Modelling Interdependent Behaviour: IACE and Sequentially-Administered Stated Choice Experiments

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Schematic representation of the Interactive Sequential Process of **Preference Revelation** under IACE

(Note language of rounds and passes: Pass 1 = rounds 1,2, Pass 2 = rounds 3,4, Pass 3 = rounds 5,6)

PASS		
	$AG_1 \rightarrow AG_2$	
Pass 1	Alt 1 - Alt 1	Agree
	Alt 2 - Alt 2	
$AG_1 \rightarrow AG_2$	Alt 3 - Alt 3	
	Alt 1 - Alt 2	Not Agree
	Alt 1 - Alt 3	
	Alt 2 - Alt 1	
	Alt 2 - Alt 3	
	Alt 3 – Alt 1	
	Alt 3 – Alt 2	
	$AG_1 \rightarrow AG_2$	
Pass 2	Alt 1 - Alt 1	Agree
	Alt 2 - Alt 2	
$AG_1 \rightarrow AG_2$	Alt 3 - Alt 3	
	Alt 1 - Alt 2	Not Agree
	Alt 1 - Alt 3	
	Alt 2 - Alt 1	
	Alt 2 - Alt 3	
	Alt 3 – Alt 1	
	Alt 3 – Alt 2	
	$AG_2 \rightarrow AG_2$	
Pass 3	Alt 1 - Alt 1	Agree
	Alt 2 - Alt 2	
$AG_1 \rightarrow AG_2$	Alt 3 - Alt 3	
	Alt 1 - Alt 2	Not Agree
	Alt 1 - Alt 3	
	Alt 2 - Alt 1	
	Alt 2 - Alt 3	
	Alt 3 – Alt 1	
	Alt 3 – Alt 2	

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SC Screen for IACE Auto purchase

Attribute	Attribute level
Engine Size	*Small* (1.2,1.3, 1.4, 1.5)
	Medium (1.6, 1.8, 2.0, 2.2)
	Large (2.3, 2.9, 3.4, 4.0)
	4WD (3.2, 4.0, 4.9, 5.7)
	Luxury (3.0, 4.0, 5.0, 5.7)
Price	*Small* ($12,000, $13,500, $15,000, $16,500)
	Medium ($19,990, $21,990, $23,990, $25,990)
	Large ($28,000, $30,000, $32000, $34,000)
	4WD ($52,990, $56,640, $60,300, $36950)
	Luxury ($54,950, $71,100, $87,300, $103,500)
Air-conditioning	Yes, No
Transmission type	Manual, Automatic
Fuel consumption *litres/100km*	*Small* (6.2, 6.7, 7.4, 7.7)
	Medium (7.6, 8.1, 8.5, 9.0)
	Large (8.8, 9.8, 10.7, 11.7)
	4WD (11.1, 13.1, 15.2, 17.2)
	Luxury (10.9, 13, 16, 18.2)
ABS	Yes, No

Table 3 An Illustrative Stated Choice Screen

	Car A	**Car B**	**Car C**	**None**
Engine size	1.4	1.5	1.4	
Price	$13500	$12000	$16500	
Air conditioning	No	Yes	No	
Transmission type	Manual	Automatic	Automatic	
Fuel consumption (litres/100km)	6.7	6.2	7.2	
ABS breaks	No	Yes	Yes	
I would choose	ÿ	ÿ	ÿ	ÿ
The other person would most likely choose	ÿ	ÿ	ÿ	ÿ

Sequential Pass Models: Mixed Logit, Joint estimation within Pass (2 rounds per pass)

Attribute	Alternative(s)	Pass 1		Pass 2		Pass 3	
		Agent 1	Agent 2	Agent 1	Agent 2	Agent 1	Agent 2
Random Parameters:							
Vehicle price ('000s) Agent 1	A-C	-0.0842 (-3.1)					
Fuel efficiency (litres/100km)	A-C, E-G	-0.1533 (-2.5)					
Fixed Parameters:							
Alternative Specific Constant	A-C	3.496 (3.3)				-0.889 (-2.3)	
Alternative Specific Constant	E-G		1.127 (1.7)				
Vehicle price ('000s) Agent 2	E-G		-0.033 (-1.5)				
Small vehicle (1,0)	A-C	-1.461 (-2.3)					
Small vehicle (1,0)	E-G				1.518 (1.4)		
Air conditioning (1,0)	A-C	1.130 (7.5)		0.490(2.6)		0.558 (2.1)	
Air conditioning (1,0)	E-G		1.149 (8.0)		0.88 (4.4)		0.948 (3.6)
Manual transmission (1,0)	A-C	1.321 (8.4)		0.648 (3.4)		0.419 (1.6)	
Manual transmission (1,0)	E-G		0.726 (5.1)		-.753 (3.7)		
ABS brakes (1,0)	A-C	0.5615 (3.8)		0.681 (3.5)		0.615 (2.2)	
ABS brakes (1,0)	E-G		0.5109 (3.6)				
Can drive manual (1,0)				-1.403 (-2.9)			
Married agents (1,0)	D,H					-1.719 (-1.8)	
Agent 1 Male (1,0)	D						
Agent 2 Male (1,0)	H						
Agent 1 Age (years)	D	0.2163 (3.2)					
Agent 2 Age (years)	H		-0.948 (-3.0)				
Agent 1 thought agent 2 would choose same alternative (1,0)	D			0.739 (2.2)			
Random Parameter Standard Deviations							
Vehicle price ('000s) Agent 1	A-C	0.0842 (3.1)					
Fuel efficiency (litres/100km)	A-C, E-G	0.1533 (2.5)					
Error Component (alternative specific heterogeneity)	D			0.0067 (1.2)			
	H				0.0925 (16.7)		
Sample size		808		328		182	
Log-likelihood at convergence		-949.07		-408.21		-237.2	

Table 5a Sources of Agreement: Pass 1 (agree=1)

Attribute	Binary Logit	Mean of Variable
Agent 1 Age (years)	0.399 (1.1)	36.3
Agent 1 Male (1,0)	0.835 (5.4)	0.54
Agent 2 Age (years)	-0.362 (-1.0)	38.6
Agent 2 Male (1,0)	0.890 (5.9)	0.46
No. of cars in household	-0.097 (-2.5)	1.8
Agent 2 was told what other agent had chosen (1,0)	**0.927 (7.7)**	0.248
Agent thought other agent would choose same alt (1,0)	1.619 (13.9)	0.449
Agents are married to each other (1,0)	0.345 (1.8)	0.108
Agents live in a defacto relationship (1,0)	-0.586 (-3.0)	0.069
Agents are not related (1,0)	0.576 (2.4)	0.059
Sample size	3232	
Log-likelihood at convergence	-1367.06	

Table 5b Sources of Agreement: Pass 2 (agree=1)

Attribute	Binary Logit	Mean of Variable
Agent 1 Age (years)	0.447(1.0)	34.3
Agent 1 Male (1,0)	-0.374 (-1.9)	0.523
Agent 2 Age (years)	-0.148 (-3.3)	35.5
Agent 2 Male (1,0)	-.120 (-.63)	0.477
Agent 2 was told what other agent had chosen (1,0)	0.818 (5.7)	0.554
Agent thought other agent would choose same alt (1,0)	2.181 (10.4)	0.193
Agents are married to each other (1,0)	**0.719 (3.4)**	0.128
Agents live in a defacto relationship (1,0)	**-0.654 (-2.6)**	0.089
Agents are not related (1,0)	**0.591 (2.2)**	0.070
Sample size	1308	
Log-likelihood at convergence	-798.12	

Table 5c Sources of Agreement: Pass 3 (agree=1)

Attribute	Binary Logit	Mean of Variable
Agent 1 Male (1,0)	-1.518 (-6.6)	0.565
Agent 2 Male (1,0)	-1.333 (-6.0)	0.434
Agent 2 Age (years)	-0.141 (-3.3)	36.8
Number of cars in household	0.226 (2.9)	1.73
Agent thought other agent would choose same alt (1,0)	1.137 (4.4)	.104
Agents are married to each other (1,0)	0.786 (2.8)	0.109
Sample size	728	
Log-likelihood at convergence	-358.56	

Empirical Measures of Influence

- An econometric modelling structure that builds on related models of influence from the marketing and non-market valuation literature (and behavioural economics).
- As an example, a parsimonious form of the family of models appears in Dellaert *et al*. (1998):

$$U_{gp} = \Sigma\,(w_i{*}V_{ip}) + \varepsilon_{gp}$$

where

U_{gp} is the utility the group *g* receives from an alternative *p*,
V_{ip} is the utility an individual agent *i* receives from *p*,
w_i is an individual's influence weight and
ε_{gp} is an error term.

$$U_{11} = \alpha_{11} + (t_{qk} * b_{qk})' * \mathbf{x}_{1k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{1k} + \varepsilon_{11}$$

$$U_{12} = \alpha_{12} + (t_{qk} * b_{qk})' * \mathbf{x}_{1k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{2k} + \varepsilon_{12}$$

$$U_{13} = \alpha_{13} + (t_{qk} * b_{qk})' * \mathbf{x}_{1k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{3k} + \varepsilon_{13}$$

$$U_{21} = \alpha_{21} + (t_{qk} * b_{qk})' * \mathbf{x}_{2k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{1k} + \varepsilon_{21}$$

$$U_{22} = \alpha_{22} + (t_{qk} * b_{qk})' * \mathbf{x}_{2k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{2k} + \varepsilon_{22}$$

$$U_{23} = \alpha_{23} + (t_{qk} * b_{qk})' * \mathbf{x}_{3k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{3k} + \varepsilon_{23}$$

$$U_{31} = \alpha_{31} + (t_{qk} * b_{qk})' * \mathbf{x}_{3k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{1k} + \varepsilon_{31}$$

$$U_{32} = \alpha_{32} + (t_{qk} * b_{qk})' * \mathbf{x}_{3k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{2k} + \varepsilon_{32}$$

$$U_{33} = \alpha_{33} + (t_{qk} * b_{qk})' * \mathbf{x}_{3k} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x}_{3k} + \varepsilon_{33}$$

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Empirical Measures of Influence

- Influence weights reflect the degree to which an individual influences a group decision-making outcome.
- In the general model given above, the weights range from
  - –1 (i.e., the group chooses the opposite of what the individual wants) to
  - +1 (i.e., the group chooses exactly what the individual wants).
- The range of the weights can be specified as appropriate for a given empirical model
  - e.g., unbounded, bounded between 0 and 1.
- The weights may be either global or attribute specific.

IACE Model and Procedure

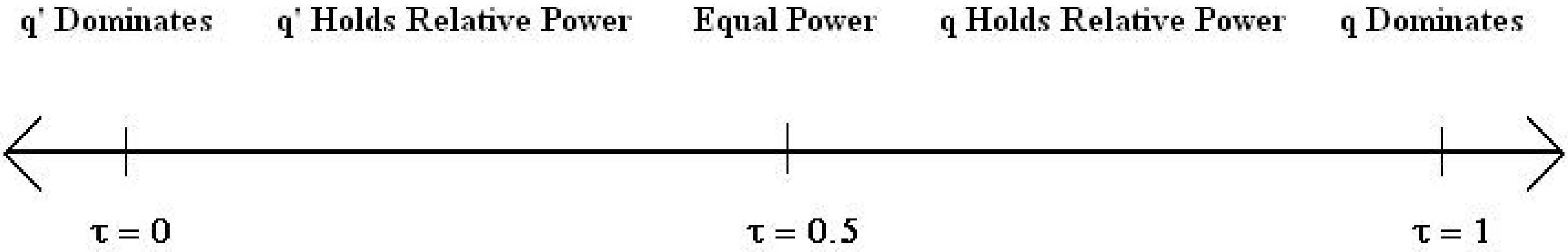
The influence measures sum to one across group members in my model, reflecting the degree to which a specific agent (q) gets their way with respect to each attribute in the alternatives.

The measures are unbounded, with the following interpretation:

$t_{qk} = 0.5$	Balanced power across decision makers
$t_{qk} > 0.5$	Agent *q* holds relative power over attribute *k*
$t_{qk} < 0.5$	Agent *q*’ holds relative power over attribute *k*
$t_{qk} > 1.0$	Agent *q* holds dominant power over attribute *k*
$t_{qk} < 0$	Agent *q*’ holds dominant power over attribute *k*

See Diagram in next slide

Power Profile



Note: Weights can be attribute and/or alternative specific for each agent

Power of Influence Weights of each Agent in Choice Process and Outcome

Dependent Variable: Log odds of Joint agent probability of alternative pair

Agent	Pass 1	Pass 2	Pass 3
1	0.982	0.960	0.143
2	0.017	0.040	0.857

Equilibrium Preferences (After Establishing Preference revelation – restructure specification)

Group Equilibrium Model Results

Attribute	Alternative(s)	Mixed Logit
Random Parameters:		
Vehicle price (‘000s)	A-C	-0.05148 (-2.1)
Fuel efficiency (litres/100km)	A-C	-0.19889 (-2.2)
Fixed Parameters:		
Air conditioning (1,0)	A-C	1.4053 (8.1)
Manual transmission (1,0)	A-C	1.1743 (6.7)
ABS brakes (1,0)	A-C	0.6399 (3.8)
Agent 1 Male (1,0)	D	0.6366 (1.8)
Number of cars in household	D	0.3519 (3.2)
Null alternative constant	D	-2.4717 (-2.4)
Pass number	D	-0.8434 (-2.2)
Random Parameter Standard Deviations		
Vehicle price (‘000s)	A-C	0.05148 (2.1)
Fuel efficiency (litres/100km)	A-C	0.07956 (2.2)
Error Component (alternative specific heterogeneity)	D	0.0153 (4.3)
Sample size		333
Log-likelihood at convergence		-358.01

Note: we only need to estimate models on A-D since both agents agreed and attribute levels are identical per alternative. We have however included the socioeconomic characteristics of each agent in the model.

Comments on Equilibrium Preference Model (EPM)

- This reflects reality
- It suggests that SC data compatibility with RP data (excl. measurement error) **when there is respondent endogeneity in choice making**
  - is most likely achieved with the EPM
  - is less likely to exist with first round (i.e. typical SC expt)
- Valuation (WTP) outputs can be obtained from this model

Probability Contrasts

Alternative Pairs	Group Equilibrium	Pass 1		Pass 2		Pass 3	
		Agent 1	Agent 2	Agent 1	Agent 2	Agent 1	Agent 2
AE (1,5)	0.258	0.267	0.275	0.280	0.304	0.266	0.296
BF (2,6)	0.266	0.271	0.276	0.283	0.280	0.245	0.273
CG (3,7)	0.274	0.274	0.280	0.278	0.287	0.265	0.275
DH (4,8)	0.199	0.187	0.168	0.157	0.127	0.223	0.157
Total sample		404		171		35	
Agree	333 comprising:	233		68		32	

Sources of Agreement: Passes 2 and 3 vs. Pass 1 Group equilibrium

Attribute	Binary Logit	Mean of Variable
Pass 23 Constant	-0.6171 (-6.7)	
Agent 1 Male (1,0)	-0.2796 (-2.3)	0.538
Age difference between Agent 1 and 2	0.403 (4.5)	-11.62
Agents are married to each other (1,0)	0.6331 (3.6)	0.114
Agents live in a defacto relationship (1,0)	0.2700 (1.2)	0.060
Agents are not related (1,0)	1.1813 (4.6)	0.063
Sample size	1332	
Log-likelihood at convergence	-829.07	

The Challenge: Modelling Interdependent Agents

- Extant stated preference methods involving interdependent agents (e.g., IACE above) may be prohibitive to implement due to population, timing or monetary constraints.

- In the **freight context**, each of these constraints may be present
  - Possibly less of a constraint at household level.
  - But definitely a constraint if other agent is an (non-household member) expert adviser

- There are a limited number of decision-making groups to sample, and securing the simultaneous cooperation of all respondents within groups may be impractical at best within the financial resources available.

A New Approach: Sequentially-Administered Stated Choice Experiments

- ***M*inimum *I*nformation *G*roup *I*nference (MIGI)** offers a stated choice platform for research into group decision making when extant (IACE) methods are infeasible

- *MIGI* analysis centres on the *sequential* sampling of group members, with group behaviour *inferred* through the coordination of each group member's stated preference rankings for a series of choice sets that are common across the group

Empirical Measures of Influence Proposed Herein

- Firstly, individuals' preferences are estimated for each decision maker based on their stated choices.
- Secondly, these estimates are then carried forward into a model of group choice.
- Influence measures are estimated with respect to the (projected) group choice and the degree to which the preferences of each decision maker are preserved in the group choice.

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MIGI Model and Procedure

This yields the following model (can be nonlinear):

$$U_{ij} = \alpha_{ij} + (\tau_{qk}*\beta_{qk})*x_{ik} + ((1-\tau_{qk})*\beta_{q'k})*x_{jk} + \varepsilon_{ij}$$

where the utility U_{ij} the group receives from the joint choice of alternatives *ij* is a function of:

- a vector of *attribute-specific* influence or power measures τ_{qk} ,
- the estimated marginal utilities of the group members β_{qk} and $\beta_{q'k}$

and

- the attribute levels in the alternatives x_{ik} and x_{jk} for agents *i* and *j*.

MIGI Model and Procedure

MIGI choice experiments are administered to one single respondent at a time within a group.

To estimate a model of joint choice we must match respondent pairs in some meaningful way, and then coordinate the preferences of the respondents toward projected group outcomes.

To accomplish this, we have developed the following four-stage sampling strategy:

MIGI Model and Procedure

- *Stage 1:* Initially sample respondents who have the information required to establish the choice scenario *and* reference alternative. (The transporter or carrier in our application)

- *Stage 2:* Fix the attribute levels and relationship characteristics in the subsequent stated choice design (i.e., for shippers) to correspond exactly to those in the choice sets answered by respondents from Stage 1 (i.e., the focal agent = transporters).

- *Stage 3:* Recruit appropriate respondents (transporters and shippers) to complete the sampled groups, and administer the survey to them.

- *Stage 4:* Project group choice outcomes for each choice set.

MIGI Model and Procedure

- MIGI utilises a series (i.e. 2 in our application) of ***concession models*** to project group choice outcomes based on the stated preferences of each respondent in a sampled group.

- Each concession model centres on the first preferences of a specific type of decision maker (e.g., transporters or shippers)
  - Transporter concession model
  - Shipper concession model

- To establish the projected group choice, the first preferences of the specific agent in a given concession model are compared with the stated willingness of other agents to accept that alternative as a group choice outcome: (see next slide)

MIGI Procedure in more detail

- *Step 1:* For each choice set *p* faced by group *g* in a concession model centring on agent type *t,* denote the first preference of the respondent of agent type *t* as J_t.
- *Step 2:* If alternative J_t was acceptable to the respondent not of agent type *t* (i.e., not the focal agent), designate the group choice as J_t. (AGREE)
- *Step 3:* If alternative J_t was unacceptable to the respondent not of agent type *t* (i.e., not the focal agent), designate the group choice as an impasse (NOT AGREE).
- When impasse occurs, the analyst can choose one of two decision rules for specifying the final group choice (depending on study objective – co-op/non-co-op vs. equil)):
  - **(1) designate the group choice as the alternative most plausible to occur under impasse; or**
  - **(2) designate the group choice as a non-coincident choice across decision makers, involving the first preferences of each decision maker.**
- In the former case (1), the analyst would project the group choice as the alternative that the group would be most likely to enact when the focal agent's (i.e., T) first preference is unacceptable to the other agent (i.e., S);
  - the reference alternative (i.e., the status quo) is a strong candidate to fill this role, as it represents the strategy being utilised by the group at the time of interaction.
- Alternatively, in the latter case (2), the projected group choice involves each agent utilising his or her preferred alternative simultaneously; this may be plausible in some applications
  - Such as a model of cooperation and non-cooperation
  - But NOT in those where consensus is required for a meaningful outcome (i.e., group equilibrium)

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Group Outcomes

- Consider a case with three alternatives 1, 2 and 3 in a choice set p faced by two respondents in a sampled group g.

- In this case there are nine (9) potential group choice outcomes when allowing for agreement and non-agreement outcomes, and three (3) potential group choice outcomes when restricting the analysis to agreement outcomes.

- The group outcome may be that both agents agree to select 1 (the group outcome for which is denoted 11), for agent q to select 1 and for agent q' to select 2 (denoted 12), through to both agents selecting 3 (denoted 33) in the general case (i.e., including non-agreement outcomes).

- When restricting the model to cases of agreement, the model reduces to the subset of equations in which alternative j is identical for both agents (i.e., both chooses 1, both choose 2, and both choose 3).

- We distinguish between:
  - A Cooperation/Non-cooperation model, and
  - A Group equilibrium outcome model

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$$U_{11} = \alpha_{11} + (t_{qk} * b_{qk})' * \mathbf{x_{1k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{1k}} + \varepsilon_{11}$$

$$U_{12} = \alpha_{12} + (t_{qk} * b_{qk})' * \mathbf{x_{1k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{2k}} + \varepsilon_{12}$$

$$U_{13} = \alpha_{13} + (t_{qk} * b_{qk})' * \mathbf{x_{1k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{3k}} + \varepsilon_{13}$$

$$U_{21} = \alpha_{21} + (t_{qk} * b_{qk})' * \mathbf{x_{2k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{1k}} + \varepsilon_{21}$$

$$U_{22} = \alpha_{22} + (t_{qk} * b_{qk})' * \mathbf{x_{2k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{2k}} + \varepsilon_{22}$$

$$U_{23} = \alpha_{23} + (t_{qk} * b_{qk})' * \mathbf{x_{3k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{3k}} + \varepsilon_{23}$$

$$U_{31} = \alpha_{31} + (t_{qk} * b_{qk})' * \mathbf{x_{3k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{1k}} + \varepsilon_{31}$$

$$U_{32} = \alpha_{32} + (t_{qk} * b_{qk})' * \mathbf{x_{3k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{2k}} + \varepsilon_{32}$$

$$U_{33} = \alpha_{33} + (t_{qk} * b_{qk})' * \mathbf{x_{3k}} + ((\mathbf{1} - t_{qk}) * b_{q'k})' * \mathbf{x_{3k}} + \varepsilon_{33}$$

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Empirical Study

- Urban freight stakeholders under distance-based road user charges

- Empirical constraints for standard methods:
  - limited population,
  - prohibitive costs,
  - difficulty in securing simultaneous cooperation of respondents

Empirical Study

- MIGI is plausible for the application by allowing:
  - A larger number of choice observations than interactive agency stated choice experiments (IACE's)
  - Respondents to be sampled one at a time
    - ☞ first sample agents (transporters) with all information necessary to *seed* stated choice menus,
    - ☞ then carry forward the identical choice sets to questionnaires given later to sampled group partners (shippers)

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Empirical Study: Freight Distribution Chains and Variable Road User Charges

- Transporters were given 4 choice sets; shippers were given 8 choice sets (the identical 4 given to transporters, plus 4 additional choice sets, as shippers did not have to supply the same level of background information as transporters).

- Choice menus involve three strategies for carrying out the identical freight tour:
  - the real-market trip (reference alternative), and
  - two SP alternatives involving distance-based charges and changes in fuel taxes.

- Attributes in the alternatives also include:
  - free-flow time,
  - slowed-down time,
  - waiting time at the destination,
  - on-time arrival probability,
  - freight rate and
  - fuel cost.

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Sydney Metropolitan Freight Stakeholders Study

Practice Game

The alternatives on this screen represent three options for carrying out the freight trip you described - the trip as it occurred, and two trips involving new combinations of fuel taxes, distance-based congestion charges, and time and cost components.
Please consider them and then answer the questions below:

	Your Recent Trip	Trip Variation A	Trip Variation B
Free-flow travel time: (definition)	15 minutes	19 minutes	22 minutes
Slowed-down travel time: (definition)	55 minutes	28 minutes	82 minutes
Total time waiting to unload goods:	10 minutes	12 minutes	8 minutes
Likelihood of on-time arrival:	80%	70%	80%
Freight rate paid by the receiver of the goods:	$450.00	$461.67	$461.67
Fuel cost:	$15.57	$19.46 (based on a 50% increase in fuel taxes)	$23.35 (based on a 100% increase in fuel taxes)
Distance-based charges:	$0.00	$7.78	$3.89
If your organisation and the receiver of the goods had to reach agreement on which alternative to choose, what would be your order of preference among alternatives? (please provide a choice for every alternative)	**My recent trip is** My 1st choice, My 2nd choice, My 3rd choice, Not acceptable	**Trip Variation A is** My 1st choice, My 2nd choice, My 3rd choice, Not acceptable	**Trip Variation B is** My 1st choice, My 2nd choice, My 3rd choice, Not acceptable
Which of these alternatives do you think would be acceptable to the receiver of the goods?		☑	☑
Which alternative do you think the receiver of the goods would most prefer?	○	○	○

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Concession Model Results

- Concession models centre on the projection of group choice equilibrium based on the stated willingness of each respondent to concede toward the first preference of his or her partner
  - Focus here is on the group equilibrium model based on three agreement pairs

- *Power (or Influence)* is represented in the concession model through the parameterisation of the proportion of the independent preferences of each decision maker that would be preserved under the group choice equilibria projected within the analysis.

Concession Model Results

- In the *shipper concession model*, the model estimates the relative power held by each decision maker with respect to each attribute that would be observed if shippers offered
  - *their maximum stated willingness to concede with respect to the first preference of the transporter*.
- **If** the shipper did not indicate such a willingness to concede, the joint choice is projected as the status quo (i.e., the reference alternative).
- Hence, the concession models frame power structures in terms of
  - the influence that would be present when transporters and shippers jointly determined whether to move away from their current agreement (i.e., the reference alternative),
  - toward an alternative distribution strategy involving a positive level of variable user charges (i.e., one of the stated choice alternatives)

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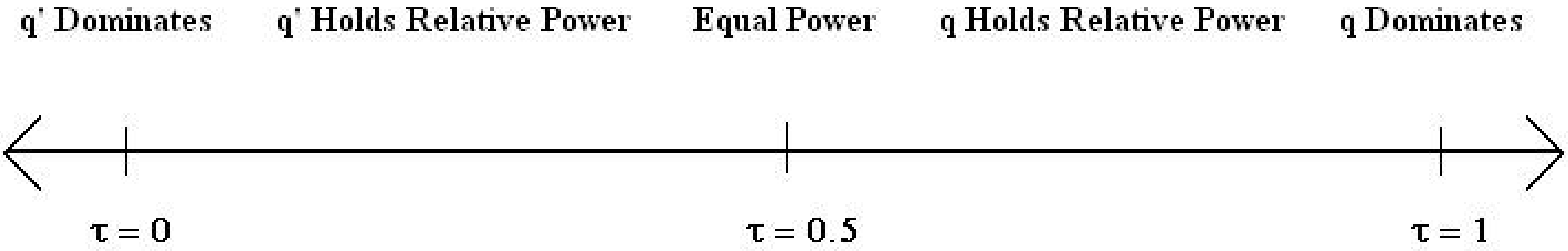
Power Profile



Concession Model Results

Summary of concession model results: power parameter weights:

(in my e.g., values towards 0: S dominates)

	FF/SD Time	On-Time Reliability	Variable Charges	Fuel Cost	Freight Rate
Shipper Concession					
Mean	0.1444	1.0991	2.8233	2.0539	0.5656
Standard Deviation	1.2476	0.2918	0.8543	1.0985	0.1005
Transporter Concession					
Mean	0.1473	1.1087	1.6735	-0.1231	0.0275
Standard Deviation	1.0131	0.0944	0.4229	0.0011	0.3339

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VTTS and VRG Findings

Value of Travel Time Savings (A$ per hour) for Transporters (non-APS)

	Free-Flow Time	**Slowed-Down Time**
Mean	**$42.48**	**$83.77**
Standard Deviation	$22.95	$8.88
Minimum	$-22.64	$55.67
Maximum	$99.39	$162.42
Proportion of Negative Values	1.9%	0%

Values of Reliability Gains (A$ per percentage point) for transporters and shippers (non-APS)

	Transporters	**Shippers – Freight Rate Only**	**Shippers – Freight Rate and Costs**
Mean	**$3.54**	$10.32	$12.67
Standard Deviation	$0.46	$1.94	$2.87
Minimum	$1.62	$0.61	$0.72
Maximum	$6.93	$17.30	$27.89
Proportion of Negative Values	0%	0%	0%

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Interpretation of VRG

- Suppose the
  - free route on average has trips arriving on time 91% of the time and
  - the toll route can deliver on time arrival 97% of the time.
- Then the value of trip time reliability (based on a 6% point difference) is 6***3.54** = $21.24 per trip. ($3.54 = mean VRG for Transporters)
- This gets added in after calculating the trip time savings and converting to dollars using FF VTTS and SD/SS VTTS

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The Way Forward

- Ongoing tasks:
  - Importing of results into physical transport models
    - Recognising the need to power weight specific attribute marginal (dis)utilities to recognise role of each agent in the distribution chain
  - Verification of results in future applications
  - Development of more sophisticated methods of capturing group behaviour with and without directly-observed interaction
    - IACE
    - SEAL (Attribute endogeneity prior to choosing)

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Papers Linked to the Freight Distribution Project

- Hensher, D.A. and Puckett, S. (2005) Refocussing the Modelling of Freight Distribution in Urban Areas: The Role of Supply Chain Alliances in Addressing the Challenge of Traffic Congestion for City Logistics (UGM#2), Transportation, 32 (6), 573-602.
- Puckett, S.M., Hensher, D.A. and Battellino, H. (2006) The Adjustment of Supply Chains to New States: A qualitative assessment of decision relationships with special reference to congestion charging International Journal of Transport Economics, XXXIII (3), October, 313-339.
- Hensher, D.A. and Puckett, S.M. Theoretical and Conceptual Frameworks for Studying Agent Interaction and Choice Revelation (UGM Paper #4), International Journal of Transport Economics, accepted March 23, 06.
- Puckett, S.M. and Hensher, D.A. Behavioural responses of freight transporters and shippers to variable road user charging schemes (UGM Paper #10) in Pricing in Road Transport: A Multi-Disciplinary Perspective, Edited by E. Verhoef, B. Van Wee, L. Steg and M. Bliemer, Edward Elgar (Due late 06)
- Hensher,D.A., Puckett, S.M and Rose, J. Extending stated choice analysis to recognise agent-specific attribute endogeneity in group negotiation and choice: some thoughts (Submitted to Transportation)
- Hensher, D.A. and Puckett, S.M. (in press) Assessing the influence of distance-based charges on freight transporters Transport Reviews
- Puckett, S.M., Hensher, D.A., Rose, J. and Collins, A. (in press) Design and Development of a Stated Choice Experiment in a Two-Agent Setting: Interactions between Buyers and Sellers of Urban Freight Services, Transportation.
- Puckett, S.M. and Hensher, D.A. (in press) The role of attribute processing strategies in estimating the preferences of road freight stakeholders under variable road user charges, Transportation Research E
- Hensher, D.A. and Puckett, S.M. Power, Concession and Cooperation in Freight Distribution Chains subject to Distance-Based User Charges International J. of Logistics: Research and Applications
- Puckett, S.M. and Hensher, D.A., Modelling Interdependent Behaviour as a Sequentially-Administered Stated Choice Experiment: Analysis of Freight Distribution Chains, IATBR 2006, Kyoto, Japan, August.
- Hensher, D.A., Puckett, S. and Rose, J. (in press) Agency Decision Making in Freight Distribution Chains: Revealing a Parsimonious Empirical Strategy from Alternative Behavioural Structures (UGM Paper #8), for Special Issue of Transportation Research B on Behavioural insights into the Modelling of Freight Transportation and Distribution Systems

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Thank You

Q and A

Concession Model Results

Shipper concession model results (mixed logit): power parameter weights:

	FF/SD Time	On-Time Reliability	Variable Charges	Fuel Cost	Freight Rate
Mean	0.1444	1.0991	2.8233	2.0539	0.5656
Standard Dev.	1.2476	0.2918	0.8543	1.0985	0.1005
95% Range of Values	-3.7267 – 1.1214	0.3518 – 1.7618	0.7786– 3.7367	-0.0328– 4.8589	0.4457 – 0.8798
Minimum	-8.6238	0.0372	-1.3056	-1.2558	0.3709
Maximum	1.1704	1.9294	4.0049	8.4883	0.9800
Values Below 0.5	51.5%	3.7%	1.2%	5.9%	19.6%
Values Above 0.5	48.5%	96.3%	98.8%	94.1%	80.4%

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Concession Model Results

Transporter concession model results (mixed logit): power parameter weights:

	FF/SD Time	On-Time Reliability	Variable Charges	Fuel Cost	Freight Rate
Mean	0.1473	1.1087	1.6735	-0.1231	0.0275
Standard Dev.	1.0131	0.0944	0.4229	0.0011	0.3339
95% Range of Values	-1.9890 – 1.7416	0.8599 – 1.3114	0.5136 – 2.2087	-0.1256 – -0.1211	-1.0728 – 0.5998
Minimum	-5.0044	0.8037	-2.2275	-0.1292	-0.1292
Maximum	2.3480	1.5787	2.5112	-0.1192	0.7374
Values Below 0.5	65.3%	0%	2.2%	100%	97.0%
Values Above 0.5	34.7%	100%	97.8%	0%	3.0%

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Concession Model Results

Summary of some concession model results:

- Transporters hold relative power over on-time reliability levels and the response to variable charges.
- Shippers hold relative power over transit time.
- One can derive power weighted VRG’s for applications.
- Relationship-specific factors (not listed) govern relative power over price (i.e., freight rate) and fuel cost. These factors include:
  - years working with one’s organisation,
  - scale of the organisation, and
  - the length of the business relationship.