

# **ADDRESSING COMPETITIVE NEUTRALITY BETWEEN ROAD AND RAIL FREIGHT**

Supplementary paper to the  
Productivity Commission's  
Review of National Competition  
Policy Arrangements

Submission in response to the  
Productivity Commission's Issues Paper  
by Pacific National Pty Limited

(ACN 098 060 550)

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# **ADDRESSING COMPETITIVE NEUTRALITY BETWEEN ROAD AND RAIL FREIGHT**

## **INTRODUCTION**

National Competition Policy (NCP) has been one of the key public policy successes in Australia over recent decades. It has raised productivity, consumer welfare and Australia's standing in the world significantly through a reform agenda that has involved close co-operation between all Governments.

Reform in road and rail has been an important cornerstone of the overall NCP reform effort. Indeed, important changes in both these areas were formulated in the early 1990s and became key planks in the 1995 NCP agreements. The formation of National Rail, for example, ended the dysfunctional system of different rail freight operators in each state, while the road reforms saw a national approach taken in freight vehicle operation, registration and driver licensing.

Although rail has been a substantial component in NCP, the extent of gains from NCP has been compromised by the failure to remove the distortions that affect Australia's land transport network. In essence, the reforms to date have only provided a platform for the required changes that are needed to enhance Australia's economic performance. The key issue of competitive neutrality between the closely competing rail and road freight transport sectors has remained largely untouched.

Addressing competitive neutrality between road and rail freight transport represents one of the most significant opportunities for future reform and is a natural extension to the current NCP agenda. These reforms by their nature have an inter-jurisdictional character and hence are well-suited to the COAG process which is central to NCP. The reform benefits would both significantly enhance competition and boost Australia's GDP, as well as greatly enhancing Australia's physical environment.

## **PURPOSE OF THIS SUBMISSION**

The purpose of this submission, therefore, is to identify the significant gains that can flow from addressing road and rail freight competitive neutrality. It will do this as follows:

1. It will, first, explain that three fundamental reforms could unlock rail's potential to become the lowest cost form of transport on most inter-capital freight corridors.
2. It will describe, in some detail, how current heavy vehicle charging in Australia is deficient in terms of its cost allocation and approach, and its increasing divergence from overseas ideas and practice
3. It will then describe the pervasive effects of this blurring of cost signals on modal shares and thus the wider economy.
4. Finally, it will suggest a way forward.

## 1. RAIL FREIGHT'S LOWEST COST POTENTIAL

With genuine competitive neutrality between rail and road, rail has the potential to be the lowest cost mode of inter-capital freight transport on key sections of the north-south corridor, whereas it currently only demonstrates a key cost advantage on inter-capitals on the east-west corridor. There are, however, three important areas of reform required to create the environment in which rail can enjoy a cost advantage.

The three distortions that currently exist are:

### **A cross subsidy for heavy vehicles**

The NRTC methodology currently underestimates the impact of heavy vehicles on road expenditure, and is clearly out of step with approaches being taken internationally. By adopting a modified approach, building on the work of the BTRE in this area, this imbalance can be corrected.

### **Externalities**

Non-road damage externalities are not currently factored into the cost bases for road and rail. These include allowing for the greater safety, environmental, and congestion problems associated with road transport compared to rail.

### **NSW Costs**

The NSW interstate track operates at significantly above efficient levels, in terms of its continuing operating and maintenance costs. The Australian Rail Track Corporation (which is soon to take over track operations) has set explicit targets to address this issue.

If these three areas are addressed, "efficient" rail could have an advantage not only on the longer East West corridors but it could also be lower cost on key routes on the shorter haul North South corridors.

This conclusion is based on an examination of the best available data sources, which have been used to build 'bottom up' a comprehensive picture of overall rail and road economics. This examination has covered:

- 'Above' road/rail costs of running trucks and trains, where it can be shown that a train can carry freight over large distances more cheaply than a truck, even allowing for the pick up and delivery.
- 'Above' road/rail capital costs where it can be shown that each locomotive can haul more carrying units on a dollar equivalent basis compared to a prime mover.
- 'Below' road/rail infrastructure operating costs where, taking into account the planned changes to costs on the North South corridor by the ARTC, and using the conservative BTRE cost allocation methodologies, rail can provide lower costs.
- 'Below' road/rail infrastructure capital where going forward rail is a less capital intensive form of transport.
- Finally, allowance has been made for the fact that rail imposes significantly lower externality (mainly accident) costs than road.

This supplementary paper will focus on the first two key areas of competitive neutrality reform – heavy vehicle pricing and externalities.

## **2. DEFICIENCIES IN AUSTRALIAN HEAVY VEHICLE ACCESS CHARGING**

The bias in user charging that favours the heaviest vehicles is large and occurs in more ways than is commonly realised. Pacific National's initial submission to the Productivity Commission Inquiry explained in some detail the issues with the current approach to heavy vehicle charging. This paper expands on the main points of our earlier submission and takes into account emerging international developments to provide a more comprehensive assessment of the current deficiencies in heavy vehicle access charging. Accompanying this submission is a detailed Appendix that reviews heavy vehicle user charges taking into account international developments.

Essentially, there are three opportunities to reform the approach to heavy vehicle charging to contribute to competitive neutrality between rail and road.

Each are addressed below:

### **2.1 Improvements to heavy vehicle costing methodology**

The first improvement involves bringing road access pricing into line with the emerging international evidence and theory. This work, which has accumulated over at least the last 15 years, allows road access charging methodologies to be divided into at least three categories<sup>1</sup>, which are shown in Exhibit 1.

<sup>1</sup> Nils Bruzelius, Measuring the Marginal Cost of Road Use: An International Survey, 2003.

Exhibit 1

METHODOLOGIES FOR CALCULATING ROAD USE COSTS			
	DESCRIPTION	EXAMPLES	POSSIBLE IMPACT
1. 'Equity'	<ul style="list-style-type: none"> <li>Allocate <b>all</b> costs between users</li> <li>May or may not refer to marginal costs as a lower bound for allocations</li> </ul>	<ul style="list-style-type: none"> <li>NRTC approach (i.e current Australian 'PAYGO' regime)</li> <li>UK NERA approach</li> <li>US federal studies (1997)</li> <li>EU Commission study (2001)</li> </ul>	<ul style="list-style-type: none"> <li>Outcome is heavily dependent on how 'non-separable' costs are allocated—by VKT* or PCU*. Current dominant methodology internationally; favours heavy vehicles if non-separable costs are allocated by VKTs</li> </ul>
2. Engineering	<ul style="list-style-type: none"> <li>Estimate the marginal cost of road usage, including impact on other road users due to road damage, based on engineering models</li> </ul>	<ul style="list-style-type: none"> <li>'Direct'—uses pavement management system models (e.g HDM4) to estimate the marginal cost of road use</li> <li>'Indirect'—uses Newbery's theorem, linking ESALs* to wear</li> </ul>	<ul style="list-style-type: none"> <li>If Marginal cost &lt; Average cost then will reduce costs and will fall short of PayGo</li> <li>If Marginal cost = Average cost, then because allocations are made based on ESALs*, it will result in increased heavy vehicle costs</li> </ul>
3. Econometric	<ul style="list-style-type: none"> <li>Use economic models on historical datasets to estimate the impact of traffic on costs</li> <li>Only works if there are strong datasets (few available now)</li> <li>VKT*, GVM*, ESAL* are correlated, making estimation of impact difficult</li> </ul>	<ul style="list-style-type: none"> <li>The Link Study (2002)</li> <li>Li et al. (2001)</li> <li>Martin (1994)</li> </ul>	<ul style="list-style-type: none"> <li>If successful, likely to result in increased allocation to heavy vehicles BUT currently does not take account of road damage externalities</li> </ul>

\* VKT = Vehicle Kilometre Travelled; PCU = Passenger Car Unit; GVM = Gross Vehicle Mass; ESAL = Equivalent Standard Axle Load

The approach currently adopted in Australia for allocating road costs among users can best be described as one based on a concept of 'equity'. Australia is not alone in using such an 'equity' allocation approach. International research has shown, however, that there are significant issues with this approach, including:

- No fixed rules for the allocation of costs between fixed and variable components, resulting in significant variations in that allocation by country;
- It preserves the option of using vehicle kilometres travelled (VKTs) as the main measurement and hence allocation key, with the direct result that a lower proportion of costs is assigned to large vehicles than would be the case under other allocation keys; and
- Road damage externalities<sup>2</sup> are not taken into account

Among the family of countries that employ a comparable 'equity' approach (including the UK), the NRTC's cost allocation system stands out as one that results in lower allocations of costs to heavy vehicles.

The NRTC divides all road expenditure into 'allocated' and 'non allocated' categories, then divides the allocated costs into separable and non-separable costs. The NRTC allocates 100% of these non-separable costs by VKTs, and so treats a car and a B-

<sup>2</sup> The road damage externalities referred to here are the costs imposed on other vehicles as a result of the road surface deterioration from heavy vehicle use.

double truck in the same way. At a minimum, this expenditure should instead be allocated using Passenger Car Units (PCUs), which is a capacity measure of the space taken up by a vehicle on the road. Using PCUs, a B-double is equal to four cars, and this is more closely representative of the impact of different vehicle types on the need to incur non-separable costs. This change alone would significantly re-weight road user charges in line with the relative amount of road space consumed by each type of vehicle. This approach is more in keeping with the nature of these non-separable costs.<sup>3</sup>

#### *Findings from the 'engineering' and 'econometric' approaches*

As discussed in our previous submission, there are two alternatives to the equity approach – the 'engineering' and 'econometric' methodologies.

These have a common link in that they seek to base charges on the actual marginal costs of road usage, including both direct marginal costs and what are termed 'damage externalities' which are the costs to other vehicles imposed by road damage and which can be significant. The 'engineering' approach seeks to use pavement management systems that determine when various maintenance tasks are necessary. The 'econometric' approach uses historical data to estimate the actual impact of traffic on costs. It is empirical, not theoretical.

On the one hand, using this research would likely see non-separable expenditure at less than 70% of allocated costs. That is, more expenditure would be driven by vehicle axle weight on the road than is currently assumed. More work is needed to determine the appropriate extent of non-separable expenditure.

On the other hand, the primary direct cost that trucks impose on the road system is that they wear out pavement and require it to be resurfaced. Pavement damage itself depends on *vehicle weight per axle*, not total vehicle weight.

The damage caused by an axle is generally measured in terms of the number of 'equivalent standard axle loads' (ESALs) causing the same damage. A marginal cost pavement charge can be assessed for heavy trucks by multiplying a vehicle's ESAL-kilometres by the marginal cost of an ESAL-kilometre. For example, one study has found that the marginal cost of an ESAL-mile on rural U.S. interstate highways to be 1.5 cents<sup>4</sup>. Thus, a truck equivalent to 2 standard axles travelling 100 miles on a rural interstate would accrue 200 ESAL-miles and a charge of \$3. Such a charge promotes efficient road use because it gives truckers an incentive to reduce axle weights by shifting to trucks with more axles, thus extending pavement life and reducing highway maintenance expenditures.

Whilst the current NRTC cost allocation methodology does make use of ESALs, the share of expenditure allocated using this parameter may not be correct. The

<sup>3</sup> Bridges, land acquisition, and earthwork costs are significant components of these non-separable costs. These are influenced by the amount of road space required.

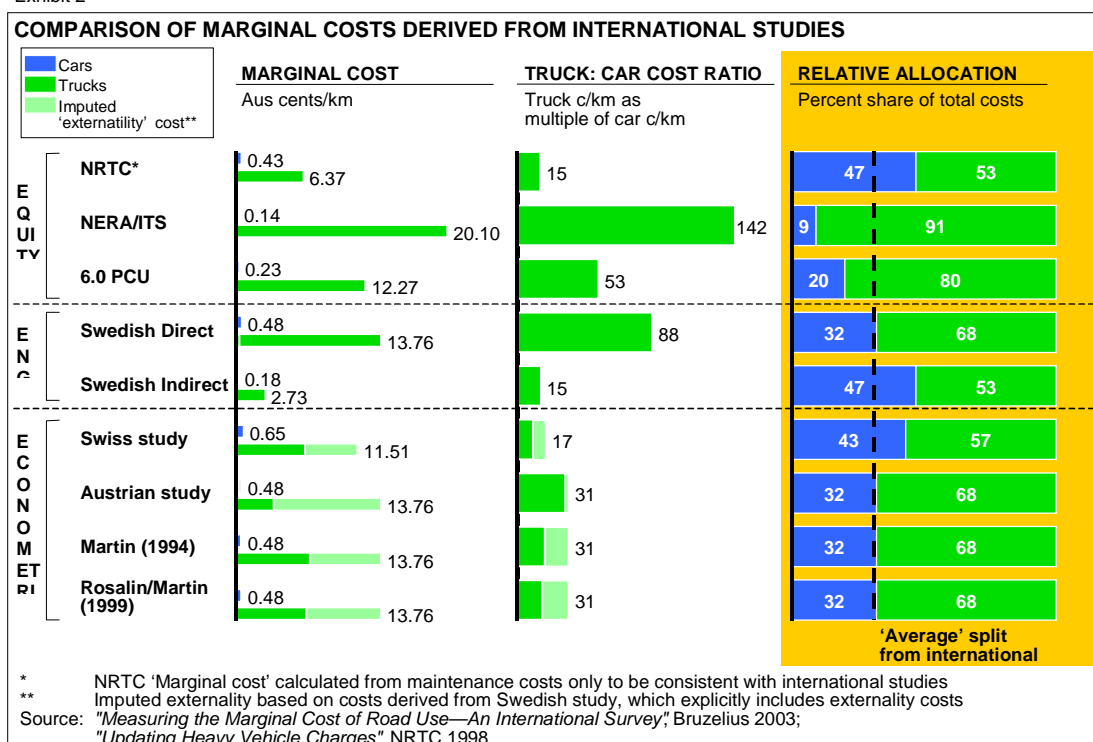
<sup>4</sup> Kenneth A. Small, Clifford Winston, and Carol A. Evans, *Road Work; A New Highway Pricing and Investment Policy*, Brookings Institution, Washington, DC, 1989

parameters used to allocate highway maintenance costs for heavy vehicle pricing purposes are currently being review using the latest data<sup>5</sup>

The effects of allocating road damage by ESALs is best seen by looking at the emerging evidence from the econometric and engineering models, which demonstrate that GVM allocation of separable costs results in underestimation of heavy vehicle cost allocations.

Exhibit 2 compares the NRTC's methodology with the outcome of several studies using alternative methodologies.

Exhibit 2

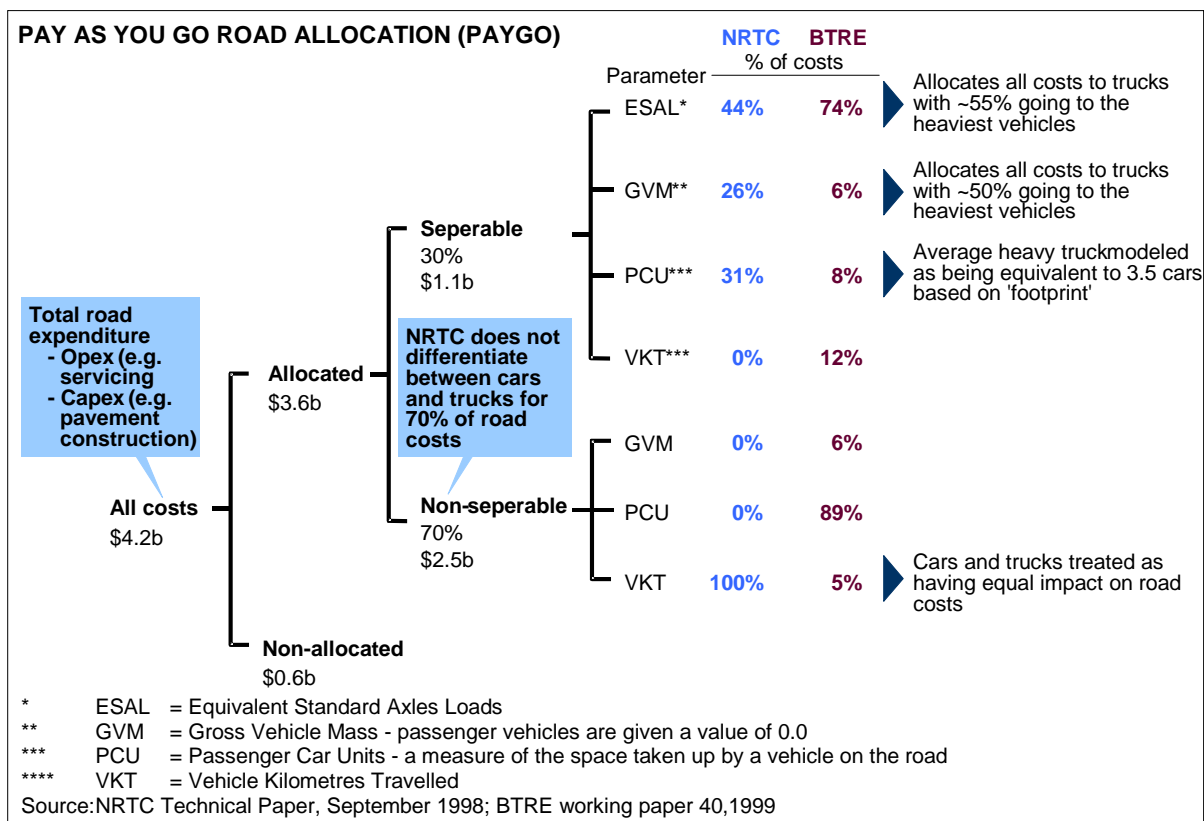


The overall impact of the NRTC approach is to reduce the share of road costs recovered from heavy vehicles, which in turn leads to excessive use of road by those vehicles. This translates into a distorted modal pattern where rail's share of the transport task is below economically efficient levels. A continued trend towards seeking ever-higher levels of cost recovery for rail, while leaving charges for road use at too low levels, would only aggravate these inefficiencies.

Some straightforward adjustments to the NRTC methodology can be made in estimating heavy vehicle costs. Exhibit 3 shows how the BTRE would alter the expenditure allocation parameters, based on Working Paper 40.

<sup>5</sup> National Road Transport Commission, 3rd Heavy Vehicle Road Pricing Determination Issues Paper, 2003

Exhibit 3



## 2.2 Moving to mass distance charging

As well as current cost allocation methodologies resulting in undercharging of heavy vehicles, current excise and registration based charging regimes are especially favourable to the long heavily laden inter-capital truck journeys that compete with rail. The BTRE and NRTC, as well as transport economists in other countries, recognise the distorting effect this has on cost recovery (Exhibit 4). As a result the logic making for 'mass-distance charging' (i.e. charging trucks per tonne kilometre travelled) is becoming more widely accepted and more compelling. At the same time, there is growing international experience with this alternative approach, allowing its effects to be better assessed.



Exhibit 4

**MASS-DISTANCE CHARGING—VIEWS FROM THE TRANSPORT ECONOMISTS**

*"For road transport there is a fixed annual registration charge and a variable fuel charge. . . this charging structure does not closely match the amounts paid to the individual vehicle's marginal cost of road use. Highly utilised vehicles and those with good fuel consumption rates pay too little."*

**NRTC 3rd Heavy Vehicle Pricing Determination Issues Paper, 2003**

*"BTE results indicate that heavily laden vehicles are currently undercharged, lightly laden vehicles are overcharged and the current imputed fuel excise credit does not recover the road wear costs caused by heavy vehicles. Some form of mass distance charge would be more efficient."*

**BTRE Working Paper 40**

**"Competitive Neutrality between Road and Rail" , 1999**

*"Passenger vehicles are expected to overpay federal user fees by about 10%, while single-unit and combination trucks will underpay by about 10 percent (in 2000). . . In virtually all truck classes, the lightest vehicles pay more than their share of highway costs, and the heaviest vehicles pay considerably less than their share of costs. Modifications to the HVUT\* rate schedule or new taxes such as a WDT or axle-WDT could result in larger gains in equity."*

**US Federal Highway Cost Allocation Study, 1998**

\* Heavy Vehicle Utilisation Tax

**Emerging International Experience with Mass Distance Charging**

Mass distancing charging is already moving from theory to practice. Systems for charging heavy vehicles based on vehicle mass (and other characteristics) and distance travelled are in place in Switzerland and Austria and are planned for implementation in Germany and the UK within the next 4 years. The systems make use of a combination of GPS technology, roadside transponders and onboard units to accurately record vehicle movements through the road network. In some cases, the charges are being set by both vehicle mass and emissions class and so have the potential to recover both road wear and environmental externality costs. Exhibit 5 summarises the schemes and technologies.

Exhibit 5

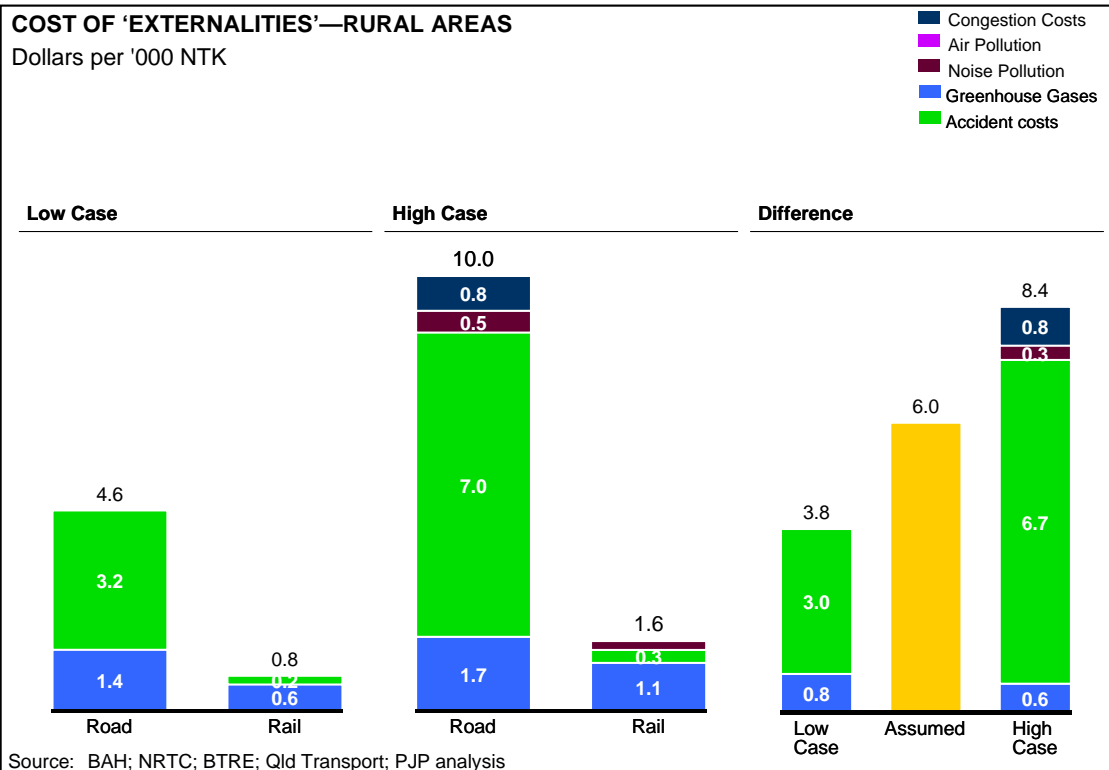
<b>SUMMARY OF EUROPEAN MASS-DISTANCE CHARGING INITIATIVES</b>					
<b>Country</b>	<b>Date</b>	<b>Technology</b>	<b>Coverage</b>	<b>Charged by</b>	<b>Use of revenue</b>
<b>Switzerland</b>	Jan-01	GPS and roadside electronic system with manual option	Trucks and buses? GVM >3.5t (all roads)	Distance driven, registered weight and emission class	Transport infrastructure, including public transport (Rail)
<b>Austria</b>	Jan-04	Fully electronic (Roadside shortwave radio)	Trucks and buses GVM >3.5t (motorways and certain expressways)	Distance driven, no. of axles	To maintain and develop the road infrastructure
<b>Germany</b>	Jan-05	GPS based electronic system with manual option	Trucks GVM 12t+ (motorways)	Distance driven, no. of axles and emission class	Transport infrastructure
<b>United Kingdom</b>	2007/8	Likely to be GPS based	Trucks GVM >3.5t		Revenue neutral

Source: Forthcoming BTRE paper—based on public information

### 2.3 Factoring in Externalities

While the theoretical case for taking account of externalities in transport charging is strong, in practice, these are often not factored into public policy. This is usually due to complexity and to political difficulties. The reality, however, is that people wishing to move goods on inter-capital corridors are making constant choices between road and rail, price is an important consideration, and the negative externalities associated with transport by road are much greater than they are for rail (Exhibit 6). Ignoring these externalities leads to poor pricing from a public policy perspective, and so poor decision making.

Exhibit 6



### 3. THE PERVASIVE AND SIGNIFICANT EFFECT OF THE BLURRING OF MARKET SIGNALS

The effects of these blurred market signals are profound, and as follows:

- At its most basic, day-to-day choices between the two transport modes are distorted, as relative rail/road price differences do not reflect the underlying cost differences.
  - The result is the over-use of freight haulage by road as a direct consequence of charges being too low.
  - At the same time, given high levels of use induced by artificially low prices, scarce investment resources are then over-allocated to road construction, compared to the socially efficient level.
- More subtly, and perhaps more powerfully, artificially low road user charges constrain rail user charge levels, given the fierce competition between these two freight transport modes.

This makes rail track maintenance and investment appear unattractive, which in turn leads to poor track quality and insufficient track investment.

Moreover, since competition from road keeps rail user charges below regulated ceiling levels, rail users face the risk that these charges can increase wherever above rail's capacity to pay increases. In other words, for operators such as PN, where rail access charges are below replacement costs there is the threat that should rail's share rise, that might serve as the trigger for an increase in access charges. This creates an effective potential 100% 'profit tax' on above rail operators which, if not effectively removed, will severely limit future above rail investment.

When choosing between freight modes, users are influenced by two factors: price and service (transit times, on time reliability, train time availability). With price signals distorted, and track investment held back, the effects of non cost-reflective road user charges for heavy vehicles are indeed profound.

With cost-reflective road user charges rail could increase its modal share significantly and bring enormous benefits to the economy. Direct benefits would equal the higher rail modal share multiplied by rail's cost advantage. In an indirect sense the likely 'multiplier' flow on effects on the rest of the economy would be large.

#### **4. POSSIBLE WAYS FORWARD**

Pacific National believes large benefits for the Australian economy would flow from changes to heavy vehicle access pricing so as to achieve competitive neutrality between road and rail freight transport. In the absence of fundamental change in this area, the gains from National Competition Policy will be diminished and the Policy's effectiveness undermined if the distortions that currently characterise the land transport system are not addressed.

Pacific National therefore urges that the Productivity Commission recommend this issue be addressed as part of the Council of Australian Government's forward NCP agenda.

Indeed, there may be merit in the Productivity Commission recommending a two stage adjustment process. As an interim step, some obvious problems could be addressed quickly such as the current practice of allocating non-separable costs by vehicle kilometres rather than PCUs.

The longer term appropriate future charging regime may require more work to ensure that any new approach provides neutrality between road and rail. In particular, it will be necessary to refine both the 'Engineering' and 'Econometric' approaches to develop an alternative to the current equity approach. Amongst other things, this will require development and testing of pavement models and econometric models in the Australian environment. Given that much of the research in these areas has been initiated in Australia, refinement of these models could be done relatively quickly.

Pacific National looks forward to providing further information to the Productivity Commission on the extent and costs of the current distortions.

*26 August 2004*

## APPENDIX ONE

### COMPARING INTERNATIONAL ROAD COSTING METHODOLOGIES AND CHARGING REGIMES

#### 1. INTRODUCTION

This appendix reviews current heavy vehicle user charges, taking into account two emerging international developments:

- Changing views relating to road cost allocation methodologies and outcomes between different users and user classes.
- The development of technologies facilitating mass-distance charging and the early implementation of those technologies in a number of European countries.

In summary, we conclude that heavy vehicles receive unduly favourable treatment using the current cost allocation methodology and charging regime. This appendix lays out the facts that support this conclusion.

#### 2. CURRENT COST ALLOCATION METHODS ARE UNDULY FAVOURABLE TO HEAVY VEHICLES

##### 2.1 Overview of the Three Different Cost Allocation Methodologies

Internationally, there are three families of cost allocation methodologies. Bruzelius (2003) [1] classifies these as Equity, Engineering and Econometric approaches (Exhibit 1):

Exhibit 1

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	DESCRIPTION	EXAMPLES	POSSIBLE IMPACT
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\* VKT = Vehicle Kilometre Travelled; PCU = Passenger Car Unit; GVM = Gross Vehicle Mass; ESAL = Equivalent Standard Axle Load

### 2.1.1 Equity methods

Equity methods seek to allocate costs amongst users on the basis of fairness. They treat road users as if they belong to a club that must collectively cover all road costs. Allocation of costs within the club aims to ensure that users pay a fair or 'equitable' contribution on the basis of the nature and amount of their road use. The majority of cost allocation methodologies used by roads authorities around the world make use of this approach. Its appeal lies in the fact that all costs can be recovered from the road user 'club' as a whole—with non-separable costs split up on the basis of some 'fair' parameter. However, the allocation of costs within the 'club' is sensitive to the parameters chosen to divide costs up amongst members of the club.

The main parameters used in Equity method cost allocations are:

- **Vehicle Kilometres Travelled (VKT)**—all vehicles treated as being equal.
- **Passenger Car Unit kilometres (PCU)**—vehicles are weighted by their size relative to a passenger car. Some approaches also take account of characteristics such as acceleration and braking.
- **(Average) Gross Vehicle Mass kilometres (AGM/GVM)**—vehicles are weighted by their total mass.
- **Equivalent Standard Axle Load kilometres (ESAL)**—the ESAL value is calculated for each axle of a heavy vehicle as  $[\text{Actual Axle load}/\text{Reference load}]^4$ . These are summed to give a total ESAL value for the vehicle.

Because the guiding principle is the notion of 'fairness', parameter choices involve an element of discretion on the part of the road authority, rather than being purely scientific. This is important as the choice and value of the parameter used to allocate a particular cost item can have a significant impact on the proportion that cost attributed to different classes of road user.

Exhibit 2 illustrates the generic equity allocation process and Exhibit 3 describes the general characteristics of and issues with the approach:

Exhibit 2

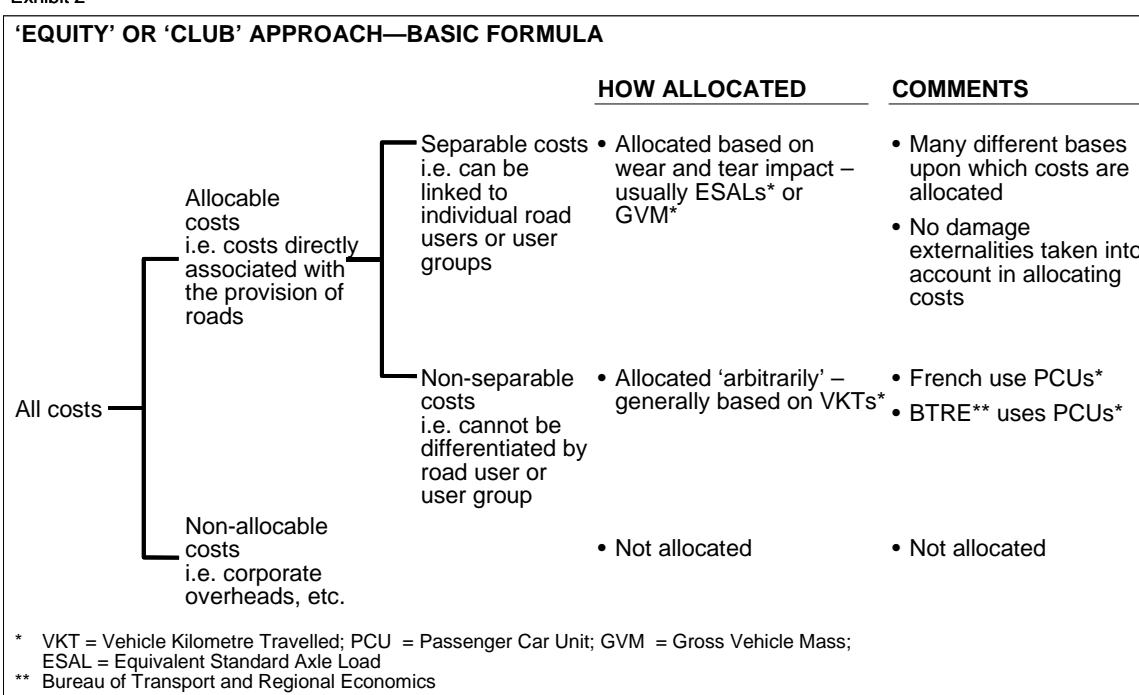


Exhibit 3

**EQUITY OR 'CLUB' APPROACH****CHARACTERISTICS**

- Generally splits costs into fixed (independent of use) and variable (with road use)—also applied to capital through a 'base'/'incremental' split
- Variable costs allocated by usage data
- Fixed costs allocated by neutral parameter (usually kilometres travelled)
- Actual costs from road authority accounts—do not take account of the 'road damage externality' (the costs that are imposed on other road users by an individual's road damage)

**ISSUES**

- No fixed rules for the allocation of costs between fixed and variable—significant variations by country
- Sensitive to allocation parameter chosen
- Choice of VKT\* vs. PCU\* is important as the latter assigns more cost to large vehicles
- Costing based on a 'snapshot' rather than an average over time
- Road damage externalities not taken into account

\* VKT = Vehicle Kilometre Travelled; PCU = Passenger Car Unit; GVM = Gross Vehicle Mass;  
ESAL = Equivalent Standard Axle Load

**2.1.2 Engineering methods**

Engineering cost allocation methodologies seek to allocate costs on the basis of engineering models of road damage. Two approaches exist:

- **Direct Approach.** A Pavement Management System (PMS) is used to forecast road management costs resulting from incremental traffic flows. The PMS contains a set of cost drivers for road damage (both direct repair costs and costs to road users) together with models relating road use to road damage, congestion etc. Costs of additional units of different types of road use can be compared with a base case to calculate their marginal costs. Importantly, because decisions in PMS systems take account of both the costs of road repairs and the costs incurred by users, the Direct Approach also captures the "damage externality"—the costs that one road user's road damage imposes on subsequent users.
- **Indirect Approach.** Makes use of a theoretical relationship between road use and road wear derived by David Newbery (see Exhibit 4). Newbery's Theorem calculates marginal cost as the average cost of road repairs per ESAL-km, by dividing the cost of periodic overlays by the accumulated ESAL-kms of traffic load carried between overlays. Unlike the Direct approach, road wear costs are the costs of road repairs only, and do not take account of externality costs imposed on other road users. In terms of cost recovery, costs allocated to traffic are scaled by a factor ( $\leq 1$ ) that takes account of non-load factors such as weather. Consequently, marginal costs so calculated may be less than average costs unless the proportion of wear due to non-load factors is set to zero.

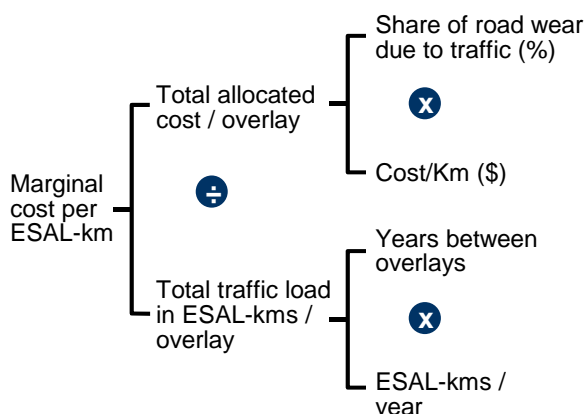
Exhibit 4

### COSTS ALLOCATED BY THE 'INDIRECT' APPROACH—THE NEWBERY THEOREM

#### STUDIES RELATING TO THE INDIRECT APPROACH

- RUC30 model (Newbery theorem)—effectively a simplified version of the HDM4
- Swedish study found 1:15 Marginal cost relativity between cars and heavy vehicles (based on allocation of variable costs)
- Lindberg (2002) estimated marginal costs of ECU 0.3/km - ECU 1.9/km for goods vehicles

#### THE NEWBERY FORMULA



Source: "Measuring the Marginal Cost of Road Use—An International Survey", Bruzelius 2003

### 2.1.3 Econometric methods

Econometric methods use regression modelling to establish "best fit" relationships between observed road costs and a set of explanatory variables (of which road use is one). Differentiation of these relationships then gives the marginal costs. Because these methods include non-load factors (weather, etc) in the explanatory variables used, the marginal cost of road use calculated will be less than average cost. Additionally, as with the indirect method only road maintenance costs are taken into account and damage externalities are ignored.

## 2.2 Comparing Outcomes From the International Studies— Current Equity Methodology Results in Undercharging of Heavy Vehicles

We have compared heavy vehicle cost allocations from international studies with the current NRTC methodology [2] and found that, in most cases, moving from the current NRTC cost allocation methodology to one of the alternatives would increase the share of costs allocated to heavy vehicles. To do this, we took the heavy vehicle results from each study and compared them with the current NRTC approach in three different ways:

- **Marginal costs**—The marginal cost impact of both cars and trucks across the different methodologies was compared. This demonstrated that while the NRTC attributes a marginal cost of \$6.37/km for trucks, the numbers are much higher with alternative methodologies, typically between \$10 and \$20/ km.
- **Truck/car cost ratio**—While marginal cost estimates are useful, they are sensitive to exchange rates as well as differences in conditions across different countries. To allow for this, the ratio of marginal costs between trucks and cars was considered. Whereas the NRTC truck/car cost ratio is about 15 to 1, other studies suggest higher ratios in most cases, in some



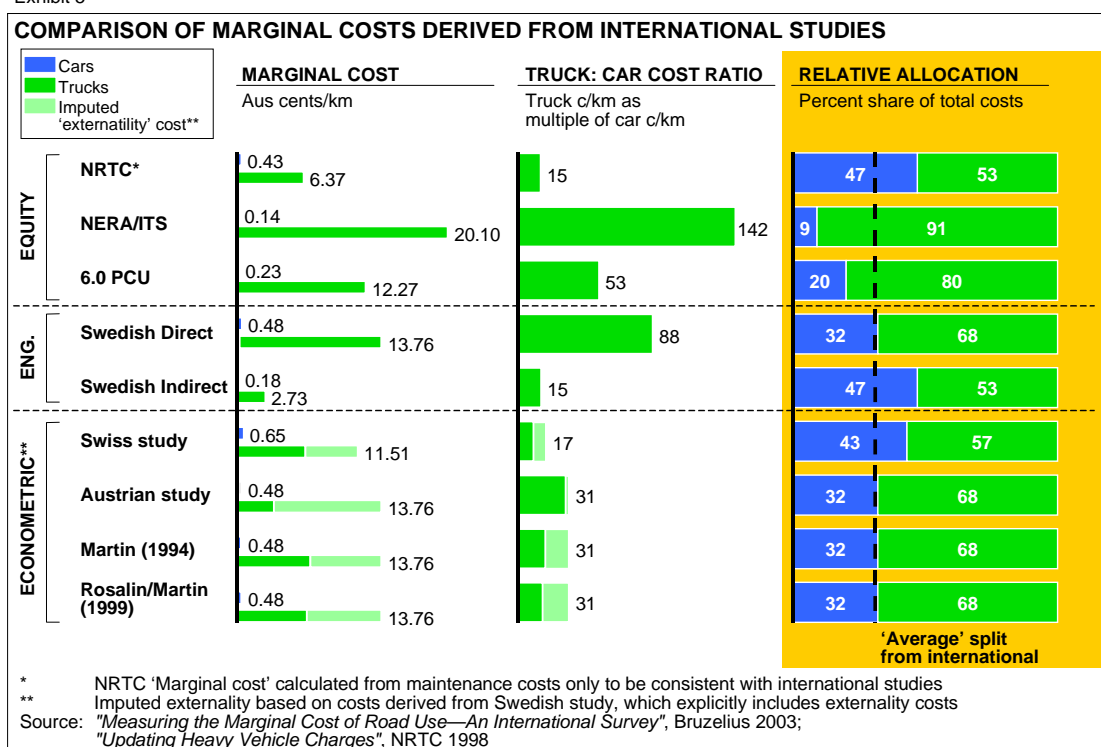
cases over 100 to 1. The two exceptions are the Swedish attempt to apply the indirect methodology, and the Swiss econometric study\*.

**Relative cost allocation**—Each of the studies results in an implied allocation of total costs between trucks and cars which, with no exceptions, results in a higher allocation to trucks than the NRTC approach. This is partly due to the different ratio of trucks to cars in each of the countries where the studies were conducted, however for the most part it is due to fundamental differences in methodology.

Exhibit 5 compares the outcomes from the application of various studies in the Australian context. The results show that the Australian NRTC approach appears to underestimate the impact of heavy vehicle costs as compared with other countries applying the same “equity” framework (eg the UK), and that moving to other more objective methodologies (econometric and engineering) will also result in a greater allocation of costs to heavy vehicles.

The remainder of this section describes the results of these various studies.

Exhibit 5



\* The Swedish study appears to have relied significantly on experience rather than a formal analysis to arrive at its cost allocations, with the Newbery formula only being applied at the final stage of analysis. The Swiss study was based on very limited data

## 2.2.1 Equity Approaches

Even when applying a more traditional equity approach, the NRTC allocations are at the lower end of the spectrum. The 2000 NERA report on Lorry Track Costs for the UK Department of Transport [3] gives details of the British equity approach. The differences between the British and Australian allocation regimes are outlined in Exhibit 6. The key difference lies in the share of costs assigned by each parameter. A greater share of costs is allocated by parameters that give high weighting to trucks, resulting in greater allocations to heavy vehicles. The effect is to increase truck/car unit cost relativities by a factor of 10 and to shift the overall heavy vehicle share of variable costs from ~50% to >80% after usage volumes are taken into account.

Perkins (2002) [4] gives another example of an alternative equity based approach. Reference is made in his paper to the French study that concludes that the passenger car equivalent ratio for a “truck” should be 6:1. This figure was arrived at after taking into account the acceleration and braking characteristics of vehicles, as well as their ‘footprint’. The NRTC currently use values of between 1.7 :1 and 4 :1 with an average of 3:1. For comparison, the French value was applied within the NRTC framework, resulting in an increase in the repair and rehabilitation cost allocation to trucks from ~50% to ~65%.

Exhibit 6

### COMPARING THE UK NERA/ITS COST ALLOCATION METHODOLOGY WITH THE AUSTRALIAN NRTC METHODOLOGY

Percent allocated using particular parameter

COST CATEGORY	Parameter							
	VKT*		PCU*		ESAL*		AGM*	
	Australia	UK	Australia	UK	Australia	UK	Australia	UK
Routine Maintenance	50	20	0	0	0	40	50	40
Reseals	50	0	0	0	0	100	50	0
Road Rehabilitation	55	0	0	0	45	100	0	0
Servicing	100	0	0	0	0	0	0	0
Bridge repair	67	0	33	0	0	0	0	100
Low cost improvements	80	30	20	0	0	0	0	70
Bridges	85	0	15	85	0	0	0	15
Pavement constructions	55	0		85	45	0	0	15
Land	90	0	10	85	0	0	0	15
Earthworks	90	0	10	85	0	0	0	15
Construction—other	90	0	10	85	0	0	0	15
Miscellaneous works	100	100	0	0	0	0	0	0
Corporate Services	100	100	0	0	0	0	0	0

\* VKT = Vehicle Kilometre Travelled; PCU = Passenger Car Unit; AGM = Average Gross Mass; ESAL = Equivalent Standard Axle Load

Source: NERA Report on Lorry Track and Environment Costs, UK Department of Transport, 2000; BTE Working Paper 40; NRTC Updating Heavy Vehicle Charges

### **2.2.2 Engineering Approaches**

Two numeric examples used the Direct and Indirect Engineering Approaches with Swedish data.

The Direct Approach calculated both the road damage costs and the damage externality per VKT for a car and a truck and found a relativity of ~140:1 when the externality was included. Application of this result to Australian road usage data allocated ~70% of costs to trucks, versus the ~50% allocated under the current NRTC system.

The Indirect Approach produced lower absolute figures and a lower truck:car cost relativity (15:1), implying that the impact of including the damage externality is much greater for trucks than for cars (indirect calculations deal with repair costs only, rather than total economic costs of road damage). Total cost allocation was in the same ratio as NRTC cost allocations. The literature gives other examples of attempts to apply Newbery's theorem in different countries and to different types of road cost, but none provide enough information to allow a comparison with Australian data to be made.

### **2.2.3 Econometric Approaches**

A number of attempts have been made internationally to apply econometric techniques to the calculation of marginal road user costs. However, the shortage of sufficiently detailed or deep data sets means that econometric analyses need further development before any hard conclusions can be drawn from the numerical results. Whilst their usefulness is therefore currently limited, two inferences can be drawn from the studies.

First is that in constructing best fit equations to explain road wear costs, the majority of studies have used ESAL or GVM kilometres to explain the traffic dependant portion of the wear costs.

Secondly, the majority of studies, including two carried out on Australian data (Martin in 1994 and Rosalin and Martin in 1999), find the share of costs attributable to traffic volumes (i.e. separable rather than non-separable) to be at least 50%. This has implications for the current NRTC system, which on average allocates only 30% of costs as separable. Exhibit 7 gives details of the allocations for the NRTC, a suggested allocation from the BTRE's paper on Competitive Neutrality [5], and the two Australian econometric studies.

Exhibit 7

**COMPARISON OF NRTC AND BTRE ALLOCATIONS WITH MARTIN'S ECONOMETRIC FINDINGS\*\***

		NRTC	BTRE	Martin (1994)	Rosalin & Martin (1999)		NRTC	BTRE	Martin (1994)	Rosalin & Martin (1999)
Allocated	Separable	30%	42%	53%	50%	ESAL*	44%	71%	0%	100%
						GVM*	26%	11%	100%	0%
						PCU*	30%	18%	0%	0%
	Non-separable	70%	58%	47%	50%	VKT*	100%	0%	100%	100%
						PCU*	0%	82%	0%	0%
						GVM*	0%	18%	0%	0%

\* VKT = Vehicle Kilometre Travelled; PCU = Passenger Car Unit; AGM = Average Gross Mass;  
ESAL = Equivalent Standard Axle Load

\*\* Based on Australian data

Source: "Measuring the Marginal Cost of Road Use—An International Survey", Bruzelius 2003;  
BTE working paper 40—"Competitive Neutrality between Road and Rail"

### 3. NEED TO CONSIDER SHIFT TO MASS DISTANCE CHARGING

Not only do current cost allocation methodologies result in undercharging of heavy vehicles, current excise and registration based charging regimes are especially favourable to the long heavily laden inter-capital truck journeys that compete with rail. The BTRE and NRTC [6], as well as transport economists in other countries, recognise the distorting effect this has on cost recovery (Exhibit 10). As a result the logic for, and experience with, 'mass-distance charging' (i.e. charging truck per tonne kilometre travelled) is increasing rapidly.

#### 3.1 Comparing Different Heavy Vehicle Charging Regimes

Traditional charging regimes in Australia and around the world have focused on standard vehicle type registration fees as well as excises on fuel. At the same time, the road damage driven by a vehicle is a function of (amongst other things) the distance it travels and the weight of its load. Therefore, the current charging regime only approximates the true damage incurred as a result of the activities of an individual vehicle

The impact of vehicle weight on the road damage incurred is illustrated in Exhibit 8. Depending on the cost allocation methodology employed, once a 6 axle articulated truck reaches approximately 20 tonnes in weight, they are undercharged, and the size of the “subsidy” increases with increased weight. At 30 tonnes the undercharging could be as high as \$6/000 ntk, even using an “equity” cost allocation methodology.

A similar relationship is observed when cost recovery across different vehicle classes is considered. Exhibit 9, based on the BTRE's analysis of NRTC costs, illustrates the variation of fuel charges with vehicle size and mass (measured in terms of ESALs). The Exhibit shows the average fuel revenue in cents per ESAL-km for each vehicle type, and the average avoidable cost per ESAL-km to be recovered from all vehicles. It can be seen that the NRTC's current charging regime over-recovers costs from smaller vehicles and under-recovers costs resulting from heavier vehicles. This observation is becoming generally well accepted (Exhibit 10).

Exhibit 8

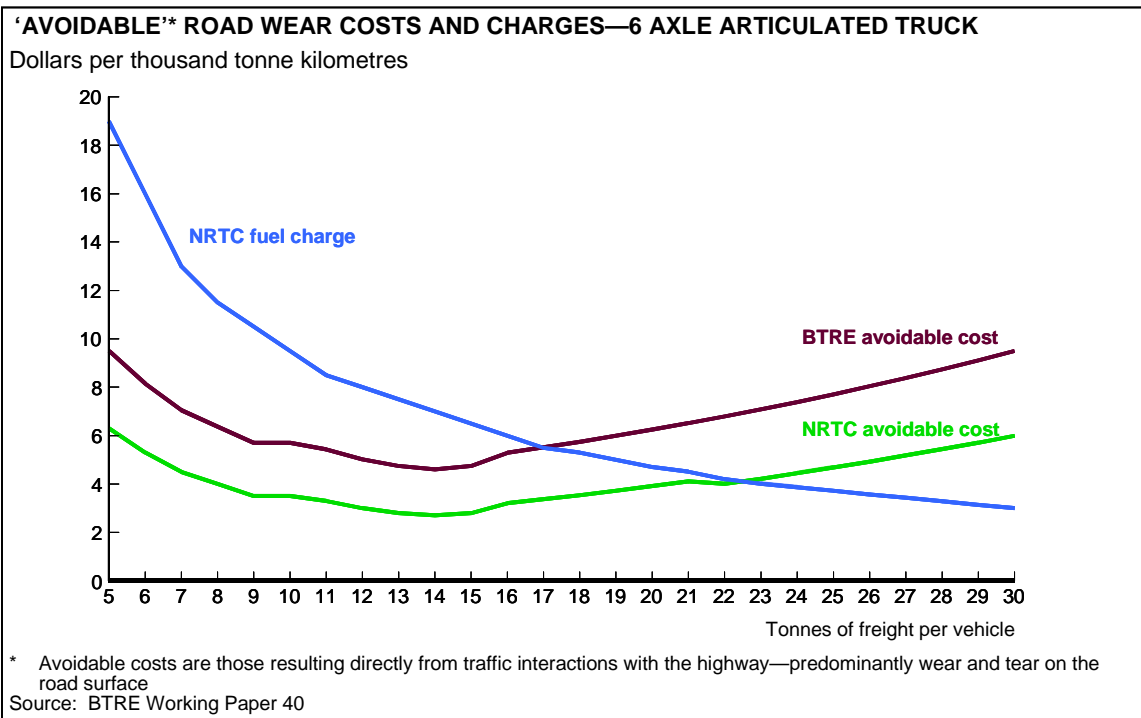
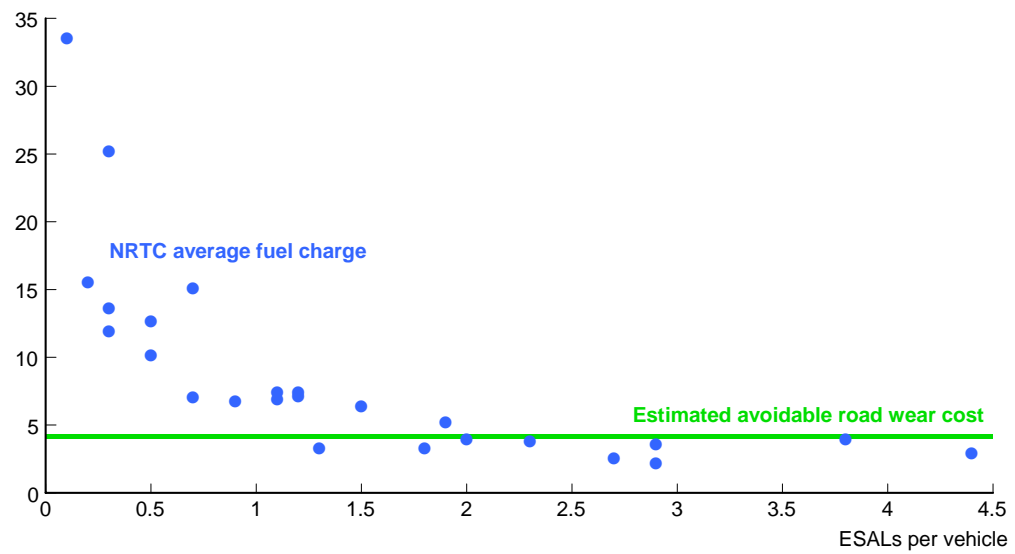


Exhibit 9

**NRTC AVERAGE HYPOTHECATED FUEL CHARGE AND AVOIDABLE ROAD WEAR COSTS  
— ALL HEAVY VEHICLES**

Cents per ESAL-km



Source: BTRE Working Paper 40

Exhibit 10

**MASS-DISTANCE CHARGING—VIEWS FROM THE TRANSPORT ECONOMISTS**

*"For road transport there is a fixed annual registration charge and a variable fuel charge. . . this charging structure does not closely match the amounts paid to the individual vehicle's marginal cost of road use. Highly utilised vehicles and those with good fuel consumption rates pay too little."*

**NRTC 3rd Heavy Vehicle Pricing Determination Issues Paper, 2003**

*"BTE results indicate that heavily laden vehicles are currently undercharged, lightly laden vehicles are overcharged and the current imputed fuel excise credit does not recover the road wear costs caused by heavy vehicles. Some form of mass distance charge would be more efficient."*

**BTRE Working Paper 40**

**"Competitive Neutrality between Road and Rail", 1999**

*"Passenger vehicles are expected to overpay federal user fees by about 10%, while single-unit and combination trucks will underpay by about 10 percent (in 2000). . . In virtually all truck classes, the lightest vehicles pay more than their share of highway costs, and the heaviest vehicles pay considerably less than their share of costs. Modifications to the HVUT\* rate schedule or new taxes such as a WDT or axle-WDT could result in larger gains in equity."*

**US Federal Highway Cost Allocation Study, 1998**

\* Heavy Vehicle Utilisation Tax

### **3.2 Emerging International Experience with Mass Distance Charging**

Mass distancing charging is already moving from theory to practice. Systems for charging heavy vehicles based on vehicle mass (and other characteristics) and distance travelled are in place in Switzerland and Austria and are planned for implementation in Germany and the UK within the next 4 years. The systems make use of a combination of GPS technology, roadside transponders and onboard units to accurately record vehicle movements through the road network. In some cases, the charges are being set by both vehicle mass and emissions class and so have the potential to recover both road wear and environmental externality costs. Exhibit 11 summarises the schemes and technologies; it is interesting to note that the Swiss system explicitly hypothecates revenue from the system to rail infrastructure investment.

## **4. CONCLUSION**

The conclusion of this work is that, while heavy vehicle charges are clearly too low, more work is required to provide an exact calculation of the right charges. To achieve this, it will be necessary to establish the correct framework for how charges should be set, and then apply it in the Australian context.

Exhibit 11

**SUMMARY OF EUROPEAN MASS-DISTANCE CHARGING INITIATIVES**

<b>Country</b>	<b>Date</b>	<b>Technology</b>	<b>Coverage</b>	<b>Charged by</b>	<b>Use of revenue</b>
<b>Switzerland</b>	Jan-01	GPS and roadside electronic system with manual option	Trucks and buses? GVM >3.5t (all roads)	Distance driven, registered weight and emission class	Transport infrastructure, including public transport (Rail)
<b>Austria</b>	Jan-04	Fully electronic (Roadside shortwave radio)	Trucks and buses GVM >3.5t (motorways and certain expressways)	Distance driven, no. of axles	To maintain and develop the road infrastructure
<b>Germany</b>	Jan-05	GPS based electronic system with manual option	Trucks GVM 12t+ (motorways)	Distance driven, no. of axles and emission class	Transport infrastructure
<b>United Kingdom</b>	2007/8	Likely to be GPS based	Trucks GVM >3.5t		Revenue neutral

Source: Forthcoming BTRE paper—based on public information



## GLOSSARY OF TERMS

Average cost	Total cost per unit of traffic load of providing the highway
Avoidable cost	Costs that would not be incurred in the absence of traffic loading (Also referred to as 'variable' cost or 'marginal' cost)
BTRE	Bureau of Transport and Regional Economics (Formerly the BTCE/BTE). The transport research arm of the Department of Transport and Regional Services.
ESAL	Equivalent Standard Axle Load. Calculated for each axle of a heavy vehicle as (Actual Axle load/Reference load) <sup>4</sup> and then summed to give an ESAL figure for the vehicle. Reference load used in Australian calculations is 8.2 tonnes. Actual loads are adjusted to take account of differences between axle configurations.
GPS	Global Positioning System. A system that uses geostationary satellites to accurately determine the position of a receiver unit by comparing signals from 3 or more satellites.
GTK	Gross Tonne Kilometre. NTK plus mass of vehicle used to haul freight.
GVM	Gross vehicle mass. The combined mass of the vehicle and any freight carried. Average Gross Mass (AGM) is often used to allow for the fact that trucks will not be fully laden on all trips.
HMD4	Highway Development and Management system developed by the International Study of Highway Development and Management Tools (ISOHDM). Uses detailed engineering and financial models to plan and optimise road management activities and costs for given traffic loadings. Used by the World Bank, as well as highways agencies and transport economists in a large number of countries.
ISOHDM	International Study of Highway Development and Management Tools – the organisation responsible for the development of the HDM4 Highway Development and Management System, used by the World Bank
Marginal cost	The costs associated with an incremental unit of traffic load. Excludes costs due to weathering, fixed costs, etc. (Also referred to as 'variable' cost or 'avoidable' cost)
NRTC	National Road Transport Commission (now the NTC). Responsible for recommending heavy vehicle charges through the Heavy Vehicle Pricing Determination (3rd Determination is currently under development).
NTK	Net Tonne Kilometre. Standard unit of freight task. Equivalent to transporting 1 net tonne of freight a distance of 1 kilometre. Used because costs increase with both freight mass and distance travelled.
PMS	Pavement Management System. A combination of engineering and economic models used to predict required road maintenance and upgrade activities and the associated costs. The World Bank/ISOHDM model, HDM4, is one example.
PCU	Passenger Car Unit. A measure of the 'footprint' of a vehicle. 1 car = 1PCU. Trucks are considered to be equivalent to 2-4 passenger vehicles depending on their size.

Regression analysis	A statistical technique that seeks to explain an outcome (dependent) variable in terms of multiple predictor (independent) variables. This analysis reveals the nature and strength of the relationship between each predictor variable and the outcome, independent of the influence from all other predictors. The term typically refers to Ordinary Least Squares (OLS) regression, which models a linear relationship among variables.
Variable cost	A cost that varies directly with road use, such as damage caused to pavements by vehicles (Also referred to as 'marginal' or 'avoidable' cost)
VKT	Vehicle Kilometres Travelled

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