Challenges and Accomplishments of Modeling Impacts of Policy Initiatives

John Bates

Background

- In a number of countries, moves are being made to include an assessment of Travel Time Variability [TTV] in project and policy appraisal
- A considerable amount of research nas been carried out in many countries
- However, the practical implications are not entirely clear!

The requirements

In order to integrate reliability into our transport models, we need to know

a) how changes in reliability will impact on demand, and

b) the outturn reliability for a given policy, and how (whether) it will be affected by the level of demand ("supply curve").

It is the supply curve where knowledge is weakest

The immediate challenge

- The challenge for TTV is not to resolve **all** the theoretical and empirical issues, but to establish a broad consensus based on reasonable theory and data, similar to that for travel time savings
- One of the key requirements is to acquire evidence about the current level of TTV

Metrics

Our attention is on unpredictable day-to-day variations in travel times at similar times of day and under similar conditions of average demand. These variations are likely to arise from:

- random (unpredictable) variations in demand
- incidents
- other random operating considerations
- While we would like evidence based on the complete distribution, for modelling we need to simplify to a representative statistic

Metrics (contd.)

- Much of the readily available information on variation in travel times confounds relevant and irrelevant variations
- Consequently we are only just starting to acquire useful data on the incidence of TTV
- While electronic sources (eg number plate matching for cars, or satellite-based tracking) have the potential for generating much larger data-sets, they typically relate only to **sections** of journeys…

Defining the distribution

- For any given mode, there will usually be technological limitations on the minimum journey time
- For the car, this is often referred to as the “free-flow time”.
- It makes sense to define TTV in terms of the **excess** time, so that the distribution starts at zero
- While this does not affect the standard deviation, confusion can arise with the “coefficient of variation” (σ/μ) when μ relates to total, not excess time

The best metric…

- This would be one which

a) accords with the way travellers respond to TTV (eg are they only concerned with the upper tail?)

b) is readily measured and parametrisable

c) can be easily explained

The hunt is still on! For the moment, more or less by inertia, we are stuck with σ

Models for σ

- The sources of TTV are such that the mean excess time will rise when demand is high relative to capacity
- Various researchers have developed models to explain TTV (eg Arup (2003), Eliasson (2008)) with the general form:

σ = f(scale, volume/capacity index)

where "scale" allows for the journey length (distance, free-flow time etc.) and the V/C index is often taken as $(T - T_{FF})/ T_{FF}$

Typically these are multiplicative models with variables raised to a power

Models for σ (contd).

- At the moment, such models are the nearest thing we have to the TTV supply curve
- Their formulations are rather *ad hoc*, and their transferability is unproven
- More work is required before they could be used with any confidence

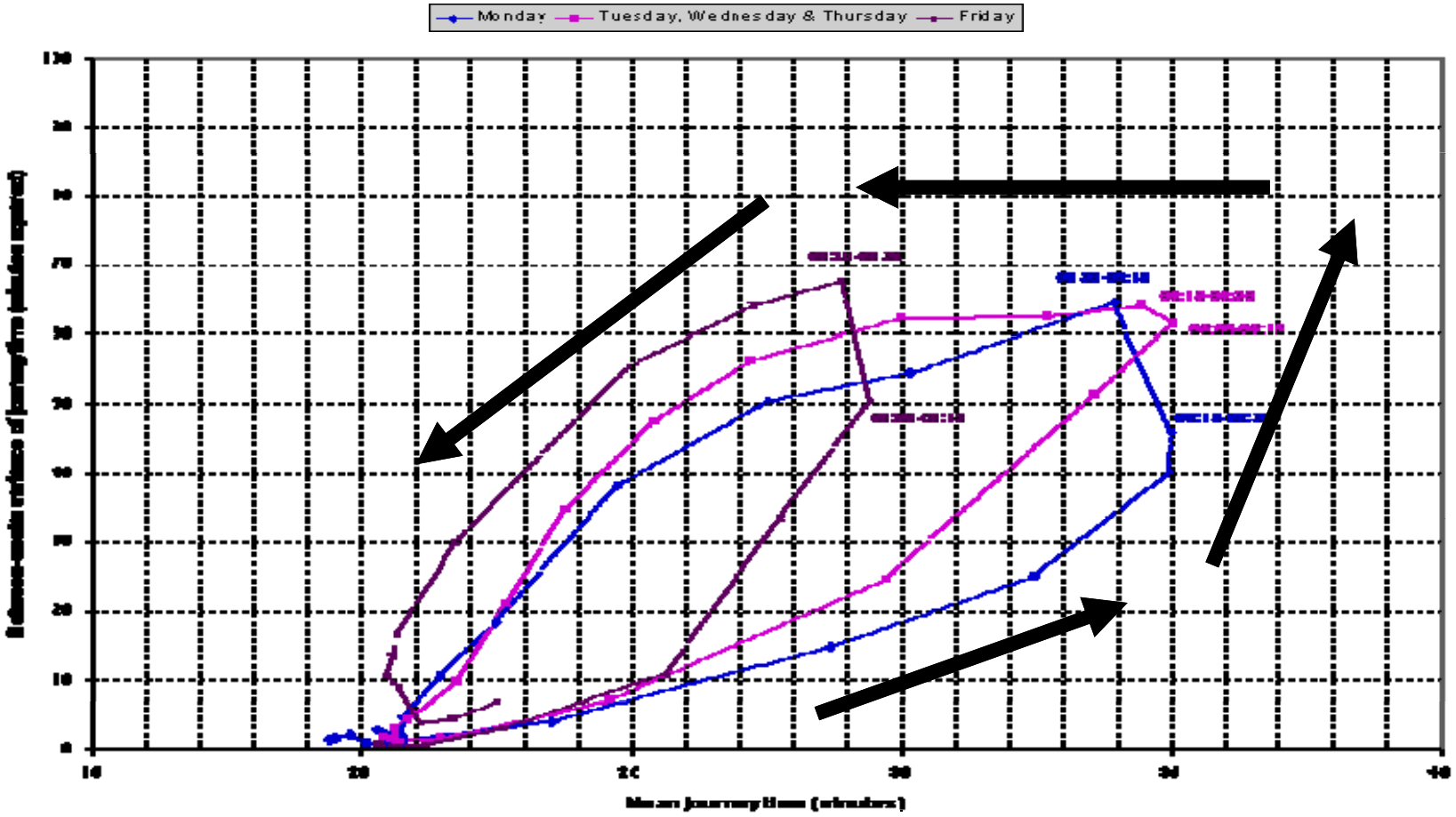
Improving the Supply curve

- On the highway side, delays are often associated with queues, which are a reflection of transient capacity problems
- This suggests a dynamic approach, which could use traffic microsimulation
- Ongoing research suggests that allowing for random variations in demand, together with microsimulation, can produce plausible patterns of TTV

The “Looping” phenonemon

- It has been noted by many researchers that if σ (or σ^2) is plotted against the mean for successive time intervals, an anti-clockwise loop is often generated
- this appears to be the impact of serial correlation in the data caused by the persistence of queues, and can be reproduced by dynamic assignment processes
- The example is from Bates *et al* (2002)

Variance vs Mean



Supply curve

- The aim of the ongoing work is

a) to generate plausible representation of TTV under different demand conditions

b) by means of further analysis, to derive practical formulations that could be reliably used in conjunction with conventional transport models

Demand…

- reasonable theoretical development (2 main approaches: scheduling theory [Small/Vickrey] and "mean/variance"…)
- Under various assumptions, these converge (eg Fosgerau), though equivalence is dependent on TTV distribution (so coefficient on σ might not be stable for policies which **change** the distribution)
- Much empirical work – mainly SP-based, apart from a few US RP studies by Small *et al*
- But problems with **presentation** of TTV

Proposal!

- We should accept the scheduling theory approach as adequate
- We should estimate scheduling coefficients in the **absence** of TTV
- We should convert to μ / σ formulation using best empirical evidence on TTV distribution
- Aim is to move to a consensus on the “value of reliability”

Other Issues: Public Transport

- On the demand side, headway between scheduled services complicates departure time choice, as well as waiting time effects. Outcome depends on temporal distribution of demand
- On the supply side, more needs to be understood about the impact of operational policies on TTV

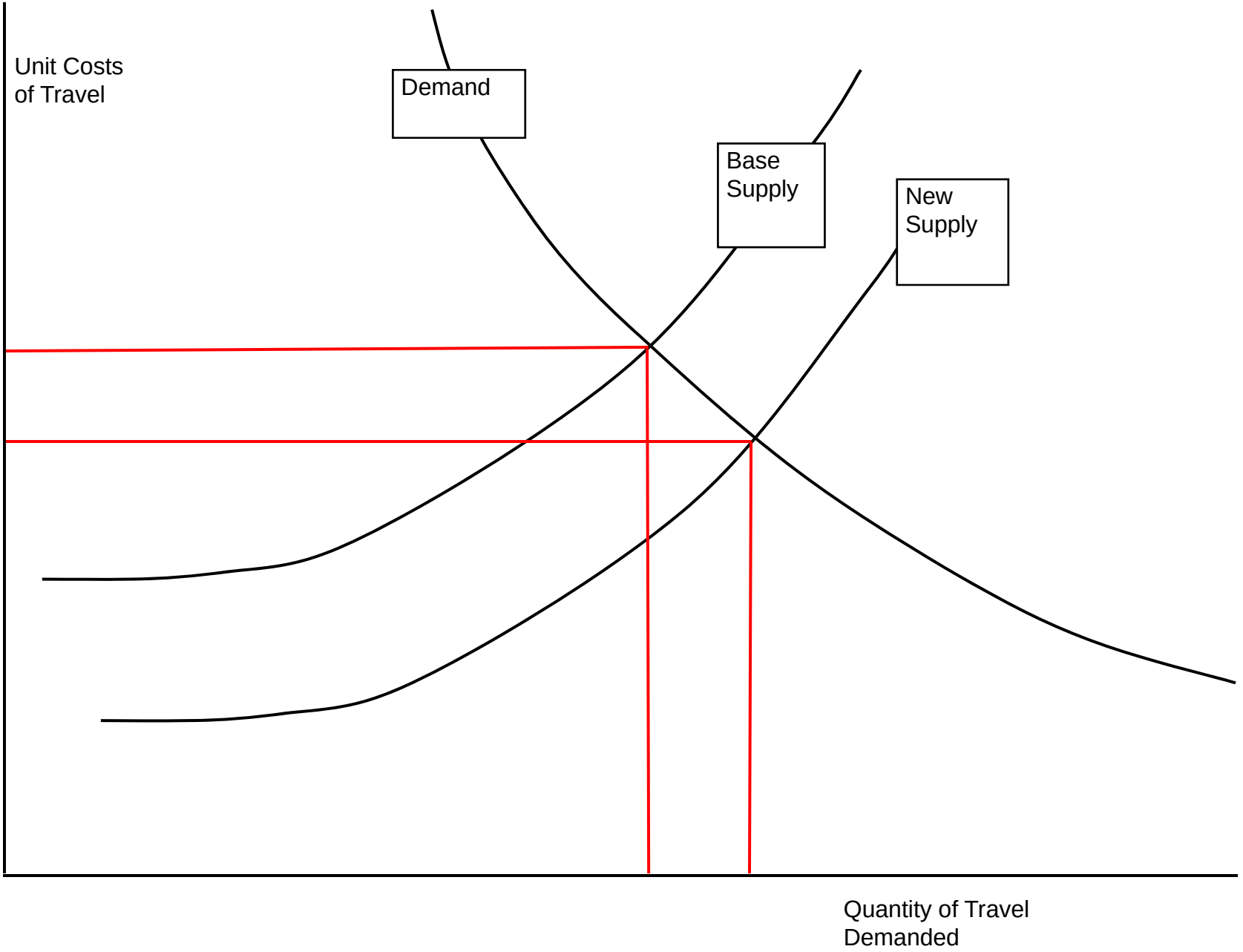
Other Issues: Route choice

- Is TTV a significant element in route choice?
- If it is, then use of σ is problematic, because not additive over links
- Given the considerable complexity, we need empirical evidence to decide whether we can continue to model **route choice** without σ (ie, ignoring TTV)

Summary

- Concentrate on Supply Issues
- Amass and analyse empirical evidence for TTV distribution
- For moment, accept σ but investigate improved metrics
- Develop testbeds for TTV supply modelling, probably using microsimulation
- On demand side, abandon attempts at SP presentation of TTV! Use scheduling instead
- More work needed for public transport

Thank You!


Unit Costs
of Travel
Demand
Base
Supply
New
Supply
Quantity of Travel
Demanded