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Extending stated choice analysis to recognise agent-specific attribute endogeneity in bilateral group negotiation and choice: A think piece

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ABSTRACT: This paper is a think piece on variations in the structure of stated preference studies when modelling the joint preferences of interacting agents who have the power to influence the attribute levels on offer. The approach proposed is an extension of standard stated choice methods. Known as 'stated endogenous attribute level' (SEAL) analysis, it allows for interactive agents to adjust attribute levels off a base stated choice specification that are within their control, in an effort to reach agreement in an experimental setting. This accomplishes three goals: (1) the ability to place respondents in an environment that more closely matches interactive settings in which some attribute levels are endogenous to a specific agent, should the modeller wish to capture such behaviour; (2) the improved ability of the modeller to capture the behaviour in such settings, including a greater wealth of information on the related interaction *processes*, rather than simply outcomes; and (3) the expansion of the set of situations that the modeller can investigate using experimental data.

KEY WORDS: ***Stated choice, attribute endogeneity, agent interaction, true bargaining set***

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1. Introduction

Many decision-making situations involve the choice among alternatives whose attributes cannot be readily altered. This ranges from simple, everyday purchasing decisions (e.g., choice of which train to catch, choice of petrol brand when re-fueling a vehicle) to serious lifestyle decisions (e.g., a couple's choice of residential location, one's choice of dwelling type, and choice of workplace destination). For such scenarios, traditional stated choice (T_SC) techniques are well-suited to capturing the behaviour of decision makers. This holds for individual decision makers, such as those in the simple purchasing scenarios described above; this also holds for interdependent decision makers, such as the physical location decision described above. The former scenarios can be modelled using standard stated choice experiments, whilst the latter lends itself to the interactive agency choice experiment (IACE) method (e.g., Hensher and Chow 1999, Brewer and Hensher 2000).

Some decision-making situations involve the choice among alternatives decribed by a set of attribute levels that can be altered by one or more of the interactive agents, as a way of establishing cooperation and possibly (market) power in determining the choice outcome. For example, when a prospective buyer and a salesperson interact in a car purchase scenario, the buyer may consider several models of vehicles (i.e., the base set of alternatives), and some of the attributes of those vehicles may be open for negotiation (e.g., colour, price, inclusion of accessories). In freight distribution, for example, the transporter and shipper may negotiate the level of delivery reliability (i.e., an acceptable window of arrival time), with each having very different starting positions.

In such cases, the added flexibility to amend the attribute level mix corresponding to an alternative is tantamount to the presence of a superset of alternatives, *the true bargaining set*, generated by the base set of T_SC or market alternatives. That is, with a set of *j* base alternatives under consideration, *c* attributes whose levels can be changed (i.e., negotiable attributes) by an agent within each alternative, and *lc* levels that each of the changeable attributes can take, the true set of alternatives that the agents could agree on is equal to $j^*\prod_{lc=1}^{LC} lc^{c}$. In the presence of quasi-continuous negotiable attributes, such as price or reliability measures, the bargaining set can be quite large.

There may be many points within the bargaining set that yield more satisfactory outcomes for a group than those that are generated in the base T_SC set of alternatives. In real market settings, there may be low barriers to reaching these points. In interactive agency space, if the traditional SC method does not allow for feasible movements to these points, then the method is potentially limiting in making inferences about the behaviour of agents, and hence in making increasingly more realistic projections of future behaviour in related settings.

These introductory remarks motivate the purpose of this paper as a think piece. In which situations are traditional SC experiments most useful, and what other method might be used as an alternative or extension of T_SC experiments when the latter are insufficient? In the following section, we use freight contract bilateral negotiations between a transporter and a shipper as a context within which to illustrate the potential shortcomings (or incompleteness) of T_SC experiments. We have chosen a two-agent setting in order to focus on the major issues that arise when introducing attribute endogeneity that is, in part at least, the result of negotiations between agents. Hensher *et al.* (in press) show evidence in the context of freight distribution chains, that local interaction amongst two players is the most common negotiation setting. Any additional party (e.g., a recipient of the goods who does not interact with the freight transport provider) was treated as an exogenous force, setting some constraints on the interaction within the two-member group.

In the following sections the proposed alternative SC method called Stated Endogenous Attribute Level (SEAL) is outlined, with a justification of its merits relative to traditional SC experiments. The paper concludes with a discussion of the behaviour that can be captured through SEAL in contrast to that which can be captured through traditional SC experiments.

2. Do Stated Choice Experiments Have an Achilles' Heel?

2.1 The Need for a Modified Method

Stated choice methods are popular among the transport research community as a powerful tool for capturing preferences and making inferences about behaviour. However SC methods in their traditional form may not always be adequate and may need some extensions to reflect specific behavioural processes. This is especially the case when a choice outcome requires negotiation between interacting agents who can adjust attribute levels as part of the bargaining basis for arrving at a cooperative or non-cooperative choice outcome. This is not a call to abandon SC methods. On the contrary, we strongly believe that the stated choice paradigm in its traditional form has great appeal for a wide range of applications, and will remain as the foundation around which variations can be introduced to account for attribute endogeneity in the context of agent interaction.

2.2 SC Modelling in the Presence of Permissible Attribute-Level Endogeneity

Consider a contract negotiation between two companies, a shipper and a freight transporter, as an application of stated choice methods (e.g., Bergantino and Bolis forthcoming, Holguin-Veras *et al.* 2004, Fowkes *et al.* 2004). We draw on this example throughout. Should a modeller wish to analyse the behaviour of agents within such a setting, SC methods might be used in one of two ways: (1) a traditional SC experiment could be implemented to establish each agent's individual preferences for contract characteristics; or (2) an IACE could be implemented to identify each agent's individual preferences for contract characteristics and to examine the influence that the preferences of one agent type have on the preferences of the other agent type through a process of feedback and revision. In both cases the modeller is able to estimate utility functions for both agent types corresponding to contract profiles. In the latter case the modeller is able to examine the impact that each agent type has on the utility of contract profiles for the other agent type (as shown in Rose and Hensher 2004) .

Both of these types of choice experiments measure preferences by having each agent choose among a set of alternatives with fixed attribute levels. In an analysis of preferences of contract characteristics, decision makers from shipping companies and freight transport companies could state their preferred alternative among a given set of fixed contract profiles. The responses of each individual could be used in the estimation of utility functions for freight contract profiles for each agent type using standard discrete choice models. Is this a plausible representation of the negotiation setting for which preferences are being estimated? T_SC methods have proven to be valuable for estimating preferences in settings in which respondents cannot influence the profiles under consideration, whether independent (via T_SC experiments) or interdependent (via IACEs).

What is missing from such analysis, however, is information on how agents respond to each other's preferences when faced with uncertainty and a desire to reach a satisfactory group outcome. When agents interact in a bargaining setting, they typically adjust to one another, choosing among all tools within their disposal. This toolkit includes each agent's ability to alter the attribute level mix on offer. Put simply, if agent *q* prefers A and agent *q*' prefers B, the two agents could adjust the flexible properties of A such that its new form, A', yields a greater joint utility than either A or B.

Thus if one wishes to model behaviour in a negotiation setting where attribute trading is permissable, traditional SC will not accomplish this; preferences may be measured, but the process by which joint preferences materialise is ignored, as is the revelation of afinal set of preferences arising from attribute revision. Negotiating agents in a T_SC environment are only able to make trade-offs across bundles of fixed attribute levels, rather than making trade-offs at the attribute level across all attributes levels under the agents' control.

In capturing this additional information, the *starting position* from which each agent’s revelation of preferences evolve can be either (i) the specification of the levels of the analyst-defined exogenous attributes (Louviere *et al.* 2000);, (ii) an agent’s endogenous attribute levels determined experimentally as in standard pivot-based SC experiments (Hensher 2006) or (iii) the offering of fixed attribute level mixes that are adjusted adaptively within the experiment (as in adaptive choice-based conjoint – see Johnson 1991). Unlike traditional SC experiments, the extended experiment, detailed below, allows respondents to *adjust* endogenous attribute levels when the first preferences of group members do not coincide, in order to move to an agreed outcome or a recognition of an impasse in agreement.

3. Foundations of a Revised Method

3.1 A Spatial Representation of Traditional SC Shortcomings

To highlight the gap between the reality that the analyst may wish to model and the capability of traditional SC experiments to capture agents' behaviour and preferences, Figure 1 represents the utility two agents q and q' would receive from three stated choice alternatives A, B and C in a given choice set. The shaded area represents the feasible bargaining set for the two agents. There are points within the shaded area in which the utility of at least one agent can be increased without decreasing the utility of the other, relative to each stated choice alternative. Hence, not only would a traditional stated choice experiment fail to represent possible Pareto improvements, but the experiment would also fail to represent outcomes that would improve utility for both agents.

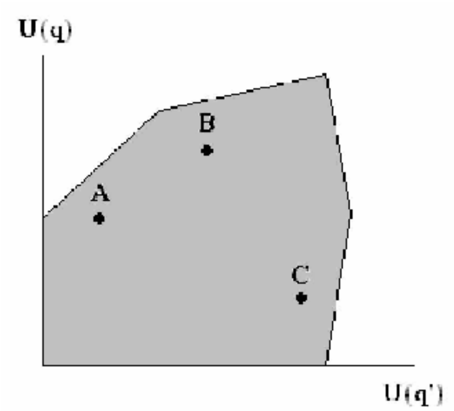

Figure 1 The decision space for interactive agent joint utility maximisation

This is only one element of the possible gap between T_SC for these settings and the corresponding reality. Specifically, the figure highlights the bounds on flexibility placed on negotiating agents in T_SC experiments *should they behave in the experimental setting as they would in a real market*. This is a shortcoming, in that information available to identify a joint utility maximisation outcome is bounded and (potentially) limits the possibility of identification of the globally optimal utility maximisation outcome.

3.2 Reflecting the "True" Process of Agent-Specific Attribute Identification

When agents have the ability to change the attribute levels on offer (e.g., changing the colour of a vehicle, lowering the price, changing the length of a contract), the behaviour of agents is not restricted to a choice among a group of fixed alternatives. For example, in the market, assume that the shipper regularly needs to move goods from its distribution centres to its retail locations, and that the current contract between the retail firm and one of its partner freight firms is about to expire. One of the two firms will contact the other to propose a contract re-negotiation. Both firms bring their expectations and needs to the discussion when trying to negotiate a new contract. Each firm may take these expectations and needs and propose an initial contract offer. Rather than haggling over which contract from the set of two offers to accept, and the alternative to decline to strike a deal, the two parties may use the two offers as starting points from which to make adjustments in their offers (Hensher *et al.* in press). This is a process in which new alternatives are generated in response to the offers and needs of the other party.

A method that embraces this process would have the potential to incorporate a mechanism that allows agents to approach a joint-utility-maximising 'equilibrium'. The proposed method which we call *Stated Endogenous Attribute Level* (SEAL) analysis, begins as a traditional SC experiment in which the levels of the attributes are determined experimentally using proven experimental design techniques for determining exogenous attribute levels (e.g., d-optimal designs – see Rose and Bliemer 2005, Kanninen 2002). The resulting initial choice sets faced by members of a sampled group are identical in form to a standard choice set given in a T_SC experiment.

However, unlike T_SC experiments, the SEAL experiment allows respondents to adjust endogenous attribute levels when the first preferences of group members do not coincide. Consider a simple choice set with three alternatives *A*, *B* and *C*, with two attributes classified by the analyst as exogenous (i.e., cannot be adjusted by respondents): travel time and damage rate. Along with these exogenous attributes, there are three endogenous attributes in each alternative: on-time arrival rate (which, given the set of exogenous constraints, could feasibly be satisfied by the transporter by taking the required measures), the freight rate charged, and customer satisfaction rating. The attribute levels could be functions of revealed preference information specified by respondents, along with their positions on the minimum and maximum levels of the attribute they believe could feasibly be offered (e.g., travel time cannot be lower than 30 minutes); this latter information could then be utilised to set the upper and lower bounds of the endogenous attributes.

Once presented with a choice set, if both respondents prefer the same alternative as given, choice equilibrium is trivial to establish. If they do not both prefer the same alternative as given, however, the experiment moves into its extended phase. One or both respondents are given the opportunity to take the alternative they would most like to use to build a counter-offer, and then each adjusts the levels of the endogenous attributes and continues to do so with feedback and revison until one arrives at attribute levels that are most conducive to establishing a satisfactory consensus outcome. For example, if the respondent representing a freight transport provider prefers a different alternative to the respondent representing a shipper, *or* if one or both respondents would prefer a variant of the same alternative, one respondent would be prompted to build a preferred counter-offer out of the set of alternatives. The respondent would then be free to select any alternative and adjust the levels of one or more of the endogenous attributes within their specified feasible ranges (e.g., select alternative *A* and raise the freight rate by $100 and raise the on-time arrival rate by 5 percent). If the other respondent is willing to accept the counter-offer as a group choice outcome, equilibrium has been reached and the choice experiment with its revised choice set has concluded. If the other respondent is not willing to accept the counter-offer, he is then given the opportunity to build a counter-offer in the same manner, selecting his most-desired alternative to use as a base and adjusting its endogenous attributes. The process repeats until either a consensus can be established, or impasse is reached (i.e., either a maximum number of iterations has passed, or one or both of the respondents states that it would be impossible to strike a compromise). Importantly the initial design is revised and assessed iteratively subject to a stop rule such as a fixed number of iterations to estbalish agreement or not. The entire process of review and revison and final choice outcome can be executed through internet-based or computer-aided personal interview data collection techniques. The final group equilibrium responses and attribute levels become the data input relevant to the estimation of the discrete choice models (see below).

3.3 Context Setting

As with all SC experiments, to make the SEAL experiment setting meaningful, one must set the context of the experiment. For the example of a freight contract between a transport provider and its client, one might ask the transporter for information about a recent or typical relevant distribution activity. This might include delivery time constraints, sizes and value of cargo, lead times, reliability requirements, travel times, costs, and distances travelled. Capturing this contextual information is essential, in order to have respondents negotiating in the same hypothetical space (i.e., in terms of the exact same distribution activity). Once the profile of the distribution activity (PDA) is established, the shipper and the freight agent are able to carry out the experiment acting in reference to the PDA.

Whilst specific context-setting information is provided by the respondents, the analyst's choice of general setting is also important. One line of experimental settings that lend themselves to SEAL analysis are responses to unexpected changes in the state of the world. For example, a government policy that directly and significantly impacts the operations of one or more agents under contract would necessitate contract re-negotiations. Hence, it could be realistic to hypothesise that a particular change in the state of the world has occurred, such as the introduction of variable use congestion charges, and that the respondents have agreed to consider re-structuring their contract (in terms of who will bear the cost).

Recruiting and matching pairs of agents is straighforward, although potentially time consuming. We have found in the freight distribution context (see Hensher *et al.* in press) that the transporter is the best starting respondent followed by a client of a freight firm. If, as can occur, a client is not provided to the analyst, we have found that matching a client (i.e, shipper) to a transporter based on a pre-defined classification rule (such as the delivery of the same product category) works well. The survey given to the other party involves the *identical* series of choice sets faced by the corresponding freight transporter.

3.4 Specification of Attribute Relationships

There are two key issues to handle when allowing for attribute levels to be endogenous within an experiment: (1) there may exist functional relationships between two or more attributes, such that varying the level of one necessitates a change in the level of another (e.g., travelling during relatively more congested periods would make average travel times greater than when travelling during relatively less congested periods, *ceteris paribus*); and (2) some attributes that matter to one agent may not matter to the other, yet there may be a functional relationship between some of them (e.g., lead time matters to the shipper but not to the transporter, travel time matters to the transporter but not to the shipper, and higher travel times cause higher lead times, *ceteris paribus*).

The importance of the first issue is that, although agents may have the power to alter some attribute levels, their flexibility may not be absolute - changing one attribute level may constrain another attribute level within a particular range. In designing an experiment, the analyst must identify, a priori, which attributes have an impact on others, and then must specify the feasible set of attribute level combinations, based on the background information uncovered by the analyst through research, focus groups, interviews and the like. SEAL respondents are informed that not all attribute level combinations are possible, and that in order to offer a particular attribute level, it may be necessary to restrict other attribute levels offered to within a particular set of ranges. Outside of these restrictions, respondents are informed that they are free to offer any attribute level combination that is allowed within the experiment.

The importance of the second issue above is that one must tie the elements of the experiment together meaningfully, such that an offer made by one agent can be converted into the terms desired by the other. This is also important for attributes between which there is no functional relationship. If such an attribute is important to an agent *q* yet has no relevance to the agent *q*', the attribute becomes important to *q*' to the extent that he or she must offer a level of the attribute that satisfies *q*. Therefore, such attributes must form part of the attribute consideration set for *q*', regardless of the level of importance of the attribute to *q*'. A SEAL experiment should be designed such that, in the presence of such cases, these attributes are automatically placed in an agent's consideration set; respondents are informed that the attributes appear in their consideration sets due to the importance of the attribute to the other agent. In the freight contract example, if travel time savings and the impact of a policy change on distribution activity are likely to be of significant importance to the freight firm; these may also matter to the shipper, but only in their manifestation into attributes that directly matter to the shipper (e.g., lead time, arrival time, cost).

3.5 The SEAL data strategy

To identify the preferences of SEAL respondents, the analyst has multiple frames of reference from which to choose. Within each choice set the analyst observes respondents: (a) selecting a preferred alternative amongst the original alternatives offered (see Figure 2 as an example); (b) constructing a counter-offer (i.e a restructured attribute package) that is preferred to the (counter) offer most recently given by the other member of the group; and (c), assuming impasse is not reached, agreeing to a group choice outcome. The information in (a) is identical to that observed in traditional SC experiments, and hence can be modelled in the same manner as in a T_SC analysis. The empirical extension offered within SEAL analysis of preference revelation lies in (b), which is an array of two-alternative choice sub-sets relating to each choice set (i.e., the counter-offer represents a chosen alternative, whilst the (counter) offer most recently given represents the unchosen alternative). This is illustrated in Figure 3. The observation in (c) is technically an extension of (b), being the final choice observation made for the choice set.

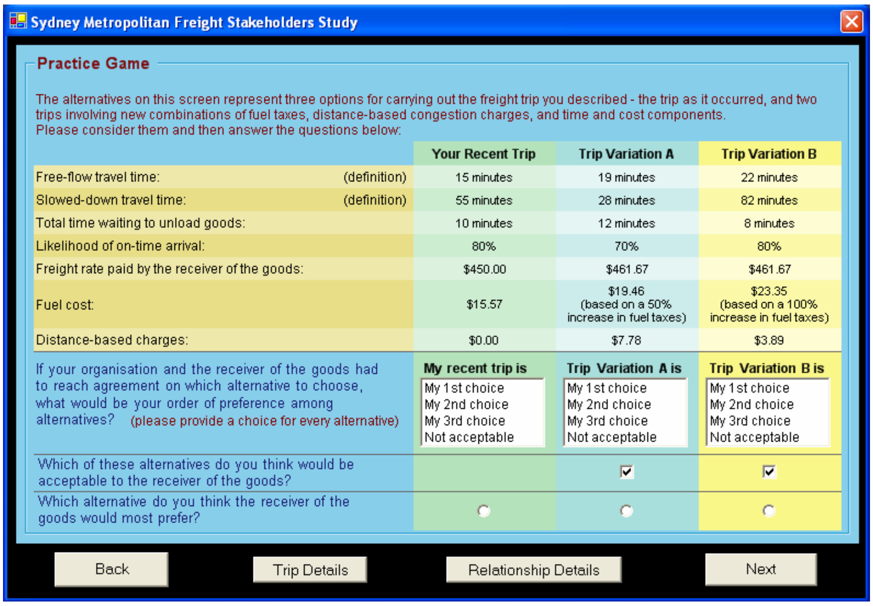

Figure 2. An example of a traditional (stage 1) SC screen

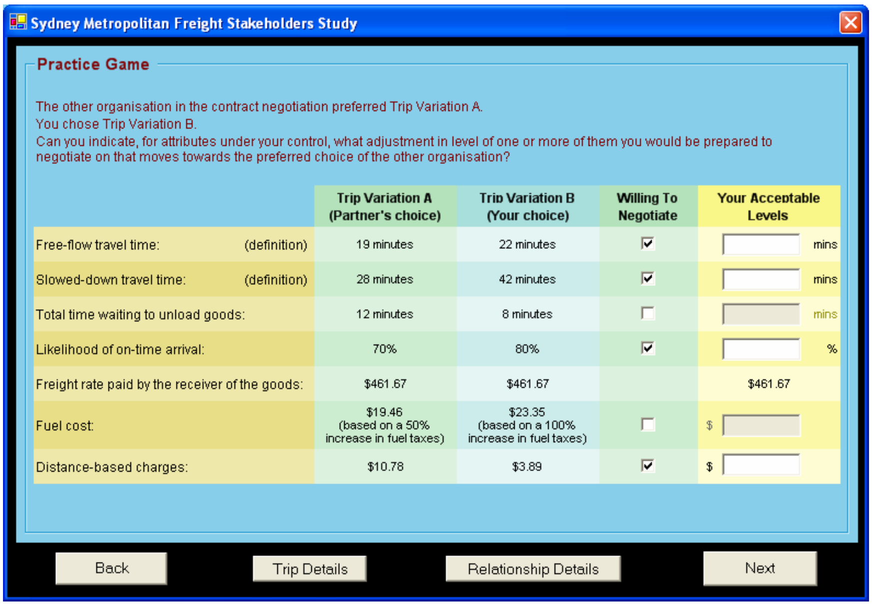

Figure 3. An example of an extended (stage 2) SC screen

This procedure may on first consideration be thought to be similar to adaptive conjoint analysis (ACA), a well-supported technique that has its sceptics and econometric shortcomings (Green *et al.* 1991, Johnson 1991). However, although the array of preferred counter-offers and less-preferred (counter) offers appears similar to ACA, there are significant differences. Adaptive conjoint analysis centres on the use of experimentally-controlled variations in one attribute level at a time, utilising standard discrete choice techniques to model the marginal rates of substitution implied in the choice of one alternative over the other. Such a procedure is purported to run the risk of biased parameter estimates (Toubia *et al.* 2003, Bradley and Daly 2000). Conversely, SEAL analysis of independent preferences centres on the use of *respondent-controlled variations in attributes* that respondents could feasibly vary in the real market. Furthermore, SEAL analysis offers respondents the opportunity to both: (a) adjust multiple attributes within a given alternative; and (b) vary the *exogenous* attribute levels within each pair of (counter) offer alternatives by selecting a different base alternative off of which to construct the counter-offer relative to the (counter) offer most recently given. Hence, SEAL analysis of independent choices is similar to ACA only to the extent that a pair of alternatives is traded off of each other, both of which are a function of the original alternatives offered.

Ultimately, the analyst can hypothesise a range of logical relationships amongst counter-offers; these relationships can be exploited to reveal additional information about the behaviour of respondents. Two examples are of primary interest. Firstly, as discussed above, each counter-offer by an agent *q* should yield a greater utility to *q* than the most recent offer by *q*', otherwise *q* would have accepted the offer rather than proposing a counter-offer. If this holds, which appears reasonable, then adjacent offer pairs such as those above can be examined in two dimensions: (1) the direct utility difference between all adjacent offer pairs; and (2) the evolution of these offer pairs as the experiment progresses.

Secondly, each offer made by an agent *q* should yield a lower utility to *q* than all offers made by *q* preceding the offer. That is, agents are likely to request a more favourable outcome initially and then concede across rounds of negotiation, rather than stepping up demands as the negotiation proceeds. This is a testable assumption which is less logically certain than the first. Marginal utility estimates from other portions of the analysis could be used to confirm the hypothesis; once confirmed, the corresponding observations could be analysed to examine the levels and types of concession made by respondents as the experiment progresses

4. The Main Modelling Structure for SEAL

The observed behaviour within a SEAL experiment can be investigated within any form of discrete choice model that is appropriate for a T_SC experiment. What separates SEAL from other T_SC analysis econometrically is the specification of the *final set of alternatives and the choice made*. This final set is referred to as the group ‘equilibrium’ and is the primary data of interest, although some analysts may be interested in the empirical path that leads to this circumstance. We do not have the relevant data at this stage to formally estimate the model but would encourage transportation research in this area.

The econometric modelling structure for any of these options is identical to that utilised within traditional SC experiments. The set of alternatives for each agent consists of the final (counter-)offer made by the respondent (which is also specified as the chosen alternative) and the most recent (counter-)offer given to the respondent. Utility estimates are calibrated against the observed choice behaviour:

$$U(1) = \beta_1 * x_1 + \beta_2 * x_2 + \ldots + \beta_K * x_K + \varepsilon_A$$

$$U(2) = \beta_1 * x_1 + \beta_2 * x_2 + \ldots + \beta_K * x_K + \varepsilon_B \quad (1)$$

$$\ldots..$$

$$U(J) = \beta_1 * x_1 + \beta_2 * x_2 + \ldots + \beta_K * x_K + \varepsilon_J$$

where β represents the marginal utility of each of K attributes x in each of J alternatives. Any exogenous attributes may be constant across a given pair of alternatives, should the (counter-) offer made by the respondent be based upon the same initial alternative as the most recent (counter) offer. This is not problematic as long as there is sufficient variation across such alternative pairs within the sample.

The model structure involves the stacking of utility expressions for each agent (1,…,N for agent 1 and N+1,…., J for agent 2). A mixed logit form provides the opportunity through random parameters and error components to account for correlated structures between alternatives and agents (Greene and Hensher 2006).

The approach based on equation system (1) focusses on the outcomes for each agent. This is extremely important information; however its primary role should be in the identification of the marginal utilities of each attribute for each agent in the circumstance where the outcome can be either one of agreement or non-agreement. Agreement exists where the same alternative is accepted by both parties as the preferred equilibrium outcome. However there will also exist non-agreement outcomes that define a situation where delivering an activity to market does not occur. Hensher *et al.* (in press) have argued that the focus of group decision making modelling should be on both studying (i) the full set of group preferences (for example, if there are 3 alternatives per person, then there are 9 group combinations, 3 of which would be associated with agreement outcomes i.e., 11, 22, and 33); and (ii) the agreement outcomes only. The former specification is particulary useful in investigating potential barriers to agreement (as shown in Brewer and Hensher 2000).

Should the group fail to strike a deal, an analysis of non-agreement can be very informative. It can be explained as a function of the characteristics of the offers made and of any additional information, such as historical evidence of cooperation, competitive effects, market power and relative performance. For example, let Y equal a (0, 1) or (-1, 0, 1) indicator of non-agreement. In both cases, one denotes termination of negotiation by at least one agent (this could be expanded into multiple indicators, one for termination by each agent type); in the latter case -1 denotes that the agents believed that an agreement was feasible, but that time constraints kept that agreement from being reached. In this case, this would be equivalent to a T_SC choice set with the number of alternatives equal to the number of offers made (and, if desired, the number of initial alternatives) plus one, in which the chosen alternative j is the decision to terminate the negotiation; that is, Y(j) = 1. The consequences of terminating the negotiation are specified within the experiment, and the characteristics of this state are reflected in the attributes of the utility expression for *j*.

The most interesting phase of modelling involves carrying forward marginal utility estimates from models of agent-specific preferences (as per equation 1) associated with *final* offers into an analysis of the group agreement outcomes (i.e., the three pairs in the example above U(11), U(22), U(33)). In a manner consistent with models by Aribarg *et al*. (2002), Dosman and Adamowicz (2006) and Hensher and Puckett (2006), the analyst has the opportunity to compare the estimated utility of a given pair of agreement offers from the set of all agreement outcomes to reveal the power relationships between the players. A contrast with the initial preferences based on a model of each individuals first preference, in the absence of negotiation, would also be informative of the role that each player exerts in achieving final agreement.

Agent-specific utility estimates can be used within a model to identify group preferences along the lines promoted by a number of authors (e.g., Dosman and Adamowicz 2006, Hensher and Knowles 2006, Hensher *et al.* in press). For a given choice set, the projected chosen alternative of the group is compared to the unchosen alternatives in order to estimate a vector of attribute-specific power measures, τ_{qk}.

To accomplish this, estimates of agent-specific group equilibrium preference parameters are carried forward as constant exogenous terms into the a *power model*, and multiplied by the corresponding attribute levels for each of the *K* attributes in each alternative *j* in choice set *p* faced by all respondents *q* in group *g*. For each simulated group interaction, *gp*, the alternative designated as the choice is the group choice projected using a choice coordination algorithm. The previously-estimated agent-specific marginal utilities derived by each *q* in each *j*, the vector of attribute levels in each alternative $\mathbf{x}_{jk}$ and any covariates of interest are the exogenous variables used to calculate the vector τ_{qk}., which, along with any alternative-specific constants are the only free parameters in the model (equation 2). Whilst the most general two-agent case is offered here, this calculation can be augmented through the inclusion of additional interacting agents:

$$\begin{aligned}
U_{11} &= \alpha_{11} + (\boldsymbol{\tau}_{\mathbf{qk}} * \boldsymbol{\beta}_{\mathbf{qk}})' * \mathbf{x}_{\mathbf{1k}} + ((\mathbf{1} - \boldsymbol{\tau}_{\mathbf{qk}}) * \boldsymbol{\beta}_{\mathbf{q'k}})' * \mathbf{x}_{\mathbf{1k}} + \varepsilon_{11} \\
&\ldots \\
U_{1J} &= \alpha_{1J} + (\boldsymbol{\tau}_{\mathbf{qk}} * \boldsymbol{\beta}_{\mathbf{qk}})' * \mathbf{x}_{\mathbf{1k}} + ((\mathbf{1} - \boldsymbol{\tau}_{\mathbf{qk}}) * \boldsymbol{\beta}_{\mathbf{q'k}})' * \mathbf{x}_{\mathbf{Jk}} + \varepsilon_{1J} \qquad (2) \\
&\ldots \\
U_{JJ} &= \alpha_{JJ} + (\boldsymbol{\tau}_{\mathbf{qk}} * \boldsymbol{\beta}_{\mathbf{qk}})' * \mathbf{x}_{\mathbf{Jk}} + ((\mathbf{1} - \boldsymbol{\tau}_{\mathbf{qk}}) * \boldsymbol{\beta}_{\mathbf{q'k}})' * \mathbf{x}_{\mathbf{Jk}} + \varepsilon_{JJ},
\end{aligned}$$

where U_{jm} is the estimated utility the group *g* derives from the joint choice of alternative *j* by agent *q* and alternative *m* by agent *q*' in simulated group interaction *gp*, α represents an alternative-specific utility component for the joint choice alternative, $\tau_{qk}*\beta_{qk}$ represents a vector of the product of relative influence measures for agent type *q* and the independent marginal utility derived by *q* for attribute *k* in *j*, $\mathbf{x}_{jk}$ represents the vector of levels of each *k* present in *j*, $((1-\tau_{qk})*\beta_{q'k})'$ represents a vector of the product of relative influence measures for the *q*'th agent $(1-\tau_{qk})$ and the independent marginal utility derived by *q*' for *k* in *m*, $\mathbf{x}_{mk}$ represents the vector of levels of each *k* present in *m*, and ε_{jm} represents the unobserved effects for the joint choice alternative.

The econometric analysis focuses on a power model that reflects the relative power structure present between agent types (herein a transport or a shipper). Analysing influence structures, the data allow us to infer estimates of relative power between agents. The power measures for agents *q* (τ_{qk}) and *q'* (**1-**(τ_{qk}) sum to unity for each attribute *k*, making comparisons of influence across agent types straightforward. If the two power measures are equal for a given attribute *k* (i.e., τ_{qk} = (1 - τ_{qk}) = 0.5), then group choice equilibrium is not governed by a dominant agent with respect to attribute *k*. In other words, regardless of the power structure governing other attributes, agent types *q* and *q*' tend to reach perceptively fair compromises when bridging the gap in their preferences for *k*. If the power measures are significantly different across agent types (e.g., τ_{qk} >> (1 - τ_{qk})), then τ_{qk} gives a direct measure of the dominance of one agent type over the other with respect to attribute *k*; as τ_{qk} increases, so does the relative power held by agent type *q* over *q*' for *k*.

For example, in a freight distriibution chain, the power measures may reveal that one agent type tends to get its way with regard to monetary concerns, whereas the other agent type tends to get its way with regard to concerns for levels of service. These relationships can be examined further within subsets of agent groups (by decomposition of the random parameter specification of τ_{qk} in a mixed logit model), in order to reveal deviations from the inferred behaviour at the sample level associated with exogenous influneces that may be present for a particular type of relationship.

5. Concluding Remark

This paper is a think piece to generate debate on alternative ways in which choice experiments can be specified in order to capture the realities of markets in which many decisions involve interaction and negotiation between two or more agents. While stated choice experiments will remain an appealing paradigm, there is a risk that they are seen as the only way forward. Their popularity must be conditioned by their suitability.

This paper promotes an ongoing dialogue on alternative ways in which we might represent the way in which agents make decisions in real markets. SEAL data can be analysed using the same set of econometric methods currently used in traditional stated choice studies, such as mixed logit. The crucial difference however is the behavioural richness of the extended SC data that has resulted from a process of review and feedback amongst agents to reveal a more likely structure for the attribute package(s) that would deliver joint utility maximising group outcomes, in contrast to the requirement in traditional stated choice to have to undertake an increased amount of extrapolation and inference within the bounded attribute space under study (which may not cover the ultimate decision package leading to agreement) in order to seek out the utility maximising group outcome.

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