the Wave 2 Survey was completed between November 2005 and January 2006. Wave 2 data collection was originally scheduled to take place in September / October 2005. However, it was re-scheduled to begin in November as a result of construction taking place on I-394 during the early Fall time period. In order to keep panel members abreast of the situation, another postcard was sent to panel members in early Fall. A total of 950 respondents completed the Wave 2 Survey. Of these, 549 were panel members (interviewed in both the Baseline and Wave 2), 151 were MnPASS subscribers, and 250 were transit users. The overall response rate was 65%.[1] Table 1 provides additional detail on the panel sample.

TABLE 1 Completion Rates by Sample Type – Wave 2

Sample Type	Sample	Completed Interviews	Completion Rate (%)
I-394 Baseline	736	413	56
I-35W Baseline	244	136	56
MnPASS Subscribers	583	151	26
Transit Users	1,001	250	25
Total	2,564	950	37

Source: NuStats (2006) MnPASS Evaluation Attitudinal Panel Survey Wave 2, Final Report

The Wave 2 Survey experienced an attrition rate of 44% of the Baseline respondents.

[1] Response rate takes into consideration eligibility criteria such as disconnected phone numbers and use of the target corridor so that it is higher than the completion rate presented in Table 1.

While this rate of attrition was higher than expected, it is comparable to that experienced in other recent transportation panels.[2] Reasons for the attrition in Wave 2 included: unable to locate or contact target person, target person no longer willing to participate, or target person no longer using corridor. Because of the panel attrition, an analysis was conducted in which the demographic characteristics of respondents completing both Waves 1 and 2 were compared to respondents who only completed the Baseline Survey. The analysis revealed that persons "lost" to the panel tended to be persons who rented rather than owned their residences and who were age 34 or younger. This outcome was not surprising given the fact that such persons tend to be more mobile. They would be more likely to change residences, jobs or their travel patterns making them difficult to locate and /or otherwise non-qualified to participate in the Wave 2 survey. For other demographic characteristics measured, no significant differences were found.[3] The attrition did reduce the effective sample size for longitudinal analysis – particularly those analyses of specific sub-samples, such as those used in the SP analysis.

Eighty-nine percent of the total 950 Wave 2 respondents (or 847 persons) agreed to be re-contacted in the Wave 3 Survey. Of the 549 panel members, 88% (or 482 persons) agreed to be re-contacted in the Wave 3 Survey.

Wave 3 Survey

Wave 3 was the final wave of the Attitudinal Panel Survey. It had four unique sample types: (1) returning random panel (N=549), (2) MnPASS subscriber panel (N=151), (3) transit panel (N=250), and (4) a new random cross-sectional sample. This latter sample type was added to refresh the random sample of I-394 travel shed respondents. It consisted of RDD sample drawn in a similar manner to the Baseline Survey sample. The Wave 3 Survey utilized slightly modified versions of the Wave 2 materials. Wave 3 data collection took place in May / June 2006. In order to remind panel members of their agreement to be interviewed, a postcard was sent to panel members in early April. A total of 1,228 respondents completed Wave 3 interviews. Of these, 343 were panel members (interviewed in the Baseline, Wave 2 and Wave 3), 106 were MnPASS subscribers, 178 were transit users, and 601 were new cross-sectional panel members (see Table 2). In total, two-thirds (66%) of Wave 2 participants were re-surveyed in Wave 3. The overall response rate for the Wave 3 Survey was 45%. One-third (34%) of the original panel members were successfully interviewed in all three waves of the Attitudinal Panel Survey (see Table 3).

TABLE 2 Completion Rates by Sample Type – Wave 3

[2] Panel attrition was about 33% per six-month wave in the I-15 panel survey. The German Mobility Panel experienced a 43% attrition rate in the second wave (i.e., 1-year interval). The London Panel Survey had an attrition rate of 38% per year.

[3] Other demographic variables were: household size, household vehicles, education, employment status, licensed driver, household income, and gender.

Sample Type	Sample	Completed Interviews	Completion Rate (%)
I-394 Baseline & Wave 2	413	266	65%
I-35W Baseline & Wave 2	136	77	57%
MnPASS Subscribers	151	106	70%
Transit Users	250	178	71%
New RDD Sample	6108	601	10%
Total	7058	1228	17%

Source: NuStats (2006) MnPASS Evaluation Attitudinal Panel Survey Wave 3, Final Report

TABLE 3 Panel Attrition Overview

Panel Type	Baseline		Wave 2		Wave 3
	Interviewed	Agreed to Continue	Interviewed	Agreed to Continue	Interviewed
I-394	750	736	413	364	266
I-35W	250	244	136	118	77
Total	1000	980	549	482	343

The Wave 3 Survey experienced an attrition rate of 29% of the Wave 2 panel respondents. Reasons for the attrition in Wave 3 were the same as noted for Wave 2: unable to locate or contact target person, target person no longer willing to participate, or target person no longer using corridor. An analysis of the attrition revealed that there was no systematic bias introduced into the Wave 3 sample. The demographic differences found in the Wave 2 attrition analysis were not present. However, the attrition did reduce the effective sample size for longitudinal analysis – particularly those analyses of specific sub-samples, such as those used in the SP analysis.

STATED PREFERENCE (SP) DESIGN

Stated preference (SP) questions were developed to measure willingness to pay for use of the HOT lane. The same SP measurement design was used in all three waves of data collection, in order to be able to compare SP results across the waves of data collection. SP tradeoff questions were asked of all respondents who reported making a reference trip as a solo driver on the I-394. A quota was designed based on the questionnaire items about the reference trip, to ensure a distribution of 75% peak period and 25% non-peak period trips. The tradeoff questions were introduced with the following wording:

> *Now assume you're making the same trip in the future that you just told me about. It's a trip on the same day of the week, at the same time of day, for the same purpose, and you're under the same time pressures. You enter the freeway, I-394, and find out that you can make this trip using a toll lane and paying via electronic toll collection if you want to.*

To avoid bias due to ordering effects, the questions were asked in two different ways. Versions 1 and 2 below differ only in the order in which the toll and non-toll options are described to the respondent. Each respondent was assigned one of the two orderings at random, and that same ordering was used for all of the SP scenarios presented to that respondent:

VERSON 1: If you were to use the general traffic lanes on I-394, your trip would take [reported travel time without congestion + Y minutes] and be free. If you were to use the toll lane you would $X and your trip would take [reported travel time without congestion] saving Y minutes. Now under these conditions, which would you choose to do?

Use the toll lane, pay $X and save Y minutes

Use the general lane for free.

VERSION 2: If you were to use the toll lane on I-394, you would pay $X and your trip would take [reported travel time without congestion]. If you were to use the general lanes, your trip would take [reported travel time without congestion +Y minutes], Y minutes longer than the toll lane, but it would be free. Now under these conditions, which would you choose to do?

Use the general lane for free.

Use the toll lane, pay $X and save Y minutes

The SP experimental design included two different methods for setting the toll and time savings levels (X and Y above). The reasons for the two methods were: (1) to add confirmatory credibility to the SP results, assuming similar estimates of demand resulted, and (2) to include a method that could provide individual-level estimates of willingness to pay, to facilitate a wider variety of analyses.

In Method A, each person received four different HOT lane scenarios, each with a different amount of time saving (Y = 5, 10, 15 or 20 minutes) and toll (X = 50 cents, $1, $2, $3, $4, $5, $6 or $7). The time for the MnPASS lane was set to be the travel time with no congestion, based on a response to a prior question about a specific reference trip that each respondent had recently made. Nine different sets of four scenarios were used across the sample, with each respondent assigned one of the nine sets at random. So, in total, 36 (9 x 4) different scenarios were used, each identifying a different time savings/toll level tradeoff point, with the identified values of time ranging from $1.50/hour (50 cents for 20 minutes saved) up to $84.hour ($7 for 5 minutes saved).

In Method B, the same type of scenario was presented again, but this time using the “price meter” adaptive approach to set the time and toll levels. Each respondent was assigned a level of time savings (S = 5, 10 or 15 minutes) at random. Then a random toll price point was chosen (P = 50 cents, $1, $2, $3, $4, $5, $6 or $7) and the same question wording as in Method A was used to present

the choice options. If the person said that he/ she would pay the toll, a higher price point was chosen at random, and if he/she said they would not pay the toll, a lower price point was chosen at random, and the question was asked again at the new toll level. This procedure was continued until the "switching point" was identified – e.g. the respondent would be willing to pay a toll of $2, but not $3 – or if the respondent would not pay even the lowest toll level, or would pay even the highest toll level. In this way, the price meter approach provides an individual-level estimate of the willingness to pay (monetary value of time savings) for each respondent. Note that the transition from the Method A design questions to the Method B design question was designed to be transparent to the respondent, since the same question wording was used for both.

STATED PREFERENCE RESPONSES

The SP data on willingness to pay were analyzed in three different ways: (1) cross-sectional comparisons of Baseline, Wave 2, and Wave 3 responses and results; (2) panel analysis to measures the correlation between the individual-level VOT estimates across waves; and (3) a multivariate analysis using pooled Baseline and Wave 3 data. It should be noted that Baseline data was gathered from randomly sampled respondents only; whereas Wave 2 and Wave 3 samples included choice samples as well (i.e., listed samples described elsewhere).

Cross-Sectional Comparisons Across Waves

The first analysis was to compare Wave 3 responses to the Baseline and Wave 2 SP responses and results. In this analysis, there was no explicit linkage between responses from the same panel member in different waves—the data was analyzed as repeated cross-sections, allowing us to use the full samples from both waves, rather than just panel members. There were 412 SP respondents in the Baseline Survey, 366 in Wave 2, and 535 in Wave 3, for a total of 1313. Nearly all of those respondents completed both Methods A and B, with the exception of Wave 2 where Method B was skipped for a substantial number of respondents due to CATI software difficulties. Figure 2 shows the percent of respondents choosing the MnPASS lane at different levels of time savings/toll tradeoff ratios. Although there is inevitably some random noise in such a plot due to fairly small sample sizes at each tradeoff point, the overall patterns look quite smooth and quite similar between the two SP methods and three waves of data.

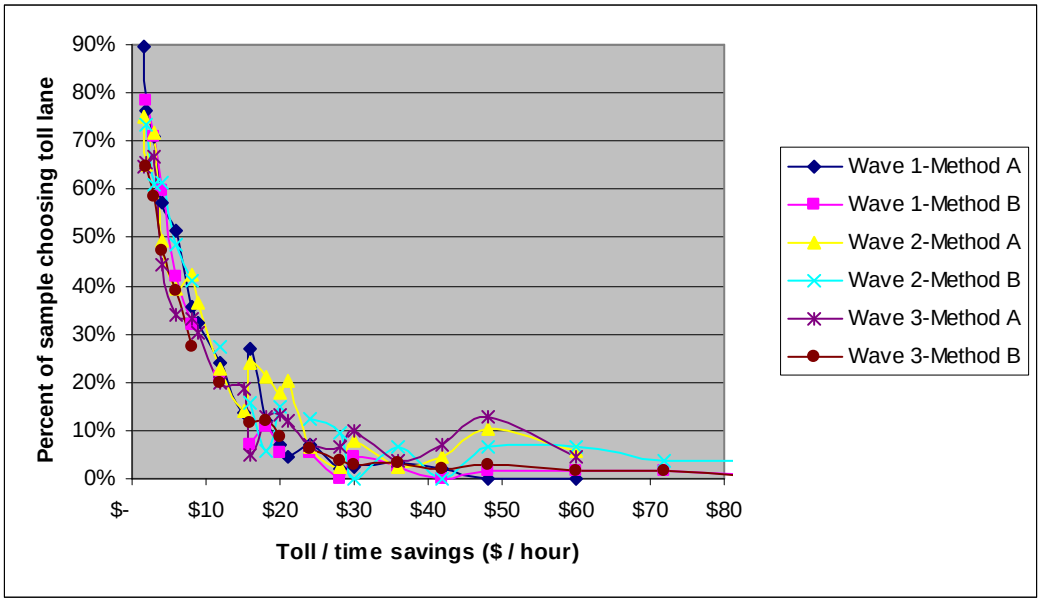

FIGURE 2 Percent of Stated Preference Choices Paying Toll vs. Time/Cost Tradeoff for Cross-Sectional Samples in Baseline, Wave 2, and Wave 3 Surveys

One advantage of the Method B price meter data is that it provides an individual level estimate of VOT for each respondent. Figure 3 is a plot of the cumulative distribution of those values from each of the three waves of data. While the Wave 2 curve looks somewhat different than the Baseline, with somewhat higher values of time, the Wave 3 curve looks almost identical to the Baseline Survey.

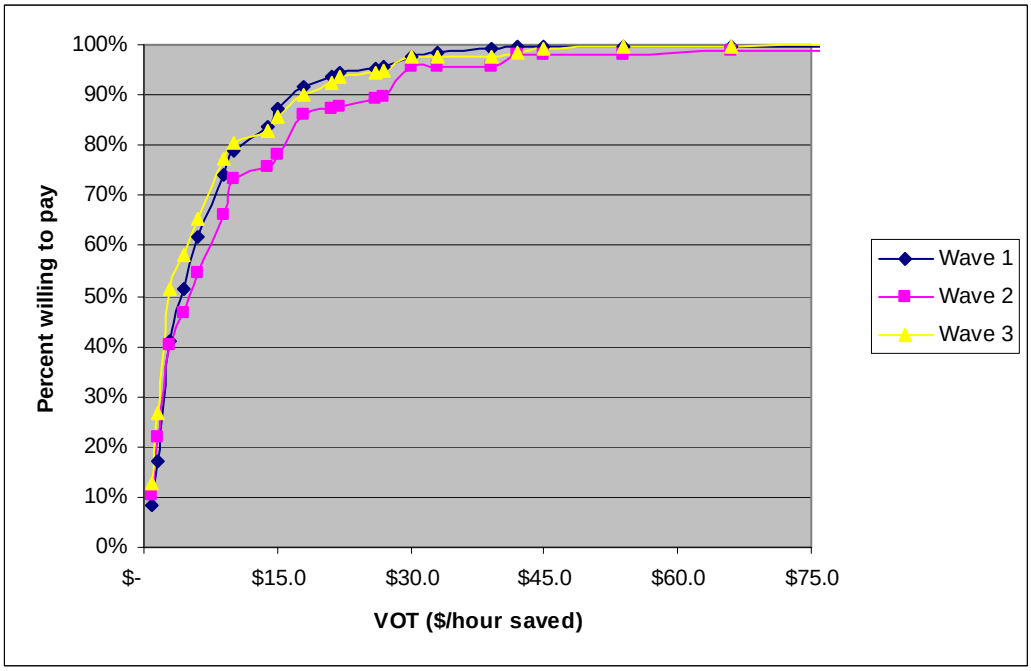

FIGURE 3 Cumulative VOT Distributions from Method B Data for Cross-Sectional Samples in Baseline, Wave 2, and Wave 3 Surveys

Panel Analysis of Individual Level VOT Correlations

Another interesting analysis was to measure the correlation between the individual-level VOT estimates for the same respondents between waves. The results are presented in Table 4.

TABLE 4 Individual-Level VOT Estimates for 3-Wave Panel Respondents Only

Wave Relationship	Frequency	Correlation
Baseline with Wave 2	101	-0.017
Wave 2 with Wave 3	86	+0.095
Baseline with Wave 3	169	+0.367

Source: NuStats (2006) MnPASS Evaluation Attitudinal Panel Survey Wave 3, Final Report

The correlation between the Baseline Survey and Wave 3 VOT's for the 169 respondents who provided price meter data in both waves is +0.367, which is highly statistically significant. The Wave 2 VOT estimates are not significantly correlated with either the Baseline or Wave 3 values for the same persons. This result, combined with the fact that the SP questions were not carried out for a significant percentage of Wave 2 respondents, led us to doubt the usefulness of the intermediate period wave 2 data in comparative analysis. For that reason, the further analysis was described below was carried out using only Waves 1 and 3, the first and last waves.

Multivariate Analysis

In this analysis, the Method A and Method B data from Waves 1 and 3 was pooled in order to estimate a logistic multivariate model of VOT that can sort out the effects of several variables that may be correlated with one another. The results of two of the most interesting models are shown in Table 5. (Note that these models are intended for explanatory purposes, and not for direct use in demand forecasting. Before the data could be used for forecasting, it would need to be weighted to adjust for the non-random methods of recruitment and attrition for the panel, MnPASS and transit samples.) Binary logit models with error scaling were used to estimate models with the time coefficients directly in units of VOT ($/hour). In Model 1, the "base" value of time is $9.63, but there several additional "modifier" variables that are related to either lower or higher willingness to pay:

Income: No significant difference in VOT is found between the income groups below $50K and between $50K and $100K (the base group). However, it appears that willingness to pay rises sharply with income above the $100K level, and is $6.45 (about 70%) higher than the base level for those with income above $125K.

Age: Relative to the base age group of 45-65, younger people have higher VOT and older people have lower VOT, on average. This is presumably due to a busier lifestyle for younger people –

particularly those with children. Note that the age effect is additive to the income effect, and that many younger people have lower than average income, so that the net effect of the age and income modifiers may be negative. This fact underlines the importance of analyzing correlated variables simultaneously to avoid spurious results as much as possible.

Trip purpose/time of day: The willingness to pay for time savings in the AM commute and for work-related non-commute trips is about $3/hour higher than the base, while the VOT for the PM commute is less than $1 higher than the base. The value for non-work trips in the PM peak is about $2/hour lower than the base group. (The "base" group includes any purpose for which there is no modifier variable, in this case mainly off-peak social and recreation trips.)

TABLE 5 Logit Analysis Results

	Model 1		Model 2	
	Coefficient	T-stat	Coefficient	T-stat
Base value of time ($/hour)	9.63	6.9	10.33	7.7
Differences from the base VOT				
HH income under $50K	+0.02	0.0	+0.04	0.1
HH income $100K-$125K	+2.07	4.0	+1.84	3.7
HH income over $125K	+6.21	15.0	+5.12	12.7
Age under 35	+2.44	4.5	+2.62	4.9
Age 35 to 45	+1.38	3.3	+1.42	3.5
Age over 65	-2.87	-4.2	-2.87	-4.3
AM commute trips	+3.46	6.1	+0.86	1.5
PM commute trips	+0.85	1.2	-0.17	-0.3
Other AM peak trips	-0.02	0.0	-0.55	-1.1
Other PM peak trips	-2.10	-3.2	-2.53	-4.0
Work-related trips	+3.82	6.4	+3.21	5.5
Shopping/pers.business trips	+1.51	2.2	+1.51	2.3
Trip distance under 10 miles	-1.90	-4.6	-1.28	-3.2
Trip distance over 20 miles	+2.28	5.6	+1.11	2.7
Time saved = 15 minutes	-2.03	-3.1	-1.84	-3.0
Time saved = 20 minutes	-2.21	-2.5	-1.82	-2.2
Price meter (B) data	-0.16	-0.4	-0.22	-0.5
Wave 1- SP Panel	+0.63	1.2		
- Is a MnPass subscriber			+2.65	1.8
- Is not a MnPass subscriber			+0.70	1.3
- Used the MnPass lane				
- Did not use MnPass lane				

Wave 3 – SP Panel	-3.08	-5.3		
- Is a MnPass subscriber			+2.48	1.8
- Is not a MnPass subscriber			-3.09	-5.4
- Used the MnPass lane				
- Did not use MnPass lane				
Wave 3 – New SP	-1.77	-4.3		
- Is a MnPass subscriber			+5.95	10.3
- Is not a MnPass subscriber			-4.68	-10.6
- Used the MnPass lane				
- Did not use MnPass lane				
Additional variables				
Toll cost ($/$)	-1.00	fixed	-1.00	Fixed
Constant for MnPass lane ($)	-1.61	-8.7	-1.41	-8.1
Scale on the error term	0.8014	38.4	0.8490	38.4
Model fit statistics				
Observations	11250		11250	
Final log-likelihood	-3880		-3705.3	
Rho-squared (0)	0.502		0.525	
Rho-squared (const)	0.31		0.341	

Source: NuStats (2006) MnPASS Evaluation Attitudinal Panel Survey Wave 3, Final Report

Trip distance: Relative to medium-distance trips, trips of less than 10 miles are related to a significantly lower value of time, while trips of more than 20 miles have significantly higher value. One might expect the opposite effect because each minute saved is a higher percentage of travel time on short trips. On the other hand, it is often found that peoples' marginal disutility of in-vehicle time increases as more time is spent in the vehicle, and these results confirm that finding.

Time saved: The willingness to pay for each marginal minute of time saved may also depend on the total amount saved. The marginal willingness to pay for 15 and 20 minute time savings is about $2/hour (about 3.5 cents/minute) lower than for the base levels of 5 and 10 minutes. Perhaps respondents think that saving 5 or 10 minutes would already get congestion down to bearable levels, or else some people may not believe that 15 or 20 minute savings are realistic.

Price meter (method B): When compared to the base Method A data, the price meter SP choices do not give significantly higher or lower values of time. This result is very encouraging for analyses such as this one that pool the data from the two designs together. [Note: For pooled analysis, the adaptive nature of the "price meter" data is adjusted for by using inferred responses for any price levels that were not asked directly. Without such an adjustment, using data from an adaptive SP design is prone to give biased estimates (see Bradley and Daly, 2000).]

Toll lane constant: Aside from time and cost differences, there is a negative constant on the toll lane equivalent to about $1.60. This result suggests that some people have resistance to using the toll lane, regardless of the toll or time savings levels. This may be related to the perceived difficulty of subscribing, of getting into and out of the lane, or simply an aversion to the concept of tolls.

Wave/sample: Among the SP panel members (the 126 individuals that completed all SP questions in both the Baseline and Wave 3, the average VOT in the Baseline was very similar to the that for the other Baseline respondents (63 cents difference). In Wave 3, however, the mean value of time for the SP panel members is $3.71 lower (-$3.08 - 0.63) than it was for the same individuals in the Baseline. That means that the willingness to pay for those individuals dropped by almost 40% between the two waves, after any other differences are taken into account. The VOT for the non-panel SP respondents in Wave 3 is $1.77 lower than for the non-panel in the Baseline. So, the willingness to pay for other respondents also decreased between the two waves, but not by as much as for the SP panel members.

The non-panel SP sample in Wave 3 is non-random and includes a proportion of MnPass subscribers that is higher than in the general population, so any comparison with Wave 1 must be interpreted with caution. Further analysis described below was done in an attempt to sort out some possible reasons for the decrease in willingness to pay between waves. In Model 2, instead of the three VOT modifiers for Baseline SP panel, Wave 3 SP panel and Wave 3 new respondents, each of those groups is further divided by whether or not the respondent was a MnPass subscriber at the time of Wave 3. The results are:

- **SP panel members who have subscribed to MnPass**: In the Baseline, (before they actually subscribed), this group had a $2.65 higher willingness to pay than the other Baseline respondents. In Wave 3, the same group had an average willingness to pay that was virtually unchanged since the Baseline ($2.48 higher than the base group).
- **SP panel members who have NOT subscribed to MnPass:** In the Baseline, this group has an average VOT that was not significantly different ($0.70 higher) than the other Baseline respondents. In Wave 3, however, the average VOT for this group is over $3.00 lower than the base group. Thus, the drop in willingness to pay among panel members occurs entirely among those who have not subscribed to MnPass.
- **New Wave 3 SP respondents who have subscribed to MnPass:** This group has the highest VOT, about $6/hour higher than the non-panel Wave 1 SP.
- **New Wave 3 SP respondents who have NOT subscribed to MnPass:** This group has the lowest VOT, almost $5/hour lower than the non-panel Wave 1 SP.

Even though these variables are very significant, most of the other variables related to income, age, etc. also remain significant and similar to Model 1. That indicates that most of the differences related to MnPass subscription and panel participation are not due to correlations with other variables.

(The biggest changes between Models 1 and 2 are the AM commute and trip distance>20 miles effects, suggesting that many of the MnPass subscribers with high willingness to pay are in those trip segments.)

It is interesting that the difference in willingness to pay between subscribers and non-subscribers is much larger for the new Wave 3 respondents than for the panel respondents. It may be the case that people who agree to participate in the survey now that the system is in place tend more often to be those who have strong feelings one way or the other, with fewer in the middle. It may also be the case that people who have completed the survey before respond somewhat differently than the new respondents, either because they want to respond in a way that is consistent with past responses, or because they are more "educated" about the tradeoffs involved.

CONCLUSIONS

While there is the cost advantage to a panel of being able to spread out the recruitment cost over multiple waves of data collection, pricing studies often require analyses of specific subgroups that may not be present in sufficient numbers in a pure random sample. In the case of the MnPASS panel, the need to recruit additional subscribers and transit users diminished the cost advantage of the panel. In addition, panel attrition limited the samples sizes available for longitudinal analyses, particularly within specific subgroups. This fact limited the statistical advantage of the panel design. That said, the panel data was shown to be extremely useful for disentangling the longitudinal effects of road pricing projects.

As other research has identified, there does seem to be a positive association between experience with the road pricing project and positive attitudes towards it. This was borne out in the willingness to pay measures from Baseline to Wave 3 survey iterations. The willingness to pay was found to be significantly related to several observable factors of the traveling population, including income, age, trip purpose, time of day, trip distance, and amount of time saved. Relative to the pre-introduction SP, the measured value of time in the post-introduction SP is strongly bifurcated, with MnPass subscribers and users showing willingness to pay at least 3 times as high as non-subscribers/non-users. Because the majority of the population are non-users, this will tend to skew the distribution even further to the left, with a lower median VOT but with a higher variance.

These findings have some interesting implications for the use of SP methods to predict willingness to pay and usage of HOT lanes. It seems that when an SP survey is done before respondents have any experience with the actual HOT lane context, their responses may tend to "homogenized" to some extent. After the actual HOT lane system is introduced, on the other hand, respondents may have a much better idea of whether or not they would be willing to pay the toll in specific situations, so their responses will tend to show a wider variance. A mediating influence on this process is the requirement to subscribe to the MnPASS lane and rent a transponder. This requirement, in effect, adds a fixed cost and inconvenience onto the price of using the toll lane for any

given trip. This process may serve to further segment HOT lane users into more frequent users with generally high willingness to pay versus less frequent users and those with generally lower VOT, even if their willingness to pay a toll for a single specific trip context might be more similar. It would be interesting to repeat this type of before and after analysis in a context with a higher percentage of users able to pay the toll without having to have a special subscription for the HOT lane (e.g. in a region like New York or the Bay Area that already use transponders to pay bridge and tunnel tolls).

In the longer term, as more HOT lane systems open, it would be best to build up revealed preference (RP) evidence on willingness to pay and value of time. This would require linking the types of trips that were intercepted in the MnPASS surveys to actual operating data on the toll levels charged and the time savings offered at the times that the reported trips were made. We hope to be able to complete such analyses in the future.

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