A political economy model of road pricing

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Some observations on congestion pricing

• Road pricing or congestion charges are considered by many economists to be a good idea
• Few cases where actually implementated
• In all cases were congestion charges were introduced
  – A majority of voters was against the policy change ex ante
  – More people were in favor of the policy after its introduction than before (in several cases a majority)
  – Toll revenues were almost exclusively used for public transport
Motivation of this paper

• Propose very simple model that might explain (or is at least consistent with) some of these observations:
  – Why so few successful cases of road pricing?
  – Why introduced against the will of the majority?
  – Why the change in attitudes ex ante versus ex post?
  – Why revenues to public transport?
Overview of the paper

• Examples of introduction of some form of congestion pricing

• A simple basic model: one mode, lump sum redistribution of toll revenues, majority voting

• A two-mode model with different possible uses of toll revenues, majority voting

• Policy implications and conclusions
Introduction congestion charges

• **Succes**
  – Singapore
  – London (2003-)
  – Latvia (Riga), Malta (Valetta)
  – Highways Santiago de Chile

• **Failure**
  – Edinburgh, Manchester, Birmingham, Coventry
  – Lyon
  – New York

• **Future introduction**
  – Netherlands (?)
  – San Francisco (?)
London congestion charge

- Smeed Report (64) and GLC (73) argue in favor
- Newly elected Labour Council rejects pricing in favor of massive public transport investments
- London Congestion Program 95
- Authority on road charging to future mayors (GL Authority Act 99)
- Ken Livingstone: manifest on road pricing
- Elected 2000
- Report Transport For London: road pricing and massive investment in public transport
- Political agreement 2002
- Introduction 2003
London: attitudes towards congestion pricing

• At the end of 2002 (prior to introduction)
  • 40% reject pricing
  • 40% support it
• After introduction in 2003:
  • 25% reject
  • 60% support
• Relatively stable figures over time afterwards
Norway I: Bergen-Oslo

• Bergen
  • One month before opening: 13% in favor, 54% strongly opposed
  • After one year of operation: 50% in favor, 36% opposed

• Oslo
  • Before opening 70% against
  • After one year: 64% against (in 98 down to 53%)
  • Very negative went from 40% down to 17% in 98
  • Positive from 30% to 46% in 98
Norway II: Trondheim

- No strong congestion problem
- Toll to finance road investment package
- Time differentiated toll
- Operated 1991-2005
- Discontinued 2005
- Attitudes negative before introduction, more positive early in the period, again more negative attitudes versus the end of the period
Fig. 1. Negative attitudes before and after (one year of) opening of urban tolls in Norway (adapted from Odeck and Brathen, 2002, 256).
Stockholm I

• In 2002, the Green Party supports minority government of social democrats and gets congestion pricing trial

• The opposition asks a referendum before, but this was not organized by the majority in power because the polls suggested a majority would vote against

• Congestion pricing trial Jan-Jul 2006 accompanied by substantial expansion public transport
Stockholm II: overview introduction

![Timeline of important events](image)

**Fig. 1.** Timeline of some important events connected to phases in the policy process.
Stockholm III

• After trial, city Stockholm decided 51% favor, 45% against

• Neighboring municipalities 40% favor, 60% against

• Pricing introduced in 2007 by liberal conservative government, earmarking investment for road and public transport investment
Stockholm: change in attitudes towards trials I

*Fig. 5.* Do you think that it is a good or bad decision to carry out the Stockholm trial? Responses: Very good or Quite good, by traveller group. County of Stockholm.
Change in attitudes towards trial II

Fig. 6. Do you think that it is a good or bad decision to carry out the Stockholm trial? Responses: Very good or Quite good. By area in County of Stockholm.
Change in attitudes III

Fig. 7. If you were to vote in a referendum today on a permanent implementation...? Responses: Very likely yes or rather likely Yes. By area in County of Stockholm.
Examples with referenda

- Edinburgh
  - One or two cordons, London technology
  - 65% vote, of these 75% vote against
  - Project cancelled

- Manchester
  - 70% vote against
  - Project cancelled

- Same story Midlands, National, etc.
Tentative conclusions

• Few cases of pricing actually introduced
• Referenda never get majority in favour
• Introduction of pricing seems to have been against a majority of population
• More positive attitudes towards pricing after introduction
• Introduction always coupled to massive investment and/or subsidies for public transport
Why are ‘good’ policies not introduced? Alternative explanations

• Lobbying and pressure groups (Dixit el al (1997), Besley and Coate (1999), Coate and Morris (1999))
• Uncertainty and status quo bias in policy making (Fernandez and Rodrik (1991), Jain and Mukand (2003), Ciccone (2004))
• Asymmetric information: losers tend to ask overcompensation that gainers are unwilling to pay (Mitchell and Miro (2006))
Uncertainty and status quo bias in policy-making: Fernandez-Rodrik

A. Majority is better off with reform ex post:

-0.2

0

0.4

0.6

1

M

D

gains

losses

But majority votes against reform ex ante:

0.2

M

expected losses

0.6

1

-0.067

B. Majority is worse-off with reform ex post:

0.3

M

D

gains

losses

0.7

0.9

1

-0.067

But majority votes for reform ex ante:

0.3

expected gains

0.015

M

D

0

0.9

1
Changing attitudes road pricing: alternative explanations

• Improvements after introduction of pricing (Odeck-Brathen (TrResA 02))

• Cognitive dissonance (Schade-Baum (TrRes07))
  – Deviation between beliefs (attitudes) and behavior causes discomfort
  – If road pricing is believed to be inevitable, this causes cognitive dissonance, and the only alternative to reduce it is to adapt attitudes

• This paper: argument along lines of Fernandez-Rodrik
Majority voting models with uncertainty

• One and two mode versions
• Individuals are uncertain about their ‘position’ after the introduction of road pricing
  • Their exact willingness to pay for car use
  • The ‘cost’ of switching from car to public transport use
• Alternatives considered include the status quo (no pricing), optimal congestion charges with lump sum redistribution of revenues, optimal congestion charges with revenues to public transport
Assumptions of the one-mode model

- One mode, one road link, morning commute
- N commuters that want to use road, indexed 1,...,n,...N
- Willingness to pay to use car is distributed uniformly and decreases linearly from 1 to N
- No other distortions, all other goods priced at marginal cost
- Individuals are risk neutral
- Value of time the same for every individual
Political decisions

• Majority voting

• We consider two alternatives only
  – Status quo without road pricing
  – Road pricing at the socially optimal toll, with lump-sum redistribution of toll revenues to all voters
Demand and costs

• Inverse demand

\[ p = a - bn \]

• Average time cost

\[ ATC = d + cn \]

• Marginal social cost

\[ MSC = d + 2cn \]
Simple model – 1 mode

Generalised price

WTP or Demand function

Ex Post equilibrium With optimal toll

Marginal social cost

Average cost

Resource cost

Total Toll revenue

Gain in Travel time

O

n

n°

N
Market and social equilibria

• Market equilibrium without pricing
  \[ n^0 = \frac{a - d}{b + c} \]

• Social optimum
  \[ n^* = \frac{a - d}{b + 2c} \]

• Optimal tax
  \[ t^* = \alpha t^* \]

• Redistribution per person
  \[ \frac{c(n^*)^2}{N} \]
Effects congestion pricing: certainty

• Initial non-drivers: interval $(n^0, N)$
  – Gain redistributed tax revenues

• Continuing drivers: interval $(0, n^*)$
  – Loose tax paid, gain time, gain redistributed revenues
  – Gain per person $-cn^* + c(n^0 - n^*) + \frac{c(n^*)^2}{N} < 0$

• People that no longer drive: interval $(n^*, n^0)$
  – Loose the value of the trip, gain saved time loss and distributed tax revenue
  – Gain is $-\left[a - bn - (d + cn^0)\right] + \frac{c(n^*)^2}{N} > 0$
Effects congestion pricing: certainty II

• There is a value $n'$ such that all $n<n'$ are worse off and all $n<n'$ are better off. It is given by

$$n' = n^0 - \frac{c(n*)^2}{bN}$$

• With certainty, there is a majority in favor of an optimal congestion toll if

$$n' = n^0 - \frac{c(n*)^2}{bN} < \frac{N}{2}$$
Introducing uncertainty

- We assume initial drivers are uncertain about their individual position (WTP) after introduction of pricing.
- They vote on the basis of expected gain in the range

\[
\frac{n^*}{n^0} \left[ -cn^* + c(n^0 - n^*) + \frac{c(n^*)^2}{N} \right] + \left[ \frac{n^0 - n^*}{n^0} \right] \left\{ \frac{c(n^*)^2}{N} - \left[ a - b \left( \frac{n^0 + n^*}{2} \right) - (d + cn^0) \right] \right\}
\]

- This is necessarily negative
- ALL initial drivers will vote against pricing
Simplest model

<table>
<thead>
<tr>
<th>Generalised price</th>
<th>Generalised price</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP or Demand function</td>
<td>Ex Post equilibrium</td>
</tr>
<tr>
<td>Total Tax revenue</td>
<td>Marginal social cost</td>
</tr>
<tr>
<td>Resource cost</td>
<td>Average cost</td>
</tr>
</tbody>
</table>

No Uncertainty about own WTP

Against reform

With Uncertainty About own WTP

Against reform

\[ n' = n^* - cn^2/bN \]

In favour of reform
Uncertainty: implications

• More people vote against ex ante than ex post
• Possible conflict between voting ex ante (uncertainty) and ex post (certainty)
• Majority against ex ante, although there would have been a majority ex post if

\[ n' < \frac{N}{2} < n^0 \]
Ex ante vs ex post majority on road pricing

EXPECTED
Gain of reform

Car drivers

REALIZED
Gain of reform

EX ANTE: NO MAJORITY FOR REFORM

EX POST: MAJORITY FOR REFORM

N

Initial Public transport users

n'

n°

N/2
Will there be a vote in favour of an experiment to reduce uncertainty?

- If there is no ex ante majority, there will also be no majority in favor of an experiment that resolves the uncertainty.
- If there is no extra ex ante information, the majority (car drivers) votes NO as their expected benefit is negative.
- This may change if different groups of car owners can be identified and have different perceptions.
Extending the model: assumptions

• Three types of individuals in the initial situation
  – car users \((n^°)\)
  – public transport users \((N-n^°)\)
  – people that for various reasons do not need peak period transport \((M-N)\)

• Different possible revenue uses
  – Lump-sum redistribution
  – Partial or full earmarking of revenues to public transport
Extend to two modes (car, public transport)

- Generalised price
- WTP or Demand function
- Marginal social cost
- Average cost
- Resource cost
- Total Toll revenue
- Gain in Travel time

Ex Post equilibrium
With optimal toll + subsidy
Initial equilibrium

$O_0 n^*$
$n^*$

$N$
The two-mode model

• Both N and M are fixed
• Optimal number of car users is easily shown to be again $n^*$
• Optimal solution can be implemented by any combination $s+t=cn^*$
• Combinations vary in the net revenue that can be redistributed, one solution is budget break even: revenues of toll = subsidies to public transportation
Extended model
Three policies considered

- Optimal road tax, zero subsidy public transport, lump sum redistribution of the revenues
- Optimal combinations of road tax and public transport subsidies without formal government budget restriction; net revenue surplus redistributed to all individuals
- Unique optimal toll-subsidy combination with formal budget restriction; revenues can only be used to subsidize public transport
Case I

- Optimal toll, no subsidy to public transport, all revenues lump sum redistributed to all $M$ individuals

$$t = cn^* = c \frac{(a - d)}{(b + 2c)}$$

$$s = 0$$

$$\text{Red} d = \frac{c(n^*)^2}{M}$$
Case II

• Set of optimal tax-subsidy policies with redistribution of excess revenues to all $M$ people

\[
t + s = cn^* = c \left( \frac{a - d}{b + 2c} \right)
\]

\[
\text{Red} = \frac{tn^*}{M} - \frac{s(N - n^*)}{M} = \frac{(t + s)n^*}{M} - s \frac{N}{M}
\]
Case III

• Optimal tax and public transport subsidy subject to full earmarking: all revenue goes to public transport

\[ tn^* - s(N - n^*) = 0 \]

• This implies unique optimal tax and subsidy

\[ t = cn^* \left(1 - \frac{n^*}{N}\right); \quad s = \frac{c(n^*)^2}{N} \]
Results certainty I

• Fewer voters are against if the revenues are used to finance public transport subsidies
• Intuition: public transport users don’t have to share revenues with people not using peak period transport (M-N)
• Easier to get a majority if road pricing is linked to public transport subsidies (or investment)
Results certainty II

- Consider voting over four alternatives: the three pricing options (1,2,3) and the status quo (0)
- Continuing drivers rank 0, 3, 2, 1
  - They prefer nothing happening
  - If congestion pricing, they prefer subsidies over redistribution (lower toll)
- People switching from car to public transport also rank 3,2,1. Alternative 0 can be anywhere
- Continuing public transport users rank 3,2,1,0
- People not using peak period transport rank 1,2,3=0
Never use car or Public transport

Switch From Car to Public transport

Always use car

Doing Nothing
Toll+subsidy
Toll+subsidy+tax decrease
Tax only

Toll+subsidy
Toll+subsidy+tax decrease
Tax only

(ranking of » Doing nothing » is undetermined for those in interval n*,n°)

Tax only
Toll+subsidy+tax decrease
Toll+subsidy = doing Nothing
Majority voting certainty I

- No toll has a majority if many people negatively affected, relative to number of voters
  \[ n' > \frac{M}{2}; \quad n' = n^0 - \frac{c}{b} \frac{(n^*)^2}{N} \]

- Road toll with revenues exclusively to public transport has a majority if the opposite holds and more than half the voters are transport users
  \[ n' < \frac{M}{2} < N \]
Majority voting certainty II

• Road toll with full redistribution gets majority if

\[ N < \frac{M}{2} \]

• Road toll with subsidies and redistribution never has a majority

• Number of voters can be manipulated to affect outcomes
Uncertainty

• Expected loss initial drivers smallest if revenues used to subsidize public transport

• In each case, uncertainty may imply conflict ex ante versus ex post; conflict arises if

\[ n^0 - \frac{c (n^*)^2}{b N} < \frac{M}{2} < n^0 \]

• Initial car drivers more than half the number of voters, and many continuing car users
Conclusions

• Uncertainty may explain why road pricing is not more often introduced
• The conflict between ex ante and ex post behavior is consistent with the change in attitudes before and after introduction of road pricing
• Introducing road pricing may require some ‘undemocratic’ behavior of policy makers
• Subsidies to public transport raise both ex ante and ex post number of voters in favor of congestion pricing