AP-R230

ECONOMIC EVALUATION OF ROAD INVESTMENT PROPOSALS:
Valuing Travel Time Savings for Freight

AUSTROADS

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Economic Evaluation of Road Investment Proposals: Valuing Travel Time Savings for Freight
First Published 2003

National Library of Australia
Cataloguing-in-Publication data:

Economic Evaluation of Road Investment Proposals: Valuing Travel Time Savings for Freight
ISBN 0 85588 668 4

Austroads Project Nos N.BS.9702 (Task 5) and BS.E.N.536 (was N.BS.9806)

Austroads Publication No. AP–R230/03

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AUSTROADS
Sydney 2003

AUSTROADS PROFILE

Austroads is the association of Australian and New Zealand road transport and traffic authorities whose purpose is to contribute to the achievement of improved Australian and New Zealand transport related outcomes by:

- developing and promoting best practice for the safe and effective management and use of the road system
- providing professional support and advice to member organisations and national and international bodies
- acting as a common vehicle for national and international action
- fulfilling the role of the Australian Transport Council's Road Modal Group
- undertaking performance assessment and development of Australian and New Zealand standards
- developing and managing the National Strategic Research Program for roads and their use.

Within this ambit, Austroads aims to provide strategic direction for the integrated development, management and operation of the Australian and New Zealand road system — through the promotion of national uniformity and harmony, elimination of unnecessary duplication, and the identification and application of world best practice.

AUSTROADS MEMBERSHIP

Austroads membership comprises the six State and two Territory road transport and traffic authorities and the Commonwealth Department of Transport and Regional Services in Australia, the Australian Local Government Association and Transit New Zealand. It is governed by a council consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

- Roads and Traffic Authority New South Wales
- Roads Corporation Victoria (VicRoads)
- Department of Main Roads Queensland
- Main Roads Western Australia
- Department of Transport and Urban Planning South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Infrastructure, Planning and Environment Northern Territory
- Department of Urban Services Australian Capital Territory
- Commonwealth Department of Transport and Regional Services
- Australian Local Government Association
- Transit New Zealand

The success of Austroads is derived from the synergies of interest and participation of member organisations and others in the road industry.

ACKNOWLEDGEMENTS

Acknowledgement from Austroads

Austroads wishes to acknowledge that this document is based on two reports prepared for Austroads by FDF Pty Ltd in conjunction with Oxford Systematics and ARRB Transport Research Ltd, as detailed herein.

Acknowledgement from the authors

The authors wish to acknowledge that a large number of people made significant contributions to this project.

- We would like to thank Mr Eddie Peters of the Department of Main Roads, Queensland and Mr Andrew Zeicman of Transport South Australia for their leadership and support in their role as Austroads Project Managers for this project.
- We also thank members of the Austroads Road User Effects Reference Group (RUERG) and several referees, who also reviewed drafts of the report, and the final report has been improved through their comments.
- Finally, we would like to acknowledge Mr Laurie Dowling, who in his capacity as Secretary of the Austroads RUERG, provided a thorough reading of the manuscript, which assisted in shaping it into an Austroads publication.

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SPECIAL NOTES FOR USERS OF THE RESULTS OF THIS STUDY

- The study described in this document provides an initial set of estimated values for experimental use.
- The values derived in this study provide a first basis for quantifying previously unmeasured benefits in the movements of freight in Australia.
- The values that have been obtained are robust and statistically significant, having regard to the circumstances of the respondents surveyed.
- The results are based on two surveys, both conducted in Melbourne, and so the results may not represent the full range of operating conditions and freight types in the Australian road freight industry.
- Much larger survey samples involving many more market segments will be required to obtain more precise values for freight travel time for the full range of operating conditions and freight types in the Australian road freight industry.
- Broader application of the methods used in this study across the freight operations in Australia would provide the data needed for routine estimation of freight travel time benefits.

ABBREVIATIONS AND ACRONYMS

ARRB	ARRB Transport Research Ltd
BCA	Benefit cost analysis
CSP	Contextual stated preference
FDF	FDF Pty Ltd
FTL	Full truck load
GDP	Gross Domestic Product
GST	(Australian) Goods and Services Tax
GCM	Gross combination mass
GVM	Gross vehicle mass
IFTL	Inter-capital full truck load
JIT	Just-in-time
LIMDEP	A general econometrics software program for estimating linear and non-linear regression models and models for discrete choice, survival, and count data and limited dependent variables, with special capability for econometric analysis and model building using cross section, time series and panel data (Econometric Software, Plainview, NY 11803, www.limdep.com)
Md	Multi-drop
MFTL	Metropolitan full truck load
MLFTL	Metropolitan less than full truck load
Mt	Megatonnes (millions of tonnes)
NS	Not significant
OECD	Organisation for Economic Cooperation and Development
R^2	Correlation coefficient
RUERG	(Austroads) Road User Effects Reference Group
SP	Stated preference (survey technique)
tkm	tonne-kilometre
TRILOG	**Tri**lateral **Log**istics (an OECD Task Force)

EXECUTIVE SUMMARY

This document contains two separate reports, both written by FDF and Oxford Systematics, in conjunction with ARRB TR, after Austroads commissioned ARRB TR to undertake a staged study of travel time savings for freight. The main parts of both stages of the study were undertaken in Melbourne, Australia in 1998 and 2000.

Introduction

Faster more reliable freight movements make up a substantial proportion of the economic benefits generated by road and transport investment. However techniques for assessing and valuing the freight component of this economic benefit have been rather limited in Australia and until recently have been ignored. As a result' benefits generated by improvements from road investment and traffic management are understated and expenditure decisions biased towards passenger movements.

Freight travel time savings are quite different from savings in vehicle operating costs and person travel time. Also, freight travel time is a larger and more inclusive concept than the inventory capital costs associated with freight holding, and is separate from the transit time of the vehicle and driver. Freight transit times are of critical importance to freight service users, 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 factors directly.

This study has identified a need for valuing the time spent in transit for individual items or loads of freight, which is omitted by most evaluations and economic assessments of transport proposals and policies in Australia. This evaluation gap was recognised by the Road User Effects Reference Group (RUERG), formerly the Road User Cost Steering Group (RUCSG) within Austroads.

Austroads commissioned ARRB TR who engaged FDF as sub-consultant to examine freight travel time savings in detail. The study comprised two Stages, as follows:

Stage 1: A pilot study using a Stated Preference (SP) survey of freight shippers, conducted in Melbourne in May 1998, with 43 respondents, and 129 completed responses (Austroads Project N.BS.9702, Task 5).

Stage 2: A survey, using similar techniques to the Stage 1 pilot survey of freight shippers in the automotive components manufacturing industry, conducted in Melbourne in late 2000, with 107 respondents, and 320 completed responses (Austroads Project BS.E.N.536 (was N.BS.9806)).

Both surveys examined four main performance attributes, viz freight rate, travel time, on-time delivery, and loss or damage, expressed as a freight rate per pallet per hour, in the context of three generic consignment types, viz:

- inter-capital full truck load;
- metropolitan full truck load; and
- metropolitan less than full truck load services (multi-drop).

This document contains the reports on these two surveys. To maximise understanding of the methodology used and the findings, it will be necessary to read both reports.

Scope of Analysis

The analysis undertaken in Stage 2 applies Contextual Stated Preference (CSP) methods and the associated multinomial logit models to estimate unit freight travel time values from an Australian survey of freight shippers using road freight transport in 2000. The survey technique of Contextual Stated Preference allows “tapping” of shippers’ values and perceptions to be done by constructing a series of freight service alternatives, around 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 trade-offs 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. These and similar techniques are widely used in industry and marketing.

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 – but associated with a reduction in estimated benefits, as these benefits are currently assessed based on vehicle operating costs factors alone. Declining estimates of 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 (Stages 1 & 2). The model on which both the Stage 1 and Stage 2 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 study 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 trade-offs 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).

Interpreting the Findings of this Analysis

The values obtained here are short run values: they reflect the perceived utilities of shippers today. Even in this context it would be desirable to analyse a sample of actual shipments to assess the relevance of CSP results in terms of shippers’ revealed preference attitudes to consistently late or early deliveries – and to identify hidden assumptions. One such assumption worth further investigation would be the perception by the respondents that they 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 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 for the Stage 1 analysis and the multi-segment automotive components sector selected for the purposes of the Stage 2 analysis however show an encouraging degree of broad agreement. In terms of results, it may be necessary to extend the coverage of this study (Stages 1 & 2) to improve precision in order to apply these values in economic evaluation processes. The results obtained so far indicate that this is 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, spatial differences 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.

Travel Time Savings for Freight

The Stage 2 survey addressed firms strongly represented in the Australian automotive components industry. They encompass very wide ranges of enterprise types (public companies, private companies and differing scales of operations etc), use of transport modes and logistics services, tasks, value densities of goods, etc. Survey responders for the Stage 1 analysis were drawn from the automotive parts, food and beverages, certain building materials, and packaging industries.

The key results are that the value of Full Truck Load (FTL) freight delays per pallet per hour on inter-capital routes, within the delivery acceptance windows, where the attribute could be traded-off, was found to be A$1.50 (A$0.70 for Stage 1) with a 40% standard error. While, the value of FTL freight delays per pallet per hour on intra-city routes was A$0.80 (A$1.30 for Stage 1) with an 85% standard error. This implies that trip time was not found to be a significant factor for the metropolitan or intra-city freight trip category. This was possibly because performance of the task within an explicit trip time was taken as a ‘given’ by shippers.

Meeting delivery acceptance windows is frequently a prescribed condition of a transport services Agreement. In an oligopsonistic (few buyers) market such as the automotive components industry, that has highly developed just-in-time manufacturing practices, it may – however critical – cease to be a variable. It may be traded off against other service attributes, as such shipments are probably the most constrained in terms of options for configuring the transport to meet specified delivery windows.

For metropolitan ‘Less than FTL’, freight delays per delivery per hour on intra-city routes was found to be A$2.20 (A$1.40 for Stage 1) per pallet with a 15% standard error. The valuation of freight time is clearly significantly higher for this transport services operation among those enterprises responding to this survey.

Estimates for the reliability and damage/loss attributes indicate that shippers in the automotive components industry place significant importance on getting shipments delivered reliably within defined time windows and without damage (or loss). For inter-capital FTL, shippers are prepared to pay approximately A$10 for increasing the probability of reliable delivery by 1%. The corresponding amount for damage and loss-free delivery is about A$77 per 1% improvement in the probability of damage/loss of shipment. Similarly, for Metropolitan FTL, shippers are prepared to pay under A$3 for 1% improvement in reliability and about A$37 per 1% increase in the probability for damage and loss-free deliveries. For ‘Less than FTL’ Metropolitan, the corresponding amounts are just over A$2 for reliability and about A$24 for damage/loss.

Three specified types of freight services models have been run on the edited available data in both linear and quadratic forms. The data prepared for analysis using the LIMDEP econometric software package must be explicitly qualified and documented at all stages of the estimation process. The adjusted R^2 values, signifying the overall statistical performance of the estimated relationships, are good (all are ~0.5). The larger survey scale of the Stage 2 research has also led to significantly more robust estimates of most parameters than were realised in Stage 1.

Conclusions

This project was limited rather than universal in scope. 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 careful selection of interviewers. The project has provided an initial set of estimated values for experimental use. Broader application of these methods across the freight operations in Australia would provide the data needed for routine estimation of freight travel time benefits.

The values derived in this study provide a first basis for quantifying 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 study (Stages 1 & 2) 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. Already preliminary freight travel time values for use in economic project evaluations have been developed from the current (Stages 1 & 2) work (Austroads 2000 and Austroads 2003).

Estimates obtained indicate that metropolitan freight travel time is more highly valued than that applying to inter-capital freight movements. However, these estimates do not allow the valuation of freight travel time to be distinguished between inter and intra-city full truck load movements. Further, they do not provide evidence that shippers attribute a non-zero value to freight time for intra-city movements. On the other hand, estimates for the reliability and damage/loss attributes indicate that shippers in the automotive components industry place significant importance upon getting shipments delivered reliably, within specified time windows and free of damage and loss.

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- Austroads Ref: Project N.BS.9702, Task 5

1.1. INTRODUCTION

This report documents the conduct and results of a stated preference (SP) survey of freight shippers. FDF carried out the survey for ARRB TR in Melbourne in May 1998. Its main aims were:

- to demonstrate the feasibility of using SP to estimate the value that freight users place on delays to freight; and
- to produce useable estimates of the value that freight users place on delays to freight.

This survey is, as far as is known, the first SP survey of freight preferences to be conducted in Australia, and one of very few SP surveys anywhere to be conducted into freight. Because the SP technique has only rarely been applied to freight, this survey is regarded as something of a learning exercise, even though it is intended to produce useable results. Consequently, it may be followed by more detailed surveys that will target specific industry sectors.

1.2. METHOD

This Chapter describes the survey method and documents the lessons learnt.

1.2.1 Stage 1 survey procedure

Step 1: Recruitment of respondents

Interviewers recruited their own survey respondents by telephone using the following procedure:

- Verify that the prospect satisfied the selection criteria (see below).
- Briefly explain the aims and nature of the survey using a fact-sheet provided by FDF.
- Ask the prospect if he or she is willing to participate.
- If yes, agree a tentative time and place.

Very few knock-backs were received, and these were all for genuine-sounding reasons; for instance, a few contacts claimed to be unavailable or to lack the required ‘hands-on’ knowledge. These people were often able to recommend others in the same firm who would respond.

Step 2: Fact-sheet

Soon after recruitment, respondents were faxed a fact-sheet (Appendix 1B) explaining the nature and purpose of the survey. This had three aims: to provide facts, to formalise the contact so it would not be forgotten, and to provide a contact in case of queries (though in fact nobody felt any need to contact FDF subsequently).

Step 3: Preliminary questionnaire

Respondents were faxed a short questionnaire (Appendix 1B, Figure1B.1). FDF used the results to estimate approximate median values of the attributes in the SP survey. These median attribute values were needed for the SP survey forms. Response to this questionnaire was very low—about 25%—suggesting that mail-out surveys to freight managers would not be feasible even if the complexities of SP could be explained other than by face-to-face interview. Fortunately, this low response did not matter, as FDF was able to augment the response with estimates based on their own industry experience, and the findings of the skirmish interviews.

Step 4: Skirmishing

The first ten interviews were conducted as ‘skirmishes’. Respondents were told that the survey form was being tested, and were asked for their views on the survey, FDF’s explanation of it, the design of the survey form, and any difficulties they experienced. These respondents were asked if they would agree to complete the fully tested survey forms later, which would be faxed to them (Appendix 1B), and to return them to FDF by fax. All agreed.

Step 5: Fine-tuning the survey

During the course of skirmishing, the following changes were made to the survey forms:

- Estimates of median values for attributes were revised.
- A simple one-page design was adopted for the survey forms.
- It was decided to administer three survey forms to each respondent, each form relating to a different type of consignment.

Step 6: Final survey

Once the content of the final survey (Appendix 1B) was agreed, FDF interviewed the remaining respondents. Skirmishing and final interviews took place over a two-week period in May 1998. Individual interviews lasted about 30 minutes on average. Much of this time was spent in explaining the survey and its context, and in answering questions.

Without exception, respondents were helpful and positive during the interview. FDF put this down to the seniority and calibre of the interviewers, who, being from the industry themselves, could relate to respondents as peers. The high response rate in face-to-face interviews contrasts starkly with the low response to the preliminary survey. Even though the questionnaire used for the preliminary survey Appendix 1B, Figure 1B.1) was far simpler than any SP survey could possibly be, it achieved only a 25% response. This suggests that the only way to obtain an acceptable response from freight managers is to get a knowledgeable person to interview them. Furthermore, since it is virtually impossible to conduct an SP survey by telephone, the interview must be in person. Nevertheless, FDF found that SP surveys can go quickly, once the concepts have been explained. It therefore makes sense to conduct several at the same site, and possibly with the same person. In this way, travel and explanation time is spread over several responses.

Lessons:

- The survey procedure as practised appears to work and to achieve good results.
- Mail-out surveys of any description, even if technically possible given the content, should be avoided, as the response would be very low.
- Interviewers must either be practitioners themselves, or at least very familiar with the industry.
- If possible, one should conduct several interviews on the one site in order to reduce costs.

1.2.2 Instructions to interviewers

1.2.2.a Imagining a scenario

During skirmishing, FDF found that it was helpful to ask respondents to treat the SP alternatives as ‘quotes’ received from a number of carriers bidding for a hypothetical regular consignment. Respondents were presented with the following scenario:

- You work for a hypothetical company in your industry.
- You have regular, identical consignments to deliver.
- Consignments consist of goods typical for your industry.
- You call for quotes from carriers.
- Although the quotes, naturally, do not state the level of damage and punctuality, you estimate these from the carriers’ reputations.
- You will choose the quote that you prefer, bearing in mind your estimate of each carrier’s performance on damage and punctuality.

1.2.2.b Consignment types

The scenario is repeated for each of three types of consignment:

- Inter-capital Full Truck Load (IFTL);
- Metropolitan Full Truck Load (MFTL); and
- Metropolitan Less than Full Truck Load, or multi-drop (MLFTL, md) (see discussion in Segmentation).

Most respondents appeared to have little difficulty imagining the scenarios, even when one or other of the consignment types did not occur in their current job (but see comments on damage and lateness below). For instance, some respondents do not handle inter-capital consignments; others have no metropolitan full truck loads, all their metropolitan deliveries being multi-drop. In such cases FDF told respondents that they could skip the particular questionnaire; however, none did. This did not surprise, because logistics managers are generally versatile and well informed about their industry. While they may not experience a particular consignment type in their current position, they know that they might in their next.

1.2.2.c A possible difficulty with 'damage' and 'lateness'

It was suspected that some respondents had problems with trading off damage and lateness against price and travel time. Specifically, they may have failed to give due weight to damage and lateness. If this has happened, the following explanation is offered.

Road freight in Australia is an extremely competitive business. By and large, shippers, especially the larger ones, get what they demand. Most demand zero damage and zero lateness. If a consignment is late or damaged (and it does of course happen, if rarely) the shipper assumes the carrier will bear the consequences. Moreover, if it happens to a significant degree, the carrier is replaced. Hence shippers assume that all carriers will be threatened into eliminating damage and lateness, whatever their quoted price.

Respondents who work on this basis, then, may have failed to play the SP 'game'. They will simply have chosen the best combination of price and travel time, and more or less disregarded damage and lateness.

Lessons:

- Since the survey, once explained, can be completed speedily, it is quite possible to have each respondent complete several questionnaires, each relating to a different type of consignment.
- Alternatives are best described as quotes from carriers.
- More work may be needed to correctly assess the effect of damage and lateness attributes.

1.2.3 Estimation of attribute values

Attribute values were estimated from:

- the industry experience of the interviewers;
- the preliminary questionnaire;
- the skirmish interviews; and
- calculations.[1]

1.2.4 Sample selection

FDF selected a sample of 45 persons. Of these, ten were used in skirmishing the survey form, of whom eight completed the final survey form. This gave a final sample of 43 completed interviews. However, since every respondent completed three survey forms, FDF received a total of 129 completed responses.

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[1] The above 'calculations' relate to the probability of damage. In order to arrive at a realistic estimate for this, we calculated the proportion of damage that would provide a realistic trade-off choice. Since the price can vary by a few dollars either way, we estimated the proportion of damage that would produce a similar variation. Assume a pallet value of, say $1,000 (this is reasonable for the industries surveyed). Our median damage proportion is 0.3%. This equates to $3 per pallet, and is comparable with the variation in price per pallet.

1.2.4.a Whom to interview: carrier, shipper or consignee?

When freight is delayed or damaged it is the consignee who normally bears the cost in the first instance. However, the consignee often has recourse in the long or short term to the shipper, who may have recourse to the carrier. In theory it does not matter whom is interviewed — carrier, shipper or consignee — provided they bear the cost of poor freight performance. By agreement with ARRB TR, FDF chose to interview the shipper since (1) the shipper is normally directly and immediately responsible for freight decisions, and (2) the consignee will normally make the shipper aware of, and penalise the shipper for, poor performance.

1.2.4.b Position in organisation

Respondents had to hold a senior management position (CEO, logistics manager, marketing manager or equivalent) in an agreed industry sector (see below). Junior staff were not interviewed, as FDF doubted they would have the breadth of knowledge or concern to provide valid responses. Respondents could come from the same firm provided they were from different departments (this occurred five times in the Stage 1 survey).

1.2.4.c A sample of opportunity

The survey sample was a ‘sample of opportunity’, that is, one composed of persons that the interviewers found easiest to recruit. Since FDF’s two interviewers had formerly worked in the freight industry, most of the sample was found by networking through industry contacts. Ideally, however, a random sample would be drawn from a sampling frame. Random sampling was not done in the current survey since its aim was mainly to prove up a technique. In any case, the budget did not permit it. Random sampling will be necessary in future if statistical reliability is to be achieved.

Lessons:

- ♦ Respondents should be drawn from shippers, not carriers or consignees.
- ♦ Respondents should be senior and well informed on logistics matters.
- ♦ Some form of random sampling will eventually be required for statistical reliability.

1.2.5 Form design, generation and coding

1.2.5.a Design

FDF was not required to design the survey, but was required to estimate approximate median values for attributes. These were to be inserted into a computer program provided by ARRB TR that would generate survey forms according to ARRB TR’s predetermined SP design.

In the event, FDF found during skirmishing that ARRB TR’s design needed to be modified in favour of a simple, one-page form layout instead of the three-page layout provided by ARRB TR. With a single exception, respondents strongly preferred the single page design with all alternatives lined up horizontally. The three-page version was found to be confusing and, it is suspected, intimidating by its sheer size. FDF modified the design accordingly, with the permission of ARRB TR.

1.2.5.b Form generation

ARRB TR’s logic for calculating attribute values had to be modified. Originally, attribute values were to be varied plus and minus 20%. In the case of the damage and lateness attributes, this range was found during skirmishing to be too small to elicit a useable response. The range was changed to plus and minus about 60%, and at the same time rounded for readability to a convenient round number. FDF modified the logic of ARRB TR’s computer program accordingly, again with the permission of ARRB TR. An electronic copy of the rewritten program (**Survey.xls**) has been provided to ARRB TR.

1.2.5.c Coding

Because each individual SP survey form is unique, the coding of SP surveys is unlike that of ordinary surveys. In SP surveys, each possible choice is characterised by (1) its attributes, and (2) whether or not it was chosen by the respondent. Since the attributes are determined by the same logic as generated the survey forms, it makes sense to use the same computer program to generate them automatically. That way, the coding task can be reduced to a single variable—respondent choice. This greatly lessens the coding task.

To make this possible, FDF constructed a coding spreadsheet that is linked to the form generation spreadsheet (**Survey.xls**). In so doing, FDF corrected a number of apparent errors in the coding data provided by ARRB TR. This spreadsheet (**Dataset.xls**) has been provided to ARRB TR. In order to eliminate these errors in future, and to lighten the coding task, FDF thinks that the entire logic for generating and coding survey forms should be embodied in a single spreadsheet along the lines adopted for the current survey.

Lessons:

- The survey form has to be short and simple, preferably no more than one page.
- Attribute values need not vary by the same proportion in all cases, and should be rounded for readability.
- There should be a single combined spreadsheet for coding and form generation.

1.2.6 Segmentation

Freight is extremely heterogeneous. Values and trade-offs that are true of one industry are unlikely to apply to another, since the circumstances of each are unique. For this reason it will be necessary to segment the freight 'market', and estimate different parameters for each segment. This section discusses how and why FDF segmented their sample, and draws lessons from the experience.

1.2.6.a The Hague Consulting Group Study

The current study builds on work done in other countries, in particular a 1992 Dutch study by *The Hague Consulting Group* (De Jong et al 1995). That study, on which this study is partly modelled, surveyed four industry sectors. Two sectors produced unfinished goods (that is, raw materials of semi-finished goods that are destined as inputs to a manufacturing process), and two produced finished goods. The finished goods sectors were further split between high and low value-density; and the unfinished goods sectors were split between high and low time-sensitivity.

De Jong et al (1995) does not say how *The Hague Consulting Group* selected their industry sectors, but the following explanation is offered.

- **Unfinished goods** are inputs to a manufacturing process. Hence delay or damage during delivery has the potential to be very costly as the entire manufacturing process may be held up. Moreover, the magnitude of the effect is likely to depend on the value-density of the commodity, not because low-value goods are any less capable of bringing production to a halt, but because they are more likely to be held in stock. The Hague Consulting Group brought this out by studying both high and low value-dense unfinished goods.
- **Finished goods** are destined for final consumption. Hence delay in delivery generally results in delayed sales; sales are normally only completely lost if the commodity deteriorates en route. The Hague Consulting Group brought this out by studying both high and low time-sensitive finished goods.

1.2.6.b Haul length

In the current study it was desired to examine a further criterion: length of haul. If the Dutch study was to be replicated, FDF would need to survey eight industry sectors - one for each of the four Dutch sectors, each split further by long and short haul. Since resources were limited, this was impractical. It was therefore decided instead to concentrate on haul length and type, which was divided into three segments:

- **Inter-capital full truck load (IFTL)** 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[2]. Normally these runs are from plant to plant, or plant to warehouse. On arrival the goods go directly into stock, hence time-sensitivity is not expected to be as high as for multi-drops (see below).
- **Metropolitan full truck load (MFTL)** describes another common kind of consignment: a fully laden articulated truck transporting loaded pallets within Melbourne. Like IFTL, these runs are normally from plant to plant or plant to warehouse, and are for stock. Unlike IFTL, they typically happen in the daytime.
- **Metropolitan LFTL less than full truck load (multi-drop) (MLFTL)** is also very common: a rigid truck or LCV doing a trip with many deliveries. The consignment may consist of pallets of parcels. Normally these runs are from plant to wholesaler, retailer or service outlets. The goods are often required immediately, hence time-sensitivity is expected to be high.

The differences between the FDF survey and the Dutch survey may reflect the differences in road transport in the two places. In Australia, for obvious geographical reasons, there tends to be a polar split in haul length, with inter-capital hauls of up to 1,000 km or more, and metropolitan hauls of less than 100 km, and very little in between. It is suspected that haul lengths in Europe are much more varied.

1.2.6.c Industry

Respondents were drawn from the following industries:

- automotive parts;
- food and beverages;
- certain building materials; and
- packaging.

Although superficially different, all have about the same value per pallet and have similar transport requirements. For these reasons, FDF was comfortable in not segmenting by industry in the first instance. However, FDF has recorded the industry of each respondent in the dataset. It would therefore be possible to segment by industry type in future analyses.

---

[2] It is recognised that, because of the variety of geographic and economic influences in Australia, the results from these surveys will not give precise values for general use throughout Australia.

Lessons:

- The current dataset may be reanalysed by industry segment.
- Future surveys should pay attention to segmentation dimensions including industry, haul length, transport attributes, value density etc.

1.3. MODEL ESTIMATION AND RESULTS

1.3.1 Introduction

Stated Preference as a method of obtaining valuations for freight shipping choices has not been previously undertaken within Australia. This report covers the data cleaning and model construction and execution of such a data set, collected by FDF to a design specified by ARRB TR (Thoresen 1997).

The proposed initial models were threefold:

- A basic logit model of choices made using actual attribute levels.
- A similar logit using centred linear main effects.
- A similar logit with linear mean centred effects and quadratic main effects.

The method adopted for the survey involved the selection of one bundle of attribute values from a set of 3 to 6 bundles of variants on these values. No rank ordering was used, and a double randomised administration process was adopted. The experimental design was produced using CONSURV by D A Hensher for ARRB TR, and was an orthogonal design aimed at measuring main effects only.

The brief was to estimate initial sets of models on the data set collected by FDF using LIMDEP 7 (Greene 1997).

- These results were specifically initial estimates only.
- No refinement of models or specifications to be undertaken.
- Simple reporting of the results only.

1.3.2 Data preparation and cleaning

The coding of the survey data proved to be under-specified, and other shortfalls in the initial coding expectations were identified in an iterative process between FDF and Oxford Systematics. FDF regenerated the blocks of attribute bundles as a first step, and identified a (small) number of errors in the ARRB-supplied administration sets of bundles as used in the field work. These discrepancies were not sought to be corrected, and the data as collected could then be coded as specified by ARRB.

A substantial amount of effort proved to be necessary to encourage LIMDEP to operate on this coded data. There were several reasons for this difficulty:

- The model LIMDEP command file provided had a number of errors in it, which had to be identified and corrected without altering the intent of the model specifications.
- The major part of the effort was spent in decoding the arcane error diagnostics produced by LIMDEP, and the inconsistent terminology used by LIMDEP in its reporting of such errors. Some errors appeared during interactive runs, other appeared only in the printouts produced during such runs, without corresponding messages to the screen.

The corrected models are reproduced in Appendix 1A.

The final diagnosis of the inconsistent errors obtained in the IFTL dataset were eventually traced to the lack of a choice selection in the coding process, so that a set of -say - 4 bundle choices were correctly coded in the data - but not one had a ‘1’ coded as the bundle selected by the subject. This error led to messages of several different types, some on the screen and some only on the printout. The assumption that ‘observation’ was a single row in the dataset was the final stumbling block, and was endorsed by ARRB. It turns out that, after coding manually all 4,500 rows into serially numbered groups of rows, that ‘observation’ was actually the number of such a group.

This tracking down of this obtuse coding anomaly cost more than two man-days of unbudgeted effort, due to the need to exhaustively enumerate and trial different forms of diagnosis. LIMDEP manuals, ITS Sydney and ARRB TR were all unable to assist, and this process had to be done systematically and - inevitably - slowly.

1.3.3. Results

1.3.3.a Intermediate results

The mean values of the corrected data sets are summarised in Table 1.1.

Table 1.1 — Mean values of attributes in the three datasets

Mean values	IFTL	MFTL	MLFTL (md)
Rate	35.0868	9.044	12.0323
Time	15.0333	4.0045	6.0026
Reliability (late)	0.0502	0.0501	0.0498
Damage and loss	0.0030	0.0031	0.0031

1.3.3.b Inter-capital Full Truck Load (IFTL)

The Inter-capital FTL survey might be expected to place high values on both reliability and damage avoidance (Table 1.2).

Table 1.2 — Summary results – Inter-capital Full Truck Load (IFTL)

Model	Freight Rate/pallet	Time	Reliability	Probability of Damage
Linear Attribute (adj R^2 = 0.51)				
Coefficient	-0.100[a]	-0.066[b]	-25.6[a]	-497[a]
Standard Error	0.014	0.031	2.9	48
	A$	0.66 A$/pallet/hr	A$2.56 per 1% △	A$49.70 per 1% △
Linear Centred Attribute (adj R^2 = 0.51)				
Coefficient	-0.100[a]	-0.066[b]	-25.6[a]	-497[a]
Standard Error	0.013	0.031	2.9	48
	A$	0.66 A$/pallet/hr	A$2.56 per 1% △	A$49.70 per 1% △
Linear + Quadratic Centred Attribute (adj R^2 = 0.52)				
Coefficient	-0.132[a]	-0.104	-32.6[a]	-637[a]
Standard Error	0.030	0.064	4.1	95
	A$	0.79 A$/pallet/hr	247 A$/ 100%	4825 A$/100%
	$(\text{Freight Rate})^2$	$(\text{Time})^2$	$(\text{Reliability})^2$	$(\text{Probability of Damage})^2$
Coefficient	-0.016[a]	-0.027	208	-22723
Standard Error	0.005	0.029	404	66027

Notes: a: $p<0.001$ (ie, significant at 0.1% or less); b: $p<0.05$ (ie, significant at 5% or less);

The quadratic effects are limited but reduce the time coefficient to a value not significantly different from zero, and reliability and probability of damage clearly dominate freight rate considerations. The signs are all consistent, all estimated coefficients are significant, at least, at the 5 per cent level and a valuation of 0.7 A$/min is indicated for all three models. A larger survey may be required for estimating more reliable values of freight time.

1.3.3.c Metropolitan Full Truck Load (MFTL)

The Metropolitan FTL survey could reasonably be expected to place higher values on time than inter-capital movements. This appears to be the case (Table 1.3), with a similar level of significance of the estimated coefficients to that of the inter-capital full truck load model. The weight given to the probability of damage is substantially higher than from the interstate survey.

Table 1.3 — Summary results - Metropolitan Full Truck Load (MFTL)

Model	Freight Rate/pallet	Time	Reliability	Probability of Damage
Linear Attribute (adj R^2 = 0.56_				
Coefficient	-0.298[a]	-0.401[a]	-37.1[a]	-545[a]
Standard Error	0.054	0.110	3.4	52
		1.3 A$/pallet/hr	A$1.25 per1% △	A$18.29 per 1% △
Linear Centred Attribute (adj R^2 = 0.56)				
Coefficient	-0.298[a]	-0.401[b]	-37.1[a]	-545[a]
Standard Error	0.049	0.110	3.4	52
		1.30 A$/pallet/hr	A$1.25 per 1% △	A$18.29 per 1% △
Linear + Quadratic Centred Attribute (adj R^2 = 0.57)				
Coefficient	-1.27	-2.15	-40.3[a]	-1551
Standard Error	12.2	23.5	3.2	12854
		1.7 A$/pallet/hr	A$.32 per 1 % △	A$12.21 per 1% △
	(Freight Rate)^2	(Time)^2	(Reliability)^2	(Probability of Damage)^2
Coefficient	-0.55	-1.73	3968	-0.0000040
Standard Error	5.84	23.37	51936	0.0000006

Notes: a: $p<0.001$ (ie, significant at 0.1% or less); b: $p<0.05$ (ie, significant at 5% or less);

The signs are consistent, and the values of time are more reliably estimated in this Metropolitan FTL survey. The linear centred attribute model here shows coefficients significantly different from zero, and with reasonable standard errors.

1.3.3.d Metropolitan multi-drop (Less than Full Truck Load, LFTL)

The Metropolitan multi-drop (or Less than Full Truck Load) survey could once again reasonably be expected to place higher values on time again than intra-city FTL movements (Table 1.4), and actually produces values similar to the Metropolitan FTL survey.

The trends in valuations are consistent. The accuracy of these values of time are severely limited, not only by the high standard errors for both time and freight rate coefficients, but also due to the low levels of significance of both time and freight coefficients in a number of the equations. This pattern is apparent in a number of models and surveys, and suggests that large samples as well as improved administration techniques may be necessary to obtain useable estimates of time valuations, reliability and damage assessment values.

An issue raised in debriefing the survey administrators was a suspicion that some subjects considered that they would have market control of freight rates, and so the variations were only between factor such as reliability and loss.

Table 1.4 — Summary results - Metropolitan multi-drop

Model	Freight Rate/pallet	Time	Reliability	Prob. Damage
Linear Attribute (adj $R^2 = 0.52$)				
Coefficient	-0.177 [a]	-0.244 [b]	-34.9 [a]	-479 [a]
Standard Error	0.049	0.102	3.2	49
		1.4 A$ /delivery/hr	A$1.97 per 1% △	A$27.1 per 1% △
Linear Centred Attribute (adj $R^2 = 0.53$)				
Coefficient	-0.177 [a]	-0.244 [b]	-34.9 [a]	-479 [a]
Standard Error	0.049	0.102	3.2	49
		1.40 A$ /delivery/hr	A$1.97 per 1% △	A$27.06 per 1% △
Linear + Quadratic Centred Attribute (adj $R^2 = 0.54$)				
Coefficient	-0.424 [a]	-0.457 [b]	-41.6 [a]	-609 [a]
Standard Error	0.112	0.190	4.8	103
		1.1 A$ /delivery/hr	A$1 per 1% △	A$14.4 per 1% △
	$(\text{Freight Rate})^2$	$(\text{Time})^2$	$(\text{Reliability})^2$	$(\text{Probability of Damage})^2$
Coefficient	-0.206 [a]	0.159	550	78778
Standard Error	0.061	0.311	414	78014

Notes: a: $p<0.001$ (ie, significant at 0.1% or less); b: $p<0.05$ (ie, significant at 5% or less);

1.4. CONCLUSIONS OF STAGE 1

The feasibility study has demonstrated that the Stated Preference approach can produce results, but that the detailed findings of the present work will need to be assessed carefully to determine the best method of undertaking a full scale survey and modelling project.

The data preparation required for LIMDEP is extremely sensitive and requires careful qualification and documentation at all stages

The coverage obtained in the present survey will need to be expanded further. It is suggested that trials on different attributes be undertaken or skirmished, as the time and rate variables were not well picked out by the respondents. A focus group may help to identify the hints raised by the survey administrators in a more concrete form, and assist in the design of the full scale work.

The key results are that the estimated value of FTL freight travel time/pallet/hr on inter-capital routes was A$0.7, and on intra-city routes was A$1.3 indicating that intra-city freight travel time is more highly valued than inter-capital. The value of Multi-drop freight travel time/delivery/hr on intra-city routes was A$1.4 which is similar to the full truck load value estimate.

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 more broadly applicable results.

Significantly larger samples will be required to obtain more precise values.

1.5. REFERENCES (STAGE 1)

GREENE, W. H. (1997). *LIMDEP version 7 Users manual.* (Bellport NY: Econometric Software)

THORESEN, T. (1997). *Estimation of non-urban freight travel time values: Methodological review and experimental de*sign. Working Document WD R97/061. (Vermont Victoria; ARRB Transport Research Ltd)

APPENDIX 1A   LIMDEP OUTPUT

Variable names and meanings

indno	Index number of data element (not used in LIMDEP)
bundle	One of the nine different bundles of attribute values used in the survey
choice	Set to ‘1’ for the bundle chosen out of a set of attribute bundles presented to a subject
setsize	The number of bundles from which the choice was made (ie, the number of bundles shown on the particular flash card used)
rate	Freight rate in $ AUD
time	Transit time (in minutes)
late	Percentage of late deliveries
bust	Percentage of deliveries arriving damaged
sequence	The sequence number of the bundles in order, in groups presented as each successive observation (these must be kept in order and in groups to comprise ‘observations; in LIMDEP terminology). This sequence includes all bundles produced by the operation of the FDF flash card generation macros)
index	The sequence number of each bundle again in observation groups) after editing out the N/A (ie, missing) bundles in each observation which comprises the experimental design.
Obs	The sequential number allocated to ALL the bundles offered at the same time to a subject (a critical but undocumented terminology within LIMDEP)
rate1	Value of freight rate corrected to difference from mean value
time1	Value of freight time corrected to difference from mean value
late1	Value of % freight late deliveries corrected to difference from mean value
bust1	Value of % freight damaged deliveries corrected to difference from mean value
rateq	Squared difference from the mean value of freight rate
bustq	Squared difference from the mean value of freight % damaged deliveries
timeq	Squared difference from the mean value of freight time
lateq	Squared difference from the mean value of freight % late deliveries

Command files

Metropolitan Multi-drop

```
read ;nvar=10;nobs=1549; file = mmtl.txt;
names=indno,bundle,choice,setsize,rate,time,late,bust,sequence,index$
open; output = mmtl.out$
dstats; rhs =*$
create
;rate1=rate-12.0323
;time1=time-6.0026
;late1=late-0.0498
;bust1=bust-0.0031
;rateq=rate1*rate1
;bustq=bust1*bust1
;timeq=time1*time1
;lateq=late1*late1$

?first run simple logit with actual attribute levels
NLOGIT
;lhs = choice,setsize, bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1, alt2, alt3, alt4, alt5 ,alt6, alt7, alt8, alt9) =
fr*rate+tm*time+rel*late+pdam*bust$

?second run is simple logit with mean centred linear mean effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
fr*rate1+tm*time1+rel*late1+pdm*bust1$

?third run is simple logit with mean centred linear and quadratic main
? effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
frl*rate1+tml*time1+rel1*late1+pdaml*bust1+
frq*rateq+tmq*timeq+relq*lateq+pdamq*bustq$
STOP
```

Metropolitan FTL

```
read ;nvar=10;nobs=1546; file = mftl.txt;
names=indno,bundle,choice,setsize,rate,time,late,bust,sequence,index$
open; output = mtftl.out$
dstats; rhs =*$
create
;rate1=rate-9.044
;time1=time-4.0045
;late1=late-0.0501
;bust1=bust-0.0031
;rateq=rate1*rate1
;bustq=bust1*bust1
;timeq=time1*time1
;lateq=late1*late1$

?first run simple logit with actual attribute levels
NLOGIT
;lhs = choice,setsize, bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1, alt2, alt3, alt4, alt5 ,alt6, alt7, alt7, alt8, alt9) =
fr*rate+tm*time+rel*late+pdam*bust$
```

```
?second run is simple logit with mean centred linear mean effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
fr*rate1+tm*time1+rel*late1+pdm*bust1$

?third run is simple logit with mean centred linear and quadratic main
? effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
frl*rate1+tml*time1+rel1*late1+pdaml*bust1+
frq*rateq+tmq*timeq+relq*lateq+pdamq*bustq$
STOP
```

Inter-capital FTL

```
? Includes the omission of the 8 data rows in Observations 124 and 331 without a choice
? NB the coded ‘observations’ numbers (obs) added for diagnosis of LIMDEP anomalies

read ;nvar=11;nobs=1532; file = iftl.txt;
names=indno,bundle,choice,setsize,rate,time,late,bust,sequence,index,obs$
open; output = i124l331.out$
dstats; rhs =*$
create
;rate1=rate-35.0868
;time1=time-15.0333
;late1=late-0.0502
;bust1=bust-0.0030
;rateq=rate1*rate1
;bustq=bust1*bust1
;timeq=time1*time1
;lateq=late1*late1$

?first run simple logit with actual attribute levels
NLOGIT
;lhs = choice,setsize, bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1, alt2, alt3, alt4, alt5 ,alt6, alt7, alt8, alt9) =
fr*rate+tm*time+rel*late+pdam*bust$

?second run is simple logit with mean centred linear mean effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
fr*rate1+tm*time1+rel*late1+pdm*bust1$

?third run is simple logit with mean centred linear and quadratic main
? effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
frl*rate1+tml*time1+rel1*late1+pdaml*bust1+
frq*rateq+tmq*timeq+relq*lateq+pdamq*bustq$
STOP
```

Results

Inter-capital FTL

```
Variable     Mean      Std. Dev.    Skew. Kurt.  Minimum     Maximum      Cases


INDNO        21.9458     13.5162   0.1   1.7      1.0000     45.0000    1532
BUNDLE        5.0483      2.5921   0.0   1.8      1.0000      9.0000    1532
CHOICE        0.2232      0.4166   1.3   2.8      0.0000      1.0000    1532
SETSIZE       4.6423      0.8414  -0.1   2.4      3.0000      6.0000    1532
RATE         35.0868      5.7492   0.0   1.5     28.0000     42.0000    1532
TIME         15.0333      2.4592   0.0   1.5     12.0000     18.0000    1532
LATE          0.0500      0.0247   0.0   1.5      0.0200      0.0800    1532
BUST          0.0030      0.0016   0.0   1.5      0.0010      0.0050    1532
SEQUENCE   1128.1305    689.7730   0.1   1.7      1.0000   2302.0000    1532
INDEX       769.1945    444.2262   0.0   1.8      1.0000   1540.0000    1532
OBS         171.4654     98.7010   0.0   1.8      1.0000    344.0000    1532
```

Linear attribute value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable               Choice
                Number of observations              342
                Iterations completed                  5
                Log likelihood function       -368.8826
                Log-L for Choice   model =    -368.8826
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -751.4508 0.50911 0.50745
                Constants only    -623.5017 0.40837 0.40637
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FR        -0.10062         0.13920E-01   -7.228   0.00000
  TM        -0.65838E-01     0.31461E-01   -2.093   0.03637
  REL        -25.640          2.9101       -8.811   0.00000
  PDAM       -496.87          48.447      -10.256   0.00000
```

Linear mean centred value model

```
              Discrete choice (multinomial logit) model
              Maximum Likelihood Estimates
              Dependent variable               Choice
              Number of observations              342
              Iterations completed                  5
              Log likelihood function       -368.8826
              Log-L for Choice   model =    -368.8826
              R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
              No coefficients   -751.4508 0.50911 0.50745
              Constants only    -623.5017 0.40837 0.40637
              Response data are given as ind. choice.

 Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X


 FR        -0.10062         0.13920E-01   -7.228   0.00000
 TM        -0.65838E-01     0.31461E-01   -2.093   0.03637
 REL        -25.640          2.9101       -8.811   0.00000
 PDM        -496.87          48.447      -10.256   0.00000
```

Linear and quadratic mean centred value model

```
              Discrete choice (multinomial logit) model
              Maximum Likelihood Estimates
              Dependent variable               Choice
              Number of observations              342
              Iterations completed                  7
              Log likelihood function       -359.7062
              Log-L for Choice   model =    -359.7062
              R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
              No coefficients   -751.4508 0.52132 0.51808
              Constants only    -623.5017 0.42309 0.41918
              Response data are given as ind. choice.

 Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X


 FRL       -0.13197         0.29535E-01   -4.468   0.00001
 TML       -0.10381         0.64284E-01   -1.615   0.10633
 REL1       -32.590          4.1431       -7.866   0.00000
 PDAML      -637.12          95.004       -6.706   0.00000
 FRQ       -0.16155E-01     0.46865E-02   -3.447   0.00057
 TMQ       -0.27081E-01     0.29344E-01   -0.923   0.35607
 RELQ        207.76          404.22        0.514   0.60726
 PDAMQ      -22793.          66027.       -0.345   0.72993
 PDAMQ      -22793.          66027.       -0.345   0.72993
```

Metropolitan FTL

```
Descriptive Statistics
Variable   Mean      Std. Dev.   Skew. Kurt.  Minimum     Maximum      Cases


INDNO        21.9638     13.1374   0.2   1.8      1.0000     45.0000    1546
BUNDLE        5.0705      2.5939   0.0   1.8      1.0000      9.0000    1546
CHOICE        0.2225      0.4161   1.3   2.8      0.0000      1.0000    1546
SETSIZE       4.6546      0.8344  -0.1   2.4      3.0000      6.0000    1546
RATE          9.0440      1.6372   0.0   1.5      7.0000     11.0000    1546
TIME          4.0045      0.8216   0.0   1.5      3.0000      5.0000    1546
LATE          0.0501      0.0247   0.0   1.5      0.0200      0.0800    1546
BUST          0.0031      0.0016   0.0   1.5      0.0010      0.0050    1546
SEQUENCE   1144.1818    702.9677   0.1   1.7      1.0000   2351.0000    1546
INDEX       773.5000    446.4361   0.0   1.8      1.0000   1546.0000    1546
```

Linear attribute value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable              Choice
                Number of observations             344
                Iterations completed                 5
                Log likelihood function       -329.5708
                Log-L for Choice   model =    -329.5708
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.56397 0.56251
                Constants only    -598.5932 0.44942 0.44759
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X


  FR        -0.29777         0.54042E-01   -5.510   0.00000
  TM        -0.40149         0.10983       -3.655   0.00026
  REL        -37.147          3.3993      -10.928   0.00000
  PDAM       -545.11          51.625      -10.559   0.00000
```

Linear mean centred value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable              Choice
                Number of observations             344
                Iterations completed                 5
                Log likelihood function      -329.5708
                Log-L for Choice   model =   -329.5708
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.56397 0.56251
                Constant s only   -598.5932 0.44942 0.44759
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FR        -0.29777        0.54042E-01   -5.510   0.00000
  TM        -0.40149        0.10983       -3.655   0.00026
  REL        -37.147         3.3993      -10.928   0.00000
  PDM        -545.11         51.625      -10.559   0.00000
```

Linear and quadratic mean centred value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable              Choice
                Number of observations             344
                Iterations completed                14
                Log likelihood function      -323.9841
                Log-L for Choice   model =   -323.9841
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.57136 0.56849
                Constants only    -598.5932 0.45876 0.45513
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FRL        -1.2725         12.200       -0.104   0.91693
  TML        -2.1537         23.582       -0.091   0.92723
  REL1       -40.259         11.327       -3.554   0.00038
  PDAML      -1550.6         12854.       -0.121   0.90399
  FRQ       -0.54827         5.8429       -0.094   0.92524
  TMQ        -1.7314         23.372       -0.074   0.94095
  RELQ        3967.7         51936.        0.076   0.93910
  PDAMQ     -0.39379E+06    0.58430E+07   -0.067   0.94627
```

Metropolitan multi-drop

```
Descriptive Statistics
Variable   Mean      Std. Dev.   Skew. Kurt.  Minimum     Maximum      Cases

INDNO        21.9283     13.1483   0.2   1.8      1.0000     45.0000    1549
BUNDLE        5.0510      2.5901   0.0   1.8      1.0000      9.0000    1549
CHOICE        0.2221      0.4158   1.3   2.8      0.0000      1.0000    1549
SETSIZE       4.6527      0.8058  -0.1   2.5      3.0000      6.0000    1549
RATE         12.0323      1.6382   0.0   1.5     10.0000     14.0000    1549
TIME          6.0026      0.8212   0.0   1.5      5.0000      7.0000    1549
LATE          0.0498      0.0246   0.0   1.5      0.0200      0.0800    1549
BUST          0.0031      0.0016  -0.1   1.5      0.0010      0.0050    1549
SEQUENCE   1158.1575    714.1451   0.1   1.8      1.0000   2398.0000    1549
INDEX       775.0000    447.3021   0.0   1.8      1.0000   1549.0000    1549
```

Linear attribute value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable               Choice
                Number of observations              344
                Iterations completed                  5
                Log likelihood function       -357.5160
                Log-L for Choice   model =    -357.5160
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.52700 0.52542
                Constants only    -614.6082 0.41830 0.41637
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FR        -0.17682         0.49325E-01   -3.585   0.00034
  TM        -0.24414         0.10199       -2.394   0.01667
  REL        -34.939          3.1723      -11.014   0.00000
  PDAM       -479.29          48.732       -9.835   0.00000
```

Linear mean centred value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable               Choice
                Number of observations              344
                Iterations completed                  5
                Log likelihood function       -357.5160
                Log-L for Choice   model =    -357.5160
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.52700 0.52542
                Constants only    -614.6082 0.41830 0.41637
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FR        -0.17682         0.49325E-01   -3.585   0.00034
  TM        -0.24414         0.10199       -2.394   0.01667
  REL        -34.939          3.1723      -11.014   0.00000
  PDM        -479.29          48.732       -9.835   0.00000
```

Linear and quadratic mean centred value model

```
                Discrete choice (multinomial logit) model
                Maximum Likelihood Estimates
                Dependent variable               Choice
                Number of observations              344
                Iterations completed                  7
                Log likelihood function       -347.0926
                Log-L for Choice   model =    -347.0926
                R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
                No coefficients   -755.8453 0.54079 0.53772
                Constants only    -614.6082 0.43526 0.43149
                Response data are given as ind. choice.

  Variable  Coefficient   Standard Error  z=b/s.e. P[=Z=Úz]   Mean of X

  FRL       -0.42355         0.11187       -3.786   0.00015
  TML       -0.45736         0.19012       -2.406   0.01614
  REL1       -41.588          4.8418       -8.589   0.00000
  PDAML      -609.00          103.21       -5.901   0.00000
  FRQ       -0.20632         0.60832E-01   -3.392   0.00069
  TMQ        0.15912         0.31078        0.512   0.60866
  RELQ        549.57          414.01        1.327   0.18437
  PDAMQ       78778.          78014.        1.010   0.31259
```

APPENDIX 1B SURVEY MATERIALS

FDF Management Pty Ltd
Incorporated in Victoria
ACN 007 285 743
69 Grey St, East Melbourne
Victoria 3002 Australia
Tel +61-3-9416 4211
Fax +61-3-9417 4407
E-mail fdfmgt@ozemail.com.au

To	Name	Fax	
At	Organisation	Pages	1
From	Nigel Rockliffe	Fax	03 9417 4407
Subject	Survey of the cost of freight delays	Date	

Thank you for agreeing to be interviewed for the freight survey that FDF is carrying out for ARRB Transport Research. This fax follows up the recent telephone call by Jeremy Pascoe/Keith McDougall. Its purpose is to provide additional information on the survey, and to keep you informed of what happens now.

- **How long will the interview take?** About half an hour, maybe less.
- **Are any sensitive or detailed data needed?** No. The survey requires only your judgment, based on your experience as a manager concerned with logistics.
- **What do I need to do?** You will be presented in the survey with a small number of alternatives, each describing a possible freight service. You will be asked to choose the alternatives that you prefer.
- Who will see the responses? Only the data analyst.
- **Are the responses confidential?** Absolutely. All responses will be aggregated and processed mathematically so that individual responses will no longer be distinguishable.
- **Can I see my own responses?** Yes. If you wish, you may have a copy of your responses and a summary of our final report.
- **Who is the survey for?** Road and traffic authorities.
- **What will they use it for?** To build and operate better roads—ones that properly account for road freight, not just personal transport.
- **Why is this survey needed?** At present, road projects that benefit freight movements are unfairly penalised because we lack information on the true cost of freight delays. This survey will provide planners with the information they need.
- **Will the survey help my firm?** Yes. At present, some road projects that would benefit firms such as yours are being shelved because it is impossible to demonstrate their full benefits. The information from this survey will help these projects to get built.
- **What happens now?** We shall contact you soon to arrange a convenient time to visit your office to conduct the survey. Our present plan is for interviewing to take place between 29th May and 12th June.
- **What can I do to help?** You can save time at the interview by answering the questions on the attached data sheet, and faxing it back to us on 03 9417 4407.

Meanwhile, if you have any questions or comments relating to the survey, please call me on 03 9416 4211. Thank you again for your assistance in this important study.

Nigel Rockliffe
Director

Name ……………………………………………………………………………………

Telephone ……………………………………………………………………………………

Position ……………………………………………………………………………………

Firm ……………………………………………………………………………………

Shipments to destinations within Melbourne

Please think of a typical shipment that you make on a regular basis, wholly or mostly within greater Melbourne. If you make many shipments like this, choose the one you think is most important. If you do not make any shipments to destinations in Melbourne, please go on to the next section.

Type of commodity: ………………………………………………………………………………

Client (choose one) Manufacturer ( ) Wholesaler ( ) Retailer ( ) Other type (specify) (……….)

Units (choose one) Pallet ( ) Kilograms ( ) Tonnes ( ) Other unit (specify) (……….)

Typical freight rate for this shipment* ……………………………………… $ per unit specified above

Typical trip duration for this shipment* ……………………………………… Hours

Typical damage experienced by this shipment* ……………………………………… % damaged

Typical proportion of deliveries not on time* ……………………………………… % not on time

Annual spend on freight transport: ……………………………………… $ thousands

Shipments to destinations outside Melbourne

Please think of a typical shipment that you make on a regular basis, to a destination over 250km from Melbourne. If you make many shipments like this, choose the one you think is most important.

Type of commodity: ………………………………………………………………………………

Client (choose one) Manufacturer: ( ) Wholesaler: ( ) Retailer: ( ) Other type (specify): (…..….)

Units (choose one) Pallet: ( ) Kilograms:: ( ) Tonnes: ( ) Other unit (specify): (…..….)

Typical freight rate for this shipment* ……………………………………… $ per unit specified above

Typical trip duration for this shipment* ……………………………………… Hours

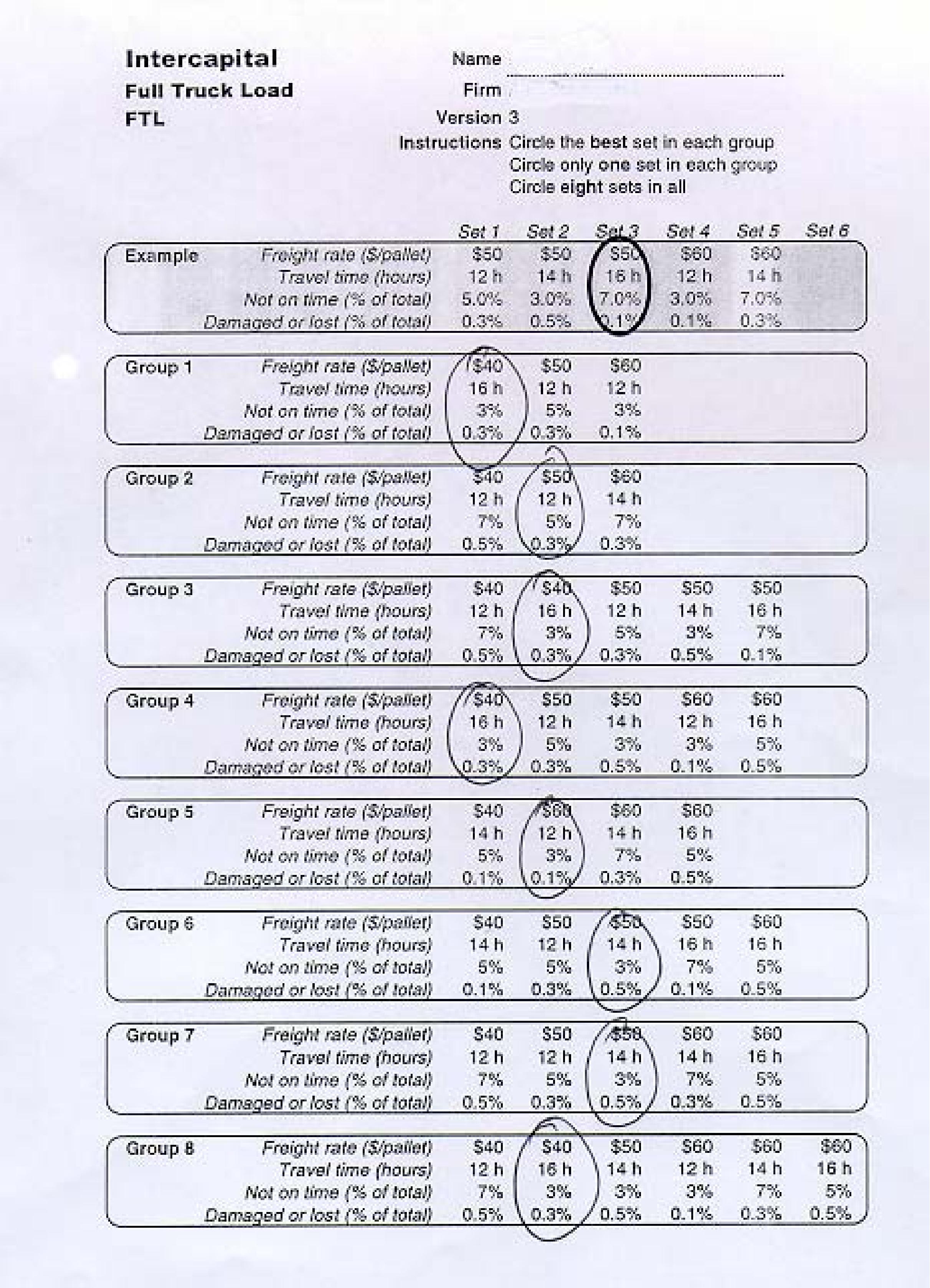
Typical damage experienced by this shipment* ……………………………………… % damaged

Typical proportion of deliveries not on time* ……………………………………… % not on time

Annual spend on freight transport: ……………………………………… $ thousands

* Please give your best estimate of the average performance for all carriers that carry the kind of shipment you have in mind. *This need not necessarily be the performance that you actually receive from your particular carrier*. Your responses will be averaged with those of other respondents.

Figure 1B.1 — Preliminary survey questionnaire

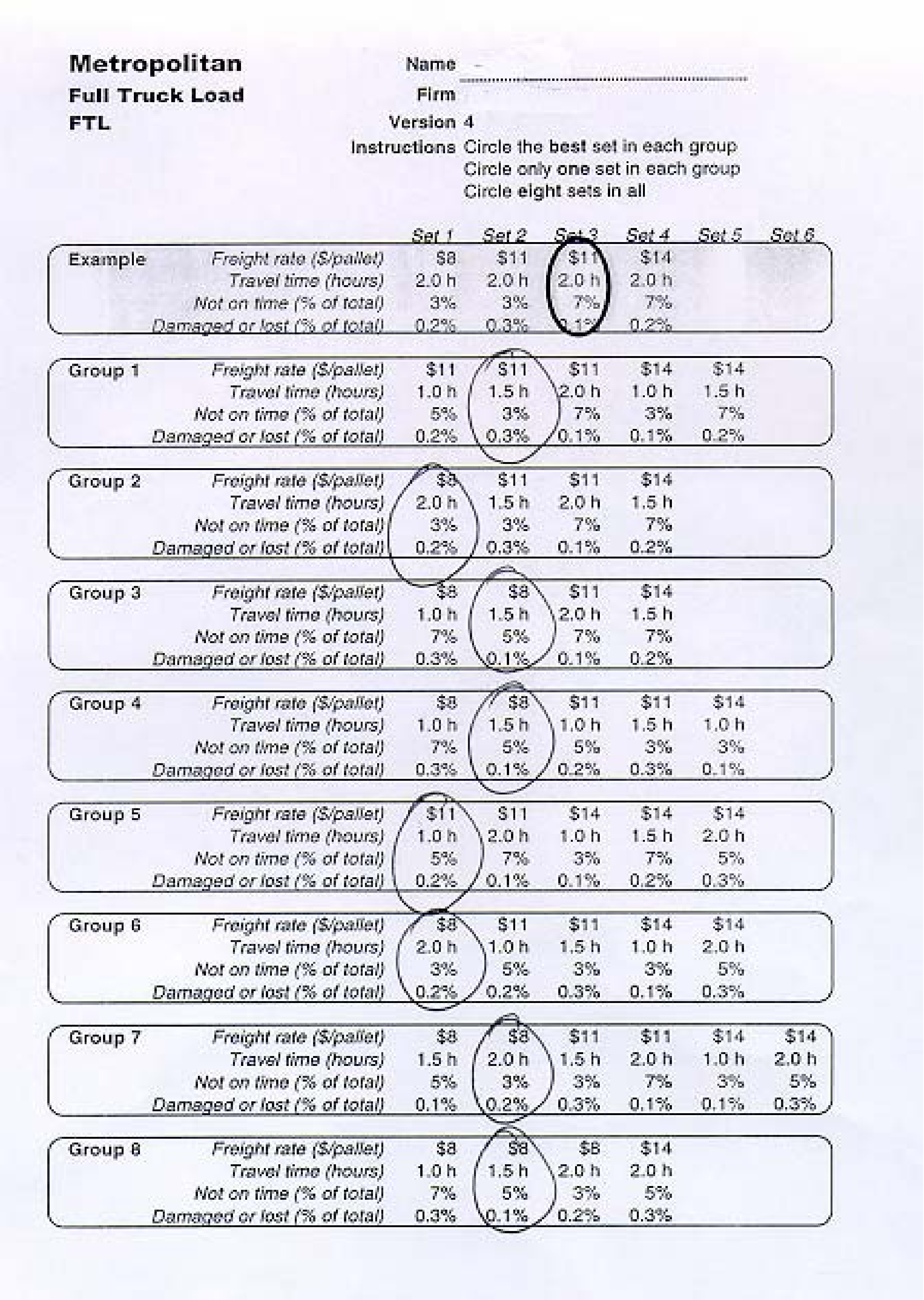


Intercapital
Full Truck Load
FTL

Name ....
Firm
Version 3
Instructions Circle the best set in each group
Circle only one set in each group
Circle eight sets in all

		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
Example	Freight rate ($/pallet)	$50	$50	[✓ $50]	$60	$60	
	Travel time (hours)	12 h	14 h	[✓ 16 h]	12 h	14 h	
	Not on time (% of total)	5.0%	3.0%	[✓ 7.0%]	3.0%	7.0%	
	Damaged or lost (% of total)	0.3%	0.5%	[✓ 0.1%]	0.1%	0.3%	
Group 1	Freight rate ($/pallet)	[✓ $40]	$50	$60			
	Travel time (hours)	[✓ 16 h]	12 h	12 h			
	Not on time (% of total)	[✓ 3%]	5%	3%			
	Damaged or lost (% of total)	[✓ 0.3%]	0.3%	0.1%			
Group 2	Freight rate ($/pallet)	$40	[✓ $50]	$60			
	Travel time (hours)	12 h	[✓ 12 h]	14 h			
	Not on time (% of total)	7%	[✓ 5%]	7%			
	Damaged or lost (% of total)	0.5%	[✓ 0.3%]	0.3%			
Group 3	Freight rate ($/pallet)	$40	[✓ $40]	$50	$50	$50	
	Travel time (hours)	12 h	[✓ 16 h]	12 h	14 h	16 h	
	Not on time (% of total)	7%	[✓ 3%]	5%	3%	7%	
	Damaged or lost (% of total)	0.5%	[✓ 0.3%]	0.3%	0.5%	0.1%	
Group 4	Freight rate ($/pallet)	[✓ $40]	$50	$50	$60	$60	
	Travel time (hours)	[✓ 16 h]	12 h	14 h	12 h	16 h	
	Not on time (% of total)	[✓ 3%]	5%	3%	3%	5%	
	Damaged or lost (% of total)	[✓ 0.3%]	0.3%	0.5%	0.1%	0.5%	
Group 5	Freight rate ($/pallet)	$40	[✓ $60]	$60	$60		
	Travel time (hours)	14 h	[✓ 12 h]	14 h	16 h		
	Not on time (% of total)	5%	[✓ 3%]	7%	5%		
	Damaged or lost (% of total)	0.1%	[✓ 0.1%]	0.3%	0.5%		
Group 6	Freight rate ($/pallet)	$40	$50	[✓ $50]	$50	$60	
	Travel time (hours)	14 h	12 h	[✓ 14 h]	16 h	16 h	
	Not on time (% of total)	5%	5%	[✓ 3%]	7%	5%	
	Damaged or lost (% of total)	0.1%	0.3%	[✓ 0.5%]	0.1%	0.5%	
Group 7	Freight rate ($/pallet)	$40	$50	[✓ $50]	$60	$60	
	Travel time (hours)	12 h	12 h	[✓ 14 h]	14 h	16 h	
	Not on time (% of total)	7%	5%	[✓ 3%]	7%	5%	
	Damaged or lost (% of total)	0.5%	0.3%	[✓ 0.5%]	0.3%	0.5%	
Group 8	Freight rate ($/pallet)	$40	[✓ $40]	$50	$60	$60	$60
	Travel time (hours)	12 h	[✓ 16 h]	14 h	12 h	14 h	16 h
	Not on time (% of total)	7%	[✓ 3%]	3%	3%	7%	5%
	Damaged or lost (% of total)	0.5%	[✓ 0.3%]	0.5%	0.1%	0.3%	0.5%

Figure 1B.2 — Survey form for Inter-capital Full Truck Load (IFTL)

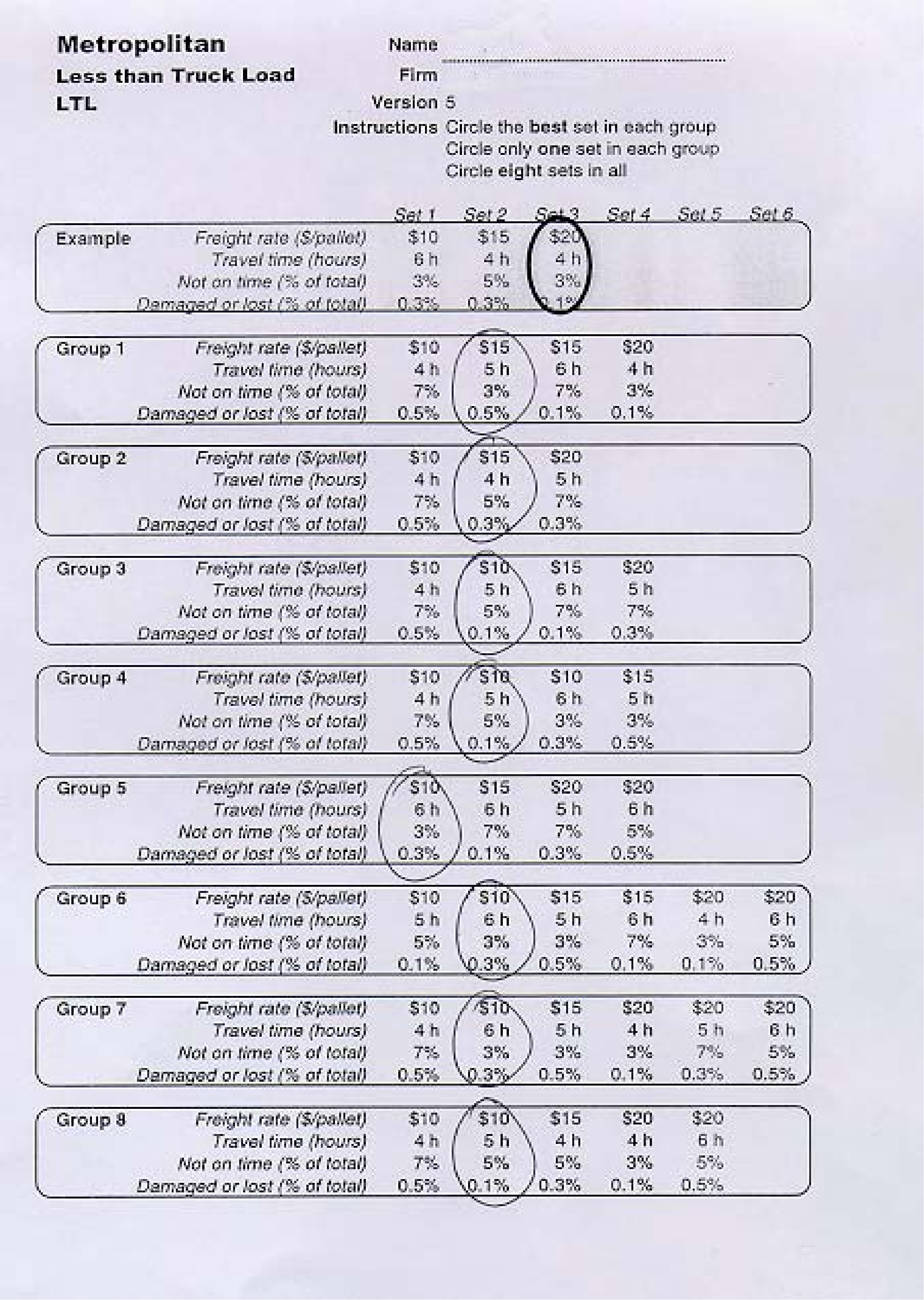


Metropolitan
Full Truck Load
FTL

Name -
Firm
Version 4
Instructions Circle the best set in each group
Circle only one set in each group
Circle eight sets in all

		Set 1	*Set 2*	*Set 3*	*Set 4*	*Set 5*	*Set 6*
Example	*Freight rate ($/pallet)*	$8	$11	[✓ $11]	$14		
	Travel time (hours)	2.0 h	2.0 h	[✓ 2.0 h]	2.0 h		
	Not on time (% of total)	3%	3%	[✓ 7%]	7%		
	Damaged or lost (% of total)	0.2%	0.3%	[✓ 0.1%]	0.2%		
Group 1	*Freight rate ($/pallet)*	$11	[✓ $11]	$11	$14	$14	
	Travel time (hours)	1.0 h	[✓ 1.5 h]	2.0 h	1.0 h	1.5 h	
	Not on time (% of total)	5%	[✓ 3%]	7%	3%	7%	
	Damaged or lost (% of total)	0.2%	[✓ 0.3%]	0.1%	0.1%	0.2%	
Group 2	*Freight rate ($/pallet)*	[✓ $8]	$11	$11	$14		
	Travel time (hours)	[✓ 2.0 h]	1.5 h	2.0 h	1.5 h		
	Not on time (% of total)	[✓ 3%]	3%	7%	7%		
	Damaged or lost (% of total)	[✓ 0.2%]	0.3%	0.1%	0.2%		
Group 3	*Freight rate ($/pallet)*	$8	[✓ $8]	$11	$14		
	Travel time (hours)	1.0 h	[✓ 1.5 h]	2.0 h	1.5 h		
	Not on time (% of total)	7%	[✓ 5%]	7%	7%		
	Damaged or lost (% of total)	0.3%	[✓ 0.1%]	0.1%	0.2%		
Group 4	*Freight rate ($/pallet)*	$8	[✓ $8]	$11	$11	$14	
	Travel time (hours)	1.0 h	[✓ 1.5 h]	1.0 h	1.5 h	1.0 h	
	Not on time (% of total)	7%	[✓ 5%]	5%	3%	3%	
	Damaged or lost (% of total)	0.3%	[✓ 0.1%]	0.2%	0.3%	0.1%	
Group 5	*Freight rate ($/pallet)*	[✓ $11]	$11	$14	$14	$14	
	Travel time (hours)	[✓ 1.0 h]	2.0 h	1.0 h	1.5 h	2.0 h	
	Not on time (% of total)	[✓ 5%]	7%	3%	7%	5%	
	Damaged or lost (% of total)	[✓ 0.2%]	0.1%	0.1%	0.2%	0.3%	
Group 6	*Freight rate ($/pallet)*	[✓ $8]	$11	$11	$14	$14	
	Travel time (hours)	[✓ 2.0 h]	1.0 h	1.5 h	1.0 h	2.0 h	
	Not on time (% of total)	[✓ 3%]	5%	3%	3%	5%	
	Damaged or lost (% of total)	[✓ 0.2%]	0.2%	0.3%	0.1%	0.3%	
Group 7	*Freight rate ($/pallet)*	$8	[✓ $8]	$11	$11	$14	$14
	Travel time (hours)	1.5 h	[✓ 2.0 h]	1.5 h	2.0 h	1.0 h	2.0 h
	Not on time (% of total)	5%	[✓ 3%]	3%	7%	3%	5%
	Damaged or lost (% of total)	0.1%	[✓ 0.2%]	0.3%	0.1%	0.1%	0.3%
Group 8	*Freight rate ($/pallet)*	$8	[✓ $8]	$8	$14		
	Travel time (hours)	1.0 h	[✓ 1.5 h]	2.0 h	2.0 h		
	Not on time (% of total)	7%	[✓ 5%]	3%	5%		
	Damaged or lost (% of total)	0.3%	[✓ 0.1%]	0.2%	0.3%		

Figure 1B.3 — Survey form for Metropolitan Full Truck Load (MFTL)



Metropolitan
Less than Truck Load
LTL

Name ....
Firm
Version 5
Instructions Circle the **best** set in each group
Circle only **one** set in each group
Circle **eight** sets in all

		Set 1	*Set 2*	*Set 3*	*Set 4*	*Set 5*	*Set 6*
Example	*Freight rate ($/pallet)*	$10	$15	[✓ $20]			
	Travel time (hours)	6 h	4 h	[✓ 4 h]			
	Not on time (% of total)	3%	5%	[✓ 3%]			
	Damaged or lost (% of total)	0.3%	0.3%	[✓ 0.1%]			
Group 1	*Freight rate ($/pallet)*	$10	[✓ $15]	$15	$20		
	Travel time (hours)	4 h	[✓ 5 h]	6 h	4 h		
	Not on time (% of total)	7%	[✓ 3%]	7%	3%		
	Damaged or lost (% of total)	0.5%	[✓ 0.5%]	0.1%	0.1%		
Group 2	*Freight rate ($/pallet)*	$10	[✓ $15]	$20			
	Travel time (hours)	4 h	[✓ 4 h]	5 h			
	Not on time (% of total)	7%	[✓ 5%]	7%			
	Damaged or lost (% of total)	0.5%	[✓ 0.3%]	0.3%			
Group 3	*Freight rate ($/pallet)*	$10	[✓ $10]	$15	$20		
	Travel time (hours)	4 h	[✓ 5 h]	6 h	5 h		
	Not on time (% of total)	7%	[✓ 5%]	7%	7%		
	Damaged or lost (% of total)	0.5%	[✓ 0.1%]	0.1%	0.3%		
Group 4	*Freight rate ($/pallet)*	$10	[✓ $10]	$10	$15		
	Travel time (hours)	4 h	[✓ 5 h]	6 h	5 h		
	Not on time (% of total)	7%	[✓ 5%]	3%	3%		
	Damaged or lost (% of total)	0.5%	[✓ 0.1%]	0.3%	0.5%		
Group 5	*Freight rate ($/pallet)*	[✓ $10]	$15	$20	$20		
	Travel time (hours)	[✓ 6 h]	6 h	5 h	6 h		
	Not on time (% of total)	[✓ 3%]	7%	7%	5%		
	Damaged or lost (% of total)	[✓ 0.3%]	0.1%	0.3%	0.5%		
Group 6	*Freight rate ($/pallet)*	$10	[✓ $10]	$15	$15	$20	$20
	Travel time (hours)	5 h	[✓ 6 h]	5 h	6 h	4 h	6 h
	Not on time (% of total)	5%	[✓ 3%]	3%	7%	3%	5%
	Damaged or lost (% of total)	0.1%	[✓ 0.3%]	0.5%	0.1%	0.1%	0.5%
Group 7	*Freight rate ($/pallet)*	$10	[✓ $10]	$15	$20	$20	$20
	Travel time (hours)	4 h	[✓ 6 h]	5 h	4 h	5 h	6 h
	Not on time (% of total)	7%	[✓ 3%]	3%	3%	7%	5%
	Damaged or lost (% of total)	0.5%	[✓ 0.3%]	0.5%	0.1%	0.3%	0.5%
Group 8	*Freight rate ($/pallet)*	$10	[✓ $10]	$15	$20	$20	
	Travel time (hours)	4 h	[✓ 5 h]	4 h	4 h	6 h	
	Not on time (% of total)	7%	[✓ 5%]	5%	3%	5%	
	Damaged or lost (% of total)	0.5%	[✓ 0.1%]	0.3%	0.1%	0.5%	

Figure 1B.4 — Survey form for Metropolitan Less than Full Truck Load (MLTL)

STAGE 2 REPORT

- ARRB TR Ref: RC01174, *Valuing travel time savings for freight (Stage 2)*, by FDF Pty Ltd (N Rockliffe) and Oxford Systematics (M Wigan), in conjunction with ARRB Transport Research Ltd (D Tsolakis)
- Austroads Ref: Project BS.E.N.536 (formerly N.BS.9806)

2.1. SUMMARY

2.1.1 The Stage 2 survey

The report is a contribution to Austroads' initiative to improve the methodology for economic evaluation of road transport infrastructure projects.

The work described is a sequel to FDF's report of 1998 to ARRB TR for Austroads Project N.B.S.9702, Valuing Travel Time Savings for Freight, which is reported as "Stage 1" in this document.

One hundred and seven interviewees produced nearly 320 survey responses which valued performance attributes of:

- travel time;
- on-time delivery; and
- loss or damage,

in the context of a freight rate for:

- inter-capital full truck load (IFTL);
- metropolitan full truck load (MFTL); and
- metropolitan less than full truck load (MLFTL or md) services.

2.1.2 Results of analyses

Three specified types of freight services models have been run using LIMDEP on the edited available data in both linear and quadratic forms. The Adjusted R^2 values are good (all are ~0.5). The larger survey of the Stage 2 research has produced significantly more robust estimates of most parameters than were realised in Stage 1.

The Stage 2 survey addressed firms strongly represented in the Australian automotive components industry. They encompass ranges of enterprise types (public companies, private companies and differing scales of operations etc), use of transport modes and logistics services, tasks and value densities of freight.

Trip time was not found to be a significant factor for some freight trip categories.

This was possibly because performance of the freight task within an explicit trip time was taken as a 'given'.

Meeting delivery acceptance windows is frequently a prescribed condition of a transport services Agreement. In a monopsony market such as the automotive components industry sector, which has highly developed just-in-time (JIT) manufacturing practices, on-time delivery might cease to be a variable to be traded off against other service attributes.

The value of FTL freight delays per pallet per hour on inter-capital routes, within the delivery acceptance windows, where the attribute could be traded-off, was found to be $1.50 with a 40% standard error.

The value of FTL freight delays per pallet per hour on intra-city routes was estimated to be $0.8 with an 85% standard error. This implies it was not significantly different from zero. Such shipments are probably the most constrained in terms of options for configuring the transport to meet specified delivery windows.

For metropolitan Less than Full Truck Load services, the value of freight delays per pallet per hour was found to be $2.22 with a 15% standard error.

2.2. BACKGROUND AND OBJECTIVES

Expenditures on roads are often decided on the basis of benefit cost analysis (BCA), where benefits comprise road user cost savings and crash reductions and costs comprise road authority costs. Methods currently in use under value the benefits of improvements which affect road freight movements.

BCA estimation of road freight benefits from road improvements currently generally include computed values of reduced vehicle operating costs (fixed and variable), and reduced drivers' costs per trip or kilometre.

No benefit associated with getting the freight to its destination faster or more reliably is usually computed.

In contrast, benefits to the "contents" of cars and buses, that is passengers, are computed as savings in travel time.

Implications of the current process include:

- governments may be under-investing in roads on the basis of benefits generated; and
- economic evaluations are biased in favour of passenger vehicles.

In this context, it is relevant to establish estimates of values of freight delay for use in economic evaluation of roads projects.

Against this background, FDF reported in July 1998 with ARRB TR on Austroads Project N.BS.9702, Valuing Travel Time Savings for Freight. That report is included as "Stage 1" in this document.

The project both demonstrated the feasibility of using the Contextual Stated Preference (SP) survey method, and derived estimates of the value to shippers of the:

- time value of freight in transit;
- value of reliability of time of delivery of freight; and
- value of no damage to freight on receipt.

The results reflected interviews with 43 respondents, each of whom completed survey forms addressing the three attributes referred to above. This yielded 129 completed responses.

The objective of this related subsequent phase study (Stage 2) is to extend the data set derived in Stage 1. Its focus was determined to be on metropolitan line-haul and multi-drop freight tasks for firms in strongly represented economic sectors.

The Stage 2 study engaged the following discrete work steps:

- consultant contract establishment;
- questionnaire finalisation;
- selection of survey sample;
- conduct of survey;
- formatting and cleaning of survey data and analysis of survey results; and
- reporting.

Figure 2.1 provides detail of these stages and their inter-relationships.

Essentially the questionnaires for the stated preference surveys were to replicate those used for the Stage 1 project. Differences were expected to include the values ascribed to the parameters in each freight services Group and Set for the three freight tasks considered.

It was the intent to emphasise the higher value added manufactures segment of the freight related transport services' sector. These segments include "express distribution" and "logistics" which exhibit high task growth rates and correlate with high value density products. Metropolitan line-haul and multi-drop transport tasks for manufactures such as electronic equipment and components; motor vehicle components; pharmaceuticals and biotechnology products; beverages (juices, wine and beer); wholesale groceries; and fashion goods were all deemed to be candidates for survey.

Recent work for Austroads (Fuller and Tsolakis 2001) on targeting road infrastructure investment also guided the sample.

Notwithstanding the objectives for the sample and preferred particular enterprises, it was recognised that what we actually realised would be contingent upon the availability and interest of prospective interviewees. It was also understood that productive research of this type of sector was most likely to arise from contact with well informed interviewees who were keen to understand the origins and purpose of the research program, and the potential contribution to improved performance of their shipping and transport and logistics operations albeit over the longer term.

Survey activities ranged across skirmish interviews to establish median data values to be embodied in the questionnaires, and the conduct of those to collect the data for analysis.

Data from the interviews was established in electronic format and imported into the econometric package LIMDEP, which is used to perform the statistical analysis (see Part 1 of this document). LIMDEP is, for different models, then applied to realise values (monetary) for the freight services attributes examined.

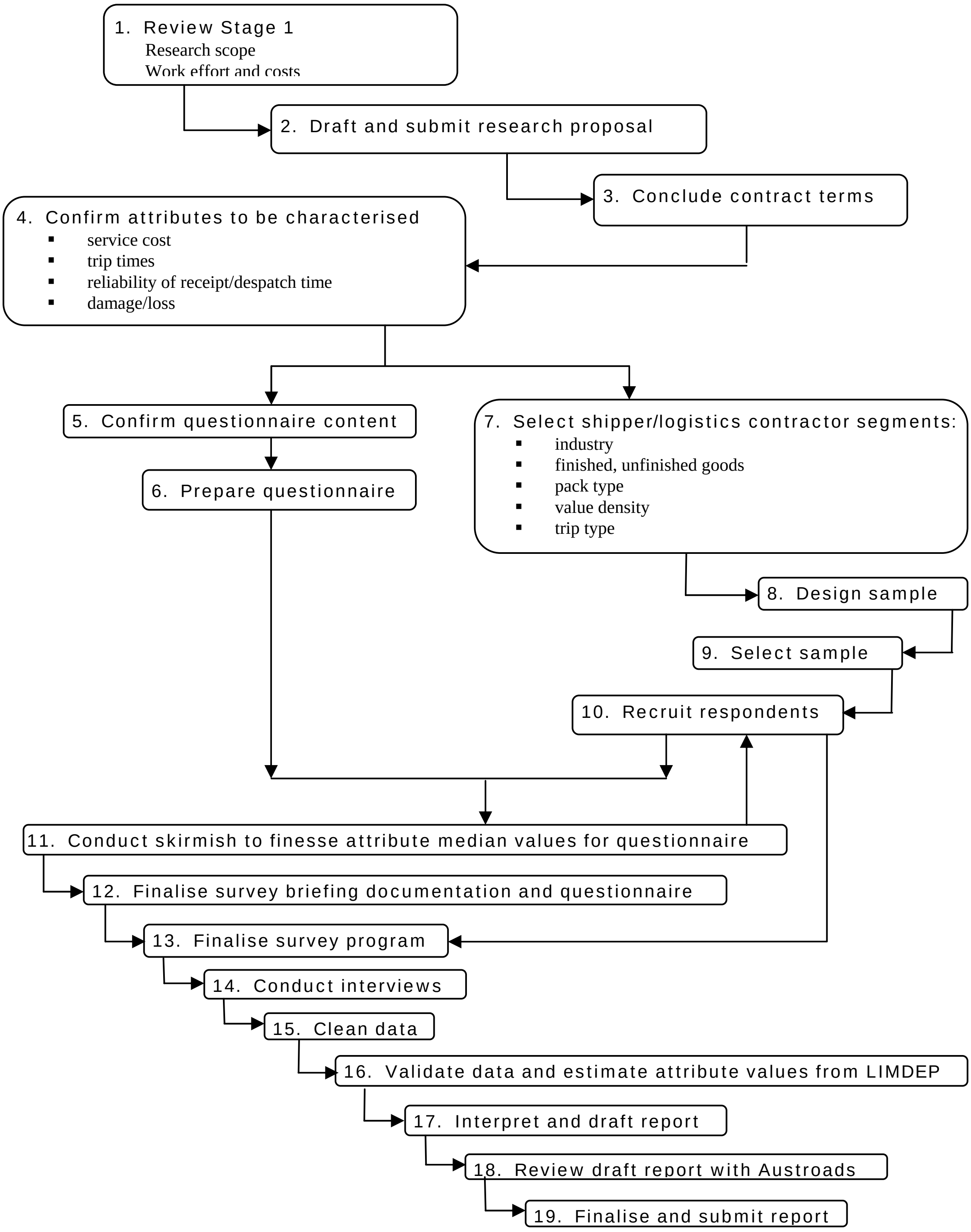


Figure 2.1 — FDF study approach - Valuing travel time savings for freight

2.3. FREIGHT AND LOGISTICS CONTEXT

The purpose of this Chapter is to provide readers with some context of the:

- importance of the freight and logistics sector to the nation's economy;
- relationship between logistics services performance and the scope, capacity and quality of the transport infrastructure; and
- diverse range in the logistics task confronted by different firms. This is reflected in terms of the scale, distances, delivery and receival constraints, pack types and perishability or susceptibility to damage of the freight. Each of these characteristics might reasonably influence the responses to and the results of, the research reported here.

The information is presented as a thought-starting-compendium and not as a treatise, which can be found elsewhere on logistics issues facing a shipper, which might affect the shippers relative valuation of trip time, on-time, and damage performance, realised by the logistics contractor.

2.3.1 The economic context

Logistics costs have been estimated by the OECD to range between 11 and 16% of world GDP.

Australia's GDP in 1997-98 was about A$560 billion. At the OECD rates, logistics costs Australia-wide are therefore likely to be in the range A$62 billion to A$90 billion per annum.

These sums provide a perspective on the benefits which might be available to the Australian economy through road system investment which advances efficiency – allocative and technical, in the logistics sector. For example, if a once off reduction of only 1% in national logistics costs was realised, the gain for the Australian economy would be in the range of A$620 million to A$900 million per annum. If it were to be sustained at this level it would represent, in present value terms, about A$6 billion to A$9 billion (assuming even a high real discount rate of 10%). Benefits of this magnitude which were attributable to transport system improvements, would clearly underwrite major transport system capital programs.

The prospect of realising economic gains of this magnitude clearly merits consideration of the means of promoting and capturing them. One small step in this process is to ensure that the methods, used to estimate the economic performance of transport system developments, do so reliably.

The purpose of this study is to provide improved information for evaluating proposals to invest in transport infrastructure.

In particular, the interests are to establish values of the benefit of reductions in the delivery time for freight, or its delivery within a more reliable timeframe, or with less damage. In this context the OECD's North American TRILOG Taskforce report of 21 June 1998 (page 17) asserts:

> *"The inefficiency of transport infrastructure and service can be considered a barrier to trade. …….. Industry views transportation and logistics expenditures as a transaction cost for business, that must be reduced to enhance corporate competitiveness in the global market place."*

and

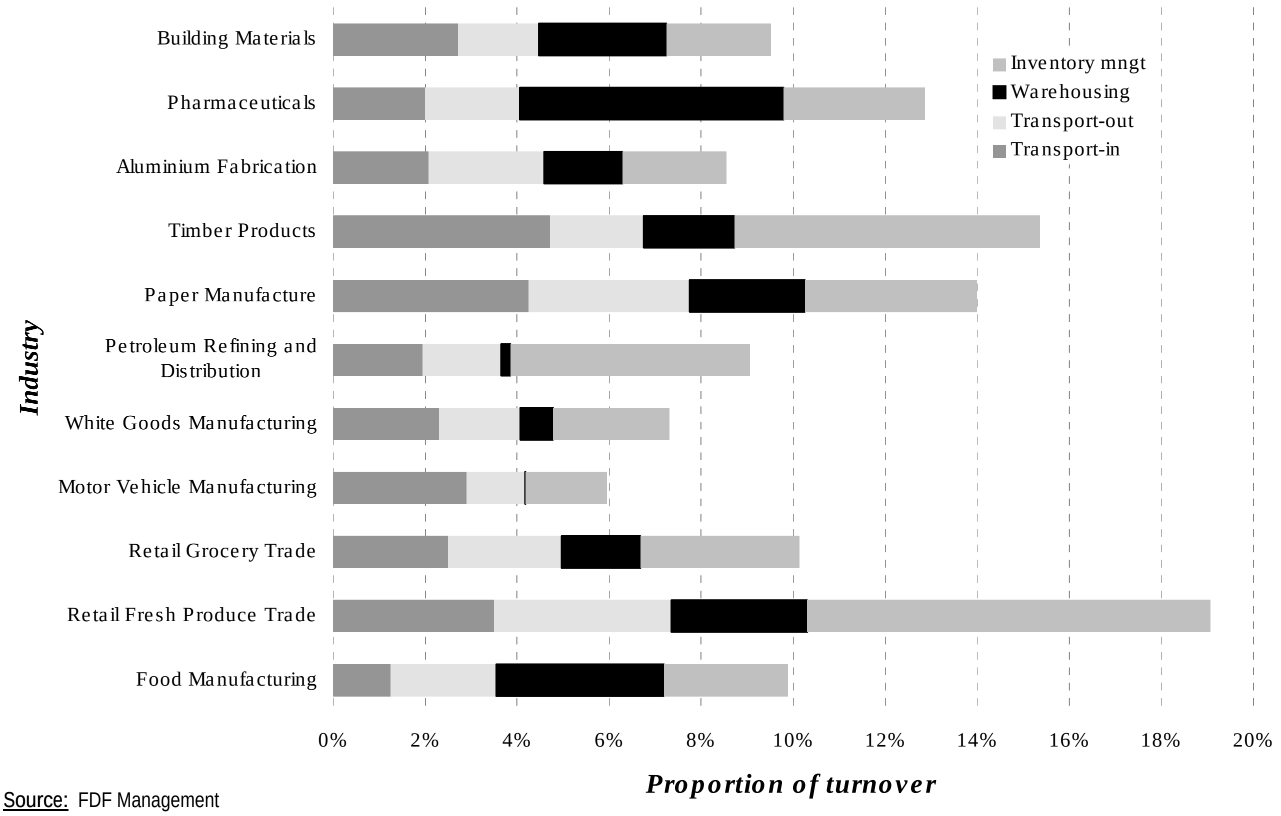
> *"The reliability of delivery schedules permits companies to reduce substantial inventory carrying costs. The ratio of manufacturing and trade inventory-to-sales has been reduced substantially over the years as transportation facilities become more ubiquitous and as electronic communications technology facilitates the exchange of information among shippers and carriers, thus increasing the flow of deliveries. Since 1991 the ratio has reduced from 1.58 to 1.35 (a reduction of 15%), with a consequent reduction in overall logistics costs."*

Relatedly, Liv-Ellen Kaldager (Kaldager and Kearney 1994) in (Logistics Excellence in Europe, a study report, prepared by A.T. Kearney on behalf of the European Logistics Association) has presented a view of the changes in the costs, service quality and productivity of logistics services since 1982. Observations included substantial service improvements (on-time delivery, order completeness, invoice accuracy, damage-free delivery), as shown in Table 2.1.

Table 2.1 — European logistics service performance changes

Service measure (average failure performance, %)	Year 1987	Year 1992
On-time delivery	15%	11%
Order completeness	14%	10%
Invoice accuracy	7.5%	5%
Damage-free delivery	5%	5%

Figure 2.2 presents an indication of the significance of freight transport costs for a range of Australian industry sectors, within a broader statement of the overall logistics costs for the sectors.



Source: FDF Management

Figure 2.2 — Logistics cost profiles for Australian industry

Freight movements conducted by an enterprise in Australia can include one, several, or all of the following, in combination:

- *trans-national or international* – by sea or air modes;
- *inter-capital* – by road, rail, sea or air modes;

- *up-country from a capital city to a rural region, or down-country from a rural region to a capital city* – by road, and or in some instances, by rail, air or coastal shipping;
- *inter-regional* – between origin and destination modes in non-capital city regions; generally by road, but possibly by rail, air, coastal shipping, or pipeline;
- *intra-regional* – between origin and destination modes within a region outside of a capital city; generally by road, but also possibly by rail, pipeline, conveyor or even barge; and
- *intra-capital* – between origin and destination modes within a capital city; predominantly by road, but also possibly by rail and pipeline.

These transport tasks will also have many different configurations in terms of directness or indirectness – of chain distribution, pick-up and delivery (multi-drop) and similar.

Table 2.2 indicates the relative significance of these categories of freight movement on the basis of tonnes uplifted, while Table 2.3 reveals how relationship changes once the distance the freight moves is also recognised.

Table 2.2 — Australian road freight uplifted (megatonnes)

Freight category	Commodity group			Totals	
	Agricultural products	Manufactures	Mineral products	Megatonnes	Per cent
Inter-capital	1	12	0	13	1
Intra-capital	25	94	506	626	58
Inter-regional	9	2	7	18	2
Intra-regional	74	30	258	363	34
Down-country	17	9	2	28	3
Up-country	4	17	6	27	2
Total	129	165	779	1,074	100
% of total uplifted	12%	15%	73%	100%	

Source: FDF FreightInfo™ 1995-96
Note: The bottom row shows the percentages by commodity group.

Table 2.3 — Australian road freight task (billion tkm)

Freight category	Commodity group			Totals	
	Agricultural products	Manufactures	Mineral products	Billion tkm	Per cent
Inter-capital	0.8	12.8	0.0	13.6	15
Intra-capital	1.1	3.9	19.7	24.7	27
Inter-regional	2.7	0.6	1.8	5.1	6
Intra-regional	5.9	2.4	20.7	29.0	32
Down-country	5.8	3.6	0.5	9.9	11
Up-country	1.9	6.5	1.2	9.7	11
Total	18.3	29.8	44.0	92.0	100
% of total freight task	20%	32%	48%	100%	

Source: FDF FreightInfo™ 1995-96
Note: The bottom row shows the percentages by commodity group.

2.3.2 Scope of logistics costs and influence of transport infrastructure

Figure 2.3 indicates the activities and costs components which contribute to total logistics costs. On-road costs – those of the shipper's embedded costs of transport-in – ie, of goods received, processed and transformed; and of transport-out – ie, of the shipper's product, are the most obviously related to road infrastructure. These are clearly subject to the distance the goods are moved (route length) and time to transact that route – given the safe freight vehicle operating speed attenuated by congestion arising from the contest for use of limited road space.

Less evident effects, among others, include that:

- unreliable shipment delivery times require a customer to increase inventory as a contingency to avoid running out of stock. The unreliability of the receival time can be a manifestation of congested infrastructure (as well as of many other contributing factors); and
- damage, loss, and degradation can all be affected by the quality of the road infrastructure – of pavement ride quality and of the system safety, reflecting crashes of freight vehicles and effects to the freight.

Figure 2.4 illustrates how the array of considerations which affect a shipper's or customer's total shipment costs, coalesce to determine the freight transport configuration. Road infrastructure's capability has an inescapable influence.

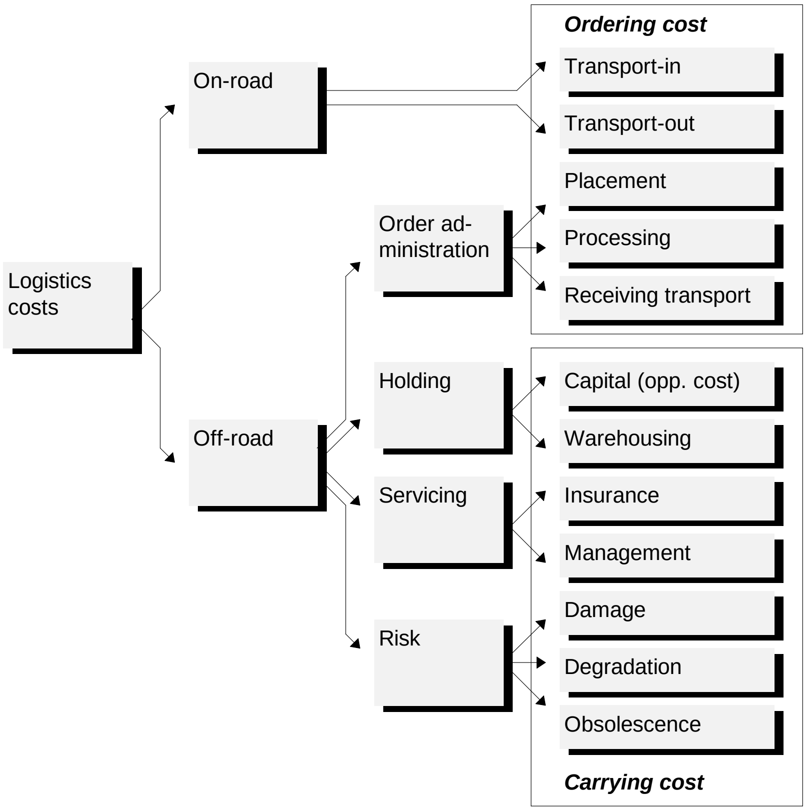


Figure 2.3
Scope and classification of logistics costs

Source: FDF FreightInfo™ 1995-96

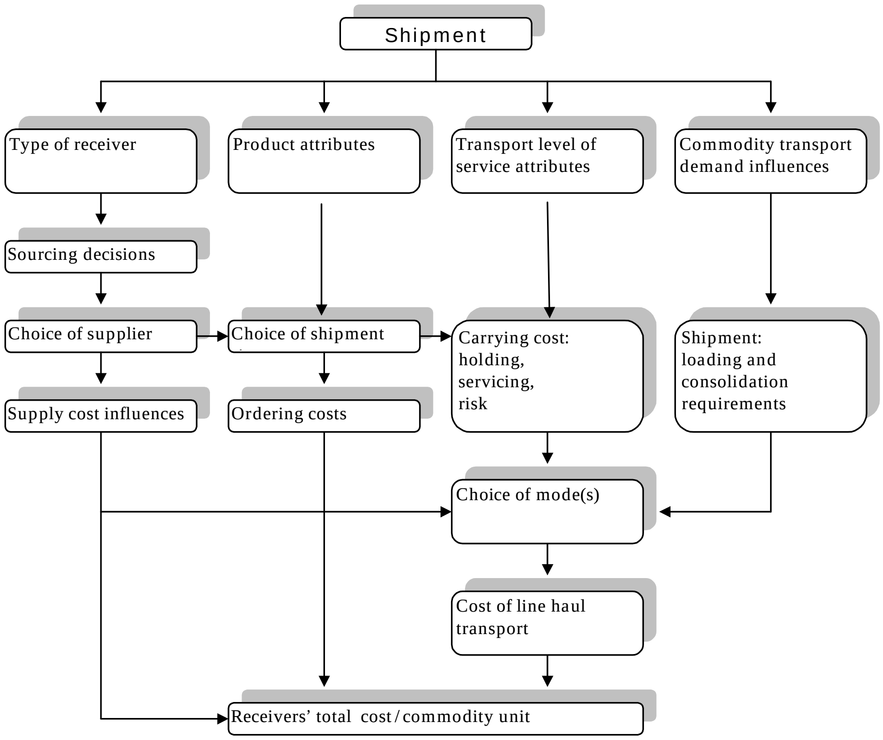


Figure 2.4
Factors influencing mode choice and logistics costs

2.3.3 Range of complexity in the logistics task

It is self evident that there is wide variability in the scope and complexity of logistics tasks performed by enterprises – within and across economic sectors. Together with that variation in complexity, from the viewpoint of influence on the outcome of the research work here at issue, is also the transparency of the freight transport performance data necessary to inform a questionnaire response.

Figures 2.5 and 2.6 provide examples of the scope of transport operations embedded in two very different firms, both engaged in producing and shipping elaborately transformed manufactures (Fuller and Tsolakis 2001).

Finally, Figure 2.7 serves to illustrate some of the different transport configurations applied to shipments and which are likely to influence, or be influenced by, the value shippers ascribe to trip time, delivery reliability, and damage or loss.

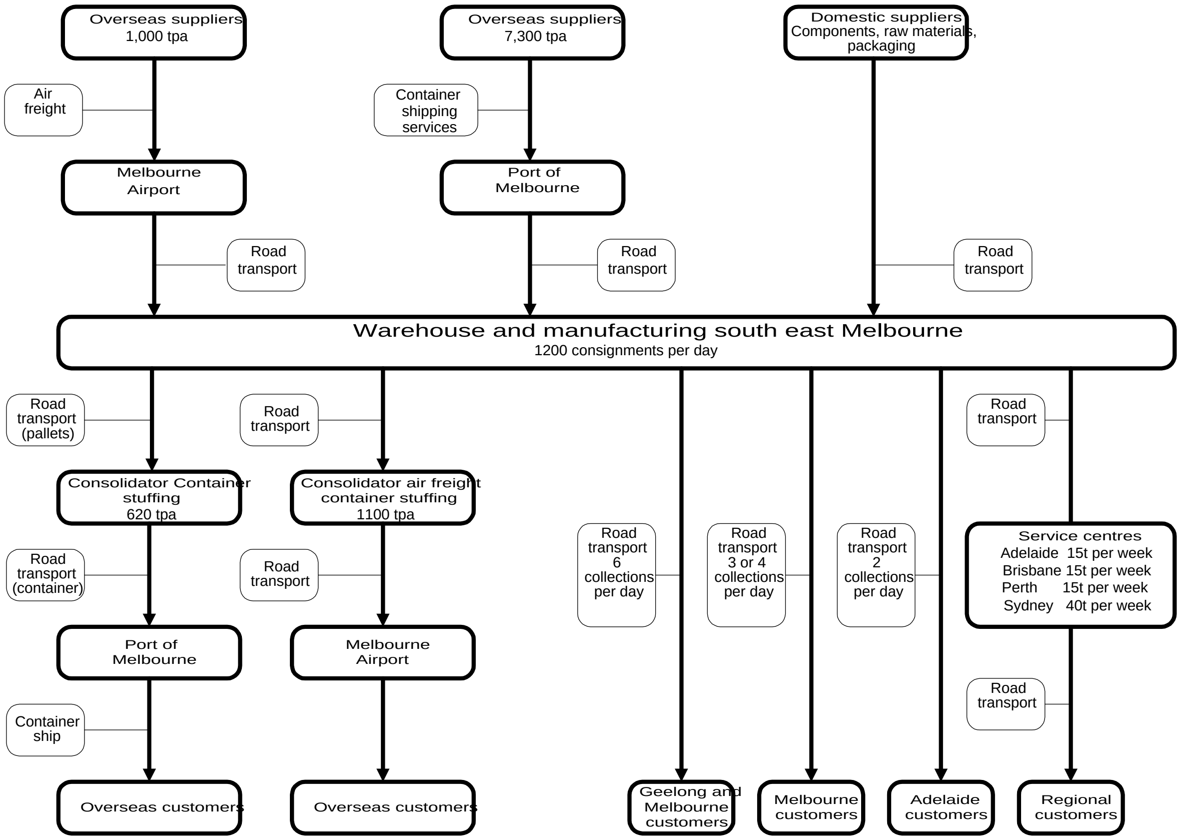


Figure 2.5 — Materials flow and freight task: Electro mechanical products manufacturer

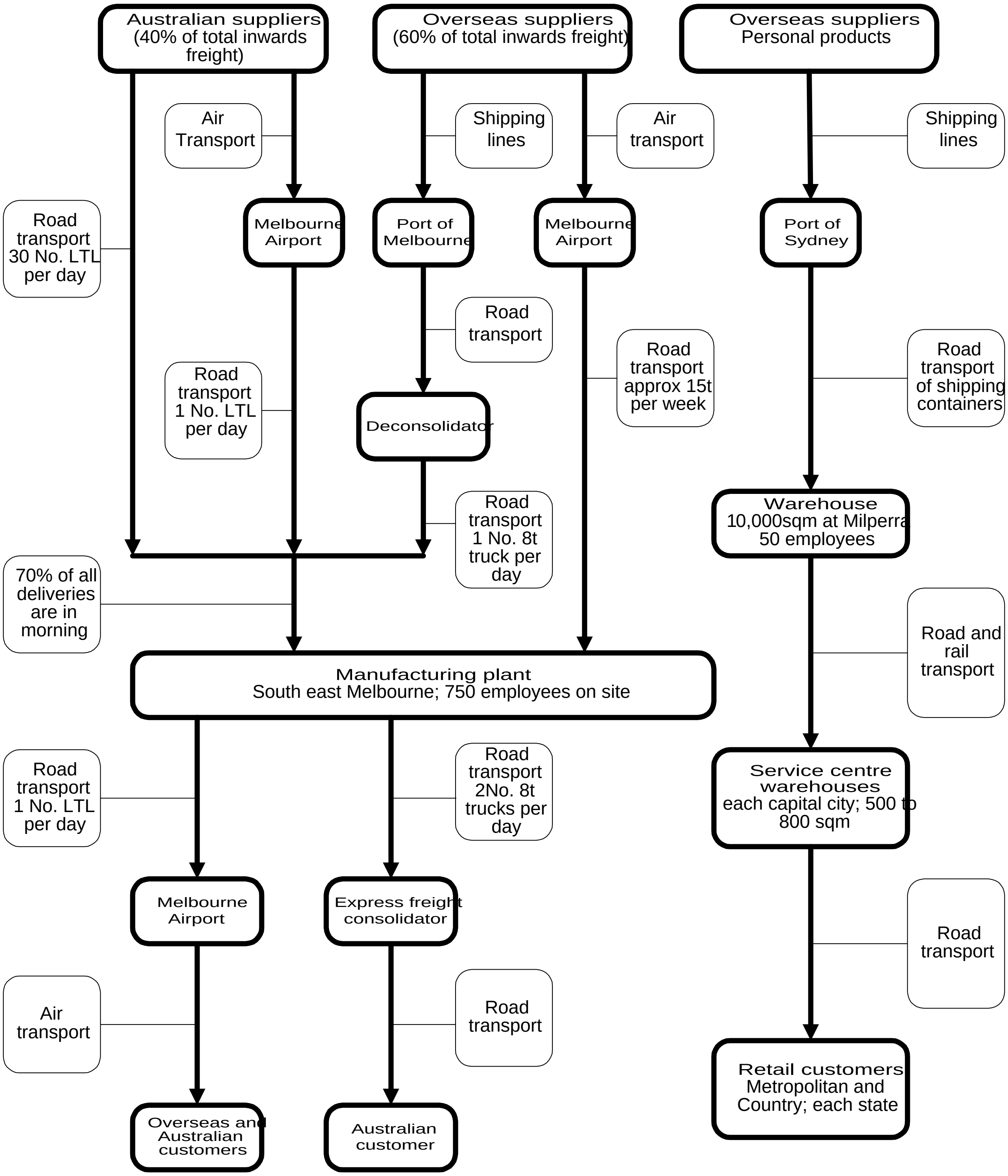


Figure 2.6 — Materials flow and freight task: Electronics manufacturer

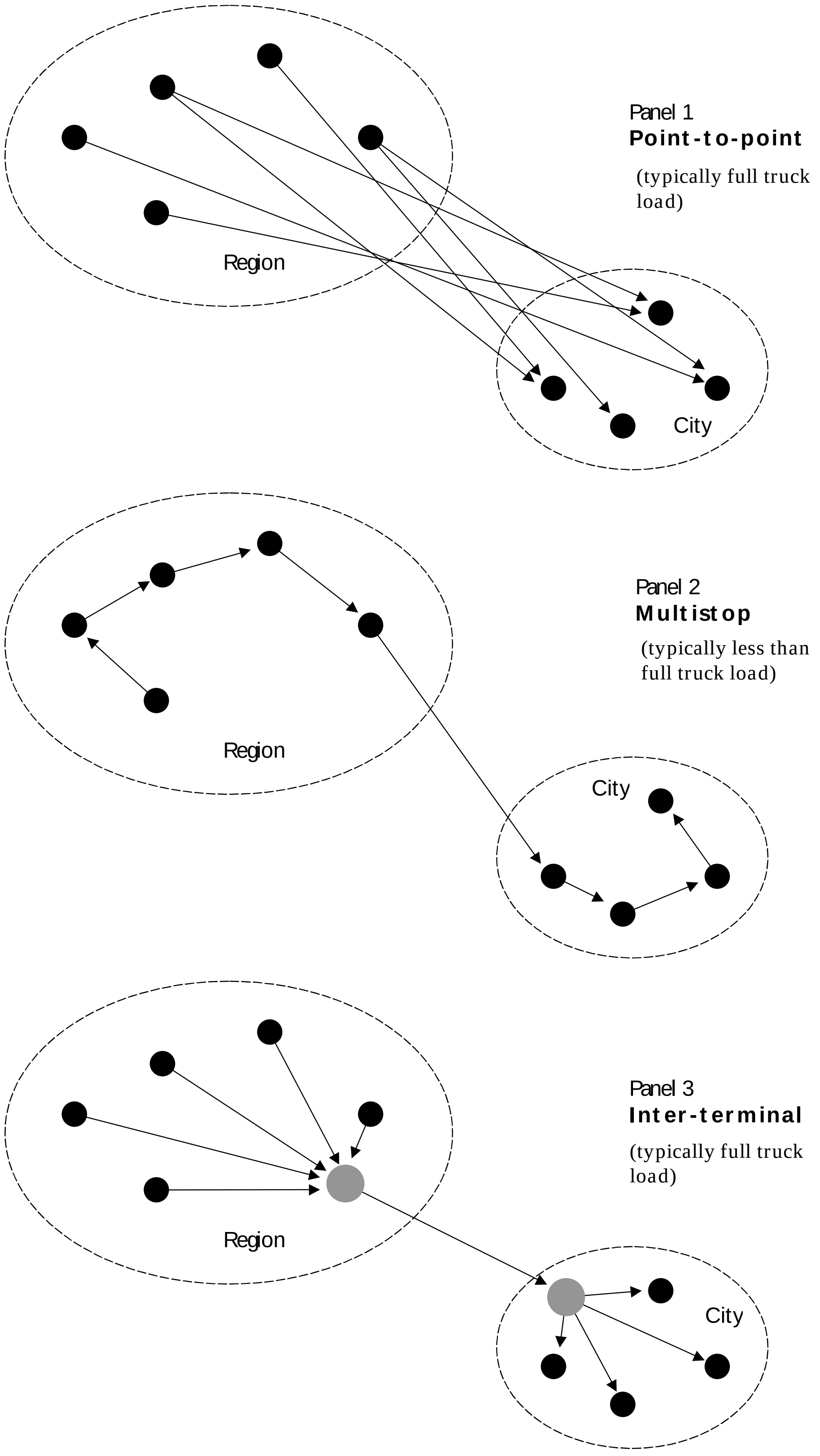


Figure 2.7 — Transport options for outbound Freight

2.4. THE STAGE 2 SURVEY

In this Chapter we address:

- establishing the survey sample;
- defining the freight product attributes and their range of values to be embedded in the surveys; and
- other matters of the performance of the survey, including of its cost, and observations of interviewees.

2.4.1 The Stage 2 survey sample[3]

We embarked on the research with a view that it should reveal information about an economic sector which might become more rather than less important as a contributor to national wealth.

At least, we thought, in this way the results might be applied to influencing policy and infrastructure investment towards abetting improvement of the sector's performance rather than diminishing it.

Attributes deemed relevant in this context include:

- contribution to total GDP;
- engagement in international trade;
- value added;
- scope and quotient of technology and knowledge inputs; and
- road transport intensiveness of its logistics task.

Further, we wanted an array of respondents which were statistically meaningful within the sector and who could be conveniently accessed in the course of the survey.

Through an essentially qualitative process which embraced these perspectives, we settled upon candidate enterprises represented within the automotive components manufacturing industry. They were all identified through the industry association directory.

It can be said of the firms in the sector that they exhibited:

- a large range in scale of activity;
- a wide variation in the value – density of products;
- a wide range in product types produced within a firm, and across firms;
- application of many different pack types applied to the product transport;
- differing levels of independence in the freight transport procurement decision;
- greatly different levels of formal systems knowledge and skill applied to the logistics task;
- large differences in the sums expended on freight transport; and
- an array of requirements for full and less than full truck loads for metropolitan and long haul, inter-capital trips.

Firms who were engaged in the course of the research are listed in Table 2.4. They either:

- contributed to the establishment of attribute values for the three freight "products" which were the subject of the formal survey;
- and/or, completed the survey questionnaires;
- or declined to participate.

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[3] The survey design, specification, parameters and conduct approach aspects in this project (Stage 2) were based and closely followed those applied during the Stage 1 (pilot) project. Part 1 of this document contains a more detailed discussion of these aspects (Rockliffe *et al* (1998) and Wigan *et al* (2000)).

Table 2.4 — Industry sector firms consulted

Firm	Location		Firm	Location	
	Suburb	Post code		Suburb	Post code
3M - Automotive Branch	Thomastown	3074	Hook Plastics	North Altona	3025
A N Cook Manu Co PL	East Kew	3102	Howe & Co Pty Ltd	Thomastown	3074
ACL Piston Products	Maidstone	3012	Insulform Pty Ltd	Heidelberg	3081
Air International	Port Melbourne	3207	Johnson Controls Aus Pty ltd	Thomastown	3074
Ajax Fasteners	Braeside	3195	Lasslett Rubber & Plastics PL	Airport West	3042
Akzo Nobel	Sunshine	3020	MacKay Consolidated Industries	Moorabbin	3189
All Head Services Pty Ltd	Braeside	3195	Mark IV Automotive PL	Hallam	3803
APA Industries PL	Kilsyth	3137	Marsden & McGain PL	Reservoir	3073
Asia Pacific Coating	Dandenong	3175	Melba Industries	Preston	3027
Aspect Packaging	Braeside	3195	Melba Industries	Thomastown	3074
Austral Gaskets Pty Ltd	Nth Coburg	3058	Melbourne Auto-Air	Box Hill	3128
Australian Arrow PL	Carrum Downs	3201	Meritor Light Vehicle Systems	Preston	3072
Australian Automotive Air PL	Croydon	3136	Mills Elastomers	Dandenong	3175
Australian Controls	Tullamarine	3043	Mitsubishi Parts Distributors	Campbellfield	3061
Austrim Textiles	Thomastown	3074	MtM Pty Ltd	Sth Oakleigh	3167
Autoliv Australia Pty ltd	Campbellfield	3061	National Forge (Operations) PL	West Footscray	3012
Automotive Components Ltd	Melbourne	3004	Natra	Noble Park	3174
BHP Structural & Pipeline Prod	Sunshine	3020	Norwellan Textiles PL	Pt Melbourne	3207
BOC Gases	Preston	3072	Norwellan Textiles PL	Stawell	3280
Boge Aust. (prev. Holding Rubber)	Dingley	3172	Nylex Polymer Products	Mentone	3194
Bostik (Australia) PL	Thomastown	3074	PBR Automotive Ltd	East Bentleigh	3165
Britax Asia-Pacific Lighting & Elec	Taree	2430	Pilkington (Aus) Ltd Automotive	North Geelong	3215
BTR Automotive Asia Pacific	Melbourne	3004	Plexicor Australia	Campbellfield	3061
BTR Engineering	Cheltenham	3192	PPG Industries Aus PL	Clayton	3168
Burtons	Brunswick	3056	Preslite	Reservoir	3073
Calsonic Australia PL	Pt Melbourne	3207	PTG Industries Aus PL	Clayton	3168
Chep Australia	Clayton	3168	Quenos Pty Ltd	Altona	3018
Composite Materials Engineering	Bayswater	3153	Renold Australia PL	Mulgrave	3170
Consolidated Manufact Ind.	Kensington	3031	RMAX Rigid Cellular Plastics	Footscray	3011
Denso Manufact Aus Pty Ltd	Altona	3018	Robert Bosch (Aus) Pty Ltd	Clayton	3168
Diver Consolidated Industries	Reservoir	3073	Silcraft Pty Ltd	Mt Waverley	3149
Dura Asia Pacific PL	Cheltenham	3192	Socobell OEM Pty Ltd	Spotswood	3015
Engineered Polymer Systems	Bendigo	3550	Surdex Steel - Keysborough	Keysborough	3173
Engineered Polymer Systems	Frankston	3199	Surdex Steel Pty Ltd	Campbellfield	3061
F & T Industries PL	Moorabbin	3189	Suspension Components Aus PL	Nth Melbourne	3051
Finemores Vehicle Transport	Laverton North	3026	Teson Trims	Mitcham	3132
Flexdrive Industries Limited	New Gisborne	3438	Textron Fastening Systems PL	Mulgrave	3170
Flexible Drive Agencies	Kensington	3031	Textron Fastening Systems PL	Rowville	3178
Ford	Campbellfield	3061	TNT Automotive Logistics	Campbellfield	3061
Forgecast Australia PL	Springvale	3171	Toll Logistics - Automotive Div	Somerton	3062
Fuji Fasteners PL	Hallam	3803	Torrington Ingersoll-Rand	Seaford	3198
Fuji Fasteners PL	Sth Dandenong	3175	Transpec	Laverton North	3026
Fujitsu Ten (Aus) PL	Altona Nth	3025	Tubemakers Sheet &Coil-Vic	Dandenong	3175
Gates Australia PL	Sth Dandenong	3175	Unidrive Worldwide-Worldclass	Clayton	3168
Goodyear Tyre & Rubber	Thomastown	3074	VDO Australia Pty Ltd	Heidelberg W	3081
GUD Manufacturing Co PL	Sunshine	3020	Velcro Australia Pty Ltd	Hallam	3803
Hella Australia PL	Mentone	3194	Wilcox Metal Finishing	Dandenong	3175
Holden Rubber	Dingley	3172	Woodbridge Hendersons Aus	Laverton North	3028

2.4.2 Defining attributes of freight product

The contextual stated preference research method required that the characterisation of the choices of freight product presented to interviewees were plausible and realistic for their operating circumstances. We therefore conducted a first round of surveys to elicit an understanding of the characteristics and issues confronting candidate firms with respect to freight tasks which entailed:

- full truck load, inter-capital services;
- full truck load, intra-city (metropolitan) services; and
- less than full truck load intra-city services. This category could entail multi-collection or multi-drop truck route configurations.

For each of these freight services it was necessary to establish values which could be used in a set of values for:

- freight rate ($ per pack);
- travel time (hours);
- early or late delivery (within the designated “window” and thus not on-time), % of total deliveries; and
- damaged or lost, % of total consignment.

While an apparently simple objective, the reality of the freight services “product” is that it has an almost infinite range of possibilities with respect to combinations of these characteristics. This complexity is promoted by a combination of the expression of shippers’ requirements and the extreme competition evident in the supply of transport services.

Some of the issues related to each of these characteristics which impact on seeking definition of the ‘freight product’ include:

- **freight rate:** the pack format – box, pallet, roll, bin, tank, stillage, bag, etc; the density of the consignment – inferring volumetric or mass limit of vehicle load; trip-ends with implication for back-loading/empty running of vehicle; frequency of task; seasonality of task; route congestion performance; transparency of freight rate to shipper and consignee etc;
- **travel time:** related to despatch time – variability for time of day, day or week, period of year; multi-drop/pick-up format and routing; consolidation/de-consolidation transparency of trip times to interviewees; time-sensitivity of freight to customer;
- **not-on-time percentage:** what is the incidence or influence of the consignee’s performance – e.g. late assembly of consignment; of other non-transport operations causes of off-time performance; of management intervention e.g. to re-schedule a delivery time-slot; and
- **damage and loss:** what represents damage – a need to replace product; insurance claim; damage to package only (i.e. not to product); units of measure – number of items in total consignment; or of number of consignments with a damaged item; on a number of units or value of product basis?; the attribution – to loading; unloading; trans-shipment; packing; en-route? and the transparency of performance to the interviewee.

The preliminary questionnaire used to garner information applied to defining the freight service product in each category was the same as that used in Stage 1, and a copy is included in Appendix 1B (Figure 1B.1).

Table 2.5 summarises some responses solicited in the course of the preliminary survey which was conducted by telephone. They are specifically related to Inter-capital Full Truck Load consignments.

Table 2.5 — Freight characterisation

Shipper	Pack type	Trip format	Trip time	On-time performance	Freight rate	Damage/loss
All Head Services	. Individual units 10-45 kg . Pallets to 200 kg	. Metro multi-drop & collection . Individual interstate consignment	. Up to 4 hours . Two days	. Not critical . Not measured	Average $15 / unit, say 25kg	. Zero for own deliveries . Up to 1.5% for interstate
APA Industries	. Individual LPG tanks	. Metro multi-drop . Pallets for interstate consignment	. Up to 4 hours . 1 to 2 days	Ditto	Not specified	Interstate truck crashes have damaged product
Aspect Packaging	50-60 kg pallets	Metro multi-drop	1.5 to 2 hours	Ditto	Use 8t truck	<0.5%
Australiain Arrow	Pallets & 50l bins	Multi pick-up	Say, 2 hours	Critical; claimed to be 100%	Not specified; to customer account	Nil Recorded as damaged parts per million.
Australian Controls	Pallets	Multi pick-up	Say, up to 4 hours	Non-critical	Customer account	None recorded
Austrim Textiles	Fabric rolls	. Direct inter-site metro . Multi-drop metro . Interstate	2 days for interstate del.		. Vehicle & driver hire rate . Adel or Syd approx	<10%
AutoLiv	Returnable bins	. Multi pick-up for metro inwards . Metro direct to customers . Interstate				
BHP	Packs	. Two consignments / trip for metro . Interstate	1 to 2.5 hours	Mostly non-critical	$100 / 12t=$8 / t for metro	0.15%
Bostik	Cartons to 1000l containers	. Metro, express . Interstate FTL	Not cited	Not available	Average for all interstate:	Low, but critical
BTR Engineered	Pallet about 0.6 to 1.0 t.	Country to city; & interstate via Melb. Trans-shipment	2.5 hours	Not an issue	$700 for return trip for semi Melbourne-Bendigo	Up to 2% of Sydney freight
BTR Highett	Cartons	Metropolitan express freight	1 to 2 hours	Not an issue	Customers account	Not recognised
Calsonic	Stillages pallets	Predominantly interstate (Adelaide). Some containerised export.	12 hours	About 5% of trips are late	Customers account	Zero for domestic; 0.5% for export.
CHEP	Empty pallets	Multi-drop / multi pick-up, but mostly (80%) single drop	. Metro 2 hours Interstate 12 hours	. Measure is missed days; 1%	$54 / hr for semi-trailer $1,100 / semi trailer for interstate	1% of consignments
Consolidated Manufactu	Pallets and stillages	Multi-drop and multi-collection	0.5 hours plus	Up to 4.5% of trips off-time	Mostly to customer account	Zero; two problems with packaging in 7 years
Denso	Pallets (20-50kg) and o'night bags	Mostly o'night courier; and 1 FTL / week	Interstate, 12 hours	Per Toyota supply assessment	Semi FTL to Sydney $1050	0.00%
Driver	Cartons, pallets, special packs	Metro and multi-drop and customer pick-up	Metro & interstate	Not critical	Mostly to customer account; operate small vehicles for metro	Very small; less than 0.5%
Dura Asia Pacific	Pallets and packages	. Interstate FTL & LTFL . Metro multi-drop & pick-up	. Adelaide 12 hours . Metro varies	90% within 30 mins of time slot	$45 / pallet to Ford in Melbourne $1,900 FTL to Adel	No damage, as expert in truck loading
Flex-drive Industries	Pallet	. Metro FTL . Interstate via Melbourne trans-shipment . Volumetric limit to load	No information	. If not on-time, achieve waiver to time slot	Not cited	0.3%; mostly associated with international transport
Forgecast	Pallet	. Metro to customer account . Metro FTL & multi-drop . Interstate LFTL	No information	. Claimed to be 100% on time	6t truck (10 pallets) for multi-drop is $30 / hr	No damage
F & T Industries	Pallets & shipping containers	. Metro multi pick-up . International shipping containers . Interstate FTL	Metro Melbourne 1 to 2 hours	70% of deliveries to schedule, but not time critical	Adelaide $18 / pallet; Sydney $22 / pallet	No damage cited
Fujitsu Ten	Pallets	. LTL interstate . LFTL metro, high frequency	Metro 10 mins	100% on-time for Toyota	Not available	Less than 1%
GUD Manufacturing	Pallets & air freight parcels	. Interstate FTL & LFTL . Metro FTL, LFTL	Metro load-deliver-return cycle time of	Better than 95%	$26 / hr for 6t & 8t vehicles said to be 16 to	About 0.2%

Table 2.5 — Freight characterisation (continued)

Contd.

Shipper	Pack type	Trip format	Trip time	On-time performance	Freight rate	Damage/loss
Holden Rubber	Pallets	. Interstate LTL . Metro LTL multi pick-up	Not known	Not known	Not known; all to customer account	Not known
Hook Plastics	Pallets	. Interstate LTL . Metro LTL multi pick-up	Not known	Not known	Not known; all to customer account	Not known
Howe Leather	Purpose designed pallets	. O/s sea and air . Metro multi-drop . Metro courier express	Not known	100%	. Metro courier approx. 16c/kg . Interstate courier approx. 15c to 36c/kg	1 pallet in 500 is damaged; approx. 0.2%
Insul Form	Pallets and product specific packs; volumetric freight	. FTL interstate . FTL metro . Multi-drop metro	. 12 hours interstate . Metro return is 1.5 to 3 hours	Not time sensitive	. Not known; for major customers, is to customer account . Metro multi-drop rate not cited, but based on truck hire rate and estimate of trip time & unloading time	Zero damage because of nature of product
Johnson Controls	. Pallets . Stillages . Boxes	. Interstate FTL . Metro multi pick-up	. Overnight . Metro trip time is 20 to 45 mins	Said to be 100%	. Not cited, are to customer account	Zero damage through pack format
3M	Boxes; pallets	. LTL interstate . LTL metro-multi pick-up format	Interstate is 1 to 2 days	Not known, but not an issue	Mostly to customer account account & not known	Less than 0.1%
Mackay Consolidated	. Pallets . Boxes . Shipping containers	. FCL for O/S . Express parcel . Metro multi-drop	. Metro 1 to 2 hours . Interstate 2 to 3 days	Not time sensitive	. Box up to 20kg for metro . Metro multi-drop vehicle	Damage generally arises through poor packing but less than 1.0%
Marsden	. Pallets . Stillages . Bins	. LTL . LTL	. Intercapital overnight . 20 mins to 40 mins for	Late delivery approx 1	Transport cost mostly to	No recorded damage
Melbourne Auto Air	. Pallets . Packages	. Metro express . FTL inter-capital . LFTL inter-capital	. Intercapital overnight (Brisbane 2 days) . Metro 90 mins	. On time performance performance is an issue, but not recorded	. $30 to $40 per hour for metro express hire rate for 2 tonne truck . Inter-capital rate variable with task	Damage not measured, but stated as low
Mills Elastomers	. Pallets . Cartons	LTL inter-capital and metro			. Interstate rate is $200 to $250 per pallet of about 0.5t . Metro $35 per hour for 10 pallet truck	Cited as less than 1.0%; general top load for interstate shipments to minimise damage
Mitsubishi	. Pallets . Containers	FTL inter-capital & metro	. 12 hours inter-capital . Metro Adelaide milk run	Overall cited as 97% on-time	Not cited	Self-insure; damage rate much less than 0.1%
MtM	. Stillages . Containers . Modular packs	. Metro multi pick-up . Intercapital LTL	Customer schedule	Not cited	Not cited; mostly to customer account	Damage generally arises through truck crash
National Forge	Pallets	Metro multi-drop	About 1 hour	Some specific delivery windows, but o.t. perf. Not an issue	Operate own 5t truck	No damage issue
Nylex	. Shipping containers . Pallets	. FCL for export . Metro multi-drop . FTL inter-capital	. Overnight inter-capital Adel, Sydney; 2 days, Brisbane . Metro multi-drop	Inter-capital is about 95% on time	Not cited	Damage generally arises on long haul routes from trans-shipment or rubbing damage but still less than 1.0%
PBR	. Export containers . Damage	. FTL metro . FTL inter-capital	. Metro FTL/hour . Inter-capital (Adelaide) 12 hours	98% to 100%	Not cited; generally to customer account	. Some loss of whole containers occurs with overseas freight . Local damage generally associated with trans-shipment at consolidated depot.
Plexicor	. Stillages . Crates . Pallets	. LTL inter-capital . LTL metro pick-up . Metro multi-drop	. Overnight intercapital to Adelaide . Metro trip as little as 30 mins	. Load to customer arrangement . No on-time performance cited	Mostly to customer account	Minimal damage cited.

Freight task format

A consignor's full truck load (FTL) could be any of the following:

(i) a semi-trailer transporting a shipping container housing consolidated pallets or other pack units; the maximum gross vehicle mass (GVM/GCM) would be 42.5 tonnes;

(ii) a semi-trailer transporting items assembled in pallet or other pack types such as stillages[4]; again the GVM/GCM would be 42.5 tonnes, and the maximum payload around 22 tonnes;

(iii) a B-double with a load format similar to type (ii) or a combination of type (i) and (ii); the GVM/GCM would be 62.5t and the maximum payload some 35 tonnes;

(iv) a rigid truck configuration with a payload capability ranging from 4 tonnes to 18 tonnes; again the vehicle would transport goods in several pack formats – pallets, stillage[4]; bins etc.

Trip time

For the Melbourne consignors, the most represented inter-capital trip destinations are Adelaide, Sydney and Brisbane. Perth is significantly less represented.

The trip time to Adelaide and Sydney is generally represented as "overnight", and to Brisbane, as "two days".

The realised trip time is constrained by matters including:

- maximum permitted shift hours for driver;
- legal speed limit;
- load/unload duration;
- trip distance;
- congestion in trip segments;
- weather conditions; and
- other factors.

Typically a Melbourne-Adelaide inter-capital trip distance will be less than 900 km. Allowing for the foregoing, the FTL consignment trip duration is frequently around 12 hours. For Melbourne-Sydney trips, the duration might be more nearly 14 hours.

On-time performance

For the highly systematic logistics configurations represented in the automotive components inter-capital freight task, on-time performance overall is cited at about 97%. This reflects a provision for trip time contingencies and the transport operator's usual initiative to target early arrival to avoid any penalties for off-time performance.

Non transport related events were also cited as causing off-time performance – for example, manufacturing schedule mishaps delaying vehicle loading.

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[4] Stillage is a form of packaging freight. It mostly refers to a packaging method (boxes/cases) maximising the volume of the freight being packaged, while at the same time minimising the probability of damage/loss.

Drainage or loss

Most respondents cited zero or very low (much less than 1.0%) damage or loss rates. Instances of significant damage or loss were most commonly cited as associated with a vehicle crash load transhipment, or theft (loss) of a shipping container in international consignment.

Cost

The freight rate visible to the consignor reflects a complex array of resource unit costs and productivity factors and short-term market responses. For the automotive vehicle components sector, consistent freight task configurations are often juxtaposed with a high density freight and a demand for a high level of service outcome expressed in terms of in-full on-time parameters. The efficiency benefits of high transport equipment utilisation are accompanied however by the cost premiums arising from the high unit cost and intensive resource necessary to realise high service levels.

What is a plausible median value for freight cost?

Vehicle and driver hire costs are about $60 per hour for a semi-trailer. A 14 hour task is therefore about $840. However, an operator will also need to allow for a return load factor which is highly likely to be less than 100%.

At $50 per pallet, a FTL (semi-trailer) rate would be some $1,100; at $55 per pallet, $1,210.
These costs reflect circumstances in year 2000, prior to the introduction of GST.

2.4.3 Values adopted for freight product attributes

Recognising the range of circumstances and their expression in clusters of freight product attributes, the values detailed in Table 2.6 were adopted. The ranges also reflect pragmatism – in adopting numbers which were 'rounded' and easily absorbed by interviewees. Here we note too the methodological obligation to have changes in the attribute levels "large enough to elicit detectable changes in stated preferences, but not so large that they would compromise credibility", (Ortuzar and Willumson 1990, p. 91).

Theses attribute values were configured into sets (of different combinations of low, medium and high values for each of the four attributes); and Groups of between three and six sets[5]. Orthogonality of the configurations was sought so that the attribute combinations varied independently from one another. This is to foster easier estimation of the effect of each attribute on the interviewee's response.

Survey forms were constructed for the interviewee to make a selection of one "Set" from between three and six sets, represented in eight "Groups" of sets. For each of the three freight services (IFTL, MFTL and LFTL), 39 different combinations of Groups and Sets were configured and applied to the research.

One such family of survey forms, together with the responses, is presented in Appendix 2B.

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[5] Values for the four freight service attributes used in this analysis (ie freight rate, trip time, on-time delivery and damage/loss) were configured into sets each representing a discrete 'product' by employing a conjoint analysis process. Conjoint analysis ensured that no 'product' was logically superior or inferior to any other. Groups of between three and six 'products', randomly drawn from a maximum set of nine such 'products', were then presented to interviewees, who were required to indicate their first choice. Respondents were required to repeat this process eight times, for different groups of 'products'. A Double-Block Randomised Design was used to ensure respondents were presented with a different run of these eight choice sets on the Questionnaire Form provided (Hahn and Shapiro (1966); Louviere (1988), Hensher 1994; and Part 1 in this document).

Table 2.6 — Freight product values

Freight task	Value status	Attribute value and variance			
		Rate ($ per pallet)	Travel time (hours)	Non on-time (% of total)	Damaged or lost (% of total)
Inter-capital Full Truck Load	Low	40	12	7	0.5
	Medium	50	14	5	0.3
	High	60	16	3	0.1
	Low variance against medium	-20%	-14%	40	67
	Medium	0%	0%	0	0
	High, variable against medium	20%	14%	-40	-67
Metropolitan Full Truck Load	Low	8	1	7	0.3
	Medium	11	1.5	5	0.2
	High	14	2	3	0.1
	Low variance against medium	-27%	-33%	40	50
	Medium	0%	0%	0	0
	High, variable against medium	27%	33%	-40	-50
Metropolitan less than full truck load	Low	10	4	7	0.5
	Medium	15	5	5	0.3
	High	20	6	3	0.1
	Low variance against medium	-33%	-20%	40%	67
	Medium	0%	0%	0%	0
	High, variable against medium	33%	20%	-40%	-67

2.4.4 Survey respondents' observations

The survey forms were presented for response on a face-to-face basis to 107 interviewees from 73 enterprises. (This produced just fewer than 320 completed survey forms.) Of these, respondents from 37 offered no comment with respect to their choice of Sets. One proffered that the research was "a stupid exercise". Explicit quotations from the balance included:

- *Damage is most important.*
- *Damage is most important.*
- *Do not want any damage.*
- *Damage is most important due to value of goods and cost of recovery.*
- *Damage is paramount on inter-capital and important on local.*
- *Damage is most important, followed by not-on-time.*
- *Damage is more important than not-on-time.*
- *Cannot afford any damage or to be late.*
- *Damage is paramount and on-time is important.*
- *Damage and on-time are most important.*
- *Damage and on-time are most important.*
- *On-time and no damage are requirements.*
- *On-time and damage are most important.*
- *On-time is most important, followed by damage.*
- *Delivery on-time and damage are most important.*

- *On-time is most important, followed by damage.*
- *Ability to move large volumes on-time without damage is most important.*
- *On-time is most important (?).*
- *Not-on-time is most important.*
- *Not-on-time is paramount.*
- *On-time is important.*
- *On-time delivery is more important than price.*
- *On-time and price are important.*
- *On-time is most important, damage not so important as product value not high.*
- *For order and export, on-time and damage are important, for after-market, on-time is not so important.*
- *Damage and on-time are most important, subject to acceptable price.*
- *Not-on-time and damage are paramount – subject to cost.*
- *Travel time and on-time are most important.*
- *Elapsed time is most important.*
- *Not-on-time and damage are paramount – subject to cost.*
- *Damage is most important, followed by not-on-time.*
- *On-time and damage are most important.*
- *Shortest delivery time and on-time are the important points.*

2.4.5 Observations of the field survey process

The following is presented to inform planning and budgeting for any further survey work which might be undertaken through Austroads' sponsorship.

The preliminary survey process entailed some one hour per enquiry. The work effort anticipated for the field interviews respected the following assumptions:

♦ telephone arrangements for appointment, allowing three attempts	15 mins
♦ scheduling to optimise travel	15 mins
♦ travel time	60 mins
♦ interview duration	30 mins
♦ follow-up and contingency	15 mins
Total	**135 mins**

Vehicle and telephone expenses were estimated at $15 per interview.

This time budget proved to be a small under-estimate.

For the record, we note that:

- the face-to-face interviews were all conducted by the same person who had also undertaken most of the previous (Stage 1) study interviews; and
- the interviewer is a person with a long professional career in the transport, logistics and manufacturing sectors at divisional and general management level at leading private and public companies.

Explicit observations of the interview process included:

- making initial phone contact with potential interviewees went according to plan – often requiring several calls due to their non-availability at the time of ringing;
- after making contact, it was usually not difficult to get potential interviewees to agree to an appointment. This was facilitated by assuring them that the interview would be brief. (Only about six contacts refused to make appointments. Some would not cooperate at all and some would only “think about it after Christmas”.)
- from telephone discussions with:
  (a) those interviewees to whom the data was faxed; and
  (b) those whom had to be telephoned to seek completion and return of sheets, left when interviewing other staff members,

  it is clear that face-to-face communication is the only effective way to conduct the survey. All interviewees have initial difficulty in accepting the hypothetical nature of the survey. They wish to relate their responses even more closely to their own businesses than is required or possible. Common comments included “Our freight cannot be put on pallets”, “We do not ship in these volumes or to these destinations”, or “Our travel times are quite different”;
- once the interviewee understood that the data is hypothetical, but grounded in reality, and they were merely being asked to use their experience as freight managers to make optimum selections from it, they easily accepted the principle. It was found to be useful to suggest to interviewees that the process was similar to selecting a carrier from a number of quotations for the same job. Each tenderer had provided a dollar per pallet rate and a transit time, and the interviewee knew from past experience with each of the tenderers what level of not-on-time and damage to expect. The only difference from real life was that the interviewee was not allowed to negotiate with the tenderers; he/she had to accept one of the offers randomised freight products in each of the eight groups as submitted (see Part 1 of this document);
- in summary, we found that the data as currently presented, was well understood by most interviewees provided it was explained in person;
- for most of the businesses interviewed, one or both of the damage and not-on-time aspects of transport were the drivers in their selection of the “best” data sets; and
- generally, price was seen as a consequence of the selection that they would have to accept, and travel time was unimportant as they would plan deliveries to accommodate this.

2.4.6 Contemporary conditions affecting the freight services market

For posterity, it is perhaps worth noting conditions at the time of the survey which could be material to the values of the attributes deduced. These include in no particular order of importance:

- a strongly performing automobile manufacturing sector, but in itself, in the face of global competition, fiercely focused on realising cost improvements in every quarter of production;
- in this vein, a strong focus of major manufacturers to force cost reductions through the logistics chain, in particular to improve on-time delivery and reduce damage and loss;
- end-customers of the components manufacturers (i.e. the major vehicle manufacturers), assuming control (but on a purchased-in basis) of freight transport through integrated logistics services operators. This has entailed recapitalisation of the vehicle fleet and packaging equipment among other initiatives to reduce logistics costs through less empty or part-load running of freight vehicles by ensuring packaging promotes full use of volumetric or mass capacity while minimising damage. So too are routes optimised to minimise travel time and vehicle operating costs;

- a persistent highly competitive supply of transport services. Vehicle performances are all the time improving. There are ever-more owner-drivers available as direct hire contractors or as sub-contractors to the major integrated logistics services operators; the market price for truck and driver hire "never seems to increase";
- tight operating conditions among shippers, customers and freight operators alike in the face of global competition in de-regulated markets, and domestic taxation system restructuring (introduction of GST) exacerbating the pressures of precise, evermore-frequent schedules for every facet of business. All of these circumstances make it more challenging to engage interviewees and realise high quality responses;
- broadly, a respondent sector embracing logistics performance standards established at a globally competitive setting;
- and in this context fostering the relocation of key suppliers to co-locate at the customer's site to achieve through-the-fence delivery thus minimising freight costs, delivery time and risk of adverse schedules etc;
- more attentive enforcement of freight vehicle driver regulations to address the unsafe practices arising out of the level of competition which sees freight operators as (marginal) price-takers;
- shippers' clear recognition of their market-power – and the wherewithal to realise evermore comprehensive and tightly specified performance standards with no or minimal price premium;
- on the other hand, some emergence of a view that reducing the "churn" in transport services contractors realised meaningful, medium term operational gains; and
- a wide range of knowledge and skill levels in logistics in shippers, customer and freight services enterprises, most often with a positive view of the transport infrastructure network applied to their task. In this context, the recently commissioned Melbourne CityLink project has realised significant operating gains for many firms.

2.5. STAGE 2 SURVEY RESULTS

Stated Preference Surveys, as a method of obtaining valuations for freight shipping choices, has not been previously undertaken within Australia other than for the pilot stage of the present project. This part of the report covers the data cleaning and model construction, execution and initial interpretation of such a data set, collected by FDF using the same orthogonal design of the previous work (Thoresen (1997); Wigan (1998)). It is important to note that this experimental design was specifically tailored to reduce the survey instrument to a manageable size for the target respondent group by excluding the extended set of questions required to measure the many interaction terms between the factors of time, cost, reliability and damage.

Several different types of models can be estimated from the results of administering this orthogonal design. The simplest and clearest model assumes that each factor influences choices in a linear manner.

Two types of models were fitted to three different types of operation, precisely matching the design of the pilot project.

The types of freight operation were:

- Metropolitan Less than Full Truck Load (MLFTL);
- Inter-capital Full Truck Load (IFTL); and
- Metropolitan Full Truck Load (MFTL).

Both “basic” and “more complex” truck logit models were applied.

The basic logit model of choices used actual attribute levels (which yields identical results to a centred linear mean effects model for this type of model specification).

The more complex logit model provided for both linear mean centred effects and quadratic main effects.

The method adopted for the survey required the respondent to select one bundle of attribute values, from a set of three to six bundles, drawn in turn from of a set of nine basic alternatives bundles. The bundles of attribute values were randomly selected for each survey questionnaire. Similarly, the survey questionnaires were randomly allocated to interviewees. (Explained in Footnote 5 and for more detail see Hensher 1994; Thoresen 1997). Only a single choice was requested from the interviewees for each set of bundles (alternatives) offered. They were not asked to rank order alternative choices. This practice replicates that adopted for the Stage 1 survey.

The original experimental design was produced using CONSURV by D.A. Hensher for ARRB TR. It was an orthogonal design aimed at measuring main effects only. The same design was used for both Stage 1 (1998) and Stage 2, reported here.

2.5.1 Data preparation and cleaning

The restructuring of the data into a LIMDEP accessible format was a substantially larger task than for Stage 1, due to the increased scale of the survey. The importance of the validation of both design implementation in administration and the accurate completion of the data entry was made salient by the pilot project. The very large number of entries (around 10,000) in the present work was therefore systematically assessed not only for entry accuracy but also to detect any possible mismatches in administration from the design, and to detect any missing values where no responses or partial responses were given.

LIMDEP has very limited input data diagnostic facilities, requiring exhaustive analysis of any and various failures to execute. A number of automated checking procedures were constructed to speed this process up, and these enabled an iterative process of trial runs and diagnostic analysis to verify the data for internal consistency. This process identified a number of processing niceties and at the last stage allowed LIMDEP diagnostics to be used to help to pinpoint three missing observations in the several thousand groups. The verification of the data coding allowed pinpointing of the three records in the total of 24,000 to be accurately identified for verification of lack of response or possible miscoding. In each case it was a deliberate lack of response from the interviewee. This meant that no choice had been recorded for one card option in each of the three types of freight operations.

The data and design quality review was completed to the same careful overall and detail auditing as in Stage 1 (pilot study). However, unlike the Stage 1, inclusion of a range of possible responses to these missing values had no visible effect on the models estimated, and once it was established that the observation should be excluded, the estimates were finalised as reported here. Considerable confidence can be held in the accuracy of each of these possible factors after the re-validation processes confirmed the design implementation and pinpointed the few missing entries.

The input specification for the models is reproduced as Appendix 2A. The Inter-capital Full Truck Load (IFTL) is shown. The Metropolitan Less than Full Truck Load (MLFTL) files differ only in the mean values specified in the transformations for the centred quadratic terms, and the names of the input and output files.

2.5.2 Intermediate results

The mean values of the data sets are summarised in Table 2.7.

Table 2.7 — Mean values of attributes in the total responses recorded to the three data sets

Value	Freight category		
	IFTL	MFTL	MLFTL
Rate ($/pallet)	50.1	11.0	15.1
Time (hours)	14.0	1.5	5.0
Late (%)	0.05	0.05	0.05
Loss/damage (%)	0.003	0.002	0.0031

2.5.3 Linear choice models[6]

Inter-capital Full Truck Load Case

As shown in Table 2.8, the inter-capital results show only a limited relationship between shipper choices and travel time. Costs, reliability and damage are clearly significant. The low weight for time committed to transit reflects the relatively greater importance of reliability of time at destination in the overall logistics system, given the overnight shipment times plausible and possible in this industry.

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[6] Non-linear choice models (quadratic) were also estimated as an additional measure of checking the performance of the linear models. However, non-linear model findings are more difficult to interpret and are included in Appendix 2B for completeness. In the quadratic models there are both linear and quadratic coefficients. However, Table 2B.1 in Appendix 2B summarises only the linear terms for both linear and quadratic models. The full set or linear and quadratic term coefficients are presented in Appendix 2A (as statistical results).

Table 2.8 — Inter-capital Full Truck Load (IFTL) - summary results for Linear Models

Model	Freight rate per pallet	Time (hours)	Reliability (probability)	Probability of damage (probability)
Linear models (adj $R^2 = 0.50$)				
Coefficient	-0.048 [a]	-0.070 [b]	-45.3 [a]	-369.9 [a]
Standard Error	0.007	0.029	2.8	28.5
		1.5 $/pallet/hour	944 $/ 100%	7706 $/ 100%

Notes: a: p<0.001 (ie, significant at 0.1% or less); b: p<0.05 (ie, significant at 5% or less);

Metropolitan Full Truck Load findings

Metropolitan full load truck operations show a lesser importance of freight rates (Table 2.9). Further, there is indication that the valuation of time differs significantly from zero. Damage is significantly more important to shipper decisions than any other factor, and has a greater impact here than it does for inter-capital shipments. Once again, the sample may have reflected the influence of a demand for reliability in that the tightly mandated time windows required by customers for delivery are a given, and freight rates may thus be discounted as a decision factor in the eyes of the shipper.

Table 2.9 — Metropolitan Full Truck Load (MFTL) - summary results for linear models

Model	Freight rate per pallet	Time (hours)	Reliability (probability)	Probability of damage (probability)
Linear models (adj $R^2 = 0.48$)				
Coefficient	-0.18 [a]	-0.14 [NS]	-47.1 [a]	-672 [a]
Standard Error	0.02	0.12	2.8	56
		0.78 $/pallet/hour	261 $/ 100%	3733 $/ 100%

Notes: a: p<0.001 (ie, significant at 0.1% or less); NS: not significant

Metropolitan Less than Truck Load findings

The Metropolitan Less than Truck Load operations show a higher (and significantly different from zero) value of time (Table 2.10). The coefficients are estimated with small standard errors. This suggests that the considerations of the shipper in using this category of transport service are comparatively homogeneous. In particular, it is a priority to address both time and reliability performance offers in their transport services purchasing decisions.

The nature of the less than full truck load task places a heavy emphasis on the utilisation of the vehicles and in minimising the distance and thus time taken for a specific drop sequence. The scope for managing these factors in a tight logistics chain is far greater for this multi-drop style of operation than for full load deliveries with tight time windows at both ends of a movement between two specific points.

Table 2.10 — Metropolitan Less than Full Truck Load (MLFTL) — summary results for linear models

Model	Freight rate per pallet	Time (hours)	Reliability (probability)	Probability of damage (probability)
Linear models (adj $R^2 = 0.50$)				
Coefficient	-0.18 [a]	-0.40 [a]	-38.7 [a]	-441 [a]
Standard Error	0.01	0.06	2.8	29
		2.22 $/pallet/hour	215 $/ 100%	2444 $/ 100%

Note: a: p<0.001 (ie, significant at 0.1% or less);

Overall discussion of findings

The use of valuations of time derived from SP studies of this type is often subject to debate. Consistent interpretation is necessary to ensure that this occurs appropriately.

The utility model estimates a set of coefficients, but it is arbitrary in which unit scale these should be expressed. If this scaling approach is adopted, as it has been in a number of other studies, then the coefficient of the freight rate should be used to alter the scale of all coefficients. This was the choice made in this study, with all coefficient and error estimate values included in Tables 4.3 to 4.5.

If the coefficient for the value of time that results from re-scaling is to be used in other, non-comparable, situations then the uncertainty in the scaling factor itself needs to be included. A straightforward pooling of the variance is not necessarily appropriate, as there may be more complex interaction terms.

The standard error for the coefficients will then lie between the scaled values presented in this report and a larger value obtained from the pooled variance of the coefficient and the variance associated with both the coefficient and the freight rate (which is used to re-scale the values of the coefficients). More recent valuation of travel time work in Europe has included interaction terms in the experimental design and final standardised coefficient values, although no error values at all are quoted in the most recent such report (Fowkes et al 2001). All of the component coefficient and variance values are given in that report. However, this is far from a universal view. For example, the Leeds University approach is to ignore covariance effects as if the two coefficients are independent estimates, and thus the variance pooling corrections for ratios are applied.

2.5.4 Quality of the estimated models

The quality of the fit of these models was remarkably uniform. As shown in Table 2.11, the Pseudo R^2 values were all between 0.48 and 0.50. These are high values for model fit for this type of approach, and are very close to those obtained in Stage 1. The preset models and data set indicate that these results are insensitive to small numbers of incomplete responses. This is unlike Stage 1 where sensitivity to even a few records was identified in the robustness testing.

Table 2.11 — Quality of fit of the estimated models

Measure of quality of fit	Freight services type		
	IFTL	MFTL	MLFTL
Observations	855	656	847
Linear Model Adjusted R^2	0.48	0.48	0.50
Non-Linear Model Adjusted R^2	0.48	0.48	0.50

If it were to be assumed that there was a constant term in these models then a Chi-Square value could be reported as a further measure of another aspect of a goodness of fit (on typically about 845 degrees of freedom). Such estimates indicate that the probability of there being a non-zero constant term was very low ($p<0.01$). Consequently estimation of such models has not been reported.

A more appropriate measure of goodness of the models is to examine the actual choice reported and those estimated by the different models (Table 2.12). The vertical columns are the nine alternatives offered to the respondents, and the horizontal rows are the predicted choices. In general, high values would be expected along the diagonals for a useful model. To make this clearer, the top four cells are highlighted in each table, and also the second top four in a lighter tone.

The pattern is as expected, with almost all the highest cells along the diagonals. There is a small difference between the linear and non-linear (quadratic) model predictions for the two full-load pairs of models (IFTL) and (MFTL) – but a substantially lower 'quality' for MLFTL, where the non-linear model performs noticeably less well on this criterion. Alternative a7 is clearly closely associated with Alternative a3 as in all of the models a3 is predicted to be the choice instead of a7 for a large minority of the choices. Nevertheless, the diagonal cells still dominate in these cases. Overall, the patterns are very much as one would expect for such a model.

Table 2.12 — Actual and predicted decisions

	MFTL Linear					Predicted				
		a1	a2	a3	a4	a5	a6	a7	a8	a9
Actual	a1	3	4	3	5	4	2	6	1	1
	a2	5	79	24	12	11	10	19	2	3
	a3	5	26	114	13	13	10	29	3	4
	a4	9	10	11	31	9	3	10	6	3
	a5	4	14	14	10	21	7	20	2	3
	a6	1	3	21	5	6	7	14	1	2
	a7	4	22	32	11	14	8	75	3	4
	a8	0	3	5	1	1	1	1	1	0
	a9	0	3	4	1	1	1	2	0	1

MFTL Non-linear					Predicted				
	a1	a2	a3	a4	a5	a6	a7	a8	a9
a1	2	4	3	5	4	2	5	1	0
a2	5	79	23	11	13	12	18	1	2
a3	4	27	108	13	16	13	29	2	3
a4	8	10	10	32	10	4	10	4	2
a5	3	14	13	10	26	8	19	2	2
a6	1	3	20	5	7	9	14	1	1
a7	4	22	30	11	17	10	73	2	3
a8	0	3	5	1	1	1	1	0	0
a9	0	3	4	1	2	1	2	0	0

Quadratic 1 less on axis than linear

	MLFTL Linear					Predicted				
		a1	a2	a3	a4	a5	a6	a7	a8	a9
Actual	a1	3	6	5	3	2	2	9	1	0
	a2	8	111	20	14	7	9	22	3	2
	a3	5	22	69	12	8	11	30	4	2
	a4	11	15	12	41	8	5	20	5	1
	a5	3	11	8	8	9	5	16	2	1
	a6	3	9	20	6	5	8	10	2	1
	a7	7	25	28	17	10	9	98	3	2
	a8	0	1	6	1	1	1	2	1	0
	a9	0	1	0	0	0	0	1	0	0

MLFTL non-linear					Predicted				
	a1	a2	a3	a4	a5	a6	a7	a8	a9
a1	2	6	5	4	3	2	9	0	0
a2	6	108	20	17	9	12	21	2	1
a3	4	21	67	14	11	13	29	3	1
a4	8	14	11	48	10	6	18	3	0
a5	2	11	8	9	11	6	15	1	0
a6	2	8	19	7	6	10	9	1	0
a7	5	24	28	20	12	11	93	2	1
a8	0	1	6	1	1	2	1	0	0
a9	0	1	0	0	0	0	1	0	0

Quadratic 19 on axis than linear

	IFTL Linear					Predicted				
		a1	a2	a3	a4	a5	a6	a7	a8	a9
Actual	a1	2	5	7	5	2	1	6	1	0
	a2	5	86	24	13	8	11	21	3	3
	a3	4	22	93	12	11	11	25	4	4
	a4	7	7	8	28	10	3	9	5	2
	a5	4	22	11	10	19	7	21	3	2
	a6	2	4	25	6	6	8	15	2	2
	a7	4	19	37	13	12	9	95	3	3
	a8	1	2	2	2	1	1	1	1	0
	a9	0	3	3	1	0	0	3	0	0

IFTL Non-linear					Predicted				
	a1	a2	A3	a4	a5	a6	a7	a8	a9
a1	2	5	6	5	3	1	6	1	0
a2	5	88	21	11	11	14	21	1	2
a3	4	25	84	11	16	16	27	2	3
a4	8	8	7	26	14	4	9	3	1
a5	3	21	9	8	26	9	20	1	1
a6	2	4	22	5	8	12	14	1	1
a7	4	19	33	12	17	12	96	2	2
a8	1	2	2	2	2	1	1	0	0
a9	0	4	3	0	1	0	3	0	0

Quadratic 1 more on axis than linear

2.6. CONCLUSIONS OF STAGE 2

The key results are that the value of FTL freight delays per pallet per hour on inter-capital routes was $1.50 with a 40% standard error, and on intra-city routes it was $0.80 with a standard error of more than 85%. These results do not allow the valuation of freight travel time to be distinguished between inter and intra-city full truck load movements. Further, they do not provide evidence that shippers attribute a non-zero value to freight time for intra-city movements.

The value of MLFTL freight delays per delivery per hour on intra-city routes was found to be $2.2 per pallet with a 15% standard error. The valuation of freight time is clearly significantly higher for this transport services operation among those enterprises responding to this survey.

The estimation of non-linear models showed that only freight rate had a significant coefficient, and that this was of the same sign, and of comparable magnitude, for all three freight services configurations.

2.7. REFERENCES (STAGE 2)

AUSTROADS (2000), *Economic Evaluation of Road Investment Proposals: Unit Values for road User Costs at June 1997 and June 1998*, AP-142/99, Austroads Inc, Sydney.

AUSTROADS (2003), *Economic Evaluation of Road Investment Proposals: Unit Values for road User Costs at September 2000*, AP-R218/03, Austroads Inc, Sydney.

FDF Management Pty Ltd, FreightInfo *TM* (1995-96) database (unpublished).

FOWKES, A. S., FIRMIN, P. E., TWEDDLE, G. and WHITEING, A. E. (2001), *How highly does the freight transport industry value journey time reliability - and for what reasons*?. Logistics Research Network (September) 2001 Conference proceedings, Institute of Logistics and Transport, London. Pp 141-148.

FULLER, T. and TSOLAKIS, D. (2001), *Roads and Road Transport in the Logistics Chain*, Research Report ARR 349, ARRB Transport Research Ltd, Melbourne, July.

GREENE, W. H. (1997), *LIMDEP version 7 Users manual*, Econometric Software, Bellport NY.

HAHN, G. J. and SHAPIRO, S. S. (1966), *A catalog and computer program for the design and analysis of orthogonal symmetric and asymmetric fractional factorial experiments,* General Electric Research and Development Center, Schenectady N.Y.

HENSHER, D. A. (1994), *Stated preference analysis of travel choices: the state of practice*, Transportation, 21, 107-133.

KALDAGER, L.E. and KEARNEY, A.T. (1994), Vision EUREKA: Efficient and Environmentally Friendly Freight Transport Conference, Lillehammer, Norway.

LOUVIERE, J. J. (1988), *Analysing Decision Making: Metric Conjoint Analysis*, Vol 67, New York: Sage Publications.

OECD (1992), Advanced Logistics and Road Freight Transport, OECD, Paris.

OECD (1998), The North American TRILOG Task Force report, *Logistics Concerns in North America: A summary of Governmental Support for Intermodal Freight Transport*, Paris.

ORTUZAR, J. de D. and WILLUMSON, L. G. (1990), “Modelling Transport”, John Wiley and Sons, Chichester UK.

THORESEN, T. (1997), *Estimation of non-urban freight travel time values: Methodological review and experimental design*, Working Document WD R97/061, ARRB Transport Research Ltd, Melbourne.

WIGAN, M. R. (1998), *Stated preference model for freight valuation choices,* Oxford Systematics, Heidelberg, July.

WIGAN, M., ROCKLIFFE, N., THORESEN, T. and TSOLAKIS, D. (2000), *Valuing Longhaul and Metropolitan Freight Travel Time and Reliability*, Journal of Transportation and Statistics, Vol. 3 (3), pp.83-89, December.

APPENDIX 2A LIMDEP MODEL SPECIFICATION AND ANALYSIS RESULTS

LIMDEP analysis variable names and meanings

Firm*	Reference number of the firm
bundle	One of the nine different bundles of attribute values used in the survey
choice	Set to ‘1’ for the bundle chosen out of a set of attribute bundles presented to a subject
setsize	The number of bundles from which the choice was made (ie, the number of bundles shown on the particular flash card used)
cost	Freight rate in $ AUD
time	Transit time (in minutes)
late	Percentage of late deliveries
bust	Percentage of deliveries arriving damaged
sequence*	The sequence number of the bundles in order, in groups presented as each successive observation. This sequence includes all bundles produced by the operation of the FDF flash card generation macros and administered to firms.
index*	The sequence number of each bundle (again in observation groups) after editing out the N/A (ie, not required) bundles in each observation which comprises the experimental design
obs	The sequential number allocated to ALL the bundles offered at the same time to a subject
cost1	Value of freight rate corrected to difference from mean value
time1	Value of freight time corrected to difference from mean value
late1	Value of % freight late deliveries corrected to difference from mean value
bust1	Value of % freight damaged deliveries corrected to difference from mean value
costq	Squared difference from the mean value of freight rate
bustq	Squared difference from the mean value of freight % damaged deliveries
timeq	Squared difference from the mean value of freight time
lateq	Squared difference from the mean value of freight % late deliveries

Note: * Not used by LIMDEP

LIMDEP 7 Command file for Metropolitan Less than Full Truck Load survey (MLFTL)

```
read ;nvar=11;nobs=8000; file = mtmd.txt;
names=firm,bundle,cost,time,late,bust,choice,sequence,index,obs,setsize$
open; output = mtmdout.txt$
/* dstats; rhs =*$   */
create
;cost1=cost-15.070
;time1=time-5.000
;late1=late-0.0503
;bust1=bust-0.00302
;costq=cost1*cost1
;bustq=bust1*bust1
;timeq=time1*time1
;lateq=late1*late1$
 ?first run simple logit with actual attribute levels
NLOGIT
;lhs = choice,setsize, bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
/* ;scale (bust, late) = 1,100,5 */
;crosstab
;model:
U(alt1, alt2, alt3, alt4, alt5 ,alt6, alt7, alt8, alt9) =
fr*cost+tm*time+rel*late+pdam*bust$
 ?second run is simple logit with mean centred linear mean effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=freight(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;crosstab
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
fr*cost1+tm*time1+rel*late1+pdm*bust1$
 ?third run is simple logit with mean centred linear and quadratic main
? effects only
NLOGIT
;lhs=choice,setsize,bundle
;choices=alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9
;tree=(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)
;crosstab
;model:
U(alt1,alt2,alt3,alt4,alt5,alt6,alt7,alt8,alt9)=
frl*cost1+tml*time1+rel1*late1+pdaml*bust1+
frq*costq+tmq*timeq+relq*lateq+pdamq*bustq$
STOP
```

Inter-capital Full Truck Load survey (IFTL) results

Linear Attribute Value Model

```
: Current sample contains    3839 observations.                              :
             +---------------------------------------------+
               | Discrete choice (multinomial logit) model   |
               | Maximum Likelihood Estimates                |
               | Dependent variable              Choice      |
               | Weighting variable                 ONE      |
               | Number of observations             855      |
               | Iterations completed                 5      |
               | Log likelihood function       -973.3103     |
               | Log-L for Choice   model =    -973.3103     |
               | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
               | No coefficients  -1878.6270  .48190  .48121 |
               | Constants only.  Must be computed directly. |
               |                  Use NLOGIT ;...; RHS=ONE $ |
               | Response data are given as ind. choice.     |
               | Number of obs.=   855, skipped   0 bad obs. |
               +---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
 |Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
 +---------+--------------+----------------+--------+---------+----------+
  FR       -.4836979708E-01  .57802568E-02   -8.368   .0000
  TM       -.7044304942E-01  .29319927E-01   -2.403   .0163
  REL      -45.33328352      2.7852937      -16.276   .0000
  PDAM     -368.9381388      28.464941      -12.961   .0000
```

Linear and Quadratic Mean Centred Value Model

```
             +---------------------------------------------+
               | Discrete choice (multinomial logit) model   |
               | Maximum Likelihood Estimates                |
               | Dependent variable              Choice      |
               | Weighting variable                 ONE      |
               | Number of observations             855      |
               | Iterations completed                 7      |
               | Log likelihood function       -957.4684     |
               | Log-L for Choice   model =    -957.4684     |
               | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
               | No coefficients  -1878.6270  .49034  .48897 |
               | Constants only.  Must be computed directly. |
               |                  Use NLOGIT ;...; RHS=ONE $ |
               | Response data are given as ind. choice.     |
               | Number of obs.=   855, skipped   0 bad obs. |
               +---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
 |Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
 +---------+--------------+----------------+--------+---------+----------+
  FRL      -.6629085124E-01  .83246920E-02   -7.963   .0000
  TML      -.7891643482E-01  .36150783E-01   -2.183   .0290
  REL1     -50.96772194      3.5685631      -14.282   .0000
  PDAML    -405.5958892      35.578555      -11.400   .0000
  FRQ      -.3967857083E-02  .10660701E-02   -3.722   .0002
  TMQ       .2832476953E-04  .32841308E-01     .001   .9993
  RELQ      395.0284896      330.69791        1.195   .2323
  PDAMQ     96336.87702      33384.106        2.886   .0039
```

Metropolitan Full Truck Load (MFTL) results

Linear Attribute Value Model

```
Last observation read from data file was    3862
             +---------------------------------------------+
              | Discrete choice (multinomial logit) model   |
              | Maximum Likelihood Estimates                |
              | Dependent variable               Choice     |
              | Weighting variable                  ONE     |
              | Number of observations              856     |
              | Iterations completed                  5     |
              | Log likelihood function       -977.8580     |
              | Log-L for Choice   model =    -977.8580     |
              | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
              | No coefficients  -1880.8242  .48009  .47940 |
              | Constants only.  Must be computed directly. |
              |                  Use NLOGIT ;...; RHS=ONE $ |
              | Response data are given as ind. choice.     |
              | Number of obs.=   856, skipped   0 bad obs. |
              +---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
 FR       -.1763259425      .19266664E-01   -9.152   .0000
 TM       -.1425968962      .11666729       -1.222   .2216
 REL      -47.06155125      2.8115644      -16.739   .0000
 PDAM     -672.1018027      55.929747      -12.017   .0000
```

Linear and Quadratic Mean Centred Value Model

```
             +---------------------------------------------+
              | Discrete choice (multinomial logit) model   |
              | Maximum Likelihood Estimates                |
              | Dependent variable               Choice     |
              | Weighting variable                  ONE     |
              | Number of observations              856     |
              | Iterations completed                  6     |
              | Log likelihood function       -971.4704     |
              | Log-L for Choice   model =    -971.4704     |
              | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
              | No coefficients  -1880.8242  .48349  .48211 |
              | Constants only.  Must be computed directly. |
              |                  Use NLOGIT ;...; RHS=ONE $ |
              | Response data are given as ind. choice.     |
              | Number of obs.=   856, skipped   0 bad obs. |
              +---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
 FRL      -.2093978826      .25660629E-01   -8.160   .0000
 TML      -.1595233549      .13663352       -1.168   .2430
 REL1     -50.73384547      3.4357902      -14.766   .0000
 PDAML    -739.3513906      69.396639      -10.654   .0000
 FRQ      -.3617199352E-01  .11373529E-01   -3.180   .0015
 TMQ       .5623476287E-01  .49365389         .114   .9093
 RELQ      193.1340508      304.68008         .634   .5262
 PDAMQ     158296.6958      125424.72        1.262   .2069
```

Metropolitan Less than Full Truck Load (MLFTL) results

Linear Attribute Value Model

```
Last observation read from data file was    3799
                +------------------------------------------+
                 | Discrete choice (multinomial logit) model   |
                 | Maximum Likelihood Estimates                |
                 | Dependent variable              Choice     |
                 | Weighting variable                 ONE     |
                 | Number of observations             847     |
                 | Iterations completed                 6     |
                 | Log likelihood function       -936.9208     |
                 | Log-L for Choice   model =    -936.9208     |
                 | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
                 | No coefficients  -1861.0492  .49656  .49588 |
                 | Constants only.  Must be computed directly. |
                 |                  Use NLOGIT ;...; RHS=ONE $ |
                 | Response data are given as ind. choice.     |
                 | Number of obs.=   847, skipped   0 bad obs. |
                 +------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
 FR       -.1338775593      .12253058E-01  -10.926   .0000
 TM       -.3967820693      .60577111E-01   -6.550   .0000
 REL      -38.70473162      2.7882395      -13.881   .0000
 PDAM     -441.4287787      29.401514      -15.014   .0000
```

Linear and Quadratic Mean Centred Value Model

```
                +------------------------------------------+
                 | Discrete choice (multinomial logit) model   |
                 | Maximum Likelihood Estimates                |
                 | Dependent variable              Choice     |
                 | Weighting variable                 ONE     |
                 | Number of observations             847     |
                 | Iterations completed                 8     |
                 | Log likelihood function       -926.5356     |
                 | Log-L for Choice   model =    -926.5356     |
                 | R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
                 | No coefficients  -1861.0492  .50214  .50079 |
                 | Constants only.  Must be computed directly. |
                 |                  Use NLOGIT ;...; RHS=ONE $ |
                 | Response data are given as ind. choice.     |
                 | Number of obs.=   847, skipped   0 bad obs. |
                 +------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
 FRL      -.1759761618      .23351910E-01   -7.536   .0000
 TML      -.5336029210      .10828012       -4.928   .0000
 REL1     -42.72751073      3.4449097      -12.403   .0000
 PDAML    -545.5217260      54.991880       -9.920   .0000
 FRQ      -.2163532719E-01  .53721415E-02   -4.027   .0001
 TMQ      -.1280611272      .15123726        -.847   .3971
 RELQ      680.7430129      523.62132        1.300   .1936
 PDAMQ    -25258.76256      37512.531        -.673   .5007
```

APPENDIX 2B NON-LINEAR MODELS

The models established for this Stage 2 study have allowed non-linear models to be estimated. The effects of permitting a quadratic term on the linear model estimates are summarised first in Table 2B.1. For the quadratic terms to be considered, they need to be significantly different from zero. Most of the coefficients of the quadratic terms in the non-linear models estimated were not significantly different from zero. In this data set, the quadratic models estimated included linear and quadratic terms for each coefficient. All of the quadratic terms for the freight rate coefficients were significantly different from zero, with the exception of the damage probability term for inter-capital movements.

The addition of quadratic terms to the models made little difference to the linear parameters. The freight rate is consistently found to have a quadratic term (all with the same sign and comparable coefficient values ranging from - 0.02 to - 0.04). This suggests that the decision processes surrounding the weighting of freight rate in choice of freight service “offers” is rather more complex than a comparatively simple trade-off with the other variables.

Reflecting the influence of logistic chain interactions in several areas would be beneficial. The damage and reliability effects are significant for all the linear models, and it might have been surmised in advance that damage probability would be significant at higher levels (ie, in the quadratic terms of quadratic models) in at least some cases. Recent research in other countries suggests that the impact of logistics integration has made it important to test large shifts in the values of the coefficients when values of travel time are an objective.

Table 2B.1 - Comparison of coefficients estimated from linear and non-linear models

Freight category	Model	Freight rate per pallet	Time (hours)	Reliability (probability)	Probability of damage (probability)
IFTL	Linear Model				
	Coefficient	-0.048[a]	-0.070[b]	-45.3[a]	-369.9[a]
	Standard Error	0.007	0.029	2.8	28.5
			1.5 $/pallet/hr	944 $/ 100%	7706 $/ 100%
	Quadratic Model				
	Coefficient	-0.066[a]	-0.079[b]	-51.0[a]	-405[a]
	Standard Error	0.008	0.036	3.6	36
			1.2 $/pallet/hr	773 $/ 100%	6140 $/ 100%
MFTL	Linear Model				
	Coefficient	-0.18[a]	-0.14[NS]	-47.1[a]	-672[a]
	Standard Error	0.02	0.12	2.8	56
			0.78 $/pallet/hr	261 $/ 100%	3733 $/ 100%
	Quadratic Model				
	Coefficient	-0.21[a]	-0.16[NS]	-50.7[a]	-739[a]
	Standard Error	0.03	0.14	3.4	69
			0.75 $/pallet/hr	241 $/ 100%	3519 $/ 100%
MLFTL	Linear Model				
	Coefficient	-0.18[a]	-0.40[a]	-38.7[a]	-441[a]
	Standard Error	0.01	0.06	2.8	29
			2.22 $/pallet/hr	215 $/ 100%	2444 $/ 100%
	Quadratic Model				
	Coefficient	-0.18[a]	-0.53[a]	-42.77[a]	-545[a]
	Standard Error	0.02	0.11	3.4	55
			2.9 $/pallet/hr	238 $/ 100%	3027 $/ 100%

Notes: a: p<0.001 (ie, significant at 0.1% or less); b: p<0.05 (ie, significant at 5% or less); NS: not significant;

INFORMATION RETRIEVAL

Austroads (2003), **Economic Evaluation of Road Investment Proposals: Valuing Travel Time Savings for Freight**, Sydney, A4, 80pp, AP-230/03

KEYWORDS:

Economic analysis, freight, investment, logistics, planning, project evaluation, road freight, road user costs, roads, transport, travel time

ABSTRACT:

This document contains two separate reports describing studies to develop initial estimates of four attributes of freight travel time costs (freight rate, travel time, on-time delivery, and loss or damage), expressed as a freight rate per pallet per hour, in the context of three generic consignment types (inter-capital full truck load, metropolitan or intra-city full truck load, and metropolitan or intra-city less than full truck load services), in Australian conditions.

The two reports describe two surveys, a pilot in 1998 (Stage 1) and a more comprehensive survey in 2000 (Stage 2). Contextual stated preference techniques were used, with a total of 150 respondents and 449 completed responses. The first report demonstrated the feasibility of using the contextual stated preference technique approach.

The reports contain the survey profoma and details of the analysis of the results.

The econometric package LIMDEP was used for statistical analysis of the survey results. The larger scale of the second survey generally led to significantly more robust estimates of the travel time parameters than were realised in Stage 1.

The 1998 pilot survey involved road freight shippers in the automotive parts, food and beverages, and selected building materials and packaging industries, whereas the 2000 larger survey specifically focussed on freight shippers in the automotive components industries sector.

The critical early finding was that interviewers must be very familiar with the freight industry, and that great care in survey design, data collection and follow up are essential.

While these studies demonstrated the feasibility of the techniques and developed initial estimates of freight travel time savings for use in economic evaluation of road investment proposals, it is concluded that similar surveys of more market segments, possibly with larger sample sizes, would provide the data necessary to support routine estimation of freight travel time benefits from road investment.

AUSTROADS PUBLICATIONS

Austroads publishes a large number of guides and reports. Some of its publications are:

AP-1/89	Rural Road Design
AP-8/87	Visual Assessment of Pavement Condition

Guide to Traffic Engineering Practice

AP-11.1/88	Traffic Flow	AP-11.9/88	Arterial Road Traffic Management
AP-11.2/88	Roadway Capacity	AP-11.10/88	Local Area Traffic Management
AP-11.3/88	Traffic Studies	AP-11.11/88	Parking
AP-11.4/88	Road Crashes	AP-11.12/88	Roadway Lighting
AP-11.5/88	Intersections at Grade	AP-11.13/95	Pedestrians
AP-11.6/93	Roundabouts	AP-11.14/99	Bicycles
AP-11.7/88	Traffic Signals	AP-11.15/99	Motorcycle Safety
AP-11.8/88	Traffic Control Devices		

AP-12/91	Road Maintenance Practice
AP-13/91	Bridge Management Practice
AP-17/92	Pavement Design
AP-23/94	Waterway Design, A Guide to the Hydraulic Design of Bridges, Culverts & Floodways
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AP-36/95	Adaptions and Innovations in Road & Pavement Engineering
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