Analysing freight transport demand using stated preference data: a survey and a research project for the Friuli-Venezia Giulia Region[1]

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Abstract

The paper surveys the application of the stated preference technique to analyse freight transport demand. The objective is to identify the contribution of the analysis of hypothetical data to the understanding of freight transport markets as opposed to the results obtained by using observed, revealed preference data.

1. Introduction

The objective of this paper is to evaluate the use of the stated preference technique to analyse freight transport demand. Stated preference (SP, hereafter) techniques can be described as a "family of techniques which use individual respondents' statements about their preferences in a set of transport options to estimate utility functions. The options are typically descriptions of transport situations or contexts constructed by the researcher" (Kroes and Sheldon, 1988). While there exist recent overviews of the use of the stated preference methodology to passenger transport demand analysis (Hensher, 1994; Polak and Jones, 1997), a review does not exist, to the best of our knowledge, for freight transport. It is recognised that studying freight transport demand poses specific difficulties not faced in passenger transport analysis (Bolis and Maggi, 1998) since:

- freight is heterogeneous;
- modal choice is influenced by the physical characteristics of the goods to be moved;
- freight transport is a derived demand since it is a part of a larger industrial/logistic process;
- more than one actor (shipper, freight forwarder, carrier(s), receiver) is usually involved in the decision making process, where no one of them has all information and decision power;
- geographical factors (presence of a port or of a logistic node) influence transport choices;
- prices are negotiated in a (often long term) contract, shippers are not price takers, and there is little information on prevailing prices.

Given the specific nature of freight transport markets, the paper aims at clarifying the contribution of the SP-based studies to the understanding of freight transport demand. Particularly, we want to assess what SP studies have been able to tell us about freight transport demand that could not have been captured by traditional revealed preference-based studies (RP, hereafter). Finally, we review the unsolved issues and the future prospects of SP studies addressing freight transport demand. The paper, based on a larger research program supported by the Friuli Venezia Giulia Region, is organised as follows. Section 2 recalls the main freight transport models and it identifies which of the analysed frameworks is consistent with the SP data. Section 3 reviews the SP data pros and cons as compared to RP data. Section 4 illustrates some SP studies identifying the addressed issues, the used techniques and the obtained results. Section 5 presents some remarks and conclusions.

[1] The paper reports on a research carried out with the contribution of the Friuli-Venezia Giulia Region (L.R. 3/98, prot. 7617/2). A previous version of the paper appeared on Trasporti Europei, n. 13, 1999.

2. Modelling freight transport demand

Freight transport demand modelling has been studied for a long time. Mazzarino (1997), in a recent survey of the literature, identifies two main groups: the macroeconomic models and the microeconomic models. Similarly, Winston (1983) distinguishes freight transport demand models between aggregate or disaggregate models. The simplest aggregate model is the modal split model, where the ratio between the market share of two modes is assumed to depend on differences in prices and in non price attributes (e.g., Boyer, 1977).
A more theoretically-grounded aggregate model is the neoclassical model (e.g., Friedlaender and Spady, 1980) based on the assumption that a firm is a neoclassical factor price-taking cost minimizer. The firm's freight transport demand by a particular mode is a derived demand arising from the cost function, through the Shepard's lemma. Assuming that all firms in a region have the same technology and using the transport flows data of the analysed region, it is possible to estimate the regional aggregate freight demand function. In this case, each modal market share typically depends on: transport prices, non-transport prices, modal attributes and output level.
Disaggregate models have the theoretical advantage of being more consistent with behavioural theories and to allow for a richer empirical specification. Moreover, the importance of variables such as shipment size and value can be tested, whereas in aggregate models they are obscured by the aggregation process. Obviously, data requirements are more cumbersome since data describing the characteristics of each modes (chosen and unchosen) must be collected. Two kind of disaggregate models have been developed in the literature: behavioural and inventory. A model is named behavioural when it focuses on the mode decisions taken by the physical distribution manager of the receiving or shipping firm (Winston, 1981). It is termed inventory when it includes the decisions of the inventory manager too, that is logistic and production decisions (Baumol and Vinod, 1970; McFadden and Winston, 1981; Abdelwahab e Sargious, 1992; Abdelwahab, 1998). Logistic decisions are influenced by a large set of (short and medium term) variables which may interact with the typical transport decisions. For instance, mode choice may depend on shipment size and frequency, which, in turn, interact with the production process. The large data requirement of the disaggregate models can be met via observed, RP (Abdelwahab e Sargious, 1992; Abdelwahab, 1998) or SP data.

3. States versus revealed preferences

Observed behaviour reveals human preferences (choices) among a number of available choices. Alternatively, preferences can be inferred from stated choices. A procedure (interview) can be set in which respondents are asked to make choices or state their preferences. The main difference between the RP and SP approach is that the former is based on actual, observed behaviour, while the latter is based on hypothetical, stated behaviour. In other words, the former choice is made in a real market, the latter in an hypothetical market.
The pros and cons of the two approaches, as a basis for analysis and policy decision-making, has been widely discussed in the literature. This debate is usually termed as the 'revealed vs. stated-preference' debate (Kopp and Smith, 1993; Louviere, 1996), and it has taken place in various fields, including marketing research, environmental valuation and transport.
The interest for hypothetical, stated preferences in marketing research is justified by the fact that generally production decisions have to be taken before the newly developed products or products scarcely known by the consumers are actually available in the market. That is, it is important to predict whether the consumer would buy the new product before the product itself is put on the market. This can be done via stated preference interviews. Similarly, environmental goods are goods not traded in the marketplace. How much does the consumer value a noise or air pollution decrease? To address the issue an interview asking the consumers which value they attribute to the

environmental good can be performed. In such a case, the method is termed contingent valuation method (Braden and Kolstad, 1991).
In the transport field, analysis were often based on revealed-preference data (e.g., trips made in a given year at a given price, ton-km transported by a given mode, etc.). But in the last two decades, stated preference techniques have been gradually introduced in passenger transport demand analysis and, less frequently, in freight transport demand analysis. The method used, termed stated choice technique, differs from the case of environmental valuation, since respondents are asked to choose among alternatives (alternative modes, for instance) with differing attributes[2]. On the basis of their choices, assuming the existence of a specific utility function, the value of the attributes can be statistically determined. The theoretic and practical characteristics of this methodology are adequately explained, e.g., in a special issue of the Journal of Transport Economics and Policy (JTEP, 1988).
For the purpose of this article, it is worthwhile to summarise pros and cons of the RP and SP approaches as they result from the theoretical debate (Wardmam, 1988). A graphic comparison among RP and SP is illustrated in Table 1.

Table 1 – RP versus SP data

Pros	*Cons*
Revealed preference method • Actually made, observed, "real" choices	• Only some attributes are measurable • Needs many costly data • Data hard to be collected (e.g. prices are confidential and of commercial nature), scarce availability of data • Correlation among attributes • Insufficient variability to allow robust estimate • Measurement errors • Unspecified choice set
Stated preference method • Hypothetical, "stated" choices in controlled experiments • Ability to analyse reaction to future, not existing options • Low cost • Precisely specified choice set • Multiple answers from each respondent • Multiple choice formats (choice, ranking or rating) • Capability of analysing trade-offs among qualitative attributes	• Hypothetical bias

The main difference between RP and SP preferences is that the former are inferred from observed choices made in real markets, while the latter are inferred from stated, hypothetical choices made in experimental markets[3].
The first issue is then how reliable are stated choices, how different the real choice will be from stated ones. In other terms, is there an hypothetical distortion? The question has no theoretical answer, but only an empirical one, that is comparing stated intentions to actual behaviour. The empirical tests so far conducted[4] suggest that "individuals' stated preferences among hypothetical

[2] To be more precise, respondents are asked either to rank, rate or choose among alternative sets.
[3] Ben Akiva and Morikawa (1990) calls them stated intentions in order to stress their hypothetical nature.
[4] For a survey on the issue of validation see Levin *et al.* (1983). For validation of passenger mode choice studies see Wardman (1988).

travel scenarios are a reasonably accurate guide to true underlying preferences". Provision could also easily be taken within the questionnaire to check for irrational or inconsistent choices.
Conversely, the hypothetical nature of the experimental market allows to:

- analyse the demand characteristics independently of supply restrictions. The observed choices in real markets are, indeed, the result of the demand-supply interplay, while in an experimental market the supply restraints can be relaxed;
- test the firm reaction to future, not-existing options;
- present a set of alternatives wider (because of new modal opportunities or of different characteristics of the existing modes - faster or more reliable trains, inter-modal opportunities, new services, etc. -) than the available one;
- express accurately the characteristics of each option. Actual choices are made on the basis of how a decision maker perceives the attributes of an option, which might differ from the researcher definition of the attributes (for instance, the perceived reliability of a train service might be perceived from the user differently than the one declared by the rail operator);
- use multiple choice formats. Actual choices are definite (a truck or a train is used), whereas in an interview a respondent might be asked to, for instance, rank or rate or choose among alternatives. This allows a better estimation of the trade-offs among attributes;
- collect several answers from each respondent in order to better estimate disaggregate models and, consequently, improve the cost-efficiency of the research[5]. SP data allows also to estimate a separate utility function for each respondent, an aspect which might be useful to identify market segments with homogeneous preferences.

Furthermore, RP data have serious well-know problems:

- data might be costly or difficult to be collected (e.g. prices might be confidential or have commercial value);
- usually only primary explanatory variables are used because they can be expressed in "objective" or "engineering" units while secondary variables (such as, in passenger transport studies, seat design or station facilities) are hardly used (Kroes and Sheldon, 1988);
- there might be correlation among explanatory variables or insufficient variation to allow robust estimates. These problems are avoided in well-specified experimental SP designs[6];
- the choice set or the measurement errors might be difficult to be identified.

The SP technique, then, seams to be a useful alternative complementing or integrating RP-based studies (Swait, *et al.* 1994, Stopher, 1998). In the next paragraphs we try to appoint if and how this statement can be referred to the freight transport demand analysis too.

4. Stated preference studies of freight transport

Freight transport studies based on stated preference techniques are quite limited. In table 2 we have listed the SP reports we have bean able to collect.

[5] This opens a econometric problem known as "repeated measure problem", when data are pooled together and the error distribution of a respondent is different from that of another respondent.
[6] The issue of the proper specification of experimental design that respects orthogonality and allows for sufficient taste variation is widely debated in the literature. See Fowkes and Wardman (1988).

Table 2 – SP freight demand studies

Authors	Issues	Sample	Technique & software
Fowkes and Tweddle (1988)*	Methodological		LASP
Ortuzar and Palma (1988)*	Refrigerated and Frozen Cargo Exports		Paper questionnaire
MVA (1990)*	Cartage distance		Paper questionnaire
MVA/ITS (1990)*	Inter-modality in exports of good from UK to Continent	40 CAPI, executives	Rating – LASP
MVA (1991)	Inter-modality in imports of good from UK to Continent	100 CAPI, executives	Rating
Fowkes *et al.* (1991)	Inter-modality		Rating – LASP
MVA/TLF (1992)*	Mode choice in bulk goods	50 CAPI, executives	Rating –ASP
de Jong *et al.* (1992)**	Value of time		
de Jong *et al.* (1995)**	Value of time		
Widlert and Bradley (1992)**	Value of time		
Fridstrøm and Madslien (1994, 1995)	Own-account versus third party freight transport	300 telephone CAPI	Choice – MINT
Tweddle *et al.* (1995, 1996)*	New freight mode (Channel Tunnel)	34 CAPI, shippers, freight forwarders and hauliers	Rating – LASP
Gattuso e Pastorino (1996)	Route choice between Sicily-Mainland Italy	Paper questionnaires	Choice
Fosgerau (1996)*	Value of time		
TRT Trasporti e Territorio (1997)	Mode choice	100 firms	Ranking among 8 alternatives
Bolis and Maggi (1998, 1999)	Transport and logistics	22 face-to-face CAPI, logistic managers	Rating – LASP

* quoted in NERA (1997), ** quoted in de Jong (unknown)

For the purposes of this paper we have chosen three of the most recent studies (among the ones illustrated in table 2) basing our choice on the topic investigated and on the exhaustiveness of the reported analysis. For each study we have summarised the issues addressed, the methodology used and the results obtained, as illustrated in the following sections.

4.1 Issues

Freight mode choice in the UK

SP techniques are used both to identify the factors influencing the freight mode choice and to assess the relative importance of each analysed factor in the decision making process. In the UK there have been several of such studies. We illustrate the MVAITS (1990) research program because it is one of the most documented ones (mainly by NERA, 1997).

The MVA/ITS (1990) study examines the importance that freight rate, reliability and transit time represents in the manufacturer transport mode choice for unitised freight traffic (Lo-Lo containers, unaccompanied Ro-Ro, accompanied Ro-Ro). Its purpose is to identify the value that users of current transport modes impute to new inter-modal freight services and technology (swap body system, small container system for consignments smaller then one vehicle load and two different piggyback systems), and to estimate the possibility of road-rail switching through the implementation of these new technologies. The focus is on exports of foods, beverages, paper and board, non-bulk chemicals, automotive components, textile, clothing, minerals, computing and electrical from the UK to the Continent. Because via the RP approach it is not possible to analyse the individual preferences for services not available in the market yet, the SP technique has been chose to perform the analysis. An analogous study was then performed by MVA (1991) focusing on imports of the same goods from the Continent to the UK.

The MVA/TLF (1992) report, instead, aims at identifying and assessing the determinants of freight mode choice in the case of bulk products. The research is focused on rail services demand and tries to identify the characteristics that need to be improved in order to match more closely the users (or potential users) expectations. In this case the SP methodology is used because it allows to better focus on the individual firm choice process. The MVA/TLF (1992) study is based on a previous study conducted by Fowkes *et al.* (1989, 1991) concerning transit time, reliability, frequency, and inter-modal systems value as perceived by the users.
Finally, Tweddle *et al.* (1995, 1996) aims at predicting the variations of the main freight traffic flows caused by the Channel Tunnel opening. The authors analyse the possible changes in freight transport demand as a consequence of the availability of the new facility. A *before* and an *after* study are performed to test the reliability of the forecasts obtained through the SP test. The test consists in asking the distribution managers to rate various hypothetical scenarios concerning cost, transit time, reliability, frequency of collections, and use of inter-modal technologies. Although some discrepancies between the predicted and the actual demand levels do exist, the overall results confirm the usefulness of the SP methodology as a forecasting tool.

Own-account versus third party freight transport in Norway

Fridstrømn and Madslien (1994, 1995) study the factors influencing the choice between own-account and third party freight transport services in the Norwegian wholesale industry. They examine the choice process distinguishing between the long run strategic decision level, and the short run operating decision level. Transit cost, time, punctuality and damage risk are investigated as the reference variables in the short run, while features like the possibility of advertising on the vehicles and drivers availability for other tasks are identified as the relevant variables in the long run.
The SP methodology allows Fridstrømn and Madslien to deeply analyse the interviewee preferences in relation to various characteristics of the proposed alternatives. With the RP technique, instead, it would have been possible to test merely the general favour for one of possible alternatives. Their research aims at a descriptive function (rather than at a predictive one), but, since they use a discrete choice methodology, their results could have been profitably used also as a forecasting tool.

Transport and logistics services in the Trans-Alpine Freight Market

Bolis and Maggi (1998, 1999) investigate the micro dimensions of freight transport demand in a logistic context, using as studying sample the Trans-Alpine freight transport market. Starting from the evidence that the shipper's mode choice is part of a more complex logistic decision process, they analyse the importance both of standard transport attributes - such as cost, transport time, reliability (percentage of shipments arriving on time) and mode - and of logistic attributes - such as frequency and flexibility (minimal notice time for transport order in hours) -. The trade-offs among the variables are then estimated and valued in monetary terms. The impact of the firm logistic approach, and the possibility of switching from road to rail in the Trans-Alpine freight transport market are finally evaluated.

4.2 Methodology

UK studies

The UK studies show few similarities, though they were designed for different purposes. In all the studies the interviewees are asked to rank (MVA/ITS, 1990 and MVA/TLF, 1992) or to rate (Tweddle at al. 1995, 1996) the different alternatives included in the proposed choice set. The rating methodology is preferred to the pure choice one because capable of better testing the intensity of the

individual comparative preferences for each available alternative, and because more efficient[7]. By "exploding" the rating data it is, indeed, possible to transform the ratings into choices, obtaining much more information from just one observation[8]. Tweddle *et al.* (1995, 1996) use the following methodology. Firstly, a pre-test, concerning both the firm's logistic organisation and its typical long distance freight flows, is administered. This step allows to know which are the typical and actual choices made by the firm. Secondly, the SP experiment is performed using a portable computer equipped with the LASP (Leeds Adaptive Stated Preference) software. This software uses the information obtained during the previous phase as a starting point and as the reference base for the interview. LASP is an adaptive procedure in the sense that the alternative sequentially proposed during the test depend on and are adapted to the respondent previous ratings. This allows to efficiently reach the indifference level among the available alternatives, discharging beforehand those alternatives that are clearly inferior compared to the respondent choices.
The ratings selected by the respondent are transformed into probabilities by the following formula:

$$\text{if Rate A} > \text{Rate B} \quad \text{then Prob A} = 1 - 0.5*\text{Rate B/Rate A}$$
$$\text{if Rate B} > \text{Rate A} \quad \text{then Prob A} = 0.5*\text{Rate B/Rate A}$$

The corresponding logit transformation is :

$$\text{Logit A} = \log \text{Prob A} / (1-\text{Prob A})$$

The value of Logit A is then regressed against the differences in the option attributes through the SAS package. The firm's evaluation of the investigated qualities of the analysed freight transportation modes is obtained as the ratio of attribute coefficients to the cost coefficient, that is the monetary value of the qualitative attributes.

Fridstrøm and Madslien

Fridstrøm and Madslien (1994, 1995) perform their interviews on the wholesalers sector in order to maintain on the one hand the homogeneity with respect to the companies type of production and on the other hand the heterogeneity of the commodity type available on the market[9]. For each iteration the interviewee is asked to chose between two options characterised by different values of the analysed variables. They opt for a pure choice test rather than for a rating or ranking one (as Bolis and Maggi, and Fowkes and Tweddle do).
The interviews are performed using a personal computer equipped with the software MINT. This software allows to perform customised and interactive tests. The interviews are customised because the alternatives characteristics are made vary around the values of the shipment and the company characteristics as recorded during an *ad hoc* pre-test. The interviews are interactive because, exploiting the transitivity assumption, the computer "learns" from previous choices, so that the following submitted options gradually narrow the indifference surface.
Fridstrøm and Madslien organise the testing process into two different steps: a strategic one and an operational one, baesd on the temporal horizon and on the importance of the firm's logistic reorganisation implied by the choices offered during the interview. During the so called "within mode game" the respondent is asked to choose between two own-account or two third party options, depending on which of the two is in use at the time of the interview. With the "between mode game", instead, the respondent is asked to choose between the actually used mode and an alternative one.

[7] See Louviere (1988), though some authors dispute such conclusion (Ortuzar and Garrido, 1994)
[8] It should be mentioned that from a theoretical point of view this approach has been criticised as the cause of some significant bias of the final estimations (Louviere, 1988).
[9] In this respect they overcame the sampling difficulties faced by Bolis and Maggi , and by Fowkes and Tweddle.

During the first phase, they propose nine plus nine different binary choices testing the willingness to purchase or renew an owned vehicle fleet versus a long term agreement with a third carrier. During the second phase they allow the respondent to choose among alternatives available in the short run only (i.e., they vary only the short run variables to specify the possible options).
To estimate the model, Fridstrøm and Madslien adopt both a parsimonious logit model, which allows to estimate a small number of parameters and which is generally used for forecasting purposes, and an ample one, which is a descriptive rather than a predictive model, and which uses a larger number of variables not necessary exogenous to the freight choice process. TRIO, by Gaudry & al. (1993), is the software used to estimate the coefficients of the independent variables. It allows the user to specify several independent variables as different Box-Cox transformations, and to estimate simultaneously the parameters (λ) with the ordinary (β) coefficients of the logit regression:

$$V_i = \Sigma_j \beta_j x_{ij}^{(\lambda j)}$$

where V_i represents the "indirect utility" function associated with the alternative i. It is worthwhile to underline that with this software they are able to estimate the conditional t-statistic associated with each estimation, beside the marginal rate of substitution of the considered factors compared to the cost term.

Bolis and Maggi

Bolis and Maggi perform a face-to-face interview involving a random sample of 4 firms in Ticino (Swizerland). A random sample of 250 firms located in Northern Italy are questioned via postal surveys (just 24 out of the 250 questionnaire could be used). They use the LASP software too. If compared to MINT, LASP has the advantage of measuring the variations of the analysed characteristics in absolute terms (rather than just in percentage terms), which is more informative and useful for explanatory and interpretative purposes.
Bolis and Maggi analysis is made of three phases (levels), on the basis that the firm's decisions are taken in a three step process too. In the first stage (strategic/long term decisions: location and general logistics) the firm is assumed to define the localisation of its production, the warehouse sites and its supplier/client network. In the second stage (strategic/medium term decisions on transport logistics) the firm deals with decisions involving its supply chain organisation, warehouse stock level, shipping frequency and dimensions, service flexibility, typology of documents, factoring, tracking and tracing systems, insurance, money back warranty. In the third stage (operative decisions on transport services) the firm establishes the transport and the logistic service level to be adopted. Performing the test, however, Bolis and Maggi focus only on the operative and medium term decision stages.
The collected data are analysed in a choice context by "exploding" the data set and then by transforming ratings into binary choices, as suggested by Fowkes and Tweddle (1996). Having to deal with probabilities instead of utilities, they can then estimate a logistic regression model, where the coefficients of the parameters represent the effect on the respondent's utility caused by a change in the corresponding variable. The ratio of the service attributes to the cost coefficient represents the monetary value at a margin, that is how changes in an attribute is traded off against a monetary change in transport cost.

4.3 Results

UK studies

The studies addressing the mode choice process as performed in the UK show how the SP technique can estimate the importance of the modal attributes, both at an individual and at an aggregate level,

for different kinds of goods. Table 3 summarises the main results at the aggregate level. A disaggregate description of the results is presented in NERA (1997). By dividing the coefficient of a non-cost variable (e.g., reliability) by the cost coefficient as obtained in the regression equation, it is possible to estimate the monetary value of the modal attribute (i.e., the willingness to pay for a marginal change of the analysed attribute). To simplify the questionnaire, Fowkes and Tweddle (1988) express each cost unit as percentages of freight rate. Each value is to be interpreted as the transport cost discount wanted by the shipper in order to accept a unit increase in each of the listed attributes.

Table 3 – Results of the UK studies

Attribute	*MVA (92) (bulk goods)*	*Fawkes et al. (89, 91, 92) Unitised and bulk*	*MVA/ITS (90) Unitised Exports*[10]	*MVA (91)*	*Tweddle (95, 96) Unitised imports*
Transit time (half day longer transit time)		13-32%	7.7%	9.5%	5%
Reliability (1% less on time)	1.5%	1-6%	3.9%	3.1%	5%
Flexibility (1 day longer notice)	2.1%				
Intermodality (use of rail)	9.1%[11]	3-14%[12]	-2%	0.1%	21%
1 less collect per week		1.5%			
1 more lifts in transit		2-42%			
Technology (use of Le Shuttle)					6.4%

Source: NERA (1997)

The UK studies demonstrate that transit time is a very important variable for the shipper. Operators are willing to accept half a day increase in transit time only if freight rate is reduced by an average of 10%. Reliability is consistently valued about 3% of the freight rate. The value of inter-modal services (the acceptance of use of rail) is quite low. Operators are willing to switch to the rail service only if compensated with high freight discounts, with the exception of unitised exports. Flexibility is valued 2% of the freight rate. As expected, the studies show that different goods have different needs (and constraints) and that the attractiveness of rail use varies largely among regions and corridors.

Finally, it is worthwhile noting that the results drawn from the 1995 report on the prospective of the freight demand as a consequence of the opening of the Channel Tunnel, matched quite appropriately the actual demand changes. It had been proved, moreover, that the discrepancies were caused by unpredictable public and private market policies (unforeseeable pore quality of the train services and excessively low prices of the available ferry services), rather than by some methodological mistake. This demonstrates how SP studies can be used for predictive purposes too.

Fridstrøm and Madslien

As the authors of the Norwegian research underline, the importance of the SP survey they performed is emphasised by the fact that "complete and relevant RP data sets on desegregate freight market choices are practically non-existent, and very hard to be collected". The information they obtained on the Norwegian wholesalers preferences and on their attitude towards own-account and

[10] These are average values for accomponied adn unaccompanied RO-RO users and LO-LO users, but we large differences among each market segment.

[11] The reported value is an average value, but there are important differences among market sectors. For example, sludge has a value equal to 6.2 and petrol equal to 12%.

[12] These values have a large standard error and therefore they are not statistically significant.

third-party freight appear particularly significant as they seam to be the only disaggregate data sets of this kind available at the present time.
Fridstrøm and Madslien divide the obtained estimates into two groups accordingly to the choice temporal horizon considered. The results are expressed as the willingness to pay for a marginal improvement of each considered variable and as marginal rate of substitution against a variation of the transport cost. A summary of these estimations is reported in Table 4.

Table 4 - Own-account versus third party freight transport in Norway

Operational (Shipment) Decision Level	
Variable	*Relative rate of substitution*
Time	• higher in short term decision process than in the long one • decreases as the transit time gets longer • higher for fresh comestibles, but negative for frozen combustibles • higher for semi-finished products • not related to the value or the size of the shipment • asymmetrical: high to avoid delays but lower to accelerate deliveries
Punctuality	• higher for comestibles • higher for longer transit time • higher for fixed delivery time
Damage Risk	• less than half of the expected loss
Strategic Decision Level	
Variable (Own-Account versus Third Party)	*Relative rate of substitution*
Employer's responsibility for drivers	• negative but statistically insignificant
Employer's responsibility for cargo	• negative but statistically insignificant
Fixed own account freight costs	• positive
Possible absence of own drivers	• negative but statistically insignificant
Availability of multitask drivers	• highly significant positive
Variable (both Own-Account and Third Party)	*Relative rate of substitution*
Inertia	• higher for TP freight users
Freight terminal opening hours	• negative in both cases
Vehicles advertising	• not statistically insignificant
Company size	• preference for TP freight services higher for bigger company

Although some of the results seem obvious and quite predictable (for example the high value of time for fresh comestibles or the absence of relationship between cargo size and the value of time), other conclusions are less self evident and reasonably unexpected (for example the asymmetrical value of time for delays and for earlier consignments or the fairly low value of damage risk).
Fridstrøm and Madslien analysed both the variables measuring the attitude towards own account versus third party options (which are represented in first half of the strategic level variables, table 4), and the general attitude of the wholesalers toward some specific characteristics of freight transport demand (inertia, vehicle advertising, and so on).
The freight market complexity required to artificially divide the short term choices from the long term ones, although they are actually interrelated aspects of the logistic chain. The potential bias

deriving from this procedure, added to the distortion caused by the analyst lack of knowledge concerning the decision context and the individual choice mechanism, question the validity and reliability of the final results. Even so it seems that only the SP approach is able to enlighten and address the relative importance of the individual preference toward the main factors influencing the freight transport demand.

Bolis and Maggi

The results obtained by Bolis and Maggi (1999), reported in monetary values in Table 5, are consistent with the ones drawn by previous analogous studies.

Table 5

Value of	*CHF/Net ton.*	
Time	1.15	CHF for 1 hour less in time
Reliability	2.42	CHF for 1% more in reliability
Flexibility	0.37	CHF for 1 hour less in notice time
Frequency	1.10	CHF for one shipment more per month (not significant)

Source: Bolis and Maggi (1999)

Bolis and Maggi (1999) calculate the trade-off among rail and non rail modes too. On the basis of their estimates a firm is indifferent in respect to the trade-offs listed in Table 6.

Table 6

Trade off rail to		
Price	17.14	CHF of rebate
Time	15.5	Hours faster
Reliability	7.5%	More reliable
Flexibility	46	Hours in notice time
Frequency	15	Times/months more frequent (not significant)

Source: Bolis and Maggi (1999)

The logistic variables (flexibility and frequency) show the proper sign, although only flexibility is statistically significant. Accordingly to Bolis and Maggi results, the firms practising the Just-In-Time (JIT) logistics place a high value on frequency an flexibility. Specifically, they notice that "if the interviewed firm itself was practising JIT, the most relevant variable is frequency. If it is the client who is working JIT, the most relevant decision variable is reliability", demonstrating the crucial role played by the logistic choice in shaping the freight transport demand. However, they also conclude that price and time confirm their overwhelming importance for each of the analysed sub samples.

5. Conclusions and resaerch proposal

Different methodologies have been adopted to analyse the determinants of freight transport demand. Traditionally, economists have estimated freight transport demand models via observed, RP data. The problems encountered, anyway, were enormous. Abdelwahab and Sargious (1992) publish a paper in which they provide RP-based estimates of a sophisticated inventory model where joint determination of mode choice and shipment size is provided. In that paper they report facing the following difficulties:

- the most recent reliable data for the US are dated back to 1977 (the 1983 data were not published because of their poor quality);
- the most disaggregate level is an origin-destination commodity matrix among 49 areas. Each of them consists of a large SMSA (Standard Metropolitan Statistical Area) with 900 or more manufacturing establishments;

- there was a lack of data for what concerns service variables, market attributes or shipper characteristics. For this reason the database was filled in with data from other sources or from theoretical models predicting levels of service attributes such as: freight charges for truck and rail, transit time and reliability of transit time for truck and rail, loss risk and damage risk of shipment moved by truck and by rail.

The informative advantages of ad hoc SP interviews need not be stressed further. They provide an essential source of direct, up-to-date information on individual firms' preferences for modal attributes, although they pose other, partly already discussed, problems. One of the issues which has not been discussed yet is the aggregation procedure. SP studies are extremely useful to understand individual firm's, micro behaviour, but faces some little explored difficulties with the aggregation process.
Such discussion has already taken place at the theoretical level when comparing disaggregated and aggregated models. Disaggregated models are better-rooted on individual behaviour but aggregate models, according to some authors (Anas, 1981), can be more useful in the context of large-scale (regional or national) analyses of freight flows if the objective is forecasting or policy analysis. Similarly, RP studies might be a better base for forecasting or policy analysis, though SP studies provide a sounder tool for understanding firms choices and analysing the trade-off between price and non-price modal choice determinants. So far SP studies have been mostly based on rating or ranking formats, which are generally thought more appropriate for trade-off analysis (sometimes terms part-worth analysis), than for modelling or prediction purposes. Moreover, SP studies have focused on few, geographically concentrated segments of the freight market. It would be interesting to see the results of an SP study with a choice format and larger scope as a basis for modelling and forecasting. The availability of cheap portable computers and the growing in this research field will certainly allow to conduct such studies in the near future.
Beside the analysed one there is a stream of literature focusing on the factors influencing freight transport mode choice that adopts a more qualitative methodology (see Matear and Gray, 1993, for a review). Through this approach shippers or freight suppliers are confronted with a large (sometimes open) selection of service attributes including carrier, route, timing, price and control characteristics (as an example see Table 7).

Table 7 - Service attributes

Component	*Service attributes*
Carrier characteristics	Arrival time, good relationship with carrier, fast response to problems, able to handle special requirements, perform urgent deliveries
Route characteristics	Know which port is used, proximity to origin, proximity to port destination
Time characteristics	High frequency of service, on time collection and delivery, short transit time, departure time from origin
Price characteristics	Low price, value for money price, special offers of discounts
Control characteristics	Transport preference of trading partner, documentation completed carrier

Source: Matear and Gray (1993)

Respondents are asked to rate (usually form 1 to 5) the importance of each attribute. A principal components analysis is then performed to obtain an average mean score for each component. The pros and cons of such analysis relative to the SP approach are the ones typically identified when comparing qualitative and quantitative methods.
Qualitative studies are very informative and detailed on all nuances of choices, but the information they produce are hard to be synthesised, let alone the possibility of estimating or validating models on such premises. SP data trade off the extensiveness of the attributes examined, with the possibility of statistically estimating their importance. The statistical estimate provides information not only on their relative importance, but also on their statistical significance, given some assumptions on the

error distribution. In this respect they allow to estimate or validate a demand model, to estimate the implicit monetary of each qualitative attribute, and to make comparisons across studies.
In section 4, the studies so far conducted have been briefly illustrated. They showed that the SP methodology produces a better understanding of the modal choice, of the prospects for transferring on rail part of the road based transport, of the choice among own and third party transport service and of the interaction among logistic and transport attributes. It seems to us that the SP analyses can produce very informative results and that previous knowledge obtained from RP or qualitative studies can be usefully complemented in a field such as freight transport, where so many economic, geographic, physical, technological variables interact and where very few generalisations can be made. As stated in the introduction freight transport demand is particularly difficult to study because of the heterogeneity of the goods transported, its characteristic of derived demand, the existence of more than one decision maker, the role of geographic factors and the use of long term, confidential prices. The SP methodology asks the operators to take part to an experimental game. If the computer possibilities are fully used to design realistic, adaptive and informative games, we believe that much can be learn about how different firms with different characteristics in different settings make choices.
Following this line a research, a research project will be carried out for the Friuli-Venezia Giulia Region (Italy) which will explore demand preferences among firms:

- which differ in the types of goods produced or inputs required
- which differ in size
- localised at differing distances from infrastructural nodes
- with various origin-destination points
- belonging to industrial districts
- with different logistic chain types
- with different outsourcing levels

By comparing the results for every firm segment, it will be possible to assess if and how the identified segments imply a significant difference in term of stated demand preferences.

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