TAKING INTO ACCOUNT THE DYNAMICS OF DEPARTURE TIME CHOICES

VINCENT A.C. VAN DEN BERG
ASSISTANT PROFESSOR AT VU AMSTERDAM

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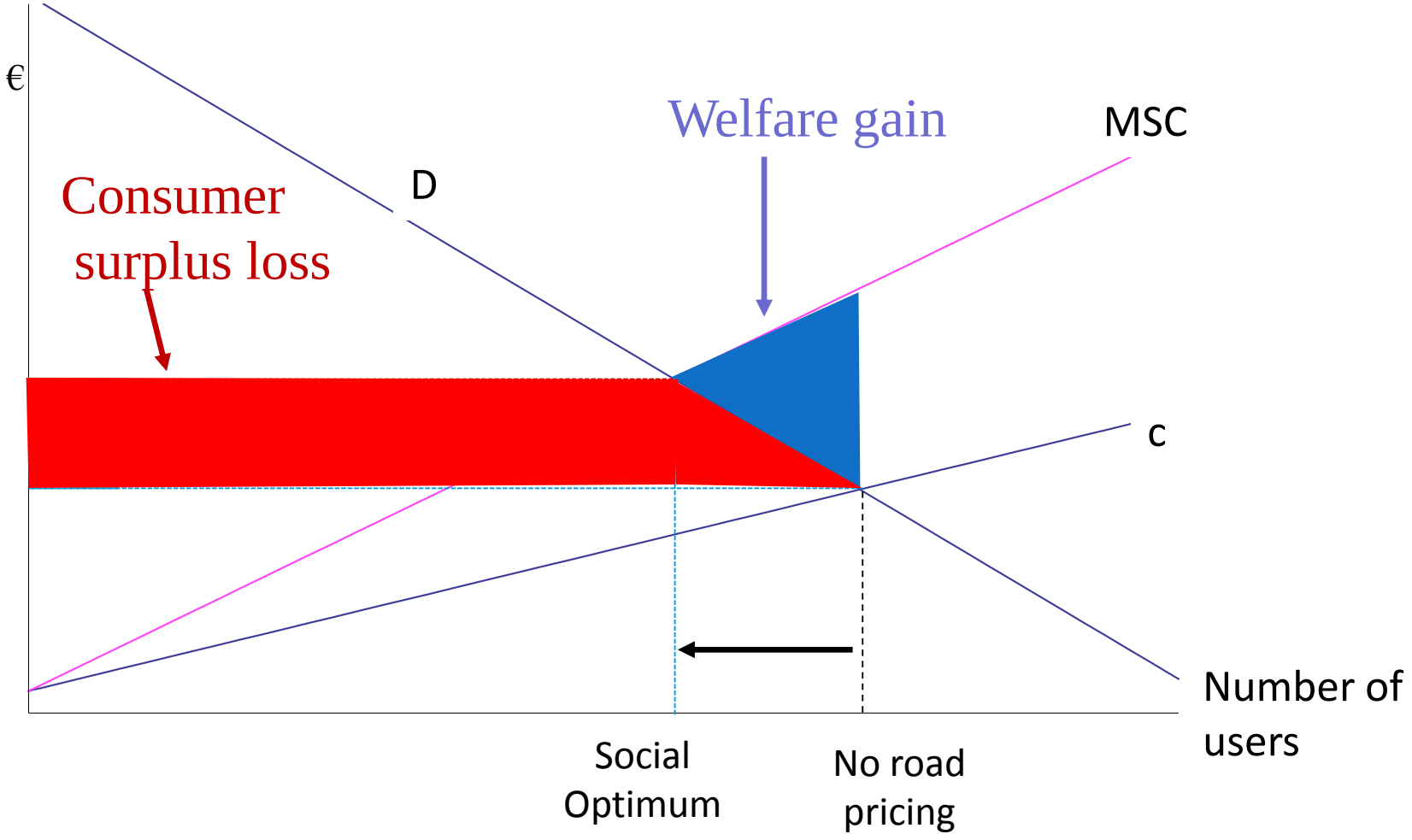
LOOKING FURTHER

Winning or Losing from Dynamic Congestion Pricing?

- Standard textbook model of congestion
  - Road pricing raises welfare
  - But (most) users lose substantially
  - The rich gain, the poor lose
- Congestion varies over the day
  - People care when they travel & have heterogeneous preferences
  - Road pricing raises welfare much more
  - Distributional effects are very different
    - Most users gain directly (without using the toll revenues)
    - It is not users with the lowest values of time that lose most

Static flow congestion



Distributional effects under static flow congestion

- 3 types of users that differ in their values of time

No road pricing

VOT in NZ$/h	8	16	32
Travel time	1h	1h	1h
Toll			
Full price	8	16	32

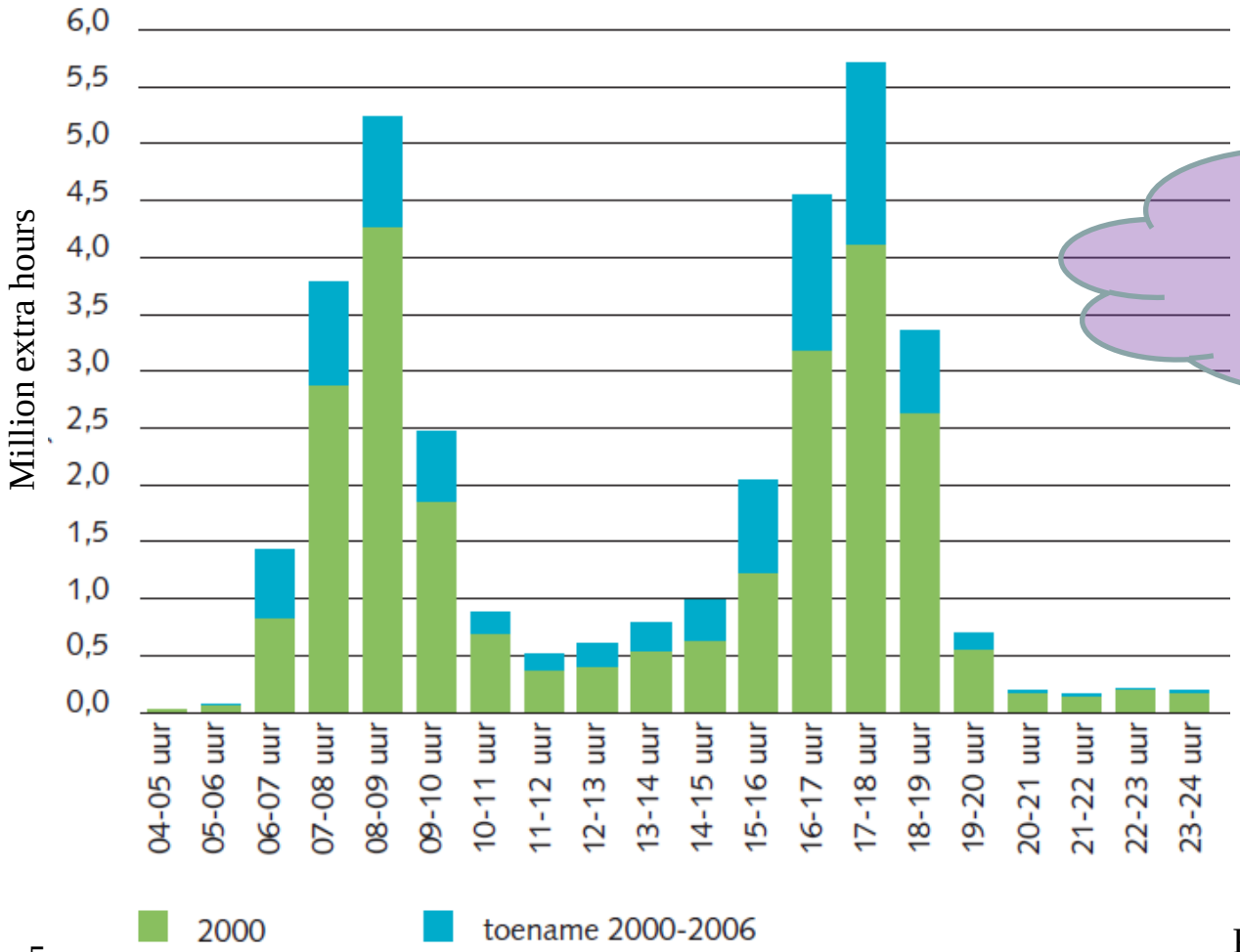
Optimal road (FB) pricing

VOT in NZ$/h	8	16	32
Travel time	½h	½h	½h
Toll	12	12	12
Full price	16	20	28
Change in price	**+8**	**+4**	**-4**

The rich gain, the poor loose

But congestion varies over the day

For the Netherlands: travel times over the day

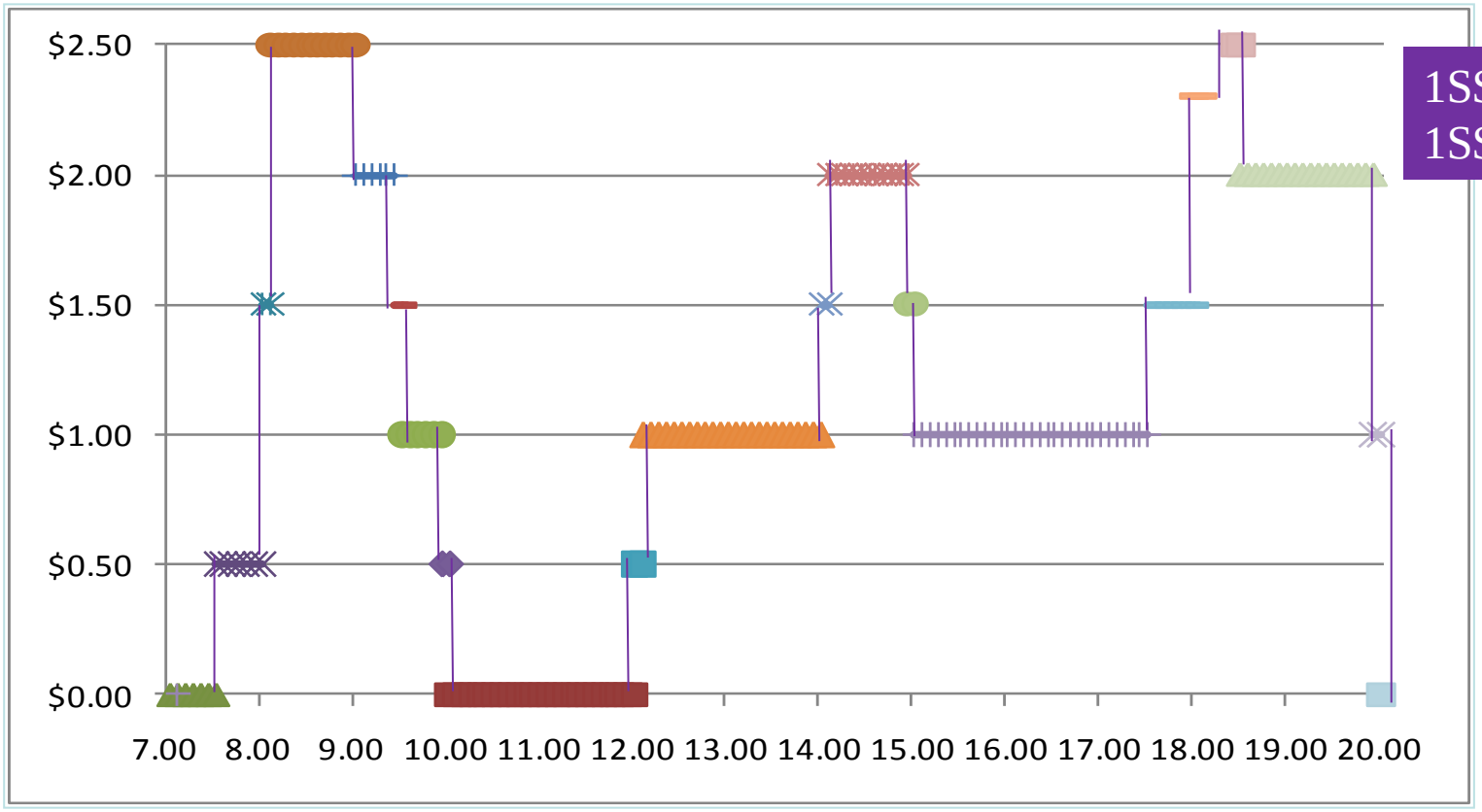


Health pollutants, global warming & accident externalities also vary

Fig. 2.1., pp. 14
Kennisinstituut voor Mobiliteitsbeleid, june 2008. Mobiliteitsbalans 2008.

The charge should also vary over time

Singapore: Bugis-Marina Centre (Nicoll Highway)



1S$=1.08NZ$
1S$≈0.62€

Figure by Robin Lindsey; data accessed on 1 May 2010, from www.onemotoring.com.sg/publish/onemotoring/en/on_the_roads/ERP_Rates.html

Bottleneck model of congestion

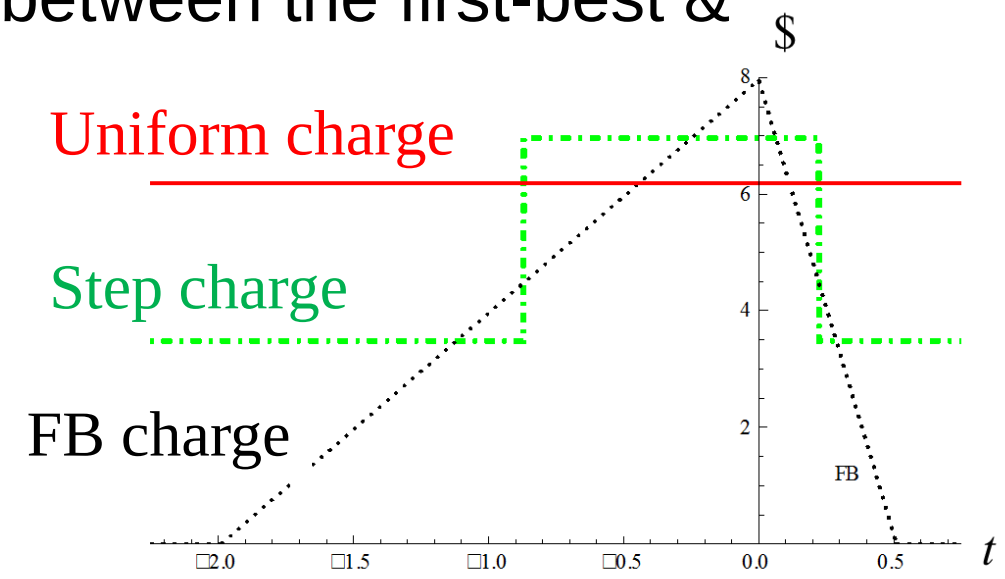
- Travel time delay due to queuing before a bottleneck
- People choose when to travel
- Preferences
  - Preferred time of arrival: t^*
  - Monetary value of a hour of travel time: α
  - Schedule delay
    - Monetary value per hour earlier arrival than preferred: β
    - Monetary value per hour later arrival than preferred: γ
- Full price: p = travel time cost + schedule delay cost + congestion charge + fuel cost

Road pricing in the bottleneck model

- For now, everyone has the same preferences
- The road charge should vary continuously over time to eliminates the queuing
- Welfare gain is much larger
  - Pricing removes all queuing and this was pure waste
  - People can also choose when to travel
- Optimal road pricing does not affect the full price
  - Queuing time costs are turned into charge payments of equal value

Less time variation in the toll

- Uniform charge
  - 1 charge for the entire day
    - Blunt instrument and queuing remains
  - **Full price is doubled**
- Single-step charge is in between the first-best & uniform
  - Much higher welfare gain
  - Full price increases by about 50%

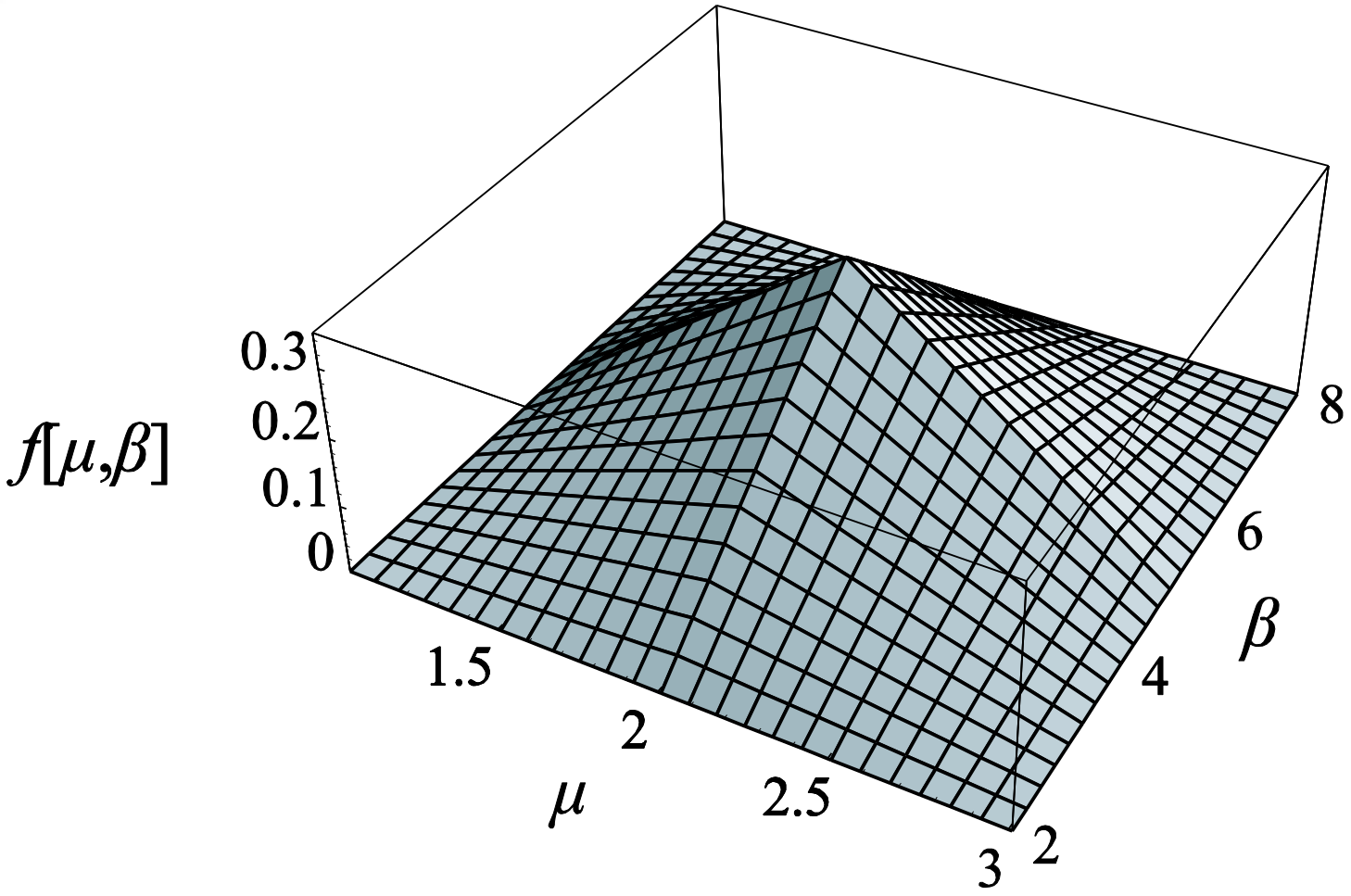


v.d. Berg (2012, fig 3)

Preferences vary over the population

- v.d. Berg & Verhoef (2011, J. of Public econ.)
- Heterogeneity in 2 dimensions
  - Proportional heterogeneity may stem from income differences
    - It equally scales all values of time and schedule delay
  - 'Ratio heterogeneity' in $\mu_i=\alpha_i/\beta_i$
    - Between value of time, α_i, & values of schedule delay, β_i
    - Differences in how people trade off travel time & schedule delay
    - Heterogeneity in flexibility

Distribution of preferences

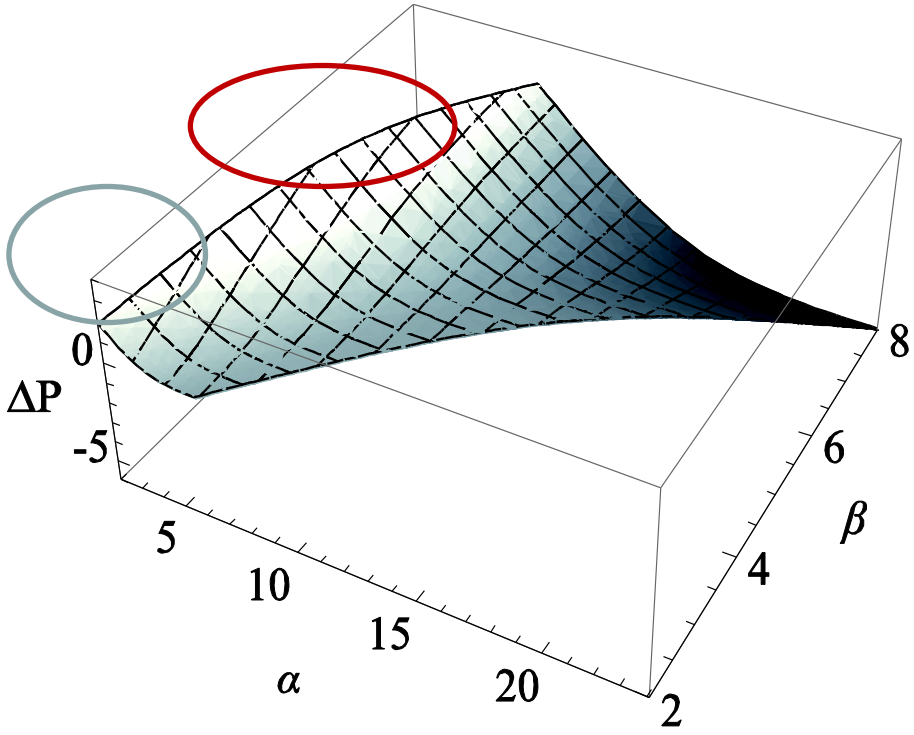


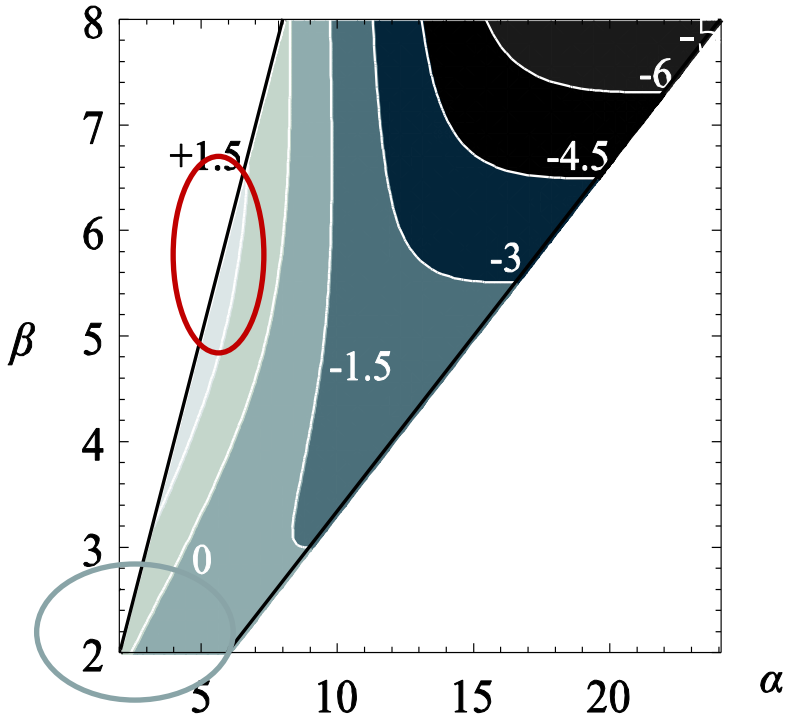
Overall effects

	Homogeneity	Base case
Spread of $\mu_i=\alpha_i/\beta_i$	–	2
Spread of β_i	–	6
No charging equilibrium		
Number of users	9000	9000
Welfare = Consumer surplus	239 332	239 332
Social Optimum (first-best)		
Number of users	9000	9054.6
Consumer surplus	239 332	242 571
Welfare	284 102	281 708
%Δ Welfare from no charging	18.7%	17.7%
% users with decrease in full price	p unchanged	55%

v.d. Berg & Verhoef (2011, Table 1)

ΔP: Full price change due to road pricing





β : Value of schedule delay	α : Value of time

v.d. Berg & Verhoef (2011, Fig. 7)

Other dynamic equilibrium models

- Chu (1994, 1999)
  - Congestion works as in the static model
  - But people do choose when to travel
- Hydro-dynamic (Mun, 1999, 2003)
  - Flow congestion and queuing
- Optimal charge
  - Should vary over time and equal the MEC[t]
  - Attains a higher welfare gain than in the static model
  - Hurts users, but less than in the static model
- Uniform toll is higher on average, hurts users more and has a lower welfare gain

Concluding

- Standard textbook model of congestion
- Congestion varies over the day
- A dynamic model of congestion
  - People care when the travel and have heterogeneous values for travel time and arrival moment
  - Road pricing is much more beneficial
  - It is vital that the toll also varies over time
  - Distributional effects differ from with static congestion
    - Most users gain directly, even before the revenue is used
    - It is not the users with the lowest values of time and schedule delay that lose most

Thanks

- Questions and discussion

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