Examining the Differences between Travelers’
Revealed versus Actual Travel Time Savings

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Abstract
Respondents to a 2010 revealed preference survey were asked questions related to their recent travel on Houston’s Katy Freeway. One question asked if they experienced any travel time savings by using the new Katy Managed Lanes (MLs). This study examined any difference between their perceived and actual travel time savings. This study found that travelers overestimate the travel time savings they experience by traveling on the MLs by a factor of 4. The magnitude of misperception varied with individuals, but the average individual saved approximately 3 minutes and thought they saved nearly 12 minutes. Linear regression models were fit to model the misperception of the travel time and found that both trip characteristics and respondent socio-economic characteristics had an effect on the magnitude of misperception of travel time savings. Respondents’ trip purpose, gender, and income were found to be significant predictors of how well they estimated their travel time savings.
INTRODUCTION

The emergence of managed lanes (MLs) in the United States provides transportation planners and researchers an opportunity to better understand how travelers’ value their time. Since MLs offer an uncongested, faster, paid-alternative to general purpose lanes (GPLs) it is possible to observe the amount of toll travelers are willing to pay to save travel time on the MLs. This comparison has the advantage of both sets of lanes being in the same highway corridor with similar entry and exit opportunities. Even with this relatively straightforward comparison, there are still difficulties in determining the value travelers place on their travel time savings. Two of the larger issues include: (1) the value travelers place on the added reliability of the MLs and (2) the amount of time the travelers think the MLs save them may differ from reality. This paper takes an in-depth look at the second issue.

This research will compare revealed preference (RP) data collected on actual travel conditions along Katy Freeway to data obtained as part of a survey of Katy Freeway travelers. The survey data included questions regarding the respondent’s most recent trip on the Katy Freeway along with the amount of time they thought the MLs saved them plus several stated preference (SP) questions.

LITERATURE REVIEW

Understanding traveler behavior, and particularly travelers’ willingness to pay (WTP) for travel time savings, has been an important area of research going back to the late 1960’s (1, 2, 3). Some of the early efforts to determine travelers’ value of time (VOT) focused on RP data, including the choice between modes (2, 4). However, those comparisons clearly have many additional, and critical, differences than just cost and time.

More recent efforts have frequently used SP data from surveys to estimate VOT, controlling for as many other factors as possible (5, 6, 7, 8, 9) In the SP approach, several hypothetical travel scenarios or travel alternatives with different travel times and trip costs are presented to respondents and they are asked to choose the alternative that best suits their travel. From the data, discrete choice models are fit to estimate the respondents’ willingness to pay. Both RP and SP approaches have their strengths and weaknesses (10). Since the RP approach relies on the revealed responses it is impossible to get RP data on a facility that does not exist. Whereas in the SP approach, since the scenarios can be hypothetical it is possible to get travelers’ preference for a non-existent facility. However, this is also a major weakness of the SP approach, since the SP approach is based on hypothetical choices and not actual choices. Making the actual decision is more complex compared to answering a hypothetical scenario, since the consequences of the decision (benefits or loss) are experienced. In a way we can say that the strengths of the RP approach are the weakness of the SP approach (10).

There is abundant literature with both RP and SP approaches trying to estimate the travelers’ WTP for travel time savings (ex: 4, 5, 11, 12, 13, 14). The estimated WTP values varied by the type of the approach used. There were few WTP studies conducted on MLs, but some of those found that the median WTP values estimated using SP data were approximately half the values estimated using RP data (see 5, 13). Two possible explanations were given by
Brownstone and Small (2005) for this underestimation of WTP by SP approaches. One explanation is that people display time inconsistency in their actual behavior, but not in their hypothetical behavior. In actual behavior people may generally prefer to choose the free lane but other time constraints may come into play and they end up needing to take the toll lane. However, they overlook those constraints while answering the SP questions and thus choose the toll road more often in real life than in hypothetical SP questions. In other words, in the SP question the traveler answers based on their typical trip. But in real life some of the trips may be hurried or pressed for time. On those few trips they do choose the toll lane (see 6 for research into this)

The other possible explanation is one of the major criticisms against RP approach. Travelers have difficulty reporting the actual values rather they tend to over- or under- estimate the travel time savings they experienced. In the studies conducted on SR 91 and I-15, when travelers were asked to report the travel time savings they obtained when using the express lanes, their responses were typically about twice as much as the average travel time savings (see 15, 16) on these lanes. This seems to indicates that people tend to overestimate their travel time savings. However, these previous studies used the average time saved compared to the reported time saved. The studies did not have information on how much time was saved during the exact date and time the trip was taken. It is possible, although unlikely, that the travelers reporting their travel time savings did indeed save as much time as they thought they did. They just happened to travel during some pockets of extreme congestion. Our research removed this potential explanation by comparing actual travel times on the Katy Freeway during the time of their trip to their estimate of time saved.

Steimetz (17) found that travelers value congested travel time twice as much as non-congested travel time. This may also be a possible explanation for over estimation of the travel time savings. Psychologists also argue that the misperception of time also depends on the magnitude of the duration. Fortin and Rousseau (18) stated that short intervals of time tend to be overestimated and long intervals of time tend to be underestimated. Since the RP approach is a common method to estimate the WTP for travel time savings, there is a need to better understand the travel time misperception among the travelers.

OBJECTIVES

The objective of this research is to examine the difference between travelers’ perceived travel time savings and their actual travel time savings. An effort will also be made to understand if the magnitude of the misperception (over- or under-) of travel time savings is dependent on trip characteristics and/or the traveler characteristics.

This study uses data collected from a 2010 survey conducted on Katy Freeway travelers in Houston and detailed traffic data collected on the roadway. Details on the survey data and actual managed lane (ML) usage are described in the next section.
DATA

The Katy Freeway is an eight-lane road with a three-lane one-way frontage road in each direction. In addition to these lanes, a portion (12 mile stretch) of the Katy Freeway near downtown was designed with two MLs in each direction (19). The 12 mile Katy Freeway MLs extend from west of SH6 to the I-10/I-610 interchange (see Figure 1). The MLs are open to both SOVs and HOVs. The SOVs pay toll to use the MLs at all times while HOVs only pay a toll during off-peak hours.

Figure 1: Katy Freeway Managed Lanes and AVI Sensor Locations (19)

2010 Katy Freeway Survey

The survey was posted on a Texas Transportation Institute server and was made available for public access through the www.katysurvey.org website. The data collection process started on June 1, 2010, and continued until July 15, 2010. Residents of Houston who use the Katy Freeway on a regular basis or have used it recently were encouraged to participate in the survey. The existence of the survey was advertised to the public through online and news media. To increase the participation in the survey, two gas cards worth $250 each were given to two randomly chosen respondents. In addition to the website ads, HCTRA added a brief note regarding the existence of the survey to its monthly HCTRA account e-notices. Emails were also sent to the 3,077 respondents from a previous (2008) Katy Freeway survey (see 20 for details) who had indicated an interest in participating in a follow-up survey. A total of 4,919 responses were obtained from the survey. However, only 3,325 of those 4,919 responses were completed to a point where they were useful for analysis.

The 2010 survey questionnaire consisted of five sections. The first section asked the respondents details about their most recent trip on the Katy Freeway. About half of the respondents were asked about their actual trip toward downtown Houston and the other half about their trip away from downtown. Questions included information about the purpose of the
trip, day of the week of the trip, when the trip began, when it ended, where the respondent got on and off the Katy Freeway, the type of vehicle, the number of passengers in the vehicle, if the respondent used MLs, etc. Since the survey was administered online, the date the survey was taken was also known. Combining these data yielded the most likely date and time of their most recent trip. There is no guarantee that this is the correct date of the trip since the questionnaire asked travelers to indicate the day of the week of their most recent trip. For many, that would be the most recent matching day of the week they were surveyed. But for infrequent Katy Freeway travelers that may have been 2 or 3 weeks prior. Based on their frequency of use of Katy Freeway (see Table 1) over 96 percent traveled on Katy Freeway during the most recent week, and therefore their day and time of travel was known.

Table 1: Survey Respondents’ Frequency of Katy Freeway Travel

<table>
<thead>
<tr>
<th>Number of Trips on the Katy Freeway during the Last Full Week</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>1</td>
<td>3.9</td>
</tr>
<tr>
<td>2</td>
<td>4.7</td>
</tr>
<tr>
<td>3</td>
<td>2.9</td>
</tr>
<tr>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>5</td>
<td>19.6</td>
</tr>
<tr>
<td>7</td>
<td>0.1</td>
</tr>
<tr>
<td>8</td>
<td>1.6</td>
</tr>
<tr>
<td>10</td>
<td>23.4</td>
</tr>
<tr>
<td>12</td>
<td>1.4</td>
</tr>
<tr>
<td>15</td>
<td>21.9</td>
</tr>
<tr>
<td>20 or more</td>
<td>17.1</td>
</tr>
</tbody>
</table>

In the second section, respondents were introduced to the new MLs and were asked about their use of those lanes (see 14 for the complete survey questionnaire). The third section was intended to identify the risk-taking behavior or preferences of the respondents with one risk-aversion question presented in the survey. In the fourth section, the respondents were presented with SP questions and the last section consisted of questions regarding socio-economic characteristics of the respondents.

Of the 3325 respondents, 1004 indicated that they had used the MLs on their recent trip. Although 1004 respondents indicated that they used the MLs, 277 respondents’ entry and/or exit locations did not match ML entry or exit locations. 20 respondents did not provide some of the information (entry and/or exit location, day of the most recent trip, start time of the trip) required to extract the actual travel time savings. Those respondents were removed from further analysis, leaving 707 responses from travelers who used the ML on their most recent trip.

These 707 survey responses were then weighted to better reflect both the frequency of travel on the Katy Freeway and percentage of trips that were on the managed lanes. Using the
data from the automatic vehicle identification sensors (see Figure 1) it was possible to get an estimate of how frequently drivers with transponders are observed using the Katy Freeway and what percentage of their trips are on the GPLs versus the MLs (see Table 2). This is only an estimate since the AVI sensors do not capture 100 percent of the trips on the GPLs. In addition, we found 57 respondents who indicated 0 trips on the Katy Freeway in the prior week, but did indicate trips on the Katy MLs. These respondents did not read or pay attention to the instructions in the question that indicated we wanted them to count all trips on the Katy Freeway (GPLs or MLs). Another 7 respondents did not include their number of trips and 28 respondents indicated 0 trips on the MLs. To get an accurate weight these respondents had to also be removed – leaving 617 responses. Despite losing some data and the inherent problems with AVI sensors on the GPLs, weighting the survey sample to better reflect the observed (AVI) data should improve the survey’s ability to represent all managed lane travelers based on their frequency of Katy Freeway use and percentage of ML use. However, note that the same analyses were run on unweighted data and the results were nearly identical to the results shown in this paper that were based on weighted data.

Table 2: Weighting of Survey Responses

<table>
<thead>
<tr>
<th>Katy Freeway Usage (All Lanes)</th>
<th>Low (1 trip/week)</th>
<th>Medium (2 to 4 trips/week)</th>
<th>High (5+ trips/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1 or 2 trips/week)</td>
<td>53.8 / 12.0 = 4.49</td>
<td>0.4 / 7.3 = 0.05</td>
<td>0.00 / 0.2 = 0.00</td>
</tr>
<tr>
<td>Medium (3 to 9 trips/week)</td>
<td>29.3 / 3.6 = 8.22</td>
<td>7.3 / 17.8 = 0.41</td>
<td>2.2 / 10.9 = 0.20</td>
</tr>
<tr>
<td>High (10+ trips/week)</td>
<td>2.9 / 1.6 = 1.78</td>
<td>2.1 / 8.1 = 0.25</td>
<td>2.0 / 38.8 = 0.05</td>
</tr>
</tbody>
</table>

Observed Traffic Data

Two types of vehicle sensors—wavetronix and automatic vehicle identification (AVI)—are installed along the Katy Freeway by TxDOT (see Figure 1 for AVI sensor locations). These sensors collect data on the speed and volume on all the lanes on the Katy Freeway. These data were used to estimate the actual travel time savings offered by the MLs.

Travel Time

Time taken to travel various sections of the Katy Freeway on the MLs and GPLs was calculated using the AVI data. AVI sensors are located along the MLs and the GPLs in each direction of travel on the Katy Freeway (see Figure 1). Each AVI sensor identifies each transponder-equipped vehicle based on the vehicle’s unique transponder ID and records the time at which the vehicle is identified. The vehicle IDs recorded at an AVI sensor are matched with the adjacent AVI sensor data and the time difference each vehicle required to cover the distance between those sensors is known. There are over 1 million records per day recorded in Houston and approximately 170,000 observations per day on Katy Freeway – more than sufficient to obtain reliable travel times. For each 15 minute period, the average travel time for all identified
vehicles between those two sensors is calculated and recorded. These travel times were used to calculate the actual travel time savings offered by the MLs.

RESULTS

The final data included the weighted responses from the 617 respondents and all analyses were weighted based on the weights shown in Table 2. In the survey the respondents were asked how much travel time they think they saved by traveling on the managed lanes. Their perceived travel time savings is presented in Table 3. Approximately 97 percent of the respondents reported that they had experienced some travel time savings. From the survey question regarding their most recent trip we obtained their Katy Freeway entry and exit location. This was used to determine the total length of their trip and the length of their trip in the portion of the freeway that had MLs.

Table 3: Respondents Perceived Travel Time Savings

<table>
<thead>
<tr>
<th>Perceived Travel Time savings</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td>3.3</td>
</tr>
<tr>
<td>1 to 2 min</td>
<td>8.6</td>
</tr>
<tr>
<td>3 to 5 min</td>
<td>22.6</td>
</tr>
<tr>
<td>6 to 10 min</td>
<td>25.1</td>
</tr>
<tr>
<td>11 to 15 min</td>
<td>23.3</td>
</tr>
<tr>
<td>16 to 20 min</td>
<td>8.1</td>
</tr>
<tr>
<td>21 to 25 min</td>
<td>1.2</td>
</tr>
<tr>
<td>26 to 30 min</td>
<td>6.6</td>
</tr>
<tr>
<td>more than 30 min</td>
<td>1.2</td>
</tr>
<tr>
<td>Weighted Average</td>
<td>10.2 min.</td>
</tr>
</tbody>
</table>

This research assumes that these values are a representative sample of drivers true perceptions regarding the amount of time saved when using the MLs. However, when using survey data there are always potential biases. In this survey there may be a sample bias consisting of travelers who really like using MLs because they think they save so much time – thus making them more likely to take the survey. There could also be a respondent bias as respondents are justifying their own use of MLs by indicating an impressive amount of travel time savings. In an effort to minimize these potential impacts (1) we examined the data to remove responses that appeared to be from the same person (2) the results were weighted to better reflect ML travelers (as discussed above) and (3) any respondents who indicated a time savings greater than 30 minutes were removed (see below).

From the observed travel time data, the average travel time savings (over all non-holidays for all of 2009) were estimated for the 11.4 mile section of the Katy Freeway for both the east and westbound directions (see Figure 2). The average travel time savings varied by time of day, but the maximum average travel time savings was approximately 8 minutes in the west bound direction and approximately 6 minutes in the east bound direction.
Next, the perceived travel time savings for their recent trip (Table 3) (which was obtained from the survey) will be compared to their actual travel time savings. The actual travel time savings for that recent trip was obtained by using the respondents’ recent trip information (survey date, day of week of the most recent trip, entry and exit location, and start time of the trip) provided in the survey and looking up with the actual travel time savings obtained from sensor data. For example, if a respondent had taken the survey on June 16, 2010 and indicated that their most recent trip was on a Friday and it started at 8:00 AM, then the most likely date of his/her recent trip will be the earlier Friday i.e. June 11, 2010. This was based on our assumption that since most of the respondents were frequent users of the Katy Freeway (see Table 1), their most recent trip reported on the survey likely occurred within the seven days prior to them taking the survey. In addition, many travelers did not travel the full length of the MLs. Only the travel time savings between the respondents’ entry and exit to the Katy Freeway was included in the actual time savings.

The average actual travel time savings were only approximately 25% of the average perceived time savings. This is similar to what has been found in previous studies of MLs (5, 13), although previous studies found the estimated actual time savings to be closer to 50% of perceived time savings. However, with the previous studies there is the possibility that these travelers happened to travel when the GPLs were particularly slow and thus may have saved as much time as they perceived. Previous studies did not have access to actual trip times, so our study is able to investigate this difference in perceived versus actual time savings in greater depth.
Figure 2: Average Travel Time Savings on the MLs by Time of Day (8)

A scatter plot of the perceived and the observed average travel time savings was plotted (see Figure 3). It can be seen that the perceived travel time savings are much higher than the average observed travel time savings. This plot shows the magnitude of the over-estimation of the travel time savings and raises an interesting question, can RP responses be used for policy analysis? It can be seen that few respondents under-estimated travel time savings and a majority of the respondents over-estimated the travel time savings. The weighted average difference between perceived and observed travel time savings was around 8.8 minutes when all data are included (8.5 minutes when responses greater than 30 minutes are excluded – see discussion below). (Note that the results for unweighted data excluding values greater than 30 minutes was 9.6 minutes, slightly larger than with weighted data.)
To examine if the magnitude of over- or under-estimation of travel time savings is related to any of the respondents’ trip characteristics or their socio-economic characteristics, a linear regression model was estimated (see Table 4 and Equation 1). A small number of respondents (approximately 1.2 percent) indicated that they saved more than 30 minutes by traveling on the MLs. However, more than 30 minutes travel time savings for a 12 mile section seems extreme, it can also be seen from Figure 3 that 99.9 percent of the time the observed travel time savings were less than 20 minutes. Therefore, those respondents who indicated that they saved more than 30 minutes were excluded from the model, leaving 597 respondents in the model.

The dependent variable for the model is difference in the perceived and observed travel time savings. Trip purpose, distance traveled on the MLs, age, gender, income, direction of travel, education and number of trips on Katy Freeway last week were considered for independent variables. However, many of the variables were found not to be significant in predicting the magnitude of the difference in perceived travel time savings. Misperception of the
travel time savings was higher for female respondents than male respondents. Respondents on
recreational trips perceived travel time savings closer to actual than those respondents with other
trip purposes. This might be because travelers who are travelling for recreation are generally not
pressed for time and can more clearly internalize the difference in travel speeds. Or it may be
because they more often travel off peak, where the speeds on the two types of lanes are closer
making a comparison easier. It is interesting to see that lower income (annual household income
less than $25,000) respondents did not over-estimate the travel time savings as much as mid- and
high- income respondents. A possible explanation to this might be that lower income respondents
are more carefully judging what value they are receiving (in time savings) for the toll that they
pay since it is a larger portion of their spending money.

Table 4: Linear Regression Model for Difference in Perceived and Observed Travel Time
Savings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual Income &lt; $25,000 (dv)</td>
<td>-3.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Trip Purpose is Recreational (dv)</td>
<td>-1.1</td>
<td>0.05</td>
</tr>
<tr>
<td>Female</td>
<td>2.5</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: dv = dummy variable.

\[
\text{Perceived Travel Time Savings} - \text{Actual Observed Travel Time Savings} = 8.0 - 3.0 \times \text{Annual Income}_{<25,000} - 1.1 \times \text{Trip Purpose}_{\text{Recreational}} + 2.5 \times \text{Female}
\]

(Eq. 1)

CONCLUSIONS
The objective of this research was to examine the difference between travelers’ perceived
travel time savings and their actual travel time savings, and to better understand the magnitude of
any misperception of the travel time savings. This research used data from a 2010 survey on
Katy Freeway travelers. In the survey respondents were asked information on their recent trip on
the Katy Freeway, including the date, time and how much time savings they think they obtained
by using the Katy MLs. This provided the perceived travel time savings and enough information to
identify their (most likely) actual travel time savings.

The perceived travel time savings varied considerably across the respondents. Nearly 97
percent of the respondents indicated that the experienced some travel time savings. Very few
respondents under-estimated travel time savings and a majority of the respondents over-
estimated the travel time savings. On average, respondents estimated they saved approximately
12 minutes when they really saved closer to 3 minutes, nearly four times as much as they
actually did. These results are higher than the limited literature in the area where perceived travel
time savings are approximately twice the average maximum savings in the peak period.

Linear regression models were fit to model the magnitude of over-, under- estimation of
the travel time savings. Among the trip characteristics only trip purpose (recreation) was found
to be a significant predictor of the misperception of travel time savings. Respondents’
characteristics including gender and income were also found to be significant in predicting the
misperception of travel time savings. This study shows that there is considerable difference
between perceived and actual values.

This research has shown that travelers do have difficulty estimating the time they save
while using a ML. They greatly overestimate the amount of time saved. However, exactly how to
incorporate this understanding in mode choice models or traffic revenue estimates in unknown. It
may well be that even though travelers are saving a small amount of time they value that time
savings (and avoiding congestion) much higher – possibly similar to their amount of perceived
travel time savings. This is an area that needs additional research. However, with ML data to use
we are gaining a better understanding of how drivers perceive and value travel time savings.

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