LOGISTICS RESEARCH NETWORK

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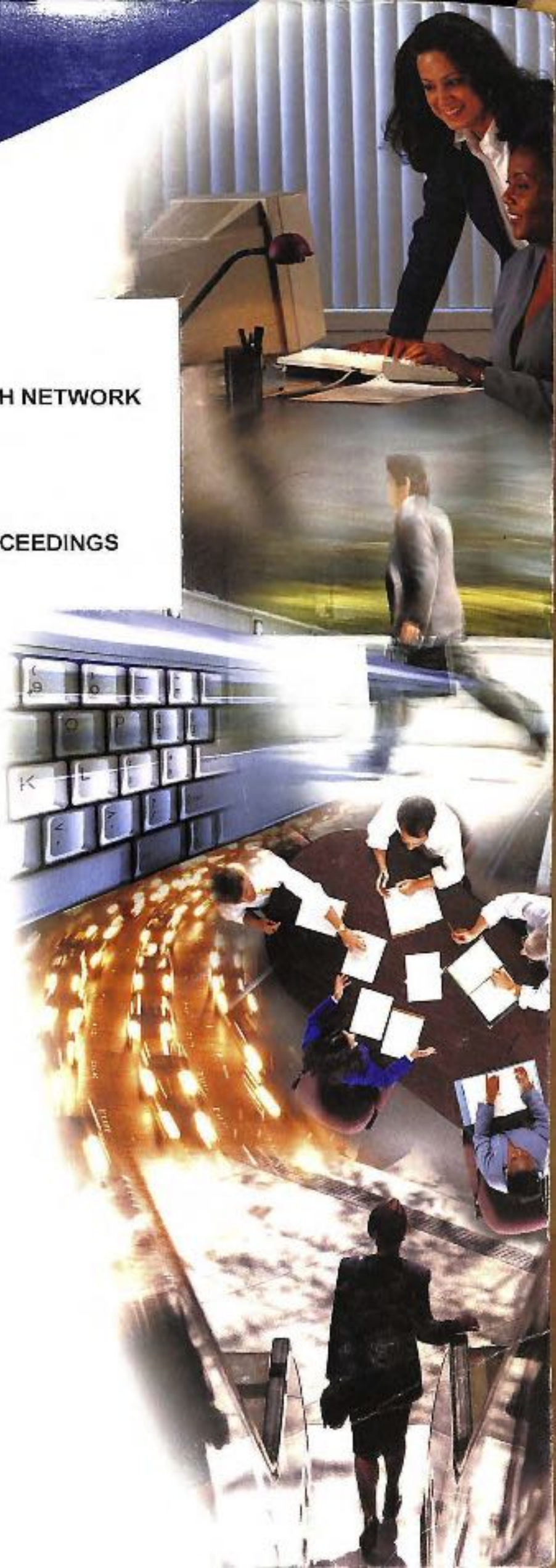

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Valuation of supplier choice factors by Australian shippers

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Abstract

Valuing the tradeoffs between reliability, delay, cost and time in transit provides public authorities with a valuable element for the assessment of the weight to be attached to freight transport movements in infrastructure projects. A stated preference experiment on Australian shippers provides new valuations of transit time for three different types of logistic movements using a stated preference technique covering tradeoffs between time, cost, reliability and damage. The segmentation structure of the survey is specified and compared to European results, and models were estimated for intercapital full loads, metropolitan full loads and multidrop urban deliveries. The appropriateness and effectiveness of this technique on the transport component alone in highly integrated logistical supply chains is considered, and hypotheses put forward for similar surveys focussed in such industry groups. Initial work has been done on such group: the automotive industry in Australia.

Keywords: time valuation, Australia, stated preference, reliability, damage, cost, shipper choice

Introduction

Australia has a large and efficient road transport infrastructure with a substantial rail complement. There are three distinctive types of movement operation: long haul, generally between the major cities (which are typically 1000km apart); metro full load single drop and metro multidrop. Freight benefits play a major role in transport assessment, and road design is often determined by the freight vehicle component of the traffic flow. Valuations of travel time are important, and the valuation of freight movement per se can be useful, rather than simply the use of driver wage. There have been a number of evaluations of freight travel time in Europe using stated preference methods, but these results are the first to be reported for Australia.

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. Time, reliability and damage factors are important to both shippers and receivers, but do not appear directly in vehicle operating costs and person travel times. Consequently benefits generated by improvements from road investment and traffic management may be understated and expenditure decisions biased towards passenger movements. The present paper applies contextual Stated Preference methods and the associated multinomial logit models to estimate the value of these factors from an Australian survey of freight shippers using road freight transport in 1998. This was a first exploration of the subject, and the field work was completed in 1998 on what was largely an opportunity sample of 43 people responsible for shipping decisions in operational companies. A value of $1.40/hour per pallet for metropolitan multidrop freight services was found and the results have proved to be sufficiently useful for a large scale study to be undertaken. This larger study was focused on the automotive industry. The automotive industry is a major industrial complex in Australia, and has a very wide range of organisations, locations and types of freight and logistic movements within its scope. This sector has special characteristics in Australia in that it is a very tightly linked monopsony, and counter intuitive results may be expected from this context. The analysis is still in process of reporting as this paper is written, but will be public by September for the Conference.

Frameworks for freight modeling

Freight modeling has proved to be considerably more difficult and complicated than passenger modeling. The task itself is complicated, and 'freight' is also subject to continuously variable shipment and categorisation changes. Commodities can be shipped in a wide range of quantities and packages, and the prediction of truck or train wagon movements from even an accurate knowledge of commodity flows is not straightforward. Approaching freight movements from an economic standpoint leads to regional input-output matrices, and flows of monetary value, and these values in turn have to be converted into commodity flows, and then again packages and/or truck or wagon loads. Taking the view that shippers simply wish to have a shipment move for one place to another allows many of these detailed modeling complexities to be bypassed. Model choices, transhipment consolidation and

repackaging are all transparent to an approach which seeks to model carrier decisions based on generalised attributes.

Previous work

The investigation of choice structures for freight shippers has long history in policy and research, but it is only comparatively recently that this has been systematically studied on a total logistics rather than a mode-specific basis. The significance of this work is in the value that it can add to the economic evaluation of road, rail and intermodal transport projects, where in the past the practice has been to evaluate the value time of freight in movement by the driver wage rate on the one hand or by the time cost of inventory holding on the other.

Both approaches have their strengths, but in both cases the context within which the values are established can have a major impact on the results obtained and their interpretation.

For example the tradeoffs between reliability, delays, damage and transport cost will not neccessarily coincide between shippers and receivers – or even between drivers and their management. In each case the domain for choice is different, and the scope and power of he variables than can be changed alters, and even the ability to accept or reject a choice alters. These questions are considered in more detail later.

European work showed key factors in EU shipper choice are reliability, damage, level of service and delays. DeJong (de Jong et al., 1992, de Jong, 1998) used stated preference methods to assess the tradeoffs between these factors in continental Europe, having first established realistic average values for each of these variables. Fowkes (Fowkes et al., 1991, Fowkes and Toner, 1998) examined similar issues and approaches using a dynamically adaptive computer based administration approach.

The importance of the context is a specific issue raised in the present paper. Examples of broadly similar studies done in different contexts include Fridstroem and Madslein (Fridstroem and Madslein, 1995) examined differences between own-account and third-party carriers in Sweden, and Westin (Westin, 1994) the characteristics of freight shipment choices in rural areas of Sweden. Earlier work in Sweden (Anon, 1992) indicated that there were strong mode-specific preferences for both rail (20%) and road (55%) for a substantial fraction of the suppliers approached, although the average damage frequency found (0.5%) was an overall value. Reliability, travel time and cost were also assessed. Stochastic models have been built including shrinkage, damage and lead time (Allen and Liu, 1993), but the basic data on which these could be built in Australia are still wanting.

The common factors of time, cost, reliability and damage expectations recurred in a range of studies, and provide a common set for the assessment of generalized supplier decisions without reference to modes used, or modal combinations adopted for any specific case. These were used for the Austroads (Austroads is a cooperative organisation jointly owned by the Federal and State Road Authorities in Australia) studies used here as the example for Australian freight shipper decision attribute valuations.

Australian study design and sample frame issues

Freight movements are critical in Australia, and a basic underpinning of a wide range of transport infrastructure and maintenance decisions. The valuation of freight movements has not always included inventory costs of freight in transit, or valuations of the other factors important to shippers – such as shrinkage and damage limitation – the sum of which leads to an implied valuation of freight in transit which may well exceed the commonly used valuation frameworks related to the wage rate of the driver. Recent evidence from the Uk (Fowkes et al., 2001 (forthcoming)) has indeed found such a result. Distinguishing between for-hire and own account trucks in particular is also desirable, if road transport is the sole mode under study, as the rates have found to be higher for companies that pay by the hour (Kawamura, 2000). However such factors are not quite so readily incorporated in studies where it is sought to use only mode-independent attributes.

Austroads has undertaken a series of projects to address this area, and the analysis by the present author for the pilot stage is used as the example later in the present paper. As second stage has now been completed, and shows distinct logistics and supply chain interactions of considerable interest. Detailed results are expected to have been approved for presentation and discussion by the date of the LRN meeting in Edinburgh in early September.

The objectives of the first round (Wigan et al., 1998) of the recent Australian program on freight shipper choice modeling were to assess what might be an appropriate the valuation of time for freight in transit – predominantly but not explicitly by road - as a basis for improved road (and rail) project evaluation and to determine if a contextual stated preference approach was likely to be effective.

A four factor orthogonal SP design was used, and the average values determined from the initial skirmish interviews and reviewed in consultation with experienced Australian shipping and logistics executives..

Field work initially established that the key variables of concern to the sample of 43 shippers, spread across all types of Australian organisations and scales, were indeed the same as found by de Jong (de Jong, 1996) and Jiang (Jiang et al., 1999): namely the likelihood of damage, the cost of the shipment, the form of packaging used for shipping (such as pallets) the delays that might be encountered and the reliability of the arrival time. Jiang et al found that for the French firms contacted, while questions of the likelihood of damage were responded to, very few shippers would respond to questions of transportation cost and time, for competitive reasons.

As reliability and damage are terms not easily defined in a consistent manner, and readily interpreted differently by different parties, the definitions sought from and given by the Australian suppliers were used.

Reliability: the portion of the designated delivery that was late.

Damage: the portion of the designated delivery that was not accepted by the receiver on the grounds of damage in transit.

The response rates finally achieved from the respondents were very high indeed. This was due in part to the use of a snowball sample, using forward references and recommendations from suppliers who had been approached, briefed and decided to participate in the work and in part due to the use of highly regarded ex-operational logistics managers as the direct interface for the interviews and meetings required. This sample frame is clearly not a regular or consistent sample from the population of shippers, but better sample frames have not proved to obtain good response rates and thus introduce their own response biases. One of the objectives of this stage of the work was to identify what indeed comprised an appropriate sample frame, and what characteristics would be most appropriate for stratification. This particular objective was only partially met.

The sensitivity to time and cost data was overcome by the approach used, with respected senior freight and logistics executives being used as consultants. The considerable cost involved in this approach to personal contact led to very high response rates indeed, and good quality data.

The issues surrounding the pilot survey of 43 firms were therefore largely restricted to the characteristics of the sample frame used. The snowball approach produced a substantial diversity of industries and organisational types and scales of operation, but – as in the case of most freight surveys – the strength of the sample fame is unclear even when drawn from an apparently valid base. The Australian Census of Manufacturing, for example, does not pick out any more than the manufacturing firms: retail and commercial activities are not covered in the same way.

Freight and shipping decisions are spread across all types of organisation, and a random sample of all organisations leads to questions of spatial specialisation in a country such as Australia. Australia tends to use samples of vehicles to measure freight flow, which covers tonnage reasonably well, but is heavily biased towards interstate movements. For example, the Australian Bureau of Statistics (ABS) Survey of Motor Vehicle Use (Australian Bureau of Statistics, 2001) found that for 12 months ended 31 October 2000, 60% of all passenger vehicle travel was within the capital city of the state of registration compared to only 18% of articulated truck travel. The ABS uses articulated vehicles as the sample frame for the national freight and commodity flow surveys now in progress. The weaknesses of this choice, especially for urban freight, are discussed elsewhere (Wigan and Rockliffe, 1998). If commodity flows are used as the basis of freight surveys then considerable effort is required to convert these flows into vehicle movements (Rockliffe et al., 1998). Clearly the choice of sample frame will be different depending on exactly what issues are being addressed.

Total logistics is concerned more with the factors determining the attributes that determine or influence the shipment choices made, rather than the details of the modes or transhipments used. In a large number of cases these aspects are not transparent to the shipper, as much of the 'overnight airfreight' between some of the Australian state capitals is still carried by road or rail, as this can ensure early morning delivery for many appropriate shipments by non-air modes.

Total logistics impacts

As distinct from purely transport assessments, least cost is not neccessarily the determining factor in overall logistics. This is made most evident in a number of integrated manufacturing and distribution networks, where the advantages of consolidated warehousing and timed deliveries can sustain a higher transport cost yet an overall drop in total logistics cost.

This effect can apply for both single firms and for industries as a whole if sufficiently coordinated. In Australia some of the multi-enterprise manufacturing networks are very well integrated across the continent. The automotive industry is perhaps the prime example. However the approach adopted for the pilot Austroads study assumes that the attributes of time, cost, delay and damage are all applicable to the shipper decision process.

The automotive component manufacturers in Australia are in some cases dealing with what are effectively monopsony buyers, and therefore have substantial control of their suppliers markets. The concentration on the transport component alone of such a large-scale total logistic network could therefore produce some interesting effects that would not be evident from a broader range of industries.

The manufacturing process requires very tight control of shipment delivery timings (a distinct from transit times), and many of the suppliers are also placed in the position of being price takers. One way in which this could show up in an SP study would be by a reduced sensitivity to travel time and also to cost. But the tighter the logistical integration of the different organisations linked by the shipments the supplier is considering, the more that time is taken to be unimportant and reliability of delivery enhanced. If timings cannot be met then the opportunity to compete at all on price is unavailable, as a threshold effect applies in a buyer controlled market ensuring that only these meeting timing standards will be in the competition pool for the business in the first place. The effect on travel time valuation is to reduce the values likely to be obtained from SP experiments, and increase the weight applied to reliability. However, the relative weight of timing and cost is also in question, and so it still needs to be tested in the field.

The second phase of the Austroads project covered a much larger sample of firms, this time drawn from the auto industry sector as a whole. This gave a wide variation in size, scale, type and commodity concern – but also provided an opportunity to assess the impact of any monopsony buyer or total logistics effects on shipper decisions. As this paper is written, it is too early to comment on the results. However the questions posed are important for transport evaluation practice.

If travel time valuations fall in this second phase, or become less reliable, due to these a effects then what valuations should be used for transport investment? Are there different ways in which the SP approach could be framed to address the issues appropriately?

Time savings leading to more efficient operation of the transport segment of the logistic chain will still represent real resources, and real opportunities for community cost reduction. However the decision processes involved in determining what weights should be applied to different shipment attributes will no longer coincide with the economic resources committed.

If the results from the second phase work show any of the hypothesized effects, then the means by which transport improvements are valued will have to be assessed at least in part from a total logistics basis, and not solely from the transport component. Commodity flow and shipment generation rates (to keep this argument mode independent) will still be needed, and forecasting the growth in the transport component will now need to include a counter-intuitive contribution which arises from the use of non least-cost routings as a contribution to lower overall logistics cost.

First stage survey

The segmentation approach used for the freight market was therefore a key issue, not only for the initial work, but also for the second phase. The first phase selected organization from the automotive parts, food and beverages, building materials and packaging industries. All those surveyed reported similar freight rates per pallet and required similar transport requirements for reliability and damage. This homogeneity is important, as other aspects of the sample frame have already been identified here as problematic. De Jong (de Jong et al., 1995) segmented further: by unfinished and finished goods: high and low value density, and high and low time sensitivity, long and short haul.

Australia can be broadly characterised as comprising a small number of major conurbations, separated by long distances. Consequently there are three major different types of movement:

- **Intercapital FTL (full truck load)** describes a common kind of consignment in Australia: a fully laden articulated truck taking pallets on a (typically) overnight run between Melbourne and Sydney or Adelaide. Normally these runs are from plant to plant, or plant to warehouse. On arrival the goods go directly into stock, hence time-sensitivity was not expected to be as high as, for example, multidrop shipments (see below).
- **Metropolitan FTL** describes another common kind of consignment: a fully laden articulated truck transporting loaded pallets within Melbourne. These runs are also normally from plant to plant or plant to warehouse for stock, usually during the day.
- **Metropolitan Multidrop** is also very common within urban areas; usually involving a rigid truck or light commercial vehicle and many drops. The consignment may consist of pallets of parcels, and generally occur from plant to wholesaler, retailer or service outlets. The goods are often required immediately, hence time-sensitivity was expected to be high.

A total 43 firms were interviewed, all of whom completed three sets of SP trials, one for each of the segments defined above (IFTL, MFTL, MMDP). The high response rate was the direct result of the use of respected industry logistics personnel to interview and brief the respondents. All respondents completed all three, yielding 129 responses from 43 respondents.

Results

The NLOGIT module of LIMDEP7 (Greene, 1997) was used to analyse the results for both linear and non-linear models.

Table 1: Summary results for linear attribute models

Segment	Freight Rate/Pallet	Time	Reliability	Damage	Pseudo R^2
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	
Metropolitan MultiDroP (MMDP)					
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

The pseudo R2 values were all around 0.5, which is partially explained by the serial correlation induced by the administration method, but still remains a good result. The linear model provided coefficients in the expected directions, and which were statistically significant for each coefficient in all segments. Table 2 presents these values in terms of cost.

Table 2: Freight Travel Time: Implicit Unit Values (in 1998 $ AUD)

Segment	Freight Travel Time	Reliability	Damage
InterCapital FTL	$0.66 Pallet/hr	$2.56 Per 1% reduction	$49.70 Per 1% reduction
Urban FTL	$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

Conclusions

These results are the first available for freight choice valuation in Australia, and have a reasonable accordance with expectation. They indicate that intercapital movements are the least sensitive to travel time and the most sensitive to timing (ie reliability) and damage and Multidrop deliveries are the most sensitive to time. A larger sample (forthcoming in the stage 2 results soon becoming available) will be necessary to identify any total logistics effects.

These findings provide a useful basis for reassessing the values associated with freight transport evaluation in Australia, but must await comparison with the results of stage 2 to determine if the

impact of total logistics effects are yet apparent. Even if they do emerge, the values presented here provide a lower limit to the appropriate values to adopt. These stage 2 results are expected to be available for presentation and discussion at the Edinburgh Logistics Conference in September.

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