Selection bias in reward experiments: evidence from a real-life peak avoidance experiment among train commuters

Stefanie Peer

Konferenz für Verkehrsökonomik und -politik
Berlin, 12. Juni 2015

Introduction

- Experiment conducted in the Netherlands (2012-2013)
  - Ca. 1000 participants
  - Train commuters received a monetary reward for traveling off-peak during a 15-18 week period
- Estimation of departure time choice models
  - Using discrete choice models: MNL and panel latent class
- Derivation of willingness-to-pay estimates
  - For reducing travel time, schedule delays, the number of transfers, crowdedness, and unreliability
  - Key values in infrastructure appraisals
  - Usually estimated from stated preference (SP) rather than revealed preference (RP) data

Current status of the research

- First paper using these data has been just submitted
- Next paper: focus on selection bias due to self-selection of the participants
  - Departure time choice models have been estimated (see this presentation)
  - Prediction/simulation part should be added

Motivation

- We observe differences between participants and non-participants in terms of socio-economic characteristics
- We observe differences between participants and non-participants in terms of their behavior in hypothetical choice situations (SP)
- We find that the during the reward period the number of peak trips among participants decreases by 22%; compared to (non-experimental) findings from the UK, NZ and Australia, that seems to be too good to be true!

Background: Train travel in the Netherlands

- Dense & busy railway network
- Demand for rail travel is still increasing
- Service frequencies close to capacity on major links
- Trains tend to be crowded during peak hours
  - Especially in the central and Western parts (Randstad)
- Time-of-day dependent pricing as a solution?
  - External crowding costs
  - Marginal environmental costs are higher for peak train travelers when off-peak supply of capacity is determined largely by peak demand (Rietveld, 2002)

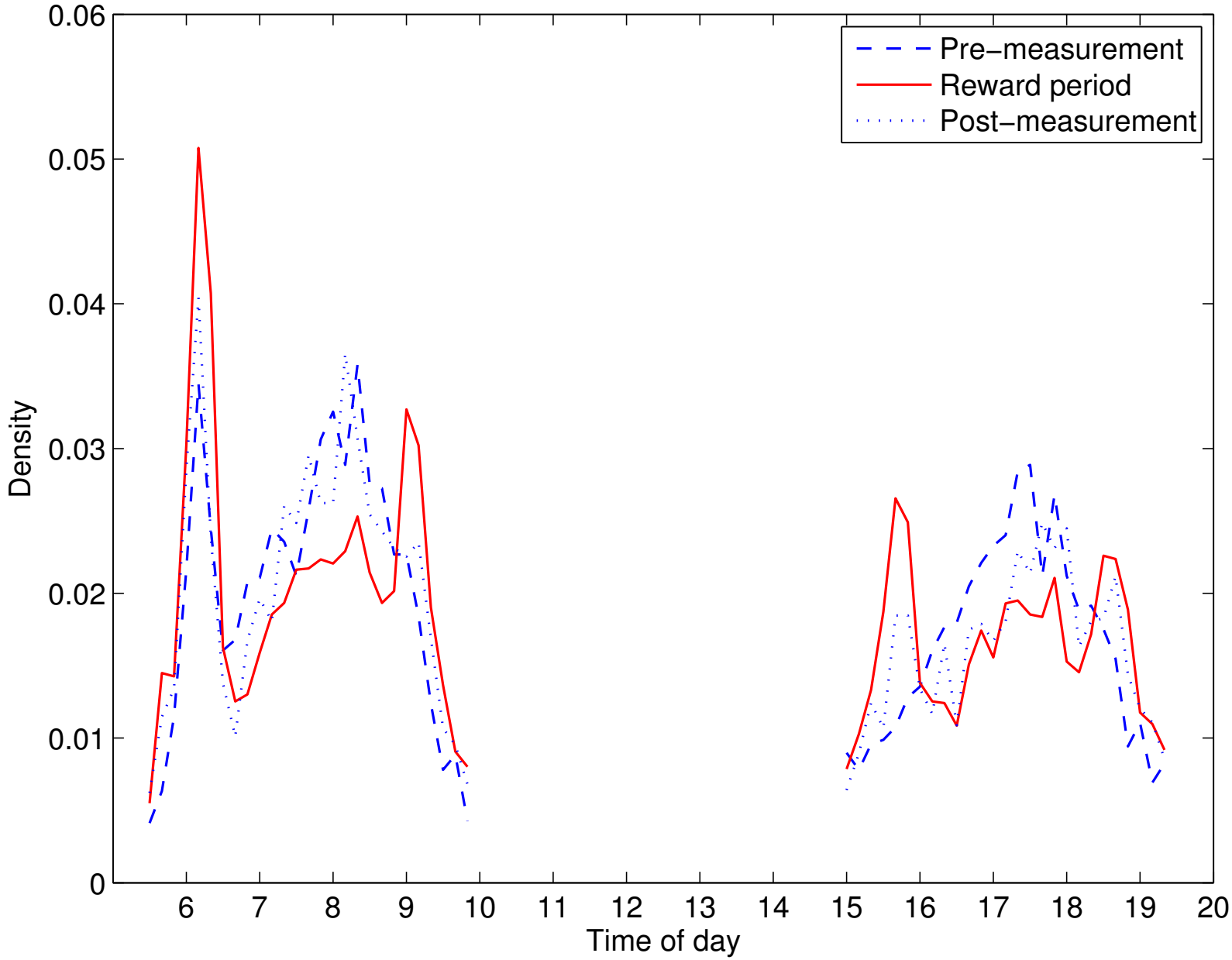
Experiment (I)

- Recruitment among train travelers with existing travel pass
- Behavior is measured via smartphone app
- Participants could gain a monetary reward for *traveling off-peak by train on their participation link*
  - No incentive to turn off app
  - Maximum 2 rewards/day
  - Morning peak: Departures between 6:30 am and 9.00 am
  - Evening peak: Departures between 16:00 am and 18:30 pm
- Reward per off-peak trip between 1.5 and 4.5 Euro
  - Reward is dependent on travel distance
  - Each participant goes through high and low reward regime

Experiment (II)

- 3 periods
  - 3 weeks of pre-measurement
  - 15-18 weeks reward period
  - 4 weeks of post-measurement
- Compulsory parts of the experiment:
  - Participation survey
  - Stated preference experiment
  - Evaluation survey
  - Logbooks during 6 weeks

Distribution of departure times over time of the day



Substantial behavioral changes induced by the reward

- During reward period: 22% decrease in peak trips compared to pre-measurement
- During post-measurement: 10% decrease in peak trips compared to pre-measurement
- Number of weekly trips per person is fairly constant between pre-measurement, reward period and post-measurement $\rightarrow$ little evidence of induced demand/selective use of app

Departure time choice model

$$U = \beta_R \text{ reward} + \beta_T \text{ travel time} + \beta_{SDE} \text{ schedule delay early} + \beta_{SDL} \text{ schedule delay late} + \beta_{TR} \text{ number of transfers} + \beta_{REL} \text{ high chance of a delay } >10 \text{ min} + \beta_C \text{ high extent of crowding}$$

- Index: person n, alternative train connection j and choice situation (day; morning/evening) m
- Willingness-to-pay estimates can be derived
  - β_R can be interpreted as marginal utility of income

Willingness-to-pay estimates: MNL, RP only

Valuations				
W_{TT}	Travel time	€/hour	15.5	3.3
W^{M}_{SDE}	Schedule delay early (morning)	€/hour	6.62	0.86
W^{M}_{SDL}	Schedule delay late (morning)	€/hour	5.56	0.65
W^{E}_{SDE}	Schedule delay early (evening)	€/hour	4.95	0.64
W^{E}_{SDL}	Schedule delay late (evening)	€/hour	3.99	0.56
W_{TR}	Transfer	€/#	2.77	0.56
W_{C}	Little crowding	€	(0.403)	0.313
W_{CU}	missing occupancy expectation	€	(-0.314)	0.484
W_{REL}	avoid P(delay>10min)>5%	€	(0.750)	0.603
Estimation statistics				
# observations	22174			
# individuals	544			
LL_{0}	−64891.476			
LL	−55471.579			

Representativeness of the results?

Recruitment:

- Invitation via personal e-mails and posters at stations
- 1011 active participants $\rightarrow$ Response rate of 1.2% to emails
- **Self-selection very likely**

Selection-bias

- Explicitly model self-selection using
  - RP data from participants
  - SP data from participants and non-participants
    - A survey among non-respondents was conducted $\rightarrow$ 489 answers (response rate of 13%)
  - Data on socio-economic characteristics, reported travel behavior, reported scheduling restrictions from participants and non-participants

Data availability: overview

Data	Participants	Non-participants
RP	X	
SP	X	X
Socio-economic characteristics	X	X

Data availability: overview

Data	Participants	Non-participants
RP	X	
SP	X	X
Socio-economic characteristics	X	X

Selection-bias: work in progress (II)

Model structure

1. Selection model (explains participation decision)
2. Scheduling choice model

Estimation

- Deterministic (participants and non-participants as observed)
- Staged (participants and non-participants as predicted)
- Simultaneous

Selection model: preliminary results

- 37 explanatory variables
- Probability of participation increases with
  - lower income
  - higher education
  - specific type of jobs (management, specialists, etc.)
  - usual time of travel being off-peak
  - higher scheduling flexibility
  - longer participation link
  - higher travel frequency
  - first-class travel pass
- Household composition and age have no effect

Joint deterministic SP-RP model for participants and non-participants

Estimation statistics	
LL Selection	−583.841
LL Choice	−17082.2
LL Global	−17666.024
Sample size	15797
Number of individuals	1132

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0323	0.0081	0.128	0.008
β_{TT}	SP Travel time	hour	−2.78	0.17	−2.72	0.15
β^M_{SDE}	SP Schedule delay early	hour	−2.04	0.10	−1.69	0.09
β^M_{SDL}	SP Schedule delay late	hour	−1.29	0.09	−1.37	0.08
$\beta_{C\mathbf{3}}$	SP Crowded train		*−0.0695*	0.0516	*−0.0853*	0.0470
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.327	0.042	−0.443	0.043
β_{REL}	SP P(delay>10min)>10%		−0.236	0.039	−0.385	0.040
β_R	RP Reward	€			0.288	0.029
β_{TT}	RP Travel time	hour			−4.21	0.64
β^M_{SDE}	RP Schedule delay early (morning)	hour			−1.44	0.11
β^M_{SDL}	RP Schedule delay late (morning)	hour			−1.13	0.06
β_{TR}	RP Transfer	#			−0.687	0.101
β_C	RP Crowded train expected				*−0.0759*	0.0830
β_{CU}	RP missing occupancy expectation				*0.0411*	0.1360
β_{REL}	RP P(delay>10min)>5%				*−0.113*	0.169
valuation						
W_{TT}	SP Travel time	€/hour	86.1	21.2	21.2	1.6
W^M_{SDE}	SP Schedule delay early	€/hour	63.2	15.5	13.2	0.9
W^M_{SDL}	SP Schedule delay late	€/hour	39.9	10.0	10.7	0.8
$W_{C\mathbf{3}}$	SP Crowded train	€	(*2.15*)	1.70	(*0.666*)	0.369
$W_{C\mathbf{4}}$	SP Very crowded train	€	10.1	2.8	3.46	0.38
W_{REL}	SP P(delay>10min)>10%	€	7.31	2.16	3.01	0.37
W_{TT}	RP Travel time	€/hour			14.6	2.5
W^M_{SDE}	RP Schedule delay early (morning)	€/hour			5.00	0.55
W^M_{SDL}	RP Schedule delay late (morning)	€/hour			3.92	0.39
W_{TR}	RP Transfer	€/#			2.39	0.43
W_C	RP Crowded train expected	€			(*0.264*)	0.293
W_{CU}	RP missing occupancy expectation	€			(*−0.143*)	0.473
W_{REL}	RP P(delay>10min)>5%	€			(*0.392*)	0.593
class share in sample			44.0%		56.0%	

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0323	0.0081	0.128	0.008
β_{TT}	SP Travel time	hour	−2.78	0.17	−2.72	0.15
β^M_{SDE}	SP Schedule delay early	hour	−2.04	0.10	−1.69	0.09
β^M_{SDL}	SP Schedule delay late	hour	−1.29	0.09	−1.37	0.08
$\beta_{C\mathbf{3}}$	SP Crowded train		*−0.0695*	0.0516	*−0.0853*	0.0470
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.327	0.042	−0.443	0.043
β_{REL}	SP P(delay>10min)>10%		−0.236	0.039	−0.385	0.040
β_R	RP Reward	€			0.288	0.029
β_{TT}	RP Travel time	hour			−4.21	0.64
β^M_{SDE}	RP Schedule delay early (morning)	hour			−1.44	0.11
β^M_{SDL}	RP Schedule delay late (morning)	hour			−1.13	0.06
β_{TR}	RP Transfer	#			−0.687	0.101
β_C	RP Crowded train expected				*−0.0759*	0.0830
β_{CU}	RP missing occupancy expectation				*0.0411*	0.1360
β_{REL}	RP P(delay>10min)>5%				*−0.113*	0.169
valuation						
W_{TT}	SP Travel time	€/hour	86.1	21.2	21.2	1.6
W^M_{SDE}	SP Schedule delay early	€/hour	63.2	15.5	13.2	0.9
W^M_{SDL}	SP Schedule delay late	€/hour	39.9	10.0	10.7	0.8
$W_{C\mathbf{3}}$	SP Crowded train	€	(*2.15*)	1.70	(*0.666*)	0.369
$W_{C\mathbf{4}}$	SP Very crowded train	€	10.1	2.8	3.46	0.38
W_{REL}	SP P(delay>10min)>10%	€	7.31	2.16	3.01	0.37
W_{TT}	RP Travel time	€/hour			14.6	2.5
W^M_{SDE}	RP Schedule delay early (morning)	€/hour			5.00	0.55
W^M_{SDL}	RP Schedule delay late (morning)	€/hour			3.92	0.39
W_{TR}	RP Transfer	€/#			2.39	0.43
W_C	RP Crowded train expected	€			(*0.264*)	0.293
W_{CU}	RP missing occupancy expectation	€			(*−0.143*)	0.473
W_{REL}	RP P(delay>10min)>5%	€			(*0.392*)	0.593
class share in sample			44.0%		56.0%	

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0323	0.0081	0.128	0.008
β_{TT}	SP Travel time	hour	−2.78	0.17	−2.72	0.15
β^M_{SDE}	SP Schedule delay early	hour	−2.04	0.10	−1.69	0.09
β^M_{SDL}	SP Schedule delay late	hour	−1.29	0.09	−1.37	0.08
$\beta_{C\mathbf{3}}$	SP Crowded train		*−0.0695*	0.0516	*−0.0853*	0.0470
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.327	0.042	−0.443	0.043
β_{REL}	SP P(delay>10min)>10%		−0.236	0.039	−0.385	0.040
β_R	RP Reward	€			0.288	0.029
β_{TT}	RP Travel time	hour			−4.21	0.64
β^M_{SDE}	RP Schedule delay early (morning)	hour			−1.44	0.11
β^M_{SDL}	RP Schedule delay late (morning)	hour			−1.13	0.06
β_{TR}	RP Transfer	#			−0.687	0.101
β_C	RP Crowded train expected				*−0.0759*	0.0830
β_{CU}	RP missing occupancy expectation				*0.0411*	0.1360
β_{REL}	RP P(delay>10min)>5%				*−0.113*	0.169
valuation						
W_{TT}	SP Travel time	€/hour	86.1	21.2	21.2	1.6
W^M_{SDE}	SP Schedule delay early	€/hour	63.2	15.5	13.2	0.9
W^M_{SDL}	SP Schedule delay late	€/hour	39.9	10.0	10.7	0.8
$W_{C\mathbf{3}}$	SP Crowded train	€	(*2.15*)	1.70	(*0.666*)	0.369
$W_{C\mathbf{4}}$	SP Very crowded train	€	10.1	2.8	3.46	0.38
W_{REL}	SP P(delay>10min)>10%	€	7.31	2.16	3.01	0.37
W_{TT}	RP Travel time	€/hour			14.6	2.5
W^M_{SDE}	RP Schedule delay early (morning)	€/hour			5.00	0.55
W^M_{SDL}	RP Schedule delay late (morning)	€/hour			3.92	0.39
W_{TR}	RP Transfer	€/#			2.39	0.43
W_C	RP Crowded train expected	€			(*0.264*)	0.293
W_{CU}	RP missing occupancy expectation	€			(*−0.143*)	0.473
W_{REL}	RP P(delay>10min)>5%	€			(*0.392*)	0.593
class share in sample			44.0%		56.0%	

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0323	0.0081	0.128	0.008
β_{TT}	SP Travel time	hour	−2.78	0.17	−2.72	0.15
β^M_{SDE}	SP Schedule delay early	hour	−2.04	0.10	−1.69	0.09
β^M_{SDL}	SP Schedule delay late	hour	−1.29	0.09	−1.37	0.08
$\beta_{C\mathbf{3}}$	SP Crowded train		*−0.0695*	0.0516	*−0.0853*	0.0470
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.327	0.042	−0.443	0.043
β_{REL}	SP P(delay>10min)>10%		−0.236	0.039	−0.385	0.040
β_R	RP Reward	€			0.288	0.029
β_{TT}	RP Travel time	hour			−4.21	0.64
β^M_{SDE}	RP Schedule delay early (morning)	hour			−1.44	0.11
β^M_{SDL}	RP Schedule delay late (morning)	hour			−1.13	0.06
β_{TR}	RP Transfer	#			−0.687	0.101
β_C	RP Crowded train expected				*−0.0759*	0.0830
β_{CU}	RP missing occupancy expectation				*0.0411*	0.1360
β_{REL}	RP P(delay>10min)>5%				*−0.113*	0.169
valuation						
W_{TT}	SP Travel time	€/hour	86.1	21.2	21.2	1.6
W^M_{SDE}	SP Schedule delay early	€/hour	63.2	15.5	13.2	0.9
W^M_{SDL}	SP Schedule delay late	€/hour	39.9	10.0	10.7	0.8
$W_{C\mathbf{3}}$	SP Crowded train	€	(*2.15*)	1.70	(*0.666*)	0.369
$W_{C\mathbf{4}}$	SP Very crowded train	€	10.1	2.8	3.46	0.38
W_{REL}	SP P(delay>10min)>10%	€	7.31	2.16	3.01	0.37
W_{TT}	RP Travel time	€/hour			14.6	2.5
W^M_{SDE}	RP Schedule delay early (morning)	€/hour			5.00	0.55
W^M_{SDL}	RP Schedule delay late (morning)	€/hour			3.92	0.39
W_{TR}	RP Transfer	€/#			2.39	0.43
W_C	RP Crowded train expected	€			(*0.264*)	0.293
W_{CU}	RP missing occupancy expectation	€			(*−0.143*)	0.473
W_{REL}	RP P(delay>10min)>5%	€			(*0.392*)	0.593
class share in sample			44.0%		56.0%	

Joint staged SP-RP model for participants and non-participants

Estimation statistics	
LL Selection	−583.841
LL Choice	−16434.9
LL Global	−17018.737
Sample size	15797
Number of individuals	1132

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0858	0.0122	0.105	0.011
β_{TT}	SP Travel time	hour	−3.84	0.25	−2.18	0.19
β^M_{SDE}	SP Schedule delay early	hour	−2.56	0.17	−1.48	0.13
β^M_{SDL}	SP Schedule delay late	hour	−0.807	0.120	−1.95	0.12
$\beta_{C\mathbf{3}}$	SP Crowded train		*0.0271*	0.0616	−0.178	0.056
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.385	0.053	−0.459	0.052
β_{REL}	SP P(delay>10min)>10%		−0.321	0.055	−0.361	0.043
β_R	RP Reward	€	0.196	0.054	0.291	0.041
β_{TT}	RP Travel time	hour	−3.75	1.24	−4.45	0.93
β^M_{SDE}	RP Schedule delay early (morning)	hour	−5.65	0.74	−1.12	0.14
β^M_{SDL}	RP Schedule delay late (morning)	hour	−0.700	0.101	−2.10	0.19
β_{TR}	RP Transfer	#	−0.552	0.179	−0.773	0.161
β_C	RP Crowded train expected		*−0.0660*	0.1150	*−0.0739*	0.1160
β_{CU}	RP missing occupancy expectation		*−0.189*	0.225	*0.218*	0.215
β_{REL}	RP P(delay>10min)>5%		*0.260*	0.295	*−0.410*	0.253
valuation						
W_{TT}	SP Travel time	€/hour	44.8	7.6	20.8	2.8
W^M_{SDE}	SP Schedule delay early	€/hour	29.8	4.5	14.1	1.6
W^M_{SDL}	SP Schedule delay late	€/hour	9.41	1.66	18.6	2.0
$W_{C\mathbf{3}}$	SP Crowded train	€	(*−0.316*)	0.730	1.70	0.54
$W_{C\mathbf{4}}$	SP Very crowded train	€	4.49	0.85	4.37	0.60
W_{REL}	SP P(delay>10min)>10%	€	3.74	0.97	3.44	0.53
W_{TT}	RP Travel time	€/hour	19.1	7.1	15.3	3.4
W^M_{SDE}	RP Schedule delay early (morning)	€/hour	28.8	9.1	3.85	0.64
W^M_{SDL}	RP Schedule delay late (morning)	€/hour	3.57	0.90	7.22	1.25
W_{TR}	RP Transfer	€/#	2.82	1.27	2.66	0.68
W_C	RP Crowded train expected	€	(*0.337*)	0.608	(*0.254*)	0.406
W_{CU}	RP missing occupancy expectation	€	(*0.964*)	1.141	(*−0.749*)	0.743
W_{REL}	RP P(delay>10min)>5%	€	(*−1.33*)	1.46	(*1.41*)	0.90
class share in sample			44.0%		56.0%	

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0858	0.0122	0.105	0.011
β_{TT}	SP Travel time	hour	−3.84	0.25	−2.18	0.19
β^M_{SDE}	SP Schedule delay early	hour	−2.56	0.17	−1.48	0.13
β^M_{SDL}	SP Schedule delay late	hour	−0.807	0.120	−1.95	0.12
$\beta_{C\mathbf{3}}$	SP Crowded train		*0.0271*	0.0616	−0.178	0.056
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.385	0.053	−0.459	0.052
β_{REL}	SP P(delay>10min)>10%		−0.321	0.055	−0.361	0.043
β_R	RP Reward	€	0.196	0.054	0.291	0.041
β_{TT}	RP Travel time	hour	−3.75	1.24	−4.45	0.93
β^M_{SDE}	RP Schedule delay early (morning)	hour	−5.65	0.74	−1.12	0.14
β^M_{SDL}	RP Schedule delay late (morning)	hour	−0.700	0.101	−2.10	0.19
β_{TR}	RP Transfer	#	−0.552	0.179	−0.773	0.161
β_C	RP Crowded train expected		*−0.0660*	0.1150	*−0.0739*	0.1160
β_{CU}	RP missing occupancy expectation		*−0.189*	0.225	*0.218*	0.215
β_{REL}	RP P(delay>10min)>5%		*0.260*	0.295	*−0.410*	0.253
valuation						
W_{TT}	SP Travel time	€/hour	44.8	7.6	20.8	2.8
W^M_{SDE}	SP Schedule delay early	€/hour	29.8	4.5	14.1	1.6
W^M_{SDL}	SP Schedule delay late	€/hour	9.41	1.66	18.6	2.0
$W_{C\mathbf{3}}$	SP Crowded train	€	(*−0.316*)	0.730	1.70	0.54
$W_{C\mathbf{4}}$	SP Very crowded train	€	4.49	0.85	4.37	0.60
W_{REL}	SP P(delay>10min)>10%	€	3.74	0.97	3.44	0.53
W_{TT}	RP Travel time	€/hour	19.1	7.1	15.3	3.4
W^M_{SDE}	RP Schedule delay early (morning)	€/hour	28.8	9.1	3.85	0.64
W^M_{SDL}	RP Schedule delay late (morning)	€/hour	3.57	0.90	7.22	1.25
W_{TR}	RP Transfer	€/#	2.82	1.27	2.66	0.68
W_C	RP Crowded train expected	€	(*0.337*)	0.608	(*0.254*)	0.406
W_{CU}	RP missing occupancy expectation	€	(*0.964*)	1.141	(*−0.749*)	0.743
W_{REL}	RP P(delay>10min)>5%	€	(*−1.33*)	1.46	(*1.41*)	0.90
class share in sample			44.0%		56.0%	

		unit	non-participants		participants	
			val	std err	val	std err
model coefficients						
β_R	SP Reward	€	0.0858	0.0122	0.105	0.011
β_{TT}	SP Travel time	hour	−3.84	0.25	−2.18	0.19
β^M_{SDE}	SP Schedule delay early	hour	−2.56	0.17	−1.48	0.13
β^M_{SDL}	SP Schedule delay late	hour	−0.807	0.120	−1.95	0.12
$\beta_{C\mathbf{3}}$	SP Crowded train		*0.0271*	0.0616	−0.178	0.056
$\beta_{C\mathbf{4}}$	SP Very crowded train		−0.385	0.053	−0.459	0.052
β_{REL}	SP P(delay>10min)>10%		−0.321	0.055	−0.361	0.043
β_R	RP Reward	€	0.196	0.054	0.291	0.041
β_{TT}	RP Travel time	hour	−3.75	1.24	−4.45	0.93
β^M_{SDE}	RP Schedule delay early (morning)	hour	−5.65	0.74	−1.12	0.14
β^M_{SDL}	RP Schedule delay late (morning)	hour	−0.700	0.101	−2.10	0.19
β_{TR}	RP Transfer	#	−0.552	0.179	−0.773	0.161
β_C	RP Crowded train expected		*−0.0660*	0.1150	*−0.0739*	0.1160
β_{CU}	RP missing occupancy expectation		*−0.189*	0.225	*0.218*	0.215
β_{REL}	RP P(delay>10min)>5%		*0.260*	0.295	*−0.410*	0.253
valuation						
W_{TT}	SP Travel time	€/hour	44.8	7.6	20.8	2.8
W^M_{SDE}	SP Schedule delay early	€/hour	29.8	4.5	14.1	1.6
W^M_{SDL}	SP Schedule delay late	€/hour	9.41	1.66	18.6	2.0
$W_{C\mathbf{3}}$	SP Crowded train	€	(*−0.316*)	0.730	1.70	0.54
$W_{C\mathbf{4}}$	SP Very crowded train	€	4.49	0.85	4.37	0.60
W_{REL}	SP P(delay>10min)>10%	€	3.74	0.97	3.44	0.53
W_{TT}	RP Travel time	€/hour	19.1	7.1	15.3	3.4
W^M_{SDE}	RP Schedule delay early (morning)	€/hour	28.8	9.1	3.85	0.64
W^M_{SDL}	RP Schedule delay late (morning)	€/hour	3.57	0.90	7.22	1.25
W_{TR}	RP Transfer	€/#	2.82	1.27	2.66	0.68
W_C	RP Crowded train expected	€	(*0.337*)	0.608	(*0.254*)	0.406
W_{CU}	RP missing occupancy expectation	€	(*0.964*)	1.141	(*−0.749*)	0.743
W_{REL}	RP P(delay>10min)>5%	€	(*−1.33*)	1.46	(*1.41*)	0.90
class share in sample			44.0%		56.0%	

Summary

- Experiment successful in shifting trips to off-peak periods
- Half of the decrease in peak trips persists during the post-measurement
- Longitudinal data, innovative data collection method
- One of the first studies that attempts to estimate value of comfort/reliability/number of transfers from RP data
- Self-selection very relevant
  - Various factors determine participation decision
  - Large difference in marginal utility of income between participants and non-participants

Next steps

- Simulation of departure time decisions for participants and non-participants using the estimated coefficients
  - To which extent would the number of peak trips decline among non-participants when fare differentiation is introduced?
    - Probably much less than 22%...