Shippers' preferences for freight transport services: a conjoint analysis experiment for Italy

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Abstract

The paper reports on the preliminary results of a research project whose aim is to evaluate and compare shippers' preferences for freight transport services. An adaptive conjoint analysis is used to estimate the relative importance shippers attribute to transport costs, transport time, risk of late arrival and risk of damage and loss. The availability of utility estimates for each individual shipper allows to compare preferences across product type, mode used, shipment distance, procurement or distribution flow, firm size, logistic and outsourcing arrangements. The interviews were administered to large and medium size manufacturing firms located in Friuli-Venezia Giulia, a region of the North-East of Italy.

Keywords

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1. Introduction

The paper reports on the preliminary results of a research project whose aim is to evaluate shippers' preferences for freight transport services. A freight transport service, which shippers (producers) buy on the market from freight operators, is characterised by the freight rate, speed, reliability, risk of loss and damage, route, vehicles or modes used, additional services such as packaging, paperwork, tracking or tracing, or logistical services, financial arrangements and so on. Shipper preference for the characteristics (technically called attributes) of a freight transport service are thought to depend upon the type of product to be shipped, the origin and destination of the shipment, and other factors related to the characteristics of the firm (such as size, role in the supply chain, logistic organisation, outsourcing arrangements and so on).

A methodology to evaluate shippers preferences is to ask them to rate each attribute in a predetermined scale of importance (e.g., 1= not important, 2=important, 3=very important) (Matear e Gray, 1993; Lu, 2000). Alternatively, the importance of freight transport demand attributes can be estimated using market data (revealed preferences) or choices stated in an interview setting (stated preferences). In our research, the latter approach was taken. Specifically, interviews were carried out via a conjoint analysis software, called ACA v. 4.0 (Adaptive Conjoint Analysis) produced ACA v. 4.0 is one of the many software packages developed by Sawtooth Software Inc. for marketing research which has two main advantages: it follows an adaptive methodology and produces individual estimates[1]. An adaptive methodology[2] means that the questions asked depend on previous answers so that interviews are customised and time-efficient. This allows through a brief series of questions – which will be presented and discussed in detail in Section 3 – to produce, via an iterative procedure, an estimate of

[1] Such characteristic is also available to the LASP software developed at Institute of Transport Studies of the University of Leeds (Fawkes and Shinghal, 2002).

[2] The ACA manual describes it as follows: "The term "adaptive" refers to the fact that the computer-administered interview is customised for each respondent; at each step, previous answers are used to decide which question to ask next, to obtain the most information about the respondent's preferences….. Questioning is done in an "intelligent" way; the respondent's utilities are continually re-estimated as the interview progresses, and each question is chosen to provide the most additional information, given what is already known about the respondent's values. Respondent utilities are available upon completion of the interview.".

shipper's individual utilities. Such a possibility is crucial in order to perform segmentation analysis when the sample size is small, as it is typically the case in stated preference studies because of budget and time constraints.

An important point about face to face interviews is that, together with preferences, it is possible to collect relevant information on the respondent characteristics which allows to perform correlation and segmentation analysis of the relationship between stated preferences and, in our case, firm's characteristics. It will then be possible not only to estimate shipper preferences for a specific product or group of products, as it is typically the case with market data, but also to study the relationship between shipper preferences and the length of the shipment, its role in the supply chain, the firm size, logistic organisation, and outsourcing arrangements.

Moreover, since ACA v.4 keeps track of respondent choices among hypothetical options presented within the interview, it is possible to perform standard econometric analysis of stated choices and estimate attribute parameters.

The paper begins with a section which presents the theoretical model on the basis of which freight demand attributes were selected. Then, Section 3 describes the methodology and the setting up of the software for the interview. Section 4 illustrates the characteristics of the firms which were interviewed, the main results obtained at individual level, and the econometric estimates. Section 5 draws some conclusions on the pros and cons of the methodology and summarises the main findings.

2. The theoretical model

In line with the abstract mode theory pioneered by Quandt and Baumol (1966), we assume that shipper have preferences for freight transport's attributes which can be investigated in an hypothetical choice context on a CA interview. No mention will be then made to the actual mode choice or mode preference[3], but only to transport service characteristics.

The selection of attributes which characterise a service option in a CA experiment is crucial. The choice is usually based on previous literature or on pre-tests. Since in a full profile CA experiment only a limited number of attributes can be evaluated in each experiment, their number is usually less than 6-7 attributes. At the theoretical level, the inventory-theoretic freight demand model, developed among others by Baumol and Vinod (1970) and Viera (1992), provides the basis for the selection of attributes in a disaggregate context. Consider the following:

C = expected total annual variable cost of handling

Y = total amount transported per year (quantity demanded annually)

r = shipping cost per unit (including freight rate, insurance, etc.)

t = average time required to complete a shipment (door-to-door time in years),

s = average time between shipments in years (e.g., s = 1/12 for monthly shipments)

u = carrying cost in transit per unit per year (interest plus deterioration)

w = warehouse carrying cost per unit per year

a = cost of ordering and processing per shipment

i = average inventory level

d = fraction of shipment lost or damaged

p = average price of product shipped

v = variability in arrival times

The total logistic costs can be calculated as

[3] While in passenger transport mode preference's might be quite strong (e.g. air flight aversion), in freight transport mode preference is likely to play a minor role since it is mode performance which matters most.

LC = direct shipping cost + in-transit carrying cost + ordering cost + recipient's inventory carrying cost + safety stock cost + loss and damage cost (1)

where

direct shipping cost per unit = (cost per unit) x (quantity shipped) = rY;

total in-transit carrying cost = (cost per unit of time) x (transit time) x (amount shipped) =utY;

ordering cost = (cost per shipment) x (number of shipments) = a/s;

recipients' inventory carrying cost = wi = wsY/2;

safety stock cost[4] = wv(Y);

loss and damage cost = dpY.

Therefore

LC = rY + utY + a/s + wsY/2 + wv(Y) + dpY (2)

The parameters *a*, *w*, *p* and *Y* are product- and firm- specific, while *r*, *t*, *v*, *d* are independent attributes or characteristics which define a transport service. The shipper determines *s* in order to minimise total logistic cost. When two options (abstract modes) are specified in terms of *r*, *t*, *v*, *d* the shipper computes the optimal shipment size and consequent logistics cost associated

[4] Baumol and Vinod (1970, p. 418) develop the following expression for the cost of safety stock, $wk((s+t)Y)^{1/2}$, assuming an Poisson distribution of the stochastic elements and considering both uncertainty in demand forecast and delivery time. (s+t) T can be interpreted as the delay because an order just misses a shipment and t is the delay in transit. Considering only the second component it can be simplified into $wk((t)Y)^{1/2}$ which we will rewrite as wv(Y). v represents the variability in arrival times. An alternative specification is provided by Vieira (1992)

$$REC = i \cdot L \frac{pQ}{365} + (1-\tau) \cdot so \frac{Q}{q} = i\left(L + \frac{1-\tau}{\Delta\tau}\right)\frac{pQ}{365}$$

it includes the cost of early arrivals, like the cost of providing extra storage space at the destination to unload vehicles that arrive early, and the cost of late arrivals, like the buyers' stock-out and safety-stock carrying costs. . $so = \frac{i}{\Delta\tau}\frac{pQ}{365}$ is the stock-out cost, τ the fraction of shipments that arrive when wanted, $\Delta\tau$ is the decrease in the probability of a stock-out from carrying an additional day of safety-stock. It can be noticed that reliability costs vary inversely with the number of late or early arrivals.

which each option, then he selects the option (abstract mode) entailing the lower total logistic cost.

Because some factors influencing the shipper choices are not measurable (e.g., attitude toward some attributes, risk aversion, cognition fatigue and so on) or measured (attributes erroneously considered unimportant by the analyst), the link between stated choice and attributes is modelled as a Random Utility Model, which is based on the assumption that the chosen option maximises utility. The indirect utility function U_{jq} ,associated with the j option and the q individual, consists of a deterministic (V_{jq}) and a random (ε_{jq}) component

$$U_{jq} = V_{jq} + \varepsilon_{jq} \tag{3}$$

Assuming that the random component has zero mean and that the deterministic component is linear and additive in the variables *r, t, v,* and *d*, (V_{jq}) can be expressed as follows

$$V_{jq} = \beta_{j1} r + \beta_{j2} t + \beta_{j3} v + \beta_{j4} d \tag{4}$$

According to the random utility theory individual q chooses the alternative A_j if and only if:

$$U_{jq} \geq U_{iq} \ , \ \forall A_i \in A \tag{5}$$

or equivalently:

$$V_{jq} - V_{iq} \geq \varepsilon_{jq} - \varepsilon_{iq} \tag{6}$$

3. Methodology

The interviews were carried out with a laptop computer equipped with two software packages called Ci3, a Windows-based software for writing and administering computer-aided questionnaires, and ACA v.4 (Adaptive Conjoint Analysis), both produced by Sawtooth Software Inc. Each interview was made up of two parts:

- the first part collected basic information about the firm and, most importantly, identified the typical input and output shipments of the firm; the Ci3 software helped organising questions and recording answers;
- bearing in mind the typical shipments, managers were then asked to answer the questions presented by the ACA software;

The ACA experiment was performed, separately, both for input procurements and for output shipments. An interview lasted less than an hour. Table 1 presents details on the type of questions asked with the Ci3 software.

Tab. - 1 – Questions asked in the first part of each interview

Basic Information

- Which is the size of the firm in term of revenues and employees?
- How many production and distribution plants are there and where are they located?
- What are the main and secondary productions carried out?

Information about relationship with customer and sellers

- Where are buyer and seller located?
- What is type of contract is used (FOB, CIF, other)

Information on production organisation

- How would you describe the firm's production organisation?
- How is inventory managed?

Information on outsourcing of logistics and transport

- Which activities are outsourced and with which contractual arrangement?

Information on typical shipment (for inputs and for outputs)

- Which is the origin/destination?
- Which is the average transport time?
- Which is the average volume/weight?
- Which is the average unit value?
- What type of good?
- Is special package needed?
- What's the transport cost?
- What's the mode of transport?

The initial questions aim at collecting basic information about the firm to be used in the segmentation analysis and, then, at defining, both in the managers mind and for statistical purposes, the typical input and output flows.

A crucial characteristic of ACA is that it estimates the utility associated with each level of each attribute as opposed to the estimate of the utility of the attribute as a whole provided by standard LOGIT-based software packages as LASP (developed at ITS-Leeds), MINT (developed by The Hague Consulting Group) or CBC (developed by Sawtooth Co.). This characteristic had to be conjugated with two other important requirements: (a) the need, in order for the hypothetical scenario proposed by ACA to be understood by the respondent, to customise attribute levels, and (b) the need, in order to compare preferences across respondents, to be keep the specification of attribute levels constant across interviews. The need to fulfil both requirements lead us to the specification of attribute levels reported in Table 2. As the base case scenario we considered the following: transport cost equal to the current cost, travel time equal to current time, zero risk of late arrivals and zero risk of damage and loss. It should also be noticed that time attributes are expressed in absolute terms, while transport cost and risk of damage and loss are expressed in percentage terms in order to relate the attribute level to the actual transport cost and value of the typical shipment of the firm. Respondents in the first part of the interviews were asked to identify the typical flow characterised by a specific origin and destination, transport cost and travel time. In answering the questions, respondents were asked to refer to the typical flows whose values were, for convenience, reproduced in a paper sheet.

Tab. 2 – Attributes and levels used in the ACA experiment

	Attribute # 1 Cost		Attribute # 2 Transport time		Attribute # 3 Risk of late arrival		Attribute # 4 Risk of damage and loss
1	10 % less than the current cost	6	Equal to the current transport time	10	Zero risk	14	Zero risk
2	5 % less than the current cost	7	1 more day than the current transport time	11	Risk of a _-day late arrival	15	Risk of damage and loss equal to 5% of the value shipped
3	Equal to the current cost	8	3 more days than the current transport time	12	Risk of a 1-day late arrival	16	Risk of damage and loss equal to 10% of the value shipped
4	5 % more than the current cost	9	5 more days than the current transport time	13	Risk of a 3-day late arrival		
5	10 % more than the current cost						

With the attribute levels defined in Table 2, an hypothetical profile looks like the one presented in Table 3.

Tab. 3 – Specification of a transport option (full profile)

Cost	Transport time	Risk of late arrival	Risk of damage and loss
10 % less than the current cost	5 days more than the current transport time	Risk of a 3-day late arrival	Risk of damage and loss equal to 5% of the value shipped

With the aim of ensuring realism to the hypothetical scenarios given the heterogeneity of typical flows, the ACA software could be set up to allow the interviewee to define the attribute levels to be considered acceptable and the one to be consider not acceptable under any circumstances. Such a procedure is illustrated in fig. 1. This would exclude the use of dominated profiles during the interview (e.g., the inclusion of a 5 day-delay in a 1-day shipment). While such a choice enhances realism and credibility of scenarios it had negative effects on comparability across firms.

Fig. 1 – Elimination of unacceptable levels

Type the number by any that you could not accept under any conditions

1 10 % less than the current cost
2 5 % less than the current cost
3 Equal to the current cost
4 5 % more than the current cost
5 10 % more than the current cost

The main step of the ACA procedure is the choice section, also called Graded Paired Comparison section. The ACA software presents two options as in Fig. 2. The options can be described in a full or partial profile manner. We decided to set up the programme as to always have a full profile definition. The respondent is asked to compare them by choosing among the two profiles on 9-point scale: 1 represents a maximum preference for the option on the left, 9 a maximum preference for the option on the right, and 5 an indifference among the two profiles.

Fig. 2 – Choice among alternative profiles

Which would you prefer?

10% more than the current cost	5% less than the current cost
Zero risk of late arrival	Risk of a 1-day late arrival
Zero risk of damage and loss	Risk of damage and loss equal to 10%
1 day more than the current time	3 days more than the current time

Strongly Prefer Left				Indifferent				Strongly Prefer Right
1	2	3	4	5	6	7	8	9

The ACA estimation procedure is described in detail in the software manual and presentation paper (www.sawtooth.com). First of all, respondents rate or rank by importance each attribute level. These values are then re-scaled, so that:

- for each attribute the range of utility values is proportional to stated importance, and attribute importances differ by at most a factor of 4;
- within each attribute the values have a mean of zero, and differences between values are proportional to differences in desirability ratings or rank orders of preference..

These values are the *priors* (y and b_1) which are updated after each paired-comparison response via a Bayesian estimating procedure . Let X be a matrix of predictor variables with a row for each of n observations and a column for each variable; y be a vector of responses for the first n observations (for the first iteration it would be the priors estimated during the first part of the interview); z' be a row vector of predictor values for a new observation, appended as a row to X (that is a row with the attribute levels used during the Graded Paired Comparisons part of the test); and r be a response for the new choice exercise. For the first observation the estimating procedure can be represented by the regression equation:

$$X\,b_1 \sim y$$

where $b_1 = (X'X)^{-1}(X'y)$

while for the following observations the estimating model would be

$$\begin{bmatrix} X \\ z' \end{bmatrix} \tilde{b}_{n+1} \sim \begin{bmatrix} y \\ r \end{bmatrix}$$

where

$$\tilde{b}_{n+1} = (X'X + z'z)^{-1} (X'y + zr)$$

This procedure provides individual estimates of each attribute level. Since the software records all steps and choices made by the respondent, it is also possible to use information on choices and ratings to apply LOGIT and PROBIT estimation models so as to obtain standard econometric estimates of attribute parameters. We tested the application of the LOGIT model making use of data on choices (excluding the indifference answers) and of the ORDINAL PROBIT model making use of information on preference intensities (on the 1 to 9 scale).

4. Results

As just explained, the ACA software allows two type of results:

- individual estimates of utility levels which can be further studied by segmentation analysis, and
- econometric estimates of attribute importance.

It should be noted that the results presented in this paper are preliminary since interviews are not yet completed.

4.1 The sample

The sample consists of 42 manufacturing firms, specialised in a variety of products, localised in Friuli Venezia Giulia, a region in the North-East of Italy bordering with Austria and Slovenia. The transport and logistic managers were interviewed. Firms are mostly of small or average size: 22 firms have between 100 and 500 employees; 7 firms have more than 500 employees; and the remaining have less than 100 employees. All firms buy transport services from third-party providers. 3 firms outsource transport and inventory and 3 firms outsource transport, inventory and packaging. Managers, when asked to define how they organise their input and output flows, responded as in Table 4.

Tab. 4 – Type of inventory policy

	Inputs	Output
Inventory-to-demand	28	15
Inventory-to-order	7	5
Just-in-time	7	22

Just-in-time principles are adopted in half of the firms for output management, but only in 7 firms for input management. Analysis of data on the typical shipment, as identified by managers, provides the following information:

- out of 84 shipments, 7 are within the region, 47 are within the rest of Italy, 19 are with European countries and 11 with non-European countries;

- 68 shipments are made by road-only, the rest is made by other modes or combined modes (2 by rail, 2 by sea, 2 by air, 3 by road and rail, and 7 by road and sea)
- in 57 out of 84 cases, manager declare to use mainly CIF transport arrangements, in 21 they use mainly FOB arrangements. The rest use both arrangements in equal proportions

4.2 Individual estimates

First of all, let us look at the choice-set definition. As mentioned, a decision was made to allow managers to exclude, at the beginning of each ACA experiment, the attribute levels judged unacceptable. This decision was motivated by the need not to include attribute levels that would lead to a quick rejection of the profile. Analysis of the number of times a level has been judged unacceptable (Table 5) provides information on the realistic choice-set.

Tab. 5 - Number of times a level has been judged unacceptable over 62 shipments

Attributes and levels	Input flows	Output flows	Total
Cost			
• 10 % less	0	3	3
• 5 % less	0	0	0
• Equal	0	0	0
• 5 % more	10	13	23
• 10 % more	18	28	46
Transport time			
• Equal	0	0	0
• 1 day more	1	0	1
• 3 days more	19	33	52
• 5 days more	22	33	55
Risk of late arrival			
• Zero risk	0	0	0
• Risk of a _-day	0	0	0
• Risk of a 1-day	13	16	29
• Risk of a 3-day	22	34	56
Risk of damage and loss			
• Zero risk	0	0	0
• Risk of 5%	1	2	3
• Risk of 10%	21	30	51

Considering totals, a 10% increase in transport cost is considered unacceptable in 46 out of 62 cases, a risk of 3 days late is unacceptable in 56 cases, 3 days or more transport time is also viewed as highly unacceptable as is a risk of 10% damage or loss. Output shipments appear to have a narrower definition set than input shipments.

Though allowing managers to exclude unacceptable levels improves the significance of the choice experiments, it proved to have high costs when we tried to aggregate results. In fact, since respondents defined their individual choice set, individual utilities are not homogeneous. The software distributes 400 utility points among attributes levels, but the number of attribute levels might differ among firms (because respondents excluded some attributes), so individual utilities can not be compared. Forcing this logical constraint we present anyhow aggregate results obtained through a simple average (Table 6). Because of the logical inconsistency just mentioned, results for often-excluded attribute levels have little value. Fortunately, there remains a narrower level set that could be used, as below discussed.

Tab. 6 – Average utility by attribute level

Attribute and levels	**Average Utility** (absolute value)	**Average Utility** (difference)
Cost		
• 10 % less	73,69	48,86
• 5 % less	50,31	25,47
• Equal	24,83	0,00
• 5 % more	10,28	-14,55
• 10 % more	2,56	-22,28
Transport time		
• Equal	62,08	0,00
• 1 day more	6,27	-55,82
• 3 days more	4,51	-57,57
• 5 days more	0,02	-62,06
Risk of late arrival		
• Zero risk	55,47	0,00
• Risk of a _-day	16,78	-38,69
• Risk of a 1-day	3,77	-51,70
• Risk of a 3-day	1,05	-54,42
Risk of damage and loss		
• Zero risk	100,89	0,00
• Risk of 5%	3,15	-97,75
• Risk of 10%	2,17	-98,73

Table 6 is to be read as follows. The first column present average utility values for each attribute level for the entire sample. The second columns presents the difference among the utility associated to each level minus the utility of the base level (current transport cost, current transport time, no risk of late arrival, no risk of damage or loss). In order to overcome the impossibility of aggregating all data due to the "unacceptable" distortion, we performed the rest of the analysis considering only those levels who contained fewer or no unacceptable levels, i.e. which were considered in all or most definition sets. We estimated an compensation index defined as

$$CI_{XC} = -\frac{\Delta X}{\Delta C}$$

where ΔX is either a 1-day increase in transport time, a _ day increase in the risk of late arrivals or a 5% damage and loss risk (attribute levels almost generally considered acceptable) and ΔC is a 5% transport cost decrease. Consequently:

- CI_{TC} is the percentage discount rate to be applied to transport cost to compensate a 1-day increase in transport time (provided transport cost are a linear function);
- CI_{PC} is the percentage discount rate to be applied to transport cost to compensate a _ day increase in the risk of late arrivals (same provision as above);
- CI_{DC} is the percentage discount rate to be applied to transport cost to compensate a 5% damage and loss risk (same provision as above).

With these definitions and caveats in mind, let us review the results illustrated in Table 7.

Tab. 7 – Average compensation indices

Compensation index type	Average	Standard deviation
CI_{TC} 1-day more transport time	2,13	1,64
CI_{PC} 1/2-day risk of late arrival	1,57	1,53
CI_{DC} 5% risk of damage and loss	3,67	3,14

On average the risk of damage and loss is the most important attribute followed by the risk of late arrival and transport time (a half a day risk of late arrival is valued more the a half a day transport time). Given the availability of estimates on utilities at firm level, it is possible to analyse results at a disaggregate level. Tables 8 and 9 present results at a sectoral level, firstly for inputs and then for outputs. Sectors with low time, reliability and damage and loss compensation indices will be termed cost sensitive, whereas sectors with high time, reliability and damage and loss compensation indices will be termed quality sensitive. The other will be called intermediate.

Tab. 8 – Compensation indices by attribute and sector

Transport time compensation index		Risk of late arrival compensation index		Risk of damage and loss compensation index	
Chemicals	5,9	Chemicals	3,8	Chemicals	7,8
Machinery and mechanical products	3,6	Machinery and mechanical products	2,5	Machinery and mechanical products	5,4
Metal products	3,1	Commerce	2,2	Metal products	5,2
Commerce	2,2	Furniture	2,1	Commerce	5,1
Furniture	1,7	Metal products	2,0	Construction	4,9
Electric equipment	1,5	Construction	1,4	Food and beverages	3,6
Food and beverages	1,2	Computers and electronics	1,0	Furniture	3,5
Construction	1,1	Electric equipment	0,9	Computers and electronics	2,3
Computers and electronics	0,3	Food and beverages	0,8	Electric equipment	1,8
Paper and paper products	0,01	Paper and paper products	0,01	Paper and paper products	0,05

As regards to input shipments, sectors which appear to be quality sensitive are chemical, machinery and mechanical products, metal products and commerce. On the contrary, paper and paper products, food and beverages, electrical equipment, computers and electronics seem more cost sensitive.

Tab. 9 – Compensation indices by attribute and sector

Transport time compensation index		Risk of late arrival compensation index		Risk of damage and loss compensation index	
Food and beverages	4,9	Computers and electronics	3,3	Computers and electronics	7,4
Computers and electronics	4,6	Food and beverages	3,3	Machinery and mechanical products	5,7
Plastic and rubber products	4,0	Plastic and rubber products	2,8	Food and beverages	5,5
Construction	3,3	Metal products	2,1	Plastic and rubber products	5,2
Paper and paper products	3,0	Construction	1,9	Furniture	5,1
Machinery and mechanical products	2,9	Machinery and mechanical products	1,6	Construction	5,0
Chemicals	2,0	Commerce	1,5	Paper and paper products	3,8
Commerce	1,7	Chemicals	1,2	Chemicals	2,4
Minerals extraction	1,5	Furniture	1,1	Metal products	2,2
Furniture	1,5	Paper and paper products	1,0	Commerce	1,9
Metal products	1,1	Minerals extraction	0,8	Electric equipment	1,8
Electric equipment	1,0	Textile	0,7	Textile	1,7
Wood	0,3	Electric equipment	0,4	Minerals extraction	1,0
Metal products	0,3	Wood	0,3	Metal products	0,9
Textile	0,2	Metal products	0,3	Wood	0,2

As to output shipments, food and beverages, computers and electronics, plastic and rubber products and machinery and mechanical products are quality sensitive, while textile, metal products are wood are cost sensitive.

Having tested several segmentation techniques, we report in Table 10 an analysis on the average compensation indices by type of flows and a t-test of the differences in the means.

Table 10 - Average compensation indices and t-test of the differences in the means

	Input flows	Output flows	p-value*	t-stat.
CI_{TC}	1,66	2,89	0,10	1,67
CI_{PC}	1,72	2,01	0,65	0,45
CI_{DC}	3,68	4,27	0,49	0,70
	Road only	Not road only	p-value*	t-stat.
CI_{TC}	2,67	1,64	0,24	1,18
CI_{PC}	2,05	1,06	0,16	1,41
CI_{DC}	4,05	4,43	0,70	0,39
	Less than 3-day door-to-door travel time	3-days or more door-to-door travel time	p-value*	t-stat.
CI_{TC}	2,69	2,03	0,36	0,93
CI_{PC}	2,09	1,37	0,22	1,25
CI_{DC}	3,83	4,84	0,20	1,28
	Less than 500 employees	More than 500 employees	p-value*	t-stat.
CI_{TC}	2,58	2,16	0,62	0,50
CI_{PC}	1,94	1,69	0,71	0,37
CI_{DC}	4,40	2,81	0,09	1,75
	Other than JIT input procurements	JIT input procurements	p-value*	t-stat.
CI_{TC}	2,50	2,53	0,96	0,05
CI_{PC}	1,70	2,75	0,12	1,57
CI_{DC}	4,01	4,57	0,55	0,60
	Other than JIT output shipments	JIT output shipments	p-value*	t-stat.
CI_{TC}	2,36	2,65	0,65	0,45
CI_{PC}	1,71	2,09	0,48	0,72
CI_{DC}	4,18	4,04	0,84	0,20
	Outsourcing transportation only	Outsourcing transportation and inventory	p-value*	t-stat.
CI_{TC}	2,49	0,75	0,20	1,30
CI_{PC}	1,87	0,64	0,25	1,15
CI_{DC}	4,04	1,75	0,12	1,59

* A p-value is the probability of observing a given sample results, or one more extreme, assuming that H0 is true (H0: m1-m2=0)

Input vs. output flows: all output compensation indices are larger than input compensation indices. Time compensation indices are statistically significantly different. A possible explanation is that customer satisfaction prevails on internal production logistics concerns.

Road-only vs. other-than-road-only shipments (e.g. road and rail): average time and reliability compensation indices are higher for shipments which made use of road transportation only. The absolute difference among averages is considerable (one point), though the t-test of difference in means shows a week statistical significance. As regards to the safety compensation index there is no significant difference in the averages. The result confirms that the road mode has mainly a time-related advantage over other modes.

Less than 3-day door-to-door travel time vs. 3-days or more door-to-door travel time: for shipments which take a longer time firms appear to be more concern with safety and less with reliability and travel time.

Less than 500 employee vs. more than 500 employees: larger firms have small time reliability and (statistically significant) safety compensation indices, that is, the freight cost attribute is more important than quality attributes. A possible explanation is that larger firms have higher bargaining power which allows them to impose high quality standards to their third-party providers.

Other than JIT input procurements vs. JIT input procurements: firms which have organised there input procurements on JIT principles are definitely more sensitive to the reliability attribute (with a 0,12 p-value) than firms who buy on order or on demand. They are also slightly more sensitive to the safety attribute whereas there is no difference as regards to the door-to-door travel time.

Other than JIT output shipments vs. JIT output shipments. Similarly to JIT procurements, firms which have organised their output shipments on JIT principles are more sensitive to the reliability attribute but the absolute amount and the statistical significance is much reduced. JIT firms appear also slightly more sensitive to the speed of the shipment. There is no difference with regard to the safety attribute.

Outsourcing transportation only vs. Outsourcing transportation and inventory: Firms that have outsourced inventory as well as transportation appear statistically significantly less concern with quality attributes and more with the cost attribute. This might mean that global outsourcing takes place when quality matters are of less importance to the firm production process.

4.3 Econometric estimates

Using data on choices it is possible to estimate a LOGIT or a ORDINAL PROBIT model. The main advantage of these estimates over the ACA utility estimates is to have information on the statistical significance of the attribute parameters. The disadvantage is that it can be basically obtained for the attribute as a whole and not for pre-specified attribute levels. Furthermore, statistical estimates are available over the sample or specific sub-samples, and not at the individual level[5].

We tried to estimate both the LOGIT or a ORDINAL PROBIT model with the ACA1 data, expressing attribute levels both in percentage and in absolute terms. For the whole sample, we did not get satisfactory results. The sign of coefficient, apart from the risk of damage and loss attribute, is contrary to what expected and most coefficients are not significant. We came to the conclusion that this is due to two factors: the heterogeneity of freight flows which requires large samples and, above all, a lexicographic bias in respondents' answers. Analysing choices, it appears that the risk of damage and loss "dominated" the other attributes obscuring their effect on stated choice. Such a distortion, we believe, was due to our decision of presenting alternative as full profiles (all four attributes together). A partial profile presentation (two or more attributes at a time) would have, perhaps, allowed to estimate the role of each variable.

The most significant results were obtained when estimating specific homogenous sectors, as presented in table 16.

[5] Unless a fixed-effect model is estimated as in Maier and Bergman (2000).

Tab. 16 – Estimates for specific sector (both input and output shipments)

Coefficients	Food and beverages	Chemicals Rubber-Plastic Commerce Petrol produce	Mechanics Metal-mechanics Construction	Textile Electronics Computers Paper
Observation N.	43	53	67	71
R^2 Adj no coeff.	0,388	0,113	0,055	0,625
Transport cost	-1,989	-3,233	-5,258	5,459
p-value	0,747	0,529	0,148	0,371
Transport time	0,548	-0,877*	-0,346	-0,356
p-value	0,905	0,044	0,132	0,513
Risk of late arrival	0,208	-1,509*	0,441	0,503
p-value	0,965	0,054	0,348	0,345
Risk of damage and loss	-35,786*	-28,369*	-11,504*	-49,285*
p-value	0,020	0,007	0,063	0,009

It can be seen that no sector has all significant coefficients. Risk of damage and loss is the only variable which has a large and significant coefficient in all sectors. Its importance already could be seen in the ACA estimates.

5. Conclusion

In this research project we tested the use of the ACA software to evaluate shippers preferences. The possibility of using an adaptive methodology which would allow to obtain individual estimates of attribute levels seemed very interesting for the prospects of analysing the relationship between preferences and product type, trip length, mode used, input and output flows, firm size and logistic and outsourcing arrangements.

Since the ACA software is set up to provide an estimate of attribute levels, these have to be pre-specified and have to be kept constant for all interviews. Due to the heterogeneity of freight shipments as regards to trip cost, trip length and to the value of the good transport, such a requirement proved difficult to successfully overcome. The solution we adopted (specifying levels in terms of variation from the firm’s actual level and allowing to exclude unacceptable levels) proved sufficient to allow meaningful hypothetical options in the choice section of the interview, but posed heavy constraints in the comparability of individual estimates of attribute levels across firms. This forced to recalculate results in terms of compensation indices between time, reliability or safety and transport costs. Nonetheless, the analysis of the estimated compensation indices provides meaningful and interesting results:

- The risk of loss and damage appear to be a very important attribute relative to transport cost, its importance is higher than travel time and reliability;
- Preferences are found to vary across sectors and to differ from the many assumed determinants. The t-test of differences in means signalled a sufficient (a p-value of less than 20%) statistically significant relationship among these variables;
  - output flows have a higher time compensation index than for input flows;
  - shipments which take place by road-only have a higher reliability compensation index than shipments involving not only road vehicles;
  - small and medium size firms have a higher preference for safety than for large firms;
  - firms adopting JIT principle show a higher preference for reliability than other firms especially with regards to the adoption of the JIT system in managing inputs and therefore affecting there production process;
  - firms which outsource inventory as well as transportation have lower quality preferences than firms which outsource transportation only.

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