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A Primer on Stated Preference and Panel Surveys: Examples with Implications to Congestion Pricing in NYC

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Stated vs. Revealed Preference Data

Need for disaggregate data

- Traditional (aggregate) demand models have proven to be:
  - Good for the analyses of capacity improvement alternatives, and things like that
  - Really bad for analyses of policies in which the response of the users is conditioned by individual characteristics, e.g., road pricing
- This is why disaggregate (behavioral) choice models are used
- Disaggregate models need disaggregate data

Disaggregate data: Stated vs. Revealed

- Typically, data represent either actual (revealed), or declared (stated) behavior
- Revealed preference data: Mode used to come here
- Stated preference data: the choice of mode in a hypothetical scenario

Comparison of RP and SP data

	Revealed	**Stated**
Preference	Choice in actual market Congruent with actual behavior Market /personal constraints considered	Choice in hypothetical scenarios May be incongruent with actual behavior Market and personal constraints may not be considered
Alternatives	Actual alternatives Responses to non-existing alternatives are not observable	Generated Can elicit preference for non-existing alternatives

	Revealed	Stated
Attributes	May include measurement errors Correlated attributes Ranges are limited	No measurement errors Multicollinearity could be avoided in experimental design Ranges can be extended
Choice set	Typically ambiguous	Pre-specified
Number of responses per interviewee	Typically only one	Multiple
Response form	Only choice	Choice, ranking, rating, matching

Stated Preference Approaches

- Experimental setting
  - Context
  - Alternatives or profiles defined as bundles of attributes
- Elicitation of preferences
  - Choice: Preference of <u>one</u> alternative relative to the others
  - Ranking: Preference of <u>each</u> alternative relative to the others
  - Rating: Respondent puts each alternative on a scale good to bad
  - Matching: Relative value of attributes being traded off. Often done with a price attribute.

Potential sources of bias

- Indifference to the experimental task
- Policy response bias
- Justification bias
- Omission of situational constraints
- Incomplete description of alternatives
- Cognitive incongruity with actual behavior (mismatch between stated and actual behavior)
- Value of data is context specific (depend on the scenarios)

Experimental design

- Attributes: the key variables to play with
- Levels: the values that the attributes would take
- Profiles: a combination of attribute levels presented to a respondent
- Typically "non-feasible" profiles are eliminated

- Key issue: combinatorial number of possibilities
  - If we have five attributes with four levels each, the total number of scenarios is:

$$4x4x4x4x4 = 1024$$

- Full factorial designs have huge numbers of profiles
- Fractional factorial designs focus on an “optimal” subset of profiles
  - Using fractional designs has important implications for model estimation as not all them enable to estimate all parameters in a model
  - Some designs are only able to estimate “main effects”
- Randomly generated designs

Typical process

- Identify variables influencing the decision process (focus groups)
  - Individual/business characteristics
  - Policy variables
- Define the range of values of policy variables
- Design (meaningful/realistic) choice situations
- Questionnaires with (randomized) choice situations
- Pilot test/Refine/Focus group/Finalize questionnaires
- To eliminate selectivity bias use random sampling

Collect stated preference data

- Using mail-out and Internet based surveys
  - Print (and Internet) randomized questionnaires
  - Draw a sample of respondents from sampling frame
  - Mail out questionnaires, or URL, to participants
  - Mail reminder cards
  - Repeat the process
- Internet surveys could be used, though correction techniques are needed to eliminate bias

- Estimate discrete choice models
- The entire data set will be split in:
  - a calibration data set (80%), and
  - a validation data set (20%)
- Specify Utility functions as a function of:
  - Attributes of the individual (e.g., Income, company size, type of business)
  - Policy variables (e.g., Tolls, Tax incentives)

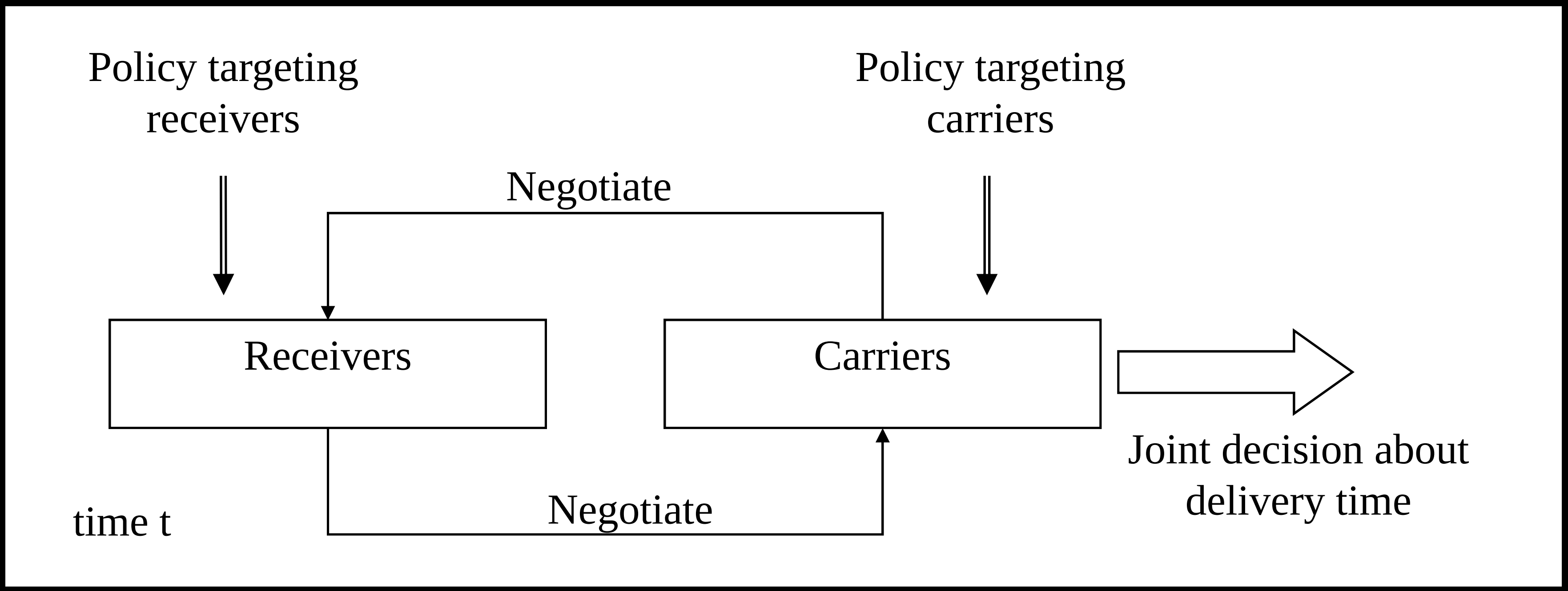
Examples:
NYSDOT Off-hours delivery study

Implications for freight road pricing

- Objectives
  - To design policies to foster truck traffic during off-hours
  - To assess the effectiveness of such policies
- Tricky design:
  - The decision about delivery times is jointly made between carriers and receivers
  - Thus, there are two sets of policy variables (ones for receivers, and another for carriers)

Carrier-Receiver Interactions

- Each of them will react to a policy, and to the feedback received from the other, before making a joint decision



Policies considered: Receivers

- Tax deductions if they agree to OPD
- Lower shipping costs if they agree to OPD (not really a public policy)

Key carrier policies (each of them with SP)

- A request from receivers (to analyze the effectiveness of no carrier-specific policy)
- A request from receivers and toll savings to carriers
- A request from receivers and financial rewards per mile traveled during the off-peak hours
- The creation of a neutral company to do the last leg of delivery
- The creation of a staging area in Brooklyn for off-peak trucks to stay overnight, delivering during day hours

Stated Preference Data Collected

- Collected for modeling purposes, to assess the effectiveness of alternative policies
- Manhattan:
  - 200 common/private carriers serving Manhattan
  - 200 Manhattan receivers
- Brooklyn
  - NJ common and private carriers serving Brooklyn
  - Brooklyn common and private carriers serving NYC
  - 200 receivers

Key findings

- Receivers are sensitive to tax deductions for OPD
- Carriers are sensitive to their customer requests (not rocket science)
- Some segments of carriers and receivers are particularly sensitive to policies

Receivers are sensitive to incentives

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
A tax deduction in any employee assigned to OPD	TDEDUCT	8.392E-05	1.410
Reasons for not receiving OPD			
No access to building/freight entrance after hours	REASON1	-1.234	-1.571
Interferes with normal business	REASON2	-0.591	-1.208
Additional costs to the business if accepting more OPD	COST	-0.888	-3.232
Policy interaction terms			
Tax deduction for Wood/lumber	TDCOM8	6.968E-04	2.219
Tax deduction for Alcohol	TDCOM4	4.356E-04	2.209
Tax deduction for Paper	TDCOM9	2.627E-04	2.988
Tax deduction for Medical supplies	TDCOM22	2.598E-04	3.188
Tax deduction for Food	TDCOM2	1.875E-04	3.973
Tax deduction for Printed Material	TDCOM21	1.652E-04	1.802
Tax deduction for Metal	TDCOM13	1.415E-04	1.410
Other interaction terms			
Number of employees in a branch facility	BRANEMP	9.867E-03	1.612
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	1.599	4.151
R^2	0.172		
Adjusted R^2	0.140		

Carriers are sensitive to receivers' wishes

Variable	Name	Coefficient	t-value
Utility of off-peak deliveries:	C4CHOICE		
Percentage of customers requesting OPD	PCUST	0.017	2.912
(Variables deleted)			
Parking infractions in Manhattan per driver per month			
Nothing	FINE0		
From $1-$100	FINE100		
Policy interaction terms			
Toll savings for Petroleum/coal	TOLCOM10	0.440	1.606
Toll savings for Wood/lumber	TOLCOM8	0.340	1.912
Toll savings for Food	TOLCOM2	0.209	2.733
Toll savings for Textiles/clothing	TOLCOM6	0.217	2.022
(Variables deleted)			
R^2	0.194		
Adjusted R^2	0.146		

ALL truckers are sensitive to customers requesting OPD

ONLY some segments of the industry are sensitive to tolls

Key implications

- Freight road pricing by itself will not reduce urban freight deliveries
  - Carriers cannot pass the costs
  - Even if they pass costs, rate increases are too small
- Comprehensive policies targeting receivers and carriers are needed
  - The wish of receivers is more important than tolls
  - All carriers are sensitive to customer needs
- Under contract with USDOT, we are designing a system based on these principles for NYC

Examples:
Evaluation Study of the Port Authority of New York and New Jersey Time of Day Pricing Initiative

- Objectives
  - To assess behavioral changes, and to estimate effectiveness of potential toll policies
- Both revealed and stated preference data collected:
  - Revealed: Time of travel, mode, etc. after toll increase for the last trip made through the facilities
  - Stated: What would they do if tolls are X$?
- The only data collected in NYC on this subject

- Experimental design:
  - Choice situation: Thinking about the last trip (the same one for the observed part), what would you do if tolls are x$ and ...
  - Experimental variables: Time to cross the toll booths, and toll differential between peak and off-peak, for both EZ-Pass and cash users
  - Treatment levels: Two
  - Target populations: Regular users (EZ-Pass and cash)
  - Sample size:400

Scenario	Time Saving (T)	Difference in peak toll ($A)	Difference in off-peak toll ($B)
1	0	$ 3.00	$ 4.00
2	0	$ 3.00	$ 6.00
3	0	$ 5.00	$ 6.00
4	15	$ 3.00	$ 4.00
5	15	$ 3.00	$ 6.00
6	15	$ 5.00	$ 6.00
7	15	$ -	$ 4.00
8	15	$ -	$ 6.00
9	15	$ -	$ -

- Scenario # 9: Would have you switched to EZ Pass if it had saved you 15 minutes in travel time?
  - Yes/No
- Scenarios # 7-8: Would have you switched to EZ Pass if it had saved you 15 minutes in travel time *and B* dollars in tolls when you travel in the off-peak?
  - Yes/No
- What time of the day would have you made your trip?
  - Peak/Off-peak

Preliminary results

- Change of time of travel not likely as regular users of the facility face time of arrival constraints
- Change of travel mode is more likely
- A Nested Logit was estimated:
  - Two level structure
    - Upper level: Payment choice (EZPass or cash)
    - Lower level: Time of travel (Peak or Off-peak)

Model A – Upper Level

Variable	Description	EZPASS	CASH
AGE	Age of the individual	-0.0352266 (-3.140)	
RCOME	Average annual household income	8.39E-06 (1.886)	
ED8	Binary variable for individuals with some Graduate education		1.492026 (3.467)
WHITE	Binary variable for Caucasian		1.173487 (2.973)
REC	Binary variable for recreation based trips		0.801825 (2.401)
MINC	Average annual income for males		9.55E-06 (2.374)
CONST	CONSTANT	3.076355	
Inclusive Value Parameters		.360388 (.789)	.392975 (.857)

Model A – Lower Level

Variable	Description	EZPASS PEAK	EZPASS OFFPEAK	CASH PEAK	CASH OFFPEAK
WTINC	Average annual income for Caucasians				-1.718E-05 (-3.446)
STATEN	Binary variable for individuals from Staten Island	-1.5828 (-2.409)			
TSTRTE	Amount of time an individual is willing to depart earlier (min)	-0.01905 (-2.132)		-0.01905 (-2.132)	
TENDL	Amount of time an individual is willing to arrive later (min)	-0.017319 (-1.889)		-0.017319 (-1.889)	
CPTDIFF	Toll savings ($)	0.21867 (1.615)	0.21867 (1.615)		
HOLTUN	Binary variable for Holland Tunnel users	-0.51809 (-1.469)			
TPTEST	Time to cross toll facilities	-0.02936 (-1.397)	-0.02936 (-1.397)	-0.02936 (-1.397)	-0.02936 (-1.397)
ETOT	Scheduled delay for a user to switch to a new travel time		-0.00121 (-0.920)		-0.00121 (-0.920)
NEWTIME	Door to door travel time	0.03125 (2.001)	0.03125 (2.001)	0.03125 (2.001)	0.03125 (2.001)
CONST	CONSTANT		-0.3504001	-0.748072	0.120405

Log Likelihood Function	-339.3158	R-squared	.24455
Restricted Log Likelihood	-449.1594	R-squared Adj	.22787
Chi-squared	219.6872		

General Findings

- The more time of travel flexibility (departing from origin, or arriving at destination), the more likely to travel off-peak
- The longer the scheduled delay to switch to a new travel time, the less likely they will travel during the off-peak
- The longer the time in which it would take to cross the toll facilities, the more likely individuals would choose EZ-Pass.
- The higher the toll savings, the more likely they will choose an EZ-Pass alternative
- The higher the door-to-door travel time is, the more likely the individual would pick a given alternative

Policy Analysis

- The models enable policy analysis
- By changing toll savings, the market shares for the different alternatives could be estimated
- These analysis indicate:
  - There is a meaningful switch to EZPass-Off-peak
  - Increases in EZPass-peak is smaller
  - There are small reductions in Cash-Peak and Cash-Off-peak

Source of Change

Model A			Source of Change		
EZP Savings	**EZPOP Savings**	**Net Increase for EZPOP**	**EZP**	**CP**	**COP**
1	From 1 to 5	10.36%	-84.39%	-4.09%	-11.52%
1	From 5 to 10	20.98%	-80.46%	-5.29%	-14.20%
3	From 3 to 5	5.37%	-86.24%	-3.67%	-10.28%
3	From 3 to 10	17.47%	-82.88%	-4.64%	-12.48%
5	From 5 to 7	5.47%	-86.84%	-3.66%	-9.87%
5	From 5 to 10	13.23%	-85.03%	-4.08%	-10.96%
MEAN		**100.00%**	**-84.31%**	**-4.24%**	**-11.55%**

Model B			Source of Change		
EZP Savings	**EZPOP Savings**	**Net Increase for EZPOP**	**EZP**	**CP**	**COP**
1	From 1 to 5	12.33%	-67.08%	-10.54%	-22.22%
1	From 5 to 10	26.18%	-60.96%	-12.87%	-26.13%
3	From 3 to 5	6.43%	-71.06%	-9.31%	-19.48%
3	From 3 to 10	21.76%	-65.76%	-11.35%	-22.93%
5	From 5 to 7	6.71%	-72.88%	-8.79%	-18.03%
5	From 5 to 10	16.51%	-70.14%	-9.87%	-19.87%
MEAN		**100.00%**	**-67.98%**	**-10.46%**	**-21.44%**

Conclusions

- Through the behavioral modeling, toll savings, scheduled delay in order to switch time of travel, and time to cross through toll facilities are all found to be significant.
- Policy analysis showed that any increase in toll savings will increase EZ-Pass off-peak usage, but mostly at the expense of EZ-Pass peak, and not cash peak or cash off-peak.

To panel or not to panel, that’s the question

Single Cross Sections: Pros and Cons

- SCS: A single sample of individuals is drawn, and data are collected
  - Relatively easy to plan and execute
  - Provides an idea about cross-sectional patterns
  - Does not say much about dynamic (over-time) changes
    - User response to policies take place over time
    - Not accounting for this may lead so wrong conclusions

Repeated Cross Sections: Pros and Cons

- RCS: Independent cross-sectional samples of individuals are drawn, and data are collected for each of them
  - Relatively easy to plan and execute
  - Provides an idea about changes in aggregate cross-sectional patterns
  - Causality cannot be studied in depth as the individuals are not the same from sample to sample
  - Does not say much about dynamic (over-time) changes
    - User response to policies take place over time
    - Not accounting for this may lead so wrong conclusions

Panels: Pros and Cons

- In panels, the "same" set of individuals participate in different waves of data collection
  - This enables to track the impact of policies on specific individuals, and unravel cause-effect relations
  - If the panel is refreshed to make sure each wave is representative of the population, it could also be used as a cross-section
  - Panels suffer from attrition bias, require statistical compensation
  - Panel stagnation, panel fatigue may be an issue.

Hybrid panel designs

- Rotating panel surveys (RPS):
  - Individuals are rotated off fairly soon, and panel is refreshed to ensure it represents the population
  - Rapid rotation may limit the ability to identify longitudinal effects
- Split panel surveys (SPS):
  - It includes a longitudinal panel (with same participants in multiple waves) and a non-overlapping cross-sectional sample)
  - Require a large effort and cost though it may be worth it

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Thanks!