Article:
Shinghal, N. and Fowkes, A.S. (2002) Freight mode choice and adaptive stated preferences. Transportation Research. Part E: Logistics and Transportation Review, 38 (5). pp. 367-378. ISSN 1366-5545

https://doi.org/10.1016/S1366-5545(02)00012-1

FREIGHT MODE CHOICE AND ADAPTIVE STATED PREFERENCES

Nalin Shinghal
Container Corporation of India Ltd
nshinghal@hotmail.com
Tony Fowkes
Institute for Transport Studies
University of Leeds, LS2 9JT, UK
tfowkes@its.leeds.ac.uk

Abstract

This paper presents empirical results from a survey of determinants of mode choice for freight in India. The Leeds Adaptive Stated Preference software was used for the main survey which was carried out in summer 1998 on the Delhi to Bombay corridor. The survey results show that frequency of service is an important attribute determining mode choice. Valuation of reliability is generally lower than expected. Value of time is quite similar across different product segments. Given prevailing costs, the results suggest that intermodal services can be viable for high value and finished goods.

1. INTRODUCTION

In this paper, we present empirical results from PhD research on determinants of mode choice for freight services in India. It was required, within a modest budget, to evaluate the viability of introducing regular domestic container train services between main centres. Currently, intermodal services are at an early stage of development in India and the volume of domestic traffic being carried by these services is not very large. Consequently, very little data was available on this mode and hence it was not possible to use Revealed Preference (RP) methods for this work. Instead it was decided to use Stated Preference (SP) methods. However, the likely attribute valuations to be expected were not known and it was felt that

they might vary greatly over the range of traffics to be surveyed. This led to the need to use some sort of adaptive SP design.

The Leeds Adaptive Stated Preference (LASP) software was used for the survey. A full description of the software working is available in Fowkes and Shinghal (2001). Further details of the survey are available in Shinghal (1999). During the course of the research we were not able to locate any literature pertaining to use of Adaptive or any other sort of Stated Preference methods in developing countries. This paper attempts to fill this gap and to present these results to a wide audience, since published valuations are scare anywhere and virtually non-existent in developing countries.

In section 2 we describe the survey design and execution. Section 3 presents the details of analysis of the survey data. Section 4 presents the empirical results. Finally section 5 presents our conclusions, on attribute valuations by sector, including a judgement as to the viability of a domestic intermodal service on the Delhi to Bombay route.

2. THE SURVEY

2.1 The survey design

LASP is Adaptive SP data collection software, designed to be used on a laptop computer. It has been successfully used for freight studies within Great Britain (Fowkes, Nash & Tweddle, 1991), for Cross Channel studies (Tweddle, Fowkes & Nash, 1995, 1996; Fowkes & Tweddle, 1997) and on the Continent (Bolis & Maggi 1998, 1999).

On the basis of the results of a pilot survey, it was decided to go ahead with the use of LASP with the following format:

1) Alternatives offered :

a) currently used road service

b) a new road service

c) intermodal container service

d) rail service (express service with wagon-load consignments moving in trainloads all the way from origin to destination)

(During the course of the survey some modifications were made to accommodate firms presently using intermodal services. These are described in section 2.4).

2) Attributes to be used :

a) Cost (for door to door movement)

b) Door to Door Transit time (with increments of one third of a working day i.e.: morning delivery, afternoon delivery, evening delivery)

c) Reliability of service (defined as the percentage of consignments arriving within scheduled time)

d) Frequency of Service (at three levels viz. daily, tri-weekly & weekly)

3) Presentation method: Windows based system running on a laptop computer, presenting the alternatives in form of four 'cards' on the screen, so that it is possible to shuffle the cards and change the sequence in which the alternatives are viewed.

2.2 Simulation Testing

Simulations were carried out to ensure that the problems associated with Adaptive SP methods (Bradley & Daly, 1993) did not exist in this case. The recoverability of the assumed attribute valuations was tested over a very wide range of values using simulated data, since very little information was available about the sort of attribute valuations that were likely to be obtained. The range of attribute values tested was:

- Value of Door to Door Transit Time (VOT) : 3% per day to 90% per day (the higher value representing an exporter who might be willing to pay almost double the charges to save a day in order to catch a particular ship).
- Value of Reliability (VOR) : 0.2% to 10% per percentage point change in reliability.
- Intermodal Container Service Alternative Specific Constant (ASC – IM) : 20% to -30%. The positive value was used to represent people actually preferring Container service, all else being equal.
- Rail Alternative Specific Constant (ASC – Rail) : 0% to -40%. In this case, there was thought to be almost no possibility of anyone preferring the rail service due to the extra handling involved.
- Discount required for tri-weekly service as compared to a daily service (F1): 5% to 20%
- Discount required for weekly service as compared to a daily service (F2): 10% to 40 %

Twenty one combinations of these values were tested, as listed in Table 1.

Table 1 : Attribute level combinations used in the simulation testing

Test	ASC - IM	ASC- Rail	F1	F2	VOT	VOR
1	-10	-10	10	20	3	0.2
2	-10	-10	10	20	15	1
3	-10	-10	10	20	30	5
4	-10	-10	10	20	90	10
5	+20	-40	10	20	3	0.5
6	+20	-40	10	20	3	5
7	+20	-40	10	20	30	1
8	-30	-40	10	20	30	10
9	-30	-40	10	20	90	10
10	-30	-40	10	20	90	5
11	0	-20	5	10	15	2
12	0	-20	5	10	15	5
13	0	-20	5	10	15	10
14	-20	-40	10	20	90	10
15	-20	-40	10	20	30	5
16	-20	-40	10	20	90	5
17	-10	-20	10	20	3	0.2
18	-10	-20	10	20	3	5
19	+20	-30	20	40	30	5
20	-20	-20	10	10	30	5
21	0	30	20	40	90	10

In the final analysis of survey data some of the values were found to lie outside the tested range (most notably F1 & F2) and, consequently, the simulations were repeated using the actual estimated values to confirm that the algorithm was capable of recovering those values correctly.

In addition to this, the effect of difference in the rating behaviour between respondents (some respondents may give very widely varying ratings while others may give ratings in a narrow range) was also simulated using an additional attribute (‘K’) where a low ‘K’ value represented a narrow rating respondent and a high ‘K’ value represented a wide rating respondent with an average rating respondent being represented by ‘K’ = 100. Five different values of K were tested for.

The results showed that the highest errors (between input value and recovered value) occurred for very 'narrow' rating respondents, e.g. those always rating close to 100. However, even in these cases, the weighting function led to errors reducing to under 20%. Other than these, the error levels were under 10% for most cases except when the value of VOR was numerically very much higher than the VOT. However, this was not expected to lead to any problems as we did not expect such a pattern in real life.

2.3 Survey Location

The Delhi - Bombay (North to West) corridor was selected for the survey as this is one of the most important freight corridors in the country. On this corridor the roads carry over 40 million tonnes of freight per annum with an average length of haul of almost 1000 Km (RITES 1996). In addition, this is also the most important route for export/import traffic, much of which is already containerised. This route accounts for almost 40% of the total volume of export/import traffic handled by the Container Corporation of India (CONCOR), the sole intermodal service provider in India. The distance from Delhi to Bombay is almost 1500 Km by road with the entire route being upgraded to a 4 lane highway with double carriageway.

The main survey was conducted in April - May 1998. The respondents were asked for data on flows travelling on this route for distances greater than 1000 Km, i.e. not necessarily from Delhi to Bombay. In many cases, the traffic originated/terminated beyond these two cities. In a handful of cases no flows could be identified on this route and similar alternative routes were taken.

2.4 Composition of the survey

A total of 41 firms were contacted from which 32 successful interviews were obtained.

Of the 32 successful interviews, 7 pertained to export traffic (coded A1 - A7) and 25 to domestic traffic. In the case of Exports the commodities covered were Brass-ware, Rice and Handicraft Items, which were some of the most important exports (in volume terms) from this area. Regarding domestic traffic, a study carried out in 1996 (RITES 1996) indicated that some of the most important commodities moving on the Delhi - Bombay route were Rice, Chemicals, Autoparts, Food Products and Electrical and Electronic items. There was also a lot of parcels and miscellaneous traffic, handled by Freight Forwarders and Third Party Transporters. Six companies were contacted in the Chemicals industry (coded C1 – C6), five Electrical and Electronic equipment manufacturers (D1 – D5), four Autoparts manufacturers (E1 – E4), two Food Product companies (F1 and F2) and eight Freight Forwarders and Third Party Road Transporters (B1 – B8). In terms of the characteristics of the companies, the size varied from companies with a total turnover of about a quarter of million pounds per annum to one with a turnover of over a billion pounds per annum. In terms of the total volume of traffic of the company, this varied from about 20 tonnes a month to 20,000 tonnes a month. Brief details of the companies and the selected flow are given in the Appendix.

The current mode was Road for 30 firms and Intermodal Container services for 2 firms. Alternative ‘B’ was kept the same as the current mode in all the cases. Alternative ‘C’ was taken as Intermodal Container service in 30 cases and containerised lorries(i.e. lorries with fully enclosed and lockable bodies) in the remaining 2 cases (where the current mode was

Intermodal Container service). Alternative 'D' was taken as rail in 20 cases and containerised lorries/ISO containers on road lorries in 8 cases, Rail Parcel service in one case and conventional (open top) road lorry in another case. In the remaining two cases alternative 'D' was left blank as no suitable service could be identified since the respondents were not willing to consider the other alternatives irrespective of the discount offered.

3. DATA ANALYSIS

3.1 Individual Firm Models

The data was first modelled at the individual firm level using a logit model. The methodology used was based on that presented in Fowkes, Nash and Tweddle (1991), and is discussed in full in Fowkes and Shinghal (2001). Respondents' ratings for alternatives were analysed pairwise. Each set of 4 ratings gives us 3 paired choices (A vs B, A vs C, A vs D). As such, from an inteview with 9 LASP iterations, we get 3 times 9 = 27 'observations'. For each pair a pseudo-probability of choosing the first alternative was derived and converted into a 'log-odds' value. Finally the log-odds were regressed against the difference (between the two alternatives) in terms of time, cost (as a percentage of cost by current mode), reliability, together with dummy variables for two levels of frequency and two Alternative (Mode) Specific Constants (for the options considered for each interview – in most cases these were Intermodal and Rail). A weighting was used. The coefficients so obtained were converted to cost terms by dividing all the coefficients by the coefficient of cost – the regression coefficients and the valuations obtained for firm A1 are given in Table 2 below.

Table 2 : Individual firm regression model and valuations (Firm A1)

	IM Dummy	Rail Dummy	F1 Dummy	F2 Dummy	Cost Difference	Time Difference	Reliability Difference
Regression Coefficient	-0.2236	-0.0825	0.3237	0.6166	-0.0179	-0.0545	0.0601
Monetary Valuation obtained	12.4797	4.6062	-18.0716	-34.4211	1.0000	3.0429	-3.3532

Codes are defined in Table 4. Time difference is in 8 hour periods, so the valuation per day is 9.1% of the current cost.

For simplicity of representation in the results, all figures have been taken as a percentage of cost by the currently used mode (as shown in column 6 of the table in the Appendix) this was achieved by defining our cost difference variable in percentage terms in the model set up. It is permissible to do so here since a single route has been taken with most flows in the range of 1200 - 1600 Km. In a case where there was a wide spectrum of distances, we would need to take into account the fact that costs would naturally increase with distance but absolute attribute valuations may not do so (as would be implied by taking fixed percentage valuations). We investigated the relationship between absolute valuation and distance but found that this offered no improvement in our case.

The individual firm results are given in Table 3. Column 1 gives the company code, columns 2 to 6 are the ASCs (where 'RC/IM' refers to the ASC for containerised lorry with respect to intermodal container service, all other ASCs being with respect to Road Lorries, IM refers to Intermodal Container Services and RC to road based container services). Columns 7 & 8 are the frequency discounts where F1 represents a tri-weekly service and F2 represents a weekly service (both are in comparison to a daily service). Columns 9 & 10 give the values of Time

(as a percentage of freight rate per day extra scheduled transit time) and Reliability (as a percentage of freight rate per percent point change in reliability) respectively. Column 11 gives the Adjusted R Squared value for the regression. The 't' values of the estimates are given, in italics, below the estimates.

Table 3: Results of Individual firm level analysis

Company Code	Estimated % Valuations ('t' values given in italics) (codes as in Table 4)									Adj R^2
	RC/IM	IM	Rail	Parcel	RC	F1	F2	Time	Reliability	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A1		**12.5** *2.8*			**4.6** *1.2*	**-18.1** *-3.6*	**-34.4** *-6.0*	**9.1** *1.4*	**-3.4** *-2.1*	**0.73**
A2	**10.5** *1.4*	**23.0** *2.6*				**-26.2** *-1.8*	**0.0**	**14.2** *1.6*	**-1.8** *-0.8*	**0.36**
A3		**12.0** *1.0*			**7.9** *0.6*	**-42.1** *-2.8*	**-125.8** *-6.9*	**6.5** *0.5*	**-10.8** *-2.4*	**0.48**
A4		**27.5** *3.8*			**3.2** *0.4*	**-45.3** *-4.4*	**-84.9** *-9.0*	**9.7** *1.6*	**-5.5** *-2.9*	**0.62**
A5		**-7.4** *-0.9*	**-50.5** *-6.8*			**-61.6** *-7.3*	**-231.6** *-4.0*	**39.9** *5.1*	**-0.2** *-0.1*	**0.58**
A6		**5.7** *0.9*	**-8.3** *-1.4*			**-48.8** *-7.7*	**-263.8** *-5.4*	**11.4** *2.2*	**-11.3** *-7.2*	**0.77**
A7		**7.6** *2.4*				**-19.0** *-4.4*	**-63.4** *-12.3*	**9.3** *3.6*	**-1.8** *-2.3*	**0.86**
B1		**-9.5** -0.9	**-61.3** -7.8			**28.0** 1.5	**2.3** 0.2	**1.5** 0.2	**-0.4** -0.2	**0.43**
B2		**-5.8** *-0.9*	**-12.4** *-2.0*			**1.6** *0.1*	**-31.9** *-3.8*	**6.5** *0.7*	**-2.0** *-0.8*	**0.58**
B3		**0.3** *0.1*	**-17.5** *-3.0*			**-21.7** *-3.5*	**-88.5** *-11.9*	**3.5** *0.5*	**-3.6** *-2.2*	**0.65**
B4		**-16.1** *-3.7*	**-15.2** *-3.4*			**-38.8** *-7.9*	**-51.6** *-8.7*	**17.2** *4.1*	**-1.5** *-1.2*	**0.66**
B5		**-10.7** *-3.2*	**-25.0** *-7.2*			**-27.2** *-4.1*	**-65.0** *-14.4*	**13.9** *3.7*	**-0.7** *-0.6*	**0.77**
B6		**-2.8** *-0.3*	**-41.1** *-5.2*			**-21.3** *-2.8*	**-62.8** *-6.4*	**28.4** *3.9*	**-4.2** *-2.2*	**0.44**
B7		**-1.1** *-0.2*	**-34.3** *-3.4*			**13.4** *1.1*	**-18.3** *-1.7*	**19.5** *2.0*	**2.4** *0.9*	**0.41**
B8		**2.8** *0.4*	**-29.4** *-4.1*			**-18.7** *-2.5*	**-84.9** *-6.5*	**7.9** *1.2*	**-1.4** *-0.7*	**0.66**
C1		**-2.9** *-0.5*	**-26.1** *-3.6*			**-7.3** *-0.7*	**-2.4** *-0.3*	**10.3** *1.5*	**-0.6** *-0.3*	**0.54**
C2		**-3.4** *-0.3*	**-17.6** *-2.0*			**-22.4** *-1.5*	**-95.0** *-6.9*	**22.2** *1.8*	**0.7** *0.2*	**0.45**
C3		**6.5** *0.8*	**-42.5** *-6.8*			**-14.4** *-1.6*	**-18.3** *-1.9*	**13.2** *1.7*	**-4.3** *-2.3*	**0.41**
C4		**15.3** *3.1*	**-28.3** *-4.9*			**-15.5** *-2.7*	**-56.8** *-7.2*	**15.0** *3.2*	**-3.0** *-2.4*	**0.63**
C5		**-2.8** *-0.7*			**-3.9** *-0.7*	**-2.9** *-0.4*	**-19.8** *-3.3*	**5.8** *1.2*	**-0.7** *-0.5*	**0.75**
C6		**-7.9** *-1.3*	**-32.1** *-6.0*			**-15.7** *-2.2*	**-16.7** *-2.1*	**16.6** *3.4*	**-1.5** *-1.1*	**0.54**
D1		**-0.6** *-0.1*			**-4.0** *-0.4*	**-59.0** *-5.2*	**-124.5** *-7.1*	**9.1** *1.1*	**-6.4** *-2.6*	**0.80**
D2		**33.4** *2.5*	**-77.5** *-5.6*			**-31.2** *-1.2*	**-87.3** *-4.5*	**11.8** *1.0*	**2.1** *0.5*	**0.54**
D3		**-6.2** *-1.0*	**-11.4** *-2.1*			**2.3** *0.2*	**5.4** *0.5*	**7.5** *1.4*	**-1.5** *-0.8*	**0.53**
D4		**-14.6** *-6.4*	**-14.6** *-6.4*			**-16.5** *-2.9*	**-44.6** *-13.2*	**3.2** *1.0*	**-1.3** *-1.3*	**0.81**
D5		**0.0** *0.0*			**-4.6** *-1.8*	**-2.4** *-0.7*	**-32.6** *-9.7*	**14.6** *4.0*	**1.3** *1.4*	**0.85**
E1		**6.6** *1.0*		**-31.3** *-5.0*		**-3.7** *-0.5*	**-29.0** *-2.6*	**10.7** *1.6*	**-2.4** *-1.4*	**0.54**
E2		**26.5** *6.5*			**6.2** *1.3*	**-17.2** *-2.1*	**-46.9** *-8.0*	**14.3** *2.9*	**-4.1** *-2.7*	**0.69**
E3		**-12.0** *-2.8*			**-12.0** *-2.8*	**-0.6** *-0.1*	**0.1** *0.0*	**11.8** *2.1*	**-1.7** *-1.2*	**0.73**
E4		**-2.2** *-0.1*	**-37.9** *-2.1*			**32.4** *0.9*	**-266.4** *-2.0*	**4.9** *0.2*	**-10.1** *-1.4*	**0.76**
F1		**25.1** *3.4*				**-31.6** *-2.0*	**-4.6** *-0.2*	**-1.6** *-0.2*	**-4.1** *-2.2*	**0.44**
F2		**12.6** *2.9*	**-16.4** *-4.1*			**0.4** *0.1*	**-6.3** *-1.1*	**7.2** *1.3*	**-0.7** *-0.6*	**0.76**

The interpretation of the entries in Table 3 can be illustrated as follows. Firstly, the entries in columns 2 to 6 represent Alternative (Mode) Specific Constants. For example, looking at column 3, Firm A2, an Exporter, is willing to pay an additional 23% (all else equal) to have the option of using an intermodal alternative (IM). Firm B4, in contrast, would require a 16% reduction in cost to compensate for having the use an intermodal system (all else equal). Columns 7 and 8 show the cost reductions necessary to compensate for moving from a daily to a tri-weekly (F1) or weekly (F2) service. The positive entries are irrational, but are never statistically significant. Values greater than a hundred indicate that the respondent would practically never use the service. Column 9 shows the percentage of the freight rate equivalent to a one day change in the journey duration; eg Firm C4 is willing to pay 15% to save one day, or would need to receive a 15% reduction if the journey time was extended by one day. Column 10 shows the percentage of the freight rate that is equivalent to a one percentage point change in the percentage of on-time arrivals, which we refer to as Reliability. For example, firm B2, which happens to initially have only 70% on-time arrivals (as shown in the Appendix), would be willing to pay an extra 20% on the freight rate if 80% on-time arrivals could be achieved.

3.2 Aggregated Sector Models

The individual level models were then aggregated by sector (see Table 4) using weighted means of the individual attribute valuations with weights set as inverse of the variance of the individual estimates.

Table 4: Percentage Valuations by Sector

('t' values shown in brackets)

Sector	No of firms		ASCs					Frequency Discounts		VOT	VOR
			RC/IM	IM	Rail	Parcel	RC	F1	F2		
Exporters	7	Estimate	10.5	10.1	-25.4		4.6	-30.2	-59.7	11.5	-3.6
		't'	*1.4*	*4.9*	*-5.4*		*1.4*	*-11.7*	*-17.2*	*6.1*	*-6.4*
F. Forwarders Transporters	8	Estimate		-7.6	-24.9			-23.7	-56.2	13.5	-1.6
		't'		*-3.9*	*-12.5*			*-8.8*	*-21.3*	*6.4*	*-2.7*
Chemicals	6	Estimate		1.3	-30.9		-3.9	-12.8	-26.9	12.7	-2.0
		't'		*0.5*	*-10.8*		*-0.7*	*-3.8*	*-8.1*	*5.3*	*-3.0*
Electrical/ Electronics	5	Estimate		-7.3	-15.5		-4.6	-8.6	-38.6	8.3	-0.4
		't'		*-4.5*	*-7.5*		*-1.8*	*-3.3*	*-16.8*	*4.0*	*-0.7*
Autoparts	4	Estimate		7.6	-37.9	-31.3	-4.2	-4.0	-21.5	12.5	-2.8
		't'		*2.8*	*-2.1*	*-5.0*	*-1.3*	*-1.1*	*-5.9*	*3.9*	*-3.2*
Food	2	Estimate		15.9	-16.4			-3.1	-6.2	4.8	-1.7
		't'		*4.23*	*-4.1*			*-0.6*	*-1.1*	*1.0*	*-1.7*

All valuations are shown as a percentage of the current cost (or 'freight rate')
VOT: Value of a Time Reduction of one day
VOR: Value of a Reliability Reduction of one percent less on-time arrivals
F1: Discount required for tri-weekly service as compared to a daily service
F2: Discount required for weekly service as compared to a daily service
RC/IM: ASC for containerised road services with respect to Intermodal services
IM: ASC for Intermodal services with respect to conventional road services (i.e. open 2 axle lorries)
Rail: ASC for rail services with respect to conventional road services
Parcel: ASC for rail parcel services with respect to conventional road services
RC: ASC for containerised road services with respect to conventional road services

All the aggregate results have correct signs even though we had some wrong signs in the case of the frequency discounts and the VOR estimates in the individual firm models. For Food Products manufacturers we have some low 't' values which appear to be caused by the fact that we have data only for two firms in this sector.

4. Analysis Results

4.1 Intermodal Service Alternative Specific Constant

For Export traffic the Intermodal Service ASC is 10% (favourable), ie Exporters would be willing to pay 10% more than they are currently paying for their road service. This is understandable as the cargo is to be ultimately dispatched overseas in containers and it makes sense to load it into containers from the factory itself. In the case of the Freight Forwarders the ASC is -8% (adverse) as these firms have to ultimately collect and deliver the consignments to their own clients and for this reason have their own lorries and labour. In addition to this, they are working in a highly competitive market and need to be sure of the service they are providing and do not like to have the consignments going out of their direct control. The Chemicals firms appear to be indifferent to intermodal service, as compared to road. The Electrical and Electronics firms have an ASC of -7% (adverse). In this case, the sample is not very homogenous with both low value products (Cables) and high value products (Electronics & Home Appliances). In this sector the low value product firms appear to have an adverse view whereas the high value product firms show mixed responses. In the case of the Autoparts sector, we have an ASC of 7% (favourable). This is due to the high value and damageable nature of the products. The Food product manufacturers show a strong liking for intermodal services (ASC 15.9% favourable) due to the damageable nature of the cargo.

4.2 Rail Alternative Specific Constant

For using rail, all the firms have adverse ASCs ranging from about -15% for the Electrical & Electronics products manufacturers to -38% for the Autoparts manufacturers. In the case of the Autoparts manufacturers, the high ASC is due to the high value and damageable nature of

the products, whereas for the Electrical and Electronics industry the overall value is not very high because of the effect of the low values for the cable manufacturers. For Export traffic, most of the firms were not willing to consider this mode at all. Freight Forwarders and the Chemicals manufacturers are in the intermediate range due to the wide variety of the commodities involved.

4.3 Discounts for Tri-weekly Services

In the case of the Export traffic the (weighted) average discount required for using tri-weekly services is 30%. This is due to the fact that the cargo is usually dispatched just in time to catch a ship and the Exporters do not like to have another variable in the service (matching the day of service with the day of sailing of the ship). For Freight Forwarders, also, the value is quite high at 23%, since this would mean that the freight forwarder would need to collect the cargo from his clients and store in his own warehouse while waiting for the service. For the Chemicals industry, the discounts required are not so high, at 12%, due to the fact that they have lower frequency of deliveries to geographically distributed firms and they also have sufficient storage space. For the Electrical and Electronics industry, we have quite a low aggregate required discount of 8%, however the values for the high value product manufacturers are quite high and those for the low value products are low. This is as would be expected, since the high value product manufacturers would like to keep their inventories low. The Autoparts industry and the Food product manufacturers appear to be indifferent to this degree of reduced frequency. This is due to the very low frequency of dispatches involved. In the case of Autoparts, the dispatches could be as low as 1 or 2 lorry loads a month and for Food products, the flows considered were low value bulk flows to regional

distribution centres. In both these cases, the movement could be scheduled to match the days of service.

4.4 Discounts for Weekly Services

Weekly services are viewed very adversely by almost all the sectors with the Exporters and the Freight Forwarders requiring discounts of almost 60% for utilising these services. For the Electrical and Electronics sector the aggregate figure is 38% but the individual figures for the high value product manufacturers are much higher. For the Chemicals and Autoparts the required discounts are only 27% and 21% respectively, due to the very low frequency of dispatches involved in these cases. The estimate for Food product manufacturers is again low.

4.5 Value of Door to Door Transit Time (VOT)

The VOT is not significant for Food product manufacturers, which could again be due to our small sample size for this sector. Out of the other 5 sectors, the VOT is 8% per day in one case (Electrical and Electronics - with high value products having a VOT above this figure and the lower value products having a VOT below this) and about 12% per day in the other 4 sectors.

4.6 Value of Reliability (VOR)

The VOR is the highest for the Exporters at 3.6% per percentage point change in on-time arrivals. This appears to be due to their need to ensure that the consignment arrives at the port in time for the ship. They would not like to despatch very early either, as they do not like to have the consignments waiting at the port for long. The VOR for the Autoparts manufacturers is the next highest at 2.8% and this is also related to the nature of the

manufacturing system in the industry where some firms attempt to work on a Just-in-Time basis. In fact, one of the Autoparts manufacturers was having to arrange for warehousing facility at the destination, at his own cost, to meet requirement of Just-In-Time deliveries for an auto manufacturer. For Freight Forwarders and the Chemicals industry, the VOR was 1.6% and 2% respectively, and for the other two sectors the estimates were not significant. The overall low values of reliability for most sectors appears to be a reflection of the existing poor level of reliability in the Indian transport industry in general.

5. CONCLUSIONS

This paper presents empirical results from an adaptive SP survey of freight mode choice in India. The survey covered 32 firms from 6 different product sectors. To the best of our knowledge, this is the first time that attribute valuations for India or any other developing country have been presented publicly.

Sensible looking models have been obtained. This also demonstrates the effectiveness of Adaptive SP methods with small samples and in developing countries with vastly different transport service characteristics as well as socio-economic conditions compared to what these methods were originally developed to handle.

In our survey all six sectors indicate a dislike for Through Rail services and require discounts between 15% to 30% of current transport cost for using rail even if it was able to match the road service quality. As far as Intermodal Container services are concerned, some sectors (Exports, Electrical/Electronic products and Food products manufacturers) have shown a preference for these services whereas the others have shown a dislike for it, with the sector values ranging between 16% (favourable) of current transport cost for the Food

products sector, to -8% (unfavourable) for the Freight Forwarders. The frequency of service appears to be an important factor in mode choice, especially for the manufactured goods sectors, with tri-weekly services being acceptable to some sectors but weekly services not acceptable for most sectors. The value of scheduled journey time appears to be quite similar in percentage terms with most sectors requiring a discount of about 12% of current cost, per day, for a slower service. As expected, the reliability of transit times appears to be very important for Exporters and also important for the Autoparts sector due to the effect it can have on the production process.

Taken with the analysis of cost data not presented here, these results would appear to suggest that intermodal services can be viable in India for high value and finished goods, but these would need high frequency, reliable and fast services. On the other hand, it should be possible for rail to serve the bulk goods sectors.

REFERENCES

Bolis, S. and Maggi, R. (1998), Adaptive Stated Preference Analysis of Shippers' Transport and Logistics Choice, paper presented at the *38th ERSA conference, Vienna.*

Bolis, S. and Maggi, R. (1999), Logistics Strategy and Transport Service Choices – an Adaptive Stated Preference Experiment, paper presented at the *39th ERSA Conference, Dublin.*

Bradley, M. and Daly, A.(1993), New analysis issues in Stated Preference research. *PTRC 21st Summer Annual Meeting 1993, Proceedings of Seminar-D,* 75-89, PTRC, London.

Fowkes, A.S., Nash, C.A. and Tweddle, G. (1991), Investigating the market for intermodal freight technologies, *Transport Research-part A*, 25A (4), 161-172.

Fowkes, A.S. and Tweddle, G. (1997), Validation of Stated Preference forecasting: A case study involving Anglo-Continental Freight, *European Transport Forum - 25th Annual Meeting, Proceedings of Seminar F*, PTRC, London.

Fowkes, A.S. and Shinghal, N. (2001). *The Leeds Adaptive Stated Preference Methodology*, Working Paper 558. Institute for Transport Studies, University of Leeds.

RITES (1996), *Study on the Decline in Railway's Share in Total Land Traffic*, Rail India Techno-Economic Services, December 1996, New Delhi.

Shinghal, N. (1999). *An application of Stated Preference methods to the study of Intermodal Freight Transport Services in India*, Institute for Transport Studies University of Leeds, Phd Thesis (unpublished), October 1999.

Tweddle, G., Fowkes, A.S. and Nash, C.A. (1995), *Impact of the Channel Tunnel: A survey of Anglo-European unitised freight. Results of the Phase I interviews*, Institute for Transport Studies, University of Leeds ,Working Paper 443, October 1995.

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

APPENDIX

In order to maintain confidentiality, the companies are identified by company codes (column 1) and some of the data has been rounded off. Column 2 gives the approximate monthly transport requirements of the companies. Columns 3 through 11 give details of the specific flow selected for the exercise and the current mode of transport being used for this flow. In particular, Column 9 gives the time taken by the present mode (in days) and column 10 gives the reliability of the current mode (taken as the percentage of consignments arriving within time in the previous three months). The last column indicates whether the respondent had any previous experience of container or rail based services.

Summary of firms interviewed and selected flows

Firm	Total Traffic Ton/Mth	Details of Selected Flow									
		Commodity	Distance (Km)	Tons/ Month	Freight Rate (£/ton)	Product Value (£/ton)	Vol. Constrained	Transit Time (Days)	Reliab. (%)	Current Main Mode	Used Rail/ Container
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Exporters											
A1	300	Brass-ware	1700	240	43	1,300	Y	4	90	Road	Y
A2	65	Carpets	1600	65	40	1,900	Y	8	90	Container	Y
A3	600	Carpets/Yarn	1600	210	29	1,900	Y	5	95	Road	Y
A4	300	Home Furnishings	1600	300	40	2,000	Y	5	90	Road	Y
A5	6000	Rice	1000	3000	7	600	N	5	85	Road	Y
A6	1500	Rice	1600	1300	9	600	N	4	80	Road	Y
A7	800	Yarn	1500	10	33	2,000	Y	5	80	Road	Y
Freight Forwarders & Transporters											
B1	15000	Indl. Intermediate	2200	350	21	600	Y	7	95	Road	Y
B2	5700	Indl. Intermediate	3000	900	24	900	N	9	70	Road	Y
B3	2500	Indl. Intermediate	1500	1300	13	500	N	5	90	Road	Y
B4	5000	Indl. Intermediate	3000	225	31	80	N	7	93	Road	Y
B5	2200	Mixed	1500	1100	14	1,900	N	4	90	Road	N
B6	1500	Mixed	1500	700	14	700	Y	5	95	Road	N
B7	1600	Mixed	1500	550	11	1,300	N	5	90	Road	N
B8	1800	Autoparts	1500	250	29	4,300	Y	5	90	Road	N
Chemicals											
C1	3500	Chemicals	1800	450	21	150	N	8	85	Road	Y
C2	1700	Chemicals	1750	100	25	500	N	6	95	Road	Y
C3	3200	Chemicals	2200	280	40	1,400	Y	8	85	Road	Y
C4	3500	Petro. Products	1600	400	17	700	Y	7	80	Road	N
C5	1300	Chemicals	1550	200	26	500	Y	6	95	Road	Y
C6	20000	Chemicals	650	1500	7	1,100	N	3	90	Road	Y
Electrical & Electronics											
D1	1500	Home Appliances	1500	250	29	4,300	Y	5	95	Road	N
D2	350	Home Electronics	1250	80	57	7,100	Y	7	80	Road	N
D3	160	Cables	1500	15	18	800	Y	5	100	Road	Y
D4	80	Cables	1250	60	23	1,900	N	9	80	Road	N
D5	200	Misc. Equipment	1500	15	19	2,900	Y	5	90	Road	N
Autoparts											
E1	600	Autoparts	1550	15	34	1,400	Y	7	90	Road	Y
E2	700	Autoparts	1700	30	57	3,100	Y	5	90	Road	Y
E3	300	Autoparts	1200	10	37	3,400	Y	6	100	Road	Y
E4	5500	Autoparts	1550	2000	59	2,700	Y	6	90	Road	Y
Food											
F1	6000	Food products	1200	700	17	1,600	Y	5	100	Container	Y
F2	6000	Soya Oil	1250	2000	16	300	N	7	90	Road	Y

asf/rep/2001/lasp3c