Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

Transportation
DOI 10.1007/s11116-014-9566-x

Rail freight transport and demand requirements: an analysis of attribute cut-offs through a stated preference experiment

María Feo-Valero · Leandro García-Menéndez · Salvador del Saz-Salazar

Abstract This paper analyses the choice between road and rail in Spain where rail market share for freight is still residual. Discrete choice models are estimated with data obtained through a two-phase fieldwork, thus allowing us to carry out a stated preference efficient design for each interviewee. We analyse the existence of attribute cut-offs and the presence of a segment of the population with a zero value of frequency. Our results show that ignoring the existence of cut-offs and segments of the population with polarised valuations can lead to erroneous conclusions in terms of the possibilities of rail for absorbing significant quota.

Keywords Stated preference experiments · Freight transport · Attribute cut-offs · Zero-valuation · Mixed logit

Introduction

The research here presented aims to increases the empirical evidence available on transport decisions. Indeed, although it has grown over the last years, empirical evidence on freight transport decisions is still scarce compared to the one available for passengers, due, among

M. Feo-Valero (✉)
International Economics Institute, University Jaume I of Castellon, Campus del Riu Sec, 12071 Castellón de la Plana, Spain
e-mail: maria.feo@eco.uji.es

L. García-Menéndez · S. d. Saz-Salazar
International Economics Institute, University of Valencia, Avda dels Tarongers s/n, 46022 Valencia, Spain
e-mail: leandro.garcia@uv.es

S. d. Saz-Salazar
e-mail: salvador.saz@uv.es

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

other reasons, to the difficulties in obtaining disaggregated freight data and the high heterogeneity of transport flows.

The objective of this paper is to estimate a discrete choice model providing empirical evidence on the determinants of mode choice between pure road and intermodal-rail transport in the Spanish freight corridor linking the regions of Aragon and Valencia (see Fig. 1). The population under study are the producers and distributors of manufactured goods that have handled unitised shipments in this corridor. The results obtained will allow us to assess the real possibilities of rail for transporting significant quotas of freight cargo on a national scale.

From a methodological point of view, we have used a disaggregated behavioural model similar to the ones previously applied in the area of freight transport by Brooks et al. (2012), Rotaris et al. (2012), Arunotayanun and Polak (2011), and Beuthe and Bouffioux (2008) among others. These models, based on the random utility approach and the application of discrete choice models (McFadden 1974; Manski 1977), assume that the decision-maker chooses the transport alternative that maximises utility (see De Jong 2008; Feo et al. 2011 for a detailed review of the difficulties related to the use of these models in the area of freight transport).

The proposed model reports an advance in understanding freight transport modal choice processes to the extent that it incorporates non-compensatory behaviours and comes therefore closer to the way decision-makers really behave. Indeed, in transport modelling researchers usually assume fully compensatory behaviours, that is, it is supposed that the decision-maker explicitly or implicitly use trade-offs between the levels of the different attributes, so that low levels of service for one or more attributes can be offset by high levels of service offered in terms of other or others attributes. However, given the decision-makers' limited capabilities (and resources) for processing information, the imposition of thresholds during the modal choice process seems to be more realistic. One of the specific objectives of this application is to analyse the existence and influence of attribute cut-offs.

Our work also tries to contribute to the practical implementation of state-of-the art data gathering techniques in the area of freight transport by illustrating the design of the questionnaire and the fieldwork carried out. In order to increase the statistical efficiency of the results, efficient stated preference (SP) techniques (Rose et al. 2008) have been applied. More specifically, carrying out the fieldwork in two separated phases have allowed us, on the one hand, to obtain information about the reference levels of service currently faced by interviewees and, on the other hand, to estimate the prior parameters required for generating the SP tailored efficient designs conducted during the second phase of the interview in the best possible way. In view of the crucial effect that these issues have on the quality of data, and therefore, on the quality and validity of the results derived from the model, we consider that the information provided could help to pave the way for other research groups working in the area of freight transport.

The rest of the paper is organised as follows: in Sect. 2 we present a description of the local context of the research and a review of the literature on discrete choice models with cut-offs. Section 3 provides a detailed description both of the design of the questionnaire and of the fieldwork carried out. Specifications carried out and policy implications drawn from the research are detailed in Sect. 4. Finally, Sect. 5 presents the conclusions.

Local context and literature review

Local context

At this moment there is one rail service connecting Valencia with Zaragoza with a frequency of two departures per week. However, this service is restricted to maritime traffics

Fig. 1 Corridor under analysis, Region of Valencia–Aragon

between the Port of Valencia and the Zaragoza Logistics Platform. Therefore, the only alternative currently available for transporting national shipments on this corridor is road transport.

Even if the quota of rail in the inland leg of Spanish maritime shipments is still low, around 2.5 % (Spanish Ministry of Public Works 2013a), fostering these services is one of the priorities of the current national and European freight transport policies (Spanish Ministry of Public Works 2010, 2013b; European Commission 2011). Nowadays no one doubts of the potential of rail for the management of maritime traffics. Proof of this is the strong bet made by private companies since the liberalisation of the sector in 2005: in the period July–December 2013, the 68 % of total national regular rail services operating in Spain were services devoted to the overland transport of containers (Valenciaport Foundation 2014). The problem is that the role played by rail for transporting pure domestic cargo is much less evident, and open regular rail services for unitised domestic shipments are almost non-existent. This lack of supply contrasts with the high quota that domestic road transport flows represent over total road traffic in Spain in tonnes, a 94 % in 2013 (Spanish Ministry of Public Works 2014). Given that figure, it is clear that the achievement of the objective of rebalancing modal split in Spain will require, not only transferring intra-European shipments from road to alternative modes, but also consolidating the rail mode in the domestic market.

In this sense the corridor under analysis is very interesting as the distance between Valencia and Zaragoza (312 kms.) is similar to that of others highly representatives national freight corridors such as the one linking Valencia with Madrid or Barcelona with Zaragoza. In countries like Spain, where the quota of rail for transporting freight cargo is still residual and the supply deregulation process still needs to be completed, obtaining an accurate knowledge of the logistics requirements of the demand is deemed essential for achieving the objective of rebalancing the modal split.

Literature review

According to the review carried out by Swait (2001), the generalised use of specifications based on fully compensatory decision-making rules would not be responding to a strong belief of its higher adequacy, but to the operative difficulties that relaxing this assumption entails. Conceptually, the two-stage approximation formulated by Manski (1977) seems more appropriate, as it recognises that in most of the cases decision-makers are unable to perfectly process all the information available due to limited resources and capabilities. However, its implementation can be extremely complex, as the number of choice sets increases exponentially with the number of alternatives considered. This approach presupposes that the decision-maker firstly applies the elimination-by-aspects rule developed by Tversky (1972): after ordering the attributes by their importance, the decision-maker examines the levels displayed by each of the alternatives and excludes from his choice set those that do not verify the "minimum/maximum expected level", that is, the cut-off. Following this, the compensatory decision-making rule is applied to identify among the remaining alternatives the one maximising utility.

Ben-Akiva and Boccara (1995) focused on the first stage of the choice process, the choice set generation, developing an explicit probabilistic representation of alternatives' availability. In order to do so, the authors took into consideration both observable and latent variables the latter allowing to obtain information on aspects that cannot be directly inferred from observed behaviour.

Cantillo and Ortúzar (2005) take the two-stage model formulated by Manski (1977) as a basis and analyse how the use of specifications that do not take into account non-compensatory behaviours, affect the accuracy of the estimations and the model predictive capacity. They use simulated and real data to compare the results provided by a multinomial logit (MNL) and a mixed logit (ML) assuming only compensatory behaviours with those provided by a semi-compensatory two-stage discrete choice model combining the elimination-by-aspects rules with compensatory behaviours. The authors obtain that, while the fully compensatory MNL and ML models provide estimations of cost and time coefficients significantly different from targets, their model estimates have the targets within their confidence intervals.

Moreover, Swait (2001) points out that when thresholds are introduced in the specification, they normally are introduced as "hard", its violation automatically leading to the exclusion of the alternative from the choice set (that is the case of the model proposed by Cantillo and Ortúzar 2005). However, this assumption does not correspond to the empirical evidence available on consumer decision strategies, which suggests the existence of what Swait calls "soft cut-offs", that is, attributes thresholds whose violation do not necessary lead to the rejection of the alternative. With the objective of relaxing these restrictions, Swait (2001) developed an extension to the traditional compensatory utility maximisation framework, which, besides allowing the introduction of non-compensatory behaviour rules, allows the violation of these rules. The model allows decision-makers to break their self-imposed cut-offs when disutility derived from breaking it is more than compensated by the increase in utility resulting from the good level of service displayed by the rest of attributes considered.

The *implicit availability/perception model* (IAP) developed by Cascetta and Papola (2001) is in line with the constrains' violation relaxation introduced by Swait. In their model the availability of a given alternative is represented by a continuous variable defined over the interval (0,1) that makes it possible capturing different degrees of availability/perceptions. Thus, in addition to conventional extreme cases of 0 (alternative definitely excluded from the choice set) and 1 (alternative included in the choice set), the IAP model allows for intermediate situations where alternatives are only partially taken into account. The constrained logit model (CLM) of Martínez et al. (2009) deepens into the model of

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

Cascetta and Papola and allows incorporating individuals' behaviour constraints in multinomial logit models by introducing a binomial logit factor representing soft cutoffs.

It should be pointed out that, unlike the specification proposed by Cantillo and Ortúzar (2005), where cut-offs are introduced as endogenous variables, in the model developed by Swait cut-offs are exogenous and, consequently, interviewees have to provide information about their attribute thresholds. Indeed, most of the research on non-compensatory behaviours infer thresholds through choices made by decision-makers, applications directly introducing self-reported cut-offs being less frequent. Endogenous applications estimate both the model's taste parameters and those of the threshold probability distribution function imposed by the researcher (normal, truncated normal, triangular, uniform, etc.). Although these specifications allow incorporating random and deterministic variations among individuals (for example by expressing the means as functions of the decision-makers characteristics), their capacity for capturing highly heterogeneous contexts is lower than that of self-reported cut-offs. Moreover, the effect that a misspecification of the threshold distribution may have on the results have to be further analysed. On the other hand self-reported cut-offs have the disadvantage of being "stated" values. Therefore, we cannot be certain that they are not affected by bias and that they fully correspond to real thresholds applied during the modal choice process.

Marcucci and Scaccia (2004) and Danielis and Marcucci (2007) also analysed the imposition of attribute cut-offs during the modal choice process in the area of freight transport in Italy. The authors applied the model proposed by Swait (2001) to a data sample on modal choice between pure road and intermodal transport obtained using SP questionnaires. In both cases, the results obtained showed that specifications including cut-offs substantially increased the predictive capacity of the model. More specifically, Danielis and Marcucci (2007) concluded that conventional models based on fully-compensatory behaviours overestimate coefficients, as they are capturing both, the importance attached to the attribute itself and that attached to the violation of the cut-off. Moreover, their results confirm the presence of heterogeneity in shippers' attribute preferences and in cut-offs levels. From an applied perspective the results show that, while transport cost and loss and damages variables display significant coefficients for both the level of the attribute and the magnitude of the cut-off violation, only the latter is found significant for transit time and delays. This result indicates that while the levels of these variables remain below the threshold their role in the modal choice process is not significant.

Questionnaire design

Efficient designs

For decades, the use of orthogonal designs has been considered common practice in the construction of stated choice experiments (Louviere et al. 2000). In an orthogonal design attributes are treated as statistically independent variables, being possible to estimate the influence of each attribute upon the observed outcomes. The problem is that whereas in linear models the orthogonality in the design avoids multicollinearity and thus it ensures that the model will optimize the significance level of the parameter estimates, these properties are not transferred to non-linear models such as discrete choice models. In that case, recent researches have highlighted the advantages of using efficient designs to obtain better results in terms of statistical efficiency, as they provide more reliable parameter estimates with equal or lower sample size (Rose and Bliemer 2009). This property is especially appealing in the case of freight transport where samples sizes are relatively small. Moreover, efficient designs also tend to result in better forecasts (Ferrini and Scarpa 2007).

The objective of efficient designs is to obtain data allowing to estimate parameters with standard errors as low as possible. Statistically, minimising standard errors is equivalent to minimise the D-error, that is, the determinant of the asymptotic variance–covariance matrix (AVC).

$$D - error = \Omega_N(X, Y, \beta) = -[E(I_N(X, Y, \beta))]^{-1} = -\left[\frac{\partial^2 L_N(X, Y, \beta)}{\partial\beta\partial\beta'}\right]^{-1} \quad (1)$$

where I is the Fisher information matrix, L the maximum-likelihood function, N the number of individuals in the sample, X the experimental design, Y the outcomes of the dependent variable and β the vector of parameters.

The problem is that the AVC matrix varies with the model to be estimated. It depends therefore on the design matrix X, the outcomes of the survey Y and the parameter values β. The fact that prior information on the parameters is required for identifying the optimum design in terms of statistical efficiency is paradoxical, since the objective of the design is precisely to obtain the necessary data for estimating a model providing estimates of these parameters.

In practice, when compared to orthogonal designs, the implementation of efficient SP experiments has two main drawbacks. First of all, prior information about unknown parameters is needed, which, in the case of freight transport, it is not always evident to obtain. Indeed, the empirical evidence available in the freight transport research area is relatively scarce, which can make it difficult to find reference values corresponding to similar populations and decision-making processes.

Secondly, if you want to adjust the levels of the attributes to the respondent's current experience in order to gain realism in the outcomes, you will also need information on the reference levels. Here again, for freight transport, obtaining this information is not always straightforward. Levels of service are much less homogeneous than in passenger transport since transport shipments requirements vary enormously depending on a variety of factors such as the size (consolidated or full-loaded), the type of product (refrigerated, dangerous, etc.) or simply the shipper relative negotiating power. Moreover, those data are not directly available for the researcher, but rather have to be provided by the interviewee, who in many cases considers this information as strategic for its competitiveness and wants therefore to keep it confidential.

To solve these difficulties in this research we structured the fieldwork in two separate phases. Firstly, during a personal interview, we collected information about the main characteristics of the shipment and the transport reference alternative and we carried out a non-efficient SP experiment. Thus, we were able to estimate a preliminary model providing the prior parameters afterwards used in the construction of the D-efficient experiment. Moreover, the information obtained about the characteristics of the current transport alternative allowed us to generate, with the Ngene software (ChoiceMetrics 2009), a specific efficient design for each of the companies. This SP experiment was conducted during the second phase of the fieldwork. Although we would have preferred to carry out face-to-face interviews since this survey mode allows to increase the quantity and quality of the information obtained, budget restrictions forced us to carry out the efficient SP experiment on a web basis. Nevertheless, the fact that a personal interview had already been carried out (allowing us to make sure that the interviewee fully understood the SP experiment) and the telephone follow-up allowed us to maximise the quality of the results.

Description of the questionnaire and data

SoftwareSawtooth (2008) was used in the design and application of the questionnaire. Questionnaires were performed by researchers specialised in transport and logistics through personal interviews that lasted around 30 min (57 questions).

The questionnaire carried out during the first phase was structured into 3 sections. The objective of the first section was to obtain general information on the characteristics of the company and on their perception about the level of service currently offered by road transport services connecting Aragon and Valencia. During the second block the interviewer identified the reference shipment and gathered information about the characteristics of the transport service effectively employed and about the theoretical cut-offs imposed by the interviewee for each of the attributes. Finally, using the information obtained regarding the characteristics of the reference shipment and its transport alternative as a basis, a 12-scenario non-efficient SP experiment was carried out.

The SP experiment finally carried out included the following attributes (Fig. 2 displays the screen introducing the SP experiment):

- Door-to-door transport cost, in Euros per shipment.
- Door-to-door transit time, in hours.
- Frequency of the transport service, in number of weekly departures.
- Delays, in terms of the percentage of shipments suffering significant delays.
- Notice for contracting, variable that combines the notice for contracting the transport service before the scheduled time of departure (in days) with the probability of the shipment being finally transported in that service.

The attributes and their levels were initially chosen on the basis of the information provided by the panel of rail and transport experts participating in the focus group. The two pilots carried out with producers allowed us to adjust the attribute levels to our specific case study and to verify the existence of trade-offs.

Information about decision-makers switching behaviour (Ben-Akiva and Morikawa 1990) was obtained through an experiment requiring choosing between the current transport option and a hypothetical one.

As a result of the pilots the SP design was substantially modified (see Table 1). Specifically, the levels of the variables door-to-door transit time—time since the shipment is picked up at the installations of the shipper until it is delivered to the receiver—and transport cost were changed, and the variable “schedule” initially included in the experiment replaced by “delays”.

Concerning door-to-door transit time, the levels for the hypothetical alternative were initially adjusted to the one of the reference transport option (increases of 200, 250 and 325 %). However, during the pilot study we realised that those levels resulted in an excessive transit time, since the reference level provided by producers (door-to-door total transit time including consolidating and de-consolidating time) did not matched average transit times provided by transport providers during the focus group, which corresponded to pure transport time between Aragon and Valencia. Consequently, the levels of the door-to-door transit time variable were re-adjusted and defined independently from the reference alternative. Door-to-door transport cost levels were also modified following the pilot, savings derived from the shift to our hypothetical intermodal-rail option being increased.

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

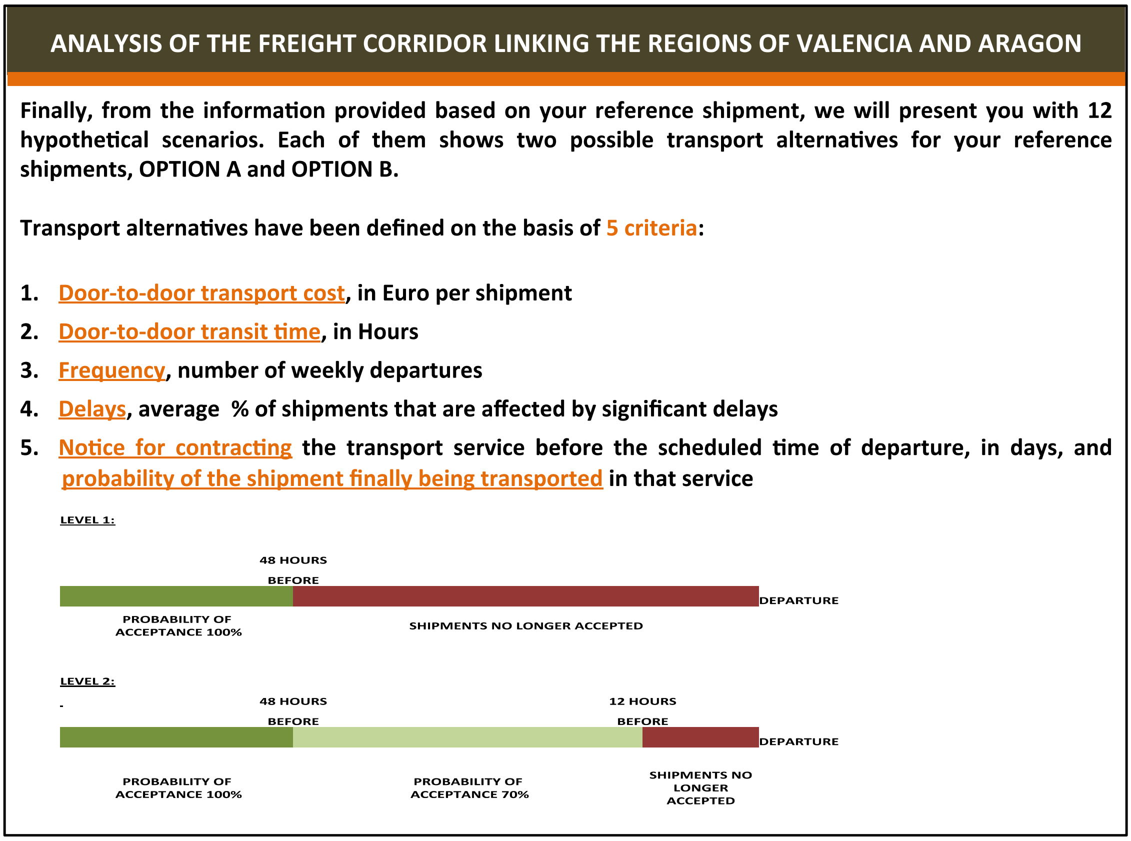

Fig. 2 Introduction to the SP experiment screen

Finally, the variable "schedule" was replaced by "delays". In the first version of the experiment our hypothetical rail service was offering either an evening departure—rail service leaving during the evening and arriving first hour in the morning, making it possible to deliver shipments to their final destination this same morning—, or a night departure—departure early morning and arrival next day mid-morning, delivery to the final destination not being possible until the evening-. The difference between the two services lied therefore in the expected delivery time: next day during the morning/afternoon in the case of the evening service and next day during the evening or even 2 days after for the night service. It must be pointed out that rail freight services have to share infrastructure with passenger services and that the latter have priority over the former. By including this variable we wanted to incorporate to the analysis this rail transport peculiarity and to value to what extent the passenger services priority is limiting/restricting the capacity of rail to attract cargo from road. But during the pilot study we realised that differentiating between an evening and a night service only makes sense for pure transport transit times of 15 h or less. Above this threshold, total transit time was not affected by the rail timetable, the responsible of larger transit times being the door-to-rail and rail-to-door segments.

Concerning the delay variable it should be recalled that the concept of delays in delivery times incorporates both the *percentage of shipments that are affected by delays on the delivery date originally scheduled* and the *absolute magnitude of such delays*. In this research we have focused on the former, leaving for future works the analysis of the average size of delays. Moreover, in order to take into account the subjective nature of delays—what a delay is substantially varies across shipments—the variable was defined as "the percentage of shipments suffering *significant* delays", thus being the interviewee (in

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

Table 1 Non-efficient design: attributes and levels

Attributes	Alternative	Unit	Initial design	Final design
Transit time (time)	Road	Hours	Current level	Current level
	Rail	Hours	Level 1: 200 % of road level	Level 1: 15 h
			Level 2: 250 % of road level	Level 2: 24 h
			Level 3: 325 % of road level	Level 3: 36 h
Transport cost (cost)	Road	€/shipment	Current level	Current level
	Rail	€/shipment	Level 1: 80 % road level	Level 1: 65 % road level
			Level 2: 90 % road level	Level 2: 75 % road level
			Level 3: 95 % road level	Level 3: 90 % road level
Frequency (freq)	Road	Weekly departures	Current level	Current level
	Rail	Weekly departures	Level 1: 1 weekly departure	Level 1: 1 weekly departures
			Level 2: 3 weekly departures	Level 2: 3 weekly departures
			Level 3: 5 weekly departures	Level 3: 5 weekly departures
Notice for contracting (cont)	Road	Days, %	Current level, acceptance 100 %	Current level, acceptance 100 %
	Rail	Days, %	Level 1: 2 days before, 100 % acceptance	Level 1: 2 days before, 100 % acceptance
			Level 2: ½ day before, 70 % acceptance	Level 2: ½ day before, 70 % acceptance
			Level 3: ¼ day before, 30 % acceptance	
Schedule	Rail	Schedule	Level 1: evening	
			Level 2: night	
Delays (del)	Road	%		Current level
	Rail	%		Level 1: road level + 2 perc. points
				Level 2: road level + 5 perc. points
				Level 3: road level + 10 perc. points

the first part of the questionnaire) the one fixing from what moment he considered a significant delay was taking place.

During the first phase of the fieldwork, 159 interviews were carried out with companies located in the provinces of Valencia (99) and Zaragoza (60). Data obtained through the SP allowed us to estimate a preliminary multinomial logit model (Eqs. 2 and 3) providing the priors parameters required for generating SP efficient designs. Although the pseudo-panel structure of the data makes the use of models allowing for correlation among non-observed factors—such as mixed logit—more convenient, in this phase of the research we considered that the operational advantages of the MNL overcame its limitations.[1]

$$U_{nroad} = \beta_1 COST_{road} + \beta_2 TIME_{road} + \beta_3 FREQ_{road} + \beta_4 DEL_{road} + \beta_5 CONT_{road} + \varepsilon_{nroad} \quad (2)$$

$$U_{nrail} = \beta_1 COST_{rail} + \beta_2 TIME_{rail} + \beta_3 FREQ_{rail} + \beta_4 DEL_{rail} + \beta_5 CONT_{rail} + \varepsilon_{nrail} \quad (3)$$

where ε_n is the random term which is Gumbel identically and independently distributed.

Version 2.2 of BIOGEME software (Bierlaire 2003) was used for estimating the model. Table 2 displays the results obtained.

All the coefficients, except the one for "delays", are significant and display the expected sign: positive in the case of frequency and negative for transport cost, transit time and notice for contracting.

The variable "notice for contracting" is specific to our application and combines the notice for contracting the transport service before the scheduled time of departure with the probability of the shipment being finally transported in that service. Freight transport providers participating in the focus group stressed the role played by the *booking window* in the relative competitiveness of intermodal transport when high levels of demand are reached and additional increases in supply cannot be achieved in the short/medium term due to infrastructure and equipment restrictions. During the review of the literature we were not able to identify any similar variable, which makes our 2-phase fieldwork particularly interesting, since it allowed us to obtain the parameter estimates necessary for generating the D-efficient design in the best possible way.

Moreover, personal interviews allowed us to obtain accurate information about the levels of service offered by the reference alternative, which in turns enabled us to adjust transit time levels to the one displayed by the current road service in order to increase the realism of the experiment.

The fact that the coefficient of delays was not significant contradicts both the empirical evidence available on the subject (De Jong et al. 2014; Kurri et al. 2000) and the empirical evidence obtained through the fieldwork since when asked to rate the importance given to transport attributes in the modal choice process, a vast majority of interviewees considered delays to be one of the most important factors (see Fig. 3).

One possible explanation for this counter-intuitive result could be that the levels of delays in the SP game were not adequately defined. Given the high level of service that road hauliers were offering in terms of delays—on average the interviewees qualified the current level of service as good-, the levels proposed for the rail alternative—road delays increased by 2, 5 and 10 percentile points—would be, in many cases, below the maximum percentage of delayed shipments that companies will be willing to accept, that is, our levels will be below the cut-off. In this sense, the result would be in line with that obtained by Marcucci and Scaccia (2004) in relation to the imposition of cut-off points in attribute levels: while the levels of these attributes remain below the maximum level a decision maker would accept, their role in modal choice will be insignificant.

During the personal interview companies were asked to assess the cut-offs that they were theoretically imposing to each of the attributes. Thus, for example, companies were

[1] Simulations carried out (Rose et al. 2009) show that designs generated for MNL perform reasonably well with more advanced models such as mixed logit.

Table 2 Preliminary estimates with non-efficient data

Variable	Coefficient	T test
Door-to-door transport cost (cost)	−0.00346	−2.84
€ per shipment		
Door-to-door transit time (time)	−0.0249	−8.37
Hours		
Frequency (freq)	+0.463	+12.43
No of weekly departures		
Delays (del)	−0.0141	−0.87
% of shipments affected by significant delays		
Notice for contracting (cont)	−0.177	−3.91
Days before the scheduled time of departure and probability of acceptance.		
No of observations = 1,908	$Rho^2 = 0.230$	
Log likelihood = −1,018	Adjusted $Rho^2 = 0.226$	
Log. lik. Ratio test = 608		

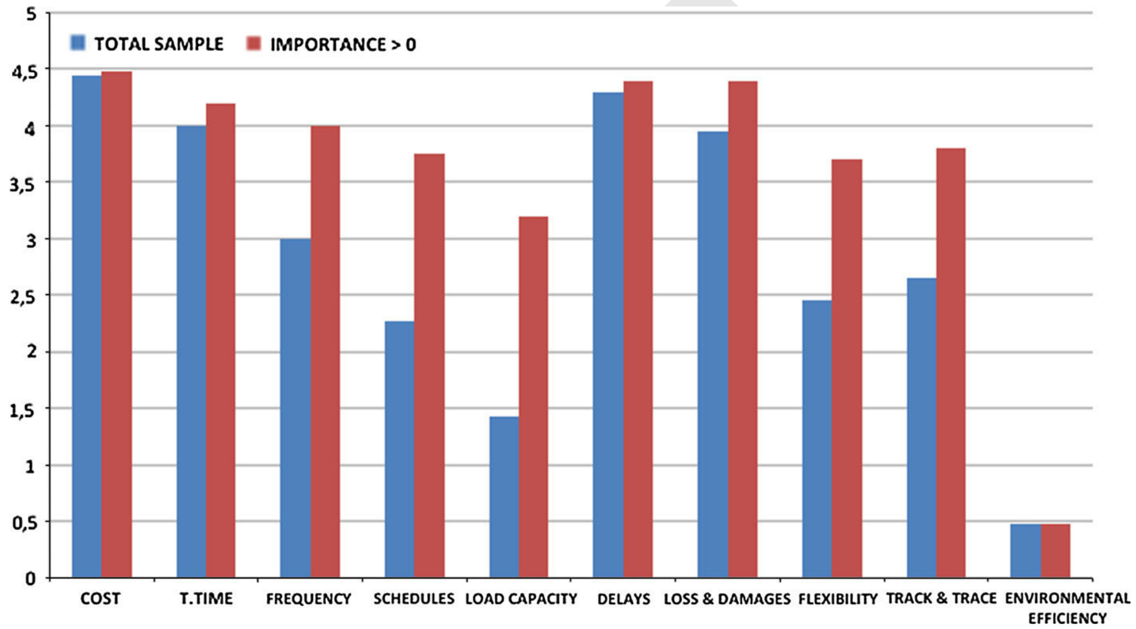

Fig. 3 Average importance that interviewees said to attach to transport attributes during the transport provider choice process in the corridor linking Aragon and Valencia regions

asked to provide both the current reference shipment' transport cost and the maximum transport cost they will accept to pay. Figure 4 shows how this information was requested.

Table 3 shows the average results obtained. The margin' column shows the difference between the current level of service and the theoretical cut-off both in absolute and relative terms. For example, the average transport cost in our sample is 155 euros per shipment, whereas the average cut-off is of 216 euros. Therefore, there will be a margin for a 28 % increase in the cost. As it can be seen, the delay variable displays the bigger difference between the current average level of service and its theoretical cut-off. In this sense, our initials levels of "2 and 5 percentile points more than the road" will barely allow us to reach the 7 % cut-off. Consequently, in the efficient design the levels of the delay variable were increased to 5, 10 and 15 percentile points more than in the current road alternative. Last column of Table 3 shows the number of efficient SP scenarios displaying levels for delays above the stated cut-off.

Once the attributes and levels of the experiment were re-adjusted (see Table 4), software Ngene (ChoiceMetrics 2009) was used to generate the efficient design for each of the 159 shipments identified in the corridor. A specific design was created for every single respondent (Rose et al. 2008) using a MNL specification with the parameter priors obtained through the first phase of the fieldwork and the values of the attributes provided by the interviewee for the reference transport alternative.

During the second phase of the fieldwork—efficient SP experiments via web-, only 14 companies (9 %) of the initial sample refused to continue participating, while 7 companies (4 %) have ceased activity. A web link to the tailored efficient SP experiment was then sent to each of the remaining 138 companies. The number of scenarios was set to 12 since we considered it would allow us to gather enough observations as to adequately estimate the model while keeping the experiment manageable to the interviewee. In the end, 94 companies answered to the efficient SP experiment (1,128 observations), which represents a response rate of 68 %. The average characteristics of the 94 companies finally considered in the sample, as well as those of the reference shipment and transport option, are presented in Tables 5, 6 and 7.

Analysis of the existence of attribute cut-offs: estimation and results

The results of the models specified to analyse the existence of attribute cut-offs are shown in Table 8. As stated preference was used to obtain the data, each company providing 12 observations, the use of a model allowing the existence of correlation among non-observed factors was considered more appropriate. All the specifications shown correspond to a mixed logit error components model (EC-ML). The high statistical significance of sigma (the standard deviation of the vector of random errors) confirms the higher adequacy of the specification employed compared to a traditional multinomial logit[2] model.

Model 1 is based on the conventional compensatory-behaviour framework (Eqs. 4 and 5).

$$\begin{aligned} U_{nroad} = {} & ASC\_ROAD + \beta_1 COST_{road} + \beta_2 TIME_{road} + \beta_3 FREQ_{road} + \beta_4 DEL_{road} \\ & + \beta_5 CONT_{road} + m_n + \varepsilon_{nroad} \end{aligned} \tag{4}$$

$$U_{nrail} = \beta_1 COST_{rail} + \beta_2 TIME_{rail} + \beta_3 FREQ_{rail} + \beta_4 DEL_{rail} + \beta_5 CONT_{rail} + m_n + \varepsilon_{nrail} \tag{5}$$

Model 2, based on the *soft cut-offs model* proposed by Swait in 2001, allows for changes in the marginal utility above the stated thresholds by introducing for each of the attributes a fictitious variable that takes the value of the difference between the proposed level of service and the cut-off if this value is positive (the cut-off is violated) and value 0 if the difference is negative (we are below the cut-off). Equations (6) and (7) show the specification employed.

[2] Models displayed in Table 8 were also estimated as multinomial logit, obtaining in all the cases lower R^2 than the ones presented here.

ANALYSIS OF THE FREIGHT CORRIDOR LINKING THE REGIONS OF VALENCIA AND ARAGON

Please, provide the following information on the characteristics of your reference shipment' current transport option.

ATTRIBUTE	LEVEL OF YOU CURRENT TRANSPORT OPTION	CUT-OFF(1)
DOOR-TO-DOOR TRANSPORT COST Euro per shipment		
DOOR-TO-DOOR TRANSIT TIME Hours		
FREQUENCY Weekly departures		
DELAYS % of shippments suffering significant delays		

(1) In this column you should indicate the maximum/minimum level of the attribute that you are willing to accept for your reference shipment. For example, a cost cut-off of 800 Euro means that the maximum price you will be willing to pay for transporting the reference shipment is 800€.

Fig. 4 Characteristics of the reference shipment' current transport option and cut-offs screen

$$\begin{aligned} U_{n_{road}} = {} & ASC_{road} + \beta_1 COST_{road} + \beta_2 TIME_{road} + \beta_3 FREQ_{road} + \beta_4 DEL_{road} + \beta_5 CONT_{road} \\ & + \beta_6 \max[0, COST_{road} - COCn] + \beta_7 \max[0, TIME_{road} - COTn] \\ & + \beta_8 \max[0, FREQ_{road} - COFn] + \beta_9 \max[0, DEL_{road} - CODn] + \mu_n + \varepsilon_{n_{road}} \end{aligned} \tag{6}$$

$$\begin{aligned} U_{n_{rail}} = {} & \beta_1 COST_{rail} + \beta_2 TIME_{rail} + \beta_3 FREQ_{rail} + \beta_4 DEL_{rail} + \beta_5 CONT_{rail} \\ & + \beta_6 \max[0, COST_{rail} - COCn] + \beta_7 \max[0, TIME_{rail} - COTn] \\ & + \beta_8 \max[0, FREQ_{rail} - COFn] + \beta_9 \max[0, DEL_{rail} - CODn] + \mu_n + \varepsilon_{n_{rail}} \end{aligned} \tag{7}$$

where

- COC is the maximum cost, in euros per shipment, the interviewee says he will be accepting to pay for transporting the reference shipment.
- COT is the maximum transit time, in days, the interviewee says he will be willing to accept for transporting the reference shipment.
- COF is the minimum level of frequency, in weekly departures, the interviewee says he will be willing to accept for transporting the reference shipment.
- COD is the maximum percentage of significant delays the interviewee says he will be willing to accept for transporting the reference shipment.
- μ is a vector of random errors with zero mean and σ standard deviation.
- ε is a random error, which is Gumbel identically and independently distributed.

The log-likelihood ratio test carried out between model 2 and 1 confirms that the inclusion of cut-offs significantly improves the goodness-of-fit.

Likewise, we analysed the presence of random variations in individual preferences by introducing attributes and cut-offs coefficients as random. One of the most critical issues in the specification of mixed logit models is to determine which coefficients should be introduced as random. The Lagrange multiplier test proposed by Train and McFadden (McFadden and Train 2000) and the t-statistic of the standard deviation of the random parameter (Hensher and Greene 2003) have been used to identify random coefficients (see

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

Table 3 Average level of service provided by road transport and average cut-offs

	Road average level (A)	Average cut-off (B)	Margin		Violation of cut-off	
			C = B − A	C/B (%)	No of scenario	%/ total
Cost € per shipment	155	216	61	28	180	16
Time Hours	34	50	16	31	668	59
Frequency Weekly departures	5	4	−1	−39	528	47
Delays % of delayed shipments	3	7	4	57	1,004	89

Mariel et al. 2013 for a comparison of size and power of the two tests). Both tests provide the same result: from all the attributes considered in our model the only one whose coefficient should be introduced as random is frequency. Model 3 is analogous to model 2 but with the coefficient of frequency introduced as random following a triangular distribution.

The coefficient of the frequency variable is only significant in model 3, when introduced as a random parameter with a triangular distribution, which indicates that there might be a high level of heterogeneity in the valuation of this attribute among the companies of our sample. Our believe was that while a segment of the sample was indeed valuing frequency in a positive way, the other segment was indifferent to this variable, they have a zero or a near zero value of frequency, so at the end the significance of the coefficient for the entire population was hampered by the presence of respondents who were not taking this variable into account during the modal choice process.

In order to corroborate this hypothesis, we have followed the analysis proposed by Hess et al. (2006). Specifications of models 4 and 5 are analogous to that used in model 3, but instead of specifying a continuous distribution for the coefficient of frequency a discrete mixture has been employed (Greene and Hensher 2003) allowing for the estimation of two class-specific parameters. The log-likelihood ratio test carried out between models 3 and 4 and 3 and 5 confirms that the latent class specification leads to a significant improvement.

In model 4 (restricted model) one of the frequency-coefficients is fixed at zero, whereas in model 5 (unrestricted model) both coefficients are estimated freely. Even if the likelihood-ratio test carried out between models 5 and 4 (test $\chi^2 = 4.024$ and 95 % threshold = 3.84) suggests that the unrestricted model significantly improves the goodness-of-fit at the 95 % confidence level, it should be pointed out that the opposite is concluded at the 99 % confidence level. Moreover, the value estimated for one of the frequency coefficients in model 5 is close to zero and only significant at the 10 % level. The coefficient obtained for the other segment of the population is however highly significant and shows the expected sign. So, even if results should be interpreted with caution, they are aligned with our initial hypothesis that a segment of the sample (41 % according to the mass probability estimated in model 4 and 35 % in model 5) is indifferent to this variable. Given the limitations of the Spanish rail infrastructure, and the fact that a critical mass has to be reached in order to make the train service economically viable, the results obtained point out the huge effort that train operators have to make to accurately identify potential

Table 4 Efficient design: attributes and levels

Attributes	Alternative	Unit	Design used in the 1st phase of the fieldwork	Final design used in the 2nd phase of the fieldwork
Transit time (time)	Road	Hours	Current level	Current level
	Rail	Hours	Level 1: 15 h	Level 1: road level + ½ day
			Level 2: 24 h	Level 2: road level +1 day
			Level 3: 36 h	Level 3: road level + 2 days
Transport cost (cost)	Road	€/shipment	Current level	Current level
	Rail	€/shipment	Level 1: 65 % road level	Level 1: 65 % road level
			Level 2: 75 % road level	Level 2: 75 % road level
			Level 3: 90 % road level	Level 3: 90 % road level
Frequency (freq)	Road	Weekly dep.	Current level	Current level
	Rail	Weekly dep.	Level 1: 1 weekly dep.	Level 1: 1 weekly dep.
			Level 2: 3 weekly dep.	Level 2: 3 weekly dep.
			Level 3: 5 weekly dep.	Level 3: 5 weekly dep.
Notice for contracting (cont)	Road	Days, %	Current level, acceptance 100 %	Current level, acceptance 100 %
	Rail	Days, %	Level 1: 2 days before, 100 % acceptance	Level 1: 2 days before, 100 % acceptance
			Level 2: ½ day before, 70 % acceptance	Level 2: ½ day before, 70 % acceptance
Delays (del)	Road	%	Current level	Current level
	Rail	%	Level 1: road level + 2 perc. points	Level 1: road level + 5 perc. points
			Level 2: road level + 5 perc. points	Level 2: road level + 10 perc. points
			Level 3: road level + 10 perc. points	Level 3: road level + 15 perc. points

customers requirements, being aware that in some cases aggregating both segments of such a polarised demand will not be possible. This is a key issue from the supplier and policy-maker perspective. Of particular relevance for future research are therefore the analysis of attribute non-attendance and the identification of class-membership functions in line with the researches carried-out by Greene and Hensher (2010).

For the delay variable, we only obtain a significant coefficient in model 1. When cut-offs are included in the specification, the coefficient of the variable is no longer significant, whereas the one of its cut-off is very significant. This result is in line with that obtained by Marcucci and Scaccia (2004) and confirms our previous hypothesis, made during the design of the experiment, about the non-significance of this variable while its level remains below the cut-off. One of the main conclusions of our research is therefore that delays are of low importance if the cut-off is respected.[3] However, once the cut-off is reached, additional increases in the percentage of shipments suffering significant delays are very

[3] In order to ensure that this result indeed reflects a non-compensatory behaviour and is not just the consequence of the relatively low proportion of scenario with acceptable delay levels (11 % of total observations display levels of delays in the rail alternative below the cut-off), model 2 was re-estimated with data obtained from the first SP experiment. In this experiment rail levels of delays were lower, resulting in a

Table 5 Average characteristics of companies included in the sample

	No of companies	%/total
Companies located in the region of Valencia	54	57
Companies located in the region of Aragon	40	43
Producing-only companies	47	50
Distributing-only companies	7	7.5
Producing and distributing companies	40	42.5
Companies exporting	71	76
Assume logistics for international shipments	50	53
Own means of transport for domestic shipments	19	20

	Minimum	Average	Maximum	SD
Export quota (%)	0	23	85	26
No of employees	4	55	550	83

Table 6 Average characteristics of reference shipments

	No of shipments	%/total
Region of Valencia–Aragon	54	57
Aragon–Region of Valencia	40	43
Full loaded	19	20
Supplier: freelance	9	10
Supplier: transport agency	84	89
Own means of transport	9	10
Fixed day pick-up	8	9
Delivery on the same day	2	2

	Average	SD
Quota corridor/total domestic sales	9 %	8
Shipment frequency (no weekly departures)	0.9	1.3
Value (€ per shipment)	5,049	8,740
Threshold significant delay (h)	22	22

strongly penalised, thus the attribute delays becomes a key determinant of the relative competitiveness of the transport alternative.

For the cost variable, both the coefficients of the attribute and of the cut-off are significant. The absolute value of the cut-off parameter is more than twice the one obtained for the attribute parameter, so when the upper limit is reached, additional increases in transport cost are strongly penalised. In the case of transit time and frequency, we obtain a non-significant coefficient for their cut-offs, which indicates a compensatory behaviour.

Considering the logistics characteristics of rail transport, the "notice for contracting" variable has been introduced in the model. The results obtained show the importance of the

Footnote 3 continued
higher proportion of *below cut-offs* cases (25 %), and yet we obtain the same result: non-significant coefficient for the attribute and very high significance of the coefficient of the cut-off.

Journal : Small 11116 Dispatch : 29-10-2014 Pages : 22

Table 7 Average characteristics of transport reference alternative

	Average	SD
Transport cost	150	195
€ per shipment		
Transit time	34	22
Hours		
Delays	4 %	11
% of delayed shipments		
Frequency	6	3
No of weekly departures		
Notice for contracting	6	16
Hours		

own specificities of each sector logistic chain with regard to its shipments and the timing of these latter. To date, this variable has not been considered in the previous literature despite its obvious importance.

Table 9 shows the subjective values of freight transport attributes under the hypothesis that the level of transport cost remains below its cut-off.

Special attention must be paid to the effect that the introduction of cut-offs has on the subjective value of delays that rises from 2.84 euros for reducing the probability of suffering significant delays in one percentile point, to 26 and 20 euros in models 2 and 3, respectively, and to 13 and 14 euros in models 4 and 5, respectively. In the same vein, the subjective value of frequency is substantially affected by the existence of population segments with zero-valuation, thus its non-consideration leading to artificially low figures.

Finally, Table 10 displays changes in the probability of choosing rail transport when faced to variations in the levels of the attributes of both, the road and the rail alternative.[4] Even if their absolute value is questionable—as they have been obtained with SP data-, they are indicators of the decision-makers relative sensitivity to variations in the configuration of the supply and therefore interesting conclusions can be drawn.

An increase in the cost of road transport is among the most effectives measures in terms of modal shift. The higher sensitivity to deteriorations in the cost of the competing mode than to improvements in the own level of service becomes especially relevant when attributes cut-offs are introduced. This is a particularly interesting result, as it sheds some light to the ongoing European debate on the optimal way of internalising freight transport externalities: via road pricing schemes such as the ones considered in the Eurovignette (European Parliament 2011) and/or via direct subsidies to alternative modes such as the Italian Ecobonus and Ferrobonus.[5] Beyond the budget and social considerations inherent to the internalisation in one way or another, what is clear is that their estimated efficiency can largely be biased in the presence of non-compensatory behaviours. Thus, a conventional specification (Model 1) will lead us to affirm that the choice of internalising externalities

[4] The sample enumeration method has been used to calculate variations in the rail probability. Model 3 forecasts have been calculated using the estimated mean for the parameter of frequency. In model 4 individuals have been randomly assigned to one of the two segments following the estimated mass probabilities.

[5] The objective of the Ecobonus and Ferrobonus aid schemes is to reduce the cost of combined transport using short-sea shipping or electrified rail transport for at least part of the journey. It consists of a partial payment to the users covering the part of the external costs avoided compared to pure road transport.

Table 8 Estimation results

Attributes	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef.	T test	Coef.	T test	Coef.	T test	Coef.	T test	Coef.	T test
ASC road	0.265	0.32	−0.554	−0.69	−1.080	−1.15	−1.18	−1.64	−1.29	−1.84
Cost	−0.027	−5.44	−0.022	−3.74	−0.028	−3.74	−0.026	−5.28	−0.026	−5.25
Time	−0.043	−4.78	−0.042	−2.86	−0.048	−2.93	−0.048	−3.36	−0.049	−3.43
Delays	−0.077	−2.36	−0.070	−0.93	−0.126	−0.33	−0.120	−1.450	−0.124	−1.53
Notice for cont.	−0.444	−2.46	−0.545	−3.24	−0.680	−3.16	−0.621	−4.150	−0.632	−4.21
Frequency	0.134	0.84	0.004	0.06	0.094	2.16				
Frequency spread					−0.26	−2.41				
Frequency (A)							0.644	4.26	0.609	4.43
Frequency (B)							0		−0.091	−1.78
Mass for (A)							0.585	3.12	0.645	3.66
Mass for (B)							0.415	2.21	0.355	2.01
Cut-off cost			−0.054	−4.26	−0.067	−3.61	−0.059	−2.97	−0.059	−2.94
Cut-off time			−0.011	−0.64	−0.020	−0.86	−0.013	−0.77	−0.013	−0.79
Cut-off frequency			0.004	0.06	0.000	0.00	0.003	0.04	0.004	0.05
Cut-off delays			−0.585	−4.96	−0.569	−4.12	−0.341	−2.22	−0.378	−2.23
Sigma	2.8	6.32	2.77	6.36	3.49	3.35	3.17	7.51	3.15	7.65
No obs.	1,128		1,128		1,128		1,128		1,128	
No. of indiv.	94		94		94		94		94	
Log-likelihood	−453.216		−453.216		−416.859		−414.495		−412.483	
Adjusted Rho^2	0.411		0.411		0.451		0.453		0.455	
No of parameters	7		11		12		13		14	
Test χ^2			54[a]		19[b]		4.73[c]		8.72[d]	
Critical value—95 %			9.49		3.84		3.84		5.99	

[a] Log-likelihood ratio test between models 1 and 2

[b] Log-likelihood ratio test between models 2 and 3

[c] Log likelihood ratio test between models 3 and 4

[d] Log likelihood ratio test between models 3 and 5

through one measure or another is relatively neutral. However, when non-compensatory behaviours are allowed the higher efficiency of road pricing schemes is obvious.

For the rest of the attributes the opposite pattern is observed, the rail probability being more sensitive to improvements in its own level of service than to variations in the alternative mode. Proactive polices increasing rail services quality are therefore necessary.

Finally, the crucial role frequency plays in the competitiveness of rail transport must be highlighted. Here again, using one specification or another leads to opposite conclusions, moving from a scenario where frequency is not even significant to another where it is highly important. The results obtained in models 3 and 4 suggest that, in the specific case of the corridor under analysis, only rail services offering high levels of frequency will be able to fully compete with road transport. The question then arises of how to deal with the

Table 9 Estimated subjective values of transport attributes

Attributes	Model 1	Model 2	Model 3	Model 4	Model 5
Cost below its cut-off					
Transit time	1.60	1.89	1.72	1.85	1.90
€ per shipment and hour					
Frequency			3.39		
€ per shipment and weekly departure					
Segment A				24.67	23.60
Segment B				0	−3.52
Notice for contracting	16.44	24.66	24.37	23.79	24.50
€ per day					
Delay	2.84	26.47	20.39	13.06	14.65
€ per percentile point increase above cut-off level.					

Table 10 Variations in the probability of choosing intermodal rail

	Model 1	Model 2	Model 3	Model 4
Road				
Transport cost +1 %	0.542	0.454	0.548	0.588
Transit time +1 %	0.174	0.068	0.067	0. 082
Delays +1 %	0.041	0.116	0.071	0.075
Notice for cont. +1 %	0.016	0.009	0.011	0.013
Frequency −1 dep. per week	–	–	0.020	1,352
Rail				
Transport cost −1 %	0.420	0.166	0.204	0.229
Transit time −1 %	0.291	0.105	0.105	0.123
Delays −1 %	0.128	0.232	0.181	0.183
Notice for cont. −1 %	0.061	0.027	0.029	0.032
Frequency +1 dep. per week	–	–	0.343	1,449

vicious circle that hampers the consolidation of rail and maritime modes in short/medium distances: offering high levels of frequency requires a certain level of demand, however, this critical mass can only be reached if high levels of service are offered. In this sense, scenarios where rail services are open to both domestic cargo and door-to-port/port-to-door traffic should be considered/analysed, as they will allow reaching more easily the occupancy rate required for the project being profitable and thereby increase the engagement of the private sector.

In terms of the optimal configuration of the transport service and also in terms of policy-making recommendations, the results obtained are completely different depending on whether or not we are taking into-account both cut-offs and the presence of population segments with zero-valuations.

Conclusions

In this application efficient SP designs have been used to obtain data. The main advantage of these designs is that they maximise the statistical efficiency of the results in non-lineal models. This is particularly interesting in the case of freight transport applications where sample sizes are normally limited. Low sample sizes can therefore be partially offset by the higher statistical efficiency achieved through the use of this technique.

However, the implementation of efficient designs presents the drawback of requiring prior information on the unknown parameters. Moreover, if you want to adjust the levels of the attributes to the respondent's current experience in order to gain realism in the outcomes, you will also need information on the reference levels. The fieldwork in two phases carried out in our research has been very useful in solving these limitations.

Methodologically, the models estimated have allowed us to analyse the existence and influence of attribute cut-offs and to highlight the presence of a segment of the population with a zero-value of frequency. Moreover, our specifications include an attribute—notice for contracting—that, as far as we know, has never been considered in freight modal choice problems besides being a key determinant of the intermodal alternatives relative competitiveness.

The results obtained in relation to the transport cost variable show that decision-makers strongly penalised increases in transport cost above its cut-off. Concerning delays, the non-significance of its coefficient when attribute cut-offs are introduced indicates that, while its level remains below the cut-off, decision-makers do not take this variable into account during the modal choice process. However, once the cut-off is reached, additional increases in the percentage of shipments suffering significant delays are very strongly penalised. For the frequency variable, the results obtained show the existence of highly polarised positions, emphasising the weaknesses of traditional specifications that average extreme positions and lead to erroneous subjective values figures. Disregarding the existence of cut-offs and/or of segments of the population with polarised valuations can therefore lead to erroneous conclusions in terms of the real possibilities of rail for absorbing quota from road.

References

Arunotayanun, K., Polak, J.W.: Taste heterogeneity and market segmentation in freight shippers' mode choice behaviour. Transp. Res. Part E **47**, 138–148 (2011)

Ben-Akiva, M., Boccara, B.: Discrete choice models with latent choice sets. Int. J. Res. Mark. **12**(1), 9–24 (1995)

Ben-Akiva, M., Morikawa, T.: Estimation of switching models from revealead preferences and stated intentions. Transp. Res. Part A **24**(6), 485–495 (1990)

Beuthe, M., Bouffioux, Ch.: Analysing qualitative attributes of freight transport from stated orders of preference experiment. J. Transp. Econ. Policy **42**, 105–128 (2008)

Bierlaire, M.: BIOGEME. A free package for the estimation of discrete choice models. In: Proceedings of the 3rd Swiss Transportation Research Conference, Ascona, Switzerland (2003)

Brooks, M., Puckett, S., Hensher, D.A., Sammons, A.: Understanding mode choice decisions: a study of australian freight shippers. Marit Econ Logist **14**(3), 274–299 (2012)

Cantillo, V., Ortúzar, J.: A semi-compensatory discrete choice model with explicit attribute thresholds of perception. Transp. Res. Part B **39**, 641–657 (2005)

Cascetta, E., Papola, A.: Random utility models with implicit availability/perception of choice alternatives for the simulation of travel demand. Transp. Res. Part C **9**, 249–263 (2001)

ChoiceMetrics: Ngene 1.0. User manual & reference guide. The Cutting Edge in Experimental Design. www.choice-metrics.com (2009). Accessed April 2014

Danielis, R., Marcucci, E.: Attribute cut-offs in freight service selection. Transp. Res. Part E **43**, 506–515 (2007)

De Jong, G., Kouwenhoven, M., Bates, J., Koster, P., Verhoef, E., Tavasszy, L., Warffemius, P.: New SP-values of time and reliability for freight transport in the Netherlands. Transp. Res. Part E **64**, 71–87 (2014)

De Jong, G.C.: Value of freight travel time savings revised and extended chapter. In: Hensher, D.A., Button, K.J. (eds.) Handbook of Transport Modelling, Handbooks in Transport, vol. 1, pp. 553–563. Elsevier, Amsterdam (2008)

European Commission: White paper 2011: roadmap to a single european transport area—towards a competitive and resource efficient transport system. COM(2011) 144 final. http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm (2011). Accessed April 2014

European Parliament: Directive 2011/76/EU of the European Parliament and of the Council of 27 September 2011 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures Text with EEA relevance (2011)

Feo, M., García, L., Garrido, R.: Valuing freight transport time using transport demand modelling: a bibliographical review. Transp. Rev. **31**(5), 625–652 (2011)

Greene, W.H., Hensher, D.A.: A latent class model for discrete choice analysis; contrasts with mixed logit. Transp. Res. Part B **37**, 681–698 (2003)

Greene, W.H., Hensher, D.A.: Revealing additional dimensions of preference heterogeneity in a latent class mixed multinomial logit model. (2010). doi:10.2139/ssrn.1836702

Hensher, D.A., Greene, W.H.: The mixed logit model: the state of practice. Transportation **30**, 133–176 (2003)

Hess, S., Bierlaire, M., Polak, J.: Discrete mixtures models. Paper presented at the. 6th Swiss Transport Research Conference (Ascona, Switzerland). http://www.strc.ch/conferences/2006/Hess_Bierlaire_Polak_STRC_2006.pdf (2006). Accessed April 2014

Kurri, J., Sirkïa, A., Mikola, J.: Value of time in freight transport in Finland. Transp. Res. Rec. **1725**, 26–30 (2000)

Louviere, J.J., Hensher, D.A., Swait, J.: Stated Choice Methods: Analysis and Applications in Marketing, Transportation and Environmental Valuation. Cambridge University Press, Cambridge (2000)

Manski, C.: The structure of random utility models. Theor. Decis. **8**, 229–254 (1977)

Marcucci, E., Scaccia, L.: Mode choice models with attribute cutoffs analysis: the case of freight transport in the Marche region. Eur. Transp. **25**(26), 21–32 (2004)

Mariel, P., de Ayala, A., Hoyos, D., Abdullah, S.: Selecting random parameters in discrete choice experiment for environmental valuation: a simulation experiment. J. Choice Model. **7**, 44–57 (2013)

Martínez, F., Aguila, F., Hurtubia, R.: The constrained multinomial logit: a semi-compensatory choice model. Transp. Res. Part B **43**, 365–377 (2009)

McFadden, D.: The measurement of urban travel demand. J. Publics Econ. **3**, 303–328 (1974)

McFadden, D., Train, K.: Mixed MNL models for discrete response. J. Appl. Econ. **34**, 1509–1518 (2000)

Rose, J., Bliemer, M., Hensher, D., Collins, A.: Designing efficient stated choice experiments in the presence of reference alternatives. Transp. Res. Part B **42**, 395–406 (2008)

Rose, J.M., Bliemer, M.C.J.: Constructing efficient stated choice experimental designs. Transp. Rev. **29**(5), 587–617 (2009)

Rose, J.M., Scarpa, R., Bliemer, M.C.J.: Incorporating model uncertainty into the generation of efficient stated choice experiments: a model averaging approach. In: International Choice Modelling Conference, March 30–April 1, Yorkshire (2009)

Rotaris, L., Danielis, R., Sarman, I., Marcucci, E.: Testing for nonlinearity in the choice of a freight transport service. Eur. Transp. **50**, 1–22 (2012)

SawtoothSoftware: Choice Based Conjoint Software http://www.sawtoothsoftware.com/products/cbc/ (2008). Accessed April 2014

Spanish Ministry of Public Works: Permanent Survey on Road Freight Transport, Year 2013. http://www.fomento.es/Contraste/MFOM/LANG_CASTELLANO/ATENCION_CIUDADANO/INFORMACION_ESTADISTICA/Transporte/EPTMC/EPTMC_Publicacion/defaultEPTMC2013.htm (2014). Accessed April 2014

Spanish Ministry of Public Works: Annual Statistic Report of the State-Owned Port System. http://www.puertos.es/sites/default/files/anuario_estadistico2012/archivos_internos/index_eng.html (2013a). Accessed April 2014

Spanish Ministry of Public Works: Infraestructures, Transport and Housing Plan PITVI (2012–2024), preliminary document for institutional presentation and public consultation. http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/PLANES/PITVI/PITVI_DOCU/ (2013b). Accessed April 2014

Spanish Ministry of Public Works: Strategic Plan to Promote Freight Rail Transport in Spain. http://www.fomento.gob.es/NR/rdonlyres/E9229D97-59DB-44BE-BA47-AC93A45C4C72/98696/10091401PEITMF.pdf (2010). Accessed April 2014

Swait, J.: A non-compensatory choice model incorporating attribute cutoffs. Transp. Res. Part B **35**, 903–928 (2001)

Tversky, A.: Elimination-by-aspects: a theory of choice. Psychol. Rev. **79**, 281–299 (1972)

Valenciaport Foundation 2014. Line Rail Newsletter, July_December (2013) http://www.fundacion.valenciaport.com/docs/BOLETIN%20LINERAIL_06.pdf. Accessed April 2014

María Feo-Valero is Assistant Professor at the University Jaume I of Castellón (Spain) and member of the International Economics Institute of Castellón. Her research interests include the study of freight transport demand determinants and the analysis of European freight transport policy.

Leandro García-Menéndez is Professor of Economics at the University of Valencia (Spain) and Director of the International Economics Institute of Valencia. His current research focuses in transport economics, logistics chains and externalities generated by transport infrastructures.

Salvador del Saz-Salazar is Associate Professor at the University of Valencia. Over the years, he has accumulated a rich experience on non-market valuation of environmental goods. His current research focuses on estimating in monetary terms the damage caused to third parties by transport externalities.

Journal : **11116**
Article : **9566**

Springer
the language of science

Author Query Form

Please ensure you fill out your response to the queries raised below and return this form along with your corrections

Dear Author

During the process of typesetting your article, the following queries have arisen. Please check your typeset proof carefully against the queries listed below and mark the necessary changes either directly on the proof/online grid or in the 'Author's response' area provided below

Query	Details Required	Author's Response
AQ1	Reference Ferrini and Scarpa (2007) is cited in text but not provided in the reference list. Please provide reference in the list or delete these citation.	