The valuation of travel time variability

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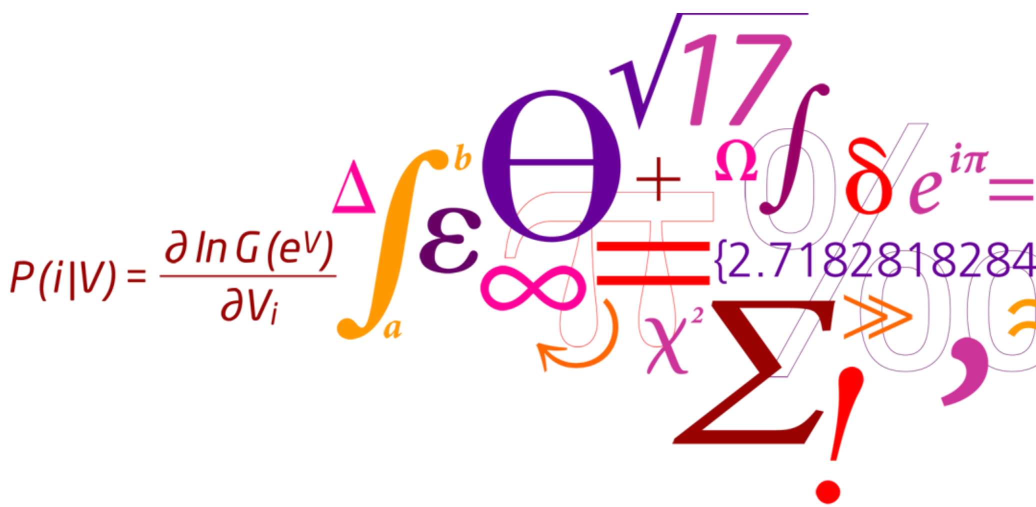

The issue of travel time variability

- 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

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

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

- Second term $\int_{\frac{\gamma}{\beta+\gamma}}^{1} F^{-1}(s)ds$ 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.

	Journey A	**Journey B**
Departure time	8:00 AM	7:40 AM
Travel time	6 out of 10 times the journey takes **17** minutes 4 out of 10 times the journey takes **25** minutes	2 out of 10 times the journey takes **12** minutes 8 out of 10 times the journey takes **20** minutes
Cost	21 DKK	39 DKK
Your choice?	O	O

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!