Zero value of time?

Automation and the value of time in passenger transportation

Mogens Fosgerau

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UNIVERSITY OF COPENHAGEN

Introduction

- Travel time is becoming less costly for travelers
  - New tech promises to free car drivers from driving
  - Mobile devices make public transport passengers more productive
- Transport policy is about trading off money and time
  - Infrastructure
  - Pricing
  - Accessibility
- The value of travel time (VTT) summarizes trade-off
- What will happen to VTT?
  - Derive from first principles
- What are the policy implications?
  - Congestion pricing, congestion dynamics, travel time variability, urban form
- WTP for self-driving cars

The value of travel time when in-vehicle time is productive

- Main take-away, based on more complete theory

$$VTT = (1 - \alpha)w$$

- Value of travel time is based on net after tax wage rate w
- Scaled by $(1 - \alpha)$, where α is the productivity of in-vehicle time relative to time at work or at home

- In vehicle time is either spent producing leisure or working
- More complicated expressions are available that take into account the marginal utility of different time uses

Business travel - Cost saving approach

- Extreme assumptions
  - Travel time is unproductive
  - Business travelers are zombies

- VTT is then equal to gross wage rate, including indirect taxes

$$\text{VTT} = W$$

- Unaffected by in-vehicle productivity

Business travel – Hensher approach and simplified

- Hensher: decompose VTT into
  - The gross wage rate, multiplied by the proportion of travel time that is unproductive.
  - The value of resting during travel
  - The willingness-to-pay of the worker for converting business travel time not spent producing leisure into working time
  - The willingness-to-pay of the worker for converting business travel time spent producing leisure into leisure time.
- Complicated, elusive

- Simplify:
  - Business travelers are zombies
  - But may be productive, also while traveling
- Then

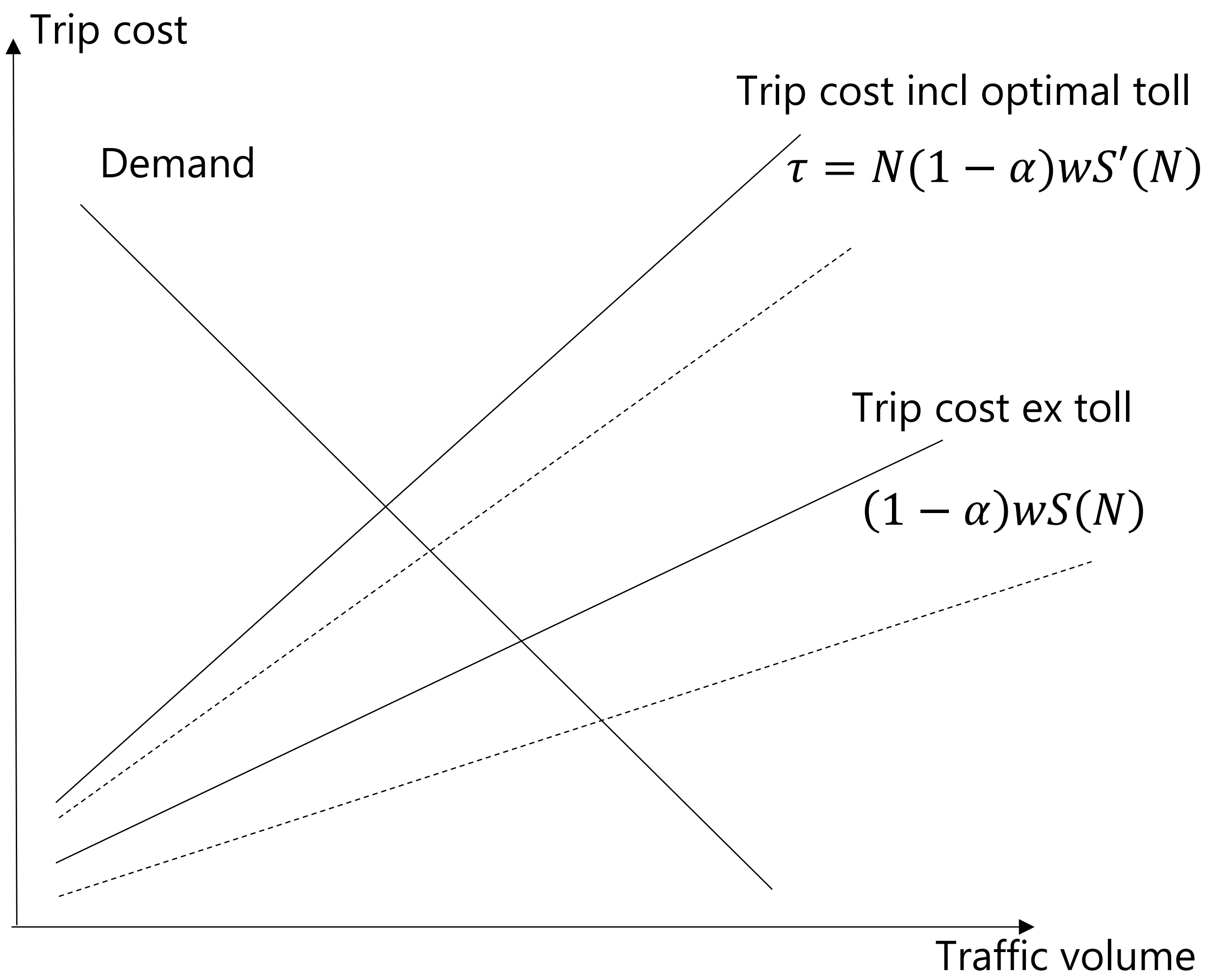
$$\mathrm{VTT} = (1 - \alpha)W$$

- Same as for private travel, except now based on gross wage rate

Congestion pricing – static analysis

- Increase in in-vehicle productivity α
- Leads to lower trip cost
- Induces more traffic

- Both with and without optimal tolling



Scheduling utility – trip timing

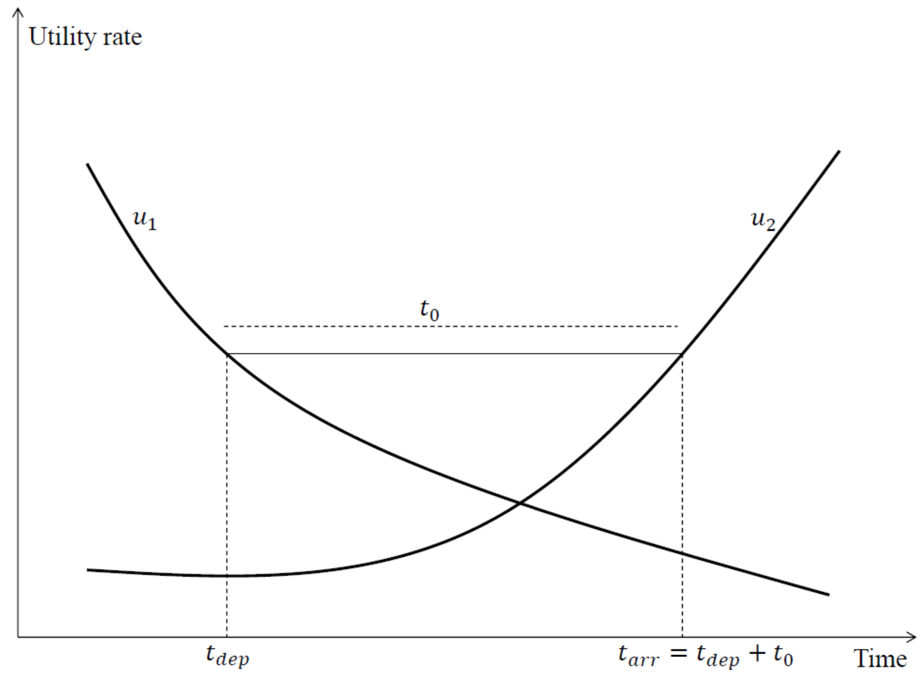
- Include $(1-\alpha)$ in two different ways

- Model 1:

$$(1-\alpha)U_{departure\ time} + (1-\alpha)U_{arrival\ time}$$

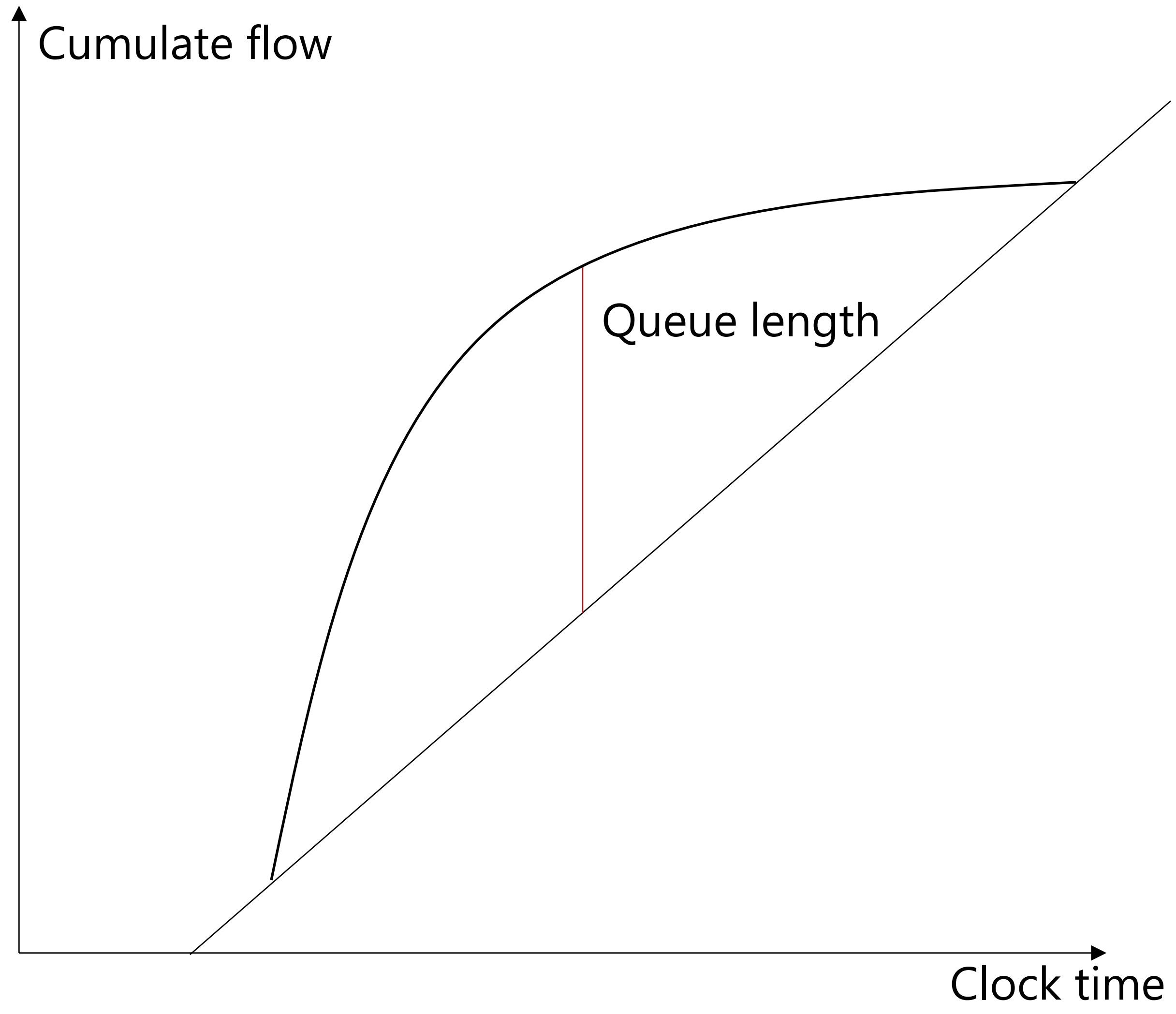
- Model 2:

$$(1-\alpha)U_{travel\ time} + U_{arrival\ time}$$



Congested demand peaks – bottleneck congestion

- Bottleneck with fixed capacity
  - Fixed no. of cars pass per time unit
- Length of peak determined by number of cars
- Timing of peak determined by equilibrium
  - Travelers indifferent between different departure times
- Queue length also determined by equilibrium



Congested demand peaks – bottleneck congestion

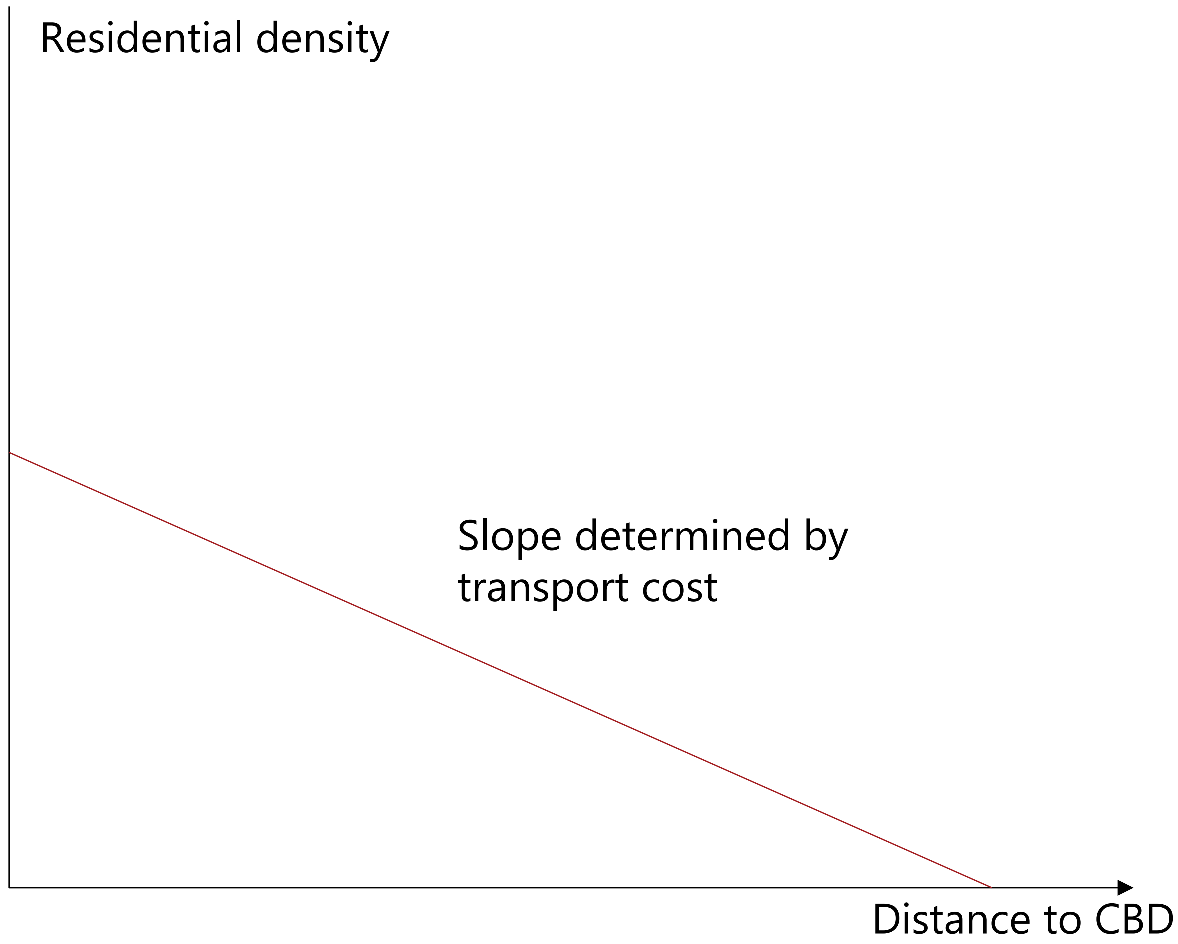
- Model 1, $\alpha\uparrow$
- No direct impact on duration of peak
- No direct impact on queue length at any time during peak
- Indirect effect through induced traffic
  - Expect the duration and queue length to increase
- Driverless cars concentrate in middle of peak

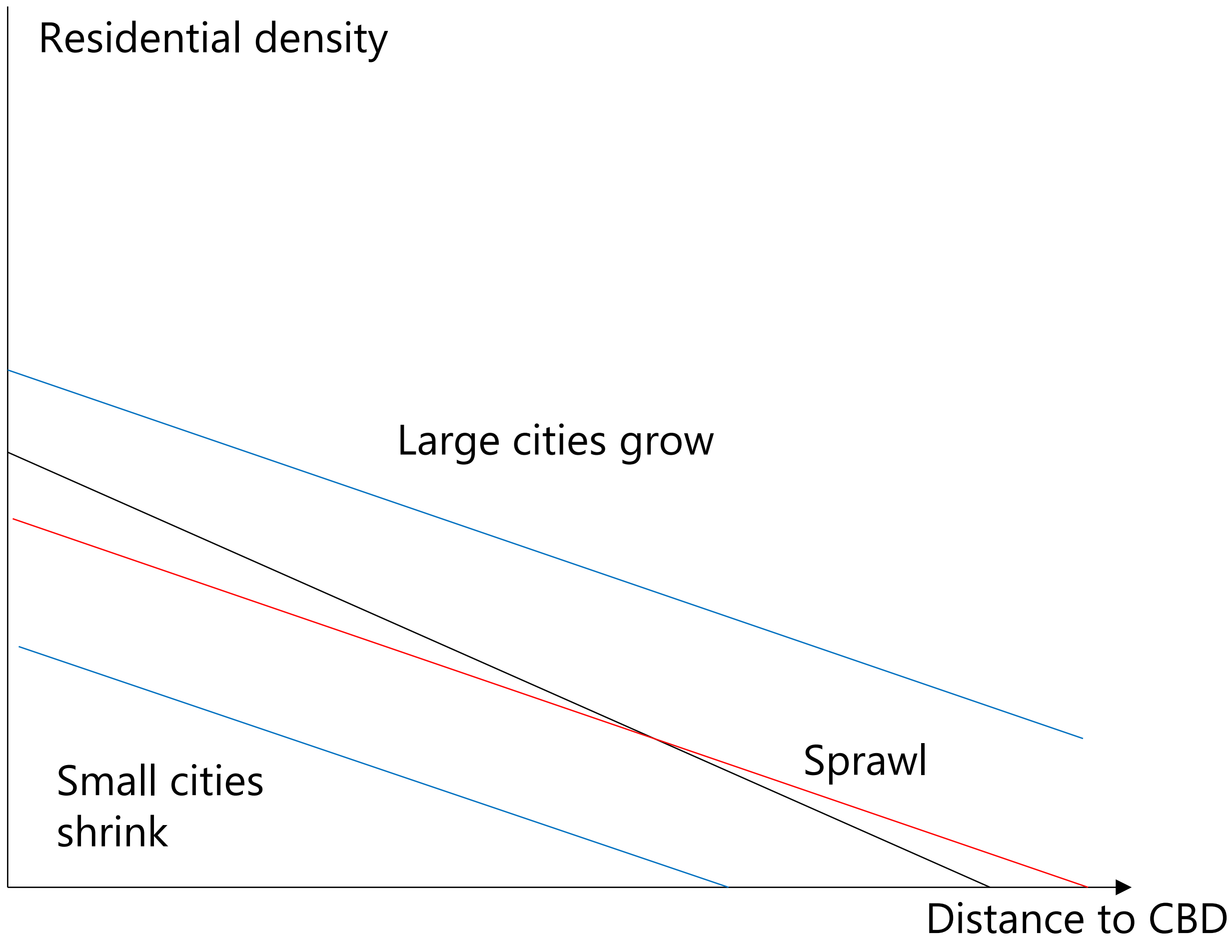
- Model 2, $\alpha\uparrow$
- No direct impact on duration of peak
- Queue length increases during peak
- Smaller indirect effect through induced traffic
  - Expect the duration and queue length to increase
- Capacity may improve, reducing travel cost for everybody. Users of non-driverless cars may be worse off

Travel time variability

- Workers with fixed work start time
  - VTTV is proportional to standard deviation of travel time
- Workers with flexible work start time
  - VTTV is proportional to variance of travel time
- Impact of productivity α
  - Model 1: VTTV proportional to $1-\alpha$
  - Model 2: VTTV independent of $1-\alpha$
- It is important to distinguish between models 1 and 2

Monocentric cities





Conclusions

- Increasing in-vehicle productivity
  - Reflected in lower VTT
- Impact on case for infrastructure investment is ambiguous
  - Lower VTT vs induced traffic
- The economic argument for road pricing (Pigou) is unchanged
  - Traffic volumes will increase, even in the presence of optimal toll
  - Optimal toll may increase or decrease
- The value of travel time variability will not increase
- Demand peaks
  - No direct effect on duration
  - Driverless cars will tend to concentrate in the middle of peaks
  - Queue lengths may increase
  - Capacity may improve, reducing travel cost for everybody. Users of non-driverless cars may be worse off
- More dispersed cities (relative terms)
  - Large cities may become even larger

The value of travel time in a self-driving car

- Compare different transport modes
  - Car driver vs car passenger, train passenger etc.
  - Control for self-selection to find comfort effect
- Evidence suggests that $\alpha = 0.25$ is a large number
- And only on the parts of the road network where technology works
- Willingness-to-pay for self-driving technology
  - Car drives 300,000 km during lifetime
  - Suppose technology works on half: about 2,500 hours
  - Worth about 25,000 EUR
  - Allow for discounting: 12,500 EUR
  - Suppose $\alpha = 0.1$
  - Then WTP is 1250 EUR, i.e. not a lot
- Very low compared to current predictions of cost of technology.
- Suggests small market share, for a long time