

**EFFECT OF TRUCK CHARGES ON
RAIL
INFORMATION PAPER**

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National Transport Commission

Prepared by:

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National Transport Commission

Effect of Truck Charges on Rail

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Objectives: To identify the issues in understanding the impact of pricing/cost recovery issues on modal choice for freight between road and rail and to undertake an analysis of the impacts to the extent possible.

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Abstract: **This report looks into the argument that there is under recovery from the road transport industry of the costs associated with the provision of road infrastructure and that this has distorted modal choice decisions for the movement of freight.**

Purpose: For information

Key words: modal choice, freight price elasticities, 3rd Determination Heavy Vehicle Road Pricing Charges, rail access prices

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FOREWORD

The National Transport Commission (NTC) is an independent body established under an Inter-Governmental Agreement, and funded jointly by the Australian Government, States and Territories. The NTC has an on-going responsibility to develop, monitor and maintain uniform or nationally consistent regulatory and operational reforms relating to road transport, rail transport and intermodal transport.

The NTC's heavy vehicle road pricing work contributes to strategies pursuing transport as a more sustainable activity, and in devising smarter approaches to regulation, provides both increased flexibility and greater certainty about results achieved.

National heavy vehicle road use charges were first introduced in 1995-96 following the First Heavy Vehicle Road Pricing Determination. A Second Heavy Vehicle Road Pricing Determination was agreed and implemented in 2000. The Third Heavy Vehicle Road Pricing Determination is an efficiency initiative on the NTC's national regulatory reform agenda, and is focussed on ensuring the prices paid by heavy vehicles for use of the road system reflect the Pricing Principles agreed by the Australian Transport Council (ATC), and in particular, continue to recover their share of the costs of providing and maintaining roads.

Work on the 3rd Determination has involved a major overhaul of the input data to the cost allocation model used in the Second Determination. The cost allocation model uses road expenditure and road usage data as inputs, and attributes expenditure by vehicle class as output.

The main purpose of this information paper is to identify the issues in understanding the impact of pricing/cost recovery issues on modal choice for freight between road and rail, and to undertake an analysis of the impacts to the extent possible.

The NTC acknowledges the work of Margaret Starrs of MM Starrs Pty Ltd as the author of this report, as well as the contributions of the NTC Road Pricing Team comprising Chris Egger, Fiona Calvert, Kerry Todero and Keith Lloyd.

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SUMMARY

Objectives

The objectives of this paper are to:

- identify the issues in understanding the impact of pricing/cost recovery issues on modal choice for freight between road and rail; and
- undertake an analysis of the impacts to the extent possible.

Tasks

The work was divided into 5 broad tasks, with some being dependent on others or related to them in some way. The tasks were as follows:

- 1 Assess the factors affecting mode selection, which were identified by a review of the literature.
- 2 Estimate freight price elasticities on the basis of the literature review.
- 3 Estimate the share of charges in truck operating costs (and/or freight rates) as changes to truck charges can only have an appreciable effect on mode choice if the truck charges themselves are a significant proportion of total costs.
- 4 Forecast how changing truck charges is likely to affect the demand for rail transport for a range of truck charge scenarios.
- 5 Compare and contrast rail and road access prices with respect to competitive neutrality.

Literature Review

The main conclusions drawn from the review of literature on factors affecting the demand for freight transport are that:

- supply chain management changes have favoured road transport because of its flexibility and ability to handle small shipment sizes;
- service level is more important relative to price due in part to these changes. For some users price is the main determinant of the mode choice decision and they are more likely to use rail, but these users are in the minority; and
- rail has advantages where it already has a good market share and has potential advantages where costs can be reduced and service levels improved.

A small, but significant, share (between 20 and 35 per cent) of European users of freight services makes mode decisions on price alone. These shippers are already using rail transport as they are cost conscious. The largest group of shippers are committed to road transport. There is no similar data available on the freight market in Australia and there is no way of knowing whether the European figures are transferable.

For most users, service levels are more important than price. These users will not be affected by changes to the level of truck charges to the same extent as users who make their decisions based solely on costs. This conclusion is based mainly on European and USA literature, but two studies relevant to the market for intercapital freight in Australia do not contradict this literature. Indeed, some support is given to the claim of disadvantages to rail of changes in supply chain management, to the importance of service levels in the demand for freight services, and to the need for rail to improve efficiency.

Freight Price Elasticities

Evidence on the level of elasticities was obtained from the literature review, from which there are large number of estimates with a wide range of values. There are a small number of elasticity estimates for the intercapital freight market, also with a wide range. There are very few estimates of cross price elasticities or how the demand for one mode (in our case rail) is affected by changes in the price of another mode (road). Estimates of cross elasticities are calculated from own price elasticities, although it is recognised that the use of this method will over-estimate the elasticities to some unknown extent.

The Australian elasticity values range from -0.2 to -1.1 , and are in the range of international experience. Given the large spread in values, no single value was used to estimate the effect of truck charges on rail demand. Four values were selected, with lower values for short haul corridors than for medium haul corridors, and lower values for medium haul corridors than long haul corridors. When combined with corridor specific data on market shares and freight rates a wider range of cross price elasticities was obtained as shown in the table below:

Corridors	Road Price	Cross Price Elasticity	
	Elasticity	Minimum	Maximum
Short haul	-0.5	4.03	5.39
	-0.7	5.64	7.54
Medium haul	-0.7	3.62	3.62
	-0.9	4.65	4.65
Long haul	-0.9	0.61	0.61
	-1.1	0.75	0.75

Short haul = less than 1,000 km, medium haul = more than 1,000 km and less than 2,000 km, long haul = more than 2,000 km.

Operating Costs

Truck operating costs are estimated to enable calculation of the share of truck charges in costs (and/or freight rates). As the aim is to make estimates of how truck charges affect freight rates, the costs were checked for consistency against published costs and rates.

Costs were estimated for B-double and 6-axle articulated trucks operating on interstate routes. Costs can be expected to vary as the operators, the types of operation performed

and the demand for services vary. This has been taken into account by varying some of the unit costs and by making estimates for low utilisation (200,000 km pa) and high utilisation (400,000 km pa) truck use. The operations costed are intended to represent intercapital operations at full loads, as these appear to be the loads potentially competitive with rail transport.

It was found that the current level of truck charges comprise less than 10 per cent of total truck operating costs, with the fuel charge comprising the majority. The charges share is higher for low utilisation operations due to the fixed nature of registration charges.

Rail freight rates for comparison with road rates comprise the rail linehaul rate and the road rate for pick up and delivery (PUD) of containers to rail terminals at each end of a trip. The costs per km operated of PUD trucks are very different to linehaul trucks because they operate at much lower levels of utilisation. Compared to linehaul trucks, the share of charges in total costs is lower, at 7 per cent, while the registration component is somewhat higher and the fuel component significantly lower.

Truck Charges and Rail Demand

The NTC provided 10 scenarios to test the effect of changes in the level and structure of truck charges on rail demand. They fell into 3 categories as follows:

1. Increases of 3, 10 or 30 per cent in either or both registration charges and the fuel charge of 20 cents/litre. These alternatives comprised the first 6 scenarios.
2. A fuel charge to recover all the allocated truck costs, which results in an increase of 44 per cent in the fuel charge (Scenario 7).
3. Mass-distance charges to recover unit costs that are 3, 10 or 30 per cent higher than the ones for the 2nd Determination (Scenarios 8 to 10).

A range of results was obtained, as might be expected. In summary:

- The estimated change in demand in proportional terms decreased with corridor length. This is to be expected given the cross elasticities in the table above. The higher the existing rail market share the lower the cross elasticity, which simply reflects the lower potential for rail to increase traffic because of existing traffic levels. The changes in demand in long haul corridors are very low (0 to 3.7 per cent).
- There was very little effect on rail demand for the first 5 charges scenarios (increases of up to 10 per cent in either or both the registration and fuel charges and a 30 per cent increase in registration) for short, medium and long haul corridors. These relatively small increases, when combined with the small share of truck charges in total costs, simply do not have much effect. The changes ranged from 0 to 5.3 per cent.
- The next two scenarios (increase registration and fuel by 30 per cent, or a fuel-only charge) have a greater effect on rail demand, as one would expect. The rail demand increases are 8.1 to 18.2 per cent for short haul corridors and 9.1 to 13.0 per cent for medium haul corridors.
- The mass-distance charge scenarios also have a significant effect. Scenario 8 (increase in unit costs of 3 per cent) has less effect than the fuel-only scenario, but when unit costs are increased by 10 and 30 per cent larger increases in demand for rail transport

are forecast: up to 38.7 per cent in short haul corridors and up to 23.1 per cent in medium haul corridors.

The estimated increases in demand should be regarded as maximums as estimates of the share of truck charges in operating costs and the elasticities are conservative, and the analysis assumes that the only response to increased truck charges is an increase in freight rates.

The report contains estimates of what the proportional increases mean in terms of rail tonnes carried and rail market shares; there is uncertainty associated with these estimates as the share of freight that is contestable is not known. Again the effect is relatively small. Less than one train service per day would be required to carry the extra tonnes in all scenarios except Scenario 10 (mass-distance charges with a 30 per cent increase in unit costs). The rail market share would be relatively constant except for scenarios that involve large increases and/or changes in the structure of truck charges.

The general conclusion is that only relatively small changes in rail demand are likely to result from increases in truck charges unless the increases are very large indeed. This does not mean that the changes would not be of significance to rail operators given the continuing loss of market share that is forecast to occur in the future.

Access Charges

The final task was to compare and contrast the truck (access) charges with rail access prices with respect to competitive neutrality. The report concludes that the methods of calculation are different, but that appears to have little practical effect as rail access charges do not currently cover the full economic costs of the provision of rail infrastructure. There are insufficient data available to be more conclusive on an empirical basis. The charges that trucks pay to use the road system, as a proportion of total operating costs, are below those paid by freight trains to use rail system, and this is will continue even with any of the scenarios for truck charges analysed. As the truck and rail charges are cost-based, this is not a competitive neutrality matter, it simply reflects differences in costs.

CONTENTS

1. INTRODUCTION	1
2. FACTORS AFFECTING DEMAND.....	2
2.1 Supply Chain Management	2
2.2 Service Level vs Price	3
2.3 Advantages of Rail Transport	4
2.4 Conclusion	4
3. ELASTICITIES OF DEMAND	5
3.1 General Results	5
3.2 Australian Results.....	6
3.3 Mode Shares	7
3.4 Conclusions	8
4. TRUCK OPERATING COSTS.....	8
4.1 Total Costs.....	9
4.2 Truck Charges	11
4.3 Freight Rates	11
5. RAIL DEMAND.....	12
5.1 Cross Elasticities	12
5.2 Charge Scenarios	13
5.3 Rates and Demand.....	15
5.4 Conclusions	18
6. ACCESS PRICES.....	19
6.1 Methods of Calculation	19
6.2 Relative Levels of Charges.....	21
7. REFERENCES	22
APPENDIX A	27

LIST OF TABLES

Table 1.	Estimates of the Price Elasticity Demand	5
Table 2.	Rail Market Shares by Corridor and Year	7
Table 3.	Truck Price Elasticities for Use in Analysis	8
Table 4.	Data Used in Truck Costing.....	10
Table 5.	Truck Charges and Operating Costs	11
Table 6.	Cross Price Elasticities for Use in Analysis.....	13
Table 7.	Calculation of Mass-Distance Charges for Trucks Operating in Short and Long Haul Interstate Corridors	14
Table 8.	Change in Road Freight Rate and Rail Demand by Scenario, Short Haul Corridors (per cent).....	16
Table 9.	Change in Road Freight Rate and Rail Demand by Scenario, Medium and Long Haul Corridors (per cent).....	17
Table 10.	Rail Freight and Market Shares by Scenario.....	18

1. INTRODUCTION

The rail industry has argued that there is under recovery from the road transport industry of the costs associated with the provision of the road infrastructure and that this has distorted modal choice decisions for the movement of freight. The issue is of importance to the National Transport Commission as it undertakes the 3rd Determination for heavy vehicle charges. The issue was raised in respect of the last Determination but little work was undertaken to investigate it. That is no longer possible as competitive neutrality is an objective of the Pricing Principles now in force.

The objectives of this paper are to:

- identify the issues in understanding the impact of pricing/cost recovery issues on modal choice for freight between road and rail; and
- undertake an analysis of the impacts to the extent possible.

The work was divided into 5 broad tasks, with some being dependent on others or related to them in some way. The tasks were as follows:

- 1 Factors affecting mode selection. They were identified by a review of the literature including 1998 and later years; 1998 was used as the cut off year as a literature review was previously undertaken in 1999. It was expected that there would be more information available now and some differences in the findings due to changes in transport and logistics operations and the concentration on policies promoting the use of intermodal (road-rail) transport as an alternative to road transport. This proved to be the case.
- 2 Freight price elasticities. Information on elasticities was collected in the literature review mentioned in 1 above. Few recent Australian elasticity estimates were found but some recent and apparently significant studies have been undertaken in Europe and the USA. Whether it is reasonable to use elasticities from other places is arguable. Some confidence may be gained in the reliability of their use by some checks on their reasonableness; such checks may include evidence on market shares, the share of the traffic that is contestable, average trip distances and time sensitivity of the freight carried. The elasticities are used in conjunction with other data (see below) to show the potential effect of truck charges of a particular level and structure on the demand for rail freight.
- 3 Share of charges in truck operating costs (and/or freight rates). Changes to truck charges can only have an appreciable effect on mode choice if the truck charges themselves are a significant proportion of total costs. The task required the collection and analysis of information on costs and rates.
- 4 Forecast how changing truck charges is likely to affect the demand for rail transport. The share of truck charges is an output of the truck operating cost model so the effect of changes in charges can be estimated. Comparison of truck costs/rates can then be used in combination with rail rates and elasticities to make estimates of how rail traffic may be affected by variations in the level of truck charges.
- 5 Rail access prices. The methods used to set rail access prices are described, with the aim of identifying the differences and similarities with the truck charges, on the basis that they can be regarded as road access prices. The concentration is on the method of

calculating access charges (not the level of the charges themselves) for competitive traffics, ie traffics that could potentially be carried by either road or rail.

2. FACTORS AFFECTING DEMAND

A literature search was undertaken by ARRB Transport Research to identify references dealing with the demand for freight transport, and particularly factors affecting relative demand for road and rail transport. Key terms specified were freight transport, logistics, intermodal transport, price (freight rates, road rates, rail rates), level of service (service quality, travel or transit time, reliability), elasticity of demand (price, service level, travel time, reliability) and mode choice.

The search returned 141 potential references, of which 39 were assessed as relevant from the title and abstract. These references were then scanned and 14 rejected as they mainly related to scheduling of transport or urban freight movements or sea transport or the relative economic costs of rail and road (they are included in Appendix A). Generally literature prior to 1999 was not reviewed as the search identified such a large number of potentially relevant articles. The final review included 49, including some references from previous reviews and our wider reading on the topic. The relevant literature is summarised by year and author in Appendix A.

The three main conclusions that can be drawn from the review are that:

1. supply chain management changes have favoured road transport because of its flexibility and ability to handle small shipment sizes;
2. service level is more important relative to price due in part to these changes. For some users price is the main determinant of the mode choice decision and they are more likely to use rail, but these users are in the minority; and
3. rail has advantages where it already has a good market share and has potential advantages where costs can be reduced and service levels improved.

2.1 Supply Chain Management

Several papers examine changes to logistics that have resulted in integration of production and distribution functions (eg Disney et al 2003, Woodburn 2003). Smith et al (2002) describe the changes as follows:

Logistics managers can now integrate processes and collaborate within and across firms and so reduce cycle times, inventory, and other supply-chain costs. Successful integration supports a pull supply-chain model, where customers demand goods, which are built to order and quickly dispatched. This contrasts with the traditional push supply chain: forecast demand, produce the product for stock, and warehouse close to the customer. ... Pull systems result in the movement of smaller quantities more frequently and just in time (JIT) with, hence, lower inventory holdings. Making-to-order also leads to fewer returns. However such systems are unforgiving, and reliable delivery (on time and intact) is of higher importance.

Most authors agree that these changes have favoured road transport as it is better able to provide smaller shipments and more flexible delivery times (eg Woodburn 2003, Fowkes and Whiteing 2003, Rothengatter and Doll 2002). Producers and customers are most likely to continue to demand such types and levels of service even in the face of increases in

costs (Van Schijndel and Dinwoodie 2000, Tsamboulas and Kapros 2000). Rail and/or intermodal transport could benefit with increased speed and reliability (Smith et al 2003, Rothengatter and Doll 2002) and better synchronisation of schedules to gain the economies of scale from integrated transport services (Panayides 2002).

2.2 Service Level vs Price

A large number of references contain surveys aimed at determining the factors that drive mode choice and their relative importance. Some of these surveys are then used to estimate demand models from which elasticities can be derived (see Section 3 below).

Most of the more recent surveys are European due to the policy concentration on reducing road transport and encouraging the use of intermodal or rail transport. There are a range of results reported and they sometimes conflict, eg price is found to be the most important factor in a small number of studies (eg de Jong et al 2001), while service levels are in most studies (eg Norojono and Young 2000, 2001, Woodburn 2003, Vilain and Wolfrom 2000). Lai et al (2002) conclude that transport must be both efficient and effective and the cheapest is not necessarily selected if the service level is not adequate to meet needs.

A review of 19 studies of the factors considered by shippers in the USA clearly shows that service level is more important than price in mode choice and in the selection of a road transport operator, and reliability is the most important service level factor (Murphy and Hall 1995). Price has become relatively more important since deregulation, ie more competition, and is more important in mode choice; it nevertheless remains subservient.

An interpretation of the conflicting results on price and service level is that that no single factor is the most important for all users of freight transport. In their survey of 92 large European forwarders, carriers and shipping lines, Tsamboulas and Kapros (2000) identify three groups including one that is quality-cost oriented, representing 45 per cent, and another that is cost oriented, representing 35 per cent. Users in the latter group make decisions almost solely based on costs, are the most intensive users of intermodal services, and show the most potential to increase their rail use so long as prices remain below the alternatives. Users in the quality-cost oriented group place more emphasis on reliability, safety and flexibility and are concerned with supply variables such as frequency, mode and information systems. Intermodal transport does not fully meet the needs of this group and is unlikely to do so unless all quality aspects of intermodal transport can be improved.

These two groups could be regarded as captives in the demand modelling jargon normally applied to public transport. Indeed, Widlert and Bradley (1993) use that terminology in discussing the results of their survey of freight shippers in Sweden. They concluded that 55 per cent of freight was captive to road and 20 per cent captive to rail, with only 25 per cent potentially competitive.

A further interpretation of the conflicting results with respect to the relative importance of price lies in the definition of service level variables. The need to quantify variables for modelling purposes often means that service level is defined simply as transit time, while it is often on time arrival, time of departure, regularity and/or frequency of service that are more important. For example, a BTCE (1997) survey found that transit time was not important to forwarders that use rail but the *preferences seem to be for daily services on major routes with trains scheduled to leave as late as possible in the day, arriving at their destinations early in the morning*. Specification of level of service variables may also affect elasticity estimates, as discussed in Section 3.

2.3 Advantages of Rail Transport

The literature points to several advantages that rail has over road transport. The main ones relate to the markets in which it already does well such as loyal customers (Woodburn 2003), movement of containerised freight, particularly shipping containers (Smith et al 2002) and price oriented users (Norojono and Young 2000, 2001, Tsamboulas and Kapros 2000).

Rail and/or intermodal transport also has potential to gain new customers if its price relative to road can be reduced. This may be achieved by efficiency improvements aimed at reducing costs (Smith et al 2002, Widlert and Bradley 1993, Beuthe et al 2001) or improving service levels (BTCE 1997). In this context, two European studies model the effects of changes in price and service levels on mode choice:

1. Rothengatter and Doll (2002) model the effects of the (then) proposed increases in truck charges in Germany and conclude that domestic rail use could increase by 4 per cent and international by 7 per cent. Although these are not large increases relative to the increase in truck charges (about 5 times the existing level), they also suggest that larger increases in rail use could occur if rail service levels were improved (unspecified) at the same time (12 per cent of domestic freight and 35 per cent of international freight).
2. de Jong, Gunn and Ben-Akiva (2004) conclude that a 40 per cent increase in truck operating costs would be the most effective policy to increase rail use, although they do not specify how that would be achieved. They also note that such an increase may not have economic benefits because the increase in transport costs is unlikely to be outweighed by the savings in the environmental costs due to the mode switch.

On the other hand, several studies note the resistance of shippers of freight to switch to intermodal transport due to poor service levels (Beuthe et al 2001, Van Schijndel and Dinwoodie 2000, Woodburn 2003, Musso 2001). This resistance is not always rational but rather a perception based on past experience and/or the experience of colleagues.

2.4 Conclusion

A small, but significant, share (20 and 35 per cent) of the users of freight services makes mode decisions on price alone on the basis of studies in Sweden (Widlert and Bradley 1993) and Europe (Tsamboulas and Kapros 2000). These shippers are already using rail transport as they are cost conscious. Other shippers are either committed to road (55 and 45 per cent) or could use either mode depending prices and service levels (25 and 20 per cent). On the basis of these studies, traffic that is potentially contestable to rail or road is between 20 and 25 per cent of the freight market in Europe. There is no way of knowing whether these results are transferable.

For most users, service levels are more important than price, although price remains a factor in their mode choice. These users will not be affected by changes to the level of truck charges to the same extent; it is likely that the increase in charges would need to be large for the relative importance of price and service level to be reversed.

The review covered mainly European and USA literature, with the former predominating. The question arises about whether the conclusions drawn are transferable to the market for intercapital freight in Australia. In support, the two studies covering intercapital freight (Smith et al 2002 and BTCE 1997) do not contradict the other literature. Indeed, some

support is given to the claim of disadvantages to rail of changes in supply chain management, to the importance of service levels in the demand for freight services, and to the need for rail to improve efficiency.

3. ELASTICITIES OF DEMAND

Evidence on the level of elasticities was obtained from the literature review (see Appendix A). Although there are an increasing number of estimates, there also seems to be an increase in the range. That may make it difficult to use estimates from other places to supplement the very small number of elasticity estimates for the Australian freight market.

There are very few estimates of cross price elasticities, how the demand for one mode (in our case rail) is affected by changes in the price of another mode (road). As it is possible to make estimates of cross elasticities from own price elasticities with information on mode shares and freight rates, the own price elasticities are of interest.

3.1 General Results

Oum et al (1990, 1992) remains the most comprehensive review of freight market elasticities. The latest review by Graham and Glaister (2004) includes later references but does not interpret them to the same extent. Different measurement/modelling techniques give different measures of elasticities: for example a choice elasticity is not the same as an ordinary (or market demand) elasticity, and it is ordinary elasticities that are of interest in this study. Oum et al classify the various estimates of demand by mode and make recommendations on the likely range of the value of ordinary elasticities (see Table 1). Graham and Glaister do not comment on elasticities by mode, and they include elasticities by commodity type so they obtain a larger range. Their most likely range represents 66 per cent of the estimates reviewed. A meta model¹ using the results of several European freight models also gives elasticity values that can be interpreted as a review (de Jong, Gunn and Ben-Akiva 2004).

Table 1. Estimates of the Price Elasticity Demand

	Mode	Range Surveyed	Most Likely Range
Oum et al	Rail	-0.09 to -1.52	-0.40 to -1.20
	Truck	-0.05 to -1.34	-0.70 to -1.10
Graham & Glaister	All	1.72 to -7.92	-0.50 to -1.07
de Jong, Gunn and Ben-Akiva	Truck	-0.4 to -0.7	na

Graham and Glaister (2004) consider that the range of elasticity values is too wide to be able to make a recommendation on values that could be used in economic analysis. This is not a very helpful conclusion when some assessment of the effects of various policies is required. In selecting what might be a reasonable set of elasticities to use to estimate the

¹ A meta model is based on several other models, ie an analysis of analyses.

effect of increased truck charges on the demand for rail freight, results from specific studies are also relevant. For example:

- Demand for the use of a specific mode is more inelastic the higher the mode share (eg Beuthe et al 2001, Abdelwahab 1998). Mode shares are not often reported in the papers reviewed, but where they are they support this contention, eg the Beuthe et al data set has an overall rail market share of 9 per cent. This tends to be confirmed by Jiang et al (1999) who find that length of haul is the most significant factor in the choice of intermodal transport.
- The elasticity of demand for road transport is generally found to have a lower absolute value than that for rail transport (eg Beuthe et al 2001, Abdelwahab 1998). This is likely to reflect mode shares and length of haul to some extent, but also the users of rail transport. As noted in Section 2.2, rail users are more price sensitive than road users.
- The demand for freight overall is inelastic but where there is competition elasticities increase. Oum et al (1990) therefore suggest that the lower end of the elasticities in Table 1 should be used.

3.2 Australian Results

Most of the available Australian elasticity estimates were undertaken by the Bureau of Transport Economics (BTE) and are now very old (they date from the 1970s and 1980s). They are not included in the references in Appendix A but generally resulted in a short run road price elasticity of -0.4 and a long run one of -0.7 . They were generally confirmed in work undertaken in 1997 for the National Road Transport Commission in connection with the 2nd Determination (Melbourne Institute 1997): short run elasticity of -0.2 and long run of -0.8 . There were some deficiencies with the data and estimation techniques in all these studies, although that is probably true of most.

There are three more recent references that enable us to say something about freight price elasticity of demand and the potential effect on rail demand of changes in truck charges.

The BTE (1999) paper on competitive neutrality makes estimates of changes in demand for road and rail as a result of changes in charges. The implied cross elasticity of demand for rail with respect to the price of truck is about 0.9. The elasticity relates to an 'analytical corridor' of about 1,000 kilometres long with a rail market share of 32 per cent.

Booz·Allen & Hamilton (BAH) (2001) reports a price elasticity of -1.1 used in a mode choice model to estimate changes in demand as a result of investment in rail infrastructure. This is a choice elasticity so it is expected to be higher than an ordinary elasticity. The same value is used for both modes, short and long haul corridors and all market shares, where short haul corridors are those of less than 1,000 km. Elasticities are also included for 3 service level variables (transit time, reliability, service availability), none of which has a higher absolute value than the price elasticity but in total they just do, giving limited support that service level is more important than price.

These elasticities are not supported by the literature reviewed above. Nevertheless, BAH says that they are based on stated and revealed preference data. A potential explanation is that rail users predominated in the stated preference surveys and, as discussed in Section 2.2, they make choices based on price.

Gargett (2004) undertakes a time series regression of road freight as a function of GDP and road freight rates and reports a price elasticity of -0.9 . The GDP elasticity is 1.2,

indicating that the road freight task grows faster than income. No explanatory variables for service levels or competitive modes are included.

3.3 Mode Shares

The Bureau of Transport and Regional Economics (BTRE) has recently published data on road and rail freight flows in selected corridors, from which the rail market shares shown in Table 2 are calculated. Rail carries about one fifth of the tonnes shipped and one third of the freight task (in tonne-km): the rail mode shares are expected to fall somewhat over time. The rail share is highest in the longer corridors as expected. Rail is also expected to have an advantage over road in the carriage of high density freight, although there are no readily available data on the types of freight carried by either mode.

Table 2. Rail Market Shares by Corridor and Year

Corridor	2001	2004	2010
Melbourne-Sydney	0.12	0.10	0.07
Sydney-Brisbane	0.16	0.12	0.07
Melbourne-Brisbane	0.31	0.32	0.33
Sydney-Adelaide	0.18	0.15	0.11
Melbourne-Adelaide	0.15	0.11	0.05
Eastern States-Perth	0.71	0.71	0.71
Sydney-Canberra	0.00	0.00	0.00
All corridors (tonnes)	0.21	0.19	0.16
All corridors (tonne-km)	0.37	0.35	0.33

Source: BTRE (2003a). Market shares on either basis are essentially the same by corridor but the average rail market share over all corridors is higher on a tonne-km basis as rail market shares are higher on longer corridors.

These market shares vary somewhat from those reported by the ARTC, which gives, for example, 81 per cent between Perth and Sydney and Melbourne, 21 per cent between Melbourne and Brisbane, 19 per cent between Sydney and Brisbane, 21 per cent between Melbourne and Adelaide². The differences are likely to reflect differences in corridor definitions and the types of freight included (ie intermodal freight or all freight). There are no published data that enables any clarification of these issues.

As noted above, elasticities vary with mode shares and yet very few studies publish data on them for checks to be made on whether they may be representative of freight movements in other places. The rail share of intercapital freight in Australia is significantly greater than in Europe (approximately 10 per cent) and somewhat below that in the USA (approximately 40 per cent); this may suggest that elasticities from the latter can be transferred with greater certainty.

² <http://www.artc.com.au/docs/news/pdf/AusRAIL%202004%20Final%20-%20D%20Marchant%20ARTC.pdf>, 27/12/2004.

Many of the USA studies predate freight deregulation; as discussed in Section 2.2, that has been accompanied by a change in the relative importance of the factors affecting demand. One would therefore expect elasticity values to change also, although none of the relevant literature addresses this issue. Of course, the intercapital freight market in Australia was never controlled and has been very competitive over several decades. Elasticities may therefore be higher than in other places.

Demand is more inelastic when there are fewer alternatives or no alternatives or a mode has a specific advantage in the carriage of freight. Where these situations occur, the freight can be classified as non-contestable, ie not subject to competition from another mode. There are no specific estimates of the level of freight that is contestable in intercapital freight markets in Australia. The increasing mode share of road on short haul corridors and rail on long haul corridors suggests that there is a significant range of freight that is contestable, but also that some is not. Anecdotal evidence suggests that time sensitive or low density freight is more likely to be carried by road and freight that is containerised or high density is more likely to be carried by rail (ie international containers). But without more detailed information on the freight that is actually carried it is not possible to be precise.

Information reviewed in Section 2.2 gives some indication in other places. For example, the evidence that price is the most important factor in mode selection for rail users suggests that road would not be considered unless its price was lower, and conversely that rail service levels would need to improve rather than freight rates reduce for quality oriented shippers to change modes. Price sensitive users are estimated at between 20 and 35 per cent of the shippers in Europe (see Section 2.4).

3.4 Conclusions

There is a large range of elasticity values reviewed and the Australian results are in the range of international experience. Without more detailed information on the type of freight moved and other indications of how contestable the freight may be, a range of elasticities with variations by corridor length is used, as shown in Table 3. The categorisation by corridor length implicitly includes mode share as the longer the corridor the higher the mode share. The values selected compare with values of -0.4 and -0.7 estimated by the BTE, -0.2 and -0.8 estimated by the Melbourne Institute, -1.1 estimated by BAH and -0.9 estimated by Gargett.

Table 3. Truck Price Elasticities for Use in Analysis

Corridor	Low	High
Short haul	-0.5	-0.7
Long haul	-0.9	-1.1

Short haul is less than 1,000 km and long haul more than 1,000 km.

4. TRUCK OPERATING COSTS

Truck operating costs are estimated to enable calculation of the share of truck charges in costs (and/or freight rates). Changes to truck charges can only have an appreciable effect on mode choice if the truck charges themselves are a significant proportion of total costs.

As the aim is to make estimates of how truck charges affect freight rates, the costs need to be checked for consistency against available rates.

4.1 Total Costs

Truck operating costs are estimated from data on operating costs and freight rates collected by Ian Wright and Associates from a variety of industry sources, and checked against other readily available published sources.

Costs were estimated for B-double and 6-axle articulated trucks operating on interstate routes. Costs can be expected to vary as the operators, the types of operation performed and the demand for services vary. This has been taken into account by varying some of the unit costs and by making estimates for low utilisation (200,000 km pa) and high utilisation (400,000 km pa) truck use. The unit costs are shown in Table 4 and the resulting truck operating costs in \$ per km are shown in the right hand column of Table 5.

The operations costed are intended to represent interstate operations at full loads as these appear to be the loads potentially competitive with rail transport. New vehicles are used, fuel consumption is for a full load on a new vehicle, and maintenance costs are for new vehicles although some allowance is made for increases over time. The life of 5 years for a prime mover is for intense interstate operations, although they can be used on other tasks for many more years where reliability and relatively maintenance free operation is not so important. The fuel cost of 95 cents per litre allows for some discount on the current retail price in the order of \$1.05 per litre; discounts are common to large operators but also current recommended freight rates include fuel surcharges. No set of costs can represent the situation of every operator. The most efficient operator will always place pressure on freight rates, which is the variable that is important in determining demand for road and rail transport.

The total costs were checked for consistency against readily available published information and were found to be in line with those sources, as follows:

- The TWU/ARTF cost model gives \$1.328 per km for a full rig and \$1.186 per km for a tow operator.
- The TWU/ARTF recommended minimum rates (September 2004) vary from \$0.96 to \$1.78 per km depending on corridor and whether the load is a forward or back haul. The average is \$1.40 per km for short haul routes (less than 1,000 km) and \$1.25 per km for long haul routes (more than 1,000 km). The rate is calculated at a load of 23 tonnes in each direction in each corridor.
- In 2000 ACIL Tasman made estimates of sustainable rates on which the TWU/ARTF minimum rates are believed to be based. They estimated a rate of \$1.43 per km, including (amongst other things) profit margin, tax and full loads in each direction (ACIL Tasman 2003).

None of these cost/rates state whether they are calculated for B-doubles or 6-axle articulated trucks. They may be maximums as ACIL Tasman (2003) reports that about 65 per cent of road transport businesses do not earn a profit.³

³ 60 per cent (92 per cent of the 65 per cent) are owner operators who earn less than the truck driver wage (Table 10, p13).

Table 4. Data Used in Truck Costing

Item	Rate/Unit Cost		Comments
	B-doubles	6-axle	
Prime Mover			
Purchase price (\$)	230,000 – 250,000	210,000 – 230,000	Cost varies with km pa operated
Life (years)	5	5	
Residual (% purchase price)	20	20	
Trailers			
Purchase price (\$)	70,000 – 90,000	70,000 – 90,000	Cost varies with km pa operated
Life (years)	10	10	
Residual (% purchase price)	10	10	
Interest rate (per cent)	7.5	7.5	
Stamp duty (% purchase price)	2.5	2.5	Victorian rate
Registration (\$ pa)	7,492	4,737	Prime movers: \$5,506/ \$3,744, Trailers: \$993
Third party insurance (\$ pa)	1,510	1,510	Victorian TAC rate
Truck insurance (% purchase price)	5.5	5.5	
Labour Costs			
Drivers (cents/km)	30.14	28.65	TWU award Grades 8 and 6
Living Away Allowance (\$/night)	55	55	Nights away vary with trip length and km pa operated
Loader (\$/hour)	18.84	18.84	TWU award Grade 8; 4 hours/trip
On costs (% wages)	30	30	
Fuel			
Consumption (litres/100 km)	52-60	46-49	Varies with load (100% forward 70% backhaul)
Fuel charge (cents/litre)	20	20	
Fuel cost (cents/litre)	56.5	56.5	Retail price (95) – diesel grant (18.51) – charge (20)
Maintenance (cents/km)	10.4 –13.2	9.1 – 11.6	Costs increase over time
Tyres (cents/km)	6.6	5.0	New on steer and drive; 1/3 new, 2/3 recaps on trailers
Administration (% of costs)	5	5	

Table 5. Truck Charges and Operating Costs

Truck Type/ Use	Share of Costs (per cent)			Cost per km (\$)
	Registration	Fuel	Total	
B-double				
200,000 km	2.3	6.7	9.0	1.66
400,000 km	1.3	7.6	8.9	1.47
6-axle articulated				
200,000 km	1.2	6.8	8.0	1.40
400,000 km	0.9	7.6	8.6	1.25

4.2 Truck Charges

Table 5 shows that the current level of truck charges comprise less than 10 per cent of total truck operating costs, with the fuel charge comprising the majority.

The truck operating costs are one indication of freight rates. Rates will not exactly equal costs for several reasons. Firstly, costs vary for different types of operation. Secondly, some truck operators will make more profit than others depending on the level of competition and how cost efficient they are (ACIL Tasman 2003). Thirdly, costs other than for the truck linehaul may need to be covered, eg terminals, consolidation, loading. And lastly, many trucking companies offer discounts for big customers. Nevertheless, the estimates of the range of truck charges in total costs will be used as representing the effect on road freight rates. It is most likely that the exclusion of the variations above will add to freight rates overall so if anything the share of truck charges in rates will be lower than shown in Table 5.

4.3 Freight Rates

Estimates of road and rail freight rates were obtained from previous studies, where the estimates were generally provided on a confidential basis. They were checked with a limited number of trucking companies by Ian Wright and Associates. The road rates generally have the same pattern as the recommended minimum rates published by the TWU/ARTF. The rates overall are somewhat lower, particularly the backhaul rates. This is likely to reflect discounting practices and the difficulty of obtaining backloads from some places. The latter was also found to be the case by ACIL Tasman (2003).

Rail freight rates for comparison with road rates comprise the rail linehaul rate and the road rate for pick up and delivery (PUD) of containers to rail terminals at each end of a trip. The costs per km operated of PUD trucks are very different to linehaul trucks because they operate at much lower levels of utilisation; this affects the level of fixed costs (eg truck capital) or costs of a fixed nature (eg drivers) when expressed per km. For example, SCOT Working Party (1995) reports costs per km for a 6 axle articulated truck with a utilisation of 30,000 km pa 3.3 times higher than one performing 250,000 km pa.

We estimate that the cost of PUD trucks operating 50,000 km pa is \$3.24 per km, with charges representing 6.6 per cent of total costs (registration charges 2.9 per cent and fuel

charges 3.7 per cent). Compared to linehaul trucks, the share of charges in total costs is lower while the registration component is somewhat higher and the fuel component significantly lower.

5. RAIL DEMAND

Rail demand will increase if truck charges increase, with the size of the increase being dependent on how the truck charges affect road freight rates. The assumption is made that all of the increase in truck charges is passed fully to the shippers of freight. It is possible that competitive pressures mean that truck operators respond by making changes to their operations to achieve cost reductions in other areas or by absorbing some or all of the cost increase so that none or only part of the increase is passed on in freight rates.

5.1 Cross Elasticities

The road price elasticities of demand are converted to cross price elasticities using standard economic relationships. The cross price elasticity comprises a mode substitution effect and an effect on the overall level of demand for freight (generation effect⁴). The former can be directly related to the price elasticity as follows:

cross price elasticity = the own price elasticity multiplied by the ratio of the revenue shares of the two modes.

The cross price elasticity therefore varies with market shares, and the road and rail freight rates. For example, if the road own price elasticity is -0.5 and rail earns 20 per cent of the freight rate revenue, then the elasticity of demand for rail with respect to the price of road equals:

$$0.5 * 80/20 \text{ or } 2.0.$$

If the revenue shares are equal then the cross price elasticity is simply the road price elasticity. If the revenues shares are reversed, then the cross price elasticity is 0.125. It can be seen that cross price elasticities vary with market shares; in this case, the higher the road share the higher the cross elasticity.

The generation effect relates to the average level of freight rates in a market. If a price increases, then it is expected that the demand for freight transport will reduce overall as freight transport becomes more expensive relative to other inputs to the production process. No information on the potential size of this effect could be found but there are indications that it is not trivial: firstly, changes in production structures over time as transport costs have reduced and secondly, estimates of the elasticity of income (GDP) of greater than one in the demand for road freight transport (Gargett 2004). An alternative is to apply the elasticities only to freight that could be diverted from one mode to another, ie it is contestable. Apart from the fact that there is no information to enable estimates of such freight to be made, the elasticity values may take the level of non-contestable traffic into account. This is because most elasticity values are calculated either 'all other things being equal' or with the effect of other factors on demand being simultaneously taken into account.

⁴ This effect is referred to as a substitution effect in the economics literature as transport is substituted for other inputs. As we are talking about modal substitution, generation is used to reduce confusion; generation is commonly used in urban public transport analysis.

Only the mode substitution effect is included in the cross elasticities reported in Table 6, and it is applied to all freight in a corridor. This means that the increase in rail demand is most likely over-estimated. The only estimate of a cross price elasticity found in the literature was an implied value of 0.9 for a corridor of 1,000 km with a rail market share of 32 per cent (see Section 3.2); this is considerably lower than the values in the table.

The range presented in the table results from different market shares and freight rates in the 5 corridors for which suitable data are available. The cross elasticities are larger for the shorter corridors (Melbourne-Sydney, Sydney-Brisbane, Melbourne-Adelaide) mainly due to the low rail market shares in these corridors (10 to 12 per cent as shown in Table 2). The 2 longer haul corridors have different characteristics: between the Eastern States and Perth, rail dominates the market (71 per cent) and the distance is over 3,000 km, while between Melbourne and Brisbane, the rail share is 32 per cent and the distance less than 2,000 km. As a result, the greater than 1,000 km corridors are split into medium and long haul corridors for the rail demand analysis.

Table 6. Cross Price Elasticities for Use in Analysis

Corridors	Road Price	Cross Price Elasticity	
	Elasticity	Minimum	Maximum
Short haul	-0.5	4.03	5.39
	-0.7	5.64	7.54
Medium haul	-0.7	3.62	3.62
	-0.9	4.65	4.65
Long haul	-0.9	0.61	0.61
	-1.1	0.75	0.75

5.2 Charge Scenarios

The NTC provided 10 alternatives to test the effect of changes in the level and structure of truck charges on rail demand. They fell into 3 categories as follows:

1. Increases of 3, 10 or 30 per cent in either or both registration charges and the fuel charge of 20 cents/litre. These alternatives comprised the first 6 scenarios.
2. A fuel charge to recover all the allocated truck costs, which results in an increase of 44 per cent in the fuel charge (Scenario 7).
3. Mass-distance charges to recover unit costs that are 3, 10 or 30 per cent higher than the ones for the 2nd Determination (Scenarios 8 to 10).

For the first two categories, the existing registration and fuel charges are simply increased by the relevant percentages. For the mass-distance charge scenarios, road use costs have to be estimated for specific truck operations; the operations are the low and high utilisation B-doubles carrying full loads used in estimating truck operating costs as they are the ones most likely to compete with rail. Arterial road unit costs from the cost allocation process (for the 2nd Determination) are then applied to the truck operations, as shown in Table 7.

Table 7. Calculation of Mass-Distance Charges for Trucks Operating in Short and Long Haul Interstate Corridors

Parameter	Parameter Value	Distance (km)		Unit Cost cents/ parameter km	Total Cost (\$)	
		Short haul	Long haul		Short haul	Long haul
VKT (separable)	1	200,000	400,000	0.41	810	1,621
PCU	4	200,000	400,000	0.13	1,067	2,135
AGM (forward)	62.5	100,000	200,000	0.10	6,466	12,933
AGM (backhaul)	50.7	100,000	200,000	0.10	5,249	10,498
ESA (forward)	4.18	100,000	200,000	2.79	11,677	23,353
ESA (backhaul)	2.26	100,000	200,000	2.79	6,301	12,603
VKT (non-separable)	1	200,000	400,000	1.97	3,931	7,863
Total Costs					35,502	71,005
Current charges						
Registration					7,492	7,492
Fuel charge @ 20 cents/litre					22,400	44,800
Total charges					29,892	52,292
Mass distance charge increase (per cent)					19	36

The procedure involves the following steps:

- Allocate parameter values for the cost allocation process:
 - the passenger car unit equivalent factor (PCU) is 4 for B-doubles;
 - the average gross mass (AGM), or gross mass in this case, factor is from the truck operating cost calculations, ie trucks are fully loaded for half of the km operated (62.5 tonnes) and 70 per cent loaded the rest of the time (50.7 tonnes)⁵; and
 - calculate the equivalent standard axles (ESA) from the formula in the cost allocation process relating gross mass to ESAs, giving 4.18 for a fully loaded truck and 2.26 for a partially loaded one (NRTC 1993)⁶.

⁵ The 70 per cent is the average backhaul share of forward tonnes, calculated over several corridors, in BTCE (1995) over both short haul and long haul corridors, discounted by 20 per cent to allow for variations in tonnes carried over the year. The share for long haul corridors is 62 per cent and 73 per cent for long haul corridors.

⁶ The formula for 7 or more axle trucks is $ESA = 0.223 \times 10^{-6} \times AGM^4 + 0.78$.

- Multiply the parameter values by distance travelled (VKT), in this case 200,000 km pa in short haul corridors and 400,000 km pa in long haul corridors, to obtain distance weighted parameters (parameter km).
- Multiply the parameter km by the relevant unit cost. Arterial road unit costs from the 2nd Determination cost allocation process are used as these are the latest unit costs available.

At existing unit cost rates, mass-distance charges would result in annual payments of \$35,502 for a B-double operating in a short haul corridor and \$71,005 in a long haul corridor; these are increases of 19 and 36 per cent over the existing registration and fuel charges of \$29,892 and \$52,292 respectively. For each of the mass-distance charge scenarios, the increases in charges are higher again, with the maximum increase being 77 per cent for B-doubles operating 400,000 km pa. The increases due to mass-distance charges are sensitive to the full load assumption (40 tonnes). The existing charges and mass-distances would be equivalent at payloads of 29 and 33 tonnes in short haul and long haul corridors respectively. This implies that for trucks carrying low density freight the charge increases will be smaller and have less effect on road freight rates.

The mass-distance charge scenarios also affect the operations of trucks that pick up and deliver (PUD) goods to rail terminals. A similar approach to costing is adopted, with the following assumptions:

- The passenger car equivalent factor for 6 axle articulated trucks is 3 (PCU).
- Trucks are fully loaded in one direction and half loaded in the other direction, ie gross vehicle masses of 42 tonnes and 28 tonnes respectively (AGM). These loads are intended to approximate 2 TEUs in the fully loaded direction and 1 TEU in the other direction.
- Equivalent standard axles are 4.52 in the fully loaded direction and 1.27 in the other direction (ESA)⁷.
- PUD trucks operate 50,000 km pa (VKT).

At existing unit cost rates, mass-distance charges would result in annual payments of \$7,233 for 6 axle articulated trucks doing PUD operations; this is a decrease of 33 per cent over the existing charges of \$7,737 (registration of \$4,737 and fuel charges of \$3,000). Mass-distance charges would therefore have two effects on improving the position of rail transport: firstly, an increase in road linehaul rates and secondly, a decrease in PUD rates for delivery of containers to/from rail terminals.

5.3 Rates and Demand

Table 8 shows the range of effects on road freight rates and rail demand in short haul corridors. The increases in road freight rates are considerably below the increases in charges because they are a relatively small proportion of total truck operating costs. The rail demand changes are very small until Scenario 6 when truck charges are increased by 30 per cent overall (8.1 to 15.9 per cent). The truck charges in this scenario would be \$9,740 for registration and 26 cents/litre for fuel.

⁷ The formula for 6 axle trucks is $ESA = 1.3 \times 10^{-6} \times AGM^4 + 0.47$.

The fuel-only charge and the mass-distance charges also result in significant increases in rail demand. In the former (Scenario 7), the fuel charge would be 28.8 cents/litre. The mass-distance charges are calculated for a specific operation involving loads and km travelled generally much in excess of those for the average vehicle used to set the existing charges. For the 3 mass-distance charge scenarios, the truck charges would increase by 22, 31 and 54 per cent respectively.

Table 8. Change in Road Freight Rate and Rail Demand by Scenario, Short Haul Corridors (per cent)

Scenario	Change in Charges		Truck Freight Rate		Rail Demand	
	Registration	Fuel	Low	High	Low	High
1	3		0.0	0.0	0.1	0.3
2	3	3	0.2	0.2	0.8	1.6
3	10		0.1	0.1	0.5	1.1
4	10	10	0.7	0.7	2.7	5.3
5	30		0.4	0.4	1.5	3.2
6	30	30	2.0	2.2	8.1	15.9
7	-100	44	2.4	2.5	9.6	18.2
	Mass-distance charges (% change in unit costs)					
8	3		2.5	2.7	10.7	19.6
9	10		3.2	3.3	13.5	24.5
10	30		5.1	5.2	20.8	38.7

Table 9 shows the same results for the medium and long haul corridors. (Trucks operating in both corridor types are treated as long haul for the purpose of calculating truck charges.) The effects are muted relative to the short haul corridors due to truck charges being a lower share of operating costs (see Table 5) and the higher rail market (and revenue) shares in these corridors. Rail freight services in medium haul corridors can expect to benefit more from an increase in truck charges than in long haul corridors. This is expected in view of the existing rail market share of 71 per cent in long haul corridors.

The pattern of the estimated changes in rail demand in medium haul corridors is very similar to short haul corridors, ie little change until Scenario 6 and significant changes for the fuel-only charge and the mass-distance charges. In the 3 mass-distance charge scenarios, the truck charges would increase by 40, 49 and 77 per cent respectively. These increases are significantly more than in the short haul corridors due to the higher distance travelled each year (400,000 compared to 200,000 km).

Table 9. Change in Road Freight Rate and Rail Demand by Scenario, Medium and Long Haul Corridors (per cent)

Scenario	Medium Haul Corridors			Long Haul Corridors		
	Truck	Rail Demand		Truck	Rail Demand	
	Rate	Low	High	Rate	Low	High
1	0.0	0.2	0.3	0.1	0.0	0.0
2	0.2	0.9	1.2	0.3	0.2	0.2
3	0.1	0.7	0.9	0.2	0.1	0.1
4	0.5	3.0	3.9	0.8	0.5	0.6
5	0.4	2.1	2.8	0.6	0.4	0.4
6	1.5	9.1	11.6	2.5	1.5	1.9
7	1.7	10.1	13.0	2.8	1.7	2.1
8	1.3	7.9	10.2	2.2	1.3	1.6
9	1.8	10.5	13.5	2.9	1.8	2.2
10	3.0	17.9	23.1	5.0	3.0	3.7

Finally, some estimates are presented of the effect of the proportional changes shown in Tables 8 and 9 on rail freight (tonnes) and market shares (see Table 10). They should be regarded as indicative for several reasons. Firstly, the corridor data on the existing rail freight do not match exactly corridors for which costs are available; they are also different to data published by ARTC, as noted in Section 3.3. Secondly, the elasticities are not directly applicable to the intercapital freight market, although a range is used to partly address this concern. Thirdly, the truck price increases are only estimated for two specific truck operations. Fourthly, the increases in rail demand are applied to total existing rail freight when the truck price increases only apply to fully loaded trucks.

To enable the figures for increased rail freight in Table 10 to be put in some perspective, it may be useful to consider that a fully loaded 1500 metre container train can carry about 2,690 tonnes. Less than one train service per day would be required to carry the extra tonnes in all scenarios except Scenario 10. This is of course a simplification as not all the freight could be carried by one train given its diverse origins and destinations.

Despite this, the potential rail freight increases could well be significant to the long term viability of rail operators. The BTRE forecasts of intercapital freight show rail market shares continuing to fall in the future from 19 per cent in 2004 to 16 per cent in 2010 (see Table 2). Table 10 shows existing market shares being maintained and even increased for charge options that involve large increases and/or changes in the structure of truck charges.

Table 10. Rail Freight and Market Shares by Scenario

Scenario	Rail Freight ('000 tonnes)		Rail Market Shares (%)	
	Low	High	Low	High
1	8	11	19	19
2	36	53	19	19
3	26	38	19	19
4	121	178	19	20
5	77	114	19	19
6	364	533	20	21
7	420	615	20	21
8	396	581	20	21
9	508	741	21	21
10	820	1,198	22	23

5.4 Conclusions

The analysis shows that only relatively small changes in rail demand are likely to result from increases in truck charges unless the increases are very large indeed. This does not mean that the changes would not be of significance to rail operators given the continuing loss of market share that is forecast by BTRE (2003b).

The estimated increases in demand should be regarded as maximums for the following reasons:

- The contribution of truck charges to road freight rates is based on truck operating costs while rates should be higher than costs for operators that want to continue in business.
- The analysis assumes that the only response to increased truck charges is an increase in freight rates. In view of the responses to competition in the road transport industry over time, an increase in rates is not the only response that could be expected. Responses could be aimed at improving road transport efficiency by, for example, increased utilisation of trucks and more effective use of labour and capital resources or in logistics by changing warehouse locations and distribution patterns or by absorbing some or all of the cost increase. These types of responses are expected in response to increased truck charges in Germany and are given as a reason why large modal shifts are not expected (Rothengatter and Doll 2002).
- The elasticities used in the analysis represent only a mode substitution effect; in the face of increased truck charges, other responses are possible by shippers of freight.

6. ACCESS PRICES

The national truck charges are often referred to as access prices in competitive neutrality discussions. This is a reasonable construct for that purpose but the road system is not part of the formal access regime arrangements covering many types of infrastructure. The rail industry claims that rail is not treated in a neutral manner with respect to competitive road transport can essentially be reduced to two matters: firstly, the method of calculating truck charges and secondly, the level of the prices for the use of infrastructure paid by rail and road.

The discussion is largely restricted to the ARTC access arrangements as the tracks under its control are the ones used by rail operators to carry intercapital freight.

6.1 Methods of Calculation

The cost allocation process that leads to the truck charges is essentially based on a cash flow approach to costs, using a 3 year average of expenditure. Costs are included in the cost base to be recovered in the year that they occur. Capital costs are treated in the same manner as recurrent costs. There is no attempt to allocate the capital costs to the year they are used (through depreciation) or to earn a return on the funds invested in the capital costs⁸.

Rail access prices are based on full economic costs in theory. Capital is optimised with respect to the expected future demand (use of the infrastructure) and depreciation and return on capital are included in the cost base. The differences in the methods of calculating access prices means that neutrality of treatment does not occur. Whether one mode is disadvantaged relative to the other is an empirical matter on which it is not possible to be precise at this time.

The ACCC (2002) decision outlines the basis of the ARTC access price regime. There is a two-part tariff with a fixed component (levied on km travelled on a specific train service type and segment) and variable component (levied on gross tonne km [gtk]). The fixed charge accounts for between 20 and 40 per cent of charges for freight trains. As is normal for access regimes, the access charges are subject to negotiation. Negotiation can occur between a floor and a ceiling, with:

- the floor being the incremental or avoidable cost of providing a service, excluding depreciation and a return on assets; and
- the ceiling being the full economic cost, including the direct cost of a service/segment, depreciation, an allocation of indirect costs and return on capital.

This structure and allocation of costs has the potential for ARTC to recover economic costs. In practice, the indicative access prices do not recover economic costs. As noted by ACCC (2002, p xvii) ... *ARTC's returns appear to be well below the full economic cost of providing services. In the longer term this may undermine investment incentives and compromise the sustainability of the network.*

There is no information in ACCC (2000) that relates the indicative access prices to the floor and ceiling costs. Without that, it is not possible to make an empirical comparison of the neutrality of the truck charges and the rail access prices.

⁸ Arguably, as the capital costs are recovered in the year in which they are expended, this is equivalent to recovering an annuity including a discount rate.

The ARTC's strategy in charging less than the full economic cost is to encourage use of rail infrastructure and hence recover costs by more use rather than from existing use. If this strategy is successful then the full economic costs of the provision of track access will be recovered. Arguably, there will then be a stronger case, on both theoretical and empirical grounds, that the truck charges be calculated on a full economic cost basis to achieve the objective of competitive neutrality.

This would require the exclusion of capital costs from the costs allocated to vehicle use, of which the costs allocated to truck use are a subset, to avoid double counting. The capital costs of arterial roads are included in the "Asset Extension/Improvements" expenditure category which comprises the sub-categories of pavements, bridges, land acquisition, earthworks and other expenditure. For the 2nd Determination they comprised about 50 per cent of costs allocated to vehicle use and 60 per cent of the costs allocated to truck use. Their exclusion would significantly reduce the unit costs from the cost allocation process in Table 7 with the effect that the costs allocated to trucks are estimated to reduce by about 40 per cent. Capital costs would then need to be calculated on the same basis as rail access charges, requiring at the least:

- an estimate of the optimised replacement cost (ORC) of road assets for the expected future demand. ORC is intended to represent the cost of replacing existing assets with current technology for the forecast future demand;
- depreciation to the current value or depreciated replacement cost (DORC) on the basis of the actual expired/remaining life of assets; and
- a rate of return appropriate to the provider of road services⁹.

Whether capital costs calculated using the full economic cost method exceed those now included in the expenditure template on a recurrent basis is an empirical question. The calculation of ORC and DORC involve engineering assessments and many assumptions and forecasts that would require significant resources. In addition, ORC, as the name implies, only includes assets on which a return can be earned and that may not apply to much of the road system because charges are not specifically related to use and many roads are built despite having costs greater than benefits of use. (The latter is implied in the calculation of truck charges by excluding much local road expenditure on the basis that it is for access rather than use purposes.) There may be a case to restrict the calculations to the intercapital highways used to carry freight in competition with rail¹⁰.

Austrroads publishes a value of the arterial road system, the last being 2001. It is understood that the value is calculated on an accounting basis which does not reflect actual condition but depreciated value on a time basis. It is most unlikely that the value would represent ORC or DORC.

The above discussion is restricted to interstate freight movements as that is where the main potential for competition between the rail and road exists. BTRE (2003b) notes that the NSW access prices for grain trains recover a lower share of track costs than the ARTC prices for interstate freight trains. It is only coal (and probably some other minerals) for which access prices are based on full economic costs; as there is little competition between

⁹ This may also require a move to life cycle costing which the NTC regards as optimal but data restrictions limit the practicality of its implementation across the board for heavy vehicles.

¹⁰ Not all National Highways are economically justified. Perhaps they could be regarded as grant funded on the same basis that much rail improvement is being funded. It seems that a return on grant funded infrastructure is excluded from the ARTC cost base.

road and rail for this freight the level of truck charges is not relevant to competitive neutrality.

6.2 Relative Levels of Charges

Rail operators have in the past argued that there is some inconsistency in the fact that charges for the use of infrastructure are lower for road than for rail on a per tonne-km basis. So long as the charges are cost-based, this is not a competitive neutrality matter, it simply reflects differences in costs.

BTRE (2003b) reports that access prices comprise about one quarter of the cost of train operating costs (terminal to terminal). When PUD costs are included, the share falls to under 20 per cent. This is still a considerably larger share than for truck charges in truck operating costs. The analysis reported above shows that truck charges are below 10 per cent of total operating costs for a range of truck operations. Even if mass-distance charges applied, the share of truck charges would remain considerably below the rail access price share, at 10 per cent for low utilisation truck operations (200,000 km pa) and 12 per cent for high utilisation (400,000 km pa).

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APPENDIX A

LITERATURE REVIEW

The main relevant findings of the reviewed literature are presented in this appendix in date order and alphabetical order of authors.

Bontekoning et al (2004)

A review article that argues that intermodal rail-truck freight is becoming a new research field. Relevant comments are as follows:

- Road pick up and delivery accounts for 25 to 40 per cent of costs. This seriously affects profitability and competitiveness of intermodal transport relative to road.
- Road is generally the preferred mode. Shippers who are cost driven use rail but those who also consider service levels do not. There is some evidence that shippers rely on perceptions rather than actual conditions. Some shippers would be prepared to trade service for cost if rates were sufficiently low.
- Given the variety of results of mode choice studies, they are not generally applicable but rather are specific to the choices analysed. The variety of results may be due to over simplification of the mode choice decision making process.

de Jong, Gunn and Ben-Akiva (2004)

Report on a meta model of passenger and freight transport in Europe; a meta model uses several other models to create a single model (analysis of analyses). The model is used to test several policy options aimed at increasing the use of rail and inland transport relative to road. Implied elasticities are:

- between -0.4 and -0.7 for the truck price elasticity;
- between 0 and -0.2 for the truck price cross elasticity with respect to truck km; and
- between -0.4 and -0.7 for the time cross elasticity with respect to truck km.

In terms of modal shift, increases in truck costs were found to be most effective; this is perhaps not surprising given that the policies were assumed to increase truck operating costs by up to 40 per cent. The next most effective policies were to decrease speed limits (so that travel time increased by up to 20 per cent) and improvements in intermodal operations (via a reduction in handling costs of up to 10 per cent and a reduction in transfer times to reduce door-to-door times by up to 5 per cent). The authors note that these policies would not necessarily improve economic welfare, particularly those that increase transport costs substantially: this is because the benefits of the reduction in the use of road transport are not large (ie improved environment) as the reduction itself is not large relative to the increase in costs.

de Jong, Gunn and Walker (2004)

Review of models with no results. Provides a description of different types of mode split models and their outputs. Few of the models allow changes in the size of the freight market and many (aggregate and disaggregate multinomial models) operate under the restrictive assumption that cross elasticities are equal.

Gargett (2004)

Reports estimates of road freight flows after adjusting for changes in survey methods adopted for the SMVU over time. The demand for road freight is estimated as a function of income (GDP) and road freight rate using time series data. The resulting elasticities are 1.21 and -0.89 respectively, indicating that the road freight task grows faster than GDP. There are two dummy variables for survey method changes but no other explanatory variables in the regression.

Graham and Glaister (2004)

A review of traffic demand elasticities, including 10 articles containing freight demand elasticities (most of which are covered here or the earlier review). The articles (some of them also reviews) contained 143 freight price elasticities with a mean of -1.07 and a median of -1.05 . The range of the values is 1.72 to -7.92 with a standard deviation of 0.84 . *Despite the great range in magnitude of estimates, ... the majority of the estimates, 66% fall between -0.5 and -1.3 . Forty-two per cent of the estimates fall within the range -0.4 to -0.8 . Only 13% of the estimates are greater than -0.4 and 2% of the estimates are positive.* Graham and Glaister consider that *it would be imprudent to offer a firm conclusion about the order of magnitude* because:

- the elasticities vary by commodity, trip types and market coverage;
- estimates are sensitive to the modelling approach and the level of data aggregation;
- the treatment of short and long run effects is generally vague; and
- there are a small number of studies.

With regard to Beuthe et al 2001 (see below), the authors comment that disaggregation shows *tremendous differences* so it is not clear that elasticities based on disaggregate data are more informative than aggregate estimates. This comment may also apply to Abdelwahab's (1998) results which are discussed just prior to Beuthe et al.

Johnsson (2004, 2003)

These two papers are about the economic effect of different levels of truck charges (based on esa-km by truck type) so is not really relevant to road-rail effects. What is of interest is that the modelling allows for changes in the type of truck used in response to the charges. The effect turns out to be small relative to the effect on overall truck km; this appears to be related to the elasticities used which the author acknowledges are rather uncertain, being based on limited data. They are referred to as substitution elasticities as they are used in a GCE model but seem to be based on freight price elasticities. The main elasticities are 0.85 for freight transport, 0.6 for long distance road (switching between 2 truck types available), and 0.25 between local, regional and long distance road (3, 5 and 2 truck types respectively). Note that the elasticities are not shown as negative but the description of the elasticities seems to suggest that they should be.

The 2 long distance truck types are combination vehicles with 7 and 8 axles respectively. What the elasticity suggests is that if the operating costs of one increase relative to the other (due to esa-related charges), then the switching of freight between truck types can be estimated using the elasticity of 0.6 ; in addition there will be an effect on freight carried by the 2 truck types together that can be estimated using the elasticity of 0.85 .

Bertie (2003)

Examination of costs, particularly terminal costs. Not relevant.

Catalani (2003)

Reports a mode choice model for sea-road, road-rail and road movements in Italy based on stated preference survey data and actual trip data (time and cost). Elasticities are only reported for intermodal transport as the policy intent is get freight off the road; they are calculated from model runs for 30% reductions in intermodal costs and times.

	Road	Sea-Road	Rail-Road
Mode share (%)	65	27	8
Cost			
Sea-Road	0.3	-0.77	0.03
Rail-Road	0.1	0.13	-1.5
Time			
Sea-Road	0.4	-1.03	0.13
Rail-Road	0.13	0.17	-1.93

Disney et al (2003)

Report a model to estimate the effects of vendor managed inventory (a single point of control over the whole supply chain) on transport operations. The traditional approach is that each party controls its own operations and that may result in more and/or smaller shipments. The model shows that there is the potential to reduce transport costs significantly, but case studies are required to determine where vendor managed inventory could be applied and the actual level of savings.

Fowkes and Whiteing (2003)

Stated preference surveys of 40 shippers to determine the value of predictable travel time to freight: three types of delays (journey time, arrival time, departure time) are valued. The values range from 1.3 to 2 times the value of time. Findings of interest are that:

- the value of delay is lower where rail is an alternative mode (no explanation given);
- the value of delay is higher for longer distance journeys. The average journey length is 282 km so may not be relevant to interstate freight in Australia. Note that rail is likely to be an alternative over longer distances so a lower value freight is probably potentially competitive; and
- operations depend on a highly certain arrival time due to conditions laid down by customers, critical deadlines, eg ports, express parcels, and operation and legal compliance, eg two way loading, consolidation, driving hours, driver changeover.

The authors comment: *As more and more sectors of industry have adopted modern logistics and supply chain management techniques, there has been a tendency to look for ever higher levels of efficiency in the supply chain, with significant impacts on the demand*

for freight transport services. This fundamental impact from the demand side is compounded by the pressures faced by transport operators on the cost side ... Taking these sets of factors together, it has been in the interests of all players in the supply chain to develop solutions that involve sophisticated scheduling techniques to ensure the achievement of high levels of vehicle and equipment utilisation. The result is that lead times have been progressively shortened and on-time delivery is the general expectation.

Haywood (2003)

Review of objectives and plans of UK local authorities aimed at promoting the use of rail for the carriage of freight. No results or evidence supporting targets are given.

Jara-Diaz and Basso (2003)

Theoretical only.

Kia et al (2003)

Report a model for calculating emissions for road and intermodal transport with several distribution centres throughout Victoria to collect containers for shipment to ports. It has limited relevance as the model assumes that all freight goes by the least cost mode (ie there is no mode choice modelled) and the least cost mode is rail for trips of more than 200 km. This breakeven distance is significantly below that quoted anywhere else.

Taniguchi et al (2003)

Review of models/approaches to assessing the freight demands in urban areas. Not relevant.

Woodburn (2003)

Reports a large scale survey of manufacturers and retailers to determine whether rail use is compatible with their supply chains and, if not, what changes would be required to increase the use of rail. Changes in logistics in the recent past that may affect mode choice decisions include changes in the location of activity, the structure of manufacturing and distribution networks, trading relationships between firms, and the scheduling of production and distribution. The survey had a low response rate but did enable detailed analysis of several supply chains (paper and publishing, food and drink production and retailing, and transport equipment). Relevant findings are as follows:

- Rail use could increase considerably in the next 5 years. Companies currently using rail are more likely to believe that it can meet more of their transport needs than companies that do not use rail. The author says this result is not supported by actual rail use. The next 5 years ended in 2004/5 and rail freight use increased by 3% for the 3 years to the end of 2002/3, and that was mainly international containers. In 2003, rail carried 11% of tonne-km and 5% of tonnes in the UK.
- The most likely change in logistics expected in the next 5 years is an increase in customer requirements (eg frequency, times of delivery): *further increases in requirements from already demanding customers would be expected to be largely dependent on road haulage*. Other changes include change in product attributes, decrease/increase in company locations and change in activities by location.
- Factors that would potentially encourage companies to switch to rail (in order of importance, with percent of sample in brackets) are improved rail service quality (56%), increased road transport tax/regulation (49%), road pricing (46%), reduced rail

costs (44%), increased road congestion (38%), and improved access to the rail network (28%). There are a combination of positive and negative factors which is important from a policy perspective.

- Companies are actually more likely to improve their road transport efficiency and restructure their operations rather than move to rail (no figures reported). Very few would consider reducing customer service levels.
- The total demand for freight has increased in the last 5 years in response to customer requirements, ie reduced lead times for delivery, more frequent deliveries or smaller quantities, and low inventory strategies (eg just-in-time stockholding and production). As a result, transport efficiency had worsened for some and improved for others but the sample was too small to identify definite links between logistics changes and transport efficiency. It appears that the increase in the demand for freight has made it more difficult for rail: *The nature of the changes ... have tended to continue the trends towards the greater use of transport, often with decreases in efficiency, in order to satisfy growing customer demands. These changes have certainly not been of benefit to rail.*

Bernetti et al (2002)

Covers sea-road transport only.

Gorman (2002)

Covers rail operations and costs only.

Lai et al (2002)

Reports a theoretical model for measuring the performance of supply chain operations. The model recognises that transport must be both (cost) efficient and effective (meet service needs). The lowest cost transport mode may not be selected if the level of service required by shippers and consignees is not provided.

Nierat (2002)

A theoretical model of when intermodal could be chosen over road transport for certain levels of cost and transit time.

Panayides (2002)

Analyses the most appropriate organisation structures for intermodal transport. Container ships and land transport modes are included in the definition of intermodal so is wider than the road-rail debate. Synchronisation of schedules between modes create economies of scale so is worth pursuing; it also meets customer demands for integrated service at a predetermined price. Both efficiency and effectiveness are important. Economic integration of intermodal transport can be achieved by spot market contracts, long term contracts or vertical integration. The paper argues that vertical integration is likely to be the preferred option due to transaction costs. Areas for further research to confirm this conclusion are identified.

Proost et al (2002)

Concerned with external costs of road and its effects on prices. No demand information.

Rothengatter and Doll (2002)

Report an analysis of the likely effects of the proposed variable truck charge in Germany. They assess the effects of 4 options; of interest are the effects on the level of rail traffic. The approach is to estimate the effect of charges on truck operating costs and hence the relative effects on the demand for road and rail transport (the procedure adopted in this report). The demand effects are calculated in network models and no elasticity values are reported or can be derived. The form of the charge is per km varying with the weight of the truck and the level of emissions. The main conclusion is that rail freight levels are unlikely to be affected to any great extent (4 per cent increase for domestic freight and 7 per cent for international freight) for what are very large increases in truck charges (in the order of 5 times the existing fuel charges for trucks over 18 tonnes gross weight). One option included *substantial upgrading of the level of service of railways* (not specified) and resulted in more significant increases in rail traffic (12 per cent for domestic freight and 35 per cent for international freight).

The authors comment that the effect on rail is not as great as might be expected because of the reactions of road transport operators (efficiency improvements) and logistics suppliers (warehouse locations and distribution patterns) to increased charges. With respect to efficiency improvements it was estimated that easy-to-implement and legal adjustments would compensate for about 15 per cent of the cost increase induced by road user charging.

Smith et al (2002)

Compare and contrast Australian and Canadian reports on the expected effects of e-business on freight transport. It is of interest because of the discussion of logistics processes, and the conclusions/comments made concerning the attractiveness of rail and potential responses. *Logistics managers can now integrate processes and collaborate within and across firms and so reduce cycle times, inventory, and other supply-chain costs. Successful integration supports a pull supply-chain model, where customers demand goods, which are built to order and quickly dispatched. This contrasts with the traditional push supply chain: forecast demand, produce the product for stock, and warehouse close to the customer. ... Pull systems result in the movement of smaller quantities more frequently and just in time (JIT) with, hence, lower inventory holdings. Making-to-order also leads to fewer returns. However such systems are unforgiving, and reliable delivery (on time and intact) is of higher importance.*

Transport relevant findings are as follows:

- E-business will result in an increase in vehicle km, with a growth in the market for low bulk, high value goods (air and road) relative to bulk goods (rail and sea). There will also be an increase in customer expectations with respect to flexible and rapid delivery of smaller shipments.
- Rail freight operators are likely to be disadvantaged by JIT, low inventories and fewer bulk shipments, and advantaged by increased imports and exports, and improvements in intermodal efficiency.
- Rail expectations could improve with some initiatives currently under discussion, ie high speed rail services, adoption of e-business (claimed to be hampered by above rail competition and vertical separation).
- The main need is for rail operators to improve reliability and speed of service.

- A significant role for rail is moving containers to/from ports. Rail market share in Sydney is 25%, an increase of 80% since 1995.

Beuthe et al (2001)

An O-D matrix of goods movements by mode in Belgium is used to estimate elasticities and cross elasticities for road, rail and inland water. Costs are synthesised for each mode on each link, with the least cost mode/path selected as the freight choice; the resulting demand is calibrated against the O-D matrix and found to give good results for the existing mode split. Elasticities and cross elasticities are calculated by increasing costs by 5 per cent and using the model to calculate changes in demand. The elasticities are generalised cost elasticities rather than price elasticities and are subject to some assumptions/constraints but are within the range reported in other studies. They do not take account of changes in demand overall (induced effects), they are short run, the method of calculating costs assumes there are constant returns to scale, the calibration means that all variables affecting mode choice are constant over time except those varied to estimate the elasticities (ie reliability, safety or other qualitative attributes). Results are given overall commodities and for 9 separate groups. The overall elasticities are:

Mode	All Trips		Short Distance		Long Distance	
	Road	Rail	Road	Rail	Road	Rail
Price elasticity with respect to tonnes						
Mode share (%)	80	9				
Road	-0.59	0.09	-0.58	0.08	-0.63	0.14
Rail	2.19	-1.77	2.26	-2.06	2.13	-1.54
Price elasticity with respect to tonne-km						
Road	-1.21	0.45	-1.06	0.11	-1.31	0.67
Rail	2.03	-1.25	2.99	-1.77	1.92	-1.19

Short distance = 1-300 km, long distance = >300 km.

Road demand is inelastic with respect to tonnes due to its dominance (high market share) over short distances; the reverse is the case for rail. Long distance rail elasticities are lower than short distance as market shares are smaller (due to higher costs). Rail demand is more sensitive to cost variation than road transport in all cases.

Road elasticities by commodity group are more dispersed than those for rail. These elasticities tend to be higher than average when market share is high and/or one mode has an inherent advantage over the other, eg bulk products for rail. None of the commodity groups can be identified with containerised freight.

Comparisons with other studies, particularly Abdelwahab (1998) suggests that the values are about the same order of magnitude except some short distance rail elasticities. *This comparison suggests that, indeed, shippers tend to choose modes and routes corresponding to the least cost path, and [the] approach [used here] models their choice in a useful and consistent way.*

Booz-Allen & Hamilton (2001)

Reports an evaluation of investments to upgrade the interstate rail system. Demand diverted to rail is estimated in a logit model (market share curve) that is a function of rail and road price, transit time, reliability and service availability. Elasticities are the coefficients on each of the variables and represent the importance of each variable as a proportion of the existing rail freight rate. They were derived from stated and revealed preference data analysed in other studies that are not publicly available. The elasticities are:

	Price	Transit Time	Reliability	Service Availability
Long haul	-1.1	-0.3	0.6	0.4
Short haul	-1.1	-0.4	0.6	0.5

BAH comments: The elasticity measures reflect the relative importance of each of the characteristics for modal selection. The influence that changes in price and service characteristics have vary according to rail's existing competitive position and the relative difference between competing mode's service characteristics. For instance, even though price has the same relative importance under both short and long haul corridors, the same percentage change reduction in price has a variable impact on two corridor types.

de Jong et al (2001)

Report a stated preference survey of 100 shippers in France and logit models of freight demand using both stated preference and revealed preference data. None of the models is entirely satisfactory although cost, transit time and frequency were found to be important in the mode choice decision. No elasticity results are provided.

Kulshreshtha et al (2001)

Demand for freight, as a function of income (GDP) and price, is estimated for Indian railways using 30 years of aggregate data. Demand is mainly driven by growth (GDP elasticity of 0.9), not by price. The overall price elasticity is -0.2 , with -0.3 in the earlier years and -0.1 in the later years; this is explained by the increase in demand in later years being mainly coal and iron for which rail has a competitive advantage.

Lin (2001)

Distribution model for urban freight movements. Not relevant.

McCann (2001)

Theoretical exposition only.

Musso (2001)

Surveys on freight costs and demand in Europe are reported. They were designed to assist in determining how costs and mode choice may be affected by the internalisation of road transport costs (18 per cent in rural areas and 30 per cent in urban areas). Relevant findings were that reliability is the most important factor affecting mode choice and there is considerable resistance to changing from road transport.

With respect to shippers of freight: *When faced with several stimuli reflecting increasing difficulty or costs in maintaining their transport strategies, shippers are more willing to consider measures such as increasing transport prices or changing shipping times than changing transport mode. The unwillingness to change mode is mainly attributed to bad experience with other transport modes, no matter whether that experience was direct or reported by colleagues. Poor performance and lack of know-how to satisfy clients' changing requirements seem to remain ingrained in organisations using nonroadway modes.*

OECD (2001)

No data on demand or factors affecting demand.

Woodburn (2001)

An assessment of rail freight movements over the period 1991 to 1997 in the UK. The only growth occurred in intermodal freight, mainly international, but also some small growth in domestic traffic. Recent improvements in trip times by rail are expected to mean that rail can compete more effectively with road transport.

Norojono and Young (2000, 2001)

Report a stated preference survey of 186 freight companies carrying 4 commodities (food, textiles, leather, electronics) in Java, Indonesia followed by conjoint analysis and a probit mode choice model (small and large trucks, train). The conjoint analysis aimed to construct a quality variable. It found that reliability with respect to rail time and loss/damage are the main influences, distance to rail terminal is significant but not as influential, and train type is not significant. Model results given are for all commodities, and no market shares are reported. The elasticities for large trucks and rail are shown below, with the main conclusions being that quality elasticities are generally higher, and train is more sensitive to changes than truck.

	Large trucks	Train
Cost (freight rate)		
Large trucks	-0.53	0.42
Train	0.26	-0.88
Delivery time		
Large trucks	-0.13	0.10
Train	0.05	-0.15
Quality (reliability, safety plus for truck: truck condition, travel, for train: access to terminal, train type)		
Large trucks	1.47	-1.19
Train	0.59	2.00
Flexibility (frequency, time of departure, responsiveness to problems)		
Large trucks	1.27	-0.98
Train	0.53	1.79

Barker and Kohler (2000)

Use a regional economic model to estimate the effect of road charges designed to internalise road freight costs. The effects on the level of road transport is estimated using an elasticity of -0.7 , the average of the results reviewed in Oum et al (1992).

Bereskin (2000)

Rail costs only. Not relevant.

Garrido and Mahmassani (2000)

A multinomial probit model of motor carrier demand for loads shipped from Texas (USA). No elasticities reported.

Morris and Kornhauser (2000)

Urban goods movements only. Not relevant.

Regan and Golob (2000)

Report a survey of trucking companies to ascertain any problems with the use of intermodal maritime facilities in California. The most significant problem by a long way is congestion delays at ports.

Tsamboulas and Kapros (2000)

A model of the decision making process in intermodal transport is developed and tested using data from a survey of 92 large European companies operating throughout the

community, including producers of goods, forwarders, carriers and shipping lines. Intermodal transport is defined as *the movement of goods in one and the same loading unit or vehicle, which uses successively several modes of transport without the handling of the goods in changing modes*. Only trips of more than 500 km are covered. Fourteen factors are identified and then correlated to produce three actor groups. Of the 14 factors involved in decision making:

- cost and reliability are the most important;
- frequency of service and available modes are the most important on the supply side;
- regularity of service is a prerequisite to the use of intermodal transport;
- cost is more important for shipping lines than forwarders and shippers of goods; and
- commodity type does not affect the decision to use/not use intermodal transport.

The three actor groups are as follows:

- ‘Quality-cost oriented’, who place more emphasis on reliability, safety and flexibility and are concerned with supply variables such as frequency, mode and information systems (45 per cent). Intermodal transport does not fully meet the needs of this group and is unlikely to do so unless all quality aspects of intermodal transport can be improved.
- ‘Specific’, who operate in a specific market area with specific needs (20 per cent). They are very limited users of intermodal services, depending on availability and suitability in particular areas.
- ‘Cost oriented’, who make decisions almost solely based on costs (35 per cent). They are the most intensive users of intermodal services and there is the most potential to increase their use so long as prices remain below the alternatives.

Van Schijndel and Dinwoodie (2000)

Report a survey of shippers in the Netherlands to determine whether intermodal will be selected over road as road congestion increases. The importance of service characteristics were ranked in order: punctuality, reliability, flexibility, service, price and speed. About a quarter of companies already use or could use intermodal transport while others rejected it on the grounds of cost, service level and objections from customers. The shippers’ preferred options for overcoming congestion were night operations, dedicated truck lanes, more road capacity close to cities, and more flexible working hours. An analysis of truck operating costs shows that congestion costs are about 10% of costs so perhaps congestion is not yet of such significance as to prompt mode shift to any great extent.

Vilain and Wolfrom (2000)

Paper analysing the potential effects of a peak period toll on truck movements in the New York/New Jersey conurbation, including a survey of 50 trucking firms. Effect will depend on the share of toll cost in the generalised cost of travel (GCT) for each trip; this varies, depending on trip length, from 10 per cent to 29 per cent. Factors other than cost must be taken into account in assessing behaviour change, particularly when total logistics costs are being minimised, ie transport costs plus inventory costs plus the costs of excess inventory required to guard against unreliability. Relevant findings are as follows:

- Customers are the single biggest constraint to behaviour change, ie they want a particular level of service including delivery at times that require peak hour travel. Even if transport costs increase, total logistics costs are likely to remain at a minimum.
- The more time sensitive the goods, the less likely the impact of a congestion charge on mode choice.
- The response to a peak period toll would be relatively modest, ie demand is relatively inelastic. This conclusion is related to the fact that many of the trips are intra urban.

Wigan et al (2000)

Contextual stated preference survey of 43 people in the freight industry (129 experimental responses) to estimate values of time for freight carried by road. The average values in the survey are a freight rate of \$35 per pallet and a 15 hour journey. The intercapital full truck load value is estimated at \$0.66 per pallet/hour, with \$2.56 per 1% reduction in reliability and \$49.70 per 1% reduction in damage (\$1998). The cost per pallet/hour is equivalent to \$22.44 per hour for a B-double (34 pallets). In 2002 price levels the value of \$23.79 per hour compares to the driver cost of \$21.29 per hour used in truck operating cost models and economic evaluations (Thoresen 2004).

BTE (1999)

The BTE (1999) paper on competitive neutrality estimates the impacts of tax and charge changes in rail and road market shares in an 'analytical corridor'. The corridor is over 1,000 kilometres long and has a rail market share of 32 per cent. The cross elasticity of demand for rail with respect to the price of truck was calculated from the results in the paper, giving an elasticity of 0.86. (A value of 0.89 was calculated from the move to the new tax system and 0.83 was calculated from the move to competitive neutrality; the difference is most likely related to rounding of price and market share changes.)

Jiang et al (1999)

Report a multinomial nested logit model to estimate choice of mode by shippers of freight in France. The first level choice is between road, rail and intermodal transport and the second level choice between public and private transport. The model variables relate to the characteristics of the shippers (eg firm size, own trucks), shipments (size, distance carried, packaging, foreign/domestic) and destinations (eg warehouse, proximity to road and rail). No economic variables showed significance in modelling the choice decision so no price elasticities are reported. Choice elasticities indicate that the most significant variable in the selection of intermodal and/or rail over road is trip distance, with the maximum probability occurring at 1,400 and 1,300 km respectively.

Abdelwahab (1998)

Reports results from a simultaneous mode choice/shipment size model, using data from the USA. Demand is modelled as a function of freight charges (cost) and time. Elasticities of mode choice and ordinary elasticities are reported, including allowance for changes in market size (as shipment size can vary). The latter are shown in the table below. Rail elasticities are larger than road because rail has a smaller market share. (Note that no market shares are reported.) Trucks have little potential to increase market share by decreasing transit time (-1.0), while rail has considerable potential (cross elasticity of 5.56); this is a result of the average transit time of the trips in the database used for modelling, ie rail = 5.86 days and truck = 1.05 days.

	Truck	Rail
Freight charges		
Truck	-1.44	1.75
Rail	1.54	-1.88
Transit time		
Truck	-1.00	5.56
Rail ¹	0.03	0.17

1. - Not statistically significant

Own price and cross price elasticities are reported for 5 geographic areas and 8 commodity groups, with a large range of results. There is no information on the size of areas and none of the commodity groups is similar to containerised freight. The author comments that demand is elastic and rail price elasticities are always larger than truck but not by a large margin (reflects market share). Perhaps more important, all cross elasticities are positive (indicating competition in all cases) and they seem to vary in accordance with the own price elasticities. This implies that as competition intensifies the higher the own price elasticities: *This result is expected as modes are more likely to lose or gain traffic in market segments where the own-price elasticities are high.*

The author concludes that comparison with elasticities from other studies suggest that the results are within the same range. [Note that the comparison is only for products in the steel industry ('primary metal products', 'fabricated metal products' or similar) and those elasticities tend to be at the ends of the ranges so perhaps the conclusion is not surprising.] The great variation suggests that elasticity value is dependent on market context and the modelling approach.

BTCE (1997)

Survey of freight forwarders to determine which service variables are important when purchasing rail services. In order of importance the top five were punctuality (arrival time), care of cargo and containers, rail terminal efficiency, wagon availability and staff quality.

Note that travel time does not rate: *trains do not have to be fast, but they must be on schedule.* The benefits of reduced travel time are later cut off times and earlier arrival times. Daily services are important. In summary: *Forwarders' overall preferences seem to be for daily services on major routes with trains scheduled to leave as late as possible in the day, arriving at their destinations early in the morning.*

Murphy and Hall (1995)

Review of studies of the factors influencing mode selection pre and post deregulation in the USA. Although relatively old it is included as more competition is likely to have influenced the importance of some factors. The studies reviewed are different to most included in this review as they report the factors that shippers say they take into account rather analysing theoretical choices (stated preferences) or resulting mode choices overall (revealed preferences). The studies were divided into two categories: firstly, choice of a road transport operator and, secondly, other choices (mode, rail operator) with the former predominating. The ranking of the top 3 factors for the 19 studies reviewed are:

Factors Considered	Deregulation (1980)		Choice	
	Pre	Post	Road	Other
Reliability (or delivery time)	1	1	1	1
Transit time (or time-in-transit or speed or delivery time)	2	4	2	3
Over, short and damaged (or loss or damage or claims processing and tracing)	3	6	4	5
Freight rate (or costs or charges)	4	2	5	2
Shipper market considerations (or customer service or user satisfaction or competitiveness or market influences)	4	4	5	4
Carrier considerations (or availability or capability or reputation or special equipment or financial stability)	6	3	3	6

The main conclusions drawn by the authors are that:

- shippers consider service level as more important than freight rates. Reliability is the most important service level factor and the most important factor overall;
- freight rates are important, although not the most important factor nor a large factor in relative terms. They have increased in importance since deregulation and are more important in other choices (mode/rail) than choosing a road transport operator; and
- important factors have changed as a result of deregulation.

Widlert and Bradley (1993)

Stated preference survey of shippers of freight in Sweden to obtain values of different attributes and to model mode choice (when combined with revealed preference data). Many shippers are captive, ie 55 per cent truck and 20 per cent rail. There is extreme heterogeneity in the freight market with respect to size of shippers, frequency of shipment, and size and value of shipments.

Summary of survey results: *The results show that values are much higher for truck transports in monetary terms, per vehicle, than for rail shipments. Large changes in one mode that changes market share can therefore cause changes in the average values. One main conclusion of the study is that investments in rail infrastructure with the aim of improving conditions for freight traffic should give priority to capacity improvements that reduce the probability of delays. With the results obtained, it may be difficult to justify major investments to improve transport time for freight by rail, unless they can also be offset by reductions in rail operating costs.*

Estimate a mode choice model which gave good statistical results; no interpretation of the model parameters or elasticities are reported.

Oum et al (1990, 1992)

Review report for the World Bank covering price elasticities for passenger and freight services. Good outline of different sorts of elasticities and the relationships between them.

Variations by commodity reported but only results for all commodities are shown below. The most likely range has regard to the authors' interpretation of the different modelling techniques used to obtain the best estimates of ordinary elasticities.

Mode	Range Surveyed	Most Likely Range
Rail	-0.09 to -1.52	-0.40 to -1.20
Truck	-0.05 to -1.34	-0.70 to -1.10

Oum et al (1990) say: *Not surprisingly, because transportation is a derived demand, it tends to be inelastic. But there are exceptions, such as discretionary travel and some freight shipments. Our interests in this review is in own-price elasticities, ie the sensitivity of shippers ... to the price charged for ... service. ... Many demand studies investigate whether there is competition from other modes. Even if the overall demand for transport by shippers ... is highly inelastic, the presence of competition generally causes the own-price elasticity of demand for a specific mode to be less inelastic than the market as a whole. Therefore if one were interested in the overall or market elasticities of demand for transport, we judge that they would be toward the inelastic end of the spectrum of empirical estimates we have surveyed.*

Young et al (1982)

This is a very old reference but is included it as it is Australian and reports both a survey and model results. The table below shows the importance and satisfaction ratings (using a 100 point scale) for then existing rail and road services available to 146 shippers of goods in the Sydney-Brisbane and Adelaide-Perth corridors. All attributes have a high importance except convenience of departure. The satisfaction with all attributes is higher for road than rail, and most pronounced for transit time, reliability and communication.

Attribute	Importance	Satisfaction	
		Rail	Road
Door-to-door transit time	76.4	50.3	79.3
Reliability of meeting arrival time at destination	84.0	48.6	79.3
Availability of capacity when required	78.5	63.5	72.3
Frequency of service	76.7	62.7	75.3
Freight rates	86.2	58.8	62.8
Avoidance of damage or deterioration	82.0	56.8	72.8
Avoidance of loss or theft	76.7	66.9	78.7
Convenience of time of operation	66.0	63.4	78.2
Communication with respect to problems	85.0	55.5	75.4

Models are estimated for all shippers and then for shippers of manufactured goods and non-manufactured goods separately. Significant variables for the three models are shown below. Some attributes are correlated so the effects of two or more may be included in a significant one, eg transit time and communication are correlated with reliability, frequency is correlated with convenience and damage.

Attribute	All Shippers	Manu- factured Goods	Non- manu- factured Goods
Door-to-door transit time			
Reliability of meeting arrival time at destination	√	√	
Availability of capacity when required	√		√
Frequency of service			
Freight rates	√	√	√
Avoidance of damage or deterioration	√	√	
Avoidance of loss or theft			√
Convenience of time of operation	√	√	
Communication with respect to problems			

Elasticities with respect to changes in satisfaction levels are calculated and reported. The form of the model means that elasticities relating to physical attributes cannot be calculated.