Zero value of time?

Automation and the value of time in passenger transportation

Mogens Fosgerau

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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 \( \alpha \) 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
  \[ VTT = W \]

- 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

\[ VTT = (1 - \alpha)W \]

• Same as for private travel, except now based on gross wage rate
Congestion pricing – static analysis

• Increase in in-vehicle productivity $\alpha$
• Leads to lower trip cost
• Induces more traffic
• Both with and without optimal tolling

\[ \text{Trip cost ex toll} = N(1 - \alpha)wS'(N) \]

\[ \text{Trip cost incl optimal toll} = N(1 - \alpha)wS'(N) \]

\[ \tau = N(1 - \alpha)wS'(N) \]

Traffic volume

Demand

Trip cost
Scheduling utility – trip timing

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

- Model 1:

\[
(1 - \alpha)U_{\text{departure time}} + (1 - \alpha)U_{\text{arrival time}}
\]

- Model 2:

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

Slope determined by transport cost

Residential density vs. Distance to CBD

Large cities grow
Small cities shrink
Sprawl
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