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Distributed Work and Travel  
Behaviour: The Dynamics of  
Interactive Agency Choices  
between Employers and  
Employees

by

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**ABSTRACT:** This paper develops a framework within which multiple agents make discrete choices in respect of a common objective - the determination of participation in distributed work, especially the opportunities and constraints associated with telecommuting. Ideas in discrete choice theory and game theory are combined to define a set of choice experiments in which employees and employers interact in arriving at a choice path in a distributed work context. A stated choice experiment with offers and feedback, known as an *interactive agency choice experiment* (IACE), is empirically investigated in the context of telecommuting options with an exploratory sample of employees and employers in Sydney, Australia. The approach highlights the role of information and negotiation in breaking down the barriers to more flexible work activity, to deliver potential benefits to the transport system such as reduced traffic congestion and environmental sustainability. The paper identifies the types of incentives that an employee/er has to offer the employer/employee in securing effective telecommuting.

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## Introduction

The growing interest in distributive work, both spatially and temporally, and the implications for travel behaviour, represents an important example of the need to study the interactions between agents rather than assume their independence. Interactions between an employer and an employee are part of every day working life and represent a complex and authentic process in organisational decision making. Other complex interactions concern those between an employee and the members of their household. Two interactions of particular interest are between the travel-related work preferences of an employee and the work practices policy of an employer, and between employees in multi-worker households.

Decision making about distributing work involving agency interdependency includes negotiation, bargaining and some arbitration between an employee and an employer. Agency interdependency also occurs between individuals in a household who are affected by the choice made by the employee member(s) of the household. Interactive agency decision-making leading to choices may not produce each agent's preferred outcome. These outcomes are well encapsulated by a non-zero sum cooperative game of the Nash bargaining equilibrium structure (Gibbons 1992, Nash 1950). This regime is typically non-compliant with a competitive market where non-interactive specifications of discrete choice models can safely be assumed for modeling the choice process of each agent in the decision chain. That is, the situation where an employee chooses an option offered by an employer from a universal finite choice set in a strictly competitive regime under random utility maximisation.

Reality typically involves situations where employees through overt and/or informed experience have limited their choice set to a subset of distributed work options including the null situation (often referred to as choice through bounded rationality). As far as is known, any effort to model the choices of employers, employees and other household members with respect to the spatial and temporal nature of work activity (and consequent implications for travel behaviour), have treated each agent as a mutually exclusive element in the decision chain. Bernadino and Ben-Akiva (1996) come close with the analysis of a sample of employers and employees from the same organisation, but the links between an employee and their immediate supervisor are not analysed because the employees and employers were treated as separate samples. Only where agent independence is assured in a true competitive market can each observation be treated in the same manner as in traditional discrete choice models. From an econometric viewpoint, the market is best described as one depicting a host of different distributed work offers. Within the process of these offers, agency interdependencies are revealed through negotiation and bargaining to impose a non-independence structure on choices made between an employee and an employer, and between an employee (or commuter) and other members of their household.

This paper develops a framework within which multiple agents make discrete choices in respect of a common objective - the determination of participation in distributed work, including the opportunities and constraints associated with telecommuting. Ideas in discrete choice theory and game theory are integrated to define a set of choice experiments in which employees, in single and multi-worker households, interact with

employers in arriving at a choice path in a distributed work context. The controlled experiments are empirically implemented on an exploratory sample of employees and employers in Sydney. The complexity of a stated choice experiment with offers and feedback necessitates a small sample at this stage in exploring the potential of *interactive agency choice experiments* (IACE's).

The focus of the paper is on a situation in which negotiation and deals are the rule in agent choices in distributed work opportunities, in contrast to open-market competitive decision making. The theoretical framework uses ideas from game theory, discrete choice models with relatively free covariance structures (e.g. across-agent correlation), and forward-backward linking stated choice experiments capable of evaluating sequential-move and 'one-shot' simultaneous move negotiation regimes. The literature in integrating these three threads of a more realistic representation of complex decision making, involving interdependent agency choice, is recent. The framework offers a new challenge for anyone seeking to improve on both understanding and prediction of travel behaviour choices.

The paper is organised as follows: firstly, a conceptual framework establishing the nature of the problem, followed by secondly, a theoretical framework for choice making under distributed work regimes. Thirdly, a structural model of interacting agents' choices and details of the design of a controlled experiment that integrates both market information and stated preference data is specified. This model includes consideration of the dynamics of interaction in an experiment. Fourthly, the empirical study is defined as a sample of observed interacting employees and employers, followed by the analysis and key results. A set of concluding comments highlight the major findings.

## Establishing The Nature Of The Problem: Time, Place And Distance

The spread of business activities in time, place and distance is more and more prevalent in organisations as management disperses production and distribution processes over distance, both nationally and internationally. In the past, management sought to locate their business activities with a view to minimising costs associated with distance, given the existing or anticipated information flows (Charles 1981). Although decentralised business activities and managerial practices have been conducted for some time in western society, the emergence of new telecommunications technologies has radically enhanced management's capacity to distribute their work processes throughout a metropolitan area and beyond the urban fringe.

Distributed work begins to realise a 'virtual' work organisation amongst managers, workers and technology, enabling them to perform work that may be at variance spatially and temporally with each other. The distributed work context can be another organisation (e.g. network organisations), another workplace (e.g. home, car, telecentre) or another work site (e.g. customer service outlet) (Venkatesh and Vitalari 1992). Distributed work has come about due to:

- 1) an increasing perception that information is a significant economic resource necessary for business competitiveness
- 2) the practical consequences of conducting business over distance (Salomon and Schofer 1988, Warf 1989, deWaard 1997, Saxena and Mokhtarian 1997, Kitamura et al 1991, Handy and Mokhtarian 1995, US Department of Transportation 1993).

As information technology makes work and customer activities more location independent, distributed work will prove a greater incentive for employers. In many nations, governments are calling for better managed enterprises to provide greater organisational flexibility and improved employee relations ( Karpin 1995). Organisational flexibility is highly significant in the face of intense competition and increased labour costs which are placing pressure on management and unions to raise productivity, increase flexibility and quality of outputs (Porter 1990). Distributed work is one way of addressing these initiatives providing management is prepared to engage in appropriate work redesign (Brewer 1993, 1994, 1995; Brewer and Hensher in press; Harrison 1994).

The choice to distribute work processes or not depends on management's *capacity* to operate and manage internal, inter-workplace and inter-organisational relationships and communications in the broadest sense. Capacity refers to organisational flexibility in terms of restructuring operations, redesigning work, changing technologies and assisting people in relocating business activities to take advantage of transport and telecommunications networks (McKay 1988).

### *Telecommuting*

The focus of this paper is on telecommuting as an example of a technology supportive of distributed work processes with direct relevance for travel behaviour. Telecommuting is not limited to computer-based work and includes cognitive-based tasks such as thinking and writing (Mokhtarian 1991). Defined in a transportation context, telecommuting captures the 'telecommunications-transportation tradeoff' (Kraut 1989, Salomon and Mokhtarian 1997), as well as the potential generation of complementary travel activities. Telecommuting means a reduction in either the number of commute trips for a home-based worker or in the distance travelled to work for a telecentre worker (Handy and Mokhtarian 1996). Telecommuting can also lead to increases in other complementary travel activity such as short local non-commuting trips from home during the telecommute day. Activities that define telecommuting and non-telecommuting are difficult to distinguish when taking into account work-related trips such as visiting clients, customers or contract workers working at home.

### *Transport Demand Strategy*

Telecommuting, making commuting to and from work less significant, leads to a change in travel behaviour of workers and the subsequent impacts on traffic mix in urban areas. The linkage between saved travel due to telecommuting and possible changing non-work travel activity is crucial in understanding the contribution of telecommuting to improving air quality and reducing global warming. There is an expanding literature which suggests the potential causal linkages between alternative organisational structure, work organisation, distributed work, travel behaviour, and environmental impact. The importance of these relationships is highlighted by increasing evidence that the greatest potential for reducing greenhouse gas emissions and local air pollution due to the car, in particular, and all passenger transport in general, is through improvements in car technology and flexible work arrangements, the latter defined spatially and temporally in its most broadest sense (Hensher 1993, Niles 1991). Although car technology is contributing less pollution in the 1990s than in previous decades, their ever-increasing numbers and the growth in annual kilometres travelled means that improvements in air quality are likely to be short-lived (Hensher et al. 1997). One important way to address this significant problem is to investigate travel behaviour associated with telecommuting and the implications of the substitution of non-commuting travel activity for 'saved' commuting activity with distributed work processes. The majority of these journeys are by car with a resulting decline in public transport use. One negative impact anticipated with the implications of distributed work on travel behaviour is the increase in non-commute trips (Niles 1991).

### *Understanding Incentives and Constraints On Telecommuting*

All artefacts of work design centre on a series of time-place-distance dimensions which in turn pose opportunities and constraints. These dimensions of place-distance-time limit the way managers and employees imagine how work can be done as well as the way they design business practices, organisations, communication technologies and perceptions of travel behaviour.

*Place, distance and time* are reflected in the way work is structured. *Distance* is important in terms of the perceived need for control of a person's position in the organisational hierarchy and output. *Place* is important in terms of the perceived need for proximity in workplace relationships such as face-to-face interactions amongst coworkers and ownership of work space e.g. work station or office. *Time* is important as it is equated with loyalty or commitment - in other words, the amount of time spent at the workplace is equated with commitment and productivity. Understanding the barriers to distributed work in terms of distance, place and time will provide valuable insights into incentives and constraints on telecommuting.

## **Place**

One of the biggest obstacles in rethinking work design is that employees are viewed as passive objects (i.e. a physical body) in organisations as well as communication and transport networks. Performing work entails a series of actions in particular situations undertaken by employees in the pursuit of goals (intended/unintended). Work tasks have been designed contingent on employees being physically located in particular places at specific times.

The preoccupation with ‘place’ as a dimension of work design has led to the failure to exploit the virtual organisation, and consider out-of-work place and out-of-work time. The idea of the detachment of the ‘person’ from the workplace and the integration of person within communication networks challenges the traditional notion of organisational structure and work design.

## **Distance**

Just as distributing work has ‘distance’ connotations so do people’s capacity to distribute ‘themselves’ impinge on this notion. In the case of telecommuting, employees are able to distribute themselves, by maintaining intimate real-time contact with co-workers and business associates, through an infrastructure of communication and information technologies making connections potentially intimate, hence the nature of distance is changing both in terms of space and time (i.e. turn around time for exchanging messages is reduced) (Moss 1987 p.536). As time and place have become ‘undistanciated’ this has implications for work design for management and employees as work depends on social interaction and cooperation which traditionally has been conceived as ‘proximity’. Further implications include control (e.g. supervision), introducing change and handling subsequent resistance, and the capacity of employees to organise industrial disputes. Does telecommuting allow employees to maintain control? For example, telecommuting is potentially an anti-hierarchical in that it reconfigures work through the communication-information infrastructure to be more ‘horizontal’ in nature and less vertical. Under these conditions, the managerial hierarchy conflates.

## **Time**

Time is a critical issue in designing work. Time is usually conceived as physical in terms of standardised tasks, work and office hours, deadlines and linked to productivity, output and loyalty. Time is also equated with a worker’s investment in work such as the number of hours spent at the workplace. This investment of physical time is then translated into an emotional investment in the enterprise and equated to a worker’s commitment or loyalty to the organisation. A significant oversight in work design is that time is also qualitative in terms of how a worker uses time, regardless of institutional constraints.

The perception of distance, place and time impacts the frequency, mode, timing and nature of business activities and interactions as well as perceived travel behaviour to

participate in business activities. Table 1 provides a summary of the work design dimensions: the top row indicates typical assumptions made about work in terms of time, place and distance; the left hand column show the conversion of assumptions into artefacts. The majority of the dimensions impact on both employees and employers decision making in terms of benefits and constraints that employees and employers face when evaluating distributed work. All can be translated into a set of evaluative attributes for the employee and the employer to consider; however the translation into a set of operational attributes for the choice experiment will place a limit on the number of attributes and alternatives. We propose to limit the design to 5 attributes (see Table 3) for each of the employer and the employee and 3 alternatives - two telecommuting options and current working hours (includes rostered days off and compressed work weeks).



### *Institutional and Managerial Constraints*

The relationship between telecommuting and distributed work processes needs to be understood in terms of restructuring work scheduling options, managerial control, work support processes, and new organisational forms. Since there has been limited evaluation of experience with distributed work and telecommuting in work organisations, it is hard to ascertain the success of such projects (see for example Mokhtarian 1991). However, familiarity with a successful experience of telecommuting is important for both the employer and employee in making the choice. Success does depend on how work and organisation is structured and restructured. The opportunities for distributed work will be determined by both the benefits and problems perceived by employers and workers, the way work is structured, the desire and characteristics of the potential telecommuter, human resource (HR) policies and, most importantly, the attitude of *immediate* supervisors. For example, telecommuting may be constrained if supervisors see little positive effect with absenteeism, turnover, organisational attachment, job attitudes, off-the-job satisfaction and work-related distress.

The assumed negative impacts of telecommuting include the psychological and professional deprivation of face-to-face interaction, the need to sustain emotional distinction between work and home life, the dependence on visibility as recognition for performance and promotion by management and workers, and union concerns about a virtual workplace. These concerns will be short-lived if the relationship between distributed work and telecommuting is better understood. This relationship may lead to a ‘shrinking’ of organisational and inter-organisational relationships rather than, as is often assumed, distance them. People’s perceptions and subjective impressions of the organisation, both conventional and virtual in terms of time, place and distance, are highly significant as to whether telecommuting is successful or not in specific business contexts.

### *Organisational Commitment*

The introduction of telecommuting can be conceived as a form of organisational change. Central to processes of organisational change is a reliance by management on employee commitment, that assumes that employees will respond favourably to changes introduced into the workplace. A high level of employee responsiveness is essential for the success of a telecommuting program. Employees with low levels of skill and autonomy tend to resist change by subverting the change process (Clegg and Dunkerley 1980; Cousins 1987).

### *Life-Style Issues*

Many employees displaced through downsizing are now contracting their services to the public and private sector, and in some cases, their former employer. Distributed work offers displaced employees greater flexibility in meeting the demands of multiple projects. Gender and the rise of two-income and single parent households have emerged as a critical dimension in the literature on space and time-related constraints on the employment relationship ( McLafferty and Preston 1991). Depending on their mobility in the labour market and income, women workers and single parents tend to have shorter commuting distances, more convoluted trip chains, and rely more heavily on public transport. The location of child care facilities, that is nearer home or work, is also an important consideration. Both work and travel behaviour may have higher intra personal variability for this sector of the work force with household and child and aged care responsibilities. Distributed work may offer more flexible options for this group combining work, full-time or part-time, with their domestic routine. Distributed work also has consequences for the family life style, people with disabilities, and the duration of parental leave. There are also opportunities to combine distributed work and distance learning with obvious benefits for both the organisation and the individual.

The implications for telecommuting are multi-dimensional in terms of a transport demand management strategy, institutional and managerial constraints, commitment and life-style factors. All of these implications have second-order consequences for public policy in transport, employment and business development. Further management needs to understand these widespread benefits.

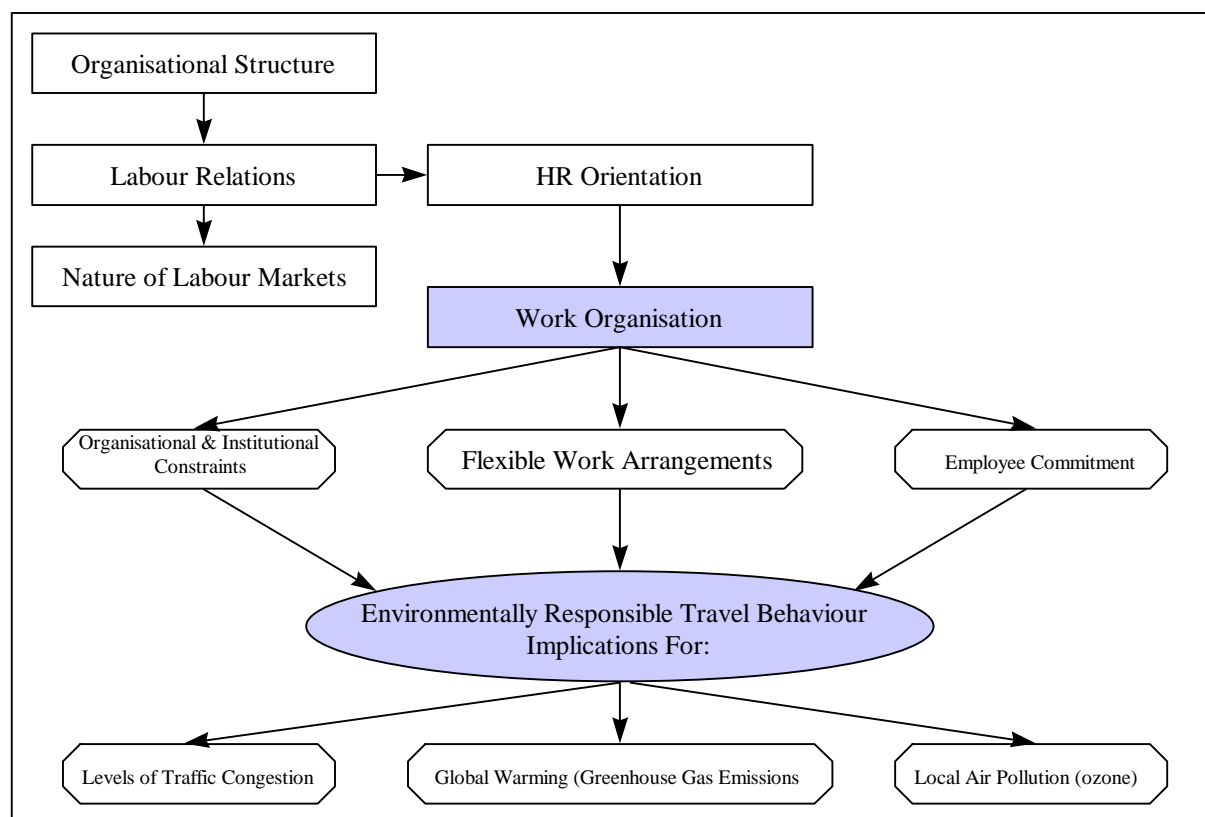
### *The Focus of the Empirical Inquiry*

In promoting these benefits to management, it is important to understand how employer and employee factors impede or facilitate the choice for telecommuting and subsequent travel behaviour. Factors determining the choice have, in most cases, been analysed at a qualitative level but with a growing number of exceptions such as La-Bella et al. (1988), Fischer et al. (1990), Bernardino and Ben-Akiva 1996, and the contributions by Mokhtarian and Salomon (1997). These barriers need to be researched further, particularly their link to potential increases in productivity and reduction of workforce problems, if the impact of telecommuting on travel behaviour is to be better understood. Who will commute and why? Who will not and why? How often will people telecommute? To answer these questions more information and modeling of managerial and worker choices are required in regard to taking up the options for distributed work.

Further, there has been very little work on the actual linkage between distributed work and travel behaviour in terms of accounting for the relationship between an employee and the managerial hierarchy which lead to a range of incentives and constraints on opportunities to take up work practices which can aid in more efficient travel patterns from the perspective of ecologically sustainable development (ESD). The extent to which employers and employees support these possibilities varies widely . The matching of employer and employee support for a distributed work policy is not necessarily strong within the one organisation; and where it does exist it is often not encouraged by managers throughout the hierarchy. Thus the translation from corporate policy to telecommuting cannot be assured.

While there are a growing number of studies (e.g. Mahmassani and Chen 1992, Mahmassani et al. 1993, Bernardino et al. 1993, Bernardino and Ben-Akiva 1996, ) which have looked at the role of the employer in influencing the employees opportunities to participate in more flexible work arrangements in the interests of improving road traffic levels, the focus has been on either simple workplace rules such as management's tolerance for lateness or the availability of flexible working hours. *We are unaware of research which has developed a formal conceptual framework to enable us to analytically model the causal structures between telecommuting, travel demand, institutional and managerial constraints, commitment and life style factors that impose limitations for the employee to exercise options in the interests of ESD* It is important to understand both the sets of constraints and incentives that potentially modify travel behaviour in the interests of reducing environmental degradation. Figure 1 summarises some of the key linkages.

**Figure 1: A Schematic Overview of the Major Potential Causal Linkages**



(Source: Brewer and Hensher (in press))

## Theoretical Framework For Choice Making Under Distributive Work Regimes

Any situation involving interaction between two or more individuals has elements of cooperation and non-cooperation. The choice outcome matters to each of them and depends on the actions of both or all of the players. At the outset of a negotiation, each person perceives the extent to which the other party will be cooperative as a commitment to choose a joint plan of action. This does not imply that either party sacrifices their interests for the sake of the other, although it may; only that each communicates and coordinates with a view to furthering their own unchanged interests by so doing. The central position here is, that, in neo-classical economic terms, ‘private decision-making leading to everyone’s good’ (or agent-independent utility maximisation) depends critically on assuming a regime of perfect competition with numerous participants. In the context of employees and employers this is an unrealistic maintained assumption.

Game theory provides compelling support for the application of a two-person cooperative game in which the employee and the employer attempt to cooperate (there being nothing to prevent them from arriving at an outcome as to what each will do). Cooperation assumes compliance with two tests: (1) for *both* the employer and the employee it cannot be bettered by some agreement, and (2) for *either* the employer or the employee it cannot be bettered by one

participant going their own way. Importantly, however, whether the employer and employee will end up acting as a unified agent ( i.e. cooperation), depends on decisions made entirely non-cooperatively by each party .

There may be lots of outcomes that pass the two tests (known as von Neumann-Morgenstern solution set of the cooperative game). Nash (1950) solved this problem of indeterminacy through bargains by recognising that the outcome of a failure to agree (all offers and counter-offers rejected) is predetermined as the status quo, which are treated here as standard working hours for the organisation (or some pre-announced outcome if cooperation does not produce a mutual outcome). In the current context, the status quo can be any paired identical outcome such as telecommuting 1 day or no telecommuting.

The game-theoretic context is used to study the evolution through negotiation and bargaining of alternative work practice regimes offered by employers and accepted by employees. The dynamics of game play is noticeably absent in the literature on stated preference experiments in general and in the revelation of the choice set and the preferred/chosen alternative spatial and temporal work practices of employees.

To illustrate how bargaining in a game context works, assume that the alternatives in the trade are telecommuting 2 days a week, 1 day a week, and non-telecommuting. The employees first strategy ( $ee_1$ ) is to opt for telecommuting 2 days a week; the second strategy ( $ee_2$ ) is to telecommute 1 day a week; and the third option ( $ee_3$ ) is not to telecommute. The employers strategies ( $er_1$ ,  $er_2$  and  $er_3$ ) consist in offering the options in the reciprocal order. If they do not agree to one of these exchanges, they will remain under current work practice. The payoffs might be as given in Table 2. Each cell identifies the payoffs to each agent. For example, in (3 , -1), 3 represents the payoff to the employee and -1 is the payoff to the employer. Thus if the employee chooses to telecommute 1 day a week ( $ee_2$ ), and the employer chooses not to telecommute ( $er_1$ ), then the employee receives a payoff of 1.5 and the employer a payoff of 0.5.

**Table 2: A Bi-Matrix of Payoffs in an Interactive Telecommuting Preference Game**

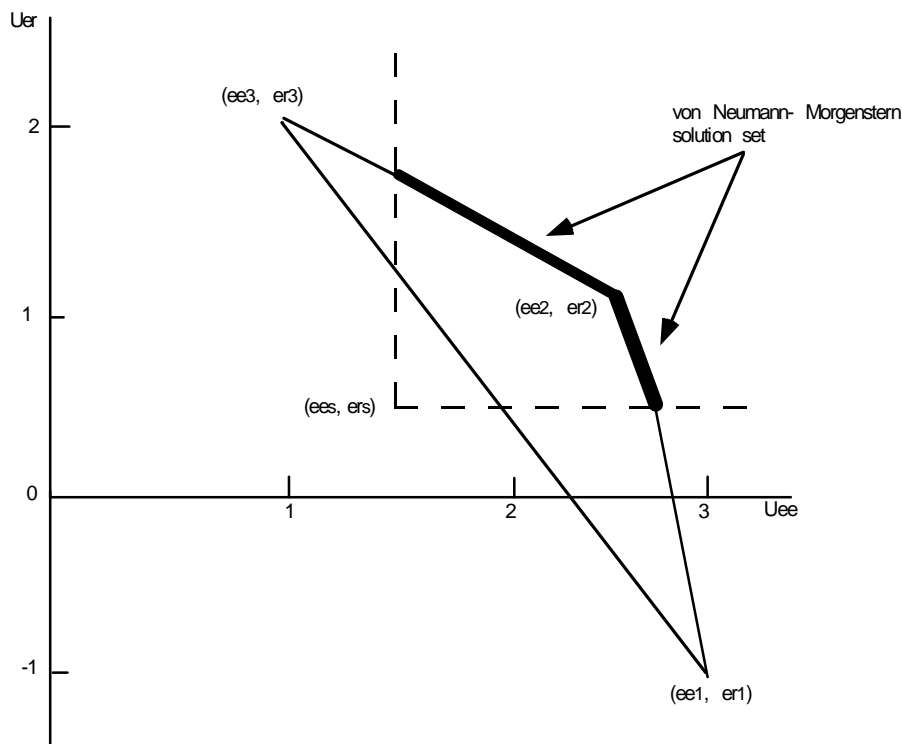
		employer	employer	employer
		$er_1$	$er_2$	$er_3$
employee	$ee_1$	(3,-1)	(1.5, 0.5)	(1.5, 0.5)
employee	$ee_2$	(1.5, 0.5)	(2.5, 1)	(1.5, 0.5)
employee	$ee_3$	(1.5, 0.5)	(1.5, 0.5)	(1,2)

The off-diagonal payoffs show the expected utilities if their demands are not acceded to. It makes no difference which demand is refused. If they fail to agree the outcome is always the same - current work practices. The attainable region R in payoff space and the status quo point ( $ee_s$ ,  $er_s$ ) are shown in Figure 2. The negotiations between the employee and the employer are assumed to be quite frank - all cards on the table. The theory of bargaining games does not say what we might hear if we witnessed the negotiations - arguments based on inter -temporal comparisons of utility, or on principles of fairness, appeals to tradition etc. ; but it is clear that

we would not observe the dissembling manoeuvres typical of real bargaining in which the employee and employer might begin by exaggerating their true minimum terms, compromising only if necessary.

The arbitration associated with the bargaining game is defined by Nash (1950) as follows: For any point  $(U_a, U_b)$  in  $R$ , consider the quantity  $(U_a - S_a)(U_b - S_b)$ , the product of the employee and the employers utility increment from the status quo. Now find  $(U_a, U_b)$  in  $R$  that maximises this product subject to the constraints that  $U_a \geq S_a, U_b \geq S_b$ . This bargaining solution is in outcome space representing the basket of attributes which are sources of expected utility. The outcome of cooperative games, the pairs of baskets or attribute mixes, define the feasible set of distributions in outcome space. The search for the feasible sets can be implemented through choice experiments. The choice probabilities from the choice experiment provide the information to construct the expected utility matrix, an input into interactive agency utility maximisation.

**Figure 2: Telecommuting Preferences**



The mapping between payoff and expected utility is not exact. The off-diagonal expected utilities are likely to be different in each cell and thus the validity of the Nash solution of equal payoff does not translate into identical expected utilities in the off-diagonal cells. Indeed the theory sets out to describe *not* behaviour but non-cooperative and cooperative modes of choice. This is why the off-diagonals can be equivalent. In the study of behavioural responses in preference space this need not be so. Another way of saying this is that, although the outcome of non-agreement will always be the same across all non-agreement pairs, the utility that an agent would have derived from securing a specific outcome if agreement had been

reached is unlikely to be the same. Our interest is in revealing the expected utility of agency outcomes and in translating this into a set of cooperative and non-cooperative probabilities of paired outcomes for a representative agency pair across a pooled sample of interacting agents. The sum of the joint probabilities in the three diagonal cells define the cooperative probability set. The choice probabilities from a discrete choice model might be as given in Table 3. These are illustrative and bear no relationship to Table 2. *Cooperation is achieved up to a probability of 0.402*, comprising the current outcome (0.0667), telecommuting 1 day a week (0.2324) and telecommuting 2 days a week (0.1027). These cooperative probabilities can be identified at each stage (or pass between the two agents) in the sequential-move interactive agency experiment (see the empirical results below).

This solution satisfies Pareto-optimality in that a distribution should not be chosen if there is another distribution which is feasible and which one player prefers and the other does not disprefer. If there was an outcome with expected utilities  $U_a, U_b$ , one bigger and one as great as the payoffs of the Nash solution, then the latter would not maximise the product of utility gains, contrary to their definition. It also meets both agents security levels and is known in the game theory literature as the negotiation (or solution) set (Von Neumann and Morgenstern 1944).

**Table 3: A Bi-Matrix of Choice Outcomes in an Interactive Telecommuting Preference Game**

		employer	employer	employer
		$er_1$	$er_2$	$er_3$
employee	$ee_1$	(.208,.250)	(.208,.583)	(.208,.168)
employee	$ee_2$	(.375,.250)	(.375,.583)	(.375,.168)
employee	$ee_3$	(.417,.250)	(.417,.583)	(.417,.168)

The nature of interactive agent choice experiments are now considered. These choice experiments will produce a set of expected utilities leading to the determination of cooperative choice probabilities associated with each mixture of outcomes evaluated by an employer and an employee. The analysis of each pass in the interactive choice experiment is best represented as a recursive discrete choice paradigm in which the prior agent's choice conditions the subsequent agent's choice. The recursive structure embodies the employee and the employer 'flip-flopping' as the prior and subsequent agent in each round of the ICE. Sequential estimation of each agent's choice process at each pass in the sequential negotiation process will enable us to track the choices made and their revisions up to the point of cooperation or experiment termination if there is no agreement after a predetermined number of rounds.

## The Empirical Paradigm - Interactive Stated Choice Experiments

The conceptual framework has identified a set of attributes which have relevance to employees and employers. The attributes selected for the choice experiments are summarised in Table 4 together with their levels. They are operational translations of an underlying set of responsibility criteria (control, communication, good citizenship) which relate to the dimensions of time, place and distance that affect the work practice decisions of an employer and an employee. These attributes together with a predefined set of alternatives provide the empirical context for the set of interactive choice experiments. The universal choice set in this exploratory phase is assumed to be three alternatives - current work practices (e.g. 9am-5pm at the employer's location - CURR), and telecommuting (TC1 or TC2). In the current study we concentrate on the choices of an employee and an employer, *exogenising* the constraints imposed on an employee by the household. In ongoing research we introduce the *endogenous* link between the employee and other household members activity choices which impact on the employees work practices.

**Table 4: Description of Choice Dimensions, Attributes and Question Items and Responses**

Choice Dimensions	Description	Participant Questions	Response Set
People contact (CONTACT)	contact with people (internal and external) necessary to perform work	If I telecommute the <b>level of contact</b> 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 <b>amount of control</b> 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 <b>productivity</b> will be....	1. lower 2. unchanged higher
Information (INFO)	access to information necessary to perform work	If I telecommute access to <b>information</b> 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 <b>career prospects</b> will be..	4. lower 5. unchanged 6. higher



Four *sequential* interactive choice experiments have been administered to a sample of employees and their employers using a randomised ordering of a series of showcards. In *Round 1*, the employee is first selected and interviewed in respect of a predefined set of distributed work opportunities including the null alternative of current work practice at a central location. The employee completes the first round of the choice experiment involving the evaluation of a number of alternative distributed work scenarios, which is repeated three times. In *Round 2*, the immediate supervisor (as the employer's representative) is asked to make an offer to the employee in the context of the same choice experiment but under two information scenarios - with and without knowledge of the employees preferred choice on each of three replications. The employee is also asked to identify an initial set of potential household constraints which influence the 'preferred' offer to the employer.

*Round 3*: a set of first round supervisor responses are fed back to the employee who assesses the 'preferred offer(s)' of the supervisor and then repeats the same experiment as in Round 1, revising or staying with their preferred first round offer. Reasons for maintaining or revising Round 1 preferences are identified. In *Round 4*, the outcome is then fed back to the supervisor who re-evaluates his position in the face of the employees second-round response (this time in full knowledge of the employee's, original or revised, preferred response). The supervisor is now supplied with the employees first *and* second round 'preferred' offers. For each of the three replications, the supervisor then makes a further offer which may maintain the first round offer or lead to a revision. Reasons are sought for maintenance or revision of round 1 preferences. If the offer from the supervisor is accepted, that is the end of the process - a cooperative solution has been produced. If s/he rejects the offer, a stalemate is the outcome. The experiment does not extend into the negotiation space of a new option set. The sequential negotiation structure is shown pictorially in Table 6 (below). The initial set of experiments are sequential. Simultaneous interactions are investigated in ongoing research where the employer and the employee are exposed to the full set of options being evaluated by both parties (with the same offer and counter-offer structure as the sequential approach).

Once the final round is complete, the supervisor and employee are interviewed separately to elicit information on the following contextual variables: significance of attribute in making choice, gender, employment status, position in organisational hierarchy, nature of employment and work responsibilities, work tenure, access to telecommunications, perceived significance of work to the organisation, perceived visible impact of work to the organisation, perception of management's view of work 'absence' during telecommuting, extent to which work requires close interaction with co-workers, supervisors, clients, nature of current trip to and from work e.g. multi- or single-trip, estimated change in daily vehicle kilometres by mode on TC day(s), perceived benefits and constraints on telecommuting, HRM Policy: employee-friendly, household constraints and organisational style.

The interactive agency choice experiment is designed as a switching design where the base is the current work practices of each sampled employee. The two switching alternatives are telecommuting for 1 day a week (TC1) and telecommuting for 2 days a week (TC2). Each option is defined by 5 attributes each at three levels. The design has 10 attributes of the order  $3^{10}$ . A fraction of 27 profiles is derived from the full factorial. The 27 profiles are a main effects plan with 2 residual degrees of freedom with one uncorrelated two-way interaction permitted. The design is perfectly orthogonal. Each employee and employer will be given 3 randomised profiles from the 27 profile set and will be randomised to ensure that each profile occurs an

equal number of times across the sample. Since estimation will be at the sample level (and not an individual level) this strategy is acceptable.

## Empirical Analysis And Results

To implement the game theoretic interactive agency problem, a small convenience sample of three large, transport-related, organisations was initially selected, yielding 20 employee-employer pairs. Additional interviews are being undertaken on a progressive basis as part of an ongoing study of telecommuting, and will be added to the sample over time. In each instance, the chief executive officer (CEO) and the Human Resource (HR) manager was contacted by letter outlining the rationale and method of the study. The letter of introduction was followed by a phone call to arrange a face-to-face meeting to set up interviews with up to 10 pairs of supervisor-employee in each organisation. Appointments were made with each pair on the same day to facilitate the interaction process. The data is sufficiently detailed in content and sample size (after expanding out the 20 pairs of employee-employer to 60 observations in round 1 and round 2) to enable preliminary analysis of the interactive choice experiments for two passes of the interaction between employee and employer. A pass is defined as a sequence of employee and employer offers. Pass 1 involves round 1 and round 2; pass 2 involves round 3 employee review given round 2 employer response. If there was agreement in pass 1 on a replication of the three ICE's then the experiment finishes for that replication.

The five design attributes in Table 4 - *contact, control, productivity, information and career* - are the main items of interest; however their role in the employee's and employer's processing of the alternatives will be conditioned by characteristics of the individual such as gender, the position held in the organisation, years employed by the organisation and nature of work undertaken. The nature of work takes on many dimensions which we have captured on a Likert scale through notions of variety, autonomy, task identity, feedback, interaction, location dependence and role ambiguity.

A summary of the key descriptive statistics is given in Table 5. In addition to the ICE attributes and selective personal characteristics, the survey obtained data on the employee and employer's views on job scope, work scheduling flexibility, pace of work, ability to partition an employee's activities and to identify contribution, feedback mechanisms for identifying performance, extent of interaction required in work activity, clarity of expectation of level of performance, perception of the family-friendliness of the organisation, and support mechanisms in the organisation to avoid stress. All of these qualitative dimensions of work practices and responses are potentially important influences on the support given by the employee and the employer to telecommuting and enable us, through model estimation, to establish an understanding of the potential constraints imposed by employers and employees in preventing cooperation on telecommuting. Each dimension is defined in the notes to Table 5 and evaluated in the choice models in the next section.

Table 6 summarises the distribution of pairs of alternatives selected at each pass in the negotiation between the employee and the employer, grouping them in terms of agreement and non-agreement. There are 9 possible paired outcomes, three of which define agreement (e.g.  $ee_{(c1)} - er_{(c1)}$ ). The role of knowledge of what the employee prefers has a very marked effect on the findings. 21 of the 27 experiments resulted in pass 1 agreement in the presence of the

employer's knowledge of the employee's offer; in contrast only 15 of the 33 experiments resulted in agreement in pass 1 in the absence of such knowledge. Furthermore, the agreement was not limited to the status quo outcome of non-telecommuting, which is encouraging, suggesting that employers are amenable to supporting telecommuting under the appropriate conditions as proposed in the attribute mixes offered in the ICE. The role of each attribute will be evaluated below through a set of recursive discrete choice models. For Pass 2 onwards, both parties have knowledge of each other's offers. The sample size is too small for pass 3 and 4, but, with reservation, one might interpret Pass 2 as demonstrating the willingness to negotiate and trade offers to arrive at a cooperative outcome. This is best highlighted by the column of 'no knowledge (pass 1)' participants; in Pass 2 the employees have revised their offers in the light of the employer's offer, producing 13 out of 18 agreements. The formal modeling below seeks to identify the influences on agreement/non-agreement in each pass as well as the influences on choice of telecommuting 1 day a week, 2 days a week or maintaining the current non-telecommuting option.

**Table 5: Summary Descriptors for Passes 1 and 2**

Acronym	Definition	ER (NO. OF CASES = 60)		EE (NO. OF CASES = 60)		COMBINED	
		MEAN	STD DEV	MEAN	STD DEV	MEAN	STD DEV
<b>PASS 1</b>	<b>ee<sub>1</sub> and er<sub>1</sub></b>						
CONTACT	see Table 4	1.083	0.696	1.017	0.676	1.050	0.684
CONTROL	see Table 4	1.133	0.596	1.167	0.668	1.150	0.630
PRODUCT	see Table 4	1.217	0.613	1.217	0.613	1.217	0.611
INFO	see Table 4	0.933	0.634	0.817	0.701	0.875	0.668
CAREER	see Table 4	1.083	0.696	1.200	0.659	1.142	0.677
EMPLOY	Years employee in organisation	5.400	3.492	5.775	4.623	5.588	4.084
GENDER	male (1), female (2)	1.250	0.437	1.850	0.360	1.550	0.500
JS	see definition below	81.000	8.068	79.800	5.710	80.400	6.985
AUTOVAR <sup>1</sup>	sum of 3.1-3.8 below	30.750	3.373	30.900	2.628	30.825	3.012
TIDENT <sup>1</sup>	3.9 below	3.500	0.748	3.000	0.713	3.250	0.770
FEED <sup>2</sup>	sum of 3.10 and 3.11 below	9.100	1.349	8.250	1.622	8.675	1.546
INTER <sup>1</sup>	sum of 3.12 and 3.13 below	6.900	1.231	6.750	0.704	6.825	1.001
ROLEA <sup>3</sup>	sum of 4.1 to 4.6 below	23.950	2.734	24.150	3.394	24.050	3.070
FAMILY <sup>4</sup>	6.4 below	3.300	1.319	3.600	1.123	3.450	1.229
VIEW <sup>4</sup>	6.5 below	3.900	1.349	3.100	1.623	3.500	1.539
<b>PASS 2</b>	<b>er<sub>1</sub> and ee<sub>2</sub></b>						
CONTACT	see Table 4	1.208	0.779	1.042	0.806	1.125	0.789
CONTROL	see Table 4	1.042	0.624	1.000	0.780	1.021	0.699
PRODUCT	see Table 4	1.042	0.690	1.042	0.690	1.042	0.683
INFO	see Table 4	1.083	0.584	1.083	0.717	1.083	0.647
CAREER	see Table 4	0.958	0.806	1.083	0.881	1.021	0.838
EMPLOY	Years employee in organisation	6.667	3.547	7.063	4.600	6.865	4.068
GENDER	male (1), female (2)	1.333	0.482	1.792	0.415	1.563	0.501
JS	see definition below	81.167	8.499	80.167	5.647	80.667	7.156
AUTOVAR <sup>1</sup>	sum of 3.1-3.8 below	30.458	3.611	30.917	2.653	30.688	3.143
TIDENT <sup>1</sup>	3.9 below	3.458	0.658	2.708	0.690	3.083	0.767
FEED <sup>2</sup>	sum of 3.10 and 3.11 below	9.583	0.830	8.792	1.062	9.188	1.024
INTER <sup>1</sup>	sum of 3.12 and 3.13 below	7.208	1.103	6.833	0.637	7.021	0.911
ROLEA <sup>3</sup>	sum of 4.1 to 4.6 below	24.250	1.894	24.292	2.612	24.271	2.257
FAMILY <sup>4</sup>	6.4 below	3.417	1.316	3.500	1.216	3.458	1.254
VIEW <sup>4</sup>	6.5 below	4.250	1.152	3.500	1.588	3.875	1.424

## Distributed Work and Travel Behaviour: The Dynamics of Interactive Agency Choices between Employers and Employees

Brewer & Hensher

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### Notes to Table 5:

JS (job scope) = 2\*AUTOVAR + TIDENT + FEED Job Scope (JS) (Based on Stone 1976) is a 13 item inventory measuring responses on a 5 point continuum, scored 1 to 5 and combined to yield a weighted measure of JS

AUTOVAR: The extent to which employees have a major say in scheduling their work, selecting the equipment they use, the pace at which they work as well as the degree to which work requires employees to perform a wide range of processes

TIDENT: the extent to which employees perform an entire or whole piece of work and can clearly identify the results of their efforts

FEEDBACK: the degree to which employees receive information as they are working which reveals how well they are performing on the job

INTER: the degree to which the employee's work requires them to interact with other people (internal and external) to the workplace

ROLEA - Role Ambiguity (based on Caplan and Jones 1975): the extent to which employees do not know what is expected of them for the adequate performance of their role or work. Items scored 1 to 5 respectively

FAMILY: the extent to which employees and employers regard their organisation as a 'family friendly' one, scored 1, 3 and 5 respectively

VIEW: the extent to which the employee perceives that the supervisor supports the view that 'working late is undesirable because eventually you will experience strain in normal working hours', scored 1, 3 and 5 respectively

1 = 1-5 scale: never, rarely, sometimes, often, always; 2 = 1-3 scale: very little, a moderate amount, very much; 3 = 1-5 scale: very little of time, little of the time, some of the time, very often, almost all of the time; 4=1-3 scale: very little, a moderate amount, very much

Likert items (same questions to employee and employer; employer wording listed below):

- 3.1 How often is employee X able to choose the methods used to do his or her work?
- 3.2 How frequently is employee X able to choose the order of things to be done to complete his or her work?
- 3.3 How often is employee X able to choose the speed at which he or she works?
- 3.4 How often does employee X alone do everything that is required to produce an entire product or provide an entire service?
- 3.5 How much is employee X left on their own to do his or her own work?
- 3.6 How often does employee X see projects or jobs through to completion?
- 3.7 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)?
- 3.8 To what extent does employee X's work rely on others (individually or as a group) to produce a given amount of work?
- 3.9 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)?
- 3.10 To what extent is dealing with other people a part of employee X's job?
- 3.11 To what extent is employee X able to act independently of his/her supervisor (you) in performing his or her job function?
- 3.12 How often is employee X required to talk to other workers, supervisors or customers about work-related matters while at work?
- 3.13 How frequently does employee X talk to other workers, supervisors or customers about non-work matters while at work?
- 4.1 I am confident that employee X knows how much authority he/she has
- 4.2 Clear, planned goals and objectives exist for employee X's job
- 4.3 I know employee X has divided his or her time properly
- 4.4 Employee X knows what his or her responsibilities are
- 4.5 Employee X knows exactly what is expected of him or her
- 4.6 Employee X receives clear explanation of what is to be done.
- 6.4 To what extent would you regard your organisation as 'family-friendly'?
- 6.5 To what extent would you support the following view that 'working late is undesirable because eventually strain will be experienced in normal working hours'?

**Table 6: Profile of Negotiation in the ICE**

	With Knowledge No of pairs = 9 No of experiments = 27		Without Knowledge (pass 1) No of pairs = 11 No of experiments = 33	
	Agree	Not Agree	Agree	Not Agree
<b>PASS 1</b> $EE_1 \rightarrow ER_1$	Current 10 TC1 7 TC2 4	$EE_1 \rightarrow ER_1$ Current - TC1 - Current - TC2 - TC1 - Current - TC1 - TC2 - TC2 - Current 2 TC2 - TC1 4	Current 2 TC1 5 TC2 8	$EE_1 \rightarrow ER_1$ Current - TC1 3 Current - TC2 1 TC1 - Current 1 TC1 - TC2 6 TC2 - Current 1 TC2 - TC1 6
<b>PASS 2</b> $ER_1 \rightarrow EE_2$	Current - TC1 3 TC2 -	$ER_1 \rightarrow EE_2$ Current - TC1 1 Current - TC2 1 TC1 - Current - TC1 - TC2 1 TC2 - Current - TC2 - TC1 -	Current 2 TC1 4 TC2 7	$ER_1 \rightarrow EE_2$ Current - TC1 - Current - TC2 - TC1 - Current 1 TC1 - TC2 4 TC2 - Current - TC2 - TC1 -
<b>PASS 3</b> $EE_2 \rightarrow ER_3$	Current - TC1 - TC2 1	$EE_2 \rightarrow ER_3$ Current - TC1 - Current - TC2 - TC1 - Current - TC1 - TC2 1 TC2 - Current 1 TC2 - TC1 -	Current 1 TC1 - TC2 1	$EE_2 \rightarrow ER_3$ Current - TC1 - Current - TC2 - TC1 - Current - TC1 - TC2 - TC2 - Current - TC2 - TC1 3
<b>PASS 4</b> $ER_2 \rightarrow EE_3$	Current - TC1 - TC2 1	$ER_2 \rightarrow EE_3$ Current - TC1 - Current - TC2 1 TC1 - Current - TC1 - TC2 - TC2 - Current - TC2 - TC1 -	Current - TC1 1 TC2 -	$ER_2 \rightarrow EE_3$ Current - TC1 - Current - TC2 - TC1 - Current - TC1 - TC2 2 TC2 - Current - TC2 - TC1 -

### Interactive Choice Experiment Findings

A series of choice models were estimated to evaluate potential influences on the employee's and the employer's preference for the status quo (CURR), TC1 and TC2. In addition to the design attributes, we are interested in the role of contextual variables describing the employee and the employer, as well as structural influences on the execution of the interactive choice experiment (ICE). The estimation procedure is recursive multinomial logit with the Murphy-Type I correction for the asymptotic standard errors. The following steps are implemented:

- *Step 1 (ee<sub>1</sub>)* : First sequential move offer of employee - 3 replications per employee. As the first experiment there is no involvement of the employer.

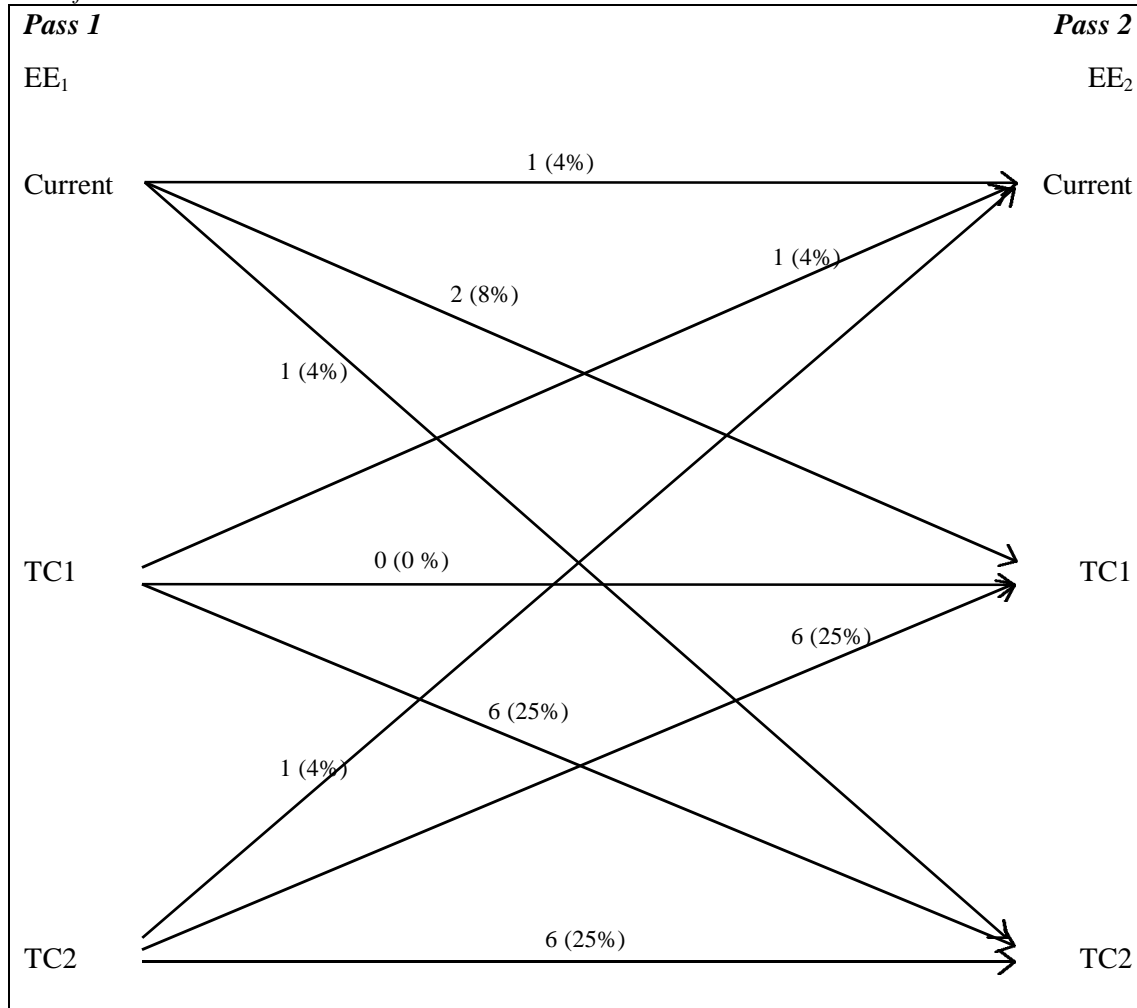
- *Step 2 ( $er_1$ ):* First sequential move offer of employer - the same 3 replications as per the employee. The knowledge of the employee's offer is revealed to half of the employers only. We include a variable representing the actual offer from the employee for the subset who are informed of the employee's choice. If the employee and employer agree on the offer in pass 1 for a replication, then that concludes the ICE for the agency pair. This state of negotiation is identified by a 'pass agreement' dummy variable (=1 if agree and 0 otherwise). An important hypothesis is that the agents are more likely to agree where the employer has knowledge of the employee's preferred offer, and where the offer of both parties is to stay with the current situation. We also expect that the agreement of agents in an *earlier* pass will arise when the status quo offer is preferred; and that the agreement on the status quo will weaken through the pass negotiations, increasing the probability that a telecommuting offer is more likely. If this is true, then we have identified the limiting value of an empirical strategy which fails to reveal the views of both parties in negotiation, denying the opportunity to relax constraints to telecommuting.
- *Step 3 ( $ee_1, er_1$ ):* Evaluate the influences on the pass agreement (1,0) outcome for the first sequential move offers. These influences include design attributes, individual characteristics and the individual's perception of the opportunities and constraints associated with telecommuting and the status quo.
- *Step 4 ( $ee_1, er_1$ ):* Calculate the expected utility matrix for the employee and the employer and identify the cooperation probability for each alternative. The non-cooperation probabilities for each off-diagonal pair of alternatives are also identified.
- *Step 5 ( $ee_2|er_1$ ):* Second sequential move of the employee given the employer's offer in pass 1, for situations of non-agreement in round 1. For Step 5 and beyond, all employees have knowledge of the employer's preferred offer. We evaluate the employee's offer which may or may not be revised from pass 1, in the light of knowledge of the employer's preferred offer (which is different to that of the employee in pass 1). We include a variable representing the actual offer from the employer in the previous round ( $er_1$ ).
- *Step 6( $ee_2|er_1$ ):* Evaluate the influences on the pass agreement (1,0) outcome for the second sequential move offers, following the approach in Step 3.
- *Step 7 ( $er_1$ ):* Re-estimate pass 1 employer model for the subset of employer's who continue into Pass 2.
- *Step 8 ( $er_1|ee_2$ ):* Evaluate the influences on the pass agreement (1,0) outcome for the second sequential move offers, following the approach in Step 3.
- *Step 9 ( $er_1, ee_2$ ):* Calculate the expected utility matrix for the employee and the employer and identify the cooperation probability for each alternative in pass 2.
- Repeat Steps 5 to 9 for pass 3
- Repeat Steps 5 to 9 for pass 4.

The process continues subject to the number of steps required to achieve a cooperative outcome and the limits on sample size for model estimation. Table 7 summarises the changes in stated choice patterns for employees from Pass 1 to Pass 2. The most interesting finding is that employees who did not make an initial offer which was in agreement and who initially preferred telecommuting have exercised their continuing preference for telecommuting through revising

their offer to the other telecommuting alternative and hardly to the status quo. This may be a strategy to send a signal to the employer that negotiation exists but that some form of telecommuting is strongly preferred. This strategy appears to be symmetrical between TC<sub>1</sub> to TC<sub>2</sub> and TC<sub>2</sub> to TC<sub>1</sub>. In ongoing research we are investigating the profile of employees and constraints they impose on themselves within each pair of pass 1-Pass 2 offers.

**Table 7: Stated Choice Patterns for Employees who continue to Pass 2**

*No of observations = 24*



The results for each step are presented in Tables 8 and 9. Table 8 summarises the results for the ICE experiment choice set. The five design attributes representing Contact, Control, Productivity, and Career prospects have been entered linearly into the indirect utility expressions for TC1 and TC2 at this exploratory stage. Information by its definition is difficult to support in this functional form and has been input as K-1 dummy variables. Each attribute associated with TC1 and TC2 has three ordered levels with the middle level being equivalent to the level currently applying to an employee. The current alternative is defined by unchanged attribute levels, essentially a base alternative.

Table 9 summarises the findings for the binary choice pass agreement models. In addition to the parameter estimates, we provide the marginal effects defined as the derivatives of the probabilities, that is  $\delta_{jm} = \partial P_j / \partial x_m = [1(j=m) - P_j P_m] \beta$ . The marginal effects have substantive behavioural meaning; the parameter estimates do not. A close inspection of the marginal effects will identify the influence that a 1 unit change in an attribute has on the probability of selecting a particular alternative, *ceteris paribus*. Three distributed work choice models have been estimated, two employee models for passes 1 and 2, and an employer model for pass 1. The pass 2 employer model is identical in form to the pass 1 model, and only estimated to identify the relevant cooperative probabilities for the employers carried forward into Pass 2 who did not reach agreement with their employee in pass 1. All three models identify a number of statistically significant influences on choice, which add to the overall goodness-of-fit in a substantial way. In contrast, the alternative-specific constants play a small role in the presence of explicit attributes.

**Table 8: The Offer Models for Each Pass**  
(t-values in parenthesis) [marginal effects in brackets]

Note: The marginal effects are reported for each of the alternatives in the order CURR, TC<sub>1</sub> and TC<sub>2</sub>. They sum to zero across the choice set. We have excluded the marginal effects for INFO since it is a (1,0) dummy variable and not meaningful as an effect at the margin

Attribute (see Table 5 for definitions)	Alternative	Pass 1 ee <sub>1</sub>	Pass 1 er <sub>1</sub>	Pass 2 ee <sub>2</sub>
constant	CURR	33.540 (3.36)	-6.680 (-1.67)	20.423 (1.96)
constant	TC1	28.46 (3.09)	-9.864 (-2.51)	23.55 (1.94)
CONTACT	TC1	-.03177 (-.11) [.21,-.46,.25]	.1034 (.29)[- .43,-.79,1.2]	-2.292 (-1.98) [4.8,-21.3,16.6]
CONTACT	TC2	-.03177 (-.11) [..19,.25,-.44]	.1034 (.29) [-.43,-.79,1.2]	-2.292 (-1.98) [5.5,16.6,-22.0]
CONTROL	TC1	.4229 (1.23) [-2.8,6.2,-3.4]	.5289 (1.34) [-2.6,6.6,-4.0]	-.4524 (-.60) [.94,-4.2,3.3]
CONTROL	TC2	.4229 (1.23) [2.6,-3.4,5.9]	.5289 (1.34) [-2.2,-4.0,6.2]	-.4524 (-.60) [1.1,3.3,-4.3]
PROD	TC1	1.5062 (3.42) [-9.9,21.9,-11.9]	.7573 (2.02)[-3.7,9.5,-5.6]	-.2381 (-.29) [.50,-2.2,1.7]
PROD	TC2	1.5062 (3.42) [-9.1,-11.9,21.1]	.7573 (2.02)[-3.1,-5.8,8.9]	-.2381 (-.29) [.57,1.7,-2.3]
INFO low	TC1,TC2	1.3349 (2.10)	-.187 (-.28)	-2.099 (-1.3)
INFO medium	TC1,TC2	.0384 (.06)	.8654 (1.27)	-2.326 (-1.34)
CAREER	TC1	.6115 (1.92) [-4.1,8.9,-4.9]	.4220 (1.29)[-2.08,5.3,-3.2]	-1.491 (-1.32)[3.1,-13.9,10.8]
CAREER	TC2	.6115 (1.92) [-3.7,-4.9,8.5]	.4220 (1.29)[-1.74,-3.2,4.9]	-1.491 (-1.32)[3.6,10.8,-14.3]
VIEW	CURR	-.8434 (-2.94)[-10.6, 5.5,5.04]	-	-1.323 (-1.41)[-5.9,2.76,3.15]
Years employed by orgn	TC2	.2893 (2.85) [-1.7,-2.3,4.0]	-	-
AUTOVAR	TC2	.2754 (1.77) [-1.7,-2.2,3.8]	-	-
TIDENT	TC2	2.010 (2.85)	-	-
INTER	TC2	1.20 (1.74) [-6.2,-8.1,14.3]	-1.487 (-2.52)[6.1,11,-17.4]	-
ROLEA	TC2	.2257 (1.96) [-1.4,-1.8,3.2]	-	1.336 (2.08) [-2.2,-2.7,4.9]
With (1), Without knowledge (0)	CURR	n/a	4.230 (3.60) [38.3,-20.9,-17.4]	-
FAMILY	CURR	-	-.9781 (-2.50) [-8.86,4.8,4.0]	-
Agent choice in previous pass	TC1	n/a	n/a	-
Agent choice in previous pass	TC2	n/a	n/a	-
Choice of prior agent in current pass	TC1	n/a	14.465 (.09) [ns]	2.8287 (2.00) [-5.9,26.3,-20.4]
Choice of prior agent in current pass	TC2	n/a	-1.4867 (-2.52)[-10.5,-19.29]	2.8288 (2.00) [-6.7,-20.4,27.2]
No. of observations		60	60	24
Log-Likelihood (β) at convergence		-41.91	-33.72	-9.57
Pseudo-R <sup>2</sup> constants to convergence		.268	.417	.461
Pseudo-R <sup>2</sup> no parameters to convergence		.280	.426	.529
Contribution of constants		.014	.09	.068



**Table 9 Sources of Influence on Co-operative Outcomes in Each Pass  
(t-values in parenthesis)**

Attribute	Pass 1 $e_1$	Pass 2 $e_2$
constant	5.493 (2.45)	33.040 (3.00)
FAMILY	-.1665 (-1.36) [-.03971]	-
VIEW	-.4519 (-3.22) [-.1078]	-
JS	-.03707 (-1.53) [-.00884]	-
MALE	-	-8.877 (-3.22) [-1.130]
AUTOVAR	-	-1.558 (-3.59) [-.1984]
TIDENT	-	-.8589 (-1.31) [-.1094]
INTER	-	3.81 (1.82) [.3922]
No. of observations	180	72
Percent who agree	60.0	66.8
Prediction success (allocated on max probability)	66.6	83.3%
Pseudo- $r^2$	.08	.49
Log-Likelihood ( $\beta$ )	-115.09	-23.52

## DISCUSSION OF FINDINGS

### *Pass 1 Employee Choice*

*The design attributes reflect the underlying dimensions of time, place and distance proposed in the conceptual framework. ‘Distance’ had the largest impact on telecommuting. Productivity, information (segmented as location-dependent and otherwise), and career all have a statistically significant positive effect on telecommuting. When personal productivity is higher as a consequence of telecommuting, the probability of an employee choosing to telecommute increases markedly, as shown by the magnitude of the positive marginal effect. The productivity effect is the most influential factor being used by employees to support telecommuting. Thus if evidence can be accumulated to support this situation, then it offers an attractive incentive to employers to support telecommuting.*

Where information is location-dependent (INFOlow), the probability of telecommuting increases relative to contexts where information to perform one’s job is limited away from the workplace, or where information needed is location independent. This finding can be interpreted in one of two ways: either that when working at home, employees would have access to information necessary for work performance, or information access could be easily transferable from office to home. This finding suggests that when information is confined to the work location it is more compatible with telecommuting.

The choice model suggests that career prospects would be higher if employees telecommuted. This finding suggests that perceived career prospects by the employee is not tied to visibility in the workplace as previously suggested in the literature. It may be that those who have high personal productivity see career prospects paralleling this, or that they see career future prospects tied to increasing workplace flexibility such as telecommuting.

The amount of interaction with people (CONTACT), either customers or co-workers, had no statistical effect on telecommuting nor did the amount of perceived control over one's work (CONTROL). These findings are interesting in that both are perceived in the literature as potential constraints on telecommuting. In other words regardless of how interactive a person's job is or the extent of control, they do not see this as affecting the capacity to telecommute or not.

Several other variables influenced the choice to telecommute in pass 1. Where employees had high autonomy (i.e. ability to choose work methods, schedules, pace and instruments) and variety (i.e. non-routine work and location, variable instruments and speed) at work as represented by AUTOVAR, the probability of telecommuting 2 days per week increases, although the marginal effect is not strong. Frequency of interaction about work- or non-work-related matters (INTER) was also a significant influence on the choice to telecommute 2 days per week by employees. Employees may no longer perceive highly interactive work to be incompatible with telecommuting due to the enhancement of telecommunications and information technologies. These new technologies allow employees to transform their work stations into their home office, and interact with co-workers, supervisors and customers who are often unaware that the employee is not in their office. The drive to negotiate harder is emanating from the flexibility that employees perceive in their work which is initially constrained by the employer. This finding is crucial to understanding the limits on the implementation of telecommuting programs in organisations. Employees may have a greater understanding of the work they perform and its compatibility with telecommuting whereas employers may be basing their decisions on 'traditional' work design assumptions.

The more likely employees know what is expected of them in terms of either work performance or demands (ROLEA), the more likely they will choose to telecommute 2 days per week. Where employees identified highly with their work (TIDENT), the higher is the probability that they choose telecommuting 2 days per week. The longer the employee's tenure with the employing organisation, the more likely that they will choose to telecommute 2 days per week. This last finding may be related to career (design attribute) in that the tenure and career prospects might be perceived as linked by the employee.

### *Pass 1 Employer Choice*

In the first round, 45 per cent of employers made a choice with knowledge of employee's preference. In the 'with knowledge' condition, where the employer is aware of the employees offer, the probability of the employer preferring the status quo increases significantly. The marginal effect is also strong. This is an important finding suggesting a much more conservative and constraining response by the employer when the employee's choice is known. This interpretation is reinforced by the evidence in Table 6 that only 10 of the 27 employee offers in pass 1 were the maintenance of the current situation. This finding demonstrates a potentially fundamental disunity in the employment relationship between employer and employee. Although this inconsistency exists, there is greater consistency between employers and employees in the model attributes. Similar to the employee model, both productivity and location-dependent information have a positive influence on telecommuting, although career does not. In other words, when the employer sees that the employee is highly productive (or motivated) and information can be transferred to the home location, these diminish as a

constraint on telecommuting. Unlike the employee model, career is not significant for the employer counterpart. Intuitively, this finding makes sense. As organisations distribute work, it is more difficult for the employer to provide a ‘traditional’ career path for employees.

There is very strong evidence that the employer is not supportive of extensive telecommuting (i.e. 2 days a week) where the employee’s work requires interaction with people internal and external to the workplace (INTER). The marginal effects are sizeable. The employer who perceives their organisation of relatively more family-friendly has a higher probability of supporting telecommuting. This is an important finding with a strong marginal effect, highlighting the building of trust as an important element of a successful telecommuting program.

### *Pass 1 Sources of Influence on Agreement and Non-Agreement*

Where job scope (JS - high variety, autonomy, feedback, task identity, interaction) is high for employee, the employer and employee are less likely to agree in Pass 1 (Table 9). Two motivators appear to be driving employees to negotiate harder. The first one is when they perceive their current employer to be a ‘family-friendly’ one (FAMILY). Shifts in social demographics have already made ‘family-friendly’ a significant dimension of human resource management. As a response toward the ‘family-friendly’ trend, many employees may be tempted to push the employer into introducing a telecommuting program to address child care and life style needs. The second motivator is when employees perceive that the employer views that ‘working late is undesirable due to eventual strain’ (VIEW). The employee may feel that telecommuting is a strategy to minimise late working hours. These three influences provide the basis for further inquiry into what constraints the organisation might review and change if they are supportive of telecommuting; however it must be recognised that the agreement model aggregates all three cooperation pairs (CURR-CURR,  $TC_1$ - $TC_1$  and  $TC_2$ - $TC_2$ ); as the accumulated sample of agency pairs increases we will be able to distinguish between the agreement pairs and unravel the particular constraints associated with agreements which promote the status quo. A contribution to this unravelling can be made in subsequent passes as we seek out the factors which have exerted some influence on further agreement after 1 round of non-cooperation. In the current paper, sample size limits this opportunity, even though the approach we have proposed is capable of revealing these influences.

### *Pass 2 Employee Choice*

In Pass 2, all design attributes are negative and create less of an impact (see Table 8), suggesting the nature of the decision making process has altered. With the exception on CONTACT, the design attributes are not statistically significant. The higher the amount of contact necessary with other people as part of work tends, ceteris paribus, to increase the probability an employee choosing to telecommute. The marginal effect is quite noticeable, and begs the question about the behavioural plausibility of a negative effect. As suggested above, the whole issue of contact being ‘optimised’ through centralisation of work in one place may be false, given the changing nature of the medium available to communicate. The current study is revealing this potential claim throughout all stages of the ICE as well as in the likert-scale dimensions.

The reduced number of observations after pass 1 (from 60 to 24), and the reduced role of the design attributes in negotiating offer positions, suggests that other factors are now playing a more important role in positioning the negotiations. The design attributes may have performed their most important role in pass 1. One might expect that with a larger sample that their effect dissipates as we move to more passes. If true, this is an important finding, suggesting that attributes influence the negotiations at different stages in some hierarchical fashion in accordance with the current state of negotiations. Our ongoing research will enable us to focus on this possibility; which if true raises fundamental concerns about a strictly ‘cross-sectional’ approach to studying interactive choice behaviour.

What is more important in Pass 2 is the impact of the manager’s decision on the employee (‘choice of prior agent in current pass’ - see Table 8). *Ceteris paribus*, where an employer in pass 1 has chosen to support a telecommuting option, the probability of an employee choosing to telecommute is higher. The marginal effect is very strong, suggesting that there is potential to establish a context for telecommuting when the employer is seen to be very supportive. An interesting implication is that in the earlier pass (pass 1), the employee may have been ‘rejecting’ telecommuting in anticipation of no support from the employer; yet when it is known that there is employer support, the employee’s true revealed option is exercised through Pass 2 revision. If true, then seeking out the reasons why the employer is willing to support telecommuting as a major constraint on the employee’s willingness to express a desire to telecommute is a priority research question.

Role ambiguity is important in employee 2 choosing TC2 (ROLEA). The more likely employees know what is expected of them in terms of either work performance or demands, the more likely they will choose to telecommute 2 days per week.

#### *Pass 2 Sources of Influence on Agreement and Non-Agreement*

Four factors were identified as influences on the probability of agreeing in Pass 2. Male employees tend, *ceteris paribus*, to have a lower probability of agreeing than females; high work autonomy and variety (AUTOVAR) and task identity (TIDENT) also reduce agreement between employer and employee. This finding is consistent with the notion that the greater personal control employees experience at work the less compliant people will be. Finally, higher interaction between people internal and external to the workplace increases the probability of agreement. The specific linkage may be an artefact of the perception of real choices which narrows the negotiation space and thus leads to an early agreement. We cannot be sure this is valid since INTER was not significant in pass 1; however it is a component of JS in pass 1, which also had a positive parameter. This brief discussion of the agreement model in Pass 2 together with the results for pass 1 suggests the need for a decomposition of agreement into the three cooperation pairs. Unfortunately sample size in the current study did not allow this. As we accumulate more data on agency pairs we will be able to investigate this matter.

*Establishing Cooperative and Non-Cooperative Probabilities*

The distribution of cooperative and non-cooperative choice probabilities for all nine agency choice pairs is given in Table 10 for pass 1 and Pass 2. As might be expected the cooperation occurs up to a probability which is higher as we progress from pass 1 to Pass 2. In particular, we have found that, for the current sample, the probability of cooperating in pass 1 is 0.4518, and 0.5714 in Pass 2. Most pleasing is a recognition that the cooperative probability for a telecommuting outcome is .3343 in pass 1 and .5235 in Pass 2. The increase within the telecommuting offers increases at a higher rate than the overall probability of cooperation, as employees and employers negotiate and gain knowledge of the underlying views of each party as revealed through the design attributes and covariates. The findings in Table 10 replace the illustrative estimates in Table 3.

**Table 10: Distribution of Co-operative Probabilities in Each Pass - Sample Means  
(each column sums to 1.0)**

Employee-Employer Pair	Pass 1: ee <sub>1</sub> to er <sub>1</sub>	Pass 2: er <sub>1</sub> to ee <sub>2</sub>
Current-Current	.1175	.0479
TC1 - TC1	.1572	.2656
TC2 - TC2	.1771	.2579
<i>Total Coop Prob</i>	<i>.4518</i>	<i>.5714</i>
Current - TC1	.0983	.0716
Current - TC2	.0509	.0056
TC1 - Current	.0708	.0395
TC1 - TC2	.0886	.0282
TC2 - Current	.0784	.0793
TC2 - TC1	.1612	.2045
<i>Total Non-Coop Prob</i>	<i>.5482</i>	<i>.4286</i>

## Conclusions

The findings are new in terms of understanding both the decision to adopt and implement telecommuting. The more flexible the work design under which the employee works, the greater their willingness to telecommute. Time, place and distance are effective in understanding how to make work more compatible with telecommuting from the employee's perspective.

It is interesting that both employer and employee see work differently and are 'blinkered' depending on the lens they are using (personal or organisational). For example, when it comes to organisational interests employers make decisions in the light of what they see is 'good' for the organisation, and when it comes to employee interests, employees are more likely to see 'what's in it for them'. It may be worth considering that employee interests equate with the best interests of the work organisation and employees are negotiating with both sets in mind. Further, the findings demonstrate that employees and employers view work design characteristics differently in terms of constraints on telecommuting. This differential perception explains the managerial constraints on telecommuting.

This paper has introduced the idea of interactive agency choice into traveller behaviour and distributed work choices where the linkages between actors or agents in the choice of work practices (i.e. employee, employer) are best represented as interdependencies or less-than-fully competitive actions which through negotiation and bargaining within sub choice sets produce outcomes which may or may not be the utility maximisation solution under independent choosing. This approach reflects what we 'observe' actually occurring in practice compared to a one-time survey.

The idea of interactive agency choice has wider application in many areas of transportation decision making than has been assumed in the literature of traveller behaviour. Indeed the interdependencies between individuals in a household and even between individuals in a particular peer structure are examples of the potential failure of the interdependency imposed on nearly all discrete choice models in transportation (there may be exceptions but we are not aware of them, although DePalma and Lefevre (1983) recognised the issue many years ago). Ongoing research is extending the choice set to include more distributed work options, as well as endogenising the choice dependencies between an employee and other members of the household. We are also evaluating alternative negotiation strategies such as *interactive simultaneity* in which an employer and an employee each see the preferred offer of the other party at the time of establishing an initial preference.

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