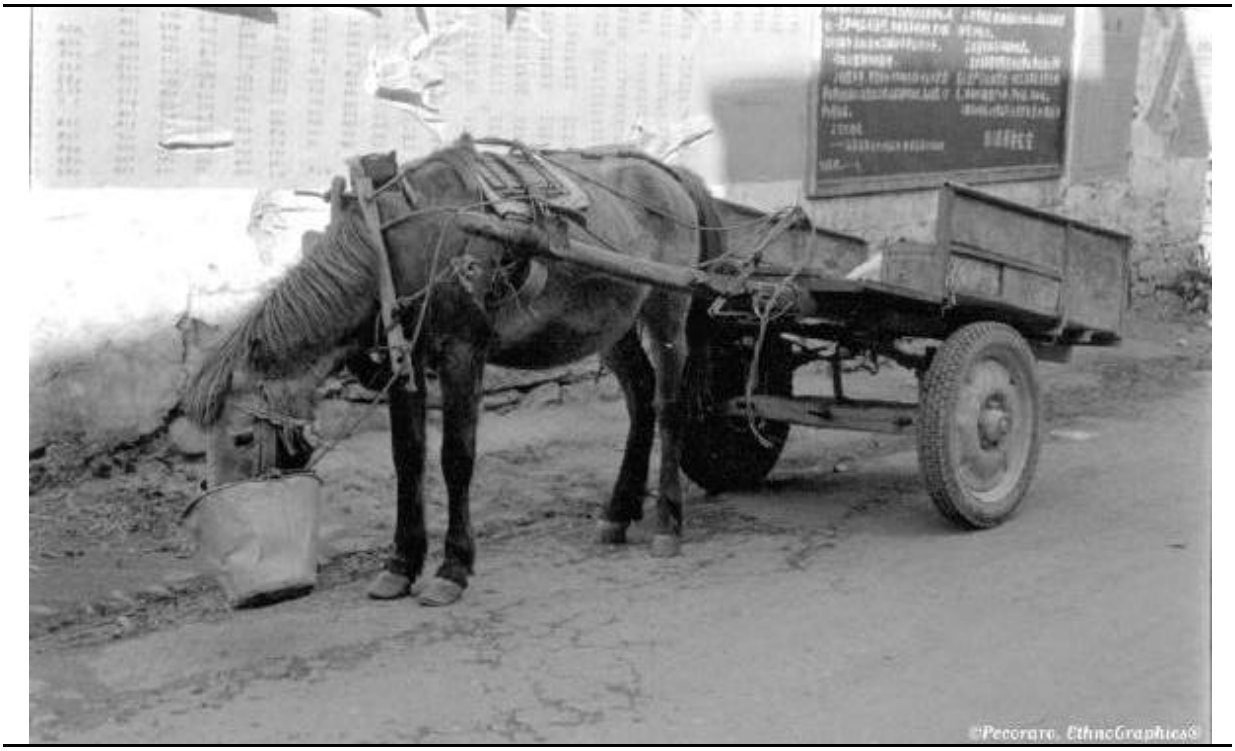


# Evidence on Shippers' Transport and Logistics Choice

**Simona Bolis, MecoP - Università della Svizzera italiana**
**Rico Maggi, MecoP - Università della Svizzera italiana**

**Conference paper STRC 2001**
**Session Choices**

**STRC** | 1st Swiss Transport Research Conference
Monte Verità / Ascona, March 1.-3. 2001

# Evidence on Shippers' Transport and Logistics Choice

Author Simona Bolis and Rico Maggi
Department MecoP
Organisation Università della Svizzera italiana
City Lugano (CH)

Phone: 0041 91 9124635
Fax: 0041 91 9124733
eMail: simona.bolis@lu.unisi.ch

## Abstract

In this paper we present the results of a microanalysis of freight transport demand in a logistics context. Current research concentrates with few exceptions on shippers' choice of a transport. However, in a global context, shippers' behaviour has to be conceived as a complex decision, which considers transport mode choice as only a part of a firm's logistics strategy. Since there exists no data to directly estimate the marginal values for different qualities of transport and logistics services a stated preference approach is applied. Adaptive stated preference experiments are performed for 22 firms in Italy and in Switzerland. The experimental results - 40 hypothetical binary choices per firm - are completed by background information on the long-term logistics strategy. The results confirm the relevance of the logistics context (e.g. JIT strategies on the suppliers or customers side) for transport demand. The calculated marginal values of time and characteristics (reliability, frequency, etc.) give important insights and will permit to reformulate generalised costs in freight transport models.

## Keywords

Freight Transport – Logistic Services – TransAlpine Transports

# 1. INTRODUCTION

The objective of this research was to produce behavioural parameters based on empirical research into shippers' valuation of freight transport services. In order to come up with realistic estimates of the determinants of service choice, which would allow guiding rail-related strategies in transalpine freight transport, this research investigates into shippers' behaviour in freight transport in the transalpine context. The motivation for this is the belief that current freight transport modelling, at least in Switzerland, does not reflect real world behaviour of shippers in a satisfactory way.

From a theoretical point of view, transport and logistics services are considered as production factors of a firm. This specification, together with the integration of the spatial structure of the firm as an output characteristic permits to set our model in a traditional microeconomic setting. The model is tested in an experimental set-up. It consists of an adaptive stated preference experiment imbedded in qualitative interviews with the logistics manager of the firms. The basic idea was to simulate a decision on hypothetical services. This has proved useful because competitive services based on the rail mode have a clearly hypothetical character for most shippers. A specificity of the SP design chosen here is that the transport modes enter as a simple quality of a service rather than as a label. With this we tried to avoid an explicit focus on a choice among modes during the experiment.

The experiments allowed identifying the relative monetary values of the most important qualities in freight transport demand. This is a progress with respect to most studies on the subject, which mainly returned classifications of the attributes. In this way it is possible to compare the value of time with the value of other variables which in our case were reliability, frequency and flexibility. The monetary values of service qualities (trade-offs between quality levels and price rebates) can be used to improve traditional freight flow models. Because they are perfectly analogous to the value of time, they can be integrated in the generalised cost of a link in the same way.

This research strategy offers an appropriate survey instrument to overcome market intransparencies and a lack of data that characterises TAFT. Furthermore, the overall research should confirm if a stated preference approach could serve as a useful tool for the analysis of quality oriented markets.

We first present a simple theoretical model that integrates logistics and transport choices. Subsequently, the empirical analysis describes the data gathering in form of an adaptive stated preference experiment by which we collect data on decisions on transport and logistics, the two lower levels of the decision tree, and present the results. Finally, some conclusions are drawn.

# 2. INTEGRATING TRANSPORT AND LOGISTIC CHOICE

For the purpose of this study it is useful to consider a decision structure of a firm which reflects the complexity of a company's strategy in a global environment. In the long run the company defines its strategic logistics in terms of localisation of the company, supplier/client network and production. In this context the firm has to take long-term decisions and hence they correspond to top level of the decision structure.
On a second level firms implement a transport logistics programme. This implies decisions on supply chain organisation, stock in warehouses, frequency and dimension of shippings, flexibility of the service, documents (paper, electronic), factoring (prepaid, collect), tracking/routing, insurance, money back warranty, etc.
The long and medium term decisions are related to the transport and logistics services available on the market. This latter represent the third decision level we want to analyse. On this level, the shipper decides on the transport service only. Examples for characteristics included are price, transport time, reliability, and safety. These characteristics are implied in a specific transport mode. In so far as shippers have preferences for modes as such, the mode enters as an additional quality.
In fact, decisions are taken simultaneously; a company organises its production in space and implements its specific logistics according to the transport services available on the market. Summarising, we have the following decision levels:

1st level: Strategic/long term (general logistics decisions in the long run)
2nd level Strategic/medium-short term (transport logistics in the medium run)
3rd level Operative (transport service decisions in the short run)

From an economic point of view it is useful to represent an industrial firm with the production function. For our purpose we integrate transport and logistics services as a production factor (input), and we conceive a firm as a network, including it as an output characteristic in the production function. Network structure captures the spatial organisation of the firm (location of plants, raw material suppliers, market outlets etc.) as well as long term logistics decisions (distribution of warehouses, organisation of the supply chain etc.).

The simple production function is:

$$Q = f(L, K, A, N) \qquad (1)$$

where:
- Q: Output
- L: Labour
- K: Capital
- A: Transport and Logistics services
- N: Network structure

Considering transport and logistics services as input makes it possible to analyse the demand for it as a normal factor demand. Taking the dual of the above production function and considering that the price of A is an hedonic price, i.e. a (non-linear) function of the levels of the characteristics of the services, we can derive a conditional factor demand for A as (see Maggi and Bolis, 1999):

$$dC/dP_a = A = f(Q, P_l, P_k, P_a, Z_1, Z_2, \ldots, Z_n, N) \quad (2)$$

where:

- $P_l$: Price of Labour
- $P_k$: Price of Capital
- $P_a$: Price of Transport Services
- $Z_1, Z_n$ Characteristics of Transport Services
- N: Network Structure

In reality, A is the demand for a certain quantity of goods to be moved according to the logistics set up and given specific transport and logistics services available on the market. In equilibrium a firm will have chosen specific services in terms of price and qualities in order to organise these movements.
In the short run, firms have determined the cost minimising A as a function of price and qualities of the services offered on the market and given the long and medium term strategies. The short run (variables) cost function of the firm become:

$$C = C(Q, A, P_l, K, N, P_a, Z_1, Z_2, \ldots, Z_n) \quad (3)$$

If we assume that the allocation of labour in the firm does not, in the short run, depend on the transport solution, we can substitute $P_1$ by the amount of labour L. Subsuming the output level and the quantities of labour and capital under the firm specific variable F that describes, together with N, the long and medium term set up, we can write the short run cost function as:

$$C = C(F, N, A, P_a, Z_1, Z_2, \ldots, Z_n) \quad (4)$$

Because the characteristics and $P_a$ represent a vector specific to a transport service, the firm minimises cost choosing among alternative services. Therefore, we can analyse the decision in the standard discrete choice framework. Considering only two alternatives[1] and assuming that the unobserved errors are independent and identically Gumbel distributed we can formulate the decision taken by the company as a binary logit model. Because cost is a disutility, the probability of company n of choosing alternative A rather than B becomes:

$$P_{nA} = \frac{\exp[C(z_B, P_{aB}, F_n, N_n, A_n)]}{\exp[C(z_B, P_{aB}, F_n, N_n, A_n)] + \exp[C(z_A, P_{aA}, F_n, N_n, A_n)]} = \frac{1}{1 + \exp[C(z_A, P_{aA}, F_n, N_n, A_n) - C(z_B, P_{aB}, F_n, N_n, A_n)]} \quad (5)$$

This model will be specified in the next section.

[1] See below for the binomial specification of the model.

# 3. SPECIFICATION OF THE ASP EXPERIMENT

In a preliminary step we have collected more information on the content of the first decision level, i.e. the long-term context. In depth interviews with four different firms in Ticino (Switzerland) and a postal survey among shippers in Northern Italy were performed. 250 questionnaires have been sent out to a random sample of firms provided by the Chamber of Commerce of Lombardy. 24 questionnaires could be used. The aim was to assess the decision structure described above. The survey data indicate that the most important qualities of this service are reliability, followed by price, speed and safety. This confirms the results of recent European surveys where reliability was shown to be one of the most important criteria for the choice of transport (see e.g. Fowkes *et al.*, 1991).
The decision about transport, therefore, is not simply dependent on the characteristics of the transported good (often approximated by the sector) and on the attributes of the mode of transport, but on the general logistics concept implemented by the company, at a strategic level, to control the flow of goods (large/small quantities, long/short distance, number of raw materials, frequency of distribution, number and location of plants and warehouses) (see Maggi and Bolis, 1999).
To perform our analysis we have chosen to use Stated Preference (SP) which is already well established in freight transport (see Bates, 1988, Fowkes and Tweddle, 1997). Revealed Preference (RP) which would be based on observed behaviour is not feasible in our context of freight transport (see Tweddle *et al.*, 1996). While the experience with SP in freight transport is generally positive, there is one drawback on the existing research. All evidence known to us is on mode choice. Hence, we have to construct a new model adapted for a more complex decision structure.
In addition, we can not use traditional conjoint measurement techniques because the choice set has to be adapted to the real context of the decision-maker interviewed. A traditional design would risk confronting the decision-maker with choices/options, which are irrelevant for him. For this reason we have used the so-called Adaptive Stated Preference technique (ASP). The ASP starts from an existing freight transport option chosen by the interviewed person. Usually this option is elaborated in discussion with the logistics responsible and it describes a typical transport for this firm (see Fowkes and Tweddle, 1996). Starting from this option, the ASP exercise implies asking the respondent to rate various hypothetical alternatives for performing the same transport task expressed in terms of the relevant attributes.
In our context of transport and logistics choice the ASP experiment has taken the following form: in a first step the general logistics strategy of the firm is assessed. This gives the relevant context of the 1st level of our choice model, in a second step a typical transport is identified in terms of the variables relevant for the transport and logistics decision (levels 2 and 3). These variables are:

Transport: price, time, reliability and mode
Logistics: frequency and flexibility.

In this way we are effectively reducing the choice levels to 2, one outside the experiment and one within. The experiment is performed on a portable computer. The screen shows three options; each described with the attributes above. The typical service described (current service) appears in column A and has a fixed rating of 100. The task to perform during the experiment

is to assign ratings to hypothetical options presented on the screen, hence the respondent is asked to rate option B and C with respect to A on a scale such that option A (current option) is 100 and option A at half its price would be 200, and option A at double its price would be 50. This is a linear-in-logs scale, but the important thing is that respondents should rank options in their desired order, and use the rating scale to roughly indicate their strength of preference (see Tweddle *et al.*, 1995).
Once the rating on screen one (iteration one) is performed, the following screen offers two new options in column B and C while column A remains reserved during the whole experiment for the reference option. At the first iteration the respondent is confronted with an option B that is cheaper but slower and options C which is cheaper but less reliable. In the following iteration the price variable changes as a function of the rating given until a point of indifference is reached. At this point the following screen will present options where the remaining attributes change following the same procedures. The attributes changed first are those referring to transport, then, once convergence is reached, those referring to logistics (flexibility and frequency). Finally, the chosen transport mode is varied.
This procedure reflects our modelling concern in several ways. First, we can integrate transport and logistics. Second, whether the transport decision is separated from the logistics one is an outcome of the experiment. Thus, transport mode looses its dominant role and enters as a simple characteristic of the transport service. Given our interest in the matter, combined transport is one of the transport modes presented.

# 4. ESTIMATION OF THE MODEL

We performed our interviews with the logistics or distribution manager who could answer questions about the distribution and the input activities of the firm.
First, we assessed the general logistics strategy of the firm in term of location of production centres, depots and distribution methods, number of suppliers and clients and their spatial distribution.
Second, four regular typical movements were identified, two for the supply side and two for the distribution.
Finally, we performed the experiment, where possible, for two typical transports: the first on the distribution side and the second on the supply side. The whole experiment lasted 1 hour on average.
In total a sample of 22 interviews corresponding to 31 ASP experiments could be used for further analysis. In particular, we have 10 typical transports on the input side and 21 on the distribution side. 22 were trans-Alpine freight transports.
It is worthwhile to note that the sample is small and it addresses a wide variety of sectors and segments of industry. Table 1 shown that, in some cases, conclusions for a particular sector were drawn from a sample of five interviews, thus causing some doubt on the representatively of the findings. On the other hand, these interviews were conducted with logistics managers of the companies. In addition, 40 observations were obtained from each interview, which, in combination with the interactive nature of the LASP programme, can produce valid and statistically significant results.

Table 1: Structure of ASP sample by nations and activity

| Sector | CH | ITA | Tot. |
|---|---|---|---|
| Perishable goods | 1 | 2 | 3 |
| Chemical | 1 | 3 | 4 |
| Machinery | 4 | 1 | 5 |
| Metallurgy | 1 | 2 | 3 |
| Varied Goods | 2 | 5 | 7 |
| Total | 9 | 13 | 22 |

The data collected were “exploded” and then ratings were transformed into binary choices (see Fowkes and Tweddle, 1996). This means that we constructed a data set where every difference in rating between an alternative offered (B) and the actual solution (“real” alternative (A)) was transformed into a choice probability for the hypothetical offer (B).
The rating exercise involved 20 interactions. Thus, we observed 40 such differences for each firm (2 per screen). Following Fowkes and Tweddle, for any given pair, the rating was converted into a probability of choosing alternative A according to:

If Rating < 100 then $P_A$= 1- (0,5 Rating/100) (6)

If Rating > 100 then $P_A$= (0.5 *100/Rating) (7)

Proceeding this way we observe probabilities and hence we can estimate a logistic regression model relating (Log ($P_B/P_A$)) to the attribute differences. Transforming the above logit probability we obtain:

Log (1-$P_A/P_A$)= C ($z_A$, $P_{aA}$, $F_n$, $N_n$, $A_n$ ) – C ($z_B$, $P_{aB}$, $F_n$, $N_n$, $A_n$) (8)

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

$$\text{Log}P_B/P_A = \alpha + \beta_1 (\text{PRICE}_B - \text{PRICE}_A) + \beta_2 (\text{TIME}_B - \text{TIME}_A) + \quad (9)$$
$$\beta_3 (\text{RELIA}_B - \text{RELIA}_A) + \beta_4 (\text{FREQ}_B - \text{FREQ}_A) +$$
$$\beta_5 (\text{NOTICE}_B - \text{NOTICE}_A) + \beta_6 \text{DUMMRAIL} + \beta_7 \text{DUMMACC} +$$
$$\beta_8 \text{NAZIONE} + \beta_9 \text{SBOCREG} + \beta_{10} \text{JITRICE} + \beta_{11} \text{JITSPED} +$$
$$\beta_{12} \text{KMBREVE} + \beta_{13} \text{HIGHVALUE}$$

Where:

| | |
|---|---|
| PRICE | transport price for 1 net ton in CHF for a door to door service, |
| TIME | scheduled journey time in hours between origin and destination, |
| RELIA | expected number of shipments per year arriving on time in %, |
| FREQ | number of shipments per month, |
| NOTICE | minimal notice time for transport order in hours, |
| DUMMRAIL | 1 if rail transport, 0 otherwise, |
| DUMMACC | 1 if multimodal transport, 0 otherwise, |
| NAZIONE | 1 if Italy, 0 if Switzerland, |
| SBOCREG | 1 if the distribution is mainly regional/local, 0 otherwise, |
| JITRICE | 1 if firm receiving the good is working JIT, 0 otherwise, |
| JITSPED | 1 if firm sending the goods is working JIT, 0 otherwise, |
| KMBREVE | 1 if the transport distance is < 500 km, 0 otherwise, |
| HIGHVALUE | 1 if the product has high value/net ton, 0 otherwise. |

The first five variables (PRICE, TIME, RELIA, FREQ and NOTICE) and the mode dummies (DUMMRAIL and DUMMACC) measure the quality of the transport service. The remaining variables (dummies) represent the firm characteristics in the above-specified cost function and hence the long terms logistics context. Travel price and travel time are defined as door to door price and time, including transhipment. "$\text{PRICE}_B$ - $\text{PRICE}_A$" indicates a rebate on B. "Notice" is our inverse measure of flexibility; i.e. the larger the notice time the lower the flexibility. Furthermore, the following weights were used:

If $\text{Rating}_B$ > 100 then $W_B$ = 100/$\text{Rating}_B$, else $W_B$ = (200-$\text{Rating}_B$)/100 (10)

This gives most weight to the least clear-cut decisions. In other words, small changes in ratings close to 100 are likely to be a lot more significant than similar changes in other ratings (see Fowkes and Tweddle, 1996).
The procedure chosen to estimate the empirical model is the Tobit ML estimator. The data set has an important characteristic; i.e. there are several observations where the rating is zero. This means that the interviewee considers the alternative proposed as unfeasible (because of technical incompatibility with a specific transport mode, or because the rebate was judged to be unrealistic, or for unacceptable levels of reliability, frequency or flexibility). The Tobit model involves censoring and it is applied to take into account these observations with a rating of zero (139 cases).
Table 2 gives an overview on the reasons for refusing the proposed alternatives. While the importance of the refusals for price reasons indicates a lack of credibility of our experiment in certain cases (mainly three cases), the problems with accepting lower frequency is an interesting additional result of our analysis. In specific logistics context (JIT) frequency is critical and changing it would require adjustment on the first level of decision, i.e. the general logistics of the firm.

Table 2: Alternatives refused per nation and region

| RATING ZERO | SWISS | % | ITALY | % | TOTAL | % |
|---|---|---|---|---|---|---|
| Price-(too high) | 18 | 23 | 23 | 38 | 41 | 29 |
| Price (too low) | 15 | 19 | - | - | 15 | 11 |
| Time | 5 | 6 | 7 | 11 | 12 | 8 |
| Reliability | 7 | 9 | 1 | 2 | 8 | 6 |
| Flexibility | - | - | 7 | 11 | 7 | 5 |
| Frequency | 23 | 30 | 17 | 29 | 40 | 29 |
| Use of Rail | 10 | 13 | 6 | 10 | 16 | 12 |
| | 78 | 100 | 61 | 100 | 139 | |
| | | 56 | | 44 | | 100 |

In what follows, the results of the estimation are presented. For interpreting the results it is important to note that the context is mainly long distance transport. The estimation results for the whole sample are shown in Table 3.

Table 3: Estimation results for the whole sample

| | Coefficient | t-ratio |
|---|---|---|
| Intercept | 0.0961 | 2.311 |
| Price | 0.0048 | 7.236 |
| Time | -0.0055 | -5.832 |
| Reliability | 0.0116 | 1.838 |
| Frequency | 0.0053 | 1.323 |
| Flexibility | -0.0018 | -2.490 |
| Rail | 0.0822 | 2.272 |
| Combined transport | 0.0083 | 0.249 |
| Italy | -0.0577 | -1.814 |
| Regional distribution | 0.1749 | 5.615 |
| JIT receipt | -0.0803 | -2.562 |
| JIT delivery | -0.0921 | -2.807 |
| Short distance | -0.1109 | -2.944 |
| High value product | 0.0772 | 2.314 |
| N.OBS 1271 / $R^2$ 0.105 | | |

All coefficients refer to the effect of some change in the respective variable on the respondent's utility (rating). Note that the coefficients have all very low values. This indicates that the marginal impact of a change in a variable on the propensity to change from the actual solution to a hypothetical one is small. As a consequence also the respective elasticites would be small.

# 5. THE TRADE-OFFS

The estimations permit to identify the critical qualities and their economic importance in different long-term logistics concepts. The stable and significant parameters allow for consistent interpretation of the implied trade-off among quality and price. Always taking the ratio of the service attributes to the price coefficient returns the monetary values of an attribute at the margin and hence gives an idea of how changes in attributes are traded off against a monetary change in transport prices. In the case of time this is the Value of Time (VOT). The finding on the trade-off ratio confirm the results of similar research carried out in a European context (see Blauwens and Van de Voorde, 1988, Winter, 1995, Fowkes and Tweddle, 1997, Jong and de Gommers, 1992, NERA, MVA, STM, ITS, 1997, Hauser and Hidber, 1996, etc.). There is evidence that quality of service factors such as notice time and reliability, etc. play a significant role in the choices of users, as well as the standard elements of travel time and price. Table 4 gives an overview on the trade-offs in CHF/net ton.:

Table 4: Trade offs for the whole sample

| 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) |

We found that across all experiments, the value of time is CHF 1.15 per hour which is more or less half the value of 1% more transits arriving on time for which shippers would on average be willing to pay CHF 2.42.
Because these values are in Swiss Francs per net ton the willingness to pay at the margin for the respective improvements in quality will vary with the weight of the load. For example, in the case of road transports of 28 tons and 40 tons, respectively, these trade offs are shown in Table 5.

Table 5: Willingness to pay for improved services

| The firm is willing to pay for each despatch FS: | Road Transport- Full Load<br>28 tons Swiss Limit<br>(15 t. net weight) | Road Transport- Full Load<br>40 tons EU Limit<br>(27 t. net weight) |
|---|---|---|
| 1 hour less | 17.25 | 31.05 |
| 1% more reliability | 36.30 | 65.34 |
| 1 hour more flexibility | 5.55 | 9.99 |
| 1 shipment more per month<br>(not significant) | 16.50 | 29.70 |

A gain of one day in transport time in a typical transport would be worth CHF 414 for an average firm in case of a 15 net tons load and CHF 745 in the case of a 27 net tons load. The difference of CHF 424 gives an idea of the value of not having to make a detour around Switzerland in the presence of a 28 tons limit. Furthermore, we can calculate the trade-off between all dummy variables and the values of the qualitative attributes. It is interesting to consider the trade-off between the use of rail and an attribute such as time, reliability, frequency and flexibility. These trade offs are presented in Table 6.

Table 6: Trade-off rail

| Trade off rail to: | | The firm is indifferent between rail and non rail if one of the following improvements is offered: |
|---|---|---|
| Price | 17.14 | FS of rebate |
| Time | 15.5 | Hours faster |
| Reliability | 7.5% | More reliable |
| Flexibility | 46 | Hours or 2 working days less in notice time |
| Frequency | 15 | Times/month more frequent (3.5 times/week) (not significant) |

For example for a rebate of 17 CHF per net ton the propensity to change from the actual service to a new one would be equal among rail and other modes. In other words, one may say that the “frustration” with current rail services could be compensated by a discount of this amount. Hence, all the above trade-offs can be interpreted as equivalent to the shift among rail and non-rail in the propensity to change the transport services.

# 6. THE ELASTICITES

In our regression, the coefficients for the logistic and transport service attributes are very low. The marginal impact of an attribute to the probability of choosing a transport service is very low also. That means elasticity values again very low. In particular, all elasticites are below 1. These results are partially due to the type of experiment we implemented: we introduced variation very high (i.e. 50% of rebate) to generate an important reaction from the interviewee persons.
The elasticites for road transport are lower than rail or combined. This confirm the results of others studies (see Viera, 1992). Actually road transport is qualitatively superior to rail and combined transport: any improvement on the road system has weaker impact on the road market share than similar qualitative improvements on rail or combined market.
The elasticites in the road, rail and combined market are differents. We conclude that is not sufficient only a market to satisfy the demand and that the level of competition inside the three markets is also different. From the point of view of the supply, there is the possibility to differentiate in any market.

Table 7: Elasticites

| | Elasticites |
|---|---|
| Cost | -0.52 |
| Time | -0.21 |
| Reliability | 0.57 |
| Flexibility | 0.02 |
| Frequency | 0.056 |

Table 8: Transport Mode Elasticites

| | Road | Rail | Combined |
|---|---|---|---|
| Cost | -0.48 | -0.68 | -0.59 |
| Time | -0.19 | -0.27 | -0.24 |
| Reliability | 0.52 | 0.75 | 0.65 |
| Flexibility | 0.02 | 0.03 | 0.02 |
| Frequency | 0.05 | 0.07 | 0.06 |

# 7. EVIDENCE FROM SUB-SAMPLES

We performed estimations on different sub set (Swiss and Italian firms, JIT production systems, transalpine transports, short and long distance transports, transport mode, final consumption and intermediate goods, transport on the input and the distribution side, transport carried out by forwarding agents).

## 7.1 Swiss and Italian firms

It is interesting to consider the behaviour of Italian and Swiss companies separately. The Italian sample has no significant preference for the mode of transport, while the Swiss reveal a clear position with respect to rail as discussed above. They are willing to use rail if the quality of service proposed to them is also satisfying. In other words, if a transport service is of equal quality, Swiss prefer rail.
For the Italians, it is important to underline that international transports are, above all, performed by forwarding agents. Companies don't really know the comparative level of services between rail, road and combined transport. That could be the reason why Italians have no significant behaviour with respect to transport mode.
Furthermore, in the Swiss sample, the constant and the cost are not significant whereas quality is significant. The prevailing concern of Swiss shippers seems to be quality and not price. It is worthwhile to note that for Swiss firms flexibility is more important than frequency while for the Italians the contrary holds. In fact, in the Italian case, the interviews show that the transport market is able to offer a high level of flexibility and for this reason, it is not taken into account by the firms when making transport decisions.
When comparing the results, it is also important to note that the interviewed Swiss firms are significant larger than the Italian firms (see below).

Table 9: Relevant Transport Service Qualities for Swiss Firms and Italian Firms

| Swiss Firms | Italian Firms |
|---|---|
| Time | Price |
| Reliability | Time |
| Frequency | Reliability |
| Rail Transport | Flexibility |

## 7.2 JIT Production Systems

While the firms in our sample that are working with traditional production system consider mainly cost and time as important decision variables, firms producing in a JIT context demonstrate a relatively high marginal willingness to pay for flexibility and frequency.
The value presented in table 10 demonstrate that having implemented JIT means attributing a higher value to flexibility and to frequency in order to allow the maximum efficiency of the

system adopted. In the case of flexibility the values is eight times higher than in the whole sample.

Table 10: Firm adopt JIT Production System (N.OBS 410 and R2 0.21)

| Value of: | CHF /Net ton. | |
|---|---|---|
| Time | 2.25 | CHF for 1 hour less in time |
| Reliability | - | CHF for 1% more in reliability |
| Flexibility | 1.75 | CHF for 1 hour less in notice time |
| Frequency | 3.25 | CHF for one shipment more per month |

In fact, in our sample, the companies using JIT system are characterised by much lower levels of flexibility (short or very short notice) and higher frequency as compared to those companies which still use traditional production systems (see table 11).

Table 11: Means values of frequency and flexibility

| Sample | | N.obs | Frequency (times/month) | Flexibility (hours/notice time) |
|---|---|---|---|---|
| All Firms | | 31 | 7 | 54 |
| | | | | |
| JIT systems | Firm which send the good: | 10 | 12 | 47 |
| | Firm which receive the good: | 9 | 9 | 34 |
| | | | | |
| Not JIT system | Firm which send the good: | 21 | 4 | 62 |
| | Firm which receive the good: | 22 | 6 | 66 |

## 7.3 Transalpine Transports

In the following table the estimation results for the 22 trans-Alpine freight transports are shown. The dummy rail is not significant and the value of reliability and frequency increases with respect to the whole sample. The absence of specific preferences for rail indicates that either firms using rail are not frustrated by the current level of services or that they do not believe in a possible improvement.
The main perceived problems seem to lie in transport logistics (reliability, frequency) and are not mode specific. This is a very interesting result if compared to the police effort in transalpine freight transport, which focus on prices and transport mode.

Table 12: Transalpine Transport (N.OBS 902 and R2 0.11)

| Value of: | CHF /Net ton. | |
|---|---|---|
| Time | 1.26 | CHF for 1 hour less in time |
| Reliability | 3.84 | CHF for 1% more in reliability |
| Flexibility | - | CHF for 1 hour less in notice time |
| Frequency | 1.96 | CHF for one shipment more per month |

## 7.4 Discussion of the evidence

In general, the analysis shows that price, time and reliability are important factors in the decision process of the firm but frequency and flexibility emerge as important decision factors when firms operate in a JIT context (the firm sending the goods or the firm receiving the goods) and when the product is a final product and/or the firm is serving directly the consumer market or the outlets.
Concerning the use of Rail and Combined Transport, the research confirms that firms don't think of combined transport as different from road transport (the technical and organisational problems the firm has to solve are the same). The situation for the rail transport is different. For rail transport, we generally find a positive sign for the constant term. This expresses a basic propensity to change from the current to a new service on rail. In particular, we find a propensity to change in firms with modern logistics concepts (firms sending or receiving the good are working with JIT systems).
Based on this evidence, we conclude that the predominant use of road transport is caused by current restrictions rather than by a mode specific preference, and we conclude also that the procedure chosen here, i.e. presenting the mode not as a label characterising an alternative but only as a further characteristic, does lead to more realistic estimates of taste shifters.
The dummy variables give further indications on the importance of logistics (in particular the general logistics based on long run decisions). If the distribution networks of the firm is regional, the propensity to change transport service decreases in the following cases: the firm is Italian, the transport is trans-Alpine, the good is a final good, the transport is on the distribution side, and the current transport is by road or combined. Whether the client receiving the goods is working with JIT production system is very relevant for the decision process of the firm, and reduces the propensity to change: this dummy is relevant for all the above subgroup. The short distance reduces the propensity to change transport service in most contexts. The evidence from our estimations is that the development of new or innovative logistics concepts introduces constraints on the feasible transport choices and hence reduces the propensity to change.
Analysing behaviour separately for transalpine transports in our sample the additional evidence is that reliability and frequency return higher values than in the overall sample. This can indicate either a bigger importance of these characteristics in transalpine transports, or a weak point of the services offered on these links. In any cases the estimated values give a precise indication on the strategic importance of these two qualities in transalpine freight transport. Furthermore they can be used, like the other estimated values for improving forecasting

models. We noticed no mode specific preferences in the transalpine context. Hence, the above mentioned frustration with rail is not showing up in the transalpine case.
Our experiments demonstrate the importance of logistics variables in the presence/absence of JIT concepts. An interesting differentiation came to light. 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. This is another point in favour of our analysis because it sheds light on important behavioural details. If the company controls the tight logistics rules it mainly wants to control the frequency of shipping. If, however, it has to deliver to a client having tight time schedules it is more dependent on high reliability. It follows that the marketing of competitive freight transport and logistics services has to be extremely customer oriented and policy initiatives promoting a specific service should try and identify their target in great detail.
A confirmation of common knowledge was found in so far as shippers producing on order place a high value on frequency while those producing on stock have as a dominant decision variable the price of transport. We might conclude that strategies mainly defined on the price variable without paying enough attention to the quality of the service risk to target a rather specific and probably not very competitive market.
Even though we found important evidence for the relevance of logistics variables such as frequency and flexibility in our experiments, the overwhelming importance of price and time has been confirmed across all sub samples. Hence, it would be inappropriate to think that in a modern logistics context the fact that goods can be stored while moving makes that time and price are no longer relevant decision variables. On the contrary, we find that in most contexts, these variables even gain in importance in presence of modern logistics concepts.

# 8. CONCLUSIONS

In this paper we presented first evidence on a model of freight transport and logistics service choice of shippers. The objective of the research is to produce realistic estimates of the determinants of service choice in order to guide rail-related strategies in trans-Alpine freight transport. The results from the analysis of 31 experiments performed with 22 firms return a total of 1271 hypothetical choices.

In some cases, especially in a straight logistics framework, firms put hard restrictions on offered alternatives; e.g. they are not willing to accept hypothetical offers that would imply a lower frequency than the one actually chosen. While this result could be anticipated on the base of expert knowledge we are now able to quantify it. Only in 7% (90 out of 1271) of the cases, a hypothetical decision was refused due to inflexibility with respect to time, reliability, flexibility or frequency. This indicates that JIT concepts implemented by shippers still leave ample space for competitive strategies based on qualities on the supply side.

A second result is that shippers, and more specifically Swiss shippers have a clear preference for change when considering offers for transport services on rail. This implies that either firms using rail are frustrated by the current quality of rail services, or companies would be keen to change to rail if only quality would be sufficient, i.e. competitive with road. This finding is important in so far as we could not identify any basic preference for road, which could not be explained by differences in quality and price. Hence, we have empirical evidence that, at least in Switzerland, rail has no general acceptance problem but one of service quality.

Our experiments confirmed the view that goods classifications are no longer an important means to analyse transport decisions. While we found no evidence for differences in valuation among sectors, we found high values for high quality goods, and above all, a significant impact of the long-term logistics context. Firms working on a JIT basis or delivering to firms with this logistics concept give significantly different importance to qualities. E.g. the value of time is twice as high and the value of flexibility is even eight times higher than for the average firm. Thus we conclude that the integration of logistics and transport services has helped to confirm ideas about the behavioural relevance of logistics. The way in which firms are organised in space and the ensuing restrictions placed on the transport process make that these „modern“ firms place a much higher value on transport qualities in general, and more specifically give great importance to reliability and flexibility aspects. As far as frequency is concerned they are often even completely unwilling to foresee any changes.The following table summarises the main evidence on logistics and the critical decision factors on transport mode.

Table 13: Critical Decision Factors

| Firms with: | Cost | Time | Reliability | Frequency | Flexibility | Mode Transp. |
|---|---|---|---|---|---|---|
| Developed Logistics Concepts | | ❷ | ❷ | ❶ | ❶ | |
| Clients with developed logistics concept | | | ❶ | ❷ | | |
| Mainly production on order | | | | ❶ | ❷ | |
| Mainly production on stock | ❶ | | | ❷ | | |

❶ - Very Important
❷ - Important

Overall, the study could confirm first, that investigating more vigorously freight transport behaviour is not only necessary but can also produce interesting and relevant results. Most of the shippers interviewed could perfectly cope with the experimental set up proposed. This was greatly helped not only by their big interest in the issue but also by the fact that we started from an actual transport performed by the firm. Hence the approach chosen here permits to describe freight transport demand behaviour in a logistics contexts. The quantitative results are realistic and policy relevant. They can be used for improving freight flow forecasts on the transalpine links. The main political implications are obvious: promote quality and customer orientation in general and more specifically on rail bound transport services, and target your service to the specific logistics set up of the clients.
Finally, it can be said that future research would first have to work on a wider base, in order to produce more representative results. Second, further research should try to integrate eventually also the longer-term decisions into the experiment itself.

# 9. References

Bates, J. (1988) Econometric Issues in Stated Preference Analysis, **Journal of Transport Economics and Policy**, Vol. 22 n.1, pp.59-68.

Blauwens, G., Van de Voorde, E. (1988) The Valuation of Time Savings in Commodity Transport, **International Journal of Transport Economics**, Vol. XV, N.1, pp.77-87.

Fowkes, A.S., Nash, C.A. and Tweddle, G. (1991) Investigating the Market for Inter-Modal Freight Technologies, **Transportation Research A**, Vol.25A-4, pp.161-172.

Fowkes, A.S. and Tweddle, G. (1996) Modelling and Forecasting Freight Transport Demand, Mimeo.

Fowkes, A.S. and Tweddle, G. (1997) Validation of Stated Preference Forecasting: A case Study Involving Anglo-Continental Freight, **Transportation Planning Methods**, Vol. II (code P415), proceedings to Seminar F. 25th European Transport Forum, published by PTRC Education and research service Ltd, London, pp.173-189.

Jong, G.C. de, Gommers, M.A. and Klooster, J.P.G.N. (1992), Time Value in Freight Transport: Methods and Results, PTRC – *Summer Annual Meeting*, UMIST, PTRC, London.

Hauser, G., Hidber, C.F. (1996) Der Wert der Zeit im Güterverkehr, in Fischer G., Lässer Ch., (eds.) **Theorie und Praxis der Tourismus- und Verkrhrswirtschaft im Wertewandel**, Paul Haupt, Bern/Stuttgart, pp.263-276.

Maggi, Rico and Simona Bolis (1999). Adaptive Stated Preference Analysis of Shippers' Transport and Logistics Choice, in: **Proceedings of the 8th World Conference of Transport Research**, (forthcoming).

Müller, K. and Maggi, M. (1998) Price Effects of Regulation, in A. Reggiani (ed.), **Accessibility, Trade and Location Behaviour**, Ashgate, Aldershot.

NERA, MVA, STM, ITS (1997), **The Potential for Rail Freight. A Report to the Office of the Rail Regulator,** (and available from that office), London.

Tweddle, G., Fowkes, A.S. and Nash, C.A. (1995) Impact of the Channel Tunnel: A Survey of Anglo-European Unitised Freight. Results of Phase I Interviews. *Working Paper 443, Institute for Transport Studies*, University of Leeds.

Tweddle, G., Fowkes, A.S. and Nash, C.A. (1996) Impact of the Channel Tunnel: A survey of Anglo-European Unitised Freight. Results of Phase II Interviews. *Working Paper 474, Institute for Transport Studies*, University of Leeds.

Winter, L.M. (1995) The Value of Time of Freight Transport in France: Estimation of Continuously Distributed Values from a Stated Preference Survey, **International Journal of Transport Economics**, Vol.22 n. 2.