DETERMINING THE PREFERENCES FOR FROZEN CARGO EXPORTS

J. de D. Ortúzar

Department of Transport Engineering
Pontificia Universidad Católica de Chile
Casilla 6177, Santiago 22, Chile

INTRODUCTION

This paper refers to a novel research aspect of a study conducted under contract to one of the major Chilean shipping companies. Background to the study was their concern about the fact that while during the high season (December to April) they need to charter several specialised ships to transport Chilean fruit (mainly grapes and apples) to the USA and European markets, many of these vessels stay almost idle for the rest of the year at great cost to the company. The general objective of the study was to investigate the likelihood that Chilean exports of low season refrigerated and frozen cargo products (such as vegetables, berries or frozen foods) would become sufficiently important in the near term to support a shipping operation and under what conditions.

The paper discusses the results of using a new technique designed to estimate the subjective valuation by refrigerated and frozen cargo exporters of shipping attributes such as service frequency and container availability, that may or may not be available at present. In marketing the technique is well known and generally referred as conjoint analysis (see 1,2) but many interesting developments have been achieved by transport specialists in passenger choice contexts (see 3,4,5). The experience discussed in this paper is the first published application to freight transport to the author's knowledge (see also 6) although its potential in this new field has been quickly realised (7).

To carry out a conjoint analysis experiment it is first necessary to design a set of mutually exclusive and realistic choice options given a set of attributes and a range of possible values for each (see 8). Defining the relevant attributes and their likely or relevant range of variation is one of the key tasks of the process, so it has to be conducted in close consultation with the study contractor. Once the options are defined they are presented to a sample of potential users who are asked to rank them in terms of attractiveness.

The rank data, together with the values of the attributes for each alternative, are next transformed into appropriate information to estimate a discrete choice model using the exploded logit technique proposed by Chapman and Staelin (9). The method works extremely well because a ranking contains more information than the usual knowledge of just the preferred alternative. Therefore, models estimated on this kind of data yield more accurate values of the model parameters for the same sample size.

APPLICATION OF THE METHOD

We will describe here the application of the method to the case of frozen fish exports which was deemed very successful; we also conducted an experiment for the case of refrigerated vegetables but found the results unreasonable. We feel this was due to the extreme heterogeneity of the sample of exporters and products we were forced to consider in that case (due to minimum sample size considerations), ranging from well established firms exporting highly priced products such as asparagus, to small and adventurous entrepreneurs exporting low priced vegetables such as tomatoes.

A sample was chosen of the main frozen fish exporting companies where we interviewed either the owner, the general manager or the traffic manager, depending on the size and experience of the firm. The interviewees were asked to rank a set of nine shipping options (presented in especially designed cards, such as those depicted in Figure 1) for exporting frozen fish from Valparaiso to Philadelphia. Information about company's size and experience was also sought in each case.

The alternatives were constructed such as to infer the relative preferences for the following attributes:

- fare (originally at three levels)
- service headway (two levels)
- travel time (two levels)
- shipment type (two levels, container or chamber)
- intermodal service (two levels, with and without it)

As mentioned, the attributes to include and their levels of variation are a key element of the success of a stated preferences experiment; we worked in this part in close consultation with the sales and technical departments of the shipping company. The aim was to define the most credible and at the same time useful (for marketing purposes) set of attributes that could be used to succinctly describe alternative shipping options.

Another important issue was the choice and training of the interviewers to conduct the experiment. Given the fact that we were trying to submit extremely busy and wealthy people to a decision making game lasting at least 20 minutes, we decided to use attractive last year (female) students at the School of Business of our university. The ploy worked well for various reasons. Firstly the girls understood well the final objective of the exercise due to their basic knowledge of marketing and economics, and secondly they possessed the language, ability and later attractiveness, to obtain an appointment with our selected interviewees and convince them then to participate in the exercise. We just provided them with appropriate credentials and a couple of good lines to seek the appointment and later start the interview; care was taken to ensure that the girls achieved a deep understanding of the general aim of the exercise and this proved crucial in some counter-interrogation cases.

Embarque de Pescado Congelado hacia Philadelphia

- Tarifa:US$ 270 por tonelada.
- Frecuencia: semanal.
- Tiempo de viaje: 13 días (+/- 1 día).
- Cámara frigorífica.
- Puerto de embarque: Valparaíso.

Embarque de Pescado Congelado hacia Philadelphia

- Tarifa: US$ 350 por tonelada.
- Frecuencia: semanal.
- Tiempo de viaje: 30 días (+/- 3 días)
- Container reefer de 40 pies.
- Puerto de embarque: El lugar de origen de la carga, con transbordo en Valparaíso, usando un solo conocimiento de embarque. Los costos adicionales son:

desde Punta Arenas	US$ 55/ton.
desde Puerto Chacabuco	US$ 47/ton.
desde Puerto Montt	US$ 67/ton.
desde Talcahuano	US$ 49/ton.

Figure 1 Example of option defining cards

DEFINITION OF ALTERNATIVES

Table 1 summarises the values of the various attributes of each alternative under the assumption that the intermodal service was offered from Puerto Chacabuco in the south of the country (where the main companies have their headquarters); in actual fact the service was offered from various locations at different prices. Fares have more than the three levels mentioned above because the alternatives were defined adding a given surcharge for intermodal services and container availability/use; monetary values of these services were provided by the shipping company using the costing mechanism they use in practice in order to make the exercise as realistic as possible.

Option	Fare (US$/ton)	Travel Time (days)	Headway (days)	Shipment Type	Intermodal Service
1	365	30	14	1	1
2	272	30	7	0	1
3	317	13	7	0	1
4	270	13	7	0	0
5	397	30	7	1	1
6	434	13	7	1	1
7	318	13	14	1	0
8	350	30	7	1	0
9	225	30	14	0	0

Table 1: Attribute Values of Each Alternative

The shipment type variable was defined with the following values:

- 1 for a 40 ft. reefer container
- 0 for a freezing chamber

and the intermodal service variable with the values:

- 1 for intermodal service (ie. loading the cargo at its port of origin and taking care of all transfer and intermediate paperwork)
- 0 for loading the cargo in Valparaiso

On the basis of this specification the sign of the coefficients of the first three attributes should be negative (as options become less attractive when the value of the attribute increases). The values of the other two should be positive under the assumption that exporters have a preference for using container and intermodal services.

MODELLING RESULTS

Multinomial logit models with linear in the parameters utility functions of the following form were postulated:

$$P_i = \exp(V_i)/\Sigma_j[\exp(V_j)] \qquad (1)$$

where:

$$V_i = \Sigma_k \theta_i X_{ki} \qquad (2)$$

with P_i the probability of choosing option A_i belonging to the choice set $\underline{A}$, V_i its measured utility, X_{ki} the kth attribute of option A_i and θ_{ki} unknown parameters which can be given a marginal utility interpretation.

To estimate the model it is first necessary to transform the ranking data obtained from the stated preferences experiment. The exploded logit technique (9) may yield up to N-1 'choices' for a ranking of N options under the following assumption: the individual would be prepared to choose the first ranked alternative, but if that one is not available, the second and so on. So, effectively, Q individuals with ranks of size N may yield up to (N-1)Q 'choice observations'. These can be then treated as usual to derive maximum likelihood estimates for the parameters of model (1)-(2).

Results for the Complete Sample

The estimated utility expression for all our data, i.e. without distinguishing size or experience of the firm, came out as follows (t-ratios in parentheses):

$$V_i = \underset{(-3.2)}{-\ 0.080F_i} \quad \underset{(-2.8)}{-\ 0.032TT_i} \quad \underset{(-1.5)}{-\ 0.056H_i} \quad \underset{(2.9)}{+\ 1.78ST_i} \quad \underset{(1.7)}{+\ 0.541S_i} \qquad (3)$$

where F stands for fare level, TT is travel time, H is headway (measured as days between each shipment), ST stands for ship ent type and IS for intermodal service. As can be seen, all parameters have correct sign; furthermore, only two (H and IS) are not significant at the 95% level, but they are significantly different from zero at the 85% level. So, we judged the problem to be insufficient data rather than lack of variable explanatory power (see 6). Indeed, the likelihood ratio with respect to the null model was 24.15 for five degrees of freedom (critical value is 11.1).

Using the values of Table 1 in equation (3) yield that option A_7 (with 21.3% of the preferences) and option A_6 (with only 5.7% of the preferences) would be considered respectively the most and least attractive alternatives according to model (1)-(2). As can be seen, their most crucial difference seems to be the fare level and this is of course consistent with the elasticity analysis we present below.

Table 2 shows average point elasticity values of the demand for shipping with respect to each attribute; these were calculated as the weighted (by the probability of choosing each option) average of the demand elasticities of each alternative, using the well known formula:

$$E(P_i,X_{ki}) = \theta_{ki}\ X_{ki}\ (1 - P_i) \tag{4}$$

Attribute	Range of Values	Average Elasticity
Fare (US$/ton)	225 - 334	- 5.28
Travel Time (days)	13 - 30	- 0.61
Headway (every n days)	7 - 14	- 0.48
Shipment Type	0 - 1	0.80
Intermodal Service	0 - 1	0.21

Table 2: Average Point Elasticities

Analysis by Size and Experience of the Firm

The data was stratified on the basis of company size, defining large (if they exported more than 1,000 ton/year), medium sized (if they exported between 500 and 1,000 ton/year) and small firms. It was also stratified on the basis of experience, defining firms which are very experienced (if they started exporting before 1980), relatively experienced (if they started exporting between 1980 and 1986) and unexperienced. The impact of both groupings together was also examined.

The first important finding was rather obvious: the general quality of the models diminished as the same number of coefficients was estimated with less observations (6). Table 3 presents average point elasticities of demand for the first stratification; as can be seen firm size seems to segment the market well. The results for small firms are particularly interesting because that segment yielded the best choice models. As can be seen, they suggest that these firms attach slightly more importance to the fare level and considerable more importance to travel time and headway that was found in the case of the complete sample. Also they seem to attach considerable less importance to shipment type and availability of intermodal services.

A key element in the design of a stated preference experiment is providing a means to externally validate its findings (see 10); in this sense the aforementioned findings are crucial as they correspond very well to an assumption of rational decision making on the part of the interviewees. Furthermore, we collected other type of data (6) which served to confirmed these findings.

Attribute	Average Point Elasticity Large	Medium	Small
Fare (US$/ton)	-4.10	-4.15	-5.85
Travel Time (days)	-0.54	-0.38	-0.85
Headway (every n days)	-0.23	na	-0.85
Shipment Type	0.80	0.95	0.44
Intermodal Service	0.25	0.17	0.15

na: the variable was found not significant and omitted

Table 3: Average Point Elasticities for Size Strata

Table 4 presents similar findings for the experience strata. It is important to mention that the only reasonable choice model in this case was obtained for the 'expert' (ie. not so experienced) firms (see 6). If we compare the findings for this stratum with those for the complete sample, it can be seen that these firms seem to attach less importance to all attributes. More interesting perhaps is the fact that very experienced firms show a much higher preference for container services than the rest. Also, that all the differences are credible and sensible, ie. the models make sense.

Attribute	Average Point Elasticity Large	Medium	Small
Fare (US$/ton)	-5.95	-4.54	-6.29
Travel Time (days)	-0.84	-0.47	-0.82
Headway (every n days)	-0.70	-0.41	-0.65
Shipment Type	1.49	0.55	0.68
Intermodal Service	0.10	0.20	0.32

Table 4: Average Point Elasticities for Experience Strata

Finally it seems that none is interested in having intermodal services; we checked this result with the aid of additional in-depth interview data and found it completely justified on economic grounds as most firms could manage to obtain handling, transport and paperwork services from their port of origin to Valparaiso, at a much smaller price than the surcharges quoted in the stated preference experiment.

Some Applications of the Results

It is probably obvious that this sort of results may be usefully employed in the design of a new marketing strategy for the shipping company; for example, information about the relative importance of each attribute, both for the general case and for each stratum, may be crucial for taking a decision about which strong points of the service offered by the company are worth stressing in a publicity campaign.

However, we would like briefly to pinpoint another more immediate application here. Firstly, the values of the coefficients of the non-categorical variables in the utility functions (2) may be used to construct iso-utility curves such as those in Figure 2; these in turn may help to decide, for example, what changes in travel time and/or headway are needed to maintain the present market share (ie. keep a constant utility level) if the shipping company intends to apply a variation in fares. Secondly, and in the case of the categorical variables, their weights in equation (3) may be used to find out, for example, what fare increase can be implemented if a container service is introduced subject to no decline in market shares.

CONCLUSIONS

The paper has discussed the application and results of a methodology to elucidate the preferences of shipping cargo users for attributes that may or may not be available at present; the method can provide a powerful and flexible marketing tool if some basic requirements are met, such as:

- the population of interest is relatively homogeneous in terms of its choices and constraints;

- the model (ie. form and structure of the utility functions associated to each option) replicates well the situation under scrutiny.

Both these requisites were accomplished in the case of frozen cargo exports, where we obtained interesting and highly credible results that should be useful to the shipping company. Furthermore some of the most interesting findings were found to be consistent with additional, largely independent, data for a bigger population.

However if these requisites are not met the models appear suspect, in some cases completely contrary to intuition and in general useless; we found this in a sister application of the method to the case of refrigerated vegetable exports, where we faced:

- a large variety of products with highly different prices at international markets;

- a rather fragile business without a constant and planned activity, but rather one where decisions change daily according to the conditions of an extremely variable market.

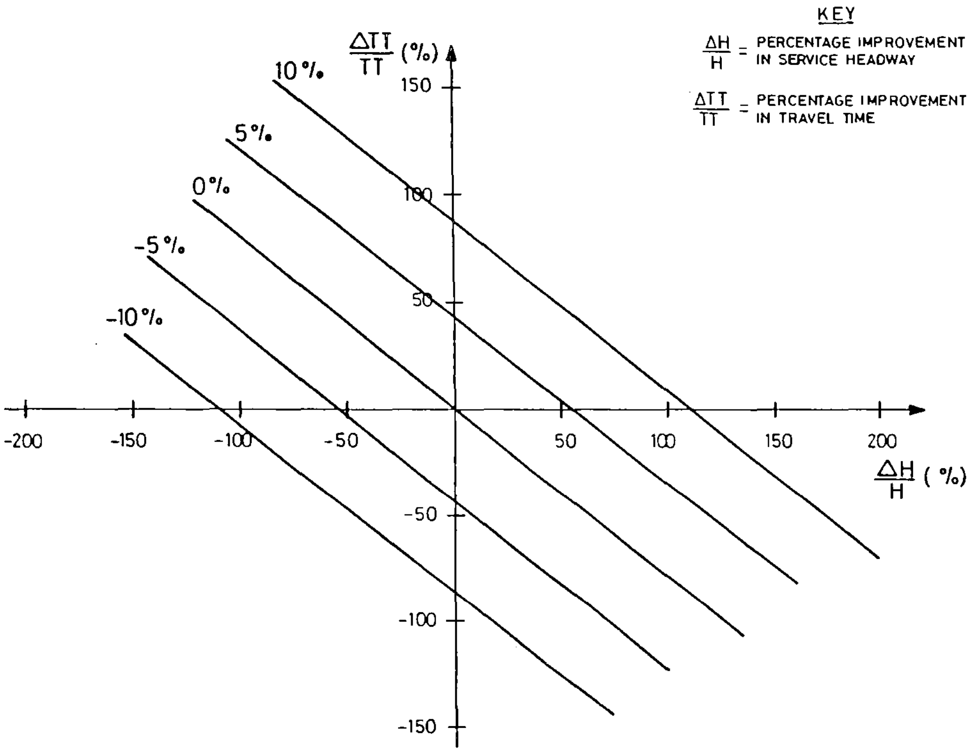

Figure 2 Iso-utility curves for variation in fares

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