Willingness to Pay in the Autonomous Vehicle Age

IBTTA Summit on Finance & Policy  July 24, 2018
PREMISE

• **Autonomous Vehicles (AVs)** are coming.

• AVs will impact long-term planning and project prioritization.

• AVs will impact user fee assets. How? Not clear yet
Willingness to pay / **Value of Time (VoT)** is a key assumption in Traffic and Revenue (T&R) forecasting, which is today’s primary means of valuating toll roads and managed lanes assets.

**How does Traveler’s VoT change in the AV age?**
WHAT IS WILLINGNESS TO PAY AND VALUE OF TIME?

1. Did you fly to Portland direct or with stops?
   • Tradeoff between time and cost

2. Did you select an airline based on on-time performance?
   • Consideration for travel time reliability

3. Would your flight choice changed if you were paying for your own ticket?
   • Differences in trip purpose

4. For the local travelers, was the ability to work / make a call / read a decision factor in taking TriMet / Amtrak?
   • Value of productivity.
Louis Berger conducted a study to evaluate willingness to pay for travelers using AVs

- Leveraged experience in
  - Traffic and Revenue (T&R) for public and private sector clients
  - Stated preference survey development
  - Estimation of willingness to pay

- Outputs useful to sensitize T&R forecasts
- First step in series of tests that can inform risk assessment and upside cases in toll asset valuations.
WHAT DO WE KNOW SO FAR?
WHAT WE FIND IN THE LITERATURE

MODELING AND RESEARCH FINDINGS

• **Modeling study in Puget Sound:** Higher capacity and lower VoT assumptions lead to higher VMT.

• **Millennial Study:** Mode choice highly influenced by ability to use laptop, and have a **have lower VOTTS** for travel and wait times.

• **Perceived train travel times:** Depends on ability to stay productive. Perceived travel time can be more influential than actual travel time.

• **Travel time perception in an AV** is less negative than traditional car and similar to riding in public transport.

• **Willingness to pay** in TX to **share a ride is lower than traveling alone**, Newer generations value privacy more.
Mode Choice study based on a survey of 2120 Northern California commuters on mode choice found that greater perceived "multitaskability" of a mode adds to its utility.

**RESPONDENTS THAT ARE LIKELY TO BE PRODUCTIVE DURING TRAVEL**

**Higher Utilities**
- Commuter Rail
- Shared Ride

**Lower Utilities**
- Drive Alone
- Transit

**Why lower utilities for transit?**
Transit is an unsupportive environment for productive tasks:
- Crowded
- Short trip legs and transfers
**LOCATIONS**

**I-95 / I-495 Express Lanes in Northern Virginia**
- 38 miles
- AADT on I-95 / I-495: 190,000 – 220,000
- Travel Time at Free Flow Speed (70 mph): approx. 35 minutes

**SR 91 Express Lanes in California**
- 18 miles
- AADT on SR91: 230,000
- Travel Time at Free Flow Speed (70 mph): approx. 15 minutes

**I-10 - Katy Managed Lanes (Katy Tollway) in Houston, Texas**
- 12 miles
- AADT on I-10: 220,000
- Travel Time at Free Flow Speed (70 mph): approx. 10 minutes

**I-95 / I-495 Express Lanes in Northern Virginia**
Survey Administration

E-Panel – 600 completes per region

**Virginia:**
- Washington, DC
- Fairfax, VA
- Falls Church, VA
- Fairfax City, VA
- Alexandria, VA
- Prince William, VA
- Manassas, VA
- Stafford, VA
- Fredericksburg, VA
- Loudoun, VA
- Spotsylvania, VA

**Texas:**
- Harris, TX
- Waller, TX
- Austin, TX
- Fayette, TX
- Colorado, TX
- Lavaca, TX
- Bastrop, TX

**California:**
- Riverside, CA
- Orange, CA
- Los Angeles, CA
- San Bernardino, CA

*Data cleaned to remove results from “speeders” (time to complete the survey less than 30% of average)*
SURVEY STRUCTURE

Overview

Section 1: Screening
Section 2: Reference Trip
Section 3: AV Description
Section 4: Choice Exercise
Section 5: Opinion and Preference Questions
Section 6: Socio-Economic Characteristics
SECTION 2: Reference Trip

SURVEY STRUCTURE

• Trip Direction, Purpose, & OD
• **Calculation of miles driven on tolled section**
• Day & Time of Trip
• Who Paid for the Trip
• Number of people in vehicles
• Importance of on-time arrival
• Trip Frequency
• Consideration of alternative modes
An autonomous car (also known as a driverless car, self-driving car, robotic car) is a vehicle that is capable of sensing its environment and navigating without human input.

In the future we will be able to move around without having to pay attention to the road, as the car itself will drive for us to our preferred destination. We will be free to use that driving time for any other activities, like making phone calls, working on our computer, watching a movie, sleeping, or even working out!
Surveys Structure

Section 4: Choice Exercise

Scenario 1: Traditional Driving

Scenario 1. You are driving a traditional car.

You are paying for the toll.

If these were your only options, which would you choose?

<table>
<thead>
<tr>
<th>Option</th>
<th>Travel Time</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free; 1:10; K Oy Freeway general purpose lanes</td>
<td>12 minutes</td>
<td>Free</td>
</tr>
<tr>
<td>1:10; Katy Managed Lanes</td>
<td>9 minutes</td>
<td>$8.00</td>
</tr>
</tbody>
</table>

Select

Scenario 2: Autonomous Vehicle

Scenario 2. You are NOT driving the car, you are in an autonomous vehicle, and you can spend your time however you want.

You are paying for the toll.

If these were your only options, which would you choose?

<table>
<thead>
<tr>
<th>Option</th>
<th>Travel Time</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free; 1:10; K Oy Freeway general purpose lanes</td>
<td>14 minutes</td>
<td>Free</td>
</tr>
<tr>
<td>1:10; Katy Managed Lanes</td>
<td>10 minutes</td>
<td>$9.60</td>
</tr>
</tbody>
</table>

Select
SECTION 5: Opinion and Preference Questions

SURVEY STRUCTURE

- Familiarity with AV’s
  - Stated \textit{(how familiar are you with AV’s?)}
  - Measured \textit{(When will we see the first AV’s?)}
- Interest in AV’s
- Attitude towards Tolled Express Lanes
- Attitude towards punctuality
- Consideration of Travel Time RELIABILITY
  - Current
  - In a future AV scenario
- Attitude towards being in a car
  - In general
  - As the Driver
  - As the Passenger
  - With the possibility of being PRODUCTIVE
- Attitude towards Commute Time

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**PREFERENCES**

Now we would like to ask about your opinions on the topics covered on this survey.

Q15
How familiar are you with the concept of AUTONOMOUS VEHICLES?

<table>
<thead>
<tr>
<th>Scale</th>
<th>Not familiar at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Very familiar</th>
</tr>
</thead>
</table>

Q16
When do you think we will see the FIRST DRIVERLESS CARS on our roads?
- Never
- 50 years from now
- 10 years from now
- 5 years from now
- There are already some

Q17
When do you think the MAJORITY OF CARS on our roads will be autonomous/driverless?
- Never
- 50 years from now
- 20 years from now
- 5 years from now
- 2 years from now
**Reference Trip**
- **Trip Purpose**: 50% work-related, 50% recreational/social
- **Day of Week**: 70% weekday, 30% weekend
- **Frequency**: 70% frequent trip, 30% occasional trip

**Socio-Economic Characteristics**
- **Gender**: 50% male, 50% female
- **Age**: equally distributed

**Sample Characteristics Most Likely Similar Across the 3 Locations**
- **Time of Day (Ref. Trip)**
  - Morning Peak: Virginia 18%, Texas 40%, California 35%
  - Midday: Virginia 24%, Texas 39%, California 33%
  - Afternoon Peak: Virginia 15%, Texas 42%, California 38%
  - Evening/Night: Virginia 5%, Texas 7%, California 5%

- **Household Income**
  - High (> $100K): Virginia 53%, Texas 21%, California 41%
  - Medium (Between $50k and $100K): Virginia 34%, Texas 44%, California 40%
  - Low (< $50K): Virginia 12%, Texas 35%, California 19%

- **Education**
  - Some studies: Virginia 40%, Texas 22%, California 29%
  - Bachelor's degree: Virginia 41%, Texas 35%, California 46%
  - High school diploma: Virginia 16%, Texas 36%, California 22%
  - Specialized degree: Virginia 40%, Texas 7%, California 3%
### Familiarity with AV's

<table>
<thead>
<tr>
<th></th>
<th>Virginia</th>
<th>Texas</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>(STATED)</td>
<td>70%</td>
<td>63%</td>
<td>74%</td>
</tr>
<tr>
<td>(MEASURED)</td>
<td>34%</td>
<td>29%</td>
<td>34%</td>
</tr>
</tbody>
</table>

### Use of Tolled Lanes (can choose multiple)

<table>
<thead>
<tr>
<th></th>
<th>Virginia</th>
<th>Texas</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the time</td>
<td>24%</td>
<td>10%</td>
<td>29%</td>
</tr>
<tr>
<td>When in a hurry</td>
<td>62%</td>
<td>61%</td>
<td>59%</td>
</tr>
<tr>
<td>When can split cost</td>
<td>17%</td>
<td>11%</td>
<td>17%</td>
</tr>
<tr>
<td>Never</td>
<td>13%</td>
<td>29%</td>
<td>9%</td>
</tr>
</tbody>
</table>

### Attitude towards Commute Time

<table>
<thead>
<tr>
<th></th>
<th>Virginia</th>
<th>Texas</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doesn't enjoy it</td>
<td>33%</td>
<td>41%</td>
<td>33%</td>
</tr>
<tr>
<td>Neutral</td>
<td>40%</td>
<td>42%</td>
<td>41%</td>
</tr>
<tr>
<td>Enjoys it</td>
<td>26%</td>
<td>18%</td>
<td>26%</td>
</tr>
</tbody>
</table>

### Attitude towards being in a car (can choose multiple)

<table>
<thead>
<tr>
<th></th>
<th>Virginia</th>
<th>Texas</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoys it</td>
<td>76%</td>
<td>80%</td>
<td>78%</td>
</tr>
<tr>
<td>Enjoys it, when DRIVER</td>
<td>74%</td>
<td>78%</td>
<td>79%</td>
</tr>
<tr>
<td>Enjoys it, when PASSENGER</td>
<td>67%</td>
<td>67%</td>
<td>67%</td>
</tr>
<tr>
<td>Enjoys it, when can do OTHER ACTIVITIES</td>
<td>62%</td>
<td>76%</td>
<td>76%</td>
</tr>
</tbody>
</table>
The majority of respondents confirmed that they consider RELIABILITY when they choose the Express Lane.

**Is a RELIABLE TRIP DURATION something you consider when you choose to take the express lane?**

- **Virginia**: 82% YES, 18% NO
- **Texas**: 87% YES, 13% NO
- **California**: 86% YES, 14% NO

This would **NOT change** for 65% to 71% of respondents in an AV scenario. They will still take the express lane to ensure a reliable travel time.

**Would certainty in travel time be as important if you were in an AUTOMATED VEHICLE?**

- **Virginia**: 65% YES, 21% NO
- **Texas**: 67% YES, 21% NO
- **California**: 71% YES, 17% NO
RESULTS

VALUE OF TIME ACROSS RESPONDENTS ($ per hour, 2018 Dollars)

<table>
<thead>
<tr>
<th>State</th>
<th>Traditional AV</th>
<th>Percentage Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIRGINIA</td>
<td>$12.91</td>
<td>$9.30</td>
</tr>
<tr>
<td></td>
<td>-28%</td>
<td></td>
</tr>
<tr>
<td>TEXAS</td>
<td>$11.97</td>
<td>$8.89</td>
</tr>
<tr>
<td></td>
<td>-26%</td>
<td></td>
</tr>
<tr>
<td>CALIFORNIA</td>
<td>$19.92</td>
<td>$14.21</td>
</tr>
<tr>
<td></td>
<td>-29%</td>
<td></td>
</tr>
</tbody>
</table>

VOT Difference | Percentage Difference
--- | ---
-$3.61 | -28%
-$3.08 | -26%
-$5.71 | -29%
### PLAUSIBLE RANGES FOR VALUES OF TRAVEL TIME SAVINGS

(Per person-hour as a percentage of total earnings)

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SURFACE MODES* (Except HSR)</th>
<th>SURVEY RESULTS VA</th>
<th>SURVEY RESULTS CA</th>
<th>SURVEY RESULTS TX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRADITIONAL OPTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>35% - 60%</td>
<td>42%</td>
<td>61%</td>
<td>44%</td>
</tr>
<tr>
<td>Business</td>
<td>80% - 120%</td>
<td>72%</td>
<td>124%</td>
<td>58%</td>
</tr>
<tr>
<td><strong>AV OPTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>35% - 60% (?)</td>
<td>28%</td>
<td>46%</td>
<td>25%</td>
</tr>
<tr>
<td>Business</td>
<td>80% - 120% (?)</td>
<td>56%</td>
<td>91%</td>
<td>61%</td>
</tr>
</tbody>
</table>

Source: Louis Berger; US DOT Departmental Guidance on Valuation of Travel Time in Economic Analysis
Results averaged for three geographical locations

### Difference in VoT by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Difference ($)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;35</td>
<td>$6.00</td>
<td>40%</td>
</tr>
<tr>
<td>&gt;35</td>
<td>$1.00</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Difference in VoT by Income

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Difference ($)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>$5.00</td>
<td>25%</td>
</tr>
<tr>
<td>High</td>
<td>$6.00</td>
<td>35%</td>
</tr>
</tbody>
</table>
### Behavioral change in an AV Scenario

**difference between VoT for traditional and AV scenarios**, compared to average across all respondents

#### HIGHER VoT difference than all respondents’ average in all 3 locations

- People with **high** AV knowledge
- People that are **driving alone**
- People with a **positive** attitude towards AV’s
- People **younger than 35**

#### LOWER VoT difference than all respondents’ average in all 3 locations

- People with **low** AV knowledge
- People that are **sharing a vehicle**
- People with a **negative** attitude towards AV’s
- People **older than 35**
- People that **do not enjoy being in a car**
- People that enjoy being a **passenger** in a car
HIGHEST INFLUENCED travelers in the AV Scenario (their VoT decreases substantially = they wouldn’t mind spending more time in the car):

- **Travelers with higher AV knowledge**
  - Better understanding of AV potential

- **Travelers driving alone**
  - Higher productivity payoff

- **Travelers who don’t enjoy commuting**
  - Might not like driving
  - Would prefer to spend time differently

- **Younger People**
  - Early technology adopters
  - Flexible users of laptops / mobile phones
• On average, for all geographies, trip purposes, and ages, willingness to pay is lower with AVs.

• There are clear tendencies for VoT being higher or lower than average when market is segmented into discrete groups.

• Travel time reliability is remains a key consideration regardless of total trip time.

• Study findings are consistent in terms of VoT as percentage of hourly wage and consistent with findings in literature.
NEXT STEPS & LIMITATIONS

• Testing value of reliability (VoR) as part of choice experiment
• Testing ridesharing vs. drive-alone in AV scenario
• Evaluate other assets (e.g. traditional toll roads)
• Analyze a mixed logit model
THANK YOU

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