The valuation of travel time variability

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The issue of travel time variability

- Travel times are random from the perspective of travellers
- This imposes an economic cost on travellers

- Travel time variability is clearly quantitatively important.
  - More than half of delays in US urban areas is due to non-recurrent events (accidents, weather, ...)

- Must include in cost-benefit analysis of transport projects and policies
- Will influence the ranking of projects and will therefore have significant real implications.

- Requirements
  - A unit of measurement for travel time variability (TTV)
  - The cost to travellers per unit TTV
  - Predictions of quantity of TTV, with and without projects
Unit of measurement

- We have a simple theoretical foundation in scheduling models
- Two basic measures emerge, depending on the scheduling preferences of travellers
  - The variance of travel time, or
  - The standard deviation of travel time

- The variance could see more use in the future
- The standard deviation is most common so far
  - It is essentially the same as several other measures used in practice
    - Difference between two specific quantiles of the travel time distribution
    - Difference between a quantile and the mean travel time,
    - The buffer time index
    - Mean lateness
  - All are proportional to the standard deviation, when the shape of the travel time distribution is constant
Standard deviation vs variance

Standard deviation
• Step model of scheduling preferences
• Applies better to travellers with fixed arrival times
  – E.g. shift workers, teachers
• Value depends on shape of travel time distribution
• Not additive

Variance
• Slope model of scheduling preferences
• Applies better to travellers with flexible arrival times
  – E.g. academics, white collar workers
• Value independent of shape of travel time distribution
• Additive
The value of standard deviation

- The value of standard deviation in the step model

\[(\beta + \gamma) \int_{\frac{s}{\beta+\gamma}}^{1} F^{-1}(s)ds,\]

- First term \((\beta + \gamma)\) comes from scheduling preferences

- Second term \(\int_{\frac{s}{\beta+\gamma}}^{1} F^{-1}(s)ds\) is the mean lateness in terms of the standardized travel time distribution
  - It captures the impact of the shape of the travel time distribution
  - This includes the degree of skewness

- Second term should be adjusted when transferring values from one context to another!
Theory meets practice: some comments on the Dutch model

- Dutch model chose the standard deviation due to convenience for traffic modelling
  - The variance can be added up from the link level, the standard deviation can not

- “The disadvantage of this definition [the standard deviation] is that it does not capture skewness of the travel time distribution.”
  - The unit value of standard deviation depends on the shape of the travel time distribution in a way that can and should be accounted for. Skewness is captured in this way

- Extreme events excluded
  - Extreme events exist. Travellers care about these as well
  - Inclusion of extreme events may lead to worse fit due to noise
Getting numbers

• We have mostly stated preference studies, so far most focus on the standard deviation
  – Historical reasons: availability of data and theory
• Revealed preference studies are emerging, primarily based on data from tolled lanes in the US

• Ballpark range:

  1 minute of standard deviation equals 0.7 – 1 minute of travel time
Stated preference – a simple question?

Choice situation 7 out of 12

Which journey do you prefer?  
Each journey has a fixed departure time.

<table>
<thead>
<tr>
<th></th>
<th>Journey A</th>
<th>Journey B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departure time</td>
<td>8:00 AM</td>
<td>7:40 AM</td>
</tr>
<tr>
<td>Travel time</td>
<td>6 out of 10 times the journey takes 17 minutes</td>
<td>2 out of 10 times the journey takes 12 minutes</td>
</tr>
<tr>
<td></td>
<td>4 out of 10 times the journey takes 25 minutes</td>
<td>8 out of 10 times the journey takes 20 minutes</td>
</tr>
<tr>
<td>Cost</td>
<td>21 DKK</td>
<td>39 DKK</td>
</tr>
<tr>
<td>Your choice?</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Stated preference data have problems

• Results depend on the choice experiment in ways that contradict the underlying theory
  – There is something wrong

• We like our theory quite a bit - for many reasons

• We like stated preference experiments less
  – They are hard to digest for respondents
  – Choices are hypothetical, no real payoffs

• We like stated preference experiments more
  – Data are cheap to collect and analyze
Revealed preference data

• Abandoned many years ago
  – Hard to identify trade-off between time and cost due to correlation

• Things have changed
  – Nowadays we can have much more data
  – Nowadays we are able to handle complete networks and not just a few routes
Freight transport

• Freight transport can be analyzed within the same framework as individual transport
  – Based on scheduling considerations
  – Can apply the same unit of measurement

• The main difference is the number of entities involved
  – One individual vs firms delivering and receiving, agents and carriers
  – This makes freight stated preference experiments difficult,
    • Who should we talk to? Do they represent the priorities of everybody?

• The case for revealed preference data seems good
  – Large-scale GPS datasets exist. Companies have logs of their trucks
  – Back out value of time and of travel time variability from observed routes (and destinations)
  – Problem remains whether observed behavior represents all priorities
Conclusion

• We have the units of measurement, we have some valuation studies, we have some values

• Problems with stated preference data
  – We should exploit big data (GPS) and new models to get better values
  – Analysis will be more expensive. Still a lot cheaper than not building the right infrastructure
    • Research!

• Travel time variability in traffic models must come next
  – Would also benefit from the use of big data

• Travel time variability is clearly an important issue
  – A value of zero is not the neutral option
  – It should be taken into account when deciding projects and policies
  – There is no reason to wait!