Does conducting activities while traveling reduce the Value of Time?

Evidence from a within-subjects designed choice experiment

Eric Molin

data collected by master thesis student Kingsley Adjenughwure
Introduction
background

- hypothesis
  - conducting activities while traveling reduces the Value of Time (VoT)

- limited empirical evidence
  - Ettema and Verschuren, 2007
  - Malokin et al., 2017
  - Kouwenhoven and de Jong, 2018
  - Varghese and Jana, 2018
measurement problem

• unexpected findings:
  • those who work while traveling or bring an ICT device have a higher VoT

• explanation: self-selection
  • those most time-pressured come equipped

• thus: comparing between individuals is problematic
  • a within-subjects design is required
within-subjects design

• observe choices of same persons in two contexts (Wardman and Lyons, 2016):
  1. able to conduct preferred activity
  2. not able to conduct preferred activity

• $\text{VoT}_{\text{non activity}} - \text{VoT}_{\text{activity}} = \text{VoA}$ (Value of Activity)

• avoid confoundment with unpleasant travel conditions
  • ‘you forgot to bring equipment’
objectives

1. test the proposed within-subject design approach

2. add to evidence for hypothesis that conducting activities while traveling reduces the VoT

3. provide VoA estimates:
   - for policy making: appraising investments that aim to reduce the disutility of travel
   - e.g. Internet, electricity, silence wagons
Experiment & data
reference trip

• trip purpose of most often made train trip
  • focus: commuters and leisure travelers

• preferred activity (spend most time on)
  • working/studying / reading / listening to music

• required equipment
stated choice experiment

- observe time & cost tradeoffs for reference trip
  - for both activity & non-activity context

- 3 time duration classes:
  1. short: 10, 20, 30 minutes, €3, €4.5, €6
  2. middle: 35, 50, 65 minutes, €6, €8, €10
  3. long: 80, 100, 120 minutes, €8, €12, €16

- D-efficient designs, priors from pilot
measurement

- two sets of six choices:
  - to avoid memory effects:
    - different time classes per context
    - randomized
  - randomized order for (non-)activity context
non-activity context choice task

My personal profile

<table>
<thead>
<tr>
<th>Purpose of my trip:</th>
<th>Commute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred activity:</td>
<td>Reading</td>
</tr>
<tr>
<td>Requirements:</td>
<td>Book/paper/something to read</td>
</tr>
</tbody>
</table>

Make a choice between the travel options below

<table>
<thead>
<tr>
<th>Your travel time amounts:</th>
<th>20 minutes</th>
<th>€ 6.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your travel costs amounts:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possibility to read:</td>
<td>No, you forgot to bring your book/paper/something to read</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>30 minutes</th>
<th>€ 4.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>No, you forgot to bring your book/paper/something to read</td>
<td></td>
</tr>
</tbody>
</table>
sample

• 6000 invited from Netherlands Railways (NS) panel
  • 1580 responses

• of which 820:
  (1) commuters or leisure travelers
  (2) conduct any of the 3 selected activities
  (3) bring equipment
Model
Value of Time (VoT) space

\[ V_i = \beta_T \cdot T_i + \beta_C \cdot C_i \quad (T=\text{time}, C=\text{Costs}) \]

\[ VoT = \frac{\beta_T}{\beta_C} \quad \Rightarrow \quad \beta_T = \beta_C \cdot VoT \]

\[ V_i = \beta_C \cdot \beta_{VoT} \cdot T_i + \beta_C \cdot C_i \]
Value of Activity (VoA)

\[ VoA = \beta_{VOT_{NAC}} - \beta_{VOT_{AC}} = \Delta \beta_{VOT} \]

\[ \beta_{VOT_{AC}} + \Delta \beta_{VOT} = \beta_{VOT_{NAC}} \]

\[ V_i = \beta_C \cdot C_i + \beta_C \cdot \beta_{VOT_{AC}} \cdot T_i + \beta_C \cdot \Delta \beta_{VOT} \cdot T_i \cdot NAC \]

estimated from pooled data of both conditions

*NAC: 1 = Non Activity Condition; 0 = Activity condition*
Results
# MNL model per group

## Commuters

<table>
<thead>
<tr>
<th>Working/studying</th>
<th>Reading</th>
<th>Listening to music</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Est.</strong></td>
<td><strong>t-value</strong></td>
<td><strong>Est.</strong></td>
</tr>
<tr>
<td>$\text{VoT}_{AC}^#$</td>
<td>12.42</td>
<td>13.59</td>
</tr>
<tr>
<td>$\text{VoA}$</td>
<td>6.36</td>
<td>4.37</td>
</tr>
<tr>
<td>$\text{VoT}_{NAC}$</td>
<td>18.78</td>
<td>16.20</td>
</tr>
<tr>
<td>$\beta_C$</td>
<td>-0.263</td>
<td>-9.51</td>
</tr>
<tr>
<td><strong>% Reduction $\text{VoT}$</strong></td>
<td>-33.9%</td>
<td>-30.7%</td>
</tr>
</tbody>
</table>

## Leisure travelers

<table>
<thead>
<tr>
<th>Working/studying</th>
<th>Reading</th>
<th>Listening to music</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Est.</strong></td>
<td><strong>t-value</strong></td>
<td><strong>Est.</strong></td>
</tr>
<tr>
<td>$\text{VoT}_{AC}^#$</td>
<td>6.54</td>
<td>8.99</td>
</tr>
<tr>
<td>$\text{VoA}$</td>
<td>1.16</td>
<td>1.05</td>
</tr>
<tr>
<td>$\text{VoT}_{NAC}$</td>
<td>7.70</td>
<td>7.16</td>
</tr>
<tr>
<td>$\beta_C$</td>
<td>-0.616</td>
<td>-6.12</td>
</tr>
<tr>
<td><strong>% Reduction $\text{VoT}$</strong></td>
<td>-15.1%</td>
<td>-47.1%</td>
</tr>
</tbody>
</table>

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$\text{VoT}_{AC} = \beta_{\text{VoT}_{AC}} \cdot 60; \ \text{VoA} = \Delta \beta_{\text{VoT}} \cdot 60; \ \text{VoT}_{NAC} = \text{VoT}_{AC} + \text{VoA}$

* Reduction $\text{VoT} = \text{VoA} / \text{VoT}_{NAC} \times 100\%$
# MNL model per group

## Commuters

<table>
<thead>
<tr>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working/studying</td>
<td></td>
<td></td>
<td>Reading</td>
<td></td>
<td></td>
<td>Listening to music</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{VoT}_{\text{AC}} )</td>
<td>12.42</td>
<td>13.59</td>
<td>11.22</td>
<td>19.04</td>
<td></td>
<td>10.26</td>
<td>10.56</td>
<td></td>
</tr>
<tr>
<td>( \text{VoA} )</td>
<td>6.36</td>
<td>4.37</td>
<td>4.98</td>
<td>5.60</td>
<td></td>
<td>3.63</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>( \text{VoT}_{\text{NAC}} )</td>
<td>18.78</td>
<td></td>
<td>16.20</td>
<td></td>
<td>-0.305</td>
<td>-14.25</td>
<td>-0.333</td>
<td>-7.66</td>
</tr>
<tr>
<td>( \beta_c )</td>
<td>-0.263</td>
<td>-9.51</td>
<td>-0.305</td>
<td>-14.25</td>
<td></td>
<td>-0.333</td>
<td>-7.66</td>
<td></td>
</tr>
</tbody>
</table>

% Reduction \( \text{VoT} \)\* = \(-33.9\%\) \(\text{VoT} \)\* \(-30.7\%\) \(\text{VoT} \)\* \(-26.1\%\)

## Leisure travelers

<table>
<thead>
<tr>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
<th>Activity</th>
<th>Est.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
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<td>Working/studying</td>
<td></td>
<td></td>
<td>Reading</td>
<td></td>
<td></td>
<td>Listening to music</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{VoT}_{\text{AC}} )</td>
<td>6.54</td>
<td>8.99</td>
<td>3.77</td>
<td>10.53</td>
<td></td>
<td>5.74</td>
<td>7.49</td>
<td></td>
</tr>
<tr>
<td>( \text{VoA} )</td>
<td>1.16</td>
<td>1.05</td>
<td>3.39</td>
<td>7.31</td>
<td></td>
<td>0.69</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>( \text{VoT}_{\text{NAC}} )</td>
<td>7.70</td>
<td></td>
<td>7.16</td>
<td></td>
<td>-0.425</td>
<td>-20.91</td>
<td>-0.430</td>
<td>-7.57</td>
</tr>
<tr>
<td>( \beta_c )</td>
<td>-0.616</td>
<td>-6.12</td>
<td>-0.425</td>
<td>-20.91</td>
<td></td>
<td>-0.430</td>
<td>-7.57</td>
<td></td>
</tr>
</tbody>
</table>

% Reduction \( \text{VoT} \)\* = \(-15.1\%\) \(\text{VoT} \)\* \(-47.1\%\) \(\text{VoT} \)\* \(-10.7\%\)

\* \( \text{VoT}_{\text{AC}} = \beta_{\text{VoT}_{\text{AC}}} \cdot 60; \text{VoA} = \Delta \beta_{\text{VoT}} \cdot 60; \text{VoT}_{\text{NAC}} = \text{VoT}_{\text{AC}} + \text{VoA} \)

\* Reduction \( \text{VoT} = \frac{\text{VoA}}{\text{VoT}_{\text{NAC}}} \cdot 100\% \)
exploring relationships

- single pooled model
  - including the 6 groups
  - effects coding

- interactions of VoA, VoT and $\beta_c$ with:
  - socio-demographics
  - trip characteristics
  - activity context order
findings

• socio-demographics
  • none for gender, age, income, education
  • impact only indirect via 6 distinguished groups

• trip characteristics
  • none for frequency, seat, transfer, part activity
  • significant effects for trip duration & who pays

• activity order: significant
activity order effect

between person comparison

within-person comparison

<table>
<thead>
<tr>
<th>first context</th>
<th>second context</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>activity</td>
<td>no-activity</td>
<td>VoA</td>
</tr>
<tr>
<td>Vo(T_{AC})</td>
<td>Vo(T_{NAC})</td>
<td>VoA</td>
</tr>
<tr>
<td>9.22</td>
<td>13.06</td>
<td>3.84</td>
</tr>
<tr>
<td>no-activity</td>
<td>activity</td>
<td>VoA</td>
</tr>
<tr>
<td>Vo(T_{NAC})</td>
<td>Vo(T_{AC})</td>
<td>VoA</td>
</tr>
<tr>
<td>9.65</td>
<td>7.10</td>
<td>2.54</td>
</tr>
</tbody>
</table>

VoA=0.43

loss
gain
endowment effect

• first context = reference

• activity first $\rightarrow$ travelers ‘owns’ activity condition
  • taking away activity (= loss) has more impact

• cost parameter is not affected: adds to validity
Conclusions
conclusion within-subject approach

• proposed approach
  • observe choices for same persons…
  • … in both activity and non-activity context

• approach ‘works’
  • statistically significant & plausible results
  • within-subject comparison is important
conclusion VoT reduction

• evidence found for the hypothesis that conducting activities while traveling reduces VoT

• % reduction VoT
  – commuters: work 33.9; read 30.7; music 26.1
  – leisure       work 15.1; read 47.1; music 10.7

• commuter results comparable to previous findings
conclusions VoA

• VoA estimates higher for commuters
  • commuters: work 6.36; read 4.98; music 3.63
  • leisure: work 1.16; read 3.39; music 0.69

• effects:
  • none for socio-demographics
  • lower for travelers who pay themselves
  • activity order - activity first (loss): VoA higher
policy implications

• VoA allows appraisal of investments that improve conducting activities
  • Internet, silence wagons, electricity
  • speed train vs. reliable Internet in China
  • e.g. Tang et al. (2017)

• automated vehicles allow conducting activities
  • decrease VoT expected in future
  • reduced benefits in infrastructure appraisal
Related work in our group

• PhD. Thesis work of Baiba Pudane who focuses on time use in automated vehicles


• Pudāne, B., Rataj, M., Molin E., Mouter, N., Cranenburgh, S., Chorus, C., Activity travel behavior in the automated vehicle area: Results from a focus group study, under review Transportation Research, part D.
Thank you for your attention