22nd Australasian Transport Research Forum
Sydney, September 1998

Valuing longhaul and metropolitan freight travel time and reliability

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Abstract:

Valuing the time spent in transit for individual items or loads of freight is an element that is omitted by most evaluations and economic assessments of transport proposals and policies in Australia Such delays – and indeed the practical value of reliability – are of utility to the shippers and the receivers, but do not appear directly in vehicle operating costs and person travel times. As a result benefits generated by improvements from road investment and traffic management are understated and expenditure decisions biased towards passenger movements. The present paper applies Contextual Stated Preference (CSP) methods and the associated multinomial logit models to estimate the value of such factors from an Australian survey of freight shippers using road freight transport in 1998. An illustration of the significance of these results is the estimated value of $1.40/hour per pallet for metropolitan multidrop freight services: potentially a substantial value not currently consistently tracked or utilised in transport evaluation procedures in Australia.

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Introduction

Faster more reliable freight movements make up a substantial proportion of the benefits generated by road and transport investment. However the techniques for assessing and valuing the different components of this economic benefit have been rather limited in Australia.

Freight travel time savings are quite different from vehicle operating cost and person travel time savings. Freight travel time is a larger and more inclusive concept than the inventory capital costs associated with freight holding, and the transit time of the vehicle and driver. The Road User Cost Steering Group within Austroads identified this evaluation gap, with the result that this study was undertaken by FDF Management and Oxford Systematics in conjunction with ARRB Transport Research as an Austroads NSRP Project. Freight transit times are of critical importance to freight shippers, and as a result have a large potential impact on the benefits from transport investments. This concept is mode independent, and relies only on the perceptions and economic drivers of the shippers and receivers. It is therefore appropriate to tap these perceptions directly.

The survey technique of Contextual Stated Preference (CSP) allows this "tapping" to be done by constructing a series of freight service alternatives, around the current real world freight services defined in terms of associated costs, delays, freight damage and reliability factors. These can be readily translated into a questionnaire format for administration to freight shippers. The aim of the questionnaire is to present respondents with a series of forced choices between bundles of variations from real world base values. This allows the underlying utility tradeoffs to be assessed without the results being dominated by travel time factors alone. In the CSP surveys, an underlying conjoint design ensures that no alternative is clearly superior or inferior to all the others.

One of the systematic biases emerging from current methods of road evaluation is caused by a continuing shift to moving a given amount of freight using fewer and larger vehicles. This has the effect of potentially having more tonnage moving – associated with a reduction in benefits, as these benefits are currently assessed based on vehicle operating costs factors alone. Declining benefits associated with the greater productivity of larger vehicles is an ironic outcome, and reflects a reduction in the overall pool of road user costs that can be affected by road improvements. This observation places a real urgency on the identification of values to redress this basic bias.

The CSP approach for estimating freight travel time values has been successfully used in Europe and the method showed promise for Australia. The model on which the present work is based is that of the Hague Consulting Group (G C de Jong et al., 1992, G C de Jong et al., 1995). These studies measured freight rates, reliability, damage, level of service and delays, using a CSP approach by examining the effects of variations around the actual observed mean values of these attributes. There have been a number of other European studies designed to determine freight rate, time, damage and reliability tradeoffs using Stated Preference methods. These include an adaptive SP technique (Fowkes et al., 1989, Fowkes et al., 1991), using a laptop computer to dynamically adapt the SP design as the interview proceeds; choices between own-account and third party carriers (Fridstroem and Madslein, 1995) and freight choices made in low density rural areas in Sweden (Westin, 1994).

Freight shipper survey

The central issue for the data collection dimension of this project was the need to ensure that judgements and values of Australian shippers were effectively tapped, and the interaction between interviewer and respondent was as effective and credible as possible. Special care was taken at the field design phases by the full team and FDF in the data collection stages, to ensure that the approach to shippers, the expert freight background for the interviewers and the feedback to the respondent all met these goals. This process proved to be time consuming, but once fully understood by all parties worked effectively. The high level of understanding within the team led to modifications to survey procedures which increased the number of expected returns by approximately 40 percent over that initially planned for.

The preliminary postal survey used to screen possible respondents and to obtain mean values for real world freight costs and the associated probabilities of delay and of damage obtained a response rate of only 25 percent. These values were further revised at a skirmish or pilot testing stage, when the full survey form and process was being field tested and subsequently modified. The final survey was administered by interviewers expert in the freight industry, and the response and completion rates were very high indeed: 129 completed responses were obtained from 43 people. It is essential to note that the survey was directed at freight shippers, not vehicle operators.

A possible minor weakness of this project was the need to make use of an opportunity sample that emerged from building on the industry contacts of the team, combined with forward referrals from initial respondents. An important requirement of the method used was that all respondents were at senior, expert and decision making levels. Although the respondents were not randomly sampled from a specified population they were all real and operational freight shipping managers who frequently made freight service decisions for their organisations. Consequently the outputs of this project are based on a sample of respondents regularly making genuine operational decisions and can therefore be used to represent this specific group, and to provide a useful basis for further work.

Study design

A set of base case values for freight rate, travel time, damage and reliability were determined from the industry survey, and variations of 20 percent up and down from these values were specified in order to develop contrasting freight service alternativ. This process was repeated for the three distinct freight market segments. The ba: experimental technique involved a two stage fractional factorial design (Hensher, 19ç to create a series of sets of alternative values of freight rate, travel time, damage a reliability drawn from these values. The general approach is to determine utilities : each of these four factors from the forced choices made from sets of alternati\ presented to the respondents (Hensher, 1994). A survey using the full range alternatives for - say - three attributes would be too much to administer using straightforward design. So, a fractional design was adopted (Hahn and Shapiro, 196 which provided an economical and concise survey instrument, at the cost of t assumption that interaction effects could be ignored. Prior to survey activities components were drawn together into a consistent experimental design (Thores‹ 1997) developed initially for non urban freight movements but later generalised encompass urban freight movements.

The freight market segmentation structure adopted also emerged as a key analytic issı The Hague Consulting group (G C de Jong et al., 1995) examined a range dimensions: unfinished and finished goods; high and low value density, and high a low time sensitivity. A smaller number of segments was used in the study outlined this paper.

In the present study a further criterion was considered: length of haul. To replicate Dutch study would require eight industry sectors to be surveyed: one for each of four Dutch sectors, each split further by long and short haul. Since resources w limited, this was impractical. It was therefore decided instead to concentrate on h length and type. This resulted in the choice of the following three freight mar segments:

- **Intercapital FTL (full truck load)** describes a common kind of consignment Australia: a fully laden articulated truck taking pallets on a (typically) overnight ı between Melbourne and Sydney or Adelaide. Normally these runs are from plant plant, or plant to warehouse. On arrival the goods go directly into stock, hence tir sensitivity is not expected to be as high as, for example, multidrops (see below).

- **Metropolitan FTL** describes another common kind of consignment: a fully la‹ articulated truck transporting loaded pallets within Melbourne. Like intercap FTL, these runs are normally from plant to plant or plant to warehouse, and are stock. Unlike intercapital FTL, they typically happen in the daytime.

- **Metropolitan Multidrop** is also very common urban freight movement involvin rigid truck or light commercial vehicle doing a trip with many deliveries. consignment may consist of pallets of parcels. Normally these runs are from plan wholesaler, retailer or service outlets. The goods are often required immediat‹ hence time-sensitivity is expected to be high.

Variation in approach and outcomes between the present survey and the Dutch survey may reflect the differences in road transport patterns in the two places. In Australia, for obvious geographical reasons, there tends to be a polar split in haul length, with intercapital hauls of up to 1000 km or more, and metropolitan hauls of less than 100 km, and very little in between. In Europe haul lengths tend to vary continuously over a narrow spectrum of distances.

Survey Segmentation

Respondents for the CSP survey were drawn from the following industries.

- Automotive parts
- Food and beverages
- Certain building materials
- Packaging

Although superficially different, all respondents indicated similar freight rates per pallet and have similar transport requirements regarding reliability and damage. For these reasons, the team was comfortable in not further segmenting by industry in the first instance. However, the industry of each respondent is recorded in the dataset making it possible to segment by industry type in future analyses.

Results

A full analysis of survey data was carried out using NLOGIT a component of the Limdep 7 software package (Greene, 1997) for several different specified multinomial logit models. Broadly comparable results were achieved for each segment. The findings reported here are those for the most straightforward model: which used a linear specification for all attributes. The results of the preliminary and skirmish surveys gave mean values of the attributes as shown in Table 1.

Table 2 summarises the coefficients estimated for the different attributes for the three different markets considered. The adjusted R^2 values are all above 0.5, and the coefficients estimated are all statistically significant and in the expected directions.

The standard errors for the time coefficient are substantial but not large enough to compromise statistical significance. Other coefficients have smaller relative standard errors. Table 3 shows the values in a more direct and useful form. In this table, unit values for freight travel, service reliability and damage have been constructed from the information contained in Table 2.

Table 1. Mean Values Of The Attributes

Mean values	Intercapital (F.T.L)	Metropolitan (FTL)	Metropolitan Multidrop Loads
Freight Rate (pallet)	35.087	9.044	12.032
Time (hours)	15.033	4.0045	6.0026
Reliability	0.0502	0.0501	0.0498
Damage	0.0030	0.0031	0.0031

Table 2: Summary Results For Linear Attribute Models

Segment	Freight Rate/Pallet	Time	Reliability	Damage	Adjus
InterCapital (FTL)					
Coefficient	-0.100 ***	-0.066 *	-25.6 ***	-497 ***	0.51
Standard Error	0.014	0.031	2.9	48	
Metropolitan (FTL)					
Coefficient	-0.298 ***	-0.401 ***	-37.1 ***	-545 ***	0.56
Standard Error	0.054	0.110	3.4	52	
Segment	**Freight Rate/Delivery**	**Time**	**Reliability**	**Damage**	**Adjus**
Metropolitan MultiDrop Deliveries					
Coefficient	-0.177 ***	-0.244 *	-34.9 ***	-479 ***	0.52
Standard Error	0.049	0.102	3.2	49	

* $p<0.05$; *** $p<0.001$

As indicated in Table 2, the estimated coefficients for travel time for intercapital FTL and multidrop were significant at the 5 percent level, while all other coefficients were significant at the 1 percent level

Table 3: Freight Travel Time: Implicit Unit Values (In 1998 $)

Segment	Freight Travel Time	Reliability	Damage
InterCapital Full Truck Loads	$0.66 Pallet/hr	$2.56 Per 1% reduction	$49.70 Per 1% reduction
Urban Full Truck Loads	$1.30 Pallet/hr	$1.25 Per 1% reduction	$18.29 Per 1% reduction
Metropolitan Multidrop Deliveries	$1.40 Delivery/hr	$1.97 Per 1% reduction	$27.06 Per 1% reduction

Interpreting the results

The values obtained here are short run values: they reflect the perceived utilities of the shippers today. Even in this context it would be desirable to analyse a sample of real shipments to assess the relevance of CSP results-- and to identify hidden assumptions. One such assumption worth further investigation would be the perception by the respondents that they already had freight rate control, thereby leading to a greater emphasis on the other aspects of the freight service.

These results are presented irrespective of whether they will subsequently be adjusted or qualified by such a follow up investigations. They should also be seen as under estimates of longer term values, as structural change within the industry continues and incorporates the efficiencies obtained from transport infrastructure and operational improvements (Wynter, 1995)

It should be noted that the segmentation of the freight industry is quite different to that for passenger transport. The three segments selected here however show a heartening degree of broad agreement. In terms of results it may be necessary to extend the coverage of the current study and improve the precision in order to apply these values in economic evaluation processes. However, initial results indicate that this is both practicable, reasonable and also thoroughly worthwhile.

It is critical to note that the values estimated are likely to be applicable across all modes, and that some of the long standing concerns of inherent modal biases in freight evaluation are directly addressed in this approach

To progress the line of work reported here will require many more market segments to be addressed, and special attention of cross modal measurements and a broader range of transport service attributes. The process will also undoubtedly clarify the requirements for improved utility modelling and determination of critical interactions for Australian circumstances.

Conclusions

The key results reported are that the estimated value of long haul freight transport travel time/pallet/hour on intercity routes is estimated to be $0.7, while on metropolitan (intracity) routes is estimated to be $1.3. These estimates indicate that metropolitan freight travel time is more highly valued than that applying to intercity freight movements. The value of multidrop freight travel time/delivery/hour on strictly metropolitan routes is estimated to be $1.4, which is similar to the metropolitan FTL estimate of $1.3

The adjusted R^2 values are reasonable (~0.5) but improved models or variable specifications may be required in conjunction with larger scale or refined data collection methods for obtaining more broadly applicable results. The detailed findings of this project need to be carefully reviewed, but provide a useful basis for developing a fuller set of freight travel time values.

Overall the objectives of this project have been met. Robust and statistically significant values for the different attributes have been obtained. The critical finding is that expert understanding of the freight industry, and great care in both survey design and data collection and follow up are essential. For survey tasks interviewers must either be practitioners themselves, or at least very familiar with the industry. The data quality was vastly improved by this approach. While the models estimated provide an initial set of values for experimental use, the broader application of these methods across the freight operations in Australia is now a clear priority.

These values provide a first basis for bringing in previously unmeasured benefits in the movements of freight in Australia. This process also offers considerable benefits by estimating appropriate freight travel time values that redress the imbalance between passenger and freight valuations in economic assessment of transport proposals.

Significantly larger samples will be required to obtain more precise values for freight travel time. However, the results of this initial study are not only encouraging, but also provide a first step for estimating the extent of previous biases in the freight evaluation components of a range of transport evaluation studies in Australia.

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