AN ADAPTIVE CONJOINT ANALYSIS OF FREIGHT SERVICE ALTERNATIVES: EVALUATING THE MARITIME OPTION

Preliminary version

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Abstract

The growing interest towards a re-balancing of freight traffic over the different modes has brought renewed focus on the opportunities to enhance the use of short sea shipping and, in particular, on the so-called "Motorways of the sea" (EU Commission, 2001). This expression was first coined in Italy in the seventies and it referred to the maritime routes running parallel to the Tyrrhenian and Adriatic coast of Italy. Since then, the various policy proposals put forward during the last thirty years have had little tangible results, even though it is widely acknowledged that these "special" motorways could constitute a valid alternative to land transport over medium-long distance, favouring, at the same time, a greater integration among different modes. The potential capacity of this alternative is still highly unexploited. While a number of documents acknowledge the great opportunities offered by the development of maritime ro/ro transport services in re-directing freight flows, little has been done to empirically identify the factors which might induce operators to opt for this alternative. In other words, the determinants of the operators' demand have not yet been object of a detailed investigation. In this paper we present the preliminary results of a pilot study aimed at identifying the value that the user assigns to the specific transport alternative and the factors - related to both the mode and the specific organisation of the companies - that exert a significant influence on the choice of the shipper in relation to the transport service. These elements represent a necessary prerequisite for traffic flow predictions and investment decisions. Using a methodology falling within the broad definition of conjoint analysis – the adaptive stated preferences approach – we have been able to measure the trade-offs among service characteristics that shippers make when evaluating alternative services already present on the market or still hypothetical. We have demonstrated how this methodology, which has already gained overwhelming success in surface transport studies, can be successfully applied, making the appropriate variations, in the analysis of maritime services and in particular, in verifying the potential success of initiatives directed at enhancing the use of the "Motorways of the sea".

1. Introduction

In the last few years the re-balancing of freight traffic over the different modes is increasingly capturing the interest of policymakers. In many European countries, ecological concerns and, more practically, the congestion of most of the surface infrastructure networks and the state of the public finance have redirected attention towards the sea alternative. Recently, in the 2001 "White Paper" issued by the European Commission, the concept of "Motorways of the sea" received renewed attention. This concept is borrowed from an Italian project which dates back to the seventies and which has been put forward in the course of the past thirty years with alternating success. However, given its limited success in the Italian transport policy, the great potential of this alternative should be evaluated in the light of the level of competitiveness required nowadays by the operators who need a flexible transport system capable of adapting to the modern structure of production and completely integrated within the logistics networks (both existing and under construction). Furthermore, in order to effectively promote the use of this alternative, it is necessary to undertake a number of initiatives directed mainly at reducing the bottlenecks currently present within ports and in the links between ports and their hinterland. The determination of the necessary investments, however, cannot disregard the dimension and the extent of the potential re-orientation of traffic flows towards maritime transport, which would yield insight on the appropriate/optimal dimension of such investments. In order to achieve this, it would be essential to have information not only on the current movements but also on the potential reallocation of traffic flows on the new alternative routes/services. An estimation of the latter cannot be achieved without an in-depth analysis of the behaviour of traffic operators.

Although in recent months, especially in Italy, a number of documents have been put forward on the great opportunities offered by the development of the "Motorways of the sea" in re-directing freight flows, there is a lack of any empirical analysis on the determinants of such choice by operators. In other words, a lot has been done in analysing supply and very little in analysing demand. Identifying the value that the user assigns to the specific transport alternative would strongly contribute to evaluating the possibility of a trade-off between the maritime short sea shipping mode and the other modes. Furthermore, the identification of the factors related to both the mode and the specific organisation of the companies that exert a significant influence on the choice of operators and the magnitude of their impact would represent, in such instances, a necessary prerequisite for any forecasts.

In the last few years, significant improvements have been made in the definition of a methodology capable of realistically interpreting the decision-making process of operators with respect to transport service choice. Nowadays, the superiority of Stated Preference techniques versus Revealed Preference techniques in these instances is generally accepted, due mainly to the characteristics of the data needed for the experiment. In this work, we follow the approach of Fowkes and Shinghal (2002), Bolis and Maggi (1999), and Fowkes and Tweddle (1996 and 1997), who overturned the traditional methodological praxis and identified the mode of transport as merely one of the different characteristics of the transport service. We thus assume that the transport service can be "broken down" into its component attributes and that each component generates a specific level of utility for the user. In particular, we attempt to measure the trade-offs users make in choosing between alternative modes. The methodology used falls within the broad family of conjoint analysis experiments, as we attempt to determine the value that individuals place on any product as equivalent to the sum of the utility they derive from all the attributes making up a specific "transport product". However, given the need to adapt the choice set to the real context of the decision maker interviewed in order to avoid offering the respondent choices/options which are irrelevant for

him/her, we discard traditional stated preference techniques in favour of the "Adaptive Stated Preference" (ASP) techniques. To our knowledge, this is the first ASP experiment performed with the scope of determining the preferences of operators in terms of service attributes of sea transport and of studying the potential reallocation of traffic from surface transport services to short sea shipping services[1].

Given the purposes of this study, for the moment we have focussed the empirical application on a specific geographical context, carrying out a pilot study. In particular, we have analysed the preferences of operators localised in the north-west regions of Italy with respect to the possibility of accessing a maritime ro-ro service from the ports of Genoa or La Spezia. The analysis has been carried out through a postal survey and direct interviews with freight forwarders. They, in fact, represent a large share of the consumers of transport services: often, especially for medium-long distance transfers, the decision on the mode to be used is delegated outside the firm to third parties. In particular, in order to present the participating operators with comparable alternatives, we have considered traffic-flows between origin-destination areas which are reachable both by sea and land. Also, we have restricted the interviewed sample to those freight forwarders who have a certain familiarity with the maritime mode. This approach has enabled us to analyse consumers' preferences for the maritime alternative and to identify the service attributes which most influence operators' attitudes towards short-sea shipping services.

In section 2 we describe the methodology used to assemble the dataset, section 3 contains the explanation of how the sample has been identified and section 4 briefly describes the design of the ASP experiment. The estimating procedure is illustrated in section 5, and in sections 6 and 7 we comment on the main results of the estimation. In section 8 a brief summary of the main conclusions is provided.

2. Data collection methodology

The conjoint alternative scenario approach is a research techniques used to measure the trade-offs people make in choosing between products and service providers. It was first developed in the marketing sector and has been largely used to predict consumers' choices for future products and services, and now it is a well-established procedure for collecting Stated Preference (SP) information from respondents in transport studies[2]. It has the advantage, with respect to standard Revealed Preferences (RP) approach, to allow analysis in contexts in which it is not possible to "observe" the real behaviour of operators either for lack of data or because the alternative to be analysed is not yet used or available for use. Application of Revealed Preference (RP) methods which would be based on observed behaviour is, generally, not feasible in the context of freight transport: i) the data on actual choices is usually commercially very sensitive and, hence, disclosed with great difficulties[3]; ii) the complexity of the freight transport decision requires the collection of large dataset on a number of variables and the observation of a great number of firms' decisions in order to take into account the heterogeneity of the context. Moreover, for the specific scope of the study,

[1] A previous study carried out on the routes between Sicily and the Continent by Gattuso and Postorino (1996) adopted standard SP methodology.

[2] In particular, in the context of freight transport, since the late seventies, since the pioneering work by Fowkes and Tweddle (1979) it has been used, among others, by Bates (1988), Fowkes and Tweddle (1996 and 1997), Bolis and Maggi (1999), Fowkes and Shinghal (2002), Danielis and Rotaris (2002) and Maier and Bergman (2002). Among these applications, the latter introduces some interesting differences with respect to the original approach: Maier and Bergman (2002), in fact, implement a fractional factorial design instead of a standard adaptive SP experiment, estimate a discrete choice model without weighting the elicited ratings and tackle the problem of repeated observations in the database.

[3] In a liberalised environment, freight rates are individually negotiated and held commercially confidential.

the limited use of the maritime alternative, especially for certain routes and products, is an additional reason against the use of RP in this context. The existence of an alternative which is not sufficiently used is analogous to analysing the choice of a new alternative (Tweddle et al., 1996). For all these reasons we have opted for SP analysis with the due adaptations needed to take account of the peculiarities of the case[4].

In our experiment, since the choice set has to be adapted to the real context of the decision-maker interviewed, we have not used traditional conjoint measurement techniques: a traditional design, in fact, might have confronted the decision-maker with irrelevant choices/options (i.e. options which are not available). For this reason we have used the so-called "Adaptive Stated Preference technique" (ASP). This interactive data collection technique amends attribute levels offered to the respondent during the experiment on the bases of the responses he/she gives. One significant advantage of this method in studying freight is that it makes it possible to cope with a wide range of "true" valuation that the experiment is trying to recover (type of commodity, time variance of attribute valuation, etc.). The ASP starts from an existing freight transport option chosen by the interviewed person. Usually this option is elaborated in a discussion with the person responsible for the mode choice, and it describes the typical transport of the firm (Fowkes and Tweedle, 1996). Starting from this option, the ASP exercise implies asking the respondent to rate various hypothetical alternatives for performing the same transport task expressed in terms of the relevant attributes.

3. Identification of the sample

For the purpose of the study we have decided to run our experiment on a set of freight-forwarding agencies. The choice has been dictated by the need to contain sampling costs. Choosing freight-forwarding agencies has given us the possibility to intercept information from a sector of the transport industry which accounts, on average, for more than half of the transport decisions, as outsourcing of transport operations is spreading rapidly. At the same time, it has allowed us to obtain a sample which, although small, is homogeneous as to the type of activity carried out by the respondents. Given the limited resources available, selecting producers would have limited the scope of the analysis to a specific sector or excessively constrained the dimension of the dataset for each industrial sector. Choosing transporters, given the current situation of the Italian surface transport industry, would have probably lead to interpretation problems due to the resistance of small operators to use intermodal transport. Moreover, recent studies have demonstrated (Tsamboulas and Kapros, 2002) that, especially in relation to multimodal transport services, the expectations on transport service attributes differ widely among different groups of users. Selecting freight-forwarding agents instead of producers or operators allows insights to be gained from a wider spectrum of possible uses.

Once the area to be covered by the study and the type of companies to insert in the experiment were identified, the data were collected in two steps. First a questionnaire was sent to a sample of ship-forwarder companies localised in the area between Genoa, Parma and Milan in order to determine whether the company was interesting for the study and whether it was useful to include it in the second phase of data collection. Inclusion, in fact, depended not

[4] As Fowkes and Shinghal (2002) remind us, initially SP experiments in transport were conducted through "pen and paper" direct interviews or through self-compilation questionnaires, with both methods sometimes involving cards showing one or more alternatives; the data collected was then elaborated with the support of statistical analysis. The development of *ad hoc* computer programmes, has allowed the experiment to be "customised" or "adapted" to the profile and the choices of the interviewee. For a detailed review of the evolution of SP techniques, the reader is referred to the work of Fowkes and Shinghal (2002).

only on the willingness of the company to be included but also on its geographical coverage and on the type of traffic it served. In order to compare surface and sea transport it was necessary to identify companies which could consider the hypothetical alternative feasible, given the characteristics of their traffic. For instance, including companies serving the route from northern Italy to Sardinia would not be appropriate (no surface alternatives could be considered viable); similarly, it would not be appropriate to include in the analysis companies serving the routes Turin to Trieste (no sea alternative would be considered viable). First a sufficient number of companies suitable for the investigation and interested in collaborating were identified, mainly through direct telephone contact with the officers and some explanation of our research. Then the first phase of the study was undertaken. It involved a questionnaire to understand better the interest of the company and to define a Stated preference experiment suitable in the context of maritime transport. Questions were printed in a typical questionnaire form on which the respondent entered information about the firm's basic shipping facts (products, destinations, typical modes, and so on). The overall response rate was good, which resulted in the collection of interesting information on the activities of the company and in the identification of the ones suitable for the study[5]. The first phase thus helped to establish the contact necessary to conduct the second phase.
For the second stage of the study, which followed a thorough pre-test of all instruments, appointments were set with the managers responsible for the mode choice. It was not possible to visit the managers of all the companies that replied to the first part of the data collection exercise, either because from the questionnaire it appeared obvious that they were not suitable for the experiment, or because they refused to proceed with the experiment due to lack of time/interest or the inability to disclose reserved data. We identified a sample of five companies[6]: four located in Genoa, one in Parma[7].

4. The ASP experiment

The second phase of the study consisted in an interactive conjoint analysis interview defined as the "ASP experiment". It consisted of a repeated set of choices recorded directly on the interviewer's portable computer, whose software presented a consistent, on-screen series of price-attributes scenario as alternatives to the baseline shipment facts provided by the respondent: on the first screen the respondent is asked to provide information to describe a "typical transport" operation performed by the company with respect to the set of attributes previously identified, plus some additional information which is used to differentiate observation later in the analysis. The information on typical transport is used, instead, to "customise" the "current choice" of the respondent which becomes the "reference option" and does not change for the whole experiment. This option is reported, at each iteration, on the left-hand side of the screen – column A – and it is automatically assigned a rating of 100: it is assumed that, among the existing alternatives, this is the preferred one, and it thus represents the operator current utility level. The other columns, which appear from the second screen onwards, report hypothetical options (B and C) for which the attribute values are generated by the programme on the basis of the known characteristics of the firms' original transport service (data inputted in screen 1 and the choices reported in each iteration). In every repetition of the conjoint experiment, the hypothetical alternatives presented in column B and

[5] For the detailed illustration of the outcome of the analysis of the data retrieved through the questionnaires see: Bergantino *et al.* (2003).
[6] The direct interviews took place in September 2002.
[7] Although a larger sample would have been desirable, even for the pilot study, sampling costs are considerable and organising the meetings quite burdensome and time consuming. Interviews with relevant decision makers have to be agreed upon, set up, often postponed and have rarely been short enough to permit two or more to be conducted on the same day. Nevertheless, we are currently organising additional interviews.

C change – new computer generated alternatives are presented – and the respondent is asked to rank the two alternatives against option A on the basis of the value he/she assigns to the service. In choosing the rating, the respondent has to use the value scale carefully illustrated by the interviewer, which ranges between 0 and 200. The iterations continue until, for each variable in turn – starting with price – indifference is reached. In other words, once variations in prices as a function of the rating given by the respondent in the previous iteration do not lead to a new variation in the rating, the new screen presents options where the remaining attributes change following the same procedures until convergence is reached. The experiment terminates either at the 20th iteration or when, for all attributes, convergence is found. It is extremely important that the respondent rank options in their desired order, having a clear understanding of the scaling, so to indicate as accurately as possible their strength of preference (Tweedle *et al*., 1995). The variables included in the experiment are: cost, time, reliability and frequency. The choice to include these variables comes out of the questionnaire; this is in line with the other ASP experiments conducted in Europe[8]. Column B always refers to the same mode of the typical transport defined by the interviewee, and column C refers to a different mode of transport. The alternative mode of transport we proposed during the experiment was always ro-ro. Each response given during the experiment is taken as a separate observation at the analytic phase. The respondent's selections have been automatically coded into the analytic categories subsequently used in a series of maximum likelihood estimation.

5. Estimation methodology

The data collected through the ASP experiment described above were analysed following the procedure introduced in Fowkes and Tweedle (1996) and then adopted by Bolis and Maggi (1999). The data set collected was "exploded" and then the recorded ratings (utilities) were transformed into binary choices: A *vs.* B, A *vs.* C, each 20 times. A data set was thus constructed where every difference in rating between an alternative offered, *i* (B or C), and the real alternative, A, was transformed into a choice probability for the hypothetical offer *i.* Given that the rating of the existing alternative (A) remains fixed and equal to 100 during the whole experiment, for any given pair, the rating assigned to alternative *i* was converted into a probability of choosing alternative A according to the following rules:

- If Rating of alternative $i < 100$ then: $P_A = 1- (0{,}5 *$ Rating of alternative $i /100)$
- If Rating of alternative $i > 100$ then: $P_A = (0.5 *100 /$ Rating of alternative $i)$

In fact, we assume that the transport service can be broken down into its component attributes and that each component generates a specific level of utility for the user, and what we have recorded is an implicit estimation of the utility the respondent place on the hypothetical offers.

Since the rating exercise generally involved 20 interactions per firm, we observe about 40 such differences in each case (degrees of freedom available for calibration)[9].

Turning to the standard approach of choice theory applied to mode choice, the (indirect) utility V_{ni} of decision maker *n* deriving from alternative *i* is defined by a function:

$$V_{ni} = f(z_{ni}, S_n) \qquad [1]$$

[8] Fowkes and Tweddle (1996 and 1997), Bolis and Maggi (1999), Fowkes and Shinghal (2002), Danielis and Rotaris (2002) and Maier and Bergman (2002).

[9] In some cases the experiment was interrupted before the 20th iteration was reached either because convergence had been reached or because the respondent seemed to be getting tired.

where $\boldsymbol{z_{ni}}$ is a vector of the attribute values of alternative *i* as viewed by decision maker *n*, and S_n is a vector of the characteristics of the decision maker *n* (or of his/her firm). Given that with only five observations we cannot perform cross-section regressions - and thus identify firm specific effects - the S_n are not included and eq. [1] becomes:

$$V_{ni} = f(z_{ni}) \qquad [2]$$

Considering only two alternatives and assuming that the unobserved errors are independent and identically Gumbel distributed, we can formulate the decision taken by the company as a binary logit model. The probability of company *n* choosing alternative A rather than B becomes:

$$P_{nA} = \frac{\exp[V(z_{nA})]}{\exp[V(z_{nA})] + \exp[V(z_{ni})]} = \frac{1}{1 + \exp[V(z_{ni}) - V(z_{nA})]} \qquad [3]$$

Proceeding this way we observe probabilities and hence we can estimate a logistic regression model relating (Log (P_A/P_B)) to the attribute differences. Choosing a linear form for *V* we can proceed by taking pairs of alternatives and calculating the difference in the attributes between each proposed alternative (*i*) and the reference alternative A (e.g. $COST_A - COST_B$, $COST_A - COST_C$, $TIME_A - TIME_B$, $TIME_A - TIME_C$ and so on).
Transforming the above logit probability we obtain:

$$\text{Log}\,(P_A/1\text{-}P_A) = V(z_{An}) - V(z_{in}) \qquad [4]$$

The dependent variable in the logistic regression (Log (P_A/P_B)) is called Log-Odds. Odds are a relative frequency. From this, it follows that all the coefficients of the dummy variables and the constant indicate shifts on (Log (P_A/P_B)). Such a coefficient elevated to the power of 'e' indicates how many times more probable it is to observe A rather than B. The coefficients of continuous variables can be interpreted in analogy, indicating marginal effects rather than shifts. Eq. [4] can be rewritten as:

$$\text{Log}\,(P_A/1\text{-}P_A) = \beta_1 (COST_A - COST_i) + \beta_2 (TIME_A - TIME_i) + \beta_3 (RELIAB_A - RELIAB_i) + \\ + \beta_4 (FREQ_A - FREQ_i) + \beta_5\, RORO + \varepsilon_i \qquad [5]$$

where the independent variables represent:

COST = transport cost in Euro for a door to door service (including transhipment),
TIME = scheduled journey time in hours between origin and destination (including transhipment),
RELIA = expected number of shipments per year arriving on time in %,
FREQ = number of shipments per month,
RORO = a dummy variable which assumes the value of 1 when ro/ro transport is used, 0 otherwise.

The β's are the estimated coefficients. In particular, β_1 to β_4 represent the value, for the respondent, of the differences in the attributes of the alternatives faced with respect to the current one (reduction in cost, frequency and reliability, variation in journey time), and β_5 measures the respondent's preference toward the maritime mode.

In order to take account of the fact that, in general, respondents might be more precise in their expressed valuation when appointing a rating near 100, weights have been introduced in the estimation[10]. The weights used are thus designed to assign greater influence to ratings as they get closer to 100 as follows[11]:

If $Rating_i > 100$ then $W_i = 100/Rating_i$, otherwise $W_i = Rating_i /100$ [6]

As can be seen, eq. [6] gives the most weight to the least clear-cut decision: small changes in ratings close to 100 are valued as a lot more significant than similar changes in the extremes of the range (see Fowkes and Tweddle, 1996 and 1997).

6. Data analysis

6.1 Descriptive statistics

In this section we describe the main characteristics of the data collected. We start with the outline of the five typical transport shipments described by each respondent and used as the benchmark for the experiment (column A). As stated in section 4, in fact, the respondent is always asked, prior to the beginning of the experiment, to identify a transport service which is organised with regularity by the company (if possible) and, given the scope of this work, for which a valid modal alternative exists (e.g. the possibility to carry out the same service using land, sea or combined transport). In four cases the typical transport was performed by road, while in one of the case studies, the service was carried out using sea transport. Some indications of the main characteristics of option A are reported in Table 1.

Table 1: Typical Transport (Average Values)

Variable	Mean	Min	Max	
Cost	1633	1215	2250	Euro
Time	66	50	90	hours
Reliability	82	50	100	%
Frequency	19,2	12	40	times month
Mean length	1260	900	200	km

In Table 2, the mean and the median values of the hypothetical offers presented to the respondent are shown. Interestingly, the mean value of the rating is always above 100 (the rating of the typical transport/reference alternative): the shippers always prefer the new services offered.

The mean of the difference between the value for each attribute of current service and of the hypothetical one offered as an alternative is shown in Table 3. Across all experiments, the hypothetical services offered a mean discount of 34.9%, a mean increase in time of about 4 hours with respect to the original journey time, a mean increase in reliability of 2% and, finally, a mean reduction of frequency corresponding to a service supplied 3 fewer times per month.

[10] Respondents, in fact, are more likely to know whether the rating of the alternative presented should be 95 or 105, compared with the base value of 100 of the reference alternative A, as opposed to 20 or 30.

[11] For greater details on the various weighting functions that can be used in this context and on the outcome of their application, the reader is referred to Fowkes and Tweedle (1996 and 1997) and Fowkes and Shinghal (2002).

Table 2: Hypothetical offers: Mean values of Transport Attributes

Firm	N. obs	Cost (Euro)	Cost (Index)	Time	Relia	Freq	Rating
case 1	41	2250	100,0	64	100,0	20,0	100,0
Mean		1421	63,4	67	95,9	14,9	105,1
Median		1338	59,0	64	100,0	12,0	100,0
case 2*	27	1215	100,0	60	50,0	40,0	100,0
Mean		977	80,4	64	49,6	37,0	124,3
Median		936	77,0	60	50,0	40,0	120,0
case 3	33	1800	100,0	90	90,0	12,0	100,0
Mean		1221	67,8	92	88,1	9,0	106,8
Median		1224	68,0	90	90,0	12,0	110,0
case 4	31	1400	100,0	66	80,0	12,0	100,0
Mean		658	47,0	72	74,7	8,1	110,0
Median		560	40,0	66	72,0	8,0	100,0
case 5	35	1500	100,0	50	90,0	12,0	100,0
Mean		1029	68,6	56	84,3	8,2	107,4
Median		1050	70,0	50	81,0	8,0	110,0
General	167						
Mean		1085,7	65,1	69,9	80,5	14,7	109,9
Median		1035,0	69,0	66,0	81,0	12,0	110,0

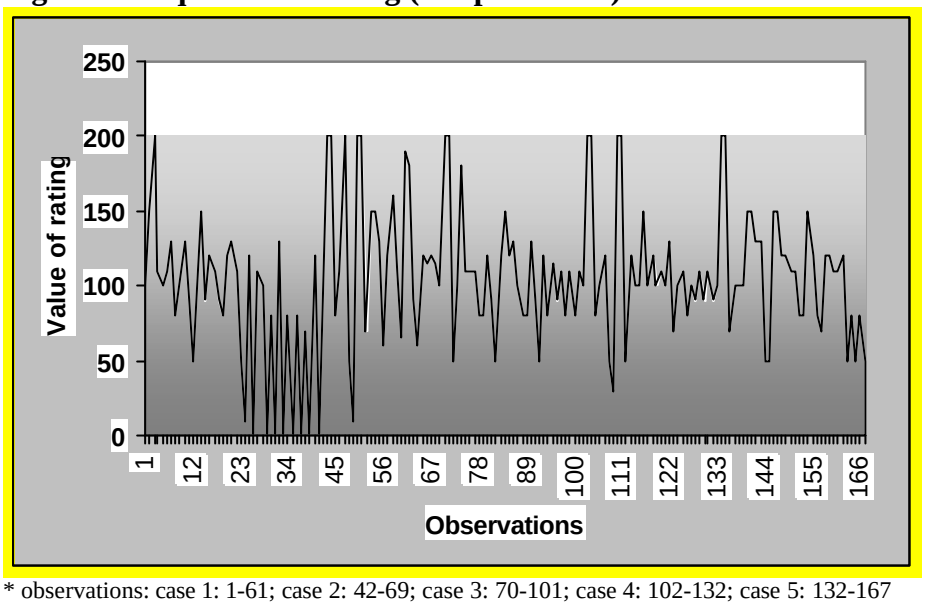
* Transport performed by the shippers using RORO

Table 3: Hypothetical offers - Mean values of the difference in Transport Attributes

Firm	Diffindex	Difftime	DiffRelia	Difffreq	Pa
case 1	0,0	0,0	0,0	0,0	0,50
Mean	36,6	-2,7	4,1	5,1	0,59
Median	41,0	0,0	0,0	8,0	0,50
case 2*	0,0	0,0	0,0	0,0	0,50
Mean	19,6	-3,9	0,4	3,0	0,45
Median	23,0	0,0	0,0	0,0	0,42
case 3	0,0	0,0	0,0	0,0	0,50
Mean	32,2	-2,1	1,9	3,0	0,49
Median	32,0	0,0	0,0	0,0	0,45
case 4	0,0	0,0	0,0	0,0	0,50
Mean	53,0	-5,7	5,3	3,9	0,49
Median	60,0	0,0	8,0	4,0	0,50
case 5	0,0	0,0	0,0	0,0	0,50
Mean	31,4	-5,8	5,7	3,8	0,49
Median	30,0	0,0	9,0	4,0	0,45
General					
Mean	34,9	-4,0	3,6	3,8	0,5
Median	31,0	0,0	0,0	4,0	0,5

As can be seen from Figure 1, which shows the variations in the rating across the experiment (the range is between 0 (refused hypothesis) and 200 with the reference option valued 100), in the five experiments carried out, the options presented have been considered unacceptable seven times. The zero-values are all concentrated in the first experiment (see below). In fact, this respondent considered the levels of reliability of our hypothetical offer to be too low.

Figure 1: Sequence of Rating (5 experiments)



* observations: case 1: 1-61; case 2: 42-69; case 3: 70-101; case 4: 102-132; case 5: 132-167

6.2 Estimation results

The procedure chosen to estimate the empirical model is the Tobit ML estimator. The data set, in fact, contains a number of zero values corresponding to those alternatives which, given the value of their attributes, have received a rating of zero. Since we can assume that those zero values correspond, in principle, to cases in which the latent variable – the indirect utility – might take negative values (i.e. unacceptable levels of reliability or frequency which would compromise the respondent activity), we can treat the zeros as a result of censoring and nonobservability and thus correctly apply the Tobit estimator.

The results of the estimation are shown in table 4.

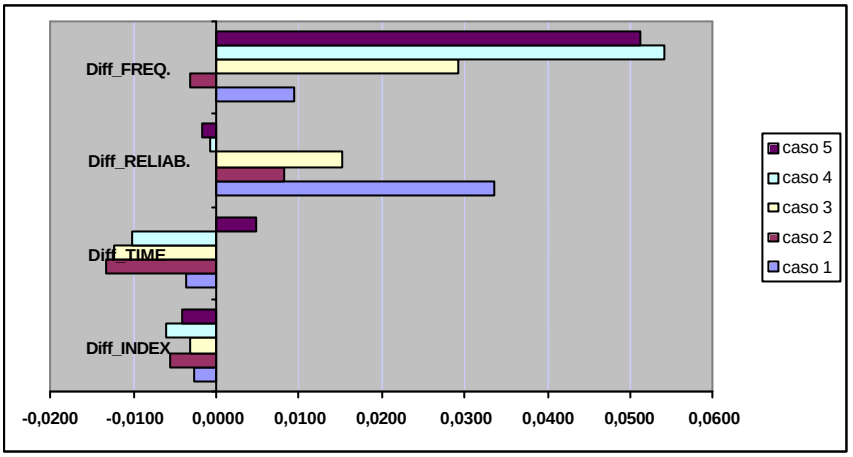
Table 4 - Estimation Results on ASP Data

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	Exp. Sign
Intercept	0,4939*	0,5377*	0,4973*	0,4912*	0,4909*	+
Cost	-0,0026*	-0,0055*	-0,0032*	-0,0061*	-0,0042*	-
Time	-0,0035	-0,0135***	-0,0125**	-0,0101**	0,0049	-
Reliability	0,0337*	0,0080	0,0152**	-0,0008	-0,0017	+
Frequency	0,0094*	-0,0033	0,0293*	0,0542*	0,0511*	+
Use of RoRo	0,0058	-0,0377	-0,0917	0,1028***	-0,0640	
Adj R^2	0,23	0,22	0,26	0,59	0,31	
F stat.	3,34**	3,32**	3,24**	9,67*	4,02*	
N. obs.	41	27	33	31	35	167

*=1% ; **=5%; ***=10%

For illustrative purposes, we report in Figure 2 the histogram of the estimated coefficients.

Figure 2: Estimated coefficients



As can be seen from Figure 2, both the values and the signs of the estimated coefficients are, generally, homogeneous.

All coefficients refer to the effect of a change in the respective variable on the respondent's utility (rating). The coefficients of cost, time, and frequency are generally significantly different from zero. In particular, the coefficient of the variable cost is always significant at the 1% level with an expected negative coefficient. The results relative to the frequency are also quite interesting as the coefficients have the expected positive sign, except for case 2, in which, however, the coefficient is not significant. In addition, the variable time is generally significantly different from zero although with larger confidence intervals. It also has the expected sign, as an increase in the difference in journey time between the current option and the alternative is likely to have a negative impact on the probability of remaining with the current service.

Also interesting is the lack of significance, in most cases, of the coefficient for the dummy relative to the maritime alternative. This variable yielded a positive significant parameter only for case 4 (at the 10% confidence level). For all the other cases the coefficients - although not significant - are negative, implying diffidence towards the maritime mode.

It can be noted, however, that for all the variables and in all cases the coefficients all have very low values. This indicates that the marginal impact of a change in a variable on the propensity to change from the current solution to a hypothetical one is small. The respective elasticities would thus be small as well (see also Bolis and Maggi, 1999).

In Table 5 we report the monetary valuations of tradeoffs between attributes given by the ratio of the parameter estimates to the cost parameter estimate, highlighting the values which refer to parameters which are significantly different from zero at least at the 10% confidence level.

Table 5 - ASP Attribute Service to Cost Trade-Off Ratio (absolute values – euro per ton)

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	AVRG.	CORR. AVRG.**
TIME	(1.35)	2.44	3.92	1.67	(1.18)	2.11	2.68
RELIBILITY	12.89	(1.46)	4.75	(0.14)	(0.40)	3.93	8.82
FREQUENCY	3.58	(0.60)	9.15	8.95	12.29	6.94	8.49

* the values in parenthesis are not significantly different from zero at the 10% confidence level.

** the corrected average includes only the values of the trade-off relative to coefficients which are significantly different from zero, at least at the 10% confidence level.

The columns report the amount of money that the respondent would be willing to pay (in case of a positive value) or to receive as compensation (in case of a negative value) for a one-unit variation in the respective variables. The ratio of the service attributes to the cost coefficient

yields, in fact, the monetary values of an attribute at the margin and hence gives an idea of how changes in attributes are traded off against a monetary change in transport costs. In the case of time this is the Value of Time (VOT), in case of reliability and frequency this is VOR and VOF, respectively. As we can see, on average, an hour reduction of journey time is valued 2.68 euro per ton, while a 1% reduction in reliability would require a compensation of 8.82 euro per ton, and a one step reduction in the frequency supplied would require 8.49 euro per ton[12].

Particularly interesting are the results of case 1 - for which reliability is evidently a very valuable service attribute (12.89 euro per ton) - and case 5, for which frequency is the most valued attribute of transport services (12.29 euro per ton). While the values of both VOR and VOF are relatively high for most cases, in general the VOT is comparatively low, although the lowest values, corresponding to cases 1 and 5, are not statistically significant. From the estimated values, taking into account only the values which are statistically significant, reliability and frequency do not seem to differ significantly in the valuation of the respondents.

7. The case studies

7.1 Description

Given the limited amount of data collected in this first pilot study, in order to gain a deeper understanding of the results presented in the previous section and to place the main findings into the appropriate context, in this section we discuss the outcome of five experiments in the light of the general characteristics of the forwarding companies noted during the interviews.

CASE 1

Typical Transport: From: Parma (I) To Badaioz (F) ; Via: Moncenisio; Distance: 1500 km; Volume: 60 m^3 ; Mode: road; Transport performed by: road haulier; Shipments per Year: 20 (every two weeks). Product Transported: machinery Product value/consignment: 100000 Euro; Transport Cost/consignment: 1125 Euro.

This forwarding agent operates mainly for firms producing machinery and its main markets are France and Spain. It does not perform the transport itself but contracts it out to well-known road haulers or shipping companies; the concern for granting his direct customers the quality of service required induces the respondent to value reliability very high. This forwarding agent works with a level of reliability of 100% (VOR - 12.89 Euro per ton for 1% more of reliability).

CASE 2

Typical Transport: From: Guastalla (I) To Barcellona (E); Via: sea; Distance: 900 km; Volume: 25/26 tons; Mode: roro; Transport performed by: the firm; Shipments per Year: 500 (two each days). Product Transported: steel tube Product value/consignment: 75000 Euro; Transport Cost/consignment: 1175 Euro

This is a very important Italian carrier, leader in the national and international markets. Along this route the company operates by sea, and the transport manager evaluates this transport as very uncertain by definition: the company, when choosing to use maritime services, seems to take into account the fact that a one-day delay in consignment has to be expected. From the estimation, in fact, it appears that for this respondent, time, reliability and frequency are not valued very high. Furthermore, the goods shipped are a low-value product, and thus transport

[12] The reduction in frequency of services varies between twice daily (upper value) and once every two weeks (lower value).

costs are relevant. Again, the estimation shows that the attribute that most affects the company's decision is "cost".

CASE 3

Typical Transport: From: Udine (I); To Tallin (FIN); Via: Germany; Distance: 2000 km; Volume: 45 m^3; Mode: road; Transport performed by: road hualier; Shipments per Year: 100; Product Transported: machinery; Product value/consignment: 50000 Euro; Transport Cost/consignment: 1750 Euro

Like case 1, this forwarding agent does not perform the services in-house, either. It operates mainly with shipping companies; in fact, about 95% of his shipments are performed by sea (equivalent to 1500 shipment per year) and only 5% by road. It is specialised in the transport of machinery. As in case 1, for the company it is very important work with "well-known" shipping companies or road haulers. It is mainly for this reason that we have noted credibility problems when performing the experiment: "we can't evaluate a service if we don't really know who is going to do this service!" The estimation shows that the VOR is 4.75 euro for a 1% increase in reliability and that the respondent would be willing to pay an additional 9.15 euro per ton in order to be granted the availability of one additional shipment per month.

CASE 4

Typical Transport: From: Goole (GB); To Brescia (I); Via: France; Distance: 1000 km; Volume: 24 tons; Mode: road; Transport performed by: road haulier; Shipments per Year: 100; Product Transported: Refractory materials; Product value/consignment: 25000 Euro; Transport Cost/consignment: 700 Euro

This shipping company operates only on international markets, mainly Great Britain/England and the U.S. The availability of the services along these routes, where little or no alternatives exist, is very important. From the experiment it appears, in fact, that the respondent has a high VOF (8.95 euro per ton).

CASE 5

Typical Transport: From: Milan (I);To Barcelona (E); Via: ; Distance: 9oo km; Volume: 8 tons; Mode: road; Transport performed by: road hauler; Shipments per Year: 100; Product Transported: furniture Product value/consignment: 50000 Euro; Transport Cost/consignment: 1500 Euro

This company operates mainly on the Spanish market; there is no evidence of a modal preference and, as in case 2, during the interview the respondent stated that when using maritime transport services, time is not very important: "one additional day of travel time is not so influential in the modal choice process of the firm". On the contrary, frequency is very relevant, as the company serves with regularity one main market; the respondent VOF is the only relevant service attribute (VOF - 6.67 euro per ton for one more shipment per month).

7.2 European comparison

The findings on the trade-off ratios confirm the results of similar research carried out in a European context, although the calculated values are generally lower: for instance, in Maier and Bergman (2002) the values for time, reliability and frequency are 9.7, 46.5 and 16.1 euro, respectively; in Danielis and Rotaris (2002) the values for time and reliability are 7.3 and 10.7

respectively and in Bolis and Maggi (1999) the values for time, reliability and frequency are 11.8, 24.9 and 11.3 euros respectively[13].
The results vary significantly among the different experiments both in absolute and in relative value. This highlights how differences in geographical contexts, estimation techniques, respondent characteristics, type of freight and so on might influence the outcome of the analysis. However, in general there are some common traits: among the three attributes, time seems to be the one which is valued the least, while reliability is definitely the service characteristic which is most highly valued when considering combined transport. This outcome, confirmed by our analysis, is particularly enlightening, since on the one hand it shows that operators, when considering whether to use the maritime alternative, do not seem to have a preclusion towards the specific mode but evaluate it on even terms with other services and, on the other hand, it confirms that the attribute on which maritime operators must compete with other transport service suppliers is the overall reliability of the services offered. Investments in the maritime sector, thus, should be channelled mainly on those infrastructures which favour the development of reliable maritime services. Travel time and frequency are, in general, less important.

7.3 Conclusions on the experiments

Although the database used for the estimation is extremely small, on the base of the five experiments carried out we can draw some preliminary conclusions. In particular, we have not found any a priori preclusion towards the maritime mode, while, in general, it was generally affirmed that the sea alternative was perceived as less reliable and more time consuming. The fact that the respondents organise the services but, generally, outsource the transport service, might imply that:

i) they return to us an evaluation of the quality of the transport services they buy in the market;
ii) reliability - and possibly a direct and experimented knowledge of the road hauler or of the ship operators - is very important for the final decision;
iii) they can obtain compensation for any disservice they might suffer.

As expected, the estimation carried out yields high mean values of reliability and frequency and relatively low values for time. Given the objective of the study, these results are encouraging, even though the results presented might be affected by the fact that the companies interviewed were not randomly chosen but, on the contrary, were selected on the basis of a certain degree of familiarity with the maritime mode.

8. Concluding remarks

In this paper we have presented preliminary evidence obtained by estimating a model of forwarding agents' behaviour with respect to the sea alternative, using adaptive conjoint data collecting methods. The final objective of the research is to produce realistic estimates of the determinants of service choice in order to guide sea-related strategies in the sea transport. A specificity of the ASP design chosen here is, in fact, that the transport modes alternative is always ro-ro (combined transport by sea). Through this we tried to stimulate an explicit focus on a specific choice among modes during the experiment. The analysis illustrated in this paper shows that the valuations placed on alternative attributes of the transport services by the five freight forwarding companies interviewed are generally consistent. Despite certain important critical variations, in fact the outcome of the estimation shows a strong and reliable influence of certain characteristics on the decision process. Most notably, and in line with the

[13] The definition of reliability for Danielis and Rotaris (2002) varies from the one adopted in the present paper in that they define it as value of risk of an hour late arrival. The definition adopted by Bolis and Maggi (2002) is also different. The calculated value is referred to an additional shipment per month.

results of other studies, reliability and frequency seem to be the key factors in the choice of the transport service alternative. This is the more so when the choice set includes maritime ro/ro transport.
According to our estimation, although referred only to a very limited database and thus to be taken with due scepticism, freight-forwarders seem to value a 1% improvement in reliability at 8.82 euro and a variation in frequency at 8.49 euro (on average per tons shipped). Apart from the estimated values, what emerges from these results is the fact that operators are more interested in these two attributes of transport than in the actual time of journey. In line with other studies, journey time does not seem to be less valuable than the time lost for low levels of reliability and frequencies. In order to improve the use of the maritime ro/ro alternative, the maritime transport shippers should focus on these two factors. Although the coefficients are generally not significant, the estimations highlight, in fact, a general reluctance by respondents to opt for ro/ro maritime transport. The estimated coefficients for the ro/ro dummy are negative for three out of the five cases. In order to promote short sea shipping it is necessarily to invest in order to increase quality of service: variation in prices would probably be accepted if balanced by real increases in reliability and frequency. In particular, any investment directed at promoting the development of the "Motorways of the sea" should thus primarily focus on creating the conditions for maritime transport operators to organise their services in order to respond fully to the need for quality put forward by the potential users. Investments should be channelled towards those infrastructures and superstructures which increase reliability of sea services.
The first step of the research confirms that the use of SP could be a valid option in order to estimate the attitude of operators towards the attributes of the services they buy in the road, sea, or ro-ro freight transport market. Overall, initial evidence is encouraging and offers some understanding of the determinants of the maritime transport choice. The empirical evidence confirms that the freight rate is not the only determinant of modal choice. Frequency and reliability are shown to be very important and a necessary basis for transport policy design.

With the availability of a more extensive sample, these two factors could be included, in the future, in a model of general freight transport cost. Furthermore, these estimations confirm the high variability of important attributes: different shippers have different market and internal structures. This implies, in turn, different needs and constraints since specific attributes are necessary to meet specific needs of the shippers themselves. These results confirm the evidence presented in other studies carried out in Europe during the last five years, although these studies focus on land transport. In the Trans-alpine region, Bolis and Maggi, 1999 and in the Austrian region Maier and Bergman, 2002 find that in order to improve the competitiveness of combined transport it is absolutely necessary to orient the services towards the need of businesses: there is clear need for action to improve customer orientation.
The next steps planned are to collect data by interviews with forwarding agents located in northern Italy and to perform cross section analysis.

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