Investigating Value of Time and Value of Reliability for Managed Lanes

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Outline

• Motivations
• Background
• Objectives
• Methodology
• Data
• Findings
• Next steps
Motivations

• VOT and VOR are key indicators of travel behavior in responding to pricing, ML strategies, and other system improvements.
• Current practices in Florida use link-based time equivalency toll method, and assumes single VOT for all drivers, regardless of trip length, time of day or purpose.
• VOR is not explicitly accounted for in modeling practices.
• This research intends to gain more understanding of toll behavior through the examination of VOT and VOR, and seeks to propose practical approaches in incorporating VOT and VOR into the modeling framework.
• *Time is Money.*
• Value of Time (VOT) represents the marginal benefit of time spent in a certain activity, which also depends on the next available alternative.
• Value is not inherent but subjective, individuals may value time differently at different times.

\[
VOT \text{ (}\$/\text{hour}\text{)} = (\frac{\beta_{TT}}{\beta_{Cost}}) \times 60
\]

• In the context of tolling/pricing: value of travel time savings (VTTS), and willingness to pay.
• In other contexts – residential location choice, activity participation allocation
• Travel time reliability measures the variability or level of consistency in travel time that users may experience.
• Similarly, Value of Reliability (VOR) can be defined as the marginal substitution between travel cost and travel time reliability improvement.
• Similarly, VOR varies by the circumstance (individual characteristics, trip attribute, the marginal gain from better reliability)
• Two most common measurement for reliability
  – Mean-variance (mean, standard deviation, travel time index, buffer index, etc.)
  – Schedule delay (percentage of on-time performance)
Objectives

• Gain better understanding of toll behavior through the examination of VOT and VOR and seeks to propose practical approaches in incorporating it into the modeling framework
  – How to define the quantify the measures
  – How to represent user heterogeneity
  – How to derive VOT and VOR curves for incorporation
Methodology – Mixed Logit

• Two basic assumptions for MNL model
  – Identical and Independently Distributed (IID)
  – Independence from Irrelevant alternatives (IIA)
  – IID and IIA property limit MNL application in managed lanes study

• In order to accommodate taste variations, Mixed Logit models
  – Allow coefficients as a realization of random variables
  – Recognize multiple observations from single decision maker
  – Include inter-alternative correlation error term
Methodology - User Heterogeneity

• User Heterogeneity
  – Full segmentation
  – Interaction variables
  – Principal component analysis
• Revealed and stated preference survey (by FTE)
  – Observations:
    • 2,041 respondents
    • 16,327 SP observations (8 different scenarios)
    • 513 RP observations (eligible I-95 respondents)
  – Study Corridors:
    • I-95 between Golden Glades & SR 112
    • I-75 between I-595 and SR 826
    • SR 826 between SR 836 and I-95
• Sample Composition

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Number</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>I-95</td>
<td>1060</td>
<td>52%</td>
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<tr>
<td>I-75</td>
<td>521</td>
<td>25.5%</td>
</tr>
<tr>
<td>SR 826</td>
<td>460</td>
<td>22.5%</td>
</tr>
<tr>
<td>Total</td>
<td>2041</td>
<td>100%</td>
</tr>
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</table>

• Stated Preference Choice alternatives
  – General purpose lane
  – Managed lane
  – Managed lane before the peak period
  – Managed lane after the peak period
  – Managed lane with additional passengers
• Regional Integrated Transportation Information Systems (RITIS)
  - Archived detector data from major freeways by direction for general purpose and express lanes
  - Four sets of data were retrieved
  - Two reliability measures were calculated by hour
    • Standard Deviation
    • Travel Time Index

http://www.cattlab.umd.edu/?portfolio=ritis
Data - Key Variables

• **Choice Attributes**: travel time, travel time reliability, travel cost

• **Trip Attributes**: trip purpose, time of travel, day of the week, trip length, vehicle occupancy, arrival flexibility, travel distance, previous congestion experience, transponder ownership

• **Traveler Characteristics**: gender, age, employment Status, household size, number of household vehicles, annual household income
Model Results - VOT and VOR

VOT ($/hour) = (\frac{\beta_{TT}}{\beta_{Cost}}) \times 60

VOR ($/hour) = (\frac{\beta_{TTR}}{\beta_{Cost}}) \times 60

<table>
<thead>
<tr>
<th>Parameter</th>
<th>coefficient</th>
<th>t-test</th>
<th>Standard Deviation</th>
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<td>Travel Cost</td>
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## Model Result - Segmentation

<table>
<thead>
<tr>
<th>Category</th>
<th>VOT (MNL)</th>
<th>VOR (MNL)</th>
<th>VOT (ML)</th>
<th>VOR (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate</td>
<td>9.30</td>
<td>27.55</td>
<td>10.71</td>
<td>47.33</td>
</tr>
<tr>
<td>Low Income (&lt;75K)</td>
<td>9.56</td>
<td>19.53</td>
<td>10.02</td>
<td>37.59</td>
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<tr>
<td>Mid-Income (75K~150K)</td>
<td>8.73</td>
<td>30.11</td>
<td>9.15</td>
<td>42.36</td>
</tr>
<tr>
<td>High Income (&gt;150K)</td>
<td>12.81</td>
<td>44.65</td>
<td>15.81</td>
<td>149.51</td>
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<tr>
<td>Age (16~35)</td>
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<td>12.00</td>
<td>10.26</td>
<td>13.41</td>
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<tr>
<td>Age (36~55)</td>
<td>8.34</td>
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<td>9.78</td>
<td>107.45</td>
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<tr>
<td>Age (56+)</td>
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<td>46.07</td>
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<tr>
<td>Delay Experienced</td>
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<td>47.85</td>
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<td>50.32</td>
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<tr>
<td>No Delay Experience</td>
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<td>16.34</td>
<td>12.26</td>
<td>116.06</td>
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<tr>
<td>Category</td>
<td>VOT (MNL)</td>
<td>VOR (MNL)</td>
<td>VOT (ML)</td>
<td>VOR (ML)</td>
</tr>
<tr>
<td>-----------------------------------------</td>
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</tr>
<tr>
<td>Aggregate</td>
<td>9.30</td>
<td>27.55</td>
<td>10.71</td>
<td>47.33</td>
</tr>
<tr>
<td>Short Trip (&lt;20 mile)</td>
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<td>10.18</td>
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<td>Long Trip (&gt;60 mile)</td>
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<td>Work/School, Airport Trips</td>
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<td>131.61</td>
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<td>Discretionary Trips</td>
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<td>44.48</td>
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<td>AM Peak</td>
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<td>Off Peak</td>
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<td>PM Peak</td>
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<td>28.48</td>
<td>10.04</td>
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<tr>
<td>Urgent Trip</td>
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<td>62.70</td>
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<tr>
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<td>Weekday Trip</td>
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<td>Weekend Trip</td>
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<td>5.90</td>
<td>22.56</td>
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## Model Results - Interaction Effects

<table>
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<tr>
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<th>Heterogeneity in mean</th>
<th>Coefficient</th>
<th>t-test</th>
<th>Sensitivity</th>
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<tbody>
<tr>
<td><strong>Travel Time</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High Occupancy Vehicle 3+</td>
<td>-0.02149</td>
<td>-3.38</td>
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<tr>
<td>Short Trip</td>
<td>0.01787</td>
<td>3.66</td>
<td>Low</td>
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</tr>
<tr>
<td>Medium Income</td>
<td>0.00721</td>
<td>1.75</td>
<td>Low</td>
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<tr>
<td>High Income</td>
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<tr>
<td>Essential Trip</td>
<td>0.00568</td>
<td>2.56</td>
<td>Low</td>
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<tr>
<td>Age 56-75+</td>
<td>0.00475</td>
<td>2.25</td>
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<tr>
<td>Male</td>
<td>0.00350</td>
<td>1.77</td>
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<tr>
<td>Drive with Another Person</td>
<td>0.03103</td>
<td>4.80</td>
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<tr>
<td><strong>Travel Time Reliability</strong></td>
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<td>High Occupancy Vehicle 3+</td>
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<td>Short Trip</td>
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<td>Delay Experience</td>
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<td>Age 56-75+</td>
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<td>Urgency</td>
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<td>Male</td>
<td>-0.11970</td>
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<tr>
<td>Drive with Another Person</td>
<td>0.6204</td>
<td>2.03</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
Model Results - Interaction Effects

Heterogeneity in Travel Time

-0.03
-0.02
-0.01
0
0.01
0.02
0.03
0.04

High Occupancy Vehicle 3+
Short Trip
Medium Income
High Income
Essential Trip
Age 56-75+
Male
Drive with Another Person
Heterogeneity in Travel Time Reliability
• Initial PCA exploration identified five factors
  – Morning commute (AM peak, frequent, drive alone, time constrained, etc.)
  – Solo traveler (single member household, low auto ownership)
  – Two person households
  – Low income young travelers
  – Local trips
• Model results exhibit reasonable VOT and VOR values, which are within the ranges in the literature.

• Mixed logit models show better performance than MNL in general, and tend to indicate higher average VOT and VOR values.

• Market segmentation exploration indicates the taste variation among users.
Next Steps

• Refine model specifications

• Further exploration on user heterogeneity
  – Principal component analysis
  – Attitudinal aspects

• Potentials for incorporation into the modeling practices
Acknowledgement

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Thomas Hill

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Andrew Velasquez URS
Mark Fowler RSG

Questions?

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Florida is experiencing a rapid increase in freight activities, with the projected growth in GDP from $720 billion in 2009 to $950 billion in 2020 and over $2 trillion in 2060 [FL Chamber].

In an effort to support the investment and policy decisions that reflect the needs of freight stakeholders in Florida, the Lehman Center for Transportation Research (LCTR) at the Florida International University (FIU) is working with the Florida Department of Transportation (FDOT) in conducting a stated preference survey to better understand:

• The underlying factors in freight transportation decisions in terms of system performance attributes,
• Users willingness to pay for improved travel time reliability.

For more information about the survey or the methodology, please do not hesitate to contact us.

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You can help shape the future of transportation in Florida

We are looking for Shippers, Carriers, Third party logistic providers or others from any region involved in the shipment of raw or finished products by highway, rail, waterways, or air.

Your response to this survey is crucial in achieving the goal of this study to provide the insights to support freight transportation planning and decision-making.

Participation in the survey is simple:
1. Complete the questionnaire about your firm and typical shipment information, which takes about 15 minutes.
2. A unique survey link will be sent to you. The survey will ask about your preferences in various transportation choice scenarios, which takes about 15 minutes to complete.

Your participation in the survey is completely voluntary and your responses will be kept confidential.

Follow the link to participate
https://fiu.qualtrics.com/SE/?SID=SV_eE9dYDjYqWOJtR3
or https://goo.gl/ILDKBE