What is the value of reliability?

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What is the value of travel time variability?

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Suggested terminology

- Travel time : TT
- Value of travel time : VTT
- Travel time variability : TTV
- Value of travel time variability : VTTV

  - Reliability is an unfortunate term
  - More appropriate for things that may break down, such as a service
  - The thing we are after is that travel times are inherently variable
  - Travel time variability is costly, hence ”**value of travel time variability**”

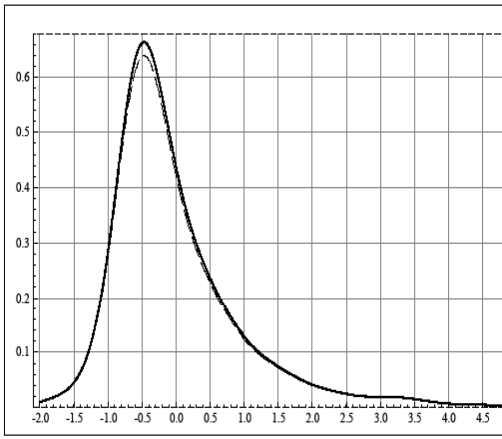
  - Perhaps it would be even better to say cost of travel time and cost of travel time variability
  - I stay with VTT, VTTV

The value of what?

- VTT is the value of travel time
- Travel time is an unambiguous quantity, a number

- VTTV is the value of something else relating to a travel time distribution
- This is ambiguous!

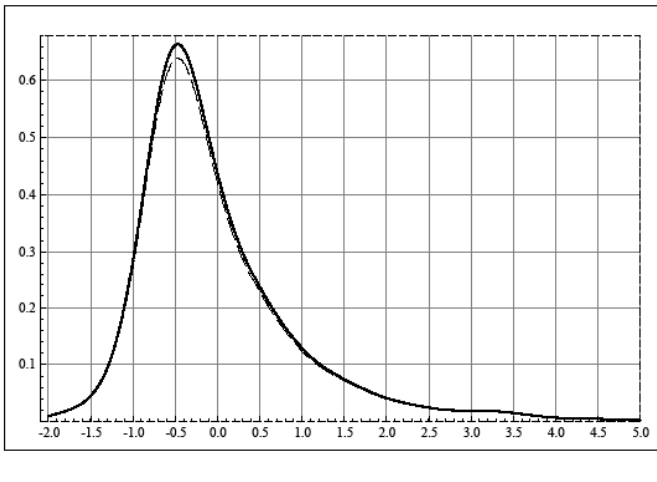
- TT distributions can be described in many ways
- Examples from the literature :
  - Standard deviation, variance, 90% and other quantiles
- Other possibilities :
  - Interquartile range, skewness, kurtosis,
- In principle, all moments of the travel time distribution are relevant …



How to choose a measure

- Depends on how travel times are actually distributed
- Depends on which kind of changes are relevant
- Depends on traveler preferences

- Employ standard neoclassical microeconomic framework
- Take travel time distribution as given
- Let's see what can be done with this



Theoretical framework

- Traveler chooses act : departure time
  - Consider travel by car – departure time can be freely chosen
  - Travel by scheduled service is another story
- ”Nature” chooses travel time at random from travel time distribution **f**
- Outcome : departure time **dep**, arrival time **arr**

- Traveler knows all this
- He has rational preferences defined over outcomes
  - Utility function then exists
  - Embodies attitude to risk
  - Preferred choice maximizes expected utility
- Traveler acts (chooses optimal departure time **dep***) to maximize expected utility

How to derive VTTV from this?

- Consider

V(f) = EU(dep*, dep* + travel time |f)

- Travel time is random, follows **f**
- Departure time **dep*** is optimal given **f**
- Arrival time is random, **arr = dep* + travel time**

- VTTV is change in **V(f)** per unit change in **f**
- What unit … ?
  - We cannot say without making more assumptions
  - Necessary to consider special case

Scheduling preferences

- Use simple form based on Vickrey (1969), Small (1982)
- Assume there is a preferred arrival time **PAT**

$$U(dep,arr) = \alpha\cdot(arr-dep) + \beta\cdot(arr-PAT)^{-} + \gamma\cdot(arr-PAT)^{+}$$

- Function of travel time, earliness, lateness

- Building on Noland & Small (1995) and Bates et al (2001),
- Fosgerau & Karlström (2009) show that optimal expected utility has simple form, linear in mean and standard deviation of travel time
- Works for any travel time distribution
  - That has a mean

The VTTV according to Fosgerau & Karlström

- Under (α,β,γ)-preferences and typical neoclassical assumptions
- The optimal expected utility is

V(f) = α·mean + (β+γ)·H(standardized f, β, γ)·stddev

- And so the VTTV is **(β+γ)·H(standardized f, β, γ)**

- This can be estimated
- This can be translated from one **f** to another since **H** is known
- Works with standard deviation, quantiles, buffers or any other measure of scale

Vices and virtues of this definition of VTTV

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Virtues

- This does what we want
- Measure of TTV is standard deviation
- VTTV can be derived from (α,β,γ)
- Depends on standardized travel time distribution in controlled way
- PAT does not appear (maxed out)
- Some robustness

Vices

- Very particular utility function
- Is (α,β,γ) a good description of preferences? Not necessarily
- VTTV depends on standardized travel time distribution, is it constant?
- Not additive across links in a network

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m1 mf, 14/10/2009

Measuring (α,β,γ)

- These parameters are of independent interest
  - Important for explaining congestion (Vickrey 1969, Arnott, de Palma, Lindsey 1993)
  - Can be used to derive the value of headway (Fosgerau 2009)
- Parameters can be measured in several ways
  - RP : from temporal shape of queues
  - SP : from choices between alternatives with different travel time distributions
    - a little bit more is needed to get (α,β,γ) and not just VTTV
  - SP : from scheduling choices

SP with travel time distributions

- SP alternatives comprising travel time distributions
  - E.g. 5 equally probable travel times
- A recent fashion
- I doubt the validity of the approach
  - Information overload, too much to digest
  - We know from behavioral economics that people have a hard time dealing with probabilities. There are systematic biases
- Safer to go for scheduling choices, not involving random travel time, provided we can make it work

Anomalies

- Systematic deviations from neoclassical rationality
- Anomalies are widespread and well documented
  - Mostly in lab, experiments, survey
  - Less in real life
- Loss aversion, probability weighting
  - Loss aversion tends to diminish with experience
- Our response depends on what we are doing
- Measurement of preferences :
  - necessary to account for anomalies, especially with SP!
- Prediction of behavior : depends…
- CBA : not clear that anomalies should be allowed into CBA
  - CBA framework is neoclassical
  - Distinction between choice and hedonic preferences

Some travel time distribution questions

- Are standardized travel time distributions reasonably stable across time and place?
- Can travel time distributions be predicted? It is not sufficient to consider just variance
- Can we generalize from links to network OD?

Conclusion

- Fosgerau & Karlström :
  - the standard deviation is a good measure of TTV
  - Consistent with (α,β,γ)-preferences
  - Sound basis in microeconomic theory
  - Works with any travel time distribution (essentially)
  - But VTTV still depends on standardized travel time distribution

- There may be better models
  - This is the best so far

- Lots of empirical work remains to be done
- Measurement of scheduling preferences
- Properties of travel time distributions