WORKING PAPERS

Edoardo Marcucci[1], Romeo Danielis[2], Guido Paglione[3]

A methodology to evaluate the prospects for the introduction of a new city logistics service

Working Paper n. 114

2007

[1] *University of Roma Tre, Department of Public Institutions, Economics and Society, Via G. Chiabrera, 199 – 00145 Rome: emarcucci@uniroma3.it*
[2] *University of Trieste, Economic and Statistics Science Department, Piazzale Europa, 1 - 31024* : danielis@units.it
[3] *Institute for Transport Studies, University of Leeds, 36-40 University Road LS2 9JT: g.paglione05@leeds.ac.uk*

UNIVERSITÀ DEGLI STUDI DI TRIESTE

DIPARTIMENTO DI SCIENZE ECONOMICHE E STATISTICHE

Abstract

The paper analyses the potential for introducing a Park&Buy service in the city of Pesaro (Italy) along the lines of the pilot project introduced in Siena, Italy, in 2004. It attempts to empirically evaluate the preferences of the parties involved and derive some suggestions on the potential compromise solution via a specifically designed stated preference experiment, drawing from the literature on interactive agency discrete choice modelling. Although various theoretical and methodological issue are still open for discussion, the methodology proves useful in giving insights - not only the parties' preference structure as normally achieved by discrete choice models - but also on shopkeepers perception of customers' preferences, on the room for bargaining, on each party's influence on choice attributes and on the determinants of the probability of achieving a comprise solution.

Keywords: city logistics, interactive choice experiments, discrete choice

1 Introduction

City centers, especially historic ones, suffer from lack of space to accommodate traffic and parking of private cars. City administrators often restrict motor vehicle access to city centers in order to reduce congestion and pollution and preserve their aesthetic quality. While these policies favor some activities (leisure activities, tourism, etc.), shopkeepers often oppose traffic restrictions on the grounds that they damage their competitiveness in favor of shops and malls located outside the city, generally equipped with large parking facilities.

These policies, specifically aimed at reducing private car traffic, are often accompanied by those limiting or regulating the access of freight vehicles to the city centre. In Europe this set of policies is defined by the concept of city logistics, since its objective is to optimize goods distribution in an urban area.

Various proposals have been advanced (see e.g. Bestuf, Cityports, CityFreights projects [LT Consultants and BCI, 2002; Egger and Ruesch, 2004; Panebianco and Zanarini, 2005]) and a number of pilot projects have been implemented. An interesting one is the Park&Buy (P&B) pilot project implemented in Siena for two weeks in 2004 within the eDRUL project (funded by the 5th Framework Programme). As the website of the project explains[1], the idea is to improve the accessibility to visitors and tourists to the 750 shops located within the city centre. Due to access restriction, in fact, visitors and tourist, contrarily to residents, can only park their vehicles in the parking lots located outside the city centre. The *P&B* service implemented within the project allows them to purchase their goods within the centre and have them delivered to the selected parking places or, alternatively, to their hotels.

During the two-week test the parcels bought in 10 shops located in the centre of Siena were delivered by the transport operator COTAS to the parking lot "Il Campo", operated by SienaParcheggi as a B2C freight pick-up point. The *P&B* service initiated with a request by the shop (either via a web portal or by phone) to the e-DRUL Agency. The request was then notified to the customers (via a SMS) and to the transport

[1] See the website http://srvweb01.softeco.it/edrul/ (Accessed the 15th November 2007).

operator. When the parcels were delivered to the pick-up point, not earlier than 2 hours after the booking request, the consumers were again informed by SMS.

The P&B service tested in Siena appeared to have two important advantages [Ambrosino *et al.*, 2005a] : (a) the efficient management of the freight traffic from the city centre to areas outside the restricted zone; (b) the increased attractiveness of the shops located in the Traffic Limited Zone (TLZ) and, in particular, of those located farther away from the parking lots.

The P&B concept bears a similarity with the home delivery service provided by many shops and supermarkets such as the Nanterre PAD association in France, the Delhaize supermarket in Belgium, the TESCO chain in UK, the online supermarket LeShop in Switzerland [Egger and Ruesch, 2004], or other pick-up point initiatives such as Tower24 in Dortmund, DHL PackStation in Koln, Cityssimo and E-Box in Paris[2]. It has the potential to be an actual city logistics innovation and it could be of interest to many Italian and European cities, both of small and large size, where city centers are restricted to private vehicles but which enjoy good public transport accessibility and excellent commercial attractiveness. Moreover, it is in line with the recommendations on the subject provided by BESTUFS [Huschebeck and Allen, 2006] which stress the attractiveness of pick-up point services with respect to traditional home delivery services and underline the important role that ICT can play in providing these services.

However, P&B also raises numerous economic and distributive issues. For instance, who should pay for the service? Shopkeepers, customers or both? In which proportion[3]? How quickly should the parcels bought in the shops be made available at the parking lot? Or, in other terms, how frequent should the service be? Should the parcels be delivered on request to other destinations (e.g. home delivery)? And who should pay for that extra-service? Should the service be organized using information technology or not?

From a theoretical point of view, the *P&B* concept is of interest because the focus of the study is a service which does not yet exist in the real world. Hence, what needs to be studied is the likelihood that such a service could successfully be introduced in the market. The technological feasibility of the service is not an issue. The real issue is, in our opinion, that various parties could determine the success or failure of the service, the most important being shopkeepers, customers and the city administration. Each one plays a different role.

The shopkeepers, first and foremost, are the ones who should be actively involved in organizing the service. However, in a city center there are numerous types of shops (groceries, domestic appliance shops, clothing departments, jewelry stores, bookstores, furniture stores, etc.) and it is quite likely that they would benefit differently from the new service. It is to be expected that they do not share the same motivation and willingness to participate. The Siena pilot experiment was funded by the City Council and the European Union. In order to be sustainable the service should be fully approved and properly financed by the business community.

Customers who are likely to benefit from the new service need to actually accept to use it and contribute to it. However, similarly to shopkeepers, different customers

[2] For more information see [Egger and Ruesch, 2004] or visit www.bestufs.net (accessed on 1th December 2007)

[3] In Siena, after the trial, the total cost to provide the *P&B* service was estimated to be between 3 to 5 € per parcel (including transport and order management cost) but the shopkeepers were willing to pay only 2 € per parcel.

will benefit differently and, hence, their interest and willingness to contribute is likely to differ. Whether and how much they are willing to contribute is a matter which needs to be determined empirically.

Finally, the city administration has the role to encourage, promote and setup the conditions for the service to be successful, including the initial financing of the project and the setup of the regulatory framework within which the new service will take place. The city benefits if the acceptance of the traffic restraint policies improves and if the attractiveness of the city center is enhanced. Indeed, a successful historical center is likely to raise real estate values and provide higher local tax revenue.

Because of the many actors involved and because of their different interests in the new service, formal and informal bargaining is likely to take place both within the business community and among the various parties involved. These theoretical features pose difficult analytical challenges to the modeller aiming at analyzing the issue at the theoretical, methodological and statistical level.

Since we would like to forecast agents' future demand for the implementation of new services we adopt a discrete-choice modelling framework, implemented by a stated preference surveys. Moreover, given our interest in analysing the interactive choice process among the parties involved, we have developed an ad hoc methodology following the line of research promoted by D. Hensher and his associates at ITSL, University of Sidney [Hensher *et al.*, 2007a].

The paper is organized as follow: Section 2 discusses the theoretical and methodological issues involved in studying social interaction. Section 3 presents the methodology adopted. Section 4 illustrates the case study and Section 5 and 6 present the descriptive and the econometric results. Finally, Section 7 provides some conclusions and discusses future research perspectives.

2 Theoretical and methodological issues in the study of social interaction

Interaction between agents takes place in many ways. At one end of the spectrum, agents interact in decision making as members of an institution (e.g., a family or a firm). They are bound by sentimental or contractual bonds and take some decisions jointly, after formal or informal group discussion. These decisions can be classified as group decisions and can be modelled as group choices. An incomplete list of recent papers on *group choice modelling* includes Arora and Allenby (1999), Aribarg *et al.* (2002), Dosman *et al.* (2002), Molin *et al.* (1997), Gliebe and Koppelman (2002, 2005), Zhang *et al.* (2004, 2006), Puckett and Hensher (2006).

On the other end of the spectrum, there are individual decisions (e.g., individual consumption decisions) which, although taken without consulting other agents, entail an element of social interactions, since they are taken in a social environment (involving, e.g., imitation, image setting, peers' opinions). Recent literature on *individual choice modelling with social interactions* includes Durlauf (2001), Brock and Durlauf (2001, 2003) Soetevent and Kooreman (2002), Hartmann and Yildiz (2007), Bresnahan and Reiss (1991), Kooreman (1994), Hensher (2000) and Paglione (2007).

Most business decisions, in fact, entail a consideration of other agents' preferences. Sometimes this is only implicit (e.g. in setting the price for a merchandise

a shopkeeper takes into account his clients' preferences). Some other times there is an actual bargaining process taking place via an explicit interaction among the buyer and the seller. During the bargaining process, or in game theoretical terms, during the bargaining game each agent might decide either to play the game or to exit it.

An agent has an interest to play the game only if s\he perceives, as Bernstein (1984) assumes, that if s\he finds an agreement there is a potential improvement in her\his welfare compared with the no agreement situation. Each agent might propose a deal to split the gain, the other might accept it, make a counter-proposal or exit the game. Entering a game and leaving it without reaching an agreement might entail a monetary or an opportunity cost .

We assume that a similar relationship exists between the shopkeeper and his customers when the P&B service is considered[4]. Such a relationship could be conceptualized as an interaction between two parties which takes the following steps. The shopkeeper designs the service in order to please customers and attract more business. The service will have certain technical characteristics (in terms of frequency of delivery at the parking lot, use of information technology and so on) and certain costs that need to be financed by the two parties[5]. The shopkeeper will propose a certain cost distribution to the customers. The customers might accept the proposal and use the new service or not.

Modelling this interaction poses several challenges to the analyst. Our aim is to develop an operational model that can provide useful information concerning the bargaining area, the values at stake and the prospects to actually implement the new city logistics service.

Since the decisions taken by the two agents determine the success or failure of this new logistics service, it is useful to analyse how the preferences of each decision maker might interact in determining the end result. In this respect, a promising research framework is the inter-agency choice modelling or group decision modelling developed in recent literature.

A common representation is following equation [Arora and Allenby, 1999; Aribarg, et al., 2002; Dosman, et al., 2002; Zhang, *et al.* 2002, 2005, 2006a, 2006b]:

.

$$U_d^j = t_{sk} b_{sk} X_k^j + (1 - t_{sk}) b_{ck} X_k^j + e^j \qquad (1)$$

Equation (1) above describes the utility that a hypothetical dyad *d*, made up by two agents (the shopkeeper *s* and the customer *c)*, derive from choosing an alternative *j* (where *j = 1…J*), as a weighted sum of the utilities of each agent, with the weights represented by the parameters t and $(1-t)$. Notice that even if both agents choose the same alternative *j*, each of them experience different marginal (dis)utilities[6] associated with it, given the fact that each of them has different preferences, represented by the agent-specific b's. The parameters t and $(1-t)$ are the weights that multiply the

[4] In the remaining of the paper we abstract, for the sake of simplicity, from the role played by the city administration and from interactions taking place among shopkeepers in deciding how to set up and finance the service.

[5] There is also a potential contribution from public subsidies motivated by improved attractiveness of the city centre and local taxed revenues.

[6] The possibility that the ß's attached to each attribute represents a marginal utility or disutility depends on the nature of the attributes considered (goods or bads).

agents' marginal utilities and represent the relative influence each agent exerts in the final group choice.

The additive formulation of the systematic component of the utility functions of the two parties of equation (1) assume cardinal and interpersonally comparable utility functions as theoretically advocated by Harsanyi (1955). This is a crucial assumption discussed at length in public choice literature (see, e.g., Mueller, 1989), with little support in normative economics but, in our opinion, it is still a useful modeling tool in the positive approach taken in this paper.

Notice also that equation (1) includes the specific assumptions made in most studies (Arora and Allenby, 1999; Aribarg, et al., 2002; Puckett and Hensher, 2006) that each agent has an *attribute-specific influence*, (the t parameter varies with the attribute k).

Drawing from the modelling framework proposed David Hensher and his associates at ITSL, Sidney like IACE (Interactive Agency Choice Experiment) (Brewer and Hensher, 2000; Hensher, 2003; Rose and Hensher, 2003), MIGI (Minimum Information Group Inference) (Puckett and Hensher, 2006), and SEAL (Stated Endogenous Attribute Level) [Puckett, Hensher e Rose, 2007] we developed a methodology comprising the following 4 steps.

First, a selection of relevant attributes for the P&B service is identified by the research group from literature review and discussion with the shopkeepers.

Second, in the interview a shopkeeper is asked to make two proposals on the cost distribution and technical characteristics of the service (Table 1): a) the one s\he prefers the most and b) the one s\he deems most preferred by his\her customers. Alternatively, the shopkeeper may decide not to make any proposal if s\he deems it not worth for his\her business. This second step provides us with information on the shopkeeper's preferred choice and on his\her perception of his\her customers' preferences. It also produces a customization of the choice experiment in the spirit of the SEAL methodology[7], whereas in the IACE methodology attribute levels are set and fixed by the analyst.

[7] But without obtaining a revision of the starting preference on the basis of the second agent counter-proposal as realized by the SEAL methodology.

Table 1 - An example of choice tasks submitted

In your view a Park-and-Buy project (delivering parcels to the parking lot) would make sense for your business? If, yes, what characteristics should it have?			
Attributes	A*	B*	None of the two is convenient to me
Cost per parcel to be charged to the shopkeeper	2	3.6	-
Cost per parcel to be charged to the customer	2.2	0.8	-
Minutes within which the parcel should be available at the parking lot	90	150	-
With the use of information technology? Yes or no?	Yes	No	-
Destinations other than the parking lot: No \ Yes, charging the extra cost to the customer \ Yes, charging the extra cost to the shopkeeper	No	Yes, charging the extra cost to the customer	-
Preferred alternative by the shopkeeper	-	-	-
Preferred alternative by the customer with no knowledge on shopkeeper's preference	-	-	-
Does the client accept the alternative chosen by the shopkeeper?	-	-	-

*In the first task A reads as follows: "This is in my view the optimal solution for my business" and B as follows: "This is, in my view, the optimal solution taking the point of view of my customers". In the subsequent tasks A reads as follows: "Alternative A" and B as follows: "Alternative B".

Using as starting point the initial choice task setup by the shopkeeper, the third step consists in developing a conjoint experiment comprising 13 choice tasks as a prefixed orthogonal variation of the initial choice task. The shopkeeper him\herself is asked to choose among 13 choice tasks with three alternatives, the third one being neither of the first two.

As a forth step, the choice experiment resulting from the shopkeepers interview is administered to his\her customers. They are asked to choose among the alternatives in the same 13 choice tasks proposed to the shopkeeper without knowing the shopkeeper's choice. Then the shopkeeper's choice is revealed to the customers and they are asked whether they would accept or not the shopkeeper's choice.

This methodology can be thought as an application of an Ultimatum Bargain Game where actually it is just one player that makes a proposal on how to share the surplus, or in our case how to structure the "Park and Ride" service, while the other player can only accept the proposal or refuse it, ending in this way the game with no gains for both agents.

A further possibility, not yet implemented, is to go back to the shopkeepers, show them his\her clients' choices and ask them to reconsider their choices.

The data generated by the two choice experiments can be analysed via a nested logit model (Figure 1) where each agent might choose either to participate to the service or not. In the former case an agent has the choice among two alternatives.

Figure 1 – The nested structure of UBAG methodology

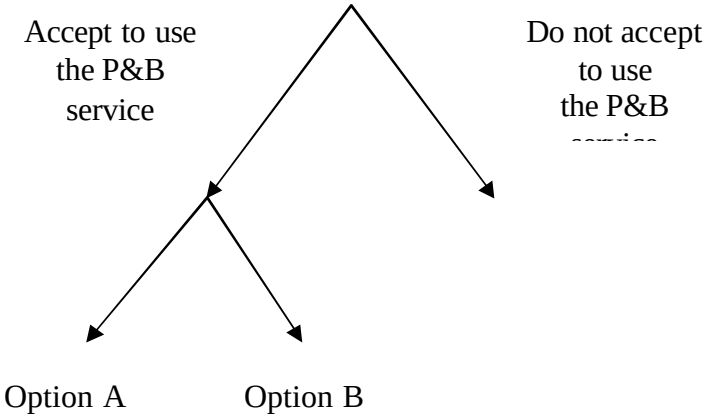


Figure 1 - Nested choice model

Since there is no actual joint choice (as it would be in a family), in order to study what the group choice would be we use the initial pass power model developed in the MIGI methodology by Puckett and Hensher (2006). The estimated coefficients of the choice model of each of two parties are carried forward as constant exogenous terms into the *initial pass power model*, and multiplied by the corresponding attribute levels for each of the *K* attributes in each alternative *j*. For each simulated group interaction, the alternative designated as the choice is the combination of the stated choices of the two parties.

In a three-choice set up the model looks as follows:

$$
\begin{aligned}
U_{11} &= a_{11} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{1k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{1k} + e_{11} \\
U_{12} &= a_{12} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{1k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{2k} + e_{12} \\
U_{13} &= a_{13} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{1k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{3k} + e_{13} \\
U_{21} &= a_{21} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{2k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{1k} + e_{21} \\
U_{22} &= a_{22} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{2k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{2k} + e_{22} \\
U_{23} &= a_{23} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{2k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{3k} + e_{23} \\
U_{31} &= a_{31} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{3k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{1k} + e_{31} \\
U_{32} &= a_{32} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{3k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{2k} + e_{32} \\
U_{33} &= a_{33} + \left(t_{sk} \cdot b_{sk}\right)' \cdot x_{3k} + \left(\left(1 - t_{sk}\right) \cdot b_{ck}\right)' \cdot x_{3k} + e_{33}
\end{aligned}
\qquad (2)
$$

This is the complete power model. When restricting the model to agreement cases, the model reduces to the subset of equations in which alternative j is identical for both agents (i.e., both choose 1, both choose 2 o both choose 3). Hensher *et al.* (in press) claim that the focus of group decision making modeling should be on both studying (i) the full set of group preferences; and (ii) the agreement outcomes only. The former specification is particularly useful in investigating potential barriers to agreement (as shown in Brewer and Hensher 2000).

As a generalization of model (1), Zhang *et al.* (2005) proposed a specification of the group utility function termed the *multi-linear group utility function:*

$$U_g = \sum_{i=1}^{n} w_i u_i + \sum_{i_1=1}^{n} \sum_{i_2>i_1}^{n} \left(w_{i_1 i_2} u_{i_1} u_{i_2} \right) + ...w_{i:n} u_1 u_2 ..u_n \qquad (3)$$

where w_i is member i's weight parameter, and $w_{i_1 i_2}, ...w_{1 \square n}$ are the intra-household interaction parameters. This model assumes that household utility can be derived by weighting the utilities of the individual household members, and adding interaction effects. The weight w_i can be interpreted as a measure of a member's power or influence in the group decision-making. The interaction parameters $w_{i_1 i_2}, ...w_{1 \square n}$ moderate the power effect and reflect the group members' concern for achieving equality of utilities. The larger the interaction parameter, the higher the group's collective desire to choose an allocation such that the utilities of all household members are more or less equal. We test if the specification (3) of the utility function of the group is superior to specification (1).

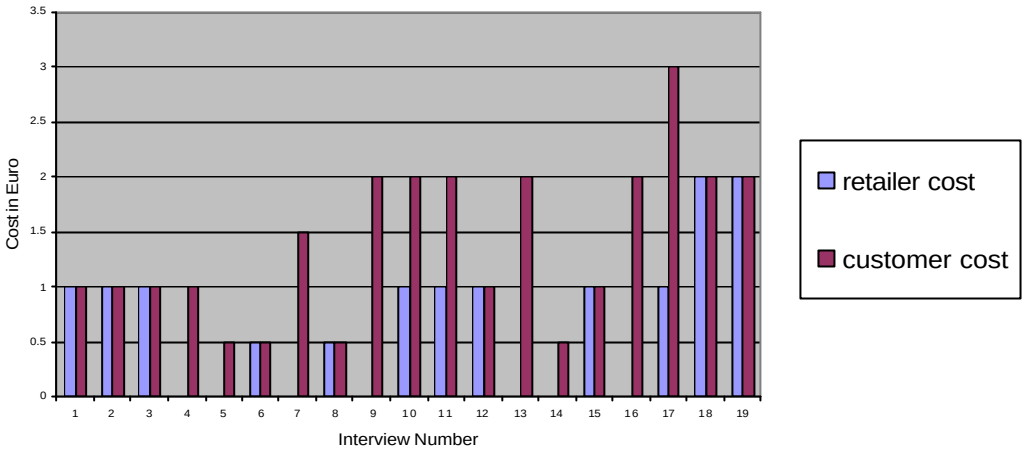
3 Sample description

The city of Pesaro (together with the city of Urbino) is one of the main towns of Marche region, located in the centre of Italy. We interviewed 21 shops located in the city centre: 5 dealing with clothing, 8 with groceries, a bookshop, a shoe shop, an optician, three selling house objects, one textiles and one underwear. The sample is reduced to 19 for estimation purposes due to the fact that 2 of them (the optician and the one selling underwear) were not interested about the implementation of the service.

4 Descriptive results

On the basis of the information gathered by the answers provided to first two columns of the first choice set by shopkeepers, it results that they propose the cost distribution per parcel illustrated in figure 2. They are willing, on average, to accept a cost equal to 0.68 Euro per consignment. 7 of them do not accept any charge, while 2 shopkeepers would accept a 2 Euro cost.

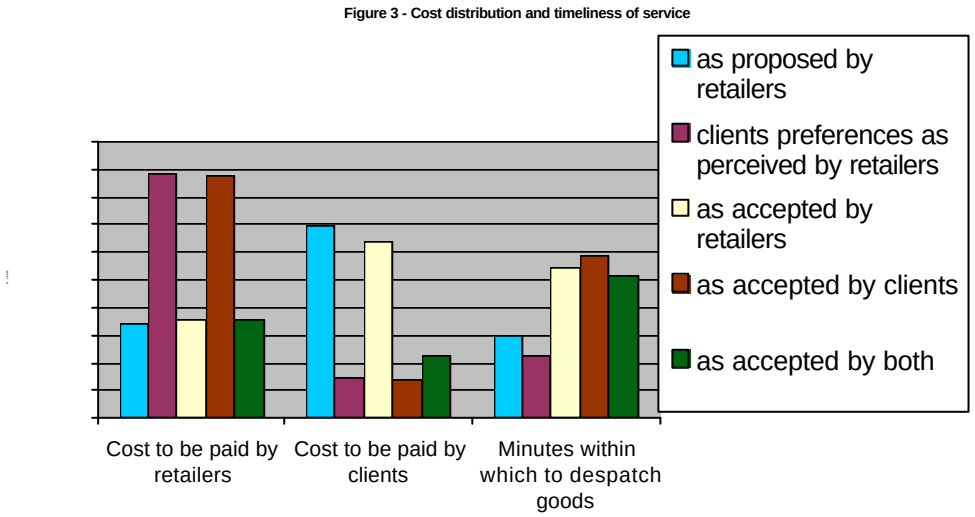
Figure 2 - Service cost allocation according to shopkeepers



On average, shopkeepers propose that clients be charged 1.39 Euro per consignment, ranging from a minimum of 0.5 Euro to a maximum of 3 Euros.

All but one shopkeeper would prefer to use information technology (either computer based or portable cell phones) to request and monitor the service. 7 of them do not consider desirable to extend the service beyond the parking area while 12 think that home delivery is a desirable feature but that the clients should be charged for the extra-service.

Figure 3 – Cost distribution and timeliness of service



With reference to the cost and time aspects of the interaction, the bargaining process between the two parties is graphically reported in Figure 3 and described in more detail below:

a) Costs to be borne by shopkeepers. On average, in the first task, shopkeepers stated that they would accept to pay 68 Eurocents per parcel as a contribution to the P&B service (first row and first column of table 1, choice task 1) - and that their customer would most likely want them to contribute a cost equal to 176 Eurocents (first row and second column of table 1, choice task 1). But in the subsequent tasks

(generated as orthogonal variations from the base case), shopkeepers choose alternatives that make them pay on average 71 Eurocents. Hence, slightly more than what stated in the first task. What do customers think shopkeepers should contribute? From the interviews, it results that customers accept to use the P&B service when shopkeepers pay on average 175 Eurocents, a strikingly similar figure to the one stated by shopkeepers (shopkeepers know their customers well!). In the agreement cases, when the same alternative is chosen by both parties[8], shopkeepers accept to pay on average 72 cents. The bargaining area for shopkeepers' contribution can consequently be estimated between 68 and 175 Eurocents.

b) Costs to be borne by customers. On average, in the first task (second row and first column of table 1, choice task 1), shopkeepers stated that customers should contribute 139 Eurocents per parcel for the P&B service. They also expect that their customer would most likely want to contribute a cost equal to 29 Eurocents (second row and second column of table 1, choice task 1). Tested via the choice tasks customers are, in fact, willing to contribute on average 28 Eurocents (again, shopkeepers know their customers well!). Alternatives chosen by both parties are those in which customers pay on average 46 cents. The bargaining area for customers' contribution can consequently be estimated between 28 and 139 Eurocents.

c) Time within which to make parcels available at the parking lot. On average, in the first task, shopkeepers stated that a parcel should be at the parking lot within 60 minutes with the P&B service. They also state that their customer would most likely want a parcel to be made available in 45 minutes. Tested via the choice tasks, however, it appears that shopkeepers are, indeed, willing to accept an average time of 109 minutes and customers a surprisingly higher time of 117 minutes . When an alternative is chosen by both parties the delivery time is equal to 103 minutes. The bargaining area for customers' contribution can consequently be estimated between 60 to 117 minutes. In fact, customers appear not to be as demanding as it is perceived by the shopkeepers.

5 Econometric results

Based on stated preference (SP) data two discrete choice models are estimated: one for the shopkeeper and one for the clients and subsequently, and, hence, the initial pass power model is estimated.

5.1 The shopkeepers' choice model

As stated before, only 19 out of 21 shopkeepers considered the service useful for their business and decided to participate to the SP experiment, providing information for the first task and choosing among the 3 alternatives. In all cases they chose one of the first two alternatives. Stated differently, they never chose not to initiate the negotiation process (the third alternative) or refused the first two alternatives.

[8] Out of the 266 tasks (14 tasks times 19 interviews), in 53 of them the customer chooses the same alternative chosen by the shopkeeper without having previous information on the latter's choice.

Consequently, a binomial logit model was estimated with the information provided by the 19 interviews[9]. The results are reported in table 2.

Table 2 - The choice model of the shopkeeper

Variable	*Coefficient*	*t-statistics*
Alternative specific constant	0.102	0.37
Cost to be charged to the shopkeeper	-3.319	-5.70
Cost to be charged to the customer	-0.640	-1.68
Minutes within which the parcel should be available at the parking lot	-0.012	-3.60
Use of information technology	0.361	1.27
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	-0.871	-2.23
Extra-cost to be charged to customers for a destination other than the parking lot	0.698	2.15

N. obs.: 266
LL(B)= -74.03
Adjusted Pseudo R^2 (no coefficients)=0.40851

The overall performance of the model is very good. The most significant variable is the cost to be borne by shopkeepers. As expected, it enters negatively the utility function of the shopkeeper. The time within which a parcel is made available at the parking lot has also a negative effect on shopkeepers' utility. Shopkeepers perceive that the quickness of the service affects positively the competitive edge of the stores located in the city center. The surcharge for the delivery to other destinations, when charged on shopkeepers, affects their utility negatively, whereas when charged on clients, it increases shopkeepers' utility. Evidently, shopkeepers believe the surcharge should be borne by clients. Surprisingly, the coefficients of the variable representing the clients' contribution to the cost of the P&B service has a negative sign with some degree of confidence. The shopkeepers most likely deem that such a cost might decrease their capacity to attract business. The use of information technology is viewed positively but with a low statistical significance.

5.2 The customers' choice model

Since for some tasks in the SP choice experiment customers chose the third alternative, that is not to choose any of the two proposed P&B services, we thought that a nested logit was appropriate to translate in model terms such behaviour . Indeed the tree structure is made up of two branches: a branch with two twigs specifying the choice among the two alternative P&B services and a degenerate branch (single twig) referred to the choice of not participating to the P&B service (figure 1).

[9] It is not possible to take into account the 2 shopkeepers that declared from the start the unsuitability of the P&B service to their business since they did not provide the starting values that endogenously activate the design of the experiment. Furthermore, since the third alternative – not accepting any of the two alternative services – was not chosen it is impossible to estimate a nested logit model as it will be done for customers.

Table 3 -Customers' choice model

Variable	*Coefficient*	*t-statistics*
Service alternative specific constant	6.700	1.87
Cost to be charged to the shopkeeper	3.925	1.93
Cost to be charged to the customer	-3.427	-1.91
Minutes within which the parcel should be available at the parking lot	0.003	0.45
Use of information technology	-0.829	-1.09
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	1.492	1.47
Extra-cost to be charged to customers for a destination other than the parking lot	0.634	0.87
No-service alternative specific constant	20.867	0.24
IV parameters tau(j|i,l),sigma(i|l),phi(l)		
SI	2.45	2.05
B(1|1,1)	2.29	.240

N. obs.: 266
LL(B)= -15.37
Adjusted Pseudo R^2 (no coefficients)= 0.88389

The result is a strikingly significant model where the customers concentrate mainly on the direct costs of buying products and have them delivered to the parking lot. The remaining variables are not significant, including, surprisingly, the time delay within which the parcel is made available at the parking lot.

5.3 The initial pass power model

Following the MIGI methodology, an initial pass power model has been estimated making use of the coefficients estimated in the previous independent choice models for shopkeepers and customers.

In the estimation process, it is considered only the choice among the two design alternatives, excluding, thereof, the 12 tasks in which the client chose alternative 3. As stated by Puckett and Hensher [2006] the initial pass power model can be estimated considering: a) all tasks, including both when the two parties choose the same alternative and when they choose a different alternative (complete first pass model) or b) only those tasks in which the two parties choose the same alternative (restricted first pass model).

The estimation of the complete first pass model produced the following results:

Table 4 – Complete Initial Pass Power Model

Mean power measures (>0.5 represents relative power to shopkeeper, <0.5 represents relative power to customer)	*Coeff.*	*t-ratio**
Cost to be charged to the shopkeeper	0.808	2.12
Cost to be charged to the customer	-1.060	-4.11
Minutes within which the parcel should be available at the parking lot	1.163	2.43
Use of information technology	0.979	1.44
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	0.517	0.07
Extra-cost to be charged to customers for a destination other than the parking lot	1.587	2.93
Constant (shopkeeper chooses 1, customer chooses 1)	-0.479	-2.50
Constant (shopkeeper chooses 1, customer chooses 2)	-0.619	-3.39
Constant (shopkeeper chooses 2, customer chooses 1)	-0.712	-2.90

* The null hypothesis is $H_0 : t = 0.5$

N.obs: 254
LL(B)= -100.11
Adjusted Pseudo R^2 (no coefficients)= 0.71

As stated before, the model is specified so that for each attribute a t larger than 0.5 signals a stronger influence, in our sample, of the shopkeeper while a t smaller than 0.5 signals an stronger influence of the customer. As in Puckett and Hensher [2006], and contrarily to the theory, we consider "unbounded" t parameters (they are free to exceed the 0-1 boundaries) because we assume that a party might trades off its influence on one variable with its influence on another one. Hence, the interpretation of the results is the following.

Shopkeepers retain control over their contribution to financing the service but customers exert an even stronger influence on their contribution. Surprisingly, the quickness of the service is more in the influence of the shopkeepers rather than in that of the customers. Such a result is consistent with what derived from the previous descriptive and analytical evidence of the data: quickness is not a requirement which worries very much the sampled population of customers.

Similarly, information technology is a feature deemed more important by shopkeepers than by customers. With reference to whom should pay for the extra-cost of home delivery the estimates provide a balanced influence on shopkeepers contribution, whereas customers contribution is very much influenced by shopkeepers preferences. Both results appear quite reasonable since the service under consideration is very much in the interest of the customers and, consequently, the parties favour a solution in which the extra-cost is borne by the customers.

In order to estimate the restricted version of the initial pass power model two sets of data are available: the one including only the agreement choices and the one which considers those tasks where the customers were willing to revise their first choice in order to come to an agreement with the shopkeepers. In our interviews both contingencies are not numerous. Out of 266 tasks, 53 resulted in immediate agreement, while 11 are the cases where clients were willing to revise their choice and accept the shopkeepers' choices. Since the data resulting from the first 53 tasks were not sufficient to estimate the model, the model was estimated combining the initial and the subsequent agreement cases.

Table 5 – Restricted Initial Pass Power Model

Mean power measures (>0.5 represents relative power to shopkeeper, <0.5 represents relative power to customer)	*Coeff.*	*t-ratio**
Cost to be charged to the shopkeeper	0.476	-0.11
Cost to be charged to the customer	-0.838	-2.40
Minutes within which the parcel should be available at the parking lot	1.463	2.48
Use of information technology		
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	0.134	-1.15
Extra-cost to be charged to customers for a destination other than the parking lot	0.733	0.30
Constant (shopkeeper chooses 1, customer chooses 1)	-0.536	-2.20
Constant (shopkeeper chooses 1, customer chooses 2)	-2.446	-4.81
Constant (shopkeeper chooses 2, customer chooses 1)	-2.189	-3.81

* The null hypothesis is $H_0 : t = 0.5$

N. obs.: 64 choice tasks (53 first-agreement cases + 11 second-agreement cases).
Information technology variable not considered
LL(B)= -42.24
Adjusted Pseudo R^2 (no coefficients)= 0.50320

The model could be estimated with all the variables used in the previous models but the variable regarding the use of information technology. The results are similar but not equivalent to the previous ones (those obtained with the complete version of the initial pass power model), demonstrating that the two models have a different meaning.

They indicate that the shopkeepers' contribution is equally influenced by the two parties, unlike the previous result. On the contrary, customers retain a great influence in determining their contribution. The quickness of the service is left to the shopkeepers as in the previous model. The contribution to the extra-cost is influenced by customers in the case of shopkeepers' contribution and vice-versa in the case of customers' contribution. Unlike the previous results, customers are less willing to accept the surcharge for home delivery.

5.4 The probability of agreement

It is also interesting to estimate how attributes affect the probability of agreement between the two parties. It can be done using the information obtained from the tasks where an agreement (either direct or after concession by the client took place) was found. The alternatives are described by the attributes levels and the alternative chosen by both parties is set to 1. The model contains the same amount of information as the restrictive initial pass power model with the difference that it is specified using the attribute levels as follows.

$$y_j = a_j + b' X_j + e_j$$

where y_j is set to 1 when the alternative j is chosen by both parties and 0 otherwise. The results are presented in Table 6.

Table 6 - Probability of agreement

Variable	*Coeff.*	*Std.Err.*	*t-ratio*
Cost to be charged to the shopkeeper	-6.367	3.367	-1.89
Cost to be charged to the customer	-8.508	3.169	-2.68
Minutes within which the parcel should be available at the parking lot	-0.024	0.008	-2.90
Use of information technology	0.645	0.606	1.06
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	0.909	0.693	1.31
Extra-cost to be charged to customers for a destination other than the parking lot	0.195	0.722	0.27
Constant	-0.454	0.603	-0.75

N. obs.: 64 choice tasks (53 first-agreement cases + 11 second-agreement cases).
LL(B)= -19.36
Adjusted Pseudo R^2 (no coefficients)= 0.50

It turns out that the increase in the minutes within which the parcel is made available at the parking lot affects negatively and significantly the probability of both parties agreeing on choosing the alternative. Notice the high coefficients attached to the cost to be charge to the customer or to the shopkeeper. They are both negative meaning that an increase in cost has a negative impact on the probability of both parties agreeing on the alternative. Both variables also have high standard errors (because of the conflicting interests among the two parties) resulting in low t-statistics. However, it turns out that the t-statistics (and also the coefficient) for the cost to be charged to the shopkeeper is actually lower than that of the customer, meaning that an increase in the cost to be charged to the shopkeeper affects less the probability of having an agreement relative to the increase in cost to the customer. All other variables are not statically significant and can be interpreted as playing a minor role.

5.5 Simulative results

In the descriptive results section the levels of the alternative preferred by the shopkeepers and by the customers were identified and discussed. They are summarised in the first three rows of Table 7. The remaining three variables are coded as dummies (both alternatives assume the use of information technology, alternative A assumes the extra-cost to be charged to the customers and alternative B to the shopkeepers). How likely is that the alternative A and B so described are accepted relative to one another? The application of the coefficients 4 estimated models (the shopkeepers' choice model, the customers' choice model, the complete initial pass power model and the agreement-only initial pass power model) provides us with an estimated of their relative degree of acceptability.

Table 7 - Simulation

Attributes	*Alternative A: Preferred by shopkeepers*	*Alternative B: Preferred by customers*
Cost to be charged to the shopkeeper	0.71	1.75
Cost to be charged to the customer	1.39	0.28
Minutes within which the parcel should be available at the parking lot	109	117
Use of information technology	1	1
Extra-cost to be charged to the shopkeeper for other destinations	0	1
Extra-cost to be charged to customers for other destinations	1	0
Models:	*P(A)*	*P(B)*
Shopkeepers' choice model	99%	1%
Customers' choice model	0%	100%
Complete initial pass power model	1%	99%
Agreement-only initial pass power model	0%	100%

It turns out that alternative A is most preferred by shopkeepers whereas it has no chance of been accepted by customers. The opposite is true for alternative B. This results is obvious since each party prefers his own alternative. But what about the dyad's preferences. The complete and the agreement-only initial pass power model deem definitely more acceptable to the dyad the customers' preferred alternative relative to the shopkeepers, meaning that the compromise solution deriving from a bargaining process would most likely be closer to alternative B than to alternative A. But the model cannot tell us neither how close these alternative are to the compromise solution nor which will be the compromise solution.

5.6 Alternative specifications of the group utility function

Because of limited size of the sample the only specification of equation 3 we were able to estimate is the one including only the direct interaction terms (all but the one relative to cost to be charged to the shopkeepers).

The model adopting the multi-linear specification of the group utility function (equation 3) is slightly superior to the linear utility model of equation 1. But none of the intra-group interaction parameter proves significant, although their signs are, in general, correct. A positive sign implies that the group utility rises when one party systematic utility improves holding the other party's utility constant (signalling positive group inter-dependence or complementarity). A negative sign implies that the group utility decreases when one party systematic utility improves holding the other party's utility constant (signalling negative group inter-dependence or substitutability). The only interaction term with a positive sign is the quickness of the service, since both party profit from its increase. On the contrary, and not surprisingly, cost variables have a negative sign, signalling conflict. Surprisingly, the information technology interaction term has a negative sign as well.

Table 8 – The multi-linear group utility function

Mean power measures (>0.5 represents relative power to shopkeeper, <0.5 represents relative power to customer)	*Coeff.*	*t-ratio**
Cost to be charged to the shopkeeper	0.854	2.26
Cost to be charged to the customer	-1.117	-3.87
Minutes within which the parcel should be available at the parking lot	0.718	0.39
Use of information technology	-0.105	-0.74
Extra-cost to be charged to the shopkeeper for a destination other than the parking lot	0.573	0.15
Extra-cost to be charged to customers for a destination other than the parking lot	1.990	3.42
Interaction term relative to the cost to be charged to the customer	-0.340	-2.32
Interaction term relative to the quickness of the service	1.114	0.45
Interaction term relative to the use of information technology	-3.852	-1.52
Interaction term relative to extra-cost to be charged to the shopkeeper	-0.096	-0.92
Interaction term relative to extra-cost to be charged to the customer	-1.869	-2.09
Constant (shopkeeper chooses 1, customer chooses 1)	-0.390	-2.15
Constant (shopkeeper chooses 1, customer chooses 2)	-0.443	-1.66
Constant (shopkeeper chooses 2, customer chooses 1)	-0.437	-1.58

* The null hypothesis is $H_0 : t = 0.5$

N. obs.: 254
LL(B)= -96.79
Adjusted Pseudo R^2 (no coefficients)= 0.72

6 Conclusions and future research agenda

The paper analyses the potential for introducing an innovative city logistics service in the city of Pesaro (Italy), a P&B service along the lines of the pilot project introduced in Siena in 2004. The idea is to organize a service to deliver the parcels bought in the stores of the traffic-restricted city center to the parking lots where the customers are forced to leave their cars or where their coaches are parked.

In order for the service to be successful, both shopkeepers and consumers need to be interested in the project and willing to share to some extent its cost. Furthermore, there is a need to determine the characteristics of the service in terms of quickness, use of information technology, destination to be served, etc..

Since at least two parties determine the success or failure of the project, group decision theory and group decision making models are necessary to fully evaluate the issues involved. Various theoretical and methodological issue are discussed in the literature on how best to analyze and predict group behavior and interaction among parties.

This paper attempts to empirically evaluate the preferences of the parties involved and derive some conclusions on the potential compromise solution via a specifically designed SP experiment, drawing from the literature on interactive agency conjoint

experiments. Attribute levels are not pre-fixed by the researcher but set by the shopkeeper, with orthogonal variations on the base scenarios. The same experiment is then administered to his potential customers, without or with previous knowledge on the shopkeeper's choice.

The descriptive and econometric results show that most shopkeepers (19 out of 21) are interested in the introduction of the new service and willing to make a proposal on its characteristics and cost distribution. Customers are also interested in the introduction of the new service.

The two parties' opinions about cost allocation are, not surprisingly, at the opposite side of the spectrum. The bargaining area for shopkeepers' contribution can consequently be estimated between 68 to 175 Eurocents while that of customers' contribution ranges between 28 to 139 Eurocents. 60 to 117 minutes is the time within which a parcel should be made available at the parking lot. Table 9 represents a summary of the econometric results obtained.

Table 9– Summary of econometric results

	Shopk.		*Cust.*		*Full PM*		*Re. PM*	
Variable	b	t-stat	b	t-stat	t	t-stat	t	t-stat
Cost to be charged to the shopkeeper	-3.319	-5.7	3.925	1.93	0.808	2.12	0.476	-0.11
Cost to be charged to the customer	-0.64	-1.68	-3.427	-1.91	-1.06	-4.11	-0.838	-2.4
Minutes within which the parcel should be available at the parking lot	-0.012	-3.6	0.003	0.45	1.163	2.43	1.463	2.48
Use of information technology	0.361	1.27	-0.829	-1.09	0.979	1.44		
Extra-cost to be charged to the shopkeeper for other destinations	-0.871	-2.23	1.492	1.47	0.517	0.07	0.134	-1.15
Extra-cost to be charged to customers for other destinations	0.698	2.15	0.634	0.87	1.587	2.93	0.733	0.3

Independent discrete choice models, one for shopkeepers only and one for customers only, are estimated. The former indicates that shopkeepers regards their contribution to the service as the most decisive factor. They attribute importance to the quickness of the service as well as to the distribution of the surcharge for destinations other than the parking lot, which they deem should be borne by customers. To some surprise their customers' contribution to the cost of the service enters negatively their utility function, so that they deem it should be reduced as much as possible, most likely because they fear an indirect negative effect on their business.

Customers' choice model is mainly determined by cost allocation. Contrary to the shopkeepers, the cost attributed to them affects negatively their utility function while

that allocated to shopkeepers affects their function positively. Furthermore, they believe the extra-cost of other than parking lot destinations should be borne by shopkeepers.

In order to estimate the influence that their preference structure plays on the bargaining process, two types of initial-pass power models are estimated as proposed in the literature: a complete power model and an agreement-only power model. The former indicates that shopkeepers exert a greater control over their contribution to the financing of the service, the quickness of the delivery (to some surprise), the surcharge attributed to the customer and the use of information technology. Customers exert more influence on the share of their direct contribution only. The agreement-only power model offers a slightly different view. Shopkeepers loose control on their direct contribution, whereas customers retain theirs. It is confirmed that the timing of the delivery is influenced by shopkeepers, whereas customers push for a shopkeepers' contribution to the extra-costs of home delivery while shopkeepers push for customers' contribution.

An enhanced version of the power model able to identified potential altruistic effects did not detect any intra-group interaction effects.

The data collected allowed us also to estimate the determinants of the probability of agreement. It turned out the cost factors affects negatively the probability of agreement, more so for the customers; a similar role is played by the time factors. Information technology, on the contrary, does not seem to play a relevant role.

Finally, a simulation was performed to estimated which of the alternatives preferred by shopkeepers and by customers was more able to succeed. It turned out, coherently with the previous results, that the one proposed by customers is more likely to be closer to the final compromise solution, or, stated in other terms, shopkeepers seem more likely to concede to customers' desires. However, the methodology is not able to forecast which will be the end result of the interaction process.

To conclude, the paper presents a methodology to evaluate the prospects for the introduction of a new city logistics service. Although various theoretical and methodological issue are still open to discussion, the methodology demonstrates to be useful in providing insights - not only the parties' preference structure as normally achieved by discrete choice models - but also on the shopkeepers perception of customers' preferences, on the area of bargaining, on each party's influence on the choice attributes and on the determinants of the probability of achieving a comprise solution.

In future research we would like to extend the analysis to different cities both to enlarge the sample size and to verify if there are different perceptions in various parts of the country. A larger sample size should also allow us to estimate different functional forms of equation 3 as well as to estimate a restricted power model with initial pass elements only. More sophisticated discrete choice models will also be estimated.

Acknowledgments – Authors would like to thank Tiziano Bartoccioni for administering the filed interviews during a torrid month of July 2007.

7 References

Ambrosino, G., Bellini, R., Liberato, A., Boero, M. and Finn, B. (2005a), "e-DRUL implementation in Siena", *City Ports Final Conference*, 13-14, June, 2005, Bologna, Available from URL http://www.cityports.net/BolognaFC.htm

Ambrosino, G., Boero, M., Finn, B. and Liberato, A. (2005b), "e-DRUL City Logistics Agency: demonstration in Siena", *3rd e-THEMATIC STEERING COMMITTEE MEETING*, 17 June 2005, Sheraton Brussels Airport.

Aribarg, A., Arora, N. and Bodur, H. (2002), "Understanding the role of preference revision and concession in group decisions", *Journal of Marketing Research*, vol. 39: 336-349.

Arora, N. and Allenby, G.M. (1999), "Measuring the influence of individual preference structures in group decision making", *Journal of Marketing Research*, vol. 36: 476-487.

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

Brock, W.A. and Durlauf, S.N. (2001), "Discrete choice with social interactions", *Review of Economic Studies*, vol. 68: 235-260.

Brock, W.A. and Durlauf, S.N. (2003), Multinomial choice with social interactions, *NBER Technical Working Paper no. 288*, pp 1-46.

Capuano, G., Martone, C. and Rondini, L. (2007), "Nota sull'economia della provincia di Pesaro ed Urbino", *report* Istituto Guglielmo Tagliacarne, pp 1-54, Available from URL: http://www.ps.camcom.it/argomenti/5a_Giornata_economia.html.

Dosman, D. and Adamowicz, W. (2006), "Combining stated and revealed preference data to construct an empirical examination of intrahousehold bargaining", *Review of the Economics of the Household*, vol. 4: 15-34.

Durlauf, S. (2001), "A framework for the study of individual behaviour and social interactions", *Sociological Methodology*, vol. 31: 47-87.

Egger, D. and Ruesch, M. (2004), "Best Urban Freight Solutions. Consolidated Best Practice Handbook", D 2.4, pp 1-387, Available from URL: www.bestufs.net.

Gibbons, R. (1992), *A Primer in Game Theory*. Harvester Wheatsheaf, London.

Gliebe, J.P. and Koppelman, F.S. (2002), "A model of joint activity participation between household members", *Transportation*, vol. 29: 49-72.

Gliebe, J.P. and Koppelman, F.S. (2005), "Modeling household activity–travel interactions as parallel constrained choice", *Transportation*, vol. 32: 449–471.

Harsanyi, J.C. (1955), "Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility", *Journal of Political Economy*, vol. 63: 309-321.

Hartmann, R.W. and Yildiz, V.T. (2007), "A structural Analysis of Joint Decision Making", *Working paper*, Stanford Graduate School of Business, Stanford University, pp 1-37.

Hensher, D.A. (2007), "Models of organizational and agency choices for passenger- and freight-related travel choices: notions of interactivity and influence", in Axhausen, W.K. (ed.), *Moving Through the Nets: The Physical and Social Dimension of Travel. Selected Papers from the 10th International Conference on Travel Behaviour Research*. Elsevier Ltd, Amsterdam, ch. 5: pp 107-129.

Hensher, D.A., Puckett, S.M. and Rose, J. (2007a), "Agency Decision Making in Freight Distribution Chains: Revealing a Parsimonious Empirical Strategy from Alternative Behavioural Structures", *Transportation Research Part B*, vol. 41: 924-949.

Hensher, D.A., Puckett, S.M. and Rose, J. (2007b), "Extending stated choice analysis to recognise agent-specific attribute endogeneity in bilateral group negotiation and choice: a think piece", *Transportation*, vol. 34: 667-679.

Huschebeck, M. and Allen, J. (2006), "BESTUFS Policy and Research Reccomendations I. Urban freight in small and medium sized cities. Urban waste logistics", D1.1, pp 1-22, Available from URL: www.bestufs.net.

Kooreman, P. and Soetevent, A. (2002), "A Discrete Choice Model with social interactions; an analysis of high school teen behaviour", *working paper*, University of Groningen, pp 1-28.

LT Consultants, L. and BCI, B.V. (2002), "Work Package 1 Final report: Comparative survey on urban freight, logistics and land use planning systems in Europe", D1, pp 1-104, Available from URL: www.cityfreight.org.

Manski, C. (2000), "Economic analysis of social interactions", *The Journal of Economic Perspectives*, vol. 14: 115-136.

Molin, E.J.E., Oppewal, H. and Timmermans, HJ.P. (1997), "Modeling Group preferences using a decompositional preference approach", *Group Decisions and Negotiation*, vol. 6: 339-350.

Mueller, D.C. (1989), *Public choice II*. Cambridge University Press, Cambridge, UK.

Muthoo, A. (1999), *Bargaining Theory with applications*. Cambridge University Press, Cambridge.

Paglione, G. (2007), "Inter-agency choice within discrete choice models: a review of methods", *4th Kuhmo Nectar Conference*, 12-13, July, 2007, Facoltà di Economia e Commercio, University "Carlo Bo" of Urbino, Urbino (IT).

Panebianco, M. and Zanarini, M. (2005), "City Ports Project-Interim Report ", Quaderni del servizio pianificazione dei trasporti e logistica 7, Assessorato Mobilità e Trasporti, Regione Emilia Romagna, pp 1-209, Available from URL: http://www.regione.emiliaromagna.it/.

Puckett, S.M. and Hensher, D.A. (2006), "Modelling interdependent behaviour as a sequentially-administered stated choice experiment: analysis of freight distributions chains", *11th IATBR Conference*, Paper presented for the workshop on Experimental Approaches, 16-20 August, 2006, Kyoto, Japan.

Yang, S. and Allenby, G.M. (2003), "Modelling interdependent consumer preferences", *Journal of Marketing Research*, vol. 40: 282-294.

Zhang, J. and Fujiwara, F. (2006), "Representing household time allocation behavior by endogenously incorporating diverse intra-household interactions: A case study in the context of elderly couples", *Transportation Research Part B*, vol. 40: 54–74.

Zhang, J., Lee, B., Kuwano, M. and Fujiwara, A. (2006), "Bayesian analysis of group choice behavior in the context of household car ownership", *11th IATBR Conference*, Resource Paper, 16-20 August, 2006, Kyoto, Japan.

Zhang, J., Timmermans, H. and Borgers, A. (2005), "A model of household task allocation and time use", *Transportation Research Part B*, vol. 39: 81–95.