Behavioral Adjustments & Equity Effects of Congestion Pricing:

Analysis of Morning Commutes During the Stockholm Trial

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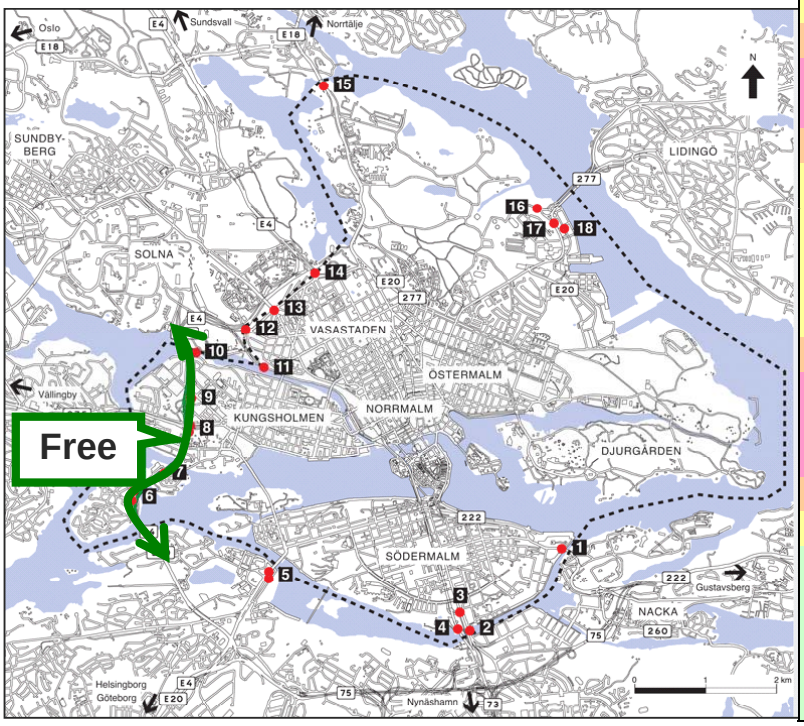
The Stockholm Trial

- Cordon Congestion Charges
- Bus Service Enhancements
- New Park-and-Ride Lots
- Initial Plan for 18-Month Trial
- Delayed Implementation, by ~1 year
  - Actual Time Period: January – July, 2006

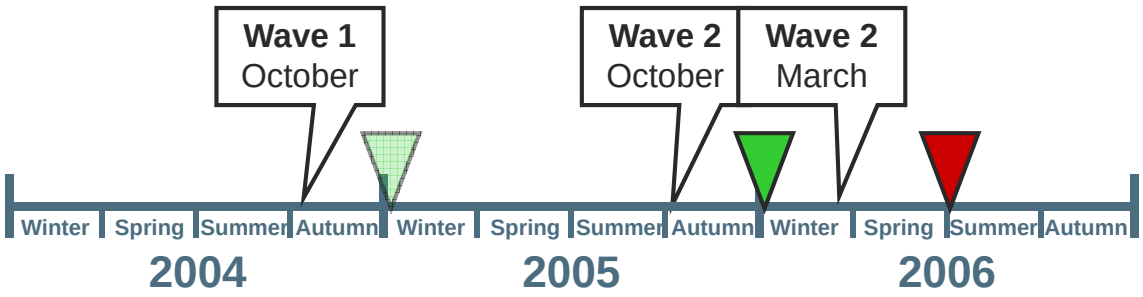
The Stockholm Trial



From	To	Charge
06:30	06:59	10 kr
07:00	07:29	15 kr
07:30	08:29	20 kr
08:30	08:59	15 kr
09:00	15:29	10 kr
15:30	15:59	15 kr
16:00	17:29	20 kr
17:30	17:59	15 kr
18:00	18:29	10 kr
18:30	06:29	0 kr

Data

- Household Travel Diaries
  - One Day/Household, 10088 households in both waves
- Two Waves of Surveys
  - Attempted October Surveys
- Second Wave Delayed by Implementation Delays
  - Result: Seasonal Effects



Seasonal Effects

- Weather:
  - October, 2004 vs. March, 2006: 15˚C difference
- Effects on Travel Behavior:
  - Non-Motorized Modes (82% reduction in bike use)
  - Trip Frequency
- Narrow Scope:
  - Morning Commute Trips (those who went to work both years)
  - Only Auto & Transit (for both 2004 & 2006)
  - Study Sample: 1500 individuals

Three Questions on Equity

Did Traveler Responses Differ with respect to Socio-Economic Groups?

1. Mode Choice
2. Departure Time Choice
3. Were Benefits and Costs Distributed Differently with respect to Socio-Economic Groups?

Part 1: Mode Choice

- Central Questions:
  1. *What detectable effect does the toll have on mode choice?*
  2. *How does that effect differ across demographic groups?*

Data Summaries: Mode Choice

Mode Choice Proportions		2004 (before toll)	
		Auto	Transit
2006 (with toll)	Auto	*"Tolled"* **607** (39%)	*"Tolled-On"* **63** (4%)
	Transit	*"Tolled-Off"* **86** (6%)	*"Un-Tolled"* **794** (51%)

Mode Choice: Methodology

- Measure Treatment Effect
  - Treated group are those who:
    - Commuted by Car *Before* the Trial
    - Have Workplaces Across the Cordon from Home
    - Have Unexempt Vehicles (e.g. *not* motorcycles, taxis, foreign-registered vehicles, etc.)
- Matching Estimator
  - Match Each *Treated* Individual with a Similar *Untreated* Individual
  - Compare *Observed* Mode Choice from *Treated* with *Expected* Mode Choice by Matching *Untreated*

Mode Choice: Methodology

- Matching based on Propensity Score
  - Individuals Matched based on Mode Choice Probability
  - Reduces Dimensionality to One Score

Note: Tr = Transit, Au = Auto

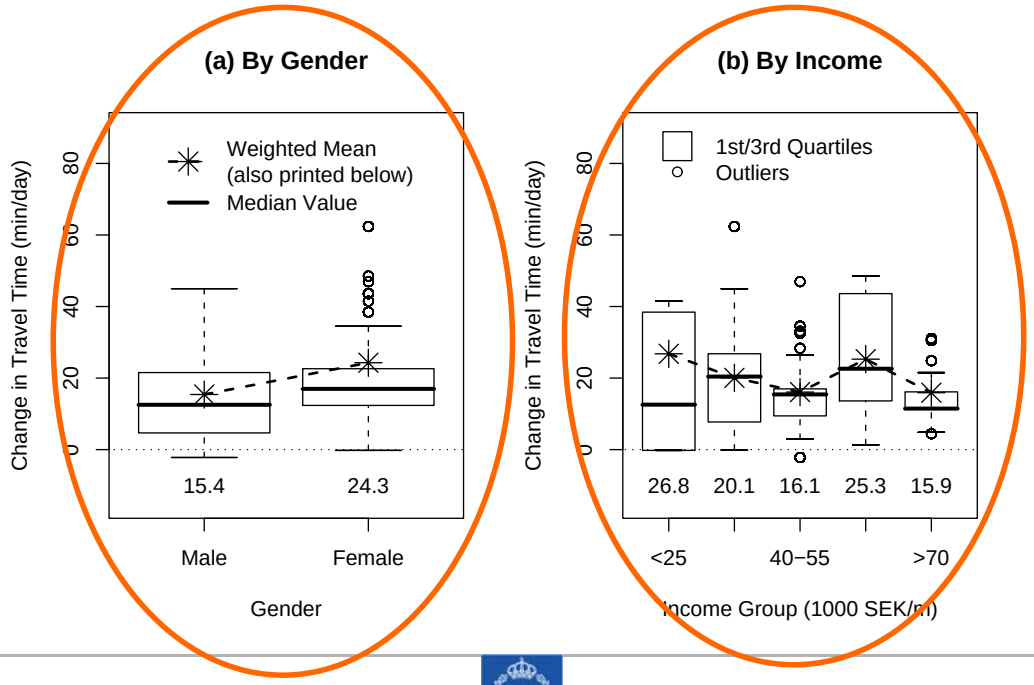
Variable	Mode Choice Coefficients	
	Value	Std. Err.
Travel Time	-0.08	0.02
Tr-Constant	1.17	0.35
Tr-Female	0.89	0.12
Tr-Flex Time	0.16	0.12
Tr-Age	-0.01	0.01
Au-Distance	-0.06	0.01
Au-Availability	0.47	0.10

Mode Choice: Results

Treat-ment Group	Average Treatment Effect on the Treated			
	Bandwidth = 8		Bandwidth = 4	
	Tolled-Off	Tolled-On	Tolled-Off	Tolled-On
Untreated	0.102	0.080	0.115	0.081
Treated	0.250	0.068	0.250	0.072

Mode Choice: Results

Those Switching from Auto to Transit:



Part 2: Departure Time

- Central Questions:
  - *What detectable effect does the toll have on departure time?*
  - *How does that effect differ across demographic groups?*

Departure Time Choice: Methodology

- Departure Time Switching Model
  - Multinomial Logit (MNL)
- Choices:
  - Same 15-Minute Period
  - Leave Earlier
  - Leave Later

Departure Time Choice: Results

Consumption Category	Change in Departure Time			
	None	Same Period	Earlier	Later
1 (Poorest)	0.27	0.41	0.14	0.18
2	0.28	0.38	0.15	0.20
3	0.20	0.47	0.16	0.18
4	0.21	0.47	0.16	0.16
5 (Richest)	0.21	0.48	0.18	0.13

Departure Time Choice: Results

	Alternative: Earlier		Alternative: Later	
Attribute	**Value**	***Std. Err.***	**Value**	***Std. Err.***
Constant	-1.78	*0.35*	-3.91	*0.49*
Formal Flex Time	0.74	*0.31*	--	
Cross the Cordon	0.43	*0.33*	0.55	*0.33*
Start Time	-0.82	*0.60*	4.02	*0.78*
Dependent Children	0.73	*0.43*	0.81	*0.39*

Part 3: Welfare Analysis

- Central Questions:
  - *What was the average effect?*
  - *How was this distributed between demographic groups?*
  - *How was this distributed* within *groups?*

Welfare Analysis: Methodology

- Total Economic Effects:
  - Tolls Paid (if any)
  - Travel Time Savings
  - Adjustment Burden
    - One-Half of Tolls Paid and Auto Travel Time Savings
- Equity Effects:
  - Group Means
  - Gini Coefficients

Welfare Analysis: Results

Group	Average Effect (SEK/year)
All	-189
By Gender:	
Male	-175
Female	-202

Welfare Analysis: Results

Income Group (SEK/month)	Average Effect (SEK/year)
< 25 000	-321
25-40 000	-199
40-55 000	-35
55-70 000	-348
> 70 000	-219

- Gini Coefficient:
  - 0.2778 → 0.2785
  - Difference: +0.0007 (regressive, but insignificant)

Welfare Analysis: Results

Commute Group	Average Effect (SEK/year)
Initial Mode:	
Automobile	-376
Public Transport	-27
Tolled Initial Commute:	
Tolled Automobile	-1840
Other	+69

Conclusions

- Mode Choice:
  - 15% effect for morning commutes
  - Women, more than men, saw increased travel times when switching to transit
- Departure Time:
  - Very small effects
  - What effect there was, correlated with flex time
- Welfare Effects:
  - Low redistribution among demographic groups
  - Redistribution impact is highly skewed by initial mode choice

Thanks to…

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