WORKING PAPER
ITS-WP-03-09

Modelling Agent Interdependency in Group Decision Making: Methodological Approaches to Interactive Agent Choice Experiments

By

John Rose and David A. Hensher

March 2003

ISSN 1440-3501

INSTITUTE OF TRANSPORT STUDIES
The Australian Key Centre in Transport Management

The University of Sydney and Monash University

Established under the Australian Research Council's Key Centre Program.

NUMBER: Working Paper ITS-WP-03-09

TITLE: **Modelling Agent Interdependency in Group Decision Making: Methodological Approaches to Interactive Agent Choice Experiments**

ABSTRACT: The past thirty years has seen a growing interest in the development of statistical methods to model choices made by individual agents. The dominant method to emerge, discrete choice modelling, has been applied to a wide number of applications in the areas such as transportation, marketing, environmental science, health economics and public utility regulation. Yet despite the wide level of acceptance, those who employ discrete choice models have often failed to acknowledge that such models assume independency between decision makers. The assumption of independence has significant implications in terms of which contexts discrete choice models should appropriately be applied to. This paper begins by establishing the rationale behind interactive agency choice experiments (IACE), an extension to the traditional discrete choice method that is designed to model agent interdependence. The paper then proceeds to discuss how to model both independent and interdependent decision making processes using the IACE methodology in order to capture information on preferences for all agents within a decision making group. The empirical case study used to illustrate the IACE method focuses on distributive work practice choices.

AUTHORS: John Rose and David A. Hensher

CONTACT: Institute of Transport Studies (Sydney & Monash)
The Australian Key Centre in Transport Management, C37
The University of Sydney NSW 2006, Australia

Telephone: +61 9351 0071
Facsimile: +61 9351 0088
E-mail: itsinfo@its.usyd.edu.au
Internet: http://www.its.usyd.edu.au

DATE: 14 March 2003

1. Introduction

A large proportion of human activity occurs as a result of group socialization in which the group not only becomes the primary agent for socialization and learning but also in affecting decision making and preference formation. Indeed, it is the household and not individual consumers that represent the basic consumption unit for the majority of consumer goods purchases, both in terms of consumer durables and non-durables. How the interaction of individual group members influence the group's decision making and preference formation processes therefore represents an important dimension of our understanding of economic behaviour.

The study of group decision making has as its early roots, research undertaken in the field of social psychology (see for example Thorndike 1938). Research in the area of group decision making has included such facets as individual behaviour in social contexts, the impact of within and between group interactions upon group performance, and the identification and categorization of means of aggregating individual beliefs and preferences into collective group consensus (Baron et al, 1992; Arrow 1963). Recent research in marketing has bought renewed interest to the issue of individual group member influences upon group decision making (Aribarg et al 2002; Arora and Allenby 1999; Dellaert et al 1998; for an excellent review of earlier work on group member influences on group decision making see Madrigal and Miller 1996). This recent research stream has made significant progress with respect to the development and testing of mathematical representations of group decision processes capable of measuring individual influences upon decision outcomes.

Research conducted by Aribarg et al (2002), Arora and Allenby (1999) and Dellaert et al (1998) present useful modelling approaches capable of assimilating the individual influences upon group decision making in a manner allowing for the estimation of individual attribute specific influences. This differs significantly from the more traditional approach of estimating a global group influence (for example Corfman and Harlam 1998; Rao and Steckel 1991). The main precept of their research is the notion that individuals exercise differential influence within the group upon each attribute and not just upon the overall or global group preference. Measurement of the individual attribute specific influences entails a multi-stage process whereby group members indicate their own preferences before coming together and undertaking the preference task as a group. Differences between derived individual preferences and that of the group indicate preference revision and concession.

Aribarg et al (2002) conducted two studies; one using a choice based conjoint (CBC) task and the second by means of a traditional conjoint undertaking involving a ratings task. In both instances, initial preferences of individual members were obtained before the parties were brought together in order to communicate their preferences to the other group member. Individual post communication preferences were then obtained before the process culminated in the members reforming as a group to undertake the task. The traditional conjoint task employed in the second study was similar to that used by Arora and Allenby (1999). In this earlier study, only a single conjoint task was undertaken without group discussion but again prior to the group task. Unlike the Aribag et al (2002) study however, Arora and Allenby included a task in which individual members were asked to allocate 100 points between themselves and other participating group members with regard to the influence each would have in the purchase decision of an oven/lawn mower. Dellaert et al (1998) employed a different empirical process in which individual members not only provide information as to their own preferences but also project the preferences of other group members with regard to the decision under consideration. A second experiment utilizing the same experimental design is then undertaken in which the projected influences are revealed to the other group members. The experiment concludes with the group jointly reviewing the profiles so as to obtain an overall group evaluation.

Whilst offering informative insights into the influences individuals have with regard to the decision processes of groups, each of these approaches handle individual group members as an exogenous input to the process of group preference formation. An alternative approach was introduced by Hensher termed interactive agency choice experiments (IACE) (Brewer and Hensher 2000; Hensher and Chow 1999) in which endogenous interactions between individual group members (called agents) are modelled through a process of feedback and revision. In this paper we revisit the IACE methodology and examine new econometric techniques capable of analysing IACE data which provide further insights into group decision behaviour.

2. Interactive Agency Choice Experiments

Decision contexts involving the interaction between multiple agents involve elements of both cooperation and non-cooperation. Both elements will be observed whether individual agents attempt to act as a single agent entity such as family members acting as a single household in the context of an automobile purchase; or as separate agent entities in competition with one another such as a car salesperson attempting to sell a motor vehicle to a family. In both cases the preferences of individual agents may be in opposition however a convergence of preferences (which may or may not be the goal of all agents present) may be achieved through a process of preference revision and concession (Aribarg et al, 2002). The end stage of this process of revision and concession is that of an equilibrium state represented by either agreement (preference convergence) or disagreement (where preferences fail to converge).

The form of agreement arrived at is dependent upon how preferences converge. Possible outcomes represent the states of choice and non-choice agreement. Choice agreement (or choice equilibrium) will occur when preferences for an alternative converge such that the rank order of preference for that alternative is highest for each agent within the group. Non choice agreement will occur when the preferences for an alternative converge such that the utility for an alternative is simultaneously ranked lower than that of the highest ranked alternative for all agents in the system. As such, non-choice agreement will result in the rejection of an alternative from the group's consideration set. It is possible for choice and non choice agreement to occur simultaneously however the existence of one state does not necessarily imply existence of the other.

The framework of IACEs is such that both independent and interdependent[1] preference formation strategies and choice outcomes may be analysed and tested for. Whilst similar

[1] In his original work, Hensher used the terms sequential and simultaneous. Given that the theoretical roots of the IACE lie in Economic Game Theory and the specific use of these terms in that literature, we prefer the use of the terms interdependent and independent respectively instead.

empirical approaches are employed in both instances, the only difference being in how the experiments are administered, the interdependent process as tested in Brewer and Hensher (2000) offers the appealing characteristic of allowing for the testing of individual agent preferences via the sharing of choice information amongst group members.

The IACE methodology is actualized through a stated preference choice experiment in which agents are administered a subset of the experimental design such that all agents within the same group receive identical profiles. In the interdependent form, the IACE commences with the administration of the experiment to the initial or starting agent. As a rule, the starting order for the experiment should be randomized unless a natural order exists amongst the agents (Hensher 2003). The initial experiment corresponds to the first round or round one. The second round consists of the administration of the experiment to the second agent under two information conditions - with or without knowledge of the prior agent's choice of alternative for each of the profiles administered. In multiple agent experiments, subsequent rounds are defined by the administration of the experimental design to successive agents within the group. The first pass is concluded when all agents within the group have been administered the experiment.

The second pass sees agents administered only with profiles in which choice agreement with other agents was not achieved in the first pass. Consider an experiment in which three profiles were administered in the initial pass. If for example in two of the profiles choice agreement was achieved for all agents, then the second pass of the experiment will proceed such that the third profile in which choice agreement was not realized will be re-administered to the agents in a new series of rounds. If agreement is made on all profiles, the experiment is terminated for that group as agreement equilibrium has been achieved. This process may continue for an indefinite number of passes, although it is suggested that the experiment be discontinued once the sample size becomes sufficiently small as to prevent model estimation. The recursive nature of an interdependent IACE for two agents (AGT1 and AGT2) is schematically represented in table 1.

The independent IACE form, although yet to be formally empirically tested, differs from the interdependent IACE form as described above in that agents are administered the experiment and asked to undertake the choice task as a group. Dissent may be observed by allowing agents to state their choice of alternative after the group choice has been made.

In cases involving more than two agents, a mixture of interdependent and independent IACE forms may be utilized. Consider a scenario in which a household consisting of a husband and wife are faced with the purchase of a motor vehicle from a salesperson. Such a scenario presents three identifiable agents within the group or network, the husband, the wife and the salesperson. In the experiment, the researcher may elect to use the interdependent IACE from for the husband and wife and a independent IACE form between the household and the salesperson. An alternative approach is to not pre-define the IACE form but rather test the appropriate IACE form as part of the experimental design.

Table 1. The IACE Structure

Groups	Choice sets	Agree	Number Agree	Pass	Not Agree	Number not agree
				Pass 1	Alt 1–Alt 2	6
48	1 set 0	Alt 1	26		Alt 1–Alt 3	8
	2 sets 0	Alt 2	30	$AGT_1 \rightarrow AGT_2$	Alt 2–Alt 1	8
	3 sets 3	Alt 3	32	*R1* *R2*	Alt 2–Alt 3	8
					Alt 3–Alt 1	11
					Alt 3–Alt 2	15
				Pass 2	Alt 1–Alt 2	3
31	1 set 11	Alt 1	8		Alt 1–Alt 3	7
	2 sets 15	Alt 2	10	$AGT_1 \rightarrow AGT_2$	Alt 2–Alt 1	4
	3 sets 5	Alt 3	9	*R3* *R4*	Alt 2–Alt 3	0
					Alt 3–Alt 1	7
					Alt 3–Alt 2	8
				Pass 3	Alt 1–Alt 2	0
19	1 set 11	Alt 1	10		Alt 1–Alt 3	0
	2 sets 6	Alt 2	1	$AGT_1 \rightarrow AGT_2$	Alt 2–Alt 1	2
	3 sets 2	Alt 3	6	*R5* *R6*	Alt 2–Alt 3	1
					Alt 3–Alt 1	6
					Alt 3–Alt 2	3
				Pass 4	Alt 1–Alt 2	0
7	1 set 4	Alt 1	0		Alt 1–Alt 3	0
	2 sets 1	Alt 2	1	$AGT_1 \rightarrow AGT_2$	Alt 2–Alt 1	2
	3 sets 2	Alt 3	1	*R7* *R8*	Alt 2–Alt 3	0
					Alt 3–Alt 1	6
					Alt 3–Alt 2	2

3. Methodological Approaches to Modelling IACEs

In Brewer and Hensher (2000), the choice experiment was used to produce a set of expected utilities resulting in the determination of choice (dis)agreement probabilities for each alternative evaluated by the employer/employee dyad for each pass. The recursive nature resulting from the interactive process of the IACE method allows for the inclusion of prior agent actions being fed to successive agents within the experimental framework, and the information state known to agents within a system tested at the time of model estimation to determine significance of knowledge of other agent actions upon choice. Tests may include model specifications such as a dummy variable indicating knowledge of prior agents actions (as in Brewer and Hensher 2000), the inclusion of the choice variable of prior agent actions for those granted knowledge of such choices within the experiment, or the use of the modelled probabilities as derived from the piror agents pass model, again interacted with whether the subsequent agent had knowledge of the prior agents choices in the previous round. Thus through the experimental manipulation of the knowledge shared throughout the group, tests as to the significance of prior knowledge upon the choice made by subsequent agents is possible, offering important clues as to the interactive relationships between the agents.

Given the simultaneous choice of a specific alternative by all individual agent members within a group, the possibility that the determinants of choice for each agent will differ from agent to agent must also be considered. For example, a husband may select a particular make and model of automobile based on the cars interior design whilst the wife may select the same make and model for its fuel economy. Whilst the same vehicle was selected by both individuals, the key decision factors underlying the choice of vehicle differed for both parties. To handle this, separate person-specific indirect utility functions for each alternative allow for tests as to whether design attributes and contextual constructs impact equally across the alternatives and separate model specifications for agents (e.g. employees and employers) allow for the testing of different sources of influence on each alternative across the group membership types.

The pass models derived for each agent are estimated from observations for which both choice agreement and choice disagreement was actually observed to have occurred. A more general model specification arises if the explanatory variables are interacted with a dummy variable indicating whether choice agreement was achieved for a profile or not. Such models will produce two parameter estimates for each explanatory variable based upon both agreement and non agreement. A Wald test of linear parameter restrictions will indicate whether two separate parameters should be estimated or whether a single generic parameter should be estimated for each variable. The latter case indicates that the weights attached to the modelled variables are equal in terms of whether agreement was reached or not for a profile, whilst the former case indicates that different weights are associated for the modelled variables for agreement/disagreement. Statistical significance of the interacted modelled variables will indicate whether each attribute and socio-demographic characteristic influences profile agreement/disagreement.

The models at each pass for each agent type produce probabilities for the selection of all alternatives within the profile set. Choice agreement, as determined by the system of pass models may be decided through an examination of these probabilities, such that an alternative will be selected by all agents if and only if the probabilities produced for that alternative are highest for all agents within a pass. Nevertheless, whilst informative, such models do not reveal the sources of influence resulting in agreement between agents. In order to determine the sources of influence resulting in agreement, we offer several possible modelling approaches. The first as related in Brewer and Hensher (2000) involves the use of binary choice pass agreement (1, 0) models. Design attributes, individual characteristics and individual perceptions may be included to determine the specific influences that result in choice agreement. Whilst informative of sources of influence, such models will not identify the non-choice agreement alternatives. A second possible modelling approach to determine the influences of agreement, which will provide insight into non-choice agreement outcomes, involves the use of a nested logit model in which the alternatives for any agent dyad are represented by the possible choice outcomes (e.g. alt1-alt1, alt2-alt2, alt3-alt3, alt1-alt2, alt1-alt3, alt2-alt1, alt2-alt3, alt3-alt1, and alt3-alt2). Figure 1 shows the nested logit structure for an agent dyad with three alternatives.

A third possible approach involves taking the difference in the probabilities for each alternative for each possible pairing within a group. These probability differences may then be used to produce separate regression models for each alternative. As the difference between any two probabilities will exist within the range -1 and 1, the use of censored regression models is suggested with a -1 and 1 lower and upper bound respectively. Further econometric consideration must be given to the likelihood of the existence of correlations between the disturbances across the system of equations. For this reason, the censored regression or tobit model should be embedded in a recursive simultaneous equations model.

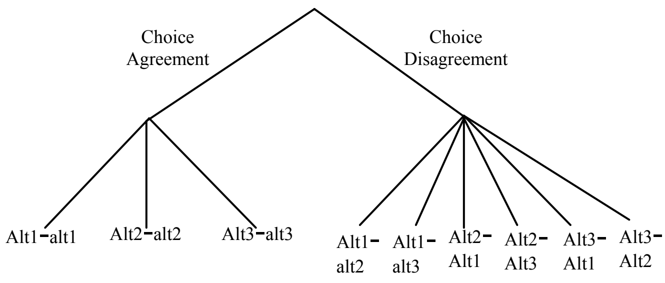

Figure 1. Nested Logit Agreement Model Tree Structure

Agreement (both choice and non-choice) up to a probability for any given alternative is determined as the probability differences estimated approaches zero. Movements away from zero towards the upper or lower bounds are suggestive of non-cooperation between the agents. To determine choice and non-choice agreement, reference to the pass probabilities of the agent dyad is necessary. Non-choice agreement for an alternative is determined by the existence of arbitrarily low probabilities derived from the agent pass models concurrently with values approaching one for the tobit model associated with that particular alternative. Choice agreement is suggested where high probabilities exist from the agent pass models.

Given difficulties in estimating recursive simultaneous equations for three or more censored regression models, an alternative approach in cases involving more than two alternatives is to use the ratio of probabilities for agent dyads instead, thus circumventing the necessity for the use of censored regression models. The ratio of any two probabilities will have a lower bound of zero with no upper bound. Rather than use the censored regression to account for this phenomenon, the log of the ratios may be used instead, which is easily modelled within the seemingly unrelated regression (SURE) system of equations.

As with the probabilities difference model, choice and non-choice agreement requires reference to the pass probabilities of the agent dyad. However, rather than predictions of zero suggesting agreement (both choice and non-choice), ratio values approaching one indicate agreement up to a probability.

4. Empirical Testing

Whilst the studies undertaken by Aribarg et al (2002), Arora and Allenby (1999) and Dellaert et at (1998) all examined household dyads consisting of either husband and wife or adult and teenager, the data for the study reported here constitutes a dyad of employees-employers. The data is that collected by Brewer and Hensher (2000) with an additional 28 employee-employer pairs gathered since the time of the original study and hence not used in the initial analysis. The data represents a small convenience sample consisting of a total of 48 employee-employer pairs from 6 different firms. The recruitment process is detailed in Brewer and Hensher (2000). The sample size is sufficiently large enough for analysis of the interactive choice experiments for three of the four passes of the interaction between employee and employer when expanded for the number of choice sets presented to each employee/employer pair per pass.

The context of the IACE related to employee/employer negotiations over the possibility to telecommute to work. It was assumed that a natural ordering exists amongst the dyad such that employees were automatically designated the initial agent within the experiment. The alternatives for this task consisted of either telecommuting one day a week, two days a week or to continue with the current workplace practice. This current alternative is equivalent to the employee not telecommuting and was defined with unchanging attribute levels. As such the current alternative represents a base alternative in the experiment. The stated preference design attributes were chosen to relate to the dimensions of time, place and distance and were deemed to be the most important attributes in forming preferences with regard to distributed work (Brewer & Hensher 2000). We show the design attributes in table 2. Given five attributes for each alternative the experimental design has a total of 10 design attributes of the order 3^{10}. An orthogonal fractional factorial design allowing for the estimation of all main effects plus one selected two-way interaction producing 27 profiles was derived from the full factorial. Each employee/employer dyad was then administered with three randomized profiles from the 27 set such that each profile was witnessed an equal number of times across the sample.

For analysis in this study changes were made to the data as originally analysed. These changes included the use of effects coding as opposed to dummy coding for the stated preference design attributes so as to avoid confoundment with model constants and the use of principle components factor analysis to construct item scales. Although the main focus of IACEs is on the interplay of choices made amongst agent groupings given the stated preference experimental design, other socio-demographic characteristics and attitudinal and perceptual constructs may also impact upon the interaction between agent members of a group. As such, the original Brewer and Hensher study (2000) included a number of item scales used to collect information about employee's perceptions of their work environment as well as the perceptions of employers on their employee's work environment.

Table 2. Stated Preference Design Attributes

Choice Dimensions	Description	Participant Questions	Response Set
People contact (CONTACT)	contact with people (internal and external) necessary to perform work	If I telecommute the **level of contact** necessary with other people for my work would be ….	1. lower 2. unchanged 3. higher
Control over job (CONTROL)	power over work process(es)	If I telecommute the **amount of control** I have over my work would be ….	1. lower 2. unchanged 3. higher
Productivity/effort (PROD)	amount of effort in relation to work output	If I telecommute, my **productivity** will be….	1. lower 2. unchanged 3. higher
Information (INFO)	access to information necessary to perform work	If I telecommute access to **information** necessary for my job would be …	1. location-dependent 2. limited away from workplace 3. location-independent
Career (CAREER)	perceived prospects of promotion threatened by telecommuting	If I telecommute, my **career prospects** will be…	1. lower 2. unchanged 3. higher

In the original study, summated scales were used for this analysis. These summated scales were used to produce similar scale constructs for both agent types as similar questions were asked of both employees and employers. For this study, principle components factor analysis was conducted separately on the employee and employer perceptions to produce perceptual constructs, the factor scores of which were saved and used for analysis. Tables 3a and 3b show the scale items, factor loadings, and variance extracted. Coefficient alpha for each construct is also shown. Examination of tables 3a and 3b reveals that employees and employers used the question items in different manners, thus grouping the items into different constructs than the summated scales reported in Brewer and Hensher (2000).

Table 3a. Factor Loadings for Employee Questionnaire Items

	EE_HEIR	EE_ROLE	EE_CHOIC	EE_INT	EE_AUTON	EE_GOALS
Even small matters have to be referred to someone	0.821					
Any decision I make has to have my supervisor's approval	0.812					
I have to ask my supervisor before I do almost anything	0.769					
A person who wants to make his/her own decisions would be quickly discouraged here	0.708					
There can be little action taken here until a supervisor approves a decision	0.671					
I know exactly what is expected of me		0.788				
I know what my responsibilities are		0.777				
I feel certain about how much authority I have		0.769				
How often do you see projects or jobs through to completion		0.651				
Explanation is clear of what is to be done		0.628				
How frequently are you able to tell from your own observations how well you are doing your work in terms of quantity and quality		0.601				
How often are you able to choose the speed at which you work			0.863			
How frequently are you able to choose the order of things you do to complete your work			0.836			
I know how to divide my time properly			0.684			
How often are you able to choose the methods you use to do your work			0.610			
How frequently are you required to talk to other workers, supervisors, or customers about work related matters while working on your job?				0.876		
To what extent is dealing with other people a part of your job				0.747		
How much are you left on your own to do your work					0.893	
How often are you given information by others (for example, other workers, supervisors, customers, etc.) about how well you are doing your work in terms of quantity and quality					-0.688	
Clear, planned goals and objectives exist for my job						0.721
How often do you talk to other workers, supervisors, or customers about non-work matters while working on your job						0.686
Scale Coefficient Alpha	0.78	0.75	0.68	0.70	0.71	0.01
Variance explained	21.04	13.93	11.71	9.18	7.89	6.47

Table 3b. Factor Loadings for Employer Questionnaire Items

	ER_ROLE	ER_HIER	ER_CHOI	ER_INT	ER_AUTON	ER_FEED
Employee X knows exactly what is expected of him or her	0.848					
Employee X knows what his or her responsibilities are	0.798					
How frequently are you able to tell from your own observations how well employee X is doing his or her work (in terms of quantity and quality)	0.656					
Clear, planned goals and objectives exist for employee X's job	0.559					
Employee X cannot take action until I, the supervisor, approve the decision		0.818				
I need to approve all of employee X's decisions		0.795				
Even small matters have to be referred to someone higher up for a final answer		0.644				
How often is employee X able to choose the speed at which he or she works			0.842			
How frequently is able to choose the order of things to be done to complete his or her work			0.745			
How often does employee X see projects or jobs through to completion			0.684			
How frequently does employee X talk to other workers, supervisors or customers about work-related matters while at work				0.828		
To what extent is dealing with other people a part of employee X's job				0.806		
To what extent does employee X's work rely on others (individually or as a group) to produce a given amount of work				0.626		
How much is employee X left to do his or her own work					0.685	
I know employee X has divided his or her own time properly					0.641	
How often do you give employee X information about how well he or she is doing in their work (in terms of quality and quantity)						0.817
Scale Coefficient Alpha	0.61	0.76	0.57	0.54	0.29	N/A
Variance explained	16.92	14.14	11.81	9.72	8.77	6.46

5. Results

Tables 4 through 6 show the employee and employer pass models for pass one through three respectively. Due to insufficient observations, models for pass four are not reported. The five design attributes representing Contact, Control, Productivity, Information and Career prospects were entered linearly into the indirect utility expressions for TC1 (telecommute 1 day per week) and TC2 (telecommute 2 days a week). For the Current alternative, these attribute levels remained fixed and hence were not included in the indirect utility functions for this alternative. The inclusion of the scale constructs requires different indirect utility functions for employees and employers given that the scale constructs are not directly comparable as a result of different survey items loading onto different factors for employees/employers. Also included are several untransformed survey questions directly entered into the indirect utility functions.

A direct behavioural interpretation of the parameter estimates reported in tables 4 through 6 is not possible given the logit transformation of the choice dependent variable required for model estimation. We therefore provide the marginal effects, defined as the derivatives of the probabilities, that is $\delta jm = \partial Pj / \partial xm = [1(j=m)-PjPm]\beta$, which have substantive behavioural meaning (Brewer and Hensher 2000). We interpret the marginal effects as the influence a one unit change in an attribute has in the probability of selecting a particular alternative, *ceteris paribus*. The above holds for continuous variables only. For effects coded and dummy coded variables, the marginal effects reported represent the derivatives of the probabilities given a change in the level of the coded variable (e.g. from low to medium; low to high; medium to high) and thus represent the influence of a change in level of the variable upon the probability of choosing a given attribute, *ceteris paribus*.

5.1 Pass 1

For pass one, 'the level of employee contact thought necessary for work' is a statistically significant influence on the choice of whether to telecommute or not for employees but not for employers. The 'level of control thought necessary' is statistically significant to both groups, whilst the 'medium level of productivity' is not statistically significant relative to the base (high) level for employees but is statistically significant for employers. The 'amount of information necessary to perform work' if an employee telecommutes is not a statistically significant influence on choice for both of the telecommute alternatives for employees and employers. The impact of telecommuting 'upon career prospects' is also a statistically significant influence for both employees and employers in choosing to telecommute to work or not. Alternative-specific parameter estimates for the career design attribute produced improved model fits for the employee model but not for the employer pass one model.

Taking the attribute 'control' for example and ignoring the employer model for the present, a close examination of the marginal effects reveals that changing from the low level ('If I telecommute the amount of control I have over my work would be lower') to the medium level ('If I telecommute the amount of control I have over my work would be unchanged') produces a reduction of 0.2616 in the probability of an employee selecting the current alternative and increases of 0.1335 and 0.1281 in the probabilities of selecting to telecommute one and two days per week respectively, *ceteris paribus*. Movement from the low contact level to the high contact level ('If I telecommute the amount of control I have over my work would be higher') suggests a reduction in the probability of an employee selecting the current alternative in the vicinity of 0.2032 and increases in the probabilities of selecting to telecommute one and two days per week of 0.1017 and 0.1015 respectively, *ceteris paribus*. *Ceteris paribus, c*hanging the contact level from the medium to high level produce probability changes of 0.0584, and minus 0.0317 and 0.0267 for the current, telecommute one and telecommute two days per week alternatives respectively.

For employers, a change in the attribute 'control' from the low level to the medium level produces a change in the probabilities of selecting the Current, telecommute one day and telecommute two days per week alternatives of -0.1813, 0.0874 and 0.0939 respectively. Changing from the low level to the high level produce similar changes of -0.0995, 0.0485 and 0.0511 whilst changes from the medium level to the high level produce probability changes of -0.0818, 0.039 and 0.0428 for each of the alternatives, current, telecommute 1 day per week and telecommute two days per week respectively *ceteris paribus*.

Several non-design attributes were also found to be statistically significant for both the employee and employer pass one models. Increases in the factor scores for the EE_CHOIC and EE_INT variables of one unit increase the probability that an employee will select the current alternative by 0.088 and 0.0799 respectively whilst the opposite effect is observed for the EE_ROLE variable (-0.1442). Changes in the probabilities for the telecommute one day and two day per week alternatives for EE_CHOIC and EE_INT are -.0451 and -0.0429 and -0.041 and -0.039 and 0.0739 and 0.0703 respectively. The happier an employee is with their work situation the more likely they will elect to telecommute with probability changes of 0.0352 and 0.0346 for the two telecommute alternatives given a one unit change in the happiness variable. *Ceteris paribus*, a one unit increase for the factor scales EE_GOALS and EE_HEIR produce changes in the three alternatives of 0.0474, 0.0427 and -0.0901 and -0.0968, 0.0427 and 0.1838 respectively. Also affecting the probability of selecting to telecommute or not is the perception of the firm as being family friendly and the requirement for specialised software with changes in the probabilities of selecting the current, one day per week and two days per week alternatives resulting from a one unit change in the variable being 0.0271, 0.0244, and -0.0515 respectively. Surprisingly, the more family friendly the organization, the less likely employees are to elect to telecommute two days a week.

Similar interpretations may be made for the employer pass one design and non-design variables. Of particular policy interest is the significance of the SAMEMALE and SAMEFEM variables. Male-male employee-employer combinations (SAMEMALE =1, SAMEFEM=0) suggest a higher probability of the employer selecting the current, non-telecommuting alternative, whilst a female employer has a higher probability of supporting a female (SAMEMALE =0, SAMEFEM=1) employee telecommuting either one or two days per week. There exists slight support by a mixed gender employee-employer combination (SAMEMALE =-1, SAMEFEM=-1) to telecommute either one day or two days per week. Examination of the marginal effects suggests a difference in the probability for a male-male employee/employer combination selecting the current, non telecommute alternative over a female-female combination of a magnitude of 0.3056 and a 0.2014 probability difference between the male-male combination and a mixture of genders. Also of policy interest is the finding that employers appear less likely to support employees telecommuting to work who are classified as managers, with an increase in the probability of 0.3242 selecting the current alternative for managers over non manager employees. Included in the employer pass one model are the probabilities for the alternatives derived by the employee pass one model. At the five percent level, the probabilities are not significant influences upon the choice of alternative as predicted by the employer pass one model, however the employee pass one probabilities are significant at the ten percent level for the telecommute one day per week alternative. The with/without information state was not statistically significant at either the five percent or ten percent level suggesting that having knowledge of the employees chosen alternative was not an influence on the choice of alternative made by employers. This suggests that the employers were acting as separate behavioural entities whose choices were not influenced by the choices of their employees.

Table 4. Employee and Employer Pass 1 Models

SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 1 EE (T stats)	Marginal Effects [Current, TC1, TC2]	SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 1 ER (T stats)	Marginal Effects [Current, TC1, TC2]
	CONSTANT	Current	-1.572 (-1.16191)			CONSTANT	Current	0.0959341 (0.11233)	
	CONSTANT	TC1	-3.72868 (-3.35348)			CONSTANT	TC1	-3.38093 (-2.85343)	
SP	CONTACT L	TC1, TC2	-0.707629 (-2.17465)	[-16.71, 8.48, 8.26][a]	SP	CONTACT L	TC1, TC2	-0.41609 (-1.45508)	[-7.97, 4.08, 3.9][a]
SP	CONTACT M	TC1, TC2	0.577952 (2.11024)	[-11.52, 5.84, 5.71][b] [5.2, -2.65, -2.56][c]	SP	CONTACT M	TC1, TC2	0.247581 (0.953592)	[-7.84, 4.01, 3.83][b] [0.14, -0.07, -0.07][c]
SP	CONTROL L	TC1, TC2	-1.22364 (-3.92779)	[-26.16, 13.35, 12.81][a]	SP	CONTROL L	TC1, TC2	-0.801687 (-2.70135)	[-18.13, 8.74, 9.39][a]
SP	CONTROL M	TC1, TC2	0.848171 (3.2379)	[-20.32, 10.17, 10.15][b] [5.84, -3.17, -2.67][c]	SP	CONTROL M	TC1, TC2	0.798276 (3.12604)	[-9.95, 4.85, 5.11][b] [-8.18, 3.9, 4.28][c]
SP	PRODUCTIVITY L	TC1, TC2	-1.59291 (-4.68845)	[-30.05, 14.59, 15.46][a]	SP	PRODUCTIVITY L	TC1, TC2	-1.77306 (-4.33318)	[-29.25, 14.47, 14.78][a]
SP	PRODUCTIVITY M	TC1, TC2	0.538929 (1.9532)	[-35.87, 17.42, 18.45][b] [-5.83, 2.83, 3.0][c]	SP	PRODUCTIVITY M	TC1, TC2	0.695287 (2.30808)	[-32.8, 16.11, 16.69][b] [-3.55, 1.64, 1.91][c]
SP	INFORMATION L	TC1, TC2	0.0926519 (0.338433)	[5.48, -2.86, -2.63][a]	SP	INFORMATION L	TC1, TC2	-0.068408 (-0.243953)	[-2.56, 1.3, 1.26][a]
SP	INFORMATION M	TC1, TC2	-0.330309 (-1.3539)	[-14.54, 6.43, 8.14][b] [-7.83, 4.11, 3.74][c]	SP	INFORMATION M	TC1, TC2	0.172458 (0.689344)	[0.39, -0.2, -0.19][b] [2.95, -1.5, -1.45][c]
SP	CAREER L	TC1	-1.92461 (-3.95141)	[-13.94, 25.12, -11.18][a]	SP	CAREER L	TC1, TC2	-0.839995 (-2.69515)	[-15.29, 7.92, 7.37][a]
SP	CAREER M	TC1	0.432709 (1.2004)	[-22.32, 40.52, -18.2][b] [-8.38, 15.4, -7.02][c]	SP	CAREER M	TC1, TC2	0.539458 (1.92766)	[-12.94, 6.72, 6.22][b] [2.36, -1.2, -1.16][c]
SP	CAREER L	TC2	-1.28094 (-2.88913)	[-17.54, -15.26, 32.8][a]	CONSTRUCT	SAMEMALE	Current	1.55957 (3.05267)	[-30.56, 15.97, 14.58][a]
SP	CAREER M	TC2	1.46231 (3.71633)	[-6.75, -	CONSTRUCT	SAMEFEM	Current	-1.34981 (-2.83883)	[-20.14,

				5.57, 12.32]][b] [10.8, 9.69, -20.49][c]					11.11, 9.03][b] [10.42, -4.86, -5.56][c]
SCALE	EE_CHOIC	Current	0.702514 (2.29032)	[8.8, -4.51, -4.29]	SCALE	ER_CHOIC	Current	1.82599 (4.33285)	[19.48, -10.04, -9.43]
SCALE	EE_INT	Current	0.604343 (2.30977)	[7.99, -4.1, -3.9]	SQ	MANAGER/PROFESSIONAL	Current	-4.40949 (-3.03598)	[32.42, -15.7, -16.72]
SCALE	EE_ROLE	Current	-1.18158 (-3.81951)	[-14.42, 7.39, 7.03]	SQ	FAMILY	Current	-0.740153 (-3.18277)	[-7.89, 4.07, 8.82]
SQ	HAPPY	Current	-0.50033 (-2.05648)	[-6.86, 3.52, 3.46]	SQ	ABSENCE	Current	1.04669 (4.35322)	[11.16, -5.76, -5.40]
SCALE	EE_GOALS	TC2	-0.773198 (-2.8303)	[4.74, 4.27, -9.01]	PROB	YEARS OF EMPLOYMENT	TC1	0.0801991 (1.86812)	[-0.44, 1.0, -0.56]
SCALE	EE_HIER	TC2	1.54622 (3.66048)	[-9.68, -8.7, 18.38]	PROB	STATUS	TC1	1.58111 (2.25895)	[-8.7, 19.51, -10.81]
SQ	FAMILY	TC2	-0.401713 (-1.70203)	[2.71, 2.44, -5.15]		PROB PASS 1 EE	TC1	1.8579 (1.76858)	[-10.22, 22.92, -12.7]
SQ	SOFTWARE	TC2	-2.27805 (-3.27438)	[13.37, 12.3, -25.67]		PROB PASS 1 EE	TC2	-1.1283 (-1.24448)	[5.83, 7.72, -13.54]
No. of observations			144					144	
Constants only Log-Likelihood (β) at convergence			-156.47474					-158.01255	
Log-Likelihood (β) at convergence			-88.13836					-86.76509	
-2 Log-Likelihood			136.67276					142.49492	
Degrees of freedom			20					20	
Chi-square (χ2)			31.4					31.4	

N.B. SP = stated preference, SCALE = Factor analyzed scale, SQ = Survey Question; Construct = developed from SQs; PROB = Agent Pair's prior probabilities

L = Low level; M = Medium Level

[a] Marginal effect for effects code: low level to medium level

[b] Marginal effect for effects code: low level to high level

[c] Marginal effect for effects code: medium level to high level

5.2 Pass 2 and 3

Tables 5 and 6 show the employee and employer pass two and three models. Examination of both the employee and employer pass-two models reveal that design attributes, previously observed to be statistically significant in pass one, are no longer so. Indeed, for the employer second pass model not a single design attribute is observed to be statistically significant. For employees, the low level of productivity is the only design attribute that remained statistically significant for the two passes, whilst the low information attribute - previously not observed to be statistically significant - becomes so in the second pass. With regard to the non-design attributes, for the employee pass two model all the variables with the exception of the software dummy variable are statistically significant and are thus modelled. Whilst several of these variables have been entered into different indirect utility functions than in the pass one employee model, importantly, the signs for these variables suggest similar influences upon choice response as in the prior model. Interestingly, several new variables are statistically significant in the second pass employee model which were not statistically significant in the first pass model.

The second pass employer model reveals that the same gender mix variables are statistically significant for male-male combinations but are no longer statistically significant for female-female combinations. Again, as with the pass one employer model, male-male employee-employer combinations suggest a higher probability of the employer selecting the current, non telecommuting alternative, a similar result as found in the employee pass two model. In a similar fashion to the employee pass two model, those variables inclusive of both pass models for employers have similar signs (but different wights) suggesting that they influence in the same direction, the choice of alternative. Examination of the pass two employee probabilities when included as part of the pass two employer model suggest that, given a higher probability of the employee selecting the telecommute one day a week, there exists a higher probability of the employer supporting this position. Nevertheless, this support does not extend to the other options available.

6. Comparison of Passes

One benefit of the IACE format is the ability to test subsequent model specifications on each successive pass. In doing so, changes in the influences of preference may be tested. In table 5 we report the log-likelihood test for comparing the pass one model specification for the second pass of employees. With one degree of freedom, the likelihood ratio is 30.18 suggesting that the second pass model produces a better model fit for the second pass than does the first pass model specification used on the second pass observations. Due to insufficient observations, we cannot report such a test for the employer pass two model.

Whilst interesting, we note that pass models produced subsequent to the first pass must be analysed with some care. Firstly, the number of observations diminishes from pass to pass, in line with the amount of agreement for each profile agreed to in the previous pass. Secondly, as a result of the above and as shown in table one, pass two consists of only those who failed to achieve agreement in pass one. Likewise, pass three consists of observations arising from those who failed to reach agreement in pass two. As a result, the pass models for each agent should be considered in light of the results as related in table one, which demonstrate how agents revise and concede their position in order to achieve agreement from pass to pass.

Table 5. Pass 2 Models for Employee and Employers

SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 2 EE (T stats)	Marginal Effects [Current, TC1, TC2]	SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 2 ER (T stats)	Marginal Effects [Current, TC1, TC2]
	CONSTANT	Current	1.15384 (0.277074)			CONSTANT	Current	-2.14142 (-0.934338)	
	CONSTANT	TC1	-0.712789 (-0.173946)			CONSTANT	TC1	-0.550943 (-0.662785)	
SP	CONTACT L	TC1, TC2	0.0176536 (0.018326)	[-3.63, 1.13, 2.51][a] [-3.53, -1.59, -1.94][b] [7.16, -2.17, -4.45][c]	SP	CONTACT L	TC1, TC2	-0.519672 (-0.836414)	[-8.93, 5.36, 3.57][a] [-10.71, 5.36, 5.36][b] [-1.79,0, 1.79][c]
SP	CONTACT M	TC1, TC2	0.473924 (0.746192)		SP	CONTACT M	TC1, TC2	0.158773 (0.342222)	
SP	CONTROL L	TC1, TC2	-0.804477 (-1.29958)	[-11.09, 5.02, 6.07][a] [-5.31, 2.17, 3.14][b] [5.78, -2.85, -2.93][c]	SP	CONTROL L	TC1, TC2	-0.817071 (-1.56898)	[-16.07, 8.93, 7.14][a] [-8.93, 3.57, 5.36][b] [-7.14, -5.36, -1.79][c]
SP	CONTROL M	TC1, TC2	0.829494 (1.3482)		SP	CONTROL M	TC1, TC2	0.747479 (1.49747)	
SP	PRODUCTIVITY L	TC1, TC2	-3.04571 (-2.18591)	[-28.57, 14.29, 14.29][a] [-32.1, 15.5, 16.6][b] [-3.57, 1.79, 1.79][c]	SP	PRODUCTIVITY L	TC1, TC2	-0.780147 (-1.33343)	[-8.93, 3.57, 5.36][a] [-14.29, 7.14, 7.14][b] [-5.36, 3.57, 1.79][c]
SP	PRODUCTIVITY M	TC1, TC2	1.2465 (1.54924)		SP	PRODUCTIVITY M	TC1, TC2	0.169813 (0.340398)	
SP	INFORMATION L	TC1, TC2	-2.41301 (-2.16293)	[-25.8, 10.6, 15.3][a] [-20.74, 7.86, 12.88][b] [5.11, -2.74, -2.37][c]	SP	INFORMATION L	TC1, TC2	-0.443825 (-0.880217)	[-10.71, 5.36, 5.36][a] [-1.79, 0, 1.79][b] [8.93, -5.36, -3.57][c]
SP	INFORMATION M	TC1, TC2	1.57976 (1.51504)		SP	INFORMATION M	TC1, TC2	0.7451 (1.85945)	
SP	CAREER L	TC1, TC2	-1.69721 (-1.3407)	[-10.94, -4.67, 6.27][a] [-20.89, 10.18, 10.72][b] [-9.95, 5.5, 4.45][c]	SP	CAREER L	TC1, TC2	-0.321364 (-0.675239)	[-7.14, 3.57, 3.57][a] [-3.57, 1.79, 1.79][b] [-3.57, 1.79, 1.79][c]
SP	CAREER M	TC1, TC2	0.124027 (0.135544)		SP	CAREER M	TC1, TC2	0.342997 (0.741416)	
Construct	SAMEMALE	Current	2.168 (2.17639)	[-25.63, 9.7, 16.86][a] [-28.98, 11.24, 17.74][b] [-3.35, 1.46, 0.88][c]	CONSTRUCT	SAMEMALE	Current	2.33847 (1.98137)	[-33.93, 19.64, 14.29][a] [-5.36, 3.57, 1.79][b] [-7.14, 3.57, 3.57][c]
Construct	SAMEFEM	Current	-0.831039 (-0.804547)		CONSTRUCT	SAMEFEM	Current	-2.01135 (-1.23804)	
SCALE	EE_CHOIC	Current	2.25046 (2.35674)	[15.58, -7.35, -8.2]	SCALE	ER_AUTON	Current	-3.47692 (-2.53629)	[-33.82, 16.91, 16.89]

SCALE	EE_GOALS	Current	2.33237 (2.35239)	[16.15, -7.62, -8.53]	SQ	ABSENCE	Current	2.44776 (2.10717)	[23.81, -11.92, -11.89]
SCALE	EE_ROLE	Current	-2.47735 (-2.53961)	[-17.16, 8.1, 9.06]	SQ	FAMILY	Current	-1.23376 (-2.11451)	[-12.0, 6.0, 6.0]
SQ	CLERK	Current	-3.00046 (-1.96418)	[-21.46, 9.09, 12.36]	PROB	PROB PASS 2 EE	TC1	4.57128 (2.4113)	[-22.26, 56.03, -33.77]
SCALE	EE_INT	TC1	1.71931 (2.16582)	[-5.62, 12.65, -7.03]	PROB	PROB PASS 2 EE	TC2	0.788041 (0.646633)	[-3.83, -5.82, 9.65]
SQ	VIEW	TC2	0.923591 (2.15565)	[-3.38, -3.78, 7.16]					
SQ	HAPPY	TC2	1.65562 (1.69224)	[-6.06, -6.77, 12.83]					
SQ	ABSENCE	TC2	-2.19081 (-2.25966)	[8.01, 8.96, -16.97]					
SQ	FAMILY	TC2	-1.0205 (-2.28644)	[3.73, 4.17, -7.9]					
No. of observations			56					56	
Constants only Log-Likelihood (β) at convergence			-60.17291					-61.17896	
Log-Likelihood (β) at convergence			-20.71979					-31.49118	
-2 Log-Likelihood			78.90624					59.37556	
Degrees of freedom			21					17	
Chi-square (χ2)			32.7					27.6	
Pass 1 model log-Likelihood (b) at convergence*			-35.8117					Insufficient Sample Size	
Pass 2 model log-Likelihood (b) at convergence			-20.71979					-36.75385	
-2 Log-Likelihood			30.18382					N/A	
Degrees of freedom			1					N/A	
Chi-square (χ2)			3.84					N/A	

*** Using the same model specification as in pass 1**
N.B. SP = stated preference, SCALE = Factor analyzed scale, SQ = Survey Question; Construct = developed from SQs; PROB = Agent Pair's prior probabilities
L = Low level; M = Medium Level
[a] Marginal effect for effects code: low level to medium level
[b] Marginal effect for effects code: low level to high level
[c] Marginal effect for effects code: medium level to high level

Table 6. Pass 3 Models for Employee and Employers

SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 2 EE (T stats)	Marginal Effects [Current, TC1, TC2]	SOURCE	ATTRIBUTE	ALTERNATIVE	PASS 2 ER (T stats)	Marginal Effects [Current, TC1, TC2]
	CONSTANT	Current	-5.172 (-2.55254)			CONSTANT	Current	-3.65987 (-1.55799)	
	CONSTANT	TC1	1.89463 (1.8568)			CONSTANT	TC1	-1.40826 (-1.14332)	
SP	CONTACT L	TC1, TC2	1.84072 (1.54765)	[13.79, -3.45, -10.34][a]	SP	CONTACT L	TC1, TC2	0.70892 (0.600692)	[[17.24, -6.9, -10.34][a]
SP	CONTACT M	TC1, TC2	-1.46789 (-1.19474)	[20.69, -3.45, -17.24][b] [6.9, 0, -6.9][c]	SP	CONTACT M	TC1, TC2	-1.18088 (-1.06149)	[6.9, -3.45, -3.45][b] [-10.34, 3.45, 6.9][c]
SP	CONTROL L	TC1, TC2	1.05007 (1.07403)	[[-6.9, 0, 6.9][a]	SP	CONTROL L	TC1, TC2	-0.913011 (-1.01662)	[-20.69, 6.9, 13.79][a]
SP	CONTROL M	TC1, TC2	-0.214885 (-0.29903)	[-24.14, 3.45, 20.69][b] [-17.24, 3.45, 13.79][c]	SP	CONTROL M	TC1, TC2	1.11729 (1.23837)	[-3.45,-3.45,0.0][b] [17.24, -3.45, -13.79][c]
SP	PRODUCTIVITY L	TC1, TC2	-1.09619 (-1.39527)	[8.16, -2.87, -5.29][a]	SP	PRODUCTIVITY L	TC1, TC2	-0.318223 (-0.264371)	[-17.24, 6.9, 10.34][a]
SP	PRODUCTIVITY M	TC1, TC2	-0.51214 (-0.568349)	[-9.08, 3.91, 8.51][b] [-15.75, 3.91, 15.17][c]	SP	PRODUCTIVITY M	TC1, TC2	1.19555 (1.00098)	[10.34, -6.9, -3.45][b] [27.59, -13.79, -13.79][c]
SP	INFORMATION L	TC1, TC2	-0.123108 (-0.108106)	[-17.24, 3.45, 13.79][a]	SP	INFORMATION L	TC1, TC2	-3.31473 (-1.93659)	[-27.59, 10.34, 17.24][a]
SP	INFORMATION M	TC1, TC2	-0.929545 (-1.28284)	[-48.28, 13.79, 34.48][b] [-31.03, 10.34, 34.48][c]	SP	INFORMATION M	TC1, TC2	1.91952 (1.58528)	[-34.48, 13.79, 21.69][b] [-6.9, 3.45, 3.45][c]
SP	CAREER L	TC1, TC2	-2.34793 (-2.31386)	[-52.72, 13.79, 37.93][a]	SP	CAREER L	TC1, TC2	-2.58013 (-1.57665)	[-27.59, 10.34, 17.24][a]
SP	CAREER M	TC1, TC2	-1.03229 (-1.07305)	[-52.72, 13.79, 37.93][b] [0.0,0.0,0.0][c]	SP	CAREER M	TC1, TC2	1.25085 (1.34924)	[-13.79, 3.45, 10.34][b] [13.79, -6.9, -6.9][c]
Construct	SAMEMALE	Current	-4.10435 (-2.70541)	[0.0, 0.0, 0.0][a]	SQ	ABSENCE	Current	2.55039 (2.11149)	[25.49, -10.78, -14.71]
Construct	SAMEFEM	Current	2.18021 (2.32855)	[-41.38, 10.34, 31.03][b] [-41.38, 10.34, 31.03][c]					
SQ	PROB PASS 2 ER	TC1	-23.326 (-2.28434)	[52.98, -172.17, 119.18]					
SQ	PROB PASS 2 ER	TC2	-9.88684 (-2.62768)	[84.05, 50.52, -134.56]					
No. of observations			29					29	
Constants only Log-Likelihood (β) at convergence			-28.4598					-26.45834	
Log-Likelihood (β) at convergence			-15.25871					-15.83673	
-2 Log-Likelihood			26.40218					21.24322	
Degrees of freedom			14					11	
Chi-square (χ2)			23.7					19.7	
Pass 1 model log-Likelihood (b) at convergence*			Insufficient sample size					Insufficient sample size	
Pass 3 model log-Likelihood (b) at convergence			-12.58835					-13.46672	
-2 Log-Likelihood			N/A					N/A	
Degrees of freedom			N/A					N/A	
Chi-square (χ2)			N/A					N/A	
Pass 2 model log-Likelihood (b) at convergence**			Insufficient sample size					Insufficient sample size	
Pass 3 model log-Likelihood (b) at convergence			-12.58835					-13.46672	
-2 Log-Likelihood			N/A					N/A	
Degrees of freedom			N/A					N/A	
Chi-square (χ2)			N/A					N/A	

*** Using the same model specification as in pass 1**

*** Using the same model specification as in pass 2**

N.B. SP = stated preference, SCALE = Factor analyzed scale, SQ = Survey Question; Construct = developed from SQs; PROB = Agent Pair's prior probabilities
L = Low level; M = Medium Level

[a] Marginal effect for effects code: low level to medium level

[b] Marginal effect for effects code: low level to high level

[c] Marginal effect for effects code: medium level to high level

7. Agreement and Disagreement

Table 7 presents for the first pass, a model specification in which each of the modelled variables have been interacted with a dummy variable indicating agreement/disagreement. Given the IACE format in which the employer either accepts or rejects the alternative chosen by the employee in the previous round, we present here only the agreement/disagreement interaction model for employers in pass one. This model represent a more general form of the pass one employer model in that design and non-design variables are allowed to vary according to whether agreement for a profile was reached or not. By using a Wald test to test for linear restrictions in the parameters, it was found that the design attribute information, both at the low and medium levels should be modelled without being interacted with agreement/disagreement (Wald est for one linear restriction; χ^2 = 11.24 and 4.35 respectively). The same gender variables (SAMEMALE: χ^2 = 6.3 and SAMEFEM: χ^2 = 3.96) and the probabilities derived from the pass one employee model (χ^2 = 18.66) also were found to be set to equality for agreement/disagreement. Testing the linear restrictions mentioned above jointly using a Wald test with five linear restrictions produced a χ^2 value of 20.82. All other variables are allowed to vary for agreement/disagreement.

Table 7. Pass 1 Agreement Interaction Model

SOURCE	ATTRIBUTE	ALTERNATIVE	PARAMETERS (T stats)	Marginal Effects [Current, TC1, TC2]
	CONSTANT	Current	0.996062 (1.05574)	
	CONSTANT	TC1	-0.226158 (-0.240271)	
SP	CONTACT LA	TC1, TC2	-0.839769 (-1.65165)	[-23.61, 14.58, 9.03][a] [-12.5, 7.64, 4.86][b]
SP	CONTACT MA	TC1, TC2	0.861327 (2.15468)	[11.11, -6.94, -4.17][c]
SP	CONTACT LDA	TC1, TC2	-0.78665 (-1.48942)	[-19.44, 11.81, 7.64][a] [-15.28, 9.03, 6.25][b]
SP	CONTACT MDA	TC1, TC2	0.533246 (1.31426)	[4.17, -2.78, -1.39][c]
SP	CONTROL LA	TC1, TC2	-0.821897 (-1.72468)	[-20.83, 12.5, 8.33][a] [-16.67, 9.72, 6.94][b]
SP	CONTROL MA	TC1, TC2	0.558164 (1.49134)	[4.17, -2.78, -1.39][c]
SP	CONTROL LDA	TC1, TC2	-0.499687 (-1.21169)	[-18.06,11.11, 6.94][a] [-4.17, 2.08, 1.39][b]
SP	CONTROL MDA	TC1, TC2	0.772109 (2.03214)	[13.89, -9.03, -5.56][c]
SP	PRODUCTIVITY LA	TC1, TC2	-1.75972 (-2.8238)	[-38.19, 21.53, 16.67][a] [-40.97, 23.61, 17.36][b]
SP	PRODUCTIVITY MA	TC1, TC2	0.769307 (1.76783)	[-2.78, 2.08, 0.69][c]
SP	PRODUCTIVITY LDA	TC1, TC2	-1.63671 (-3.1185)	[-36.11, 21.53, 14.58][a] [-34.72, 20.83, 13.89][b]
SP	PRODUCTIVITY MDA	TC1, TC2	0.896292 (2.12858)	[1.39, -0.69, -0.69][c]
SP	INFORMATION LOW*	TC1, TC2	-0.673758 (-2.15117)	[-17.36, 9.72, 7.64][a] [-11.11, 6.25, 4.86][b]
SP	INFORMATION MED*	TC1, TC2	0.580237 (2.14052)	[6.25, -3.47, -2.78][c]
SP	CAREER LA	TC1, TC2	-0.883701 (-1.78206)	[-15.28, 9.72, 5.56][a] [-24.31, 15.28, 9.03][b]
SP	CAREER MA	TC1, TC2	0.114088 (0.292579)	[-9.03, 5.56, 3.47][c]
SP	CAREER LDA	TC1, TC2	-0.179218 (-0.419059)	[-4.86, 3.47, 1.39][a] [-3.47, 2.08, 1.39][b]
SP	CAREER MDA	TC1, TC2	0.150257 (0.348539)	[1.39,-1.39, 0.0][c]
SQ	SAMEMALE*	Current	1.1738 (2.95056)	[-22.22, 12.5, 9.72][a] [-27.78, 15.97, 11.81][b]
SQ	SAMEFEM*	Current	-0.353882 (-0.980538)	[-5.56, 3.47, 2.08][c]
SQ	ABSENCE A	TC1	0.765067 (3.4446)	[10.76, -6.6, -4.16]
SQ	ABSENCE DA	TC1	0.414827 (2.03327)	[5.83, -3.58, -2.57]
Prob	PROB PASS 1 EE*	TC1	2.73012 (2.48174)	[-23.57, 35.11, -11.56]
SQ	EMPLOY A	TC1	0.155665 (2.82259)	[-1.34, 2.0, -0.66]
SQ	EMPLOY DA	TC1	0.129068 (2.15113)	[-1.11, 1.66, -5.46]
Prob	PROB PASS 1 EE A	TC2	4.1083 (2.78349)	[-22.34, -17.39, 39.78]
Prob	PROB PASS 1 EE DA	TC2	-5.55037 (-3.28849)	[30.18, 23.5, -53.68]
SQ	VIEW DA	TC2	0.888849 (3.36382)	[-4.83, -3.76, 8.59]

Restricted log likelihood function	-158.01255
Log likelihood function at convergence	-89.17597
Degrees of freedom	28
-2 log likelihood	137.67316
Chi-square (χ^2)	41.3

N.B. SP = stated preference, SCALE = Factor analysed scale, SQ = Survey Question; from; PROB = Agent Pair's prior probabilities

LA = Low level x Agree; MA = Medium Level x Agree; LDA = Low level x Disagree; MDA = Medium Level x Disagree

*** Parameters restricted to equivalence for agree and disagree**

[a] Marginal effect for effects code: low level to medium level

[b] Marginal effect for effects code: low level to high level

[c] Marginal effect for effects code: medium level to high level

Figure 2 shows the part-worth utilities for the productivity design attribute for the telecommuting alternatives. Given that the medium attribute level for productivity, when interacted with the agree dummy variable, is statistically equal to zero, we have set the part-worth utility to zero in the figure. For both agree and disagree interactions, the part-worth utilities for the telecommuting options increase as we move from the low attribute level to high attribute level. However we note a greater change in the part-worth utility level for the productivity attribute interacted with disagreement as we move between the low and medium levels of the productivity design attribute than exists for productivity when interacted with agreement. Examination of the other part-worth utility plots produce similar findings, with the one exception of the probabilities derived from the employee pass one model for the telecommute two days per week option. In this instance we note that, as the probability of the employee selecting the telecommute two days a week alternative increases, the utility for an employer who agrees with the employees choice increases, whilst the utility for an employer who does not agree with their respective employee decreases. This represents the only divergence in the signs for the part-worth utilities for the modelled variables.

Once more, in addition to the parameter estimates, the marginal effects are also reported. Comparing the marginal effects for the productivity design attribute we note similar influences upon choice of alternative when moving from the low level to the medium level of the attribute when the attribute is interacted with agreement/disagreement. From the model, for the current, telecommute one day per week and telecommute two days per week alternatives, the changes in probabilities respectively are -0.3819, 0.2153, and 0.1667 for productivity interacted with agreement and -0.3611, 0.2153, and 0.1458 for productivity interacted with disagreement. Larger differences exist when productivity is interacted with agreement/ disagreement with a movement between the low and high level (-0.4097, 0.2361, and 0.1736 for productivity interacted with agreement and -0.3472, 0.2083, and 0.1389 for productivity interacted with disagreement). This suggests that for profile sets in which agreement was reached, there exists a higher probability of selecting a telecommute alternative than for profile sets in which agreement was not reached.

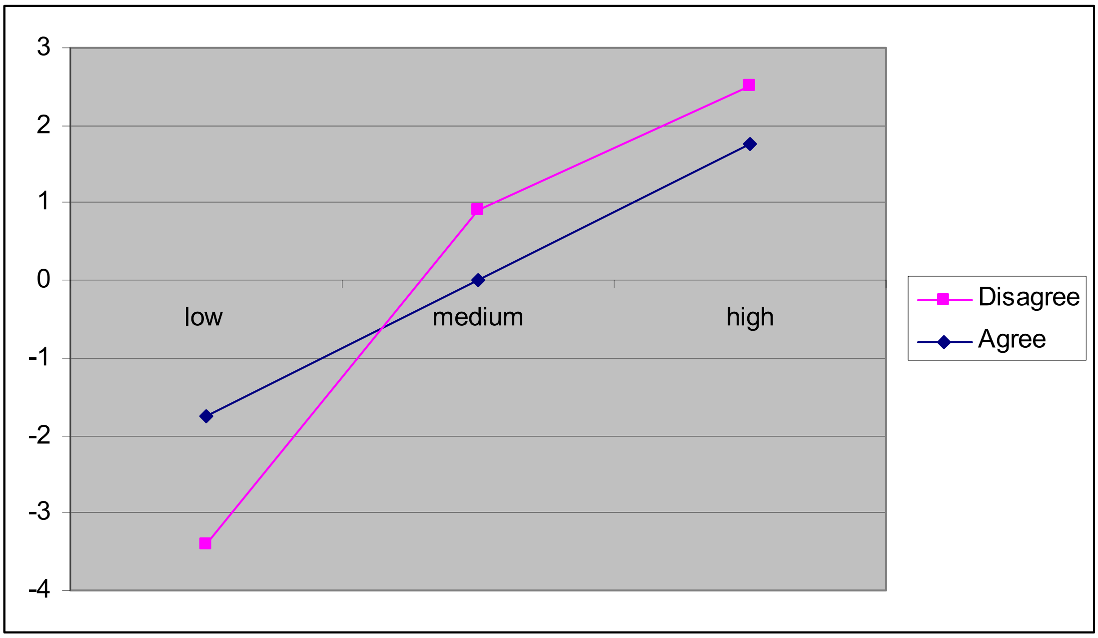

Figure 2. Productivity Design Attribute interacted with Agreement/Disagreement

Table 8 shows the binary agreement logit models for passes one and two. Given the IACE methodology, only the binary agreement model for the employer is relevant in pass one, hence no model is shown for employees for this pass. With the exception of the career at the medium level for the pass-two employee binary agreement model, no design attributes are statistically significant in determining agreement/disagreement. In pass one, a one unit increase in the scale construct ER_FEED and an increase in the length of service of the employee by one year increase the probability of the employer agreeing with the alternative choice of the employee by 0.06 and 0.01 respectively. A one unit increase in terms of how the employer views the absence of the employee negatively results in a decrease of 0.05 in terms of the probability of agreement being achieved. Other findings suggests that if the employee is a manager, or if the employer and employee are both male, there is a decrease in the probability of agreement of 0.23 and 0.17 respectively in pass one. In pass two, if the view that the employer will support telecommuting

Table 8. Pass 1 and 2 Binary Agreement Models

ER Pass 1 Agreement Model			EE Pass 2 Agreement Model			ER Pass 2 Agreement Model		
Variable*	**Coefficient (T stat)**	**Marginal Effects**	**Variable**	**Coefficient (T stat)**	**Marginal Effects**	**Variable**	**Coefficient (T stat)**	**Marginal Effects**
CONSTANT	0.668445 (2.50768)		CONSTANT	16.5421 (4.03824)		CONSTANT	-1.17955 (-1.17245)	
CONTACT L	0.0421236 (0.224477)	0.01	CONTACT L	-0.445211 (-0.823219)	-0.11	CONLOW	-0.277139 (-0.684183)	-0.07
CONTACT M	0.149252 (0.919164)	0.04	CONTACT M	0.597984 (1.42034)	0.15	CONMED	0.269375 (0.813866)	0.07
CONTROL L	-0.00578221 (-0.0307464)	0.00	CONTROL L	-0.785221 (-1.74034)	-0.2	CONTLOW	-0.681043 (-1.73945)	-0.17
CONTROL M	-0.0846145 (-0.513293)	-0.02	CONTROL M	-0.50964 (-1.19094)	-0.13	CONTMED	-0.450093 (-1.25953)	-0.11
PRODUCT L	0.0297266 (0.161218)	0.01	PRODUCT L	0.656066 (1.27037)	0.16	PRODLOW	0.621642 (1.60185)	0.16
PRODUCT. M	-0.0832985 (-0.512331)	-0.02	PRODUCT. M	-0.23589 (-0.598346)	-0.06	PRODMED	-0.111717 (-0.344381)	-0.03
INFO L	-0.306586 (-1.65123)	-0.07	INFO L	-0.813605 (-1.63753)	-0.2	INFOLOW	-0.510611 (-1.34395)	-0.13
INFO M	0.0362267 (0.216429)	0.01	INFO M	0.69423 (1.63423)	0.17	INFOMED	0.4278 (1.22092)	0.11
CAREER L	0.0356877 (0.192635)	0.01	CAREER L	-0.245947 (-0.503681)	-0.06	CARELOW	-0.13484 (-0.35308)	-0.03
CAREER M	-0.051793 (-0.313091)	-0.01	CAREER M	-1.05306 (-2.44982)	-0.26	CAREMED	-0.259742 (-0.783957)	-0.06
ER_FEED	0.243744 (2.31968)	0.06	EE_AUTON	-1.28148 (-3.01503)	-0.32	ER_CHOIC	0.497188 (1.99745)	0.12
EMPLOY	0.0438668 (2.15163)	0.01	EE_CHOIC	-1.08548 (-3.14434)	-0.27	ER_HIER	-0.685555 (-2.43944)	-0.17
ABSENCE	-0.208339 (-2.57362)	-0.05	EE_GOALS	-0.27189 (-0.645198)	-0.07	FAMILY	-0.855748 (-4.71764)	-0.21
MANAGER	-0.921513 (-2.94212)	-0.23	EE_HIER	-1.38221 (-3.34161)	-0.34	VIEW	0.90265 (3.47946)	0.23
SAMEMALE	-0.716526 (-3.5705)	-0.17	EE_INT	1.61529 (3.53935)	0.4	SAMEMALE	-0.778473 (-2.41262)	-0.19
SAMEFEM	0.149839 (0.848905)	0.04	EE_ROLE	-1.01801 (-3.36364)	-0.25	SAMEFEM	-0.559248 (-1.72179)	-0.14
			FAMILY	-0.432942 (-1.62068)	-0.11	CLERK	1.68836 (3.01037)	0.39
			VIEW	0.431779 (1.55233)	0.11			
			HAPPY	-3.03564 (-4.03603)	-0.76			
			ABSENCE	-1.66357 (-3.09907)	-0.41			
			SAMEMALE	-1.27448 (-2.27087)	-0.32			
			SAMEFEM	-0.320137 (-0.605285)	-0.08			
			MANAGER	-5.17847 (-2.11754)	-0.65			
			CLERK	3.1524 (3.97743)	0.64			
Restricted log likelihood function	-288.6833				-116.3416		-116.3416	
Log likelihood function at convergence	-267.5107				-57.61877		-77.20662	
Degrees of freedom	16				24		17	
-2 log likelihood	42.3452				114.13236		78.26996	
Chi-square ($\chi 2$)	26.3				32.7		27.6	

increases by one unit, the probability of agreement increases by 0.11. A one unit increase in the value observed for the EE_INT construct also increases the probability of agreement by the employee by 0.4. Increases in the constructs EE_AUTON, EE_CHOIC, EE_GOALS, EE_HEIR and EE_ROLE decrease the probability of an employee reaching agreement in terms of choice of alternative with the employer for pass 2. Once more, male-male employee-employer combinations significantly reduce the probability of choice agreement over a female-female combination by 0.32. For the employee, being a manager reduces the probability of agreement by 0.65 whilst being a clerk increases the probability of reaching choice agreement by 0.64.

For the second pass employer binary agreement model, different influences are observed to influence choice agreement than were observed from the first pass employer binary agreement model. Observing increases of one unit in the ER_CHOIC construct increase the probability of agreement by 0.12, whilst a one unit increase in the ER_HEIR results in a decrease in the probability of choice agreement by 0.17. The more the employer believes that the organization is family friendly, the lower the probability of choice agreement (a one unit increase decreases the probability of agreement by 0.21) whilst a one unit increase in the view that increased work hours is undesirable as held by the employer increases the probability of choice agreement by 0.23. As with the previous binary choice agreement models, male-male employee-employer dyads decrease the probability of choice agreement over female-female combinations by 0.19. As with the employee pass two model, if the employee is employed as a clerk choice agreement is more likely to occur (an increase in the probability of choice agreement of 0.39).

The previous round probabilities and the information of the previous round choice outcomes were also tested. In no binary agreement model were these variables statistically significant. This finding suggests that knowledge of the previous round choice outcomes do not influence agreement/disagreement.

The binary agreement models reported in table 8 provide information as to the sources of influence on choice agreement. Earlier we outlined several modelling strategies capable of deriving information with regard to non choice agreement. Table 9 shows the result for pass one for a system of seemingly unrelated regression models (SURE) in which the dependent variable used is the ratio of the pass one probabilities as estimated from the pass one employee/employer pass models (Prob(ee)/Prob(er)). Whilst theoretically the log of the ratio of the probabilities should be modelled we have used the untransformed ratio for ease of interpretation.

Three regression models, one for each alternative, are estimated, with the equations linked through their disturbance terms. Interpretation of each model is relatively straightforward. Ratio values derived from the regression models reported in table 9 that are less than one indicate that for the alternative being investigated, the employer has a higher probability of selecting that alternative over the employee. Ratio values exceeding one imply that the employee has a higher probability of selecting that alternative over the employer. Values approaching one indicate a convergence of probabilities for that alternative. Agreement in this instance does not necessarily translate to selection but rather that the agents agree as to the probability of selecting that particular alternative. Choice agreement is likely to occur for alternatives for which the highest probabilities, as observed from the pass models, exist concurrently,, with the ratios of the probabilities of the agents approaching one. The interpretation of the model output is relative to the starting probability ratios for each individual agent pair. For example, assume that the probabilities of selecting the Current, TC1 and TC2 alternatives for an employee are 0.60, 0.11 and 0.29 respectively and 0.89, 0.06 and 0.05 for the partnered employer. The probability ratios for this pairing are therefore 0.67, 1.83 and 5.8. Taking for example the same gender variables, if the employee and employer are both male, the signs of the parameters for all of the models for different alternatives suggest movements in the probability ratios away from one, thus suggesting a lesser likelihood of agreement, with the estimated ratios for the three alternatives being -0.005, 2.86, 6.5. If both agents are female, the direction in shift for the ratios of the probabilities suggests a preponderance for cooperation. The estimates for the ratios being 1.01, 0.7, 5.2. This result suggests that, given the starting probabilities, female-female agents are likely to cooperate in selecting, up to a probability, the current alternative. Nevertheless, convergence in agreement for other alternatives is also witnessed. Similar figures can be computed for same sex pairs.

Table 9. Pass Ratio of Agent Probabilities SURE Models

	Alternative	Current	TC1	TC2
Source	Variable	Coefficient (T-value)	Coefficient (T-value)	Coefficient (T-value)
	Constant	-1.655 (-4.34)	0.5671 (2.199)	-0.606 (-1.603)
SP	CONTACT L		-0.029 (-0.449)	-0.106 (-0.98)
SP	CONTACT M		0.0707 (1.172)	0.1535 (1.602)
SP	CONTROL L		-0.088 (-1.303)	-0.574 (-5.682)
SP	CONTROL M		-0.147 (-2.353)	0.1368 (1.331)
SP	PRODUCTIVITY L		0.3848 (5.713)	0.0114 (0.106)
SP	PRODUCTIVITY M		-0.207 (-3.288)	-0.169 (-1.723)
SP	INFORMATION L		0.0413 (0.638)	0.1315 (1.321)
SP	INFORMATION M		-0.341 (-5.638)	-0.503 (-5.132)
SP	CAREER L		-0.683 (-10.578)	-0.556 (-5.318)
SP	CAREER M		-0.142 (-2.285)	0.7348 (7.472)
SCALE	ER_AUTON	-0.174 (-3.596)		-0.291 (-4.039)
SCALE	ER_CHOIC	-1.219 (-11.222)	0.5167 (5.156)	0.4292 (4.368)
SCALE	ER_FEED	-0.190 (-2.081)	-0.408 (-4.679)	0.2346 (2.888)
SCALE	ER_ROLE	-0.127 (-2.67)		
SCALE	EE_CHOIC	0.6091 (9.473)		
SCALE	EE_HIER	-1.014 (-9.245)	-0.866 (-8.518)	0.6747 (6.979)
SCALE	EE_INT	0.2512 (4.409)		-0.468 (-5.602)
SCALE	EE_ROLE	-0.779 (-9.224)	0.3578 (4.351)	-0.637 (-8.17)
SCALE	EE_GOALS		0.2028 (3.51)	
SQ	SAMEMALE	-0.679 (-4.28)	1.0253 (6.561)	0.7030 (5.057)
SQ	SAMEFEM	0.3399 (2.053)	-1.130 (-7.013)	-0.553 (-3.538)
SQ	MANAGER/ PROF.	3.2127 (10.363)	-0.963 (-3.268)	-0.745 (-2.731)
SQ	FAMILY (ER)	0.2841 (4.631)	-0.274 (-4.559)	
SQ	ABSENCE (ER)	-0.727 (-9.876)	0.3154 (4.722)	0.2767 (4.158)
SQ	VIEW (ER)	0.2365 (4.776)		0.3737 (5.251)
SQ	ABSENCE (EE)	0.2403 (4.825)		
SQ	FAMILY (EE)	0.0468 (5.815)	-0.188 (-4.654)	-0.353 (-48.622)
SQ	VIEW (EE)		0.2204 (5.491)	
SQ	LENGTH OF SERVICE (EE)		-0.078 (-7.103)	
R^2		0.85	0.66	0.96
Constants only Log-Likelihood (β) at convergence		-353.0255	-282.0551	-434.2485
Log-Likelihood (β) at convergence		-206.5074	-192.0143	-183.2709
-2 Log-Likelihood		293.0362	180.0816	501.9552
Degrees of freedom		16	23	22
Chi-square (χ^2)		26.3	35.2	33.9

8. Discussion

In this paper, we have provided a framework, linked to a specific choice setting, within which we can identify the attributes that members of a network take into account when making a choice. This method allows for the estimation of agent- and attribute-specific sensitivities upon choice. We have further shown how the sources likely to influence cooperation may be discovered and estimated. Using different econometric modelling techniques, both choice and non-choice cooperation may be estimated.

Although the data used for the study is that of an organizational context, the method is easily generalizable to non organizational settings. Indeed understanding the decision process in any context in which individual's negotiate the choice outcome as part of a group may benefit from the use of the IACE method. Additionally, the technique is further generalizable to groups or networks with greater than two group members as discussed in this paper.

Future research in the area of IACE will require the examination of independent as well as joint independent and interdependent forms of data collection. Modelling techniques and analytical tests to determine the best form of data collection will need also to be shaped although established experimental design techniques offer useful directions for such future research efforts.

References

Aribarg A., Arora N. and Bodur H.O. (2002) Understanding the Role of Preference Revision and Concession in Group Decisions, Journal of Marketing Research, XXXIX, (August), 336-349.

Arora N. and Allenby G.M. (1999) Measuring the influences of individual preference structures in group decision making, Journal of Marketing Research, XXXVI (November), 476-487.

Arrow, K. J. (1963) Social choice and individual values, New Haven, Yale Univ. Press.

Baron, R. S., Kerr, N. L., & Miller, N. (1992), Group processes, group decision, group action, Pacific Grove, CA, Brooks Cole.

Brewer A.M. and Hensher D.A. (2000) Distributed work and travel behaviour: The dynamics of interactive agency choices between employers and employees, Transportation 27, 117-148.

Corfman K.P. and Harlem B.A. (1998) Relative Influences of Parent and Child in Joint Purchase Decisions: The Role of Product Characteristics, working paper, Stern School of Business, New York University.

Dellaert B., Prodigalidad M., and Louviere J.J. (1998) Family members' projections of each other's preference and influence: a two stage conjoint approach, Marketing Letters, 9(2), 135-145.

Hensher D.A. (2003) Models of Organisational and Agency Choices for Passenger and Freight-Related Travel Choices: Notions of Inter-Activity Influence, Paper prepared for the 8th IATBR Conference, Switzerland, 10th-15th August.

Hensher D.A. and Chow G (1999) Interacting Agents and Discrete Choices in Logistics Outsourcing: A Conceptual Framework, World Transport Research, Vol 3: Transport Modelling/Assessment (edited by Meersman H., Van de Voorder, E, and Winkelman W.), Perfamon Press, Oxford, 365-376.

Madrigal R. and Miller C.M. (1996) Construct Validity of Spouses' Relative Influence Measures: An application of the Direct Product Model, Journal of the Academy of Marketing Science, 24 (2), 157-170.

Rao V.R. and Steckel J.H. (1991) A polarization for Describing Group Preferences, Journal of Consumer Research, 18 (June), 108-118.

Thorndike, R. L. (1938), On what type of task will a group do well? Journal of Abnormal and Social Psychology, 33, 409–413.