QR Submission to Productivity Commission

Review of the Economic Costs of Freight Infrastructure and Efficient Approaches to Transport Pricing

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QR engaged Synergies Economic Consulting Pty Ltd to assist with the preparation of this submission.

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Executive Summary

QR welcomes this opportunity to present a submission to the Productivity Commission's Review of the Economic Costs of Freight Infrastructure and Efficient Approaches to Transport Pricing. Given the lack of progress made on road pricing reform in recent years, including the National Transport Commission's recent Third Heavy Vehicle Pricing Determination, the review is particularly timely.

As the only remaining fully integrated rail business in Australia with expertise across the full scope of rail services, QR is well placed to provide comments on its experience of providing rail infrastructure services within a price and access regulatory framework, as well as competing with road transport in the highly competitive freight and logistics market.

The thrust of QR's submission is that the Review should produce a set of recommendations which will maximise efficiency in the provision and use of Australia's road and rail freight infrastructure.

In this regard, QR believes that the priority of this review should be to address the cross-subsidy that exists between road charging for articulated vehicles and other road users, which in turn significantly undermines any attempt to achieve neutral competitive frameworks for the road and rail freight sectors.

Costs

A key issue for the Review will be to examine how costs change with usage of road and rail infrastructure.

There are a number of similarities between road and rail infrastructure costs:

- cost characteristics, such as economies of scope, scale and density, are important considerations for pricing structures;
- cost drivers are similar, particularly in construction;
- cost causation is similar for both modes, with large fixed capital costs and significant usage-related maintenance costs driven by the rail/wheel and road/wheel interfaces; and
- cost causation is complex because infrastructure service providers and operators can affect each others costs.

Importantly for this review the methods used by rail and road to recover these costs are very different and undermining the competitive advantage of rail. How costs are recovered from road users is a critical component of the reform task.

Externalities

Externalities are not currently factored into the cost bases for road or rail.

The key findings that can be taken from the literature relevant to the present review are:

- all modes of transport generate externalities, although rail generates fewer externalities than road transport;
- the estimated economic cost from transport externalities are substantial but subject to major estimation challenges;
- most costs are generated within major population centres; and
- measures to correct externalities mainly involve 'command and control' regulation, supplemented by economic instruments involving fuel taxes (although fuel taxes are typically applied to raise revenue).

QR submits that in principle social marginal cost pricing for externalities ought to be further investigated for transport pricing.

In the interim, QR believes the following actions should be taken because of the large costs in economic and social wellbeing from transport externalities:

- transport infrastructure investment appraisal should explicitly include the external costs. This is necessary to limit distortions to use of existing infrastructure rather than perpetuating current price distortions;
- where non-price measures are proposed to deal with externalities, further investigation of incentive mechanism should be pursued to achieve greater alignment with policy targets;
- mass distance charging should be progressed in parallel as it provides a pricing system with far clearer signals than the current heavy vehicle charging regime; and
- further consideration of increased rates of fuel charges for pollution and greenhouse related externalities.

Pricing

QR believes that pricing of road infrastructure must start to develop a greater degree of economic sophistication consistent with trends in other Australian infrastructure industries. As a priority, the Commission should map out a reform process for the implementation of individual user charging for heavy vehicles.

There are a number of well-accepted pricing principles associated with the use of and investment in monopoly infrastructure in Australia. In particular, prices should:

- send signals as to the economic impact of each user's use of the infrastructure to promote efficient consumption decisions; and
- allow the owner of the assets to have the opportunity to recover the full cost of service provision (including the recovery of capital costs) to facilitate efficient investment decisions.

Under their respective regulatory frameworks and consistent with these principles, Australian rail infrastructure providers have at least begun to develop economically sound pricing frameworks based on the establishment of price/revenue floors and ceilings reflecting incremental and full economic costs respectively.

In contrast, road pricing appears significantly out of line with rail pricing and general infrastructure pricing trends in Australia over the past decade. Currently, heavy vehicle pricing is based on a crude two part tariff, including a variable component based on diesel fuel excise, which does not reflect the costs imposed by various road users on the road infrastructure and consequently fails to send any meaningful signals to road users about their consumption decisions.

QR believes that a completely new tariff structure is required for heavy vehicle charges, including both fixed and variable components. Critically, the variable component of the tariff structure must be a mass distance charge.

Mass Distance Charging

The introduction of mass distance charging (MDC) is the critical first step in establishing a road charging mechanism which sends appropriate signals to road users about the cost of their road use.

Practical implementation of MDC in Australia has been a problem in the past, but electronic technology for distance based charging has now been successfully applied in a number of countries.

QR acknowledges that there will be a large upfront cost due to the introduction of MDC and that there are likely to be winners and losers from implementation, if for no other reason than it involves moving from the current system of average pricing to individual pricing. Consideration of how losers might be compensated is an important component of the reform process but is not unique in the Australian reform processes over the past decade.

Price distortions affecting bulk freight

To achieve an efficient allocation of resources between road and rail infrastructure, the price for use of each transport mode must reflect the resources cost of providing infrastructure services. To achieve efficient use decisions it is vital that variable charges are based on incremental costs and that common costs are allocated by methods that have some economic rationale.

Where prices do not fully reflect costs, transport operators will face distorted price signals which will, in turn, distort the pattern of usage between road and rail, as well as having a longer-term impact on economic welfare through distorted investment decisions.

The modal choice for different traffics will be driven by economic considerations such as the cost of access to road and rail infrastructure respectively and the nature of the product being shipped. Reflecting these factors, rail transport generally has a competitive advantage over road in bulk freight transport. This advantage is increasingly apparent the longer the length of a haul. However, the current pricing of road and rail does not reflect their relative cost competitiveness.

QR believes that, due to the pricing approaches applicable to road and rail infrastructure respectively, the price for using each mode does not reflect the true costs of provision. In current circumstances, freight traffic is being won by road transport by inefficient pricing of roads rather than the underlying comparative advantage of each mode.

For traffics where rail haulage still predominates, such as coal, the regulatory arrangements create a significant risk of a service provider under-recovering the true cost of service provision. QR considers that price distortions arising from the limitations of the regulatory framework that applies to rail will also have an impact on incentives to invest in rail infrastructure.

This impact is magnified by the tendency of regulators to impose a level of precision that does not exist and by the asymmetric consequences of regulatory error.

QR's views on optimal regulatory architecture revolve around the following considerations:

- the need for clear regulatory objectives;
- providing more significant status to the infrastructure provider's initial proposal;
- the availability and scope of merits review; and
- timeframes for regulatory processes.

Investment

Price is unable to efficiently direct investment in rail and road infrastructure if:

- prices are not fully cost reflective;
- institutional arrangements for the ownership and management of roads, including the receipt of revenue and allocation of funding, do not signal or facilitate efficient investment; and
- the regulation of road and rail inhibits efficient outcomes.

The reform of road pricing will require reform of the current institutional arrangements for heavy vehicle charges and the provision of road infrastructure, including the objectives of road agencies, their governance structure and their funding arrangements. Railways have made the transition from non-commercial government agencies to public and private commercial organisations. This has also been the experience in other infrastructure industries in Australia. Clearly a more commercial governance structure for road agencies should be a cornerstone of future reform.

In the absence of efficient prices, it is critically important that investment decision reflect true economic costs. Funding decisions by government need to be underpinned by cost benefit analysis. Auslink is yet to demonstrate its effectiveness in delivering efficient investment decisions, although work is underway to improve investment analysis.

Assessing the impact of reform

The correct approach to evaluating the benefits and costs of road pricing reform is to measure the national welfare gains, assessed using an appropriate model of the Australian economy. Given the importance of transport to the national economy, QR believes that a general equilibrium approach is appropriate.

QR suggests the following principles should be considered in assessing equity and efficiency trade-offs associated with higher road prices:

- equity be assessed on the final economic incidence of the price change (not the initial impact);
- any equity principles applied be transparent; and
- past benefits received by road transport operators (from under-recovery of costs) receive equal consideration to any impacts of increased charges.

Most reform processes will result in winners and losers. QR believes that effective policy implementation requires information on the available gains and a clear picture of the winners and losers from reform.

A case for phasing reform exists where:

- the immediate application of reform can be shown to increase losses compared to a phased application; and
- there are no more effective instruments for winners to compensate losers from reform.

With respect to the design of transitional arrangements QR believes the following principles should apply:

- the impact on existing suppliers/industries considers forecast market growth – often assessments of price changes on existing market size rather than future markets;
- reforms are applied where rail and road transport are substitutes – QR believes the AusLink National Network should initially define that portion of the national freight network;
- transition arrangements have a defined and preferably legislated timeframe; and
- industry compensation –to the extent appropriate – is performance based.

The way forward

QR believes an extensive program of reform is needed in many of the issues being examined by this review. QR recommends that the Commission include in its recommendations:

- Transport pricing reform should aim to achieve a situation where:
  - transport infrastructure is priced so that alternative modes may compete on their economic and practical merits;
  - investments are made in transport infrastructure which maximise social welfare; and
  - equity and other government policy objectives are transparent and delivered in an efficient manner.
- An appropriately experienced and independent research body report to COAG on how to achieve practical implementation of principle social marginal cost pricing for internalising transport externalities specifically:
  - the appropriate policy instrument for each externality;
  - the optimal level of emissions;
  - the least cost method for reducing externalities; and
  - in respect to pricing instruments, the set of prices necessary to achieve efficient levels of externalities.

- the following actions should be taken because of the large costs in economic and social wellbeing from transport externalities:
  - transport infrastructure investment appraisal should explicitly include the external costs. This is necessary to limit distortions to use of existing infrastructure rather than perpetuating current price distortions.
  - where non-price measures are proposed to deal with externalities, further investigation of incentive mechanism should be pursued to achieve greater alignment with policy targets. Regulatory impact statements should be prepared for each measure.
  - mass distance charging should be progressed in parallel as it provides a pricing system with far clearer signals than the current heavy vehicle charging regime.
  - consideration be given to increased rates of fuel charges to reduce pollution and greenhouse externalities.
- land transport prices should be structured so that:
  - in the absence of individual road user pricing, the price for the use of a road by the vehicle type which determines the ultimate standard of the road (ie the heaviest axle load) should cover at least the total incremental cost that it imposes on the road infrastructure. In addition, there are also incremental road capacity costs of relevance. Under the current road pricing approach, non-separable costs are recovered on the basis of kilometres travelled which do not reflect in any way the nature of road capacity consumption;
  - the recovery of common road costs should follow the pricing objective that is applied in rail (and other) infrastructure industries – namely that, prices should be set in such a way that minimises the distortions to consumption with the objective of recovering the full cost of infrastructure provision. Both volume and distance are likely to form part of any assignment of common costs to vehicle types. However, under a true usage-based pricing regime, care would need to be taken that common costs were not solely recovered on the same basis as any usage-related cost drivers so as not to over-signal the impact of alternative vehicle operational configurations on road costs; and
  - in allocating common costs, distortions to consumption would be minimised where prices are charged so that products whose output is less sensitive to higher charges pay relatively more of the common costs. As for rail, such price discrimination is likely to be efficient and desirable because common costs constitute a significant proportion of the total road costs to be apportioned and different traffics have differing capacities to pay.

- The introduction of mass distance charging is an essential first step in minimising these economic costs associated with the current distorted pricing arrangements. It is important to reflect the nature of freight flows in Australia where potential for modal competition exists and covers the major freight corridors. The desirable features of an MDC system in Australia would include:
  - an initial concentration on major freight corridors where road/rail competition exists, however the potential to extend the system to other parts of the road network in the future should not be excluded. In QR's view the Auslink National Network – which is the backbone of the national freight network – would be a well defined network for initially implementing MDC;
  - a recognition that the scheme's revenue recovery objective should embrace the full costs of the road infrastructure involved;
  - a variable charge reflecting incremental costs which is location specific to reflect road type (as incremental costs vary by road type and condition);
  - an emphasis on accurate measurement of both distance travelled and specific route used as well as the actual vehicle mass. The level of accuracy achieved will be subject of course to the technical and economic feasibility of the various monitoring and measurement devices available; and
  - a mechanism to ensure that revenues earned from mass distance charges flow to the infrastructure owner where the costs occurred.
- Reform of rail regulation must comprise:
  - the need for a single regulatory objective of economic efficiency;
  - the introduction of a 'propose-respond' regulatory architecture – enshrined in legislation - which will produce a more efficient regulatory framework through reduced incentives to submit ambit claims and reduced risk of regulatory error;
  - the availability and scope of merits review to ensure better quality decisions; and
  - ensuring that any mandatory timeframes for regulatory processes will not prejudice a robust and fair regulatory process.
- A more commercial governance structure for road agencies should be a cornerstone of future reform.
- On the basis of existing practice and learning from the work undertaken in Europe, the following actions are required:
  - coordination and approval for land transport investment relating to ensure that investments are consistent with economic efficiency;
  - a consistent project appraisal approach using cost benefit analysis;
  - transparent corridor assessments should support all funding decisions; and
  - projects are funded on the basis of their net economic benefit.

Contents

Chapter 1

Setting the Scene

QR welcomes the opportunity to make a submission to the Review of the Cost of Freight Infrastructure and Efficient Approaches to Transport Pricing. The Review is timely given the lack of progress achieved on road pricing reform in recent years. It also provides an opportunity to ensure the pricing and regulatory approach in the rail industry is serving the national interest.

Solutions to the deficiencies in land transport pricing and investment must be found so that the rail and road industries can maximise its contribution to the national economy.

1.1 About QR

QR is one of Australia's largest and most innovative transport providers. On any day, the QR network runs 1,000 train services and moves more than 440,000 tonnes of freight. In fact, QR moves more freight than any other organisation in Australia. A wide range of customers rely on QR's freight, transport and logistics solutions within and throughout Australia.

QR is also the only remaining fully integrated rail business in Australia with expertise across the full scope of rail services. QR is also a major provider of rail infrastructure services. QR manages network access, control of train operations and infrastructure assets worth $3.8 billion. QR is constantly investing in its rail network, although in some freight markets investment is clearly impacted by road pricing.

QR is structured into the following business operations:

- QRNational which aims to become Australia's leading coal and bulk logistics provider and a leading national freight and logistics business. It also provides services to general freight customers in regional areas;
- Passenger Services which carried approximately 49.5 million passengers in 2004-05 in Queensland;
- Network Access which delivers a safe, reliable and sustainable network in Queensland; and
- three support groups – Infrastructure Services Group, Rollingstock and Component Services and Shared Services.

1.2 The Need for Reform

The rail industry has undergone a sustained period of reform since the Industry Commission's 1991 Report into the rail industry. Since that time the efficiency and service quality of the rail industry has continually and significantly improved. Moreover since the introduction of National Competition Policy in 1995 a national market for rail has emerged and now traditional state borders are irrelevant and competition is now a permanent part of the rail industry operating reality. There has also been a considerable degree of consolidation in the rail industry.

This Review comes at a critical time where further and broader reform of land transport pricing and investment is necessary to allow the Australian economy to achieve its potential. Long-run forecasts of transport services are for sustained growth and in this environment it is critical that infrastructure is operated and expanded efficiently. Clearly the challenges for infrastructure pricing and the consequences for the community are well recognised by Government.[1]

> Modern infrastructure is costly and involves long lead times. Australia cannot afford poor and uncoordinated infrastructure decisions that impose high costs on the community, the economy and the environment.

A consistent message with respect to infrastructure performance is the absolute necessity to ensure pricing and supporting institutional arrangements support efficient outcomes.

Over many years there has been a vast amount of work done on road rail competitive neutrality but with very little in the way of practical reform in road pricing. In contrast, rail pricing has increased in sophistication and consistency with economically efficient outcomes, although further improvement is likely. While concerns put forward in the past by QR and the rail industry regarding road pricing remain valid, QR has recognised that the reform agenda is broader.

From QR's perspective the road pricing debate cannot solely focus on modal share. The real issue is the performance of infrastructure; its efficient operation and development, which is about setting infrastructure prices correctly. QR believes that there is now wide recognition that the current system administered by the National Transport Commission (NTC), with its emphasis on cost recovery, is not an efficient pricing system.

With the exception of some bulk traffics, the rail industry and QR operate in the face of competition from other transport modes. Modal competition is a positive discipline on QR to continually improve and innovate its service offerings. However, the current pricing arrangements disadvantage rail and impact its short term and long term competitiveness in most major freight markets.

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1 Department of Transport and Regional Services (2004), *Auslink Whitepaper*, p viii.

1.2.1 The Context for Reform

In an environment of intense global competition it is vitally important that non-tradable sectors such as infrastructure are provided and operated efficiently because of their impact on sectors more open to competition. For around two decades, micro-economic policy has scrutinised and made improvements to the regulation, structure and pricing of industries in the non-tradable sector, particularly infrastructure. Indeed, the current process of heavy vehicle road pricing arose during this period of reform.

The Auslink White Paper highlighted the importance of efficient transport infrastructure for an open economy like Australia.[2]

> Efficient infrastructure facilitates specialised production, price competitiveness, time sensitivity and reliability of Australian goods and services in both intra-industry and world trade markets.

The importance of transport as a production input is outlined in the Appendix A. In summary, in half of all industry sectors, transport costs form over 10 percent of total intermediate costs, and exceed 30 percent for several sectors. In most sectors, with the exception of Coal, Oil and Gas, road transport is the most significant form of transport used. While this is based on Queensland data, QR believes that it is likely to be representative for Australia. Clearly transport costs are a significant component of final prices and, as such, pricing below or above efficient levels will distort production and consumption decisions throughout the economy.

One of the key objectives of micro-economic policy is to ensure the institutional arrangements for setting prices are consistent with economically efficient outcomes. Studies of the benefits of reform have consistently shown the opportunity cost of not progressing reform to be significant. In many cases reform was achieved through market mechanisms, complemented where necessary with appropriate regulation. Arguably the past two decades has been a period of great change, learning and innovation in infrastructure price setting in Australia. Infrastructure pricing is increasing in sophistication and efficiency, except for roads.

1.3 Road Pricing Arrangements

The current system of setting road prices is far from ideal. QR considers that the Third Heavy Vehicle Pricing Determination was a timely opportunity for Australia to undertake major reform of road infrastructure pricing. Unfortunately, the Third Determination will continue to apply the current road pricing arrangements, which are not in the long-term interests of national economic performance. In this context, the costs of under-recovery of road infrastructure costs will continue to rise.

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2 Department of Transport and Regional Services (2004), op cit, p 1.

Inefficient road prices have implications for rail's competitiveness with road infrastructure. The Auslink initiative recognises that rail is underutilised in the national transport task. For example, one of the eight key Auslink strategies is directed to increasing rail's competitiveness.

> The Australian Government will improve the capacity and performance of the vitally important eastern seaboard north-south interstate corridors by upgrading critical road and rail links, increasing rail's market competitiveness, and improving intermodal integration.[3]

In general, the allocation of tasks between road and rail should accord with the competitive characteristics of each mode. For example, rail's competitive advantage over road increases the longer the haul and for bulk commodities. Road has an advantage on shorter hauls, in particular, where road transport is required to achieve final delivery.[4] Analysis by the BTRE for the Auslink National Network corridors shows rail achieving higher growth rates than road on longer hauls, with the general trend of a shift of non-bulk freight to road (see Appendix A for further details).

The Productivity Commission[5] noted that competition between road and rail will be shaped by the responsiveness of transport customers to:

- prices (freight rates); and
- service characteristics (eg. punctuality, reliability, frequency, damage to goods, transit time and capacity to carry specific commodities).

However, the allocation of tasks between modes is also heavily influenced by current pricing and investment arrangements for land transport. Where these arrangements are distorted, as they are with the current heavy vehicle charging arrangements for road, the competitiveness of rail relative to road will be adversely affected. This has already occurred, with a growing shift from road to rail in recent years, including in areas where rail has traditionally had a competitive advantage, such as bulk freight haulage. These issues will be discussed in Chapter 6.

In addition to distortion in the pricing structures, differences in institutional arrangements applicable to road and rail have also had an impact on investment decisions. In particular, rail freight providers operate in a commercial environment (and typically also a regulated environment), with a direct link apparent between costs and revenue earned. This differs from road infrastructure provision, which is not subject to the same commercial framework for service provision and where, in effect, there is no direct relationship between the costs of provision and the revenue from

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3 Department of Transport and Regional Services (2004), *op cit*, p31.

4 National Transport Commission (2005), *Effect of Truck Charges on Rail*.

5 Productivity Commission (2000), *Progress in Rail Reform*, p. 231

road use. These regulatory and governance issues are addressed in more detail in Appendix A.

It is QR's view that the pace of learning and development in heavy vehicle road pricing has been hampered by the current institutional arrangements. The focus of attention through the Determination process has been on the intricacies of the model and not whether its outputs, road prices, are providing clear signals to users on the social costs of their transport choices.

The policy objectives for heavy vehicle charging need to and are changing as part of national reform to improve resource allocation in the provision of transport infrastructure. For example, the Australian Transport Council has accepted the need for pricing arrangements to move from average to variable pricing to promote efficiency in infrastructure use and modal neutrality. However, the current principles for setting road prices have multiple objectives and need to be simplified. As discussed in Chapter 6 QR believes that economic efficiency should be the objective of road pricing arrangements.

1.4 Reform delays are costly

Several factors suggest that the opportunity cost of delaying the move efficient pricing will be significant:

- the significance of road funding in the national economy, especially given projected growth in the traffic task;
- the low traffic densities and relatively high costs of creating transport corridors in Australia serves to increase the importance of achieving modal efficiency;
- the spillover effects of distorted prices for land transport along the logistics chain.

1.4.1 Significance of road funding in the national economy

As noted in the Appendix A, the non-bulk freight task, which currently is largely serviced by road, is forecast to grow faster than road (road accounted for 69% of the freight transported in 2005, with rail accounting for 21%. Non-bulk road freight is expected to grow at 3.3 percent per annum between 1999 and 2025. Non-bulk rail freight is projected to increase at less than half the rate of growth for road). An implication of this growth, highlighted in the AusLink White Paper, is the challenge this presents to road construction and maintenance in terms of roads needing to be built to a greater depth and width and to a higher quality. Given the projected demand growth of the transport task, it is critical that future investments in transport corridors, particularly roads, are based on better price signals.

Currently governments are expected to expend around $10 billion on roads in 2005-06.[6] This is more than 1% of GDP and is greater than in any other infrastructure industry. This will be required to meet the projected growth in road market share which, according to the Business Council of Australia, will require an additional 900,000 truck trips between capital cities over the next 15 years.[7] It has been demonstrated in other infrastructure industries undertaking pricing reform that improving pricing levels and structures so as to facilitate infrastructure being expanded when it is efficient to do so.

1.4.2 Australian geography increases importance of modal efficiency

Australia's population is geographically dispersed resulting in long intercity haul distances. This means that the provision of road and rail infrastructure involves relatively high costs, a fact that is exacerbated by the relatively low traffic densities on major freight corridors.

The combination of relatively high costs of linking population centres and relatively low traffic densities highlights the importance of achieving modal efficiency in the provision of transport infrastructure for the efficiency of the economy overall.

1.4.3 Spillover effects of poor infrastructure pricing

The distortions in road rail infrastructure pricing have broader implications in terms land use decisions. Transport infrastructure costs will influence the location and design of urban areas. Sub-optimal location of activities due to distorted price signals are not easily reversed, which means the efficiency costs persist through time.

Future investment decisions across a range of industries will be sub-optimal if road pricing is not improved. As noted above, given that land use decisions are influenced by transport costs, the opportunity costs of sub-optimal decisions extend well beyond the decisions of transport operators and therefore the costs will be far greater when assessed from this broader context.

Distorted price signals reduce the efficiency of national transport as subsidies rather than relative efficiency is influencing choices of transport mode. It also makes the task of maintaining competitiveness more difficult for other transport modes. Investments which improve service capacity, quality and productivity cannot be commercially justified while market prices for land transport are effectively set by inefficient road prices.

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6 National Transport Commission (2005), *Third Heavy Vehicle Road Pricing Determination: Technical Report*, p 12.

7 Business Council of Australia (2005), *Infrastructure Action Plan for Future Prosperity*, p. 12.

Moreover, the distortions are not confined to the transport industry. Business decisions regarding inventories, production and business location across a range of other sectors are affected by inefficient road pricing. Ultimately the community will forgo higher income because a subsidised business input is displacing a more efficient option.

1.5 Direction for Reform

QR doubts that appropriate price signals will be achieved through the current road pricing arrangements. There are a number of organisations, including the BTRE that have highlighted a number of deficiencies in the heavy vehicle charging methodology that produce inefficient price signals:

- the fuel tax component is not a precise measure for infrastructure consumption;
- cross recovery based on vehicle classes produces subsidies which impact on modal neutrality;
- arbitrary cost allocation shortfalls; and
- prices do not reflect externalities which tend to be more significant for road than for competing modes (externality issues are discussed in Chapter 3).

QR believes that the future of road pricing lies in individual user charging. However there is a range of issues that need to be addressed before the benefits from individual user charging can be secured. These issues will be discussed in Chapter 5.

1.6 Components of the Reform Task

The objectives of the transport pricing reform should be to achieve a situation where:

- transport infrastructure is priced so that alternative modes may compete on their economic and practical merits;
- investments are made in transport infrastructure which maximise social welfare; and
- equity and other government policy objectives are transparent and delivered in an efficient manner.

QR notes that intergovernmental financial reform was not part of the Commission's Terms of Reference but, given the objective of improving investment signalling, a greater nexus must be achieved between costs and revenues for road owners, something which is not achieved with current heavy vehicle pricing arrangements. The Queensland Government submission provides examples of the problems of the present financial arrangements.

1.7 Structure of the submission

The submission seeks to address many of the questions asked in the Productivity Commission's Issues Paper, *Road and Rail Freight Infrastructure Pricing*, although not necessarily in the order they were asked.

The structure of the submission is as follows:

- Chapter 2 discussed the cost characteristics of land transport infrastructure and particularly the incremental costs;
- Chapter 3 reviews the literature on externalities and further work that needs to be undertaken before they can be reflected in prices;
- Chapter 4 discusses pricing objectives and contrasts approaches to rail and road;
- Chapter 5 reviews overseas experiences with mass distance charging and considers the benefits and issues associated with its implementation in Australia;
- Chapter 6 considers the impact of road pricing regulation and rail economic regulation on bulk freight railways;
- Chapter 7 considers the issues and reform of investment processes; and
- Chapter 8 concludes the submission with QR's views on the analysis of economic benefits, distributional impacts and transition arrangements necessary to support fundamental reform.

Chapter 2

Costs

2.1 Main Points

There are a number of similarities between road and rail infrastructure costs:

- cost characteristics such as economies of scope, scale and density are important considerations for pricing structures;
- cost drivers are similar particularly for constructing new assets;
- cost causation is similar for both modes with respect to capital and maintenance;
- cost causation is complex because infrastructure service providers and operators can affect each other costs.

Both road and rail infrastructure providers use rules to limit costs imposed by operator choices but there remains scope for cost reflective pricing to influence choices. The concept of incremental pricing is being generally applied in rail pricing in respect to capacity and maintenance. It does not appear to be applied to heavy vehicle charges.

2.2 Introduction

This chapter provides information on both rail and road costs and will show that they exhibit similar characteristics.

A key issue for the review will be to examine how costs change with use of infrastructure. This chapter will discuss the key drivers of rail and road costs.

Efficient infrastructure use decisions will be made when the marginal benefit to users equal the marginal cost. In the presence of indivisibilities in costs, the concept of incremental costs is more usefully applied. The Chapter concludes with a discussion of the concept of incremental costs for both road and rail transport.

2.3 Description of Costs

Road and rail infrastructure costs are characterised by high fixed costs associated mainly with construction but also aspects of operations and maintenance. Short-run variable costs largely comprise maintenance activity. Marginal costs are small given the predominance of fixed costs in total costs.

Both road and rail exhibit economies of scale, density (due to the presence of indivisibilities in capital) and scope. These characteristics are important considerations for the structure of prices.

As in most infrastructure activities, the separation of outlays into capital and operating costs in the context of roads and railways is not clear cut. The approach taken in this chapter is a predominantly time based categorisation of costs wherein capital costs are the initial costs of establishment, while operating costs relate to the on-going costs associated with maintenance of the infrastructure's service standard. In a whole of life or life-cycle cost (LCC) framework such delineation is somewhat less significant than in the case of an annualised costing approach.[8]

For a typical freight railway, capital counts for around 60% of total cost with operation and maintenance cost comprising the remaining 40%. Maintenance costs comprise around 25% of total costs.

2.3.1 Capital costs

Land

An important capital cost for road and rail is the value of land under the infrastructure.

For road corridors, land costs are largely a function of traffic volumes, environmental and safety standards, and value of the land being traversed. The impact of heavy vehicles on land costs relate to:

- alterations to approaches to urban centres or the construction of by-passes to minimise the impact of heavy vehicles; and
- alterations to horizontal alignments to achieve desired performance standards for heavy vehicles.

In Queensland the value of land under infrastructure is treated differently for rail and roads. QR understands that the value of land under state controlled roads in Queensland under the road pricing regime is effectively zero.[9] For QR's coal network, the cost of the land for existing rail corridors is its value in the next best alternative use and reflected in prices. For proposed new rail corridors, costs associated with land acquisition are likely to include compensation for land resumption and legal fees.

Earthworks

Earthworks account for approximately 45% of the total cost of road construction. The cost of earthworks is largely a function of road alignment, both vertical and horizontal.

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8 As the title suggests, life-cycle costing models consider the totality of costs associated with a particular facility over its full economic life and do not explicitly recognise the economic return on the assets involved or the depreciation of those assets. Hence, there is little or no requirement to delineate between capital and maintenance outlays. On the other hand, annual costing models require the calculation of the annual depreciation and return on investment for each component of the asset.

9 The cost of acquiring land is included in project costs but is value is written down to zero after construction is completed.

In particular, the amount of cutting and filling undertaken to achieve a particular maximum gradient will have a significant impact on the total cost of earthworks for a particular road. Maximum gradients in turn are largely determined by target vehicle speeds, maximum loads and safety considerations.

The design criterion for roads carrying heavy vehicles would be for a maximum gradient (or slope) significantly less than a road built only for light vehicles. This requirement therefore potentially has a considerable impact on the cost of earthworks. Also, the greater length of heavy vehicles will necessitate the construction of roads with more sweeping curves. This will require changes to the horizontal alignment of the road and potentially increase in earthworks. McLean[10] concluded that a comparison of truck-based and car-based standards for earthworks design suggests that, at least in hilly terrain, the adoption of truck-based standards would result in an increase in earthworks of some 25 to 50 %.

Railway construction also requires earthworks to provide a finished construction surface prepared in readiness to receive the track. The greatest constraint on railway design is the need to strictly control gradient, which sets the steepest slope over which a fully loaded train can be hauled.

The cost of earthworks is therefore determined by the amount of cut and fill necessary for the desired horizontal and vertical track alignment and gradient. Track alignment and curvature (which determine maximum permissible train speeds, as well as the level of wear on rail and rolling stock) also necessitate earthworks. Greater limitations on grades and curvatures exist for rail than on roads.

Road Pavements

Modern pavements can be constructed as either flexible or rigid structures. The selection of pavement type depends on a number of parameters, including:

- the standard and availability of materials, particularly the standard of the sub-grade i.e. a rigid pavement would be preferred where there is a low strength sub-grade;
- the required level of pavement performance and reliability;
- the curvature of the pavement and topography of the right of way[11] i.e. rigid pavements are preferred for straight sections, while flexible pavements are preferred for roads in built-up areas with tight cornering, roundabouts and intersections;

10 McLean, J. (2006) Earthworks Cost and Heavy Vehicle Use. Heavy Vehicle Charges Cost Allocation Workshop. Melbourne (April, 2006)

11 A narrow length of land used for the route of a railway, electric power line, or public road

- the totality of capital and operating costs incurred over the economic life of the road;
- traffic intensity and composition; and
- other environmental factors, e.g. noise level.

The most important factors affecting pavement cost are traffic volume and composition. Austroads[12], for example, suggests that rigid pavements are required to carry design traffics over 1×10^6 heavy vehicle axle groups (HVAG). This level of traffic would be applicable to major arterial roads and highways.

Rigid pavements are more expensive to construct than flexible pavements. However, they have a lower life cycle costs per unit of use.

Track

Decisions made with respect to earthworks and track components determine the standard of the track and the forces imparted by rolling stock that the track can safely absorb. For example, the choice of sleeper type, depth of ballast and the size of the rail.

Similar to the situation for roads, train characteristics will determine the choice of track standard.

The track standard typically varies across a network depending on the traffic mix on each rail corridor. Most importantly, track standard determines the maximum permissible axle loads and speed at which a locomotive and its wagons/carriages can operate (loaded and unloaded) safely on the tracks. Other things being equal, a higher quality track should be able to deliver a more reliable below rail service, measured in terms of on-time running for timetabled (passenger and intermodal freight) traffics and shorter cycle times for cyclic (heavy haul) traffics. This higher reliability could also increase the capacity of the track through potentially allowing more train services to operate in a given period.

In contrast to roads, heavy haul railways are normally purpose built for the particular traffic eg coal in Queensland and iron ore in the Pilbara.

2.3.2 Maintenance Costs

Road

Road maintenance is usually categorised as routine or periodic (or intervention). Box 1 lists the type of activities normally associated with each category of maintenance.

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12 Austroads (2004), *Pavement Design – A Guide to the Structural Design of Road Pavement* p 91.

Box 1 Road maintenance activities

Routine maintenance includes:

- pothole repair;
- cracking sealing and other minor resealing and resurfacing (limited thickness and length);
- edge repair and shoulder maintenance;
- drainage clearing;
- vegetation control; and
- maintenance of road side equipment.

Periodic or intervention maintenance includes:

- major resealing and resurfacing;
- pavement rehabilitation; and
- renewal.

The effects of routine maintenance only last for one to two years and hence expenditure levels need to be maintained at a reasonably constant level over time. Broadly speaking, there are two types of routine maintenance. The first type includes activities such as vegetation and drainage management that are largely independent of traffic volumes and composition. The second type includes minor pavement maintenance (crack sealing, pothole filling), edge repair and minor resealing, and minor culvert and bridge maintenance. This type of routine maintenance is related to both traffic volumes and loading.

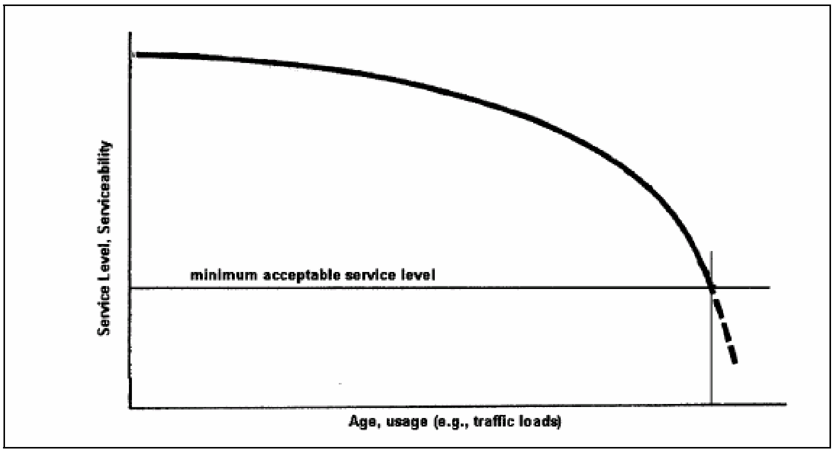
If sufficient routine maintenance is not undertaken there will be long term implications for the formation of the road and the level of future intervention or periodic maintenance activities. Hence routine maintenance is usually given the highest priority by road management authorities.

The relationship between heavy vehicle use and routine maintenance costs is the most difficult to define. This is because the relative impact of load and environmental factors (moisture and temperature) is difficult to delineate. For this reason routine maintenance is usually time based as opposed to condition based. The proportion of routine maintenance that is variable with load was the subject of research undertaken by Zongzhi (2002).[13] This research concluded that the more rigid the pavement the greater the proportion of routine maintenance costs attributable to load. The explanation of this outcome is that flexible pavements are more vulnerable to environmental factors than to traffic loading. If rigid pavements are less vulnerable to weathering (and other non-load factors) a given performance should be achievable with relatively less routine maintenance, most of which would be attributable to load.

[13] Zongzhi, Li. A determination of load and non-load shares of highway pavement routine maintenance expenditure. (2002).

Road use, particularly by heavy vehicles, results in both surface distress[14] and deformation distress[15] which undermines the bearing capacity or structural condition of the road. As the structural condition worsens the rate of deterioration and deformation increases and the greater the loads carried the faster this process of deformation occurs. The relationship is illustrated diagrammatically in Figure 1. Hence, the relationship between heavy vehicle use and the need for periodic maintenance activities is more direct than for routine maintenance.

Figure 1 Pavement Condition and Usage



Rail

Maintenance describes a wide variety of activities carried out to ensure that below rail assets continue safely in service with the required functionality and performance. Renewals also perform this role, but they usually comprise either the replacement of the whole asset or at least of component parts of the asset. Renewals are carried out when continuing maintenance ceases to be an economic option and therefore generally differ from maintenance work in terms of scale and frequency.

Different train operating characteristics also result in each traffic type having a different impact on the wear and tear of the track. For example, heavy haul trains, such as coal trains, have a significantly greater wear and tear impact on the track than passenger trains, resulting in significantly higher ongoing maintenance costs per kilometre.

Maintenance of railways is also falls into two categories; routine or major.

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14 Surface distress – wear and tear of the surfacing caused by the cumulative passing of numbers of vehicles or axles and damage caused by temperature variations resulting in an increase in aging/oxidation rates of the bitumen in the surface layer.

15 Deformation distress – Damage caused by the cumulative equivalent standard axles over a point in the pavement and damage caused by water entering and softening the materials in the lower layers of the pavement eg subbase and sub-grade layers.

Box 2 Rail maintenance activities

Routine maintenance activities consist of the following:

- inspections, including regular visual inspections by section car and the measurement of track geometry and rail flaw detection by special vehicles;
- resurfacing (tamping) to restore the elasticity of the track structure and the relative position of the track;
- bridge maintenance, particularly for timber bridges, which requires the replacement of cracked or decayed sections and periodic tightening of components. Steel and concrete bridges require relatively minor ongoing maintenance.
- miscellaneous routine track maintenance, including track geometry corrections, fencing repairs and turnout maintenance.

Renewals and major maintenance activities consist of the following:

- track relaying, involving the complete replacement of the track structure;
- re-railing, where worn rail is taken up and replaced but the sleepers still have reasonable life;
- re-sleepering, where bad or life-expired sleepers are singled out, removed and new ones slid into place;
- ballast replacement to remove accumulated dirt and replace broken ballast;
- resurfacing to keep track geometrically aligned ;
- rail grinding to remove corrugations and metal flow from the rail head, as well as maintain the profile of the rail head;
- formation maintenance, including vegetation control and drainage and ancillary facilities' maintenance; and
- miscellaneous maintenance, including culvert repair and extensions and firebreak construction.

One of the key characteristics of track and associated below rail infrastructure is that all of its components – except for the sub-grade – wear out and can be replaced on an individual basis.

Maintenance activity over the life of a railway track has three distinct phases:[16]

- phase one commences immediately after construction when all rail components are new and involves inspections and routine maintenance;
- phase two commences after around 5 years and involves more significant regular activities such as rail grinding and resurfacing, in addition to inspections and routine maintenance continue; and
- phase three begins at around 10 years after construction, as track components start to wear out and ballast becomes contaminated, major maintenance is required to supplement routine maintenance tasks.

[16] QCA, Draft Decision on QR's Draft Undertaking, Volume 3 - Reference Tariffs, December 2000, p159.

2.4 Interaction between usage and vehicle type

The causation of costs between users and providers of both road and rail infrastructure services is complex as either party can increase and decrease the costs of a road user or above-rail operator. For example, deferring maintenance will increase operating costs of users and can reduce productivity if speed or loads have to be reduced for safe operation. Similarly overloaded or vehicles exceeding prescribed speed limits can impose higher costs on infrastructure providers. In the case of rail there is a disproportionate relationship between the force exerted on a rail and speed (ie if speed doubles, the force exerted by the locomotive/wagon increases exponentially). This will result in a higher cost of track construction and/or higher ongoing track maintenance costs.

Both road and rail providers maintain operating rules to limit the negative impact of operators' decisions on infrastructure costs and to ensure safety of other users. However, cost reflective pricing signals also have a role in optimising choices by infrastructure providers and users. This section considers the major relationships that exist between use and capital and maintenance costs.

2.5 Incremental road maintenance costs

Pavements do not generally experience catastrophic failure. They normally fail due to the incremental accumulation of small but finite quantities of damage that exist after one or more repetitions of the loading unit. The damage may occur in terms of finite amounts of permanent deformations or in terms of finite strains sufficient to cause an incremental amount of fatigue damage. In either case, these small but finite amounts of damage accumulate to become visible and non-visible defects -- permanent deformations or cracks - throughout the pavement.

Pavement damage is not only a function of gross vehicle mass but also of the manner in which the weight is distributed over the pavement. Pavement damage caused by a vehicle depends on: [17]

- the number of axles on the vehicle;
- the grouping of the axles ie number of axle groups; and
- the loading transferred to the pavement via each of the axle groups (the axle group load).

These vehicle attributes will significantly affect the extent to which heavy vehicles impact on the road pavement and hence on the relationships between heavy vehicle road use and incremental costs.

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[17] Austroads (2004), *op cit*, p 7.1.

Austroads[18] stated that:

> It is well established that light vehicles contribute very little to structural deterioration and only heavy vehicles are considered in pavement design.

In addition, there is also a material interaction between heavy vehicle use and that of other road users. That is, in the absence of heavy vehicles, light vehicles are not directly responsible for any material pavement damage. However, in mixed traffic, once heavy vehicle induced pavement deterioration commences light vehicle traffic does cause the rate of deterioration to increase.

While the gross weight and axle loads of the vehicle are the loading parameters which are traditionally considered when designing a road or a bridge, the effects of other parameters are being considered in the development of models of the behaviour of the vehicle-road system. These parameters include:

- tyre type – the tyre acts through its pneumatic and mechanical properties to envelop and absorb small disturbances, spread the wheel load over an acceptable area of the pavement surface and provide vertical springing. Tyre type has been shown to be very important to the performance of the road to which it is applied.

- suspension system – the suspension provides springing and damping between the axles and the body of the vehicle and offers a smooth, progressive deflection characteristic under load.

- axle grouping – axle groups such as tandem or tridem axles usually allow for sharing and equalising load among the axles in the group.

- sprung mass of the vehicle – the sprung mass represents the portion of vehicle load carried on the suspension. It has a dominant effect on the dynamic wheel load.

An OECD study that examined the dynamic interaction between heavy vehicles and pavements found that a vehicle's suspension system could significantly reduce the dynamic forces exerted by heavy vehicles and recommended that pricing and other regulatory measures be taken to encourage increased use of road-friendly suspensions. The study found that the other vehicle characteristics listed above could affect the effectiveness of road friendly suspensions to reduce road damage

[18] Austroads (2004) op cit p 7.1

Figure 2 Maintenance Schedule without heavy vehicles

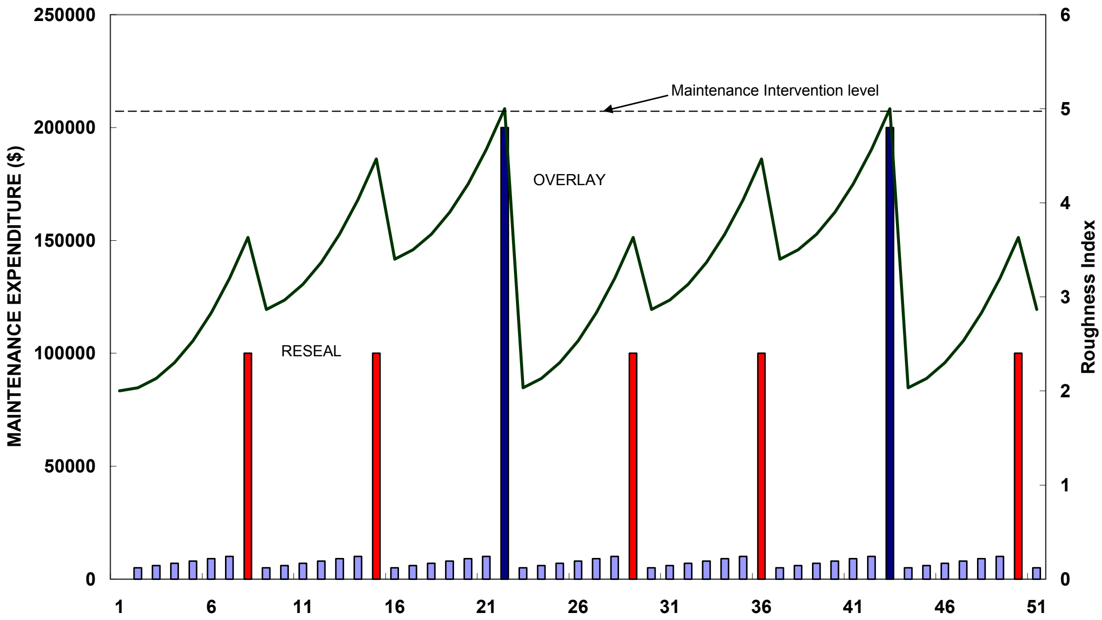
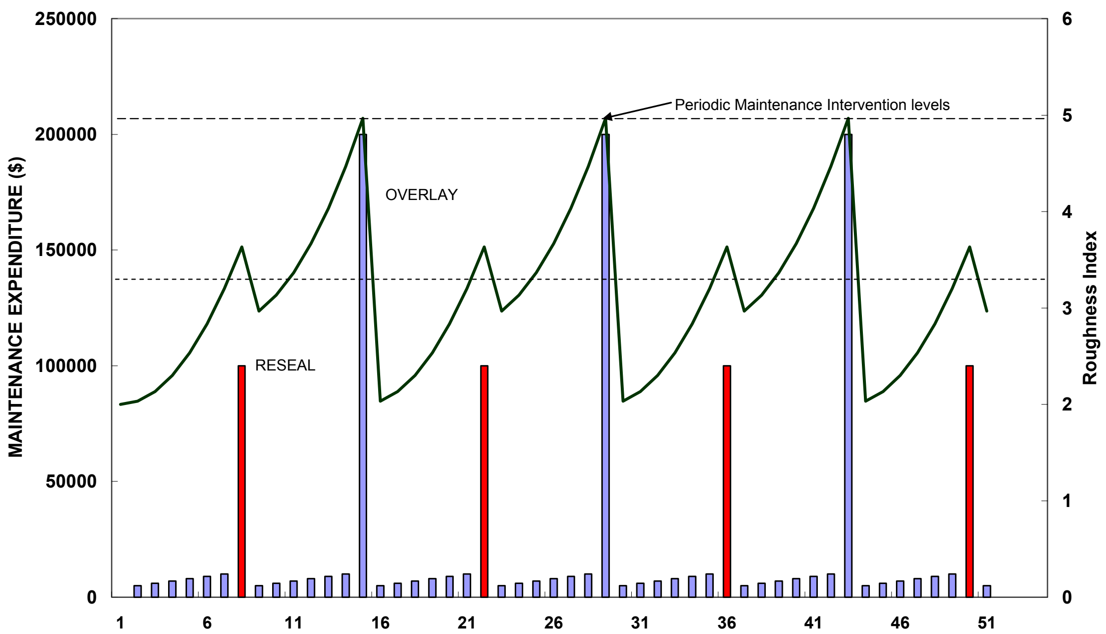


Figure 2 illustrates a maintenance program in the absence of heavy vehicles. In this program, the frequency of periodic maintenance in the form of pavement reseals is time based i.e. every seven years in this example, while major pavement refurbishment in the form of overlays are condition based. In this example, a decision has been taken that once the roughness index reaches a certain level, e.g. 5, the pavement will be substantially refurbished. As discussed above, pavements deterioration in this instance will be mainly driven by non-load factors. In the diagram road resealing improves pavement condition and lowers the rate of deterioration. This significantly extends the period between major rehabilitation activities in the form of overlays.

Figure 3 shows the impact on the maintenance program of introducing heavy vehicles. While resealing activity has not varied (because it is time based rather than condition based in this example) the incidence of major overlays and rehabilitation activities has increased. Therefore, because of the direct relationship between pavement deterioration and road usage, the frequency and cost of periodic maintenance will impact on the costs attributable to vehicle traffic.

Figure 3 Maintenance Schedule with heavy vehicles



2.6 Incremental rail maintenance costs

Low volume (tonnage) lines experience proportionately little change in total cost even if volume doubles, as there is little wear and renewal. However, a large change in use will likely trigger a new preventative maintenance regime and a higher maintenance cost.

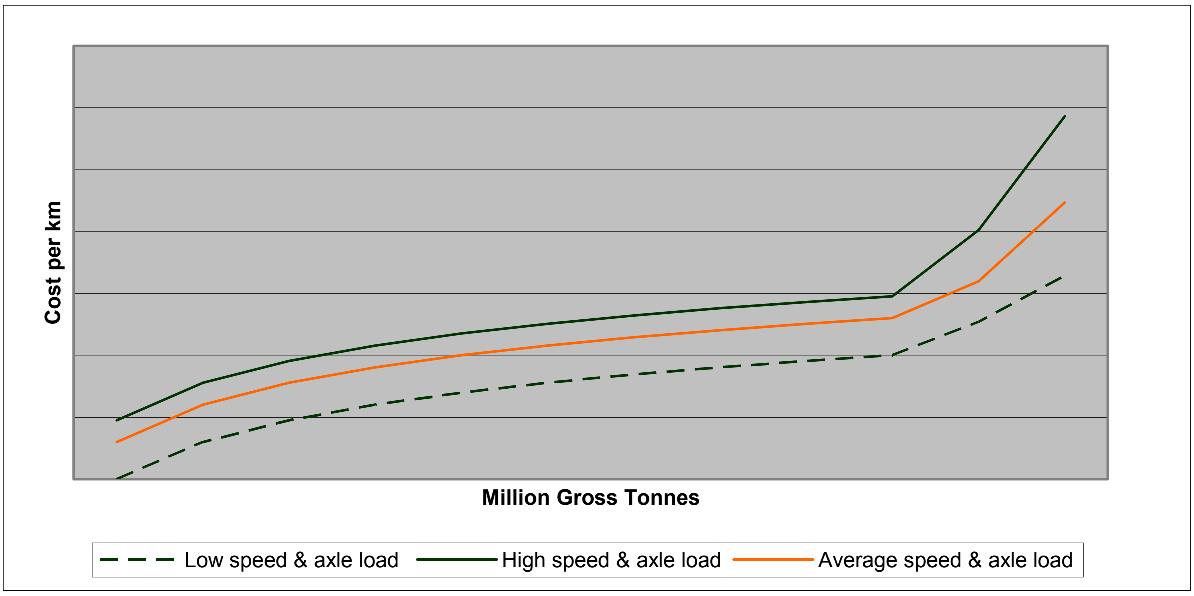
At low tonnages, only a small part of maintenance cost is variable although there is a relatively large increase in maintenance cost per kilometre for every additional tonne which steadily reduces as tonnage increases. Assuming concrete sleepered track, variable costs increase to around 20% at 5 million gross tonnes (MGT) and to around 30% at 10 MGT. At 20 MGT, variability is 45% and increases steadily until they are over 80% at 60 MGT, as maintenance activity becomes increasingly tonnage-based reflecting replacement of worn out components. The variability for these lines will approach 100% as tonnage increases beyond 60MGT.

In addition to tonnage, the variability of maintenance costs with respect to speed and axle load is also important. As previously noted, track infrastructure is built to accommodate the forces imparted by a train at a defined speed and a given axle load. For example, trains operating at faster speeds could be expected to impart more damage to the track and increase maintenance costs.

Similarly, track infrastructure is built to accommodate the forces imparted by a train with a defined axle load. Exceeding these parameters could require track reinforcements to be undertaken or enhanced ongoing maintenance regime to be established.

The relationship between track standard and volume (measured in gross tonnes) is illustrated in Figure 4.

Figure 4 Cost relationship between track standard and volume (tonnage)



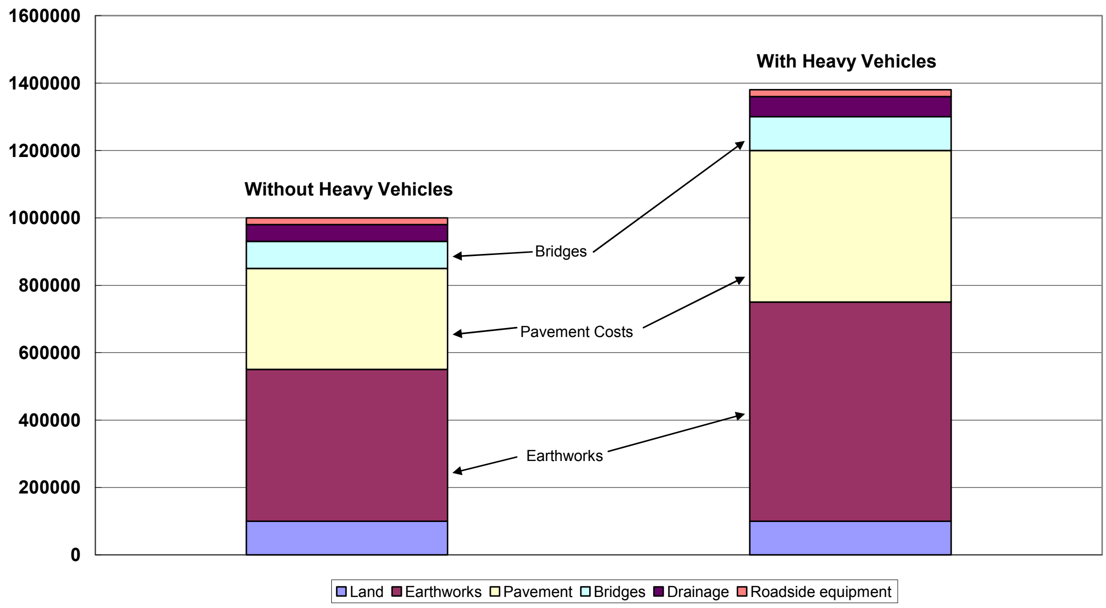
Source: Adapted from QCA, Working Paper 2: Usage-related infrastructure maintenance costs in railways, December 2000, p6

From the total maintenance cost curves in Figure 4, the rate of change of maintenance costs (the slope of the curve), at different tonnages can be estimated. This provides an estimate of the incremental cost of maintenance. In QR's case, an incremental charge is one component of the regulated multi-part reference tariffs applying in each of the clusters in the Central Queensland coal systems.

2.7 Incremental road costs

As discussed previously, the presence of heavy vehicles would usually require more rigid and thicker pavements, higher bridge standards and involve additional earthworks. The increase in total construction costs is illustrated in Figure 5.

Figure 5



Clearly, different traffic types will necessitate the construction of different pavement types and different pavement types are associated with different maintenance programs including the timing, level and type of maintenance activities undertaken to achieve desired performance levels. Hence, the relationship between specific rehabilitation and maintenance practices and pavement performance will contribute significantly to our understanding and quantification of the maintenance cost impacts of heavy vehicle traffics.

2.8 Incremental rail capacity costs

Incremental capital costs for freight is less clear for rail than road because:

- bulk rail freight often operate on single traffic corridors (or at least are the dominant traffic on the corridor);
- higher track standards provide benefits to all users (whereas on roads higher capital costs do not benefit light vehicle operators).

However, incremental capacity costs are arguably more important in rail than on road. This is largely because use of the network is closely controlled and capacity consumption is more easily measured. Incremental capital costs are those costs associated with a small increase in capacity, usually measured in terms of the number of train paths. However, for a corridor predominantly carrying freight, capacity could be measured in terms of gross or net tonnes transported.

Railway infrastructure provides capacity in discrete quantums, with an initial investment providing a finite capacity with a fixed cost. The capacity of an established railway can be expanded at a very small incremental cost as long as duplication or multiple-tracking is not required.[19]

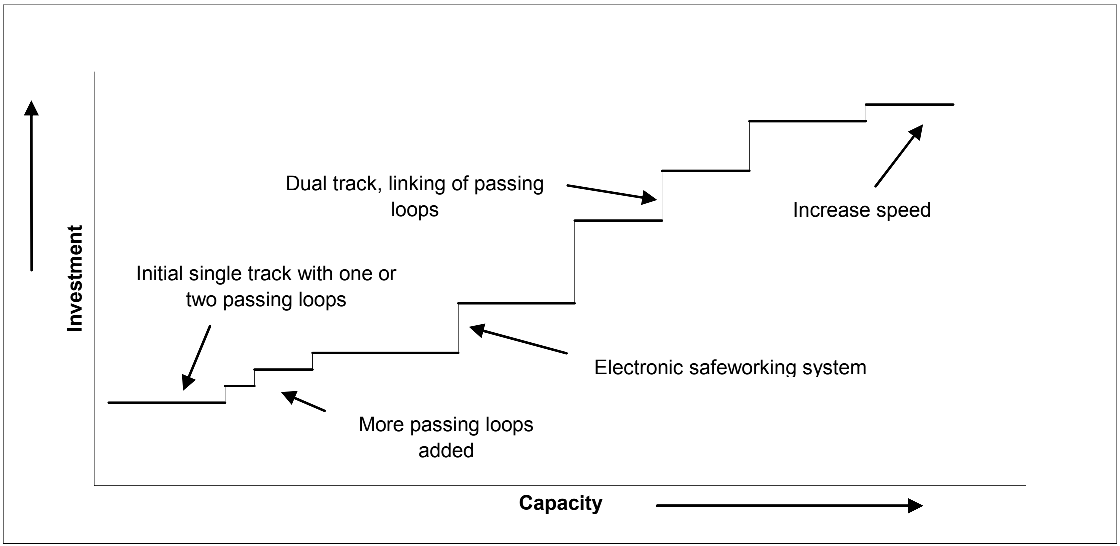
Incremental investments can progressively lift capacity until the next discrete limit is reached. For example, a single line track, with infrequently spaced passing loops, could be progressively upgraded through the provision of more loops and upgraded signalling, until a limit is reached at which point it is not practical to further sub-divide sections. Once passing loops are around 10km apart, it is generally more cost effective to duplicate sections of track, starting with those sections with the longest running times.

Doubling of sections of the track is at significantly greater cost than constructing a loop, and can continue until the whole line is double-track. However, there is a correspondingly large increase in potential capacity from this large incremental investment.

Subsequent increments in capacity become relatively cheaper through reduced signal spacing, limited only by minimum section lengths required for safe operational working.

Figure 6 illustrates a typical process of incrementally expanding below rail capacity.

Figure 6 Incremental expansion of below rail capacity



Source: QCA, Working Paper 3, Incremental Cost of Capacity, December 2000

19 However, where capacity is constained for only short periods during a given time period, this may not justify incremental investment in the short or long run.

Unlike many other infrastructure sectors, such as electricity and gas, rail and road share the characteristic that a train/motor vehicle's consumption of capacity is highly dependent upon the interaction of that train/motor vehicle with others using the infrastructure. For example, train size and performance has a significant impact on capacity as slower trains tend to occupy sections of track for a longer time, as do faster trains which receive priority when operating on the network.

In addition, demand for capacity may be concentrated at particular times of the day such that capacity is constrained at these times but is under or unutilised for long periods outside this constrained period. This is more likely to be the case for timetabled traffics like inter-modal freight and passengers, as opposed to cyclic traffics like coal.[20] These different types of demand for capacity have implications for the pricing of incremental capacity, with prices for timetabled traffics more demand-driven and for cyclic traffics more supply-driven.

The interdependency of consumption places a premium on rail/road operators using configurations that efficiently utilise capacity while meeting the needs of their customers.

In QR's case an incremental capacity charge is one component of the regulated multi-part reference tariffs applying on each of the clusters in the Central Queensland coal systems.

20 A cyclic traffic has a capacity entitlement which is expressed in terms of a number of train services within a particular period of time eg. a week or month. .

Chapter 3

Externalities

3.1 Main Points

The key findings that can be taken from the literature relevant to the present review are:

- all modes of transport generate externalities, although rail generates fewer negative externalities than road transport;
- the estimated economic cost from transport externalities are substantial but subject to major estimation challenges;
- most costs are generated within major population centres;
- measures to correct externalities mainly involve "command and control" regulation with economic instruments mainly involving fuel taxes (although fuel taxes are applied typically to raise revenue).

QR submits that in principle social marginal cost pricing for externalities ought to be further investigated for transport pricing. Further work will be required before practical implementation can be achieved, specifically:

- the appropriate policy instrument for each externality;
- the optimal level of emissions;
- the least cost method for reducing externalities; and
- in respect to pricing instruments, the set of prices necessary to achieve efficient levels of externalities.

In the interim, QR believes the following actions should be taken because of the large costs in economic and social wellbeing from transport externalities:

- transport infrastructure investment appraisal should explicitly include the external costs. This is necessary to limit distortions to use of existing infrastructure rather than perpetuating current price distortions;
- where non-price measures are proposed to deal with externalities, further investigation of incentive mechanism should be pursued to achieve greater alignment with policy targets;
- mass distance charging should be progressed in parallel as it provides a pricing system with far clearer signals that the current heavy vehicle charging regime; and
- further consideration of increased rates of fuel charges for congestion, pollution and greenhouse related externalities.

This chapter provides comment on the extent to which negative externalities[21] impact on the efficient pricing of the road and rail freight task and the issues raised by externalities when considering the way forward on pricing reform. There is a vast literature on transport related externalities. QR believes the following issues provide a relevant focus for the review in relation to externalities:

- the relevance of externalities to road and rail pricing,
- existing evidence of internalisation of externalities; and
- how pricing reform should proceed in advance of better knowledge of externality costs.

3.2 Relevance of externalities to road and rail pricing

Transport externalities are widely acknowledged to impose significant costs on the Australian community. Denniss (2003)[22] estimates the external costs of transport in Australia as at the year 2000 to approximate $30 billion per annum or approximately 6% of GDP. In comparison, the external costs of transport in the EU, as at 2002, approximated 10% of GDP.[23] However, estimates have not been established which would be accepted as appropriate for externality pricing.[24].

There is consensus as to the relevance of a number of externalities applicable to road and rail transport. Table 1 highlights the latest available Australian data on each of these major externalities.

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21 The Productivity Commission defines an externality as arising where an activity or transaction generates benefits for, or imposes costs on, individuals not party to the decision to engage in the activity or transaction… Externalities generated in the provision and use of road and rail freight infrastructure include noise and local air pollution, accidents, congestion and greenhouse gas emissions.

22 Denniss, R (2003), *Implementing policies to increase the sustainability of transport in Australia*, paper presented to 'Western Australia: Beyond Oil?', conference jointly organised by Australian Institute of Agricultural Science and Technology (WA Branch) and the Sustainable Transport Coalition, [on-line], available at: http://www.aspo-australia.org.au/References/Denniss-paper-2003.doc.

23 UIC/CER (2000), The Way to Sustainable Mobility: Cutting the External Costs of Transport, [on-line], available at: http://mct.sbb.ch/mct/en/externe_umweltkosten.pdf. The figure is 8% when excluding congestion – see European Environmental Agency (2002), Indicator: External Costs of Transport – 2002 [on-line] available at: http://themes.eea.eu.int/Sectors_and_activities/transport/indicators/cost/TERM25,2002/index_html

24 An alternative set of figures can be given for externalities expressed as a %GDP quoted in this report. The Victorian Transport Externalities Study (1994) estimated Australian transport-related externalities at 2% of GDP (the highest cost being attributable to congestion), with various detailed costings for each externality applied at the state level for Victoria. It is notable, however, that the VTES data is both dated and, as it itself acknowledges, involves a number of studies using different methodologies for different purposes and thus must be used with great caution.

Table 1 Road/Rail Externalities and their Size/Significance

Externality	Latest Data on Size/Significance
Congestion	BTCE estimated a total cost of approximately $12.8 billion per annum due to traffic, rising to around $30 billion per year by 2015 (excluding measures taken to avert costs or any major road developments since 1995). This compares with the externality identified by Denniss (2003) who indicates an estimate of the travel time costs of commuting (as opposed to congestion costs more generally) as at the year 2000 at $7.4 billion.
Noise	Denniss (2003) estimated the cost of noise pollution (due mainly to road and air traffic) at $2.29 billion to the year 2000. According to the Public Transport Users Association (2006), approximately $700 million can conservatively be attributed to road noise. Noise impacts of freight transport (urban and non-urban expressed AUD per 1000 tonne-kilometres) are estimated by Tsolakis and Houghton in their 2003 study in the range of $16-32 (average $23) for light duty vehicles and $2-$4 (average $3) for heavy duty vehicles.
Pollution	BTE (2000)[25] estimates suggest that congestion is a major contributor to vehicle emissions, with fuel consumption per vehicle (litres/100km) under congested traffic approximately twice that under free-flow conditions. Emission rates of noxious pollutants also tend to be twice as high under congested traffic conditions. As much as 40% of fuel used by road vehicles in Australia's major cities is the result of interruptions to traffic flow. The BTE[26] modelling indicates that traffic delays and flow interruptions in Australia's six major cities account for approximately 13 million tones of greenhouse gas emissions per annum – comprising 10.5 million tones of CO_2 emissions and 2.5 million tones equivalent to CO_2 arising from other gases (including methane, nitrous oxide and ozone precursors). This level is approximately 17% of the annual greenhouse gas emission due to the Australian domestic transport sector which equates to 3% of net Australian greenhouse emissions from all sectors. Projecting forward, BTE suggests annual greenhouse emissions due to urban congestion could grow to roughly 16 million tones of CO_2 equivalent by 2015. The health impacts associated with transport emissions are significant. BTRE (2005)[27] recently reported that as at 2000, motor vehicle related ambient air pollution in Australia accounted for between 900-4500 morbidity cases (cardio-vascular, respiratory diseases and bronchitis at an economic cost ranging from $0.4-$1.2 billion) and between 900-2000 early deaths (at an economic cost ranging from $1.1-$2.6 billion). The value of a statistical life used in these estimates was $1.3 million, which is a discount of 30% on BTRE's costing of transport accident fatalities to reflect the older age profile of air pollution-related deaths. Denniss (2003) indicates that the costs of urban air pollution arising predominantly from transportation are $13.22 billion as at 2000. Meanwhile, for greenhouse gas emissions by the transport sector in Australia, Denniss (2003) estimates the costs are $4.73 billion as at 2000 (being 16.1% of $29.59 billion total emissions). Overall in Australia, Marquez et al (2005) suggest the current estimates of health costs due to vehicle emissions range from 0.01 to 1% of GDP, which represents annually some AUD$5.3 billion
Accidents	In the Australian context, while road freight truck safety has improved over the period 1989-1999 with a 41% reduction in fatalities, the Australian truck fatality rate is 'considerably higher than that in the United States and some other countries (due possibly to higher speed limits in Australia and the lower proportion of truck travel on divided and limited access roads in Australia), although lower than that in New Zealand and France[28]. The total cost of road crashes (including vehicle and other property damages, emergency services, traffic delays, medical costs, lost productivity due to disability and lost quality of life) in Australia in 1996 was conservatively estimated by the BTRE (2000)[29] at approximately $15 billion (1996 AUD). Denniss (2003) indicates that the costs of transport accidents in Australia (other than those reflected in the national accounts) as at 2000 are $5.26 billion.

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25 Bureau of Transport Economics (2000), Urban Congestion – the Implications for Greenhouse Gas Emissions, Information Sheet 16, [on-line], available at http://www.btre.gov.au/docs/inforsheets/is16.pdf

26 Later data on trends associated with motor vehicle emissions can be found in Bureau of Transport and Regional Economics (2003), *Urban Pollutant Emissions from Motor Vehicles: Australian Trends to 2020*, Consultancy Report for Environment Australia, Canberra: Commonwealth of Australia.

27 Bureau of Transport and Regional Economics, *Health Impacts of Transport Emissions in Australia: Economic Costs*, Working Paper 63, Canberra: Commonwealth of Australia.

28 Bureau of Transport and Regional Economics (2003), *An Overview of the Australian Road Freight Transport Industry*, (Working Paper 60), Canberra: Commonwealth of Australia.

29 Bureau of Transport and Regional Economics (2000), *Road Crash Costs in Australia*, Report 102, (www.btre.gov.au/docs/r102/sum.html) cited in Victoria Transport Policy Institute (2005), *Transportation Cost and Benefit Analysis – Safety and Health Costs*, p5.3-15.

Habitat and wildlife destruction as well as land use effects have also been identified as externalities associated with road and rail transport.[30] While there is growing interest in the impacts and measurement of these externalities, there is a paucity of data in the literature relative to the other externalities listed above[31] and conclusions regarding their size and impact have not yet be drawn. Nonetheless, their inclusion in the future as measurable costs will increase the significance of transport externalities and their impact on the true cost of transport.

3.2.1 Modal attribution

Externality estimates attributable to rail freight are significantly lower than that for road freight[32] - a finding that is replicated internationally[33].

Webb's (2000)[34] estimates of Australian transport externalities were largely based on the BTE 1999 data which suggested the cost of road externalities is in the order of seven times the cost of rail externalities for interstate non-bulk freight transport (road accident costs were believed to be the main reason for the disparity). A BTE study in 1999 [35] indicated that road emits three times more carbon dioxide than rail per unit of freight task. The ABS (2003) indicate that, as at 2000, transport emissions attributable to road transport as a percentage of total transport emissions were 90% as opposed to 2% for rail (which excludes emissions from electrified rail because they are included in electricity generation emission data), 6% for domestic aviation and 2% for domestic shipping.

Because road generates more external costs for rail, there should be a significant difference in the cost per net tonne kilometre. Table 2 shows Australian modal estimates reported in a Canadian study. The results show that there is a limited degree of internalisation of costs, except for accident costs where for road about half the

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30 Water pollution and the cost of marine accidents are another transport-related externality but are specifically excluded from this discussion.

31 Identification and limited discussion of these externalities can be found in Shiftan, Y, Ben-Akiva, M, de Jong, G, Hakkert, S and Simmonds, D (2002), 'Evaluation of Externalities in Transport Projects', *European Journal of Transport and Infrastructure Research*, 2, No 3/4, pp285-304 and O'Mahony, M, Broderick, B, Gill, L, Ahern, A and English, L (2002), Scope of Transport Impacts on the Environment – Final Report, (2000-DS-4-M2), prepared for the Environmental Protection Agency (Ireland), [on-line], available at: http://www.epa.ie/EnvironmentalResearch/ReportsOutputs/FileUpload,1965,en.pdf.

32 Bureau of Transport and Regional Economics (2004), *Land Transport Infrastructure Pricing: An Introduction*, Working paper 57, Canberra: Commonwealth of Australia (DOTARS)

33 See European Environmental Agency (2002), Indicator: External Costs of Transport – 2002 [on-line] available at: http://themes.eea.eu.int/Sectors_and_activities/transport/indicators/cost/TERM25,2002/index_html which indicates that road transport as a whole in the EU accounts for 92% of external costs while the share of rail and water transport is very small.

34 Webb, R (2000), *Cost Recovery in Road and Rail Transport*, Parliamentary Library, Research Paper 28 1999-2000, Canberra: Parliament of Australia, [on-line], available at: http://www.aph.gov.au/library/pubs/rp/1999-2000/2000rp28.htm#Charges.

35 Bureau of Transport Economics (1999), *Competitive Neutrality between Road and Rail*, Working Paper 40, Canberra: Commonwealth of Australia.

external costs are internalised to truck operators. Note these estimates exclude any costs associated with global warming or land use/habitat externalities.

Table 2 External Costs of Rail vs. Truck (Australian cents per net tonne-km)

	Rail			Truck		
	Cost	Payment	Balance	Cost	Payment	Balance
Accident costs	0.030	0.010	0.020	0.320	0.160	0.160
Congestion	na	0.000	0.000	0.030	0.000	0.030
Air pollution	0.004	0.000	0.004	0.010	0.000	0.010
Noise	0.020	0.000	0.020	0.034	0.000	0.034

This table indicates the estimated external costs of each mode, how much they pay under the current price structure and the balance of external costs that result.

Source: VTPI 2005:2-12

Table 2 shows that accidents comprise the most significant source of external costs.

In assessing the externality relativities between road and rail it is worth noting that passenger transport is more likely to be a higher contributor to externality cost than freight primarily due to the high proportion of congestion and pollution as a contributor to transport externalities and the relative incidence and cost associated with accidents and the higher rates of noise associated with urbanisation.

QR support measures to internalise transport externalities through transport prices. Net externality costs for each mode will need to be estimated for the purpose of pricing and consideration of whether prices, is in all cases, the appropriate instrument to internalise externalities will also need to be assessed.

QR acknowledges that there is some uncertainty as to the size of externalities. Nevertheless, the key issue is whether there is sufficient certainty about each externality being at least the value that is implied in the pricing or taxing instrument. Sending even conservative signals as to the impact of externalities is better than sending no signal at all (the latter view implying that there are no significant external effects)

3.2.2 Geographic attribution

While road externalities are likely to be higher than rail, the Bureau of Transport and Regional Economics (2004)[36] study found that the cost of externalities is higher in urban areas than for rural regions. It cites the research of Meyrick (1994)[37] which estimates the charge required to cover the average cost of externalities (for all vehicles) was 7.15 cents per kilometre in urban areas versus 0.92 cents per kilometre for rural.

36 Bureau of Transport and Regional Economics (2004), *Land Transport Infrastructure Pricing: An Introduction*, Working paper 57, Canberra: Commonwealth of Australia (DOTARS).

37 Meyrick, S (1994), 'Objectives of Road Pricing', in J. Cox (ed.), Refocusing Road Reform, Melbourne: Business Council of Australia.

This point is relevant because competition between road and rail freight occurs primarily in the non-urban long distance and interstate freight markets.

3.3 Policy instruments

QR believes that there are two basic objectives that should be pursued in relation to transport-related externalities:

- reduce the level of externalities to efficient levels; and
- achieve reductions at least cost.

This will require explicit identification of the policy objectives in relation to externalities (the target) and matching it to an appropriate policy instrument. A general presumption of economic policy is that there needs to be the same number of instruments as targets.

There are four types of policy instrument available to decision makers:

- regulation, to limit or prohibit the activity causing the externality;
- price change, through for example taxes, to provide a proxy for the value of the externality caused by the transport. Price changes may be implemented through regulated variable charges (for which fuel taxes are a proxy) or fixed charges (through registration);
- establish property rights for the externality, through tradeable permits which could allow market trading to determine the reduction in externality; and
- public information and culture change, to change incentives and usage.

Box 3 Instruments and Targets – fuel excise

Some instruments are used to pursue multiple objectives. For example, fuel taxes are used for raising general revenue but in raising revenue they increase fuel prices and therefore reduce transport demand and accordingly the level of transport externalities. This is an example of the so called "double dividend" effect of a green tax.

However, to address externalities optimally fuel taxes would need to be imposed at differing rates according to the type of transport mode (and perhaps vehicle type), place and time. However, fuel excise is applied at a uniform rate nationally with differentiation only possible through a costly administrative rebate mechanism.

Fuel taxes are arguably also not the best instrument for all targets. Fuel taxes are unlikely to be effective for those externalities caused by driver attitudes to safety where there is unlikely to be a strong relationship between safe driving and fuel consumption.

The appropriate instrument to apply to a particular externality will be determined by:

- the availability of data to inform external cost estimates[38];
- uncertainty associated with stages of the calculation process meaning definitive information is usually unavailable[39];
- scientific knowledge especially for pollution[40] is still developing [41];
- inconsistency and incomparability of data across different jurisdictions and internationally, meaning comparative studies are difficult to compile; and
- significant and complex inter-relationships exist between externalities (for example the relationships between congestion, pollution, accidents and noise)[42] which impact on the ability to isolate each externality, cost and model them separately, and make informed decisions as to how policy mechanisms in one area might impact on the balance of other externalities as a whole.

Policy instruments currently employed have largely involved regulatory standards. QR is subject to a range of safety and environmental regulation. The details of QR's regulatory environment are contained in the Appendix A.

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38 Some of the identification problem of environmental externalities will hopefully be addressed, in part, through State of the Environment reporting which is scheduled to be performed this year.

39 By way of example, accident externalities are dependent on the calculation of accident risks which is dependent on the measurement of accidents. There has also been an extensive debate as to whether to use willingness-to-pay, willingness-to accept valuations of a statistical human life or human capital approaches. In terms of pollution, calculations must be performed at a number of steps which in turn influences the accuracy of the calculation of the air pollution externality:

Traffic volumes ➔➔ Total emissions/primary pollutants ➔➔ Secondary pollutants➔➔ Air quality➔➔ Human exposure; ➔➔ Dose received➔➔ Health effects➔➔ Costs.

40 See for example the special edition of the *Journal of Transportation and Statistics* (2000), Vol 3, No 2, that is entirely devoted to issues pertaining to the statistical analysis and modelling of automotive emissions as well as Peach, HG (1997), *Air Quality and Human Health*, (Department of the environment - Australia: State of the Environment Technical Paper Series (The Atmosphere)), Canberra: Commonwealth of Australia; and Bureau of Transport and Regional Economics (2005) *Health impacts of transport emissions in Australia: Economic costs*, BTRE Working Paper 63, Canberra: Commonwealth of Australia.

41 Difficulties in measuring externalities associated with air pollution are identified by a number of authors in the literature – studies providing aggregated estimates of total air pollution from transport at the national level are scarce because of lack of data for aggregation (ie mobility and traffic statistics) and problems associated with the use of historical data sets which indicate that subtle changes in fleet composition and mobility statistics can have marked effect on externality trends (it has been postulated that fleet turnover, rather than stricter emission legislation is now a more critical factor in achieving reduction in the pollution externality). In addition, lack of comparable data makes international comparison fraught. See for example, Guhnemann, A, Schafer, R-P, Thiessenhusen, K-U & Wagner, P (2003), *Monitoring Traffic and Emissions by Floating Car Data*, Working Paper ITS-WP-04-07, Institute of Transport Studies (Australian Key Centre in Transport Management), University of Sydney and Monash University; Int Panis, L, De Nocker, L, Cornelis, E & Torfs, R (2004), 'An uncertainty analysis of air pollution externalities from road transport in Belgium in 2010', *Science of the Total Environment*, pp287-298 and Int Panis, L, Watkiss, P, De Nocker, L and Torfs, R, *A comparative analysis of trends in environmental externalities of road transport (1990-2010) in Belgium and the UK*, [on-line], available at: http://www.vito.be/bugs/externe/docs/AEAT_VITO_Final%20paper.pdf

42 European Environment Agency (2006), Transport and Environmental – Facing a Dilemma, EEA Report No 3/2006, [on-line], available at:http://reports.eea.eu.int/eea_report_2006_3/en/term_2005.pdf, Bureau of Transport Economics (2000), Urban Congestion – the Implications for Greenhouse Gas Emissions, Information Sheet 16, [on-line], available at http://www.btre.gov.au/docs/inforsheets/is16.pdf

QR is not aware of any explicit charge for externalities in either of the road or rail modes in Australia.

Externality policy in Australia is thus one characterised by acknowledgement of the desirability to internalise externalities through transport prices but without any action on the implementation of practical pricing regime.

A haphazard approach to actual externality pricing reform is also a feature of international experience[43]. In Europe, the main thrust of externality internalization has been through regulation, although a number of other mechanisms have been pursued including congestion charging (for example in London). European experience in road transport emphasizes fuel tax, together with annual licence duty. The former mechanism shows enormous variance across different countries across the EU in the amount of tax paid. For the latter mechanism, low mileage vehicles are overcharged whereas high mileage vehicles end up being undercharged. Weight-distance taxes on various classes of vehicles were imposed in various countries such as Norway, Sweden and Finland but this was dropped in the interests of harmonisation on accession to the EU. A case has been made for a new mileage related tax on heavy goods vehicles varying with the characteristics of the vehicle concerned. There appears to be a concerted effort in the EU to try to establish rigorous data on externality valuation so that marginal social cost pricing can be pursued by the end of the decade.

The United States, as a general rule, appears less concerned than the EU on the externality issue, and the focus for debate in the literature appears to centre on taxation and regulatory mechanisms. Meanwhile Canada has pursued a concerted valuation exercise on externalities and has compiled cost data in an attempt to encourage policymakers to pursue marginal social cost pricing.

There is consensus that the valuation of transport externalities should be determined (consistent with economic theory) on the basis of a short-run marginal social cost approach[44]. Some commentators advocate pricing at long-run marginal cost, allowing for optimal adjustment of the capital stock, and therefore infrastructure capacity to traffic, but transport infrastructure capacity is often non-optimal and remains so for decades. Thus, according to Nash et al (2001)[45] it is better to price to obtain optimal use of existing infrastructure and rely on project appraisal methods to guide adjustment of capital stock. QR advocates this approach for pricing the use of existing infrastructure (with externality estimates informing the analysis of new investment).

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43 The European experience can be found in Nash, C, Sansom, T & Still, B (2001), 'Modifying transport prices to internalise externalities: evidence from European case studies', *Regional Science and Urban Economics*, 31, p413-431.

44 The phenomenon of transport externalities was analysed in seminal works by Pigou (1920), Knight (1924), Walters (1961) and Vichery (1969) - see Shefer, D and Rietveld, P (1997), 'Congestion and Safety on Highways: Towards an Analytical Model', *Urban Studies*, Vol 34, No 4, pp679-692.

45 Nash, C, Sansom, T & Still, B (2001), 'Modifying transport prices to internalise externalities: evidence from European case studies', *Regional Science and Urban Economics*, 31, pp421.

The possibility of imposing externality charges has been debated for some time in the Australian context. In 1991, the Industry Commission proposed an 8.5 cents per litre charge for diesel and a 5.1 cents per litre charge for petrol as a potential mechanism for addressing air and noise pollution externalities[46]. Of course since that recommendation, governments have pursued a standards based approach to reducing pollution from diesel fuel and leaded petrol has been phased out.

While externalities were only a component of the various charges considered in ensuring competitive neutrality between the sectors, the 1999 BTE study concluded introduction of more *competitively neutral* charges, including charges for externalities, in a system designed to fully recover costs from users, would see road freight rates rise by 12% and rail rates increase by about 4% relative to the post-introduction of the Government's 1999 tax system[47].

Most recently, the BTRE concluded that flexible pricing policy instruments, as well as a concerted package of mechanisms that treat the system as a whole, are needed to internalise such costs in an effective way. While road-related externalities are likely to be higher than rail, BTRE argued that charging heavy vehicles (and/or rail freight operators) but not light vehicle (or passenger rail operators) for externalities would raise important efficiency and distributional issues.

In the absence of a better instrument, fuel taxes are necessary to address the level of transport externalities. Individual road user charging is an instrument that could achieve superior alignment to targets than current measures. In fact one of the significant benefits of implementing Mass Distance Charging (MDC) is that its technology will provide the capacity to better reflect external impacts in the price for using infrastructure (even if the beneficiary of these changes is some-one other than the road provider). In the meantime there is arguably case for higher registration and fuel taxation for road and rail transport.

3.4 The way forward

There are several types of externalities associated with freight transport, each of which has different causes. For example, although several externalities result from burning fossil fuels other concern driver behaviour (safety) and travel patterns (congestion). With multiple causes and types of externalities it is unlikely that any one policy instrument will efficiently internalise externalities.

A clear and consistent finding from the research on externalities that rail has far fewer external costs per unit of freight transported than road transport.

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46 Industry Commission (1991), *Rail Transport*, Report No 13, Volume 1, Canberra: AGPS.

47 Bureau of Transport Economics (1999), *Competitive Neutrality between Road and Rail*, Working Paper 40, Canberra: Commonwealth of Australia.

Currently regulation is primarily applied to address freight related externalities, although from the available evidence it is unlikely regulation has reduced externalities to efficient levels. Fuel taxation is a widely applied instrument suggested to address externalities. However, the primary objective of fuel taxes in Australia is revenue collection. The VTPI study (2005)[48] concluded from its study of externalities that increasing fuel taxes might be an easy way to internalize costs, but such an approach 'is not optimal because it does not affect when and where driving occurs'.

QR submits that in principle social marginal cost pricing for externalities ought to be further investigated for transport pricing. Further work will be required before practical implementation can be achieved, specifically:

- the appropriate policy instrument for each externality;
- the optimal level of emissions;
- the least cost method for reducing externalities; and
- in respect to pricing instruments, the set of prices necessary to achieve efficient levels of externalities.

In the interim, QR believes the following actions should be taken because of the large costs in economic and social wellbeing from transport externalities:

- transport infrastructure investment appraisal should explicitly include the external costs. This is necessary to limit distortions to use of existing infrastructure rather than perpetuating current price distortions.
- where non-price measures are proposed to deal with externalities, further investigation of incentive mechanism should be pursued to achieve greater alignment with policy targets.
- externality charges should be set so as to send price signals as to the economic harm of transport activities, noting that the level of targeting precision available through instruments as well as the extent of uncertainty as to the quantification of harm will inform the strength of the signal that is provided by the externality charge;
- mass distance charging should be progressed in parallel as it provides a pricing system with far clearer signals that the current heavy vehicle charging regime. Chapter 5 notes that some European individual heavy vehicle pricing regimes explicitly included a pollution related charge; and
- further consideration of increased rates of fuel charges for pollution and greenhouse externalities.

48 Victoria Transport Policy Institute (2005), *Transportation Cost and Benefit Analysis – Air Pollution Costs*, [on-line], available at: http://www.vtpi.org/tca/tca00.pdf, p11-3.

Chapter 4

Pricing

4.1 Main Points

Main Points

There are a number of well-accepted pricing principles associated with the use of monopoly infrastructure in Australia. In particular, prices should

- send signals as to the economic impact of each user's use of the infrastructure to promote efficient consumption decisions; and
- allow the owner of the assets to have the opportunity to recover the full cost of service provision (including the recovery of a return on investment and other capital related costs) to facilitate efficient investment decisions.

Under their respective regulatory frameworks and consistent with these principles, Australian rail infrastructure providers have each developed economically sound pricing frameworks based on the establishment of price/revenue floors and ceilings reflecting incremental and full economic costs respectively. Rail access charges fall somewhere between the price/revenue floor and ceiling reflecting, amongst other things, the extent of inter-modal competition and users' capacity to pay. In addition, multi part tariffs are used in order to address the problem of recovery of large common costs reflecting the capital intensive nature of rail infrastructure provision.

In contrast, road pricing appears to significantly lag development of rail pricing and general infrastructure pricing trends in Australia over the past decade. Currently, heavy vehicle pricing is based on a crude two part tariff, including a variable component based on diesel fuel excise, which does not reflect the costs imposed by various road users on the road infrastructure and consequently fails to send any meaningful signals to road users about their consumption decisions.

Moreover, under the PAYGO cash accounting approach used for road expenditures, there is no attempt to account for a return on capital or depreciation. In QR's view, the steady state assumption underpinning PAYGO is not valid based on the current and foreshadowed level of road expenditure in Australia.

4.2 Introduction

Prices play a fundamental role in markets by signalling to users the costs of providing services and thereby coordinating economic activity. In the market for both road and rail infrastructure services, the level and structure of access charges should send signals to potential users which align their value of the service with the cost of providing the service and inform service providers when investment is necessary.[49] This ensures efficient resource use within both road and rail sectors regardless of existing or future modal market shares.

49 Even with undistorted prices there may be coordination problems for which there maybe a net benefit from government intervention. This issue will be further discussed in Chapter 7.

Chapter 2 of this submission noted the importance of identifying (usage-related) incremental costs as the basis for establishing an efficient infrastructure pricing methodology.

QR has previously identified, in the context of the National Transport Commission's Third Heavy Vehicle Pricing Determination, the weaknesses in the current heavy vehicle charging regime and proposed an alternative approach.[50]

The shortcomings of the heavy vehicle charging regime are in contrast to the rail pricing regimes operating across Australian jurisdictions. While QR considers there is scope for refinement of the current approach to rail pricing, it is generally undertaken on a sound economic basis and provides a model that could be adapted to road pricing.

4.3 Monopoly infrastructure pricing principles

In a competitive industry, efficient prices will be established by activity in the market. However, services provided by facilities that exhibit monopoly characteristics, such as electricity distribution and rail infrastructure, may need to be subject to some form of economic regulation to establish efficient prices. This can be a light-handed form of regulation, such as price monitoring or surveillance, or it may be a revenue or price cap form of regulation with regulatory approval of revenues and/or prices.

To the extent that services are subject to regulation, the aim of such regulation should be to ensure that prices are consistent with competitive outcomes. In particular, the key consideration is to set prices in a way that:

- is efficient in terms of sending signals as to the economic impact of each user's use of the infrastructure; and
- allows the owner of the assets providing the service to recover the full cost of providing the service (including the recovery of a return on investment and other capital related costs).

This is typically done by setting prices within the upper and lower bounds set by 'ceiling' and 'floor' pricing limits. These pricing limits are established by two tests:

- prices must be sufficient to cover the incremental cost of each user's (and each group of user's) usage of the assets – being the costs that would be avoided if the services were not provided to that user or group of users; and

[50] Queensland Rail (2004), *Submission to the National Transport Commission Third Heavy Vehicle Pricing Determination: Narrowing the Options Discussion Paper*.

- prices cannot allow recovery of "monopoly profit" – this test is satisfied by ensuring that no user or group of users pay more than the stand alone cost (SAC) of the services that they are provided. The SAC of providing a service or a cluster of services represents the total cost of supplying an individual customer or group of customers on a stand alone basis. These costs include the capital costs of providing the services.

The difference between incremental and stand alone costs represents the common costs of a system.[51] Where an infrastructure provider, like QR, is required to earn a commercial return and recover costs from users, a methodology to allocate common costs is required.[52] A variety of cost allocation methods have been employed or suggested in the literature. However, it is not generally practically achievable to allocate a share of common costs to infrastructure users without some loss in allocative efficiency. The problem then becomes implementing a tariff structure that minimises the loss in economic efficiency subject to a constraint of recovering common costs.

There are several different pricing approaches that can be used for the pricing of infrastructure services. The two most common approaches are average cost and second best pricing.

Under average cost pricing, the total cost of providing a service is divided by some unit of output, such as gross tonne kilometres. This is effective in ensuring adequate revenue is earned to sustain the investments made by the regulated business. However, because prices are not based on the cost of the additional unit of consumption fewer services will likely be consumed.

Second best pricing arrangements are based on the principle that usage decisions should be informed by marginal costs.

However, marginal cost pricing will not allow the regulated business to earn sufficient revenue to recover the full costs (including common costs) of providing the service. This is due to the capital intensive and long-lived nature of infrastructure assets. Accordingly, marginal cost pricing will result in prices being less than average costs. The inability of marginal cost pricing to allow full cost recovery is a feature of infrastructure assets which have natural monopoly characteristics. Second best pricing arrangements considered in Australia have mainly included:

- Ramsey pricing; or
- Multi-part tariffs.

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[51] Common costs are those costs incurred in providing an infrastructure service which cannot be attributed to any particular service at a particular point in time.

[52] An alternative to full cost recovery from users is deficit funding by government. Deficit funding also results in allocative efficiency losses as all taxes employed by government are distortionary.

Multi-part tariffs have been preferred to Ramsey pricing. Multi-part tariffs have been applied with varying degrees of sophistication. QR considers that its multi-part reference tariffs for the Central Queensland Network is the most sophisticated pricing arrangement currently being used (even though efficient cost of provision is being understated, see Chapter 6).

The pricing principles outlined above have been generally accepted and applied across infrastructure industries in all Australian jurisdictions over the past decade, with the exception of roads. In particular, infrastructure service providers and regulators have grappled with the problem of full cost recovery in a non-distortionary manner and developed and refined solutions over time.

QR sees no reason why these principles cannot be applied to road pricing. As discussed in Chapter 2, there are many similarities between road and rail costs which are not reflected in the respective regulated pricing approaches. QR considers the major problem with road pricing is its failure to attribute fully capital and maintenance costs generated by heavy vehicles and reflect these attributable costs in heavy vehicle prices. This matter is discussed in a later section of this chapter.

4.4 Australian Rail Pricing

Rail infrastructure in Australia is subject to third party access regulation. This takes the form of a negotiate-arbitrate model, whereby owners (or access providers) of a 'declared' facility have an obligation to negotiate in good faith with any access seeker wishing to utilise the infrastructure and to provide information to the access seeker. If the parties are unable to negotiate a commercial agreement for the terms of access, including price, the access seeker has recourse to binding dispute resolution by the jurisdictional regulator.

The information that the owner of a declared facility must provide includes information regarding the cost of providing the service. Below rail service providers' have established price and/or revenue floors, based on incremental and stand alone costs respectively, in all jurisdictions.

4.4.1 Incremental cost floor

Incremental cost is a practical proxy for marginal cost and includes both capital and operating costs.

The use of incremental costs to establish the price/revenue floor reflects the underlying regulatory principle that each traffic type should pay an access price which meets at least the incremental cost of its usage of the network. In this way, rail operators receive a price signal about the costs incurred by the below rail service provider due to their particular train service's characteristics, while the service provider receives at least the direct costs incurred in supplying the below rail service. If these costs can't be recovered then society would be better off by not performing the transport task.

However, incremental cost pricing does not address the issue of the below rail service provider recovering all common (predominantly capital) costs.

4.4.2 Stand alone cost ceiling

Capital costs, based on a whole-of-life costing of capital assets, have been included in the price/revenue ceilings established by below rail service providers. A return on capital and depreciation are the two most significant capital costs.

Asset valuation

Notwithstanding ongoing debates about its application in practice, the depreciated optimised replacement cost (DORC) method of valuing fixed assets has been accepted in the Australian rail sector (and more broadly in infrastructure sectors) as the basis for calculating a return on capital (fixed assets).

The DORC approach consists of four distinct steps:

- define the relevant assets and establish their effective lives;
- establish the current replacement cost of the modern equivalent assets in service through application of appropriate unit rates to a robust asset count ;
- adjust the replacement cost for over-design, over-capacity and redundant assets to derive the optimised replacement cost (ORC); and
- depreciate the ORC to reflect the remaining effective life of the assets in service.

Under the building block approach to regulation used in the Australian rail sector, where a regulated business' efficient operating and capital costs are built up to establish allowable annual revenue/prices, the DORC valuation of the regulatory asset base is used to establish the return on capital (through application of the regulated rate of return to the asset base value) and depreciation building blocks.

Establishment of a robust asset valuation in this way allows for the explicit recognition in pricing of the opportunity cost of resources tied up in capital assets (the return on capital) and account to be taken of the capital as it is consumed (depreciation).

Asset Consumption

For most assets, service potential diminishes over time, mainly due to ageing, use and obsolescence. There are two methods to deal with asset consumption:

- renewals annuity; and
- depreciation.

Under a renewals annuity approach, assets are treated as if their collective service potential is to be maintained in perpetuity, rather than as a collection of individual assets each with their own asset life and maintenance requirements.

Under an accounting depreciation approach, a periodic depreciation charge is made reflecting allocation of the cost of a fixed asset over the period of that asset's useful life.

The DORC valuation method is not prescriptive in respect of the choice of depreciation method that can be used to derive the DORC value of the regulatory asset base from its ORC value. However, regulators have generally used the straight line depreciation method because of its relative simplicity and general acceptability.[53]

However, QR considers that the access provider should be able to assess the depreciation profile most suited to its business, taking into account:

- asset stranding risk;
- the need to avoid substantial price shocks as aging assets are replaced;
- capital productivity – ie. recognising that real cost of capital assets typically falls over time due to improved technology; and
- the maintenance of network performance/productivity;
  - in the context of a rail network, it is not appropriate to assume that service potential will decline as reflected in a straight line depreciation profile. Rather, the network provider is likely to maintain the serviceability of the network. As a result, renewals annuity may be a more appropriate approach.
  - however, the key issue is that the regulatory framework should not preclude this possibility (although to the extent that straight line depreciation is used to determine the initial capital base, then the regulatory asset base for pricing purposes will be below the economic value of the asset).

4.4.3 Establishing prices between floor and ceiling limits

An efficient rail access charge will lie within the bounds of incremental and stand alone cost of providing a particular service. Nevertheless, there are different mechanisms available to establish prices within those boundaries.

[53] In terms of resource allocation, depreciation should reflect the consumption of capital or the reduction in service capacity. However, in practice, this is difficult to establish and is not undertaken in other industries except through periodic asset valuation

These include:[54]

- posted (set) prices;
- negotiated prices – determined within a negotiate arbitrate framework, often based on established 'reference tariffs'; or
- bidding or auctioning of train paths.

The BTRE concluded that the optimal charging structure may vary in relation to the physical and capacity utilisation characteristics of the infrastructure and on the type of goods moved. While there are general principles for access charges can be identified, there is no single optimal access charging structure.[55] From an operational point of view, it may be important to set pricing structures that are in accordance with the most efficient train operating characteristics.

Box 4 summarises the establishment and application of a revenue floor and ceiling under the WA Rail Access Regime, including the recovery of incremental and common costs. Indeed, subject to ensuring access charges do not distort upstream and downstream competition, and with the exception of heavy haul coal and iron ore operations (and potentially some rail terminals), QR believes that there is not a strong case for price regulation of rail infrastructure services.

This is because in the majority of markets in which the provision of rail infrastructure exists, the rail infrastructure provider does not possess market power and demand for the rail infrastructure service is relatively elastic due to the scope for road substitution. Consequently there is an alignment of incentives between the infrastructure owner and the above rail operator.

Box 4 Establishment of floor and ceiling under WA Rail Access Regime

The negotiation of access prices typically commences with consideration of Economic Regulation Authority (ERA)-approved floor and ceiling costs. The floor cost is the incremental cost[56] resulting from the access seekers' operations on that route and use of that infrastructure. The ceiling cost is defined to be not more than the total costs[57] attributable to that route and that infrastructure utilised for an access seeker's proposed operation. The floor and ceiling costs are then divided by the forecast route volumes to derive the floor and ceiling price limits.

Under the WA regime, because prices are determined on a route basis and costs are determined on a route section basis, revenue earned over a particular route is distributed against the cost of individual route sections. The allocation rules are that:

- Revenue earned from a route can only be allocated to the route sections on that route;
- WestNet is required to allocate revenue to cover the costs attributed to the applicable route sections in the following order:

54 BTRE (2003) *Rail Infrastructure Pricing: Principles and Practice, Report 109*, pp 52-53

55 ibid, p. 54

56 Incremental costs are defined as operating costs and capital costs and overheads (where applicable) that the Owner would be able to avoid in respect of the 12 months following the proposed access.

57 Total costs are defined as operating costs + capital costs + overheads.

– incremental costs against all applicable route sections;
– up to the ceiling on all applicable branch or feeder (dedicated) route sections; and
– up to the ceiling on all applicable shared route sections.

This tiered allocation process has an economic basis. First, to avoid cross subsidisation between route sections, revenue allocated to each route section must at least cover incremental costs. Second, recovery of capital costs on branch or feeder lines ranks ahead of shared lines on the grounds that there is no other traffic on these lines to fund the dedicated infrastructure and unless those costs are covered the line may close.

Two common approaches to establishing rail prices – namely, determination of reference tariffs and a form of market-based pricing (CIPR) are discussed further below.

Reference tariffs

For individual train services, there may be a large range between the floor and ceiling limits within which access charges will be determined.

The purpose of developing reference tariffs is to form a basis for access negotiations by increasing transparency about the costs of service provision. Where a particular service sought by an access seeker varies from the defined reference service, the access charge will diverge from the reference tariff to reflect differences in cost and risk.

Reference tariffs are typically developed for defined reference train services, encompassing a range of characteristics such as origin-destination, axle load, maximum speed and length of train (factors which drive incremental costs or relate to allocation parameters for common costs).

ARTC publishes reference tariffs for a defined reference service for specified routes as part of its access undertaking. QR has reference tariffs in place for a defined reference train service in respect of each cluster (of mines) in the Central Queensland coal region. At present, QR is developing reference tariffs for other segments of its network. Box 5 summarises how QR's multi-part coal tariff structure aims to recover its incremental and common costs through specific tariff components.

Box 5 QR's coal reference tariff structure

In QR's coal pricing arrangements, separately identified 'causative' and 'non-causative' (or allocative) elements are used to recover common costs. This structure permits QR to recover its below-rail costs in a manner that promotes efficiency while still ensuring revenue adequacy.

The causative elements are those that impose costs on the infrastructure provider. In QR's coal tariff structure, these elements are:

- a usage-based charge which reflects the incremental operating and maintenance costs, expressed on a $per '000 GTK (gross tonne kilometre) basis (AT1);
- a capacity charge that covers the incremental cost to QR of the provision of capacity, expressed on a $ per train path basis (AT2); and
- a charge for the use of the electrical overhead network (where it is used by a rail operator), levied on a gtk basis (AT5).

The larger allocative component accounts for the remainder of QR's coal revenue requirement, which reflects the causative elements' shortfall in the recovery of QR's efficiently incurred costs. For each system, the allocative charge is based on equal amounts being collected on:

- a per tonne kilometre basis (AT3); and
- a per tonne basis (AT4).

By virtue of the AT4 tariff component being calculated on a $ per net tonne basis, coal reference tariffs include a distance discount such that, other things being equal, access charges will decline on a $/net tonne basis as distance increases.

While reference tariffs have the benefit of increasing transparency, thereby potentially reducing the scope for access disputes to arise, there is an increased risk that the approved reference tariff may not be consistent with a market-based price. This may occur due to regulatory error. It is also arguable that, where the access provider and access seeker are large and well informed businesses, reference tariffs may not be necessary.

Competitive Imputation Pricing Rule

An alternative approach to establishing where an access charge should fall within the range bound by floor and ceiling costs is through the competitive imputation pricing rule (CIPR). This rule would normally be applicable for an assessment of access charges in an environment where intermodal competition exists. This approach has been explicitly adopted for the AustralAsia Railway.

Where there is a competitive market, the CIPR determines where, within the band of incremental cost (floor) and stand alone cost (ceiling), access prices should fall. Under CIPR, the access price will be the difference between the maximum competitive price an access provider could charge for the transport of freight for a particular haul and the above rail costs of providing the relevant freight service by the access provider. The resulting access charge should make the shipper indifferent between road and rail.

The principle underpinning this approach is that access charges are effectively capped by prices set by competing transport modes, such as road, rather than by prices established by a regulator. Accordingly, the access price charged is limited by the price of competitors, similar to the operation of a conventional (competitive) market.

Box 6 Competitive imputation pricing rule

In an assessment of the CIPR in the AustralAsia railway project, King and Maddock[58] concluded that the CIPR approach is desirable in particular circumstances, in particular, in establishing access prices for a new (greenfields) facility:

- where the potential returns on that facility are subject to considerable uncertainty; and
- where the investment in that facility might be rendered non-viable by any significant truncation of the distribution of potential returns from the investment.

King and Maddock concluded that, where the above criteria are satisfied, the CIPR is the only access pricing rule

[58] King, S. and Maddock, R. (1999), *Evaluation of the proposed Competitive Imputation Rule for third party access regime for the Australasia Railway Project*, p 5.

that does not distort the relevant investment decision and is ex ante efficient.

A further key consideration in determining whether this is an appropriate access pricing rule is the definition of the market – that is, whether rail and other (competing) modes of transport operate in the same market. Further, if the relevant market does include transport by modes other than rail, it must be determined whether those competing modes are likely to be a significant constraint on rail pricing.

King and Maddock noted three additional advantages of CIPR:[59]

- allows third parties to enter in situations where they can provide the service more cheaply than the incumbent. It is therefore likely to be an efficient market;
- allows all relevant producer surplus to be captured by the infrastructure service provider, thereby creating appropriate incentives for risky, greenfields investments; and
- increases the likelihood that the project will actually go ahead.

There are some practical considerations associated with the CIPR, notably that it may be difficult for an access seeker to satisfy itself of the basis of an access charge based on this rule, as it will not have access to information on the incremental cost of above-rail operations for a particular traffic.

4.5 Road Pricing

QR has previously identified three major weaknesses in the current charging regime for road infrastructure services:

- current cost recovery approaches are based on average pricing, which results in cross subsidies between different road user classes and across transport modes;
- poor cost reflectivity, with cost drivers unrelated to prices and no signals to improve efficiency; and
- cost allocation shortfalls, reflecting a questionable choice of cost allocators.

In addition, road prices do not reflect the impact of externalities, such as noise and pollution, which tend to be more significant for road than competing transport modes.

4.5.1 Cross subsidies

The BTRE has estimated that current road charges for the larger heavy trucks (B doubles and road trains) under-recover the costs of their use of the road system. In contrast, revenue recovered from smaller heavy vehicles classes (rigid trucks and buses) significantly over-recovers the costs of their use of the road system, which effectively serves to cross subsidise the larger heavy vehicles use of roads.[60]

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[59] ibid, p. 23

[60] Bureau of Transport and Regional Economics (2003a), *Land Transport Infrastructure Pricing: An Introduction*, Working Paper 57, p8.

This cross-subsidy not only creates inefficiencies in road use by heavy vehicles but also distortions in the performance of the national freight task. These issues are discussed in more detail in a later chapter of this submission.

4.5.2 Poor cost reflectivity

Current road user charges are based on a crude two-part pricing approach whereby 20 cents per litre of diesel fuel excise serves as a (variable) road use fee and an annual (fixed) vehicle registration charge, differentiated by vehicle type, serves as an access fee to recover residual road expenditure not recovered through the road use fee.

The costs of individual road use vary in a number dimensions—vehicle class, size of load, urban/rural, type of road, time of day. However, the current variable charge is related only to fuel use.

It is well recognised that fuel excise-based charging is a poor method for recovering the impact of a heavy vehicle on a road surface because road damage is related to axle load through the 'fourth power rule'. [61] In contrast, fuel based charges increase linearly with distance but at a declining rate with respect to load. Moreover, road transport has improved its fuel efficiency by greater use of articulated trucks.[62] Efficiency of road pricing (and equity between road users) would be enhanced with a closer link between the costs of individual vehicle road use and charges.

Similarly, the basis of the annual vehicle registration charge for large trucks is questionable, with smaller heavy vehicles appearing to be charged more than the costs attributed to those vehicles and some larger heavy vehicles, particularly road trains and B-doubles, charged less than their attributable costs. [63]

An assessment undertaken by the ARRB Group on behalf of QR of the total incremental cost of heavy vehicles for two representative sections of road clearly indicates that the current allocation of costs to heavy vehicles is considerably less than the costs they impose on the road network.[64] These assessments found that total incremental cost of heavy vehicles for the representative sections of road were in the order of $0.35/ESAL-km.

This estimate of the incremental cost of heavy vehicles can be compared with cost allocation data provided by the NTC in their Technical report. [65] This comparison

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[61] The fourth power rule refers to the relationship between the damage to road and axle load. As a rule of thumb, the cost of road wear increase in proportion to total axle load raised to a fourth power.

[62] Bureau of Transport and Regional Economics (2003b), *An Overview of the Australian Road Freight Transport Industry*, Working Paper 60, p34.

[63] Bureau of Transport and Regional Economics (2003a), *op cit*.

[64] The ARRB Group (formerly ARRB Transport Research) is the leading provider of value-added research, consulting and technology addressing transport problems.

[65] NTC (2005), Third Heavy Vehicle Road Pricing Determination: Draft technical Report. Pages 44 and 97.

showed that for a six axle articulated rig the total allocated cost per ESAL-km was in the order of $0.07. While our analysis has not determined precisely what cost this type of vehicle should bare, it is clear that they are currently bearing significantly less than the incremental cost they impose on the road network. In particular, the incremental costs determined by our study ignore any allocation of common costs to heavy vehicles while the NTC 'price' is inclusive of common or non-attributed costs.

Box 7 outlines the methodology employed in our assessment of the incremental cost of heavy vehicle road use. A fuller description of the approach used and the results achieved are provided in Appendix C.

Box 7 Incremental cost of Heavy Vehicle road use

The methodology used to estimate incremental costs of heavy vehicle road use applied project management and whole of life costing systems (eg HDM4) to evaluate the total costs of providing road infrastructure to a specified volume of traffic. The methodology compares the capital and maintenance costs associated with road infrastructure designed to handle two different cases:

1. The WITH heavy vehicle case – a base case that includes a specified proportion of heavy vehicles in the design traffic.
2. The WITHOUT heavy vehicle case – an alternative case that excludes all heavy vehicles from the design traffic while keeping the total number of PCUs constant.

For each case, the methodology requires the minimisation of costs and considers the capital-maintenance cost substitutability in determining the initial construction cost of the alternate road designs as well as the most cost effective maintenance and renewal program in each instance. The evaluation of capital and maintenance costs were conducted over a period of time sufficient to record any additional maintenance and renewal expenditure associated with the presence of heavy vehicles in the traffic tack.

In both cases the capital and operating cost streams were converted to present values using an appropriate discount rate. The present values for each case were then compared and the present value of the WITHOUT heavy vehicle case was deducted from the present value of the WITH heavy vehicle case. The difference in present values is therefore the total incremental cost that can be directly attributed to heavy vehicle road use.

Moreover, under the PAYGO cash accounting approach used for road expenditure, capital costs are included in the cost base in the year they occur. As a result, there is no attempt to account for the return on or of capital. The PAYGO approach is predicated on the assumption that the road network is in a steady state, that it will neither grow nor decline overtime, so that each year's investment exactly offsets depreciation, holding the capital stock constant, and that there is no merit in recovering the opportunity cost of the investment in the sunk asset which is the road network. In QR's view, the assumptions underpinning PAYGO are not valid and the approach does not accord with that applying to the pricing of the vast majority of infrastructure assets in Australia.[66] Given the stock of the asset base, PAYGO manifestly understates the incremental cost of providing road infrastructure.

66 This discussion is a summary of the arguments raised in QR's Submission to the National Transport Commission's Third Heavy Vehicle Road Pricing Determination Discussion Paper (July 2005).

4.5.3 Cost allocation shortfalls

Current road charges divide all road expenditure into 'allocated' and 'non-allocated' expenditure. Non-allocated expenditure includes vehicle registration, driver licensing, loan interest and heavy vehicle enforcement costs. It is netted off the total road expenditure to leave the 'allocated' expenditure to be recovered through the road use and access fees.

The allocated expenditure is distributed among different vehicle types based on road use giving rise to the expenditure and is divided into separable and non-separable components.

The non-separable costs make up the majority of allocated expenditures (around 70%) and are said to be based on that proportion of road expenditure that does not vary with use and so is not specifically attributable to vehicle types. However, there is considerable evidence, including Australian studies, to suggest that the non-separable components of total costs arising from the current methodology are too high and that a 50:50 split would be more appropriate.[67]

This non-separable proportion of road expenditure is then allocated between vehicle types on the basis of vehicle kilometres travelled (ie. a distance based allocator).

The separable component is allocated between road users using empirically estimated attribution parameters, including vehicle kilometres travelled, passenger car units, equivalent standard axle kilometres and average gross mass kilometres. Not surprisingly, the amount of costs attributable to heavy vehicles and hence the assignment of costs between road users is very sensitive to the choice of attribution parameter.

The result of the current charging structure is that only 21% of total road expenditure is allocated to heavy vehicles. In relation to the proportion of separable costs and criticality of the equivalent standard axle kilometres as the key allocator of maintenance related cost, there is considerable doubt as to whether this is sufficient, especially when proper account is taken of an efficient allocation of common costs including capital costs.[68]

In summary, QR believes that there is sufficient evidence to suggest that the current allocation of total costs between separable and non-separable components under-estimates the level of usage-related costs. In addition, the assignment of non-separable costs to vehicle types should reflect both distance and mass allocators, not just a distance allocator.

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67 See Martin, T. (1994), *Estimating Australia's Attributable Road Track Costs*, ARRB Research paper, ARR 254, Vermount South, Victoria and Rosalin, N. and Martin, T. (1999) *Analysis of Historical Data on Pavement Performance*, ARRB TR Report RE 7134. Vermount South, Victoria.

68 Bureau of Transport and Regional Economics (2003), *op cit*. See also Laird P., Newman P., Bachels, M., and Kenworthy, J. (2001) *Back on Track: Rethinking Transport Policy in Australian and New Zealand*, UNSW Press, Sydney.

4.6 The way forward

QR proposes that much can be learned from the pricing approaches discussed earlier in this chapter that have been adopted for the use of rail infrastructure.

An efficient road pricing structure should, at a minimum, reflect the following costs:

- incremental costs associated with the use of the road infrastructure; and
- an efficient allocation of common costs of road infrastructure services (so as to minimise distortions elsewhere in the economy allowing for amongst other things, the opportunity cost of raising taxation revenue).

As discussed in chapter 3, further work needs to be undertaken with respect to external costs, such as noise, pollution and greenhouse gases, and whether pricing approaches could complement existing non-pricing approaches.

Recovery of incremental capital and maintenance costs

As discussed in Chapter 2, a component of cost varies as proportions of output change. The additional cost associated with servicing an additional unit of output for a particular vehicle type is the incremental cost associated with that usage for that vehicle type.

The incremental costs associated with a particular vehicle type will be represented by the additional construction costs that are necessitated by that vehicles' use of the road (the initial standard of construction directly affects future maintenance costs) plus the wear and tear imparted on the road by that vehicle type as reflected in maintenance costs.

In the absence of individual road user pricing, in order to send appropriate price signals to users, at a minimum, the price for the use of a road by the vehicle type which determines the ultimate standard of the road (ie the heaviest axle load) should cover at least the total incremental cost that it imposes on the road infrastructure.

In contrast, it is not appropriate to consider price signals based on average impacts, as currently occurs in road pricing, because to do so is expected to significantly understate the cost reflective price for the use of the road network by that vehicle type. This in turn means the pricing structure will not signal to transport operators the full impact of their usage decisions. It also fails to provide an incentive for operators to adopt operating practices which would minimise maintenance impacts of their vehicles on roads. In the long run it will also distort incentives for efficient road infrastructure investment.

In addition to incremental road maintenance costs, there are also incremental road capacity costs of relevance. Each vehicle type consumes the capacity of a road to varying degrees. Heavy vehicles are relatively heavy users of road capacity due to:

- occupation of a larger "footprint" on the road surface; and
- operating characteristics, such as acceleration, maximum speed and braking characteristics bringing forward road capacity augmentation.

The relatively intensive consumption of road capacity by heavy vehicles increases the total cost of road infrastructure provision. For example, more overtaking lanes are required on major highways than would otherwise be the case.

Under the current road pricing approach, non-separable costs are recovered on the basis of kilometres travelled which do not reflect in any way the nature of road capacity consumption.

Recovery of common costs

Assuming that all vehicle types pay prices reflecting the incremental cost of their road use, there remains the issue of recovery of common costs. As previously noted, a large component of these costs is currently recovered on a vehicle kilometre basis.

QR believes the recovery of common road costs should follow the pricing objective that is applied in rail (and other) infrastructure industries – namely that, prices should be set in such a way that minimises the distortions to consumption with the objective of recovering the full cost of infrastructure provision.

In principle, common costs should be recovered by the least distorting method. Both volume and distance are likely to form part of any assignment of common costs to vehicle types. However, under a true usage-based pricing regime, care would need to be taken that common costs were not solely recovered on the same basis as any usage-related cost drivers so as not to over-signal the impact of alternative vehicle operational configurations on road costs.

In addition, in allocating common costs, distortions to consumption would be minimised where prices are charged so that products whose output is less sensitive to higher charges pay relatively more of the common costs. As for rail, such price discrimination is likely to be efficient and desirable because common costs constitute a significant proportion of the total road costs to be apportioned and different traffics have differing capacities to pay.

QR believes that reform of heavy vehicle road pricing should commence with a completely new two part tariff, with variable and fixed components. Critically, the variable component of any two part tariff should be a mass distance based charge. Mass distance charging is the subject of chapter 5 of the submission.

Chapter 5

Mass Distance Charging

5.1 Main points

Mass distance charging (MDC) is slowly emerging as feasible and preferable means for charging for the use of road infrastructure by heavy freight vehicles. Electronic technology for distance based charging has now been successfully applied in a number of jurisdictions.

The desirable features of an MDC system in Australia would include:

- initial implementation on major freight corridors where modal competition is present, however the potential to extend the system to other parts of the road network in the future should not be excluded. In QR's view the Auslink Network – which is the backbone of the national freight network – would be a well defined network for initially implementing MDC;
- variable charge reflecting incremental costs which is location specific to reflect (as incremental costs vary by road type and condition);
- an emphasis on accurate measurement of both distance travelled and specific route used as well as the actual vehicle mass. The level of accuracy achieved will be subject of course to the technical and economic feasibility of the various monitoring and measurement devices available;
- revenues earned from mass distance charges should flow to the infrastructure owner where the costs occurred.; and
- there are likely to winners and losers from implementing MDC if for no other reason that it involves moving from a system of average pricing to individual pricing. Consideration of how losers might be compensated will be an important component of the reform process.

5.2 Introduction

Mass Distance Charging (MDC) covers a range of direct user pays pricing approaches that incorporate vehicle characteristics, trip length and route details in the determination of road user charges. More specifically, MDC attempts to recover costs imposed on the road system by each vehicle in direct proportion to the mass and distance traveled. The data that is collected through the MDC technology also enables externality charges to be more precisely targeted. The approach requires the establishment of a set of mass distance related charges for each vehicle type covered by the charging mechanism. Locational signals can also be incorporated in the pricing structure if desired.

The costs recovered by MDC regimes include the short run marginal costs of road wear and the longer term costs associated with user induced road rebuilding. Capacity related costs e.g. road widening, can be recovered through specific access charges or incremental capacity charges specifically related to vehicle type.

This chapter reviews the overseas experience with mass distance charging, the key lessons for Australia for the overseas experience and QR's views on how implementation might be considered for Australia.

5.3 Overseas experience

Individual user based charging for heavy vehicles in its various forms has been implemented in a number of countries including New Zealand (1978), Switzerland (2001), Austria (2004) and Germany (2006). The following is a brief discussion of the implementation and operation of each of these international applications with a specific emphasis on any implications for the implementation of MDC in Australia.

5.3.1 New Zealand

New Zealand introduced its current Road User Charging (RUC) system in 1977. The system is a manual system relying on vehicle odometers and hubometers, to measure distance travelled, and average authorised vehicle weight (as opposed to actual) to assess user charges. The system requires truck operators to purchase licences in advance. These licenses are differentiated by vehicle type and weight and are sold in 1,000 km units.

Revenues raised by the RUC are in the order of $NZ700 million per annum. The administration cost in 2001/02 was $NZ11.5 million.

Research undertaken by the Waikato University Management Research Centre for the Road Transport Forum indicated that up to 9% of all fleet operator costs are attributable to RUC assessment and payment. Non-compliance is a major concern and it has been estimated that RUC revenues of $28 million annually are foregone due to non-compliance.

RUC rates in New Zealand are based on a fully allocated cost model similar to the PAYGO model used in Australia. Costs under this approach are defined as total road related outlays. A study undertaken for the Ministry of Transport (March, 2005) concluded that current RUC charges are in most cases greater than the level of marginal costs which principally include accident externalities and short-run marginal cost of road wear.

5.3.2 Switzerland

Switzerland introduced a heavy vehicle fee, the LSVA, in 2001 as a result of increasing public concern over rapidly growing road based freight movements. The LSVA applies to vehicles with a total weight of more than 3.5tonnes and uses three parameters:

- the kilometres travelled on Swiss roads;
- the authorised mass weight of the vehicle; and
- the emission value of the vehicle[69].

The total charge is the product of the distance travelled, the highest authorised weight of the vehicle, and the rate of the fee. It is important to note that the actual gross weight of the vehicle during a particular trip is not used in the calculation, as it was considered impractical to use a vehicle's continually changing operating weight. The vehicle is also assigned to one of three emission categories.

The fee is collected by the Swiss Federal Customs Authority (FCA) and is levied on both domestic and foreign vehicles.

The fee is a flat rate charge with three levels to differentiate vehicles by emission classes. The current flat rate fee is 0.0244 CHF/tkm (approximately 2.67 cents/tkm). The fee was determined on the basis of road user charges in other parts of Europe. That is, the fee was set so that a transit of a heavy vehicle from Basle to Chiasso (about 300 km) should not exceed the price of CHF 325 (233 AUD). According to the Swiss Federal Office of Spatial Development the fee level was determined to recover the "uncovered costs caused by heavy vehicles". No details as to what constitutes these uncovered cost is provided.

The charging system relies on the use of an on-board unit (OBU) that records the kilometres travelled and is activated and de-activated at the national border through an interface with a Dedicated Short Range Communication (DSRC) device located above the road. Automatic trailer recognition and GPS monitoring are also important elements of the charging system. As of 2002, around 55,000 vehicles were fitted with OBUs and the Government had spent a total of 240M CHF in capital related costs and outlays 24 M CHF annually in operating costs.

The major impacts of the introduction of the LSVA to date have been:

- the heavy vehicle fleet underwent a major renewal with an increase in heavy vehicle sales of 45% particularly in vehicles over 26 tonnes authorised weight. An increased use of light trucks which were not subject to the LSVA was not observed;

69 The emission value of a vehicle relates to European emission standards. Truck engines are classified as EURO I, II or III depending on the level of pollutants emitted with EURO I classified engines having the highest emission level.

- increased merger activity amongst transport operators with the objective of minimising empty vehicle running;
- reduced use of heavy goods vehicles particularly on transalpine routes;
- initially, little impact on rail activity was observed, partly due to the accompanying increase in weight limits on heavy vehicles to 40t between 2001 and 2005;
- no significant impact on goods prices was observed;
- the approach used in Switzerland does not significantly interrupt the flow of the transportation system. Fee collection is also accomplished at low cost even from foreign truck operators who must pay road user charges prior to exiting the country;
- the LSVA sets a strong incentive to use "clean" vehicles and thus to renew the fleet. The differentiation of the fee between EURO emission classes is sufficiently high to make it profitable in many cases to replace older vehicles with new ones in order to meet the more demanding EURO II / III emission levels.

5.3.3 Austria

In 2004 a distance based charge for heavy vehicles with differentiation according to axle configuration was introduced in Austria. Charges apply to use of the autobahn system and certain other major trunk routes only. Average tariffs are in the order of €0.22 ($0.37) per kilometre.

The system operates through inexpensive OBU, or GO box, which must be fitted to all eligible vehicles. These OBUs communicate with receivers located on over 400 gantries erected across the motorway system. The system automatically calculates the charge based on data transmitted from the OBU and records the amount to be paid electronically.

The Austrian system is a relatively inexpensive one. Total development and initial set-up costs were estimated be in the order of €290 million ($490 Million).[70]

[70] NTC Australia (2004). *Future heavy vehicle road pricing mechanisms information paper: Issues, options and international developments.*

5.3.4 Germany

In 1999 the German Federal Government decided to introduce distance-related tolling of heavy trucks (exceeding 12 tonnes) using Autobahns. The Toll Collect consortium uses a system that calculates the road-use fee for trucks using a satellite-based detection system. Drivers enter data on the OBU and the rest is done automatically by the equipment in the cab that contains a GPS (global positioning system) receiver and a mobile telecommunications terminal. The OBU detects the route taken by the vehicle with the aid of the GPS satellite system. The toll computer calculates the relevant fees and transmits the data over the mobile telephone network to Toll Collect, where an invoice is produced. However, OBUs are not compulsory. Where truck operators rarely use German autobahns, they can also book their route on the Internet or buy a toll ticket after entering the relevant details via the touch screen at one of 3,600 terminals across Europe.

The charging system is based on GPS/GSM in order to have the option to extend the coverage of the system to all kinds of roads and vehicles at a later date. The amount of toll is based on the internal or direct costs caused by heavy truck use which are calculated according to an EU-directive on road pricing. The average toll is 12.4 €-Cent per vehicle-kilometre with the actual charge dependent on the number of axles and emission standard of the vehicle. According to Pickhardt[71] the fact that the total revenue from the heavy vehicle charging system (around 3.4 billion Euro in 2005) would cover the entire cost of the Federal Motorway system clearly indicates that heavy vehicles are being overcharged ie the current charge has not been set optimally. In Pickhardt's view both the Federal government and the private firm that "monopolistically operates the charging system not only receives a virtually risk free profit stream, but it also gets an ideal demonstration case that will help sell the product elsewhere"[72].

The German system only applies to trucks heavier than 12 tonnes which use the Federal Motorway (Autobahn) system. The excessive charges are forcing truck operators to bypass the motorway system in favour of the less direct highway system resulting in noise pollution and congestion on those roads. According to figures from the Kraftfahrtbundesamt (2005), the number of newly registered trucks with a total maximum weight of 7.5 to 12 metric tons, i.e. trucks which are not subject to the charge, increased in the first half of 2005 by 36.9 percent compared to the same period in 2004. However, the total number of newly registered trucks increased only by 4.7 percent and in the weight class of 12 to 18 metric tons the number actually decreased by 5.2 percent during the same period.

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71 Pickhardt, M (2005) *Transport Infrastructure Provision and Road-pricing: The Sax-Wicksell Concept in the Light of Today's Policies*, Chemnitz University of Technology.

72 Pickhardt, M (2005) *op cit*, p 20.

The net toll-revenue is used exclusively for the transportation infrastructure with 50 % earmarked for Federal Highways and 50% for the Federal Railways and Inland Waterways.

This system has had little recorded adverse impact on traffic flows with non-discriminatory access for foreign vehicles.

As mentioned above, the automatic electronic toll collection system is based on GPS/ GSM technology (including a DSRC module for interoperability) and standard and individual bookings can be made via the internet or at special points of sale. The OBU for automatic toll collection is provided free of charge, with the installation being paid by the truck-owner.

One year since the introduction of the tolling system, there has been[73]:

- No traceable increase in freight-charges;
- No traceable impact on consumer prices;
- No significant shift from road to rail or inland waterways;
- A reasonable amount of trucks using alternative toll-free routes;
- Increased tendency to buy trucks with higher environmental standards;
- Significant tendency to a higher average load-factor; and
- A 15% decrease of truck-kilometre on Autobahns without cargo

5.4 Lessons from overseas experience

There are a number of lessons that can be drawn from overseas experience:

- electronic technology for distance based charging has now been successfully applied in a number of jurisdictions. Mass based charging is based on vehicle capacity rather than load due to technological constraints;
- the motivations for implementing MDC have varied across jurisdictions. Switzerland introduced the charge to influence truck movements over the Alps;
- route selection will be influenced by pricing. There have been reports from Germany the traffic volumes of heavy vehicles have increased on secondary roads. In contrast, the Switzerland route substitution has not been reported;

[73] TRB (2006) Road Pricing in Germany TRB 2006 Annual Meeting Washington D.C.

- mass distance charging has resulted in fleet renewal and fleet rationalisation. In Germany there appears to be substitution towards smaller vehicles to minimise charges. However, the German charges apply to vehicles with much higher vehicle mass compared to other jurisdictions. Substitution of lighter for heavier vehicles is not reported in jurisdictions; and
- the establishment costs of an electronic pricing system are significant but jurisdictions appear convinced that the gains exceed the costs.

5.5 Implementation in Australia

Clearly, the application of Mass Distance Charging (MDC) in a number of countries has achieved reasonable financial and technical success. More recent applications, for example those in Switzerland and Germany have employed quite advanced technological solutions to the problems of:

- distance measurement and/or route monitoring;
- mass measurement;
- data validation;
- charging and payment processing;

However, these applications have incurred considerable implementation costs and will continue to incur substantial operating cost well into the future. Before committing freight operators, transport users, consumers and possibly tax payers in Australia to the investment necessary to establish a MDC regime, its economic feasibility needs to be established. Because of the important role that transport prices play in coordination production and storage decisions, such an assessment would need to consider dynamic efficiency gains from more cost reflective transport prices.

Clearly, the main problem facing attempts to introduce individual road user charging is one of high transaction costs. The current approach to road user charging in Australia has had, as a major objective, the minimisation of transaction costs and administrative simplicity. However, this focus on transaction costs fails to recognise the efficiency losses associated with it in terms of:

- distorted prices in freight markets leading to inefficient vehicle use and modal choice;
- distorted investment incentives resulting from inefficient use of transport services facing non-cost reflective user charges;
- higher negative externalities associated with inappropriate modal choice; and
- the funding of any deficits from general taxation.

The Australian land transport task is substantial and expected to increase considerably in the coming decades. The decentralisation of the population, the distances between major population centres, as well as the location of major agricultural and mineral resource centres, highlights the importance of achieving modal efficiency in the provision of transport infrastructure. Hence, the presence of price distortions in the various markets which make up the land transport industry are likely to be associated with considerable economic losses. The introduction of mass distance charging allows individual users to make road use decisions which are reflective of the cost of their road use, rather than those of an average user.

Hence, the decision with respect to the type of road user charging system to employ should not concentrate solely on the potential for high transaction costs but needs to consider the full extent of the net change in economic surplus associated with a change in charging regime.

The introduction of mass distance charging is an essential first step in minimising these economic costs associated with the current distorted pricing arrangements. It is only through MDC that heavy vehicle user charges can:

- perform the role that prices are meant to perform in market economies;
- reduce the level of cross subsidisation currently occurring within the heavy vehicle industry and across major freight sectors;
- reflect the level of external costs caused by particular transport operators; and
- recover the true costs of road use from heavy vehicle operators.

QR is firmly of the view that the economic feasibility of the introduction of MDC can be clearly demonstrated while recognising its implementation will involve significant cost and complexity. Income effects may need to be mitigated through the application of detailed transitional arrangements for some sections of the road industry. In terms of the timing, QR would be concerned if detailed consideration of a superior road user charging mechanism was deferred to a later review of heavy vehicle charging arrangements because the efficiency gains forgone in further delaying pricing reform.

The characteristics of the MDC system that are most desirable in the Australian surface/road transport environment may well differ from those that characterise MDC regimes in other countries. It is important to reflect the nature of freight flows in Australia where potential for modal competition exists and covers the major freight corridors. The desirable features of an MDC system in Australia would include:

- an initial concentration on major freight corridors where road/rail competition exists, however the potential to extend the system to other parts of the road network in the future should not be excluded. In QR's view the Auslink National Network – which is the backbone of the national freight network – would be a well defined network for initially implementing MDC;

- a recognition that the scheme's revenue recovery objective should embrace the full costs of the road infrastructure involved;
- a variable charge reflecting incremental costs which is location specific to reflect road type (as incremental costs vary by road type and condition);
- an emphasis on accurate measurement of both distance travelled and specific route used as well as the actual vehicle mass. The level of accuracy achieved will be subject of course to the technical and economic feasibility of the various monitoring and measurement devices available; and
- a mechanism to ensure that revenues earned from mass distance charges flow to the infrastructure owner where the costs occurred.

Chapter 6

Price Distortions impacting Bulk Freight

6.1 Main points

Pricing arrangements (especially subsidised heavy vehicle road charges) have significantly contributed to deterioration in rail's competitiveness with road transport despite the intrinsic economic advantages possessed by rail for bulk commodities.

For traffics where rail haulage still predominates, such as coal, the regulatory arrangements create a significant risk of a service provider under-recovering the true cost of service provision.

Optimal regulatory architecture revolve around the following considerations:

- the need for a single regulatory objective being to promote the efficient use of and investment in transport infrastructure;
- providing more significant status to the infrastructure provider's initial proposal so that the relevant legislative instrument makes it clear that a regulator would be obliged to accept such a proposal where it conforms to the statutory criteria;
- the availability and scope of merits review;
- timeframes for regulatory processes being relaxed so that stop clock mechanisms are introduced so a regulator would not be bound to make a regulatory decision within a 6 month time frame.

6.2 Introduction

To achieve an efficient allocation of resources between road and rail infrastructure, the price for use of each transport mode must reflect the full social cost of the resources used in providing infrastructure services. Where prices do not fully reflect social costs, transport operators will face distorted price signals which will, in turn, distort the pattern of usage both between road and rail as well as decisions that are made by transport operators as to how they operate, including vehicle choice. In addition, these distortions will have a longer-term impact on economic welfare through distorting investment decisions.

The transport choice for different traffics will be driven by economic considerations such as the cost of access to road and rail infrastructure respectively and the nature of the product being shipped. Reflecting these factors, rail transport generally has an intrinsic advantage over road in bulk freight transport (although the competitive advantage has been undermined by subsidised heavy vehicle road charges). This advantage strengthens the longer the length of a haul. However, the current pricing of road and rail does not reflect their relative cost competitiveness.

It has been argued by research commissioned by the National Transport Commission (the Starr's Report) that estimated cross elasticities of demand would suggest that significant modal shift can only occur with large increases in road prices. Of course this result depends on the reliability of the elasticity estimates. As noted in Appendix A there is no recent Australian estimate of cross elasticities. Moreover, substitution possibilities between rail and road do not extend across all land transport tasks markets. For elasticity estimates to be a useful guide to impacts they would need to be estimated for the appropriate markets. In any case, Chapter 8 argues that modal share is the wrong basis on which to measure the impact of price reform.

This chapter considers the impact on rail bulk freight traffics of price distortions from underpricing road use of heavy vehicles and the impact of third party access regulation. Although rail is a major provider of bulk services, apart from coal and minerals, its position as a strong competitor with road has been steadily undermined by inefficient road pricing. QR believes that future land transport regulation needs to ensure that account is taken of all costs so that modal competition is not adversely affected by inefficient regulatory processes.

6.3 Bulk freight task

2.4 billion tonnes of freight were transported in Australia in 2005, with rail accounting for 21% of the domestic freight task compared to road, which accounted for 69%. Rail is predominantly used to transport bulk commodities. However, road also carries some bulk commodities, such as non-metallic minerals and some primary products (such as grain and livestock).

In terms of QR's operations, in 2004-2005, QR hauled a total of 175.6 million tonnes of freight. Coal haulage accounted for the largest proportion of this (89%), with 156.3 million tonnes of coal hauled in 2004-2005. Freight and minerals traffics account for the remainder of 19.2 million tonnes (11%).[74] Other than coal, bulk freight includes the haulage of grain, minerals, livestock, sugar, fuel, lead, copper and sulphur.

The choice of transport mode by customers is driven by the competitive characteristics of each mode. For example, rail typically has a competitive advantage over road the longer the haul length and for bulk commodities. Road has an advantage over shorter hauls, particularly where road transport is needed for final delivery of the goods.

[74] QR Connects, QR Annual Report 2004-2005, p. 59.

6.4 Regulation of road access and pricing

Pricing arrangements have impacted rail's competitiveness with road transport. In particular, for traffics where road and rail transport are reasonably close substitutes, rail is increasingly losing market share to road transport. Box 8 describes the factors influencing competition in grain transport. While road pricing is not the only factor influencing demand it is clearly an important factor, as shown in existing elasticity studies (refer to the Appendix).

Box 8 The factors influencing modal choice in the transport of grain

The factors influencing modal choice in the transport of grain are:

- the relative prices of road and rail;
- the recent growth of on-farm storage, which offers growers alternative marketing strategies and enables grain to travel direct from farm to port bypassing the up-country storage and handling facilities, thus reducing overall supply chain costs;
- the growth of alternative markets, such as feedlots, flour mills and potentially ethanol plants, has altered grain flows; and
- bulk handlers now allowing deliveries to ports by road (previously restricted).

Generally speaking, pricing is the most important factor which determines how grain moves throughout the supply chain. Under-recovery of road transport costs effects a broader range of decisions in a logistics change.

For example, traditional rail transport pricing has tended to take a whole of network approach. This approach allowed some cross subsidisation of routes. In general, shorter hauls were cross subsidised by longer hauls. In recent times rail operators have attempted to reverse this strategy by developing models that price on a stand alone depot by depot basis. The changes were also driven by the grain marketers who expressed a desire for grain handling and storage investment decisions to be based on cost reflective pricing. This also allowed above rail operators to rationalise their grain fleet which was not operating efficiently, largely through inefficient pricing arrangements. Under recovery from heavy vehicles is likely to cause similar distortion.

In recent times there has been significant growth in domestic markets. Growers have been able to gain access to these markets by developing on farm storage which allows growers to supply grain to flour mills, feedlots etc on an as required basis. On farm storage also allows growers, particularly for shorter hauls, to transport grain direct from farm to the ports. This reduces total supply chain costs because growers don't need to utilise up-country storage facilities.

Price signals from global markets drive the grain supply chain. Under normal seasonal conditions for wheat, there will be post harvest railing programs between September and December (depending on location) to take advantage of a supply window created by the timing of the northern hemisphere crops. This has tended to peak transport demand. Cost reflective pricing in these circumstances is important to signal to growers the costs of maintaining fleet determined by peak railings. Through service and pricing reform QR has reduced its grain fleet from 800 to 250 wagons, resulting in much higher capital productivity.

Previously most bulk handlers at ports limited the tonnages delivered by road, however in recent times they have relaxed this limitation, particularly in smaller locations such as Mackay.

It is also clear that regulatory decisions to increase mass limits without capturing full social costs in prices are inefficient. Similarly, until the charging structures and levels for heavy vehicles are efficiently determined, the adoption of incremental pricing approaches that would allow increased mass limits would be undesirable.[75]

The Productivity Commission (PC) has already noted the trend for Australia's railways to become increasingly specialised in the transport of bulk commodities, such as coal and iron ore. [76] In a modal competition sense, this advantages QR although there is some degree of substitution between rail and road for coal hauls. For example, coal is currently being hauled by trucks from Jondaryan to the Swanbank Power station, a distance of 180km. There are around 300 trucks a day delivering 35% of Port Kembla Coal Terminal's throughput, or approximately 3.5 million tonnes per annum.[77] However, QR believes that the efficiency objectives for land transport infrastructure pricing reform will allocate freight according to price and service characteristics, not preconceived views on freight and mode compatibility. For QR, a greater concern is the impact on its incentives to invest in capacity enhancements as there is a considerable risk it will not be able to recover the full cost of this investment.

The PC further noted that competition from road transport has eroded the previous dominance of railways over the transport of primary products and non-bulk freight. QR submits the regulation of access and pricing are major factors contributing to an allocation of the transport task not reflective of the intrinsic strengths of road and rail. Moreover, because market shares of the various modes have been distorted through prices not reflecting underlying cost, the overall cost to the economy of performing the transport task has increased unnecessarily.

6.5 Limitations of access regulation for rail infrastructure

For traffics where rail haulage still predominates, such as coal, the regulatory arrangements create a significant risk of a service provider under-recovering the true cost of service provision. QR considers that price distortions arising from the limitations of the regulatory framework that applies to rail will also have an impact on incentives to invest in rail infrastructure.

This impact is magnified by the tendency of regulators to impose a level of precision that does not exist and by the asymmetric consequences of regulatory error.

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75 To do otherwise ignores the theory of second-best – since current heavy vehicle charges are not efficient, the starting point for incremental analysis is quite likely to be a net cost rather than neutrality. Consequently, the overall economic impact of incremental pricing of road use associated with increased mass limits will exacerbate the distortions embedded in the current pricing arrangements rather than ameliorate them.

76 Productivity Commission (2000), *Progress in Rail Reform, Inquiry Report*, p 7.

77 Port Kembla Coal Terminal Ltd Submission to the House of Representatives Standing Committee on Transport and Regional Services: Inquiry into the integration of regional rail and road freight transport and their interface with ports. February 2006.

6.5.1 Inappropriate level of precision

The PC has already recognised that regulatory processes seek to apply a level of precision that does not actually exist in its review of the National Access Regime:[78]

> Regulators must operate with limited information and imperfect regulatory tools. This implies that precise delineation after the event between genuine monopoly rents and balancing upside profits on successful projects will be nigh impossible.

In addition, the Exports and Infrastructure Taskforce noted:[79]

> It is understandable that regulatory authorities will concentrate on objectives that are readily measurable. The apparent gains from lower prices for key services are all too readily understood and communicated. There is therefore a risk that lower prices will be seen as inherently good, with regulators concentrating on securing price falls for infrastructure without sufficient consideration of the long term consequences. The dangers that this poses to investors in infrastructure have been made all the greater by regulators' reliance on mechanisms and approaches for setting allowed prices that are complex and rely on an ability to attain a degree of precision that is not likely to be attainable in practice.

The PC also acknowledged the potential adverse consequences of access regulation, identifying as a potential cost of regulation the reduced incentives to invest in infrastructure facilities.[80] This may occur because potential exposure to access regulation is likely to increase the general level of risk attaching to investment in essential facilities. Also, investment may be deterred if regulated terms and conditions are not expected to provide a sufficient return. Regulatory pricing arrangements that limit appropriate upside returns (ie. 'regulatory truncation') can potentially be a significant source of inefficiency arising from access regulation due to the asymmetric consequences of regulatory error.

6.5.2 Asymmetric consequences of regulatory error

Where regulatory error exists, the effects of regulatory error are likely to be asymmetric in nature.

This asymmetry arises due to the tendency of regulation to place a limit on the upside, but not to place a floor under the downside outcomes. Furthermore, asymmetry arises because underinvestment in infrastructure (due to truncated regulatory returns) is likely to have more severe adverse consequences on economic welfare than excessive or inefficient investment that might occur if regulatory returns are too high.

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[78] Productivity Commission (2001), *Review of the National Access Regime*, p 82.

[79] Exports and Infrastructure Taskforce (2005), *op cit*, p 41.

[80] Productivity Commission (2001), *op cit*, p 59.

The PC accepted in its review of the National Access Regime that there is a potential asymmetry in the effects of regulatory pricing errors. The PC noted that:[81]

> Over-compensation may sometimes result in inefficiencies in the timing of new investment in essential infrastructure (with flow-ons to investment in related markets), and occasionally lead to inefficient investment to by-pass parts of a network. However, it will never preclude socially worthwhile investments from proceeding.
>
> On the other hand, if the truncation of balancing upside profits is expected to be substantial, major investments of considerable benefit to the community could be forgone, again with flow-on effects for investment in related markets.
>
> In the Commission's view, the latter is likely to be a worse outcome.

QR notes that in an environment in which demand for the service is relatively inelastic (as will be the case for those markets served by rail infrastructure subject to regulation), erring on the upper end of a reasonable range will involve relatively modest efficiency costs (if any at all) so long as the regulatory environment does not induce excessive infrastructure investment. This is due to:

- infrastructure providers being more sensitive to the impact of regulatory decisions than their customers. This follows from the fact that an infrastructure provider's capacity to earn revenue from its regulated infrastructure will be almost totally dependent upon the regulator's decision whereas the regulatory decision will affect only a fraction of the customer's cost base;
- the consequences of underinvestment – in transport networks, the consequences of underinvestment emerge in the form of congestion in the first instance and eventually lower output as dependent industries find it increasingly difficult to maintain competitiveness. The economic cost that could be imposed by such underinvestment can be seen when it is recognised that the mining industry contributes significantly to Australia's GDP;
- the major risk of a loss to economic welfare from allowing returns that are higher than strictly necessary to remunerate investment is that socially excessive investment will be undertaken by the infrastructure provider. However, one must be careful before drawing such a conclusion – the fact that returns may be slightly above those strictly necessary to remunerate investment is highly unlikely to induce socially excessive investment unless an infrastructure provider can be confident that it will secure the benefit of those returns over the life of the investment. Moreover, even if it is accepted that there is a risk of socially excessive investment, transparent planning and investment approval processes are likely to substantially reduce any risk of socially excessive investment in infrastructure.

81 Productivity Commission (2001), ibid, p. 83.

Hence, the asymmetric consequences of error are all the more likely in an environment in which there is a significant and invasive role for the regulator in assessing new investment proposals.

These concerns highlight some of the limitations of the third party access regulatory framework which applies to rail infrastructure.

6.6 Improving regulatory architecture

Rather than address specific issues concerning regulatory decisions, QR believes that it is more productive to suggest amendments to the regulatory framework to address the concerns outlined above.

QR notes that the recent COAG agreements on third party access regulation have proposed a number of changes aimed at increasing the degree of national consistency in access regulation. Whilst QR is not uncomfortable with increasing the degree of national consistency in access regulation, QR considers the more fundamental issue revolves around ensuring that the regulatory framework has an appropriate objective and produces the right balance between regulatory discretion and accountability.

QR's views on optimal regulatory architecture revolve around the following considerations:

- the need for clear regulatory objectives;
- providing more significant status to the infrastructure provider's initial proposal;
- the availability and scope of merits review; and
- timeframes for regulatory processes.

QR believes that key reforms are required to the regulatory environments governing rail access in order to mitigate the likelihood and adverse consequences of regulatory error and to minimise the extent to which regulatory risk impedes socially desirable new investment in the rail industry.

6.6.1 The regulatory objective

A key rationale for regulation is where natural monopoly businesses have the potential to exercise market power to distort upstream or downstream competition and to extract monopoly rents. QR accepts that the focus of regulators on protecting the competitive integrity of upstream and downstream markets is appropriate. However, QR is concerned that the typical focus of regulators to eliminate monopoly profits, which is manifest in a focus on reducing prices has:

- resulted in the pursuit of an unrealistic degree of precision by regulators, which will increase the risk of regulatory error; and

- overlooked the fundamental importance of infrastructure owners having sufficient incentive to invest in infrastructure.

As noted above, it is generally recognised that regulatory error has asymmetric consequences, with under-investment (which may result from insufficient regulated returns) considered a worse outcome than over-compensation.

QR is particularly concerned that a variety of regulatory objectives increases its exposure to regulatory risk and correspondingly reduces the accountability of regulators for their decisions. For example, QR argues that regulators should not be able to justify interventions that are inconsistent with economic efficiency on the basis of equity considerations.

The key rationale for access regulation should be to maximise the social surplus that arises in markets involving a natural monopoly facility. In practice however, regulators have focused on the elimination of monopoly profits where natural monopoly businesses have the market power to potentially extract such rents. This approach is appropriate under the condition of perfect information - that is there is no uncertainty as to future outcomes. However, this is not a characteristic one could reasonably associate with infrastructure service markets. The pursuit of this objective has overlooked that it increases the risk of infrastructure owners having sufficient incentive to invest. Lower returns provide a disincentive for service providers to invest in below-rail infrastructure as the risks involved are not being adequately rewarded.

The PC noted that 'imperfect regulation':[82]

> …is likely to increase the general level of risk attaching to investment in essential infrastructure. The inevitable regulatory discretion involved in the implementation of access regulation, constraints on service providers' capacity to respond to changes in the market environment and perceptions that regulatory decisions will tend to be biased in favour of users, are among the factors that contribute to regulatory risk. While these sorts of risk attach to investment in any regulated activity, the sunk nature of most infrastructure assets and the scale of the investments involved make them a much more significant consideration in the infrastructure area.

[82] Productivity Commission (2001), *Review of the National Access Regime*, Report no. 17, AusInfo, Canberra, p.279.

In recognition of the detrimental impact that regulation can have on infrastructure investment, the PC proposed the inclusion of an objects clause to clarify the objective of Part IIIA of the *Trade Practices Act 1974*. The proposed clause was to:[83]

> a. promote the economically efficient operation and use of, and investment in, essential infrastructure services, thereby promoting effective competition in upstream and downstream markets; and
>
> b. provide a framework and guiding principles to encourage a consistent approach to access regulation in each industry.

In its submission to the Exports and Infrastructure Taskforce, the Commonwealth Government re-emphasised the importance of the promotion of economic efficiency as a primary objective, which:[84]

> …explicitly recognises the importance of fostering efficient investment in new essential infrastructure, while at the same time encouraging the efficient use of existing facilities through innovation and productivity improvements.

The Taskforce concluded that:[85]

> Streamlining and better defining the objectives that regulators should pursue would help address the risks and difficulties the current situation gives rise to. To begin with, regulators should, as their primary duty, be required to ensure that efficient investment in Australia's infrastructure occurs, and occurs in a manner consistent with the continued, reliable and secure provision to the community of the services that infrastructure provides.

Moreover in a recent decision applicable to energy market regulation in Australia, the MCE has decided to include an objects clause in both the National Electricity Law and the Gas Pipeline Access Law to:[86]

- clarify the policy intent of the regime;
- provide greater certainty to service providers and access seekers about possible regulatory intervention; and
- promote rational consistency (both across jurisdictions and between access regimes).

Overall, therefore, it is critical that any access regime defines a clear overarching objective, which is based on ensuring the efficient use of existing infrastructure and optimal investment in new capacity.

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83 A slightly modified version of the PC's recommended objects clause has been included in the Trade Practices Amendment (National Access Regime) Bill 2006.

84 Commonwealth Government in Exports and Infrastructure Taskforce (2005), op.cit, p.40.

85 Exports and Infrastructure Taskforce (2005), ibid, p.42.

86 Ministerial Council on Energy (2006), *Review of the National Access Regime Decision*, May.

QR believes that a single objective focusing the process on an economic efficiency objective will best advance Australia's economic welfare. The objective of regulatory regimes in the transport industry should be to:

> promote the economically efficient operation and use of, and investment in, essential infrastructure services, thereby promoting effective competition in upstream and downstream markets

In defining a single objective for the regulatory regime, QR believes that regulators should be required to explicitly consider the risks and consequential economic costs of allowing too much and too little revenue for the assessed risks to which the infrastructure provider is exposed. QR believes that such a consideration is likely to move regulators away from a focus on the minimization of monopoly profit to maximising the sum of consumer and producer surplus over time.

Moreover, QR believes that a single efficiency objective will serve to clarify the regulator's assessment of regulatory proposals (irrespective of the status conferred upon the infrastructure provider's submission under the regulatory regime).

6.6.2 Status of a service provider's proposal in a regulatory review

Rail regulation in Australia is currently based upon a model where the service provider submits a proposal to the regulator, which is then considered and either accepted or rejected based on the regulator's assessment. Subject to complying with the principles of natural justice, the regulator is free to undertake its own assessment of the service provider's proposal more or less independently of it. There is no compulsion on the regulator to accept a reasonable position submitted by a service provider.

With some exceptions (where rail does not possess market power), the price for access to regulated rail infrastructure is the result of regulatory decisions on a range of inputs, or 'building blocks', used to determine the maximum revenue that may be earned by the business. These include opening asset value; asset consumption during the regulatory period (depreciation); capital investment over the regulatory period; cost of capital; operating costs; and volume forecasts.

For each of these inputs, there is a range of outcomes that could be characterised as being reasonable values given the uncertainty involved in estimation. However, the regulatory process has typically involved regulators choosing a point estimate which is used as the basis for determining each of the 'building blocks' irrespective of the reasonableness of the value submitted by the service provider.

Instead of regulators assessing the reasonableness of the proposal that has been submitted, the regulator will often undertake its own assessment and then compare this to the position submitted by the regulated entity. This may result in the regulated entity's submission being rejected with limited rationale, other than that the regulator (or its consultant), came to a different conclusion. Where two competing assessments exist, the regulator will naturally favour its own.

This problem is exacerbated by the reality that in many areas of regulatory decision-making, regulators are seeking a level of precision that is simply not realistic or achievable in practice. It is not clear why regulators would seek to impose a level of precision that simply does not exist, although this may reflect the focus on eliminating monopoly rents. Such precision cannot be achieved, given:

- the limited information and tools they possess;
- the inherent uncertainty of the environments within which these businesses operate; and
- the degree of judgement that must be applied in reaching decisions on issues that remain subjective.

Not only has this created an environment of increased regulatory risk, but also it has substantially weakened the incentive for service providers to submit positions to regulators that fall within a reasonable range. Indeed, the reverse is true – the current environment provides a strong incentive for service providers to "test the bounds" by submitting a relatively high value for each of parameters under consideration.

Accordingly, QR believes that the *propose-respond* model has much to commend it for the regulation of access for the transport sector.

Under this model, the regulator's first duty is to assess whether the proposal submitted by the regulated entity reasonably satisfies the relevant criteria, recognising that on many of these issues, there tends to be an acceptable range of responses rather than a precise answer.

If the proposal is not considered to be reasonable, the regulator must indicate why this is seen to be the case but may then impose its view of the "best" value on the infrastructure provider. Such a framework was endorsed by the Exports and Infrastructure Taskforce:[87]

> The relevant test applied by regulators should be simplified and based on whether what has been proposed by the infrastructure owner is reasonable in commercial circumstances and in the light of statutory objectives. This test – under which a regulator could not reject a proposed access arrangement that fell within a reasonable range, merely because it preferred another point within that range – should be applied universally and uniformly, as envisaged under the national competition policy reforms. Simplifying the regulatory test to one that merely considers whether the infrastructure provider's proposal is reasonable in the

[87] Exports and Infrastructure Taskforce (2005), Australia's Export Infrastructure: Report to the Prime Minister by the Exports and Infrastructure Taskforce, p.4.

> commercial circumstances and falls within a reasonable range should reduce the complexity of the regulator's task and result in a more timely process.

Under this framework, an infrastructure provider's proposal will be accepted provided it meets certain criteria as set out in the relevant access regime. What is considered 'reasonable' is based on establishing what a reasonable person (having regard to all the circumstances) would accept as meeting those criteria. For example, this is consistent with the Australian Competition Tribunal's interpretation of the National Gas Rules with respect to GasNet: [88]

> It is clear from the reasoning in *Michael* (Re Michael Ex parte Epic Energy (WA) Nominees Pty Ltd (2002) 25 WAR 511) that there is no single correct figure involved in determining the value of the parameters to be applied in developing an applicable Reference Tariff. The application of the Reference Tariff Principles involved issues of judgment and degree. Different minds, acting reasonably, can be expected to make different choices within a range of possible choices which nonetheless remain consistent with the Reference Tariff Principles…where there is no conflicts or tensions in the application of the Reference Tariff Principles, and where the AA (Access Arrangement) proposed by the Service Provider fails within the range of choice reasonably open and consistent with Reference Tariff Principles, it is beyond the power of the Relevant Regulator not to approve the proposed AA simply because it prefers a different AA which it believes would better achieve the Relevant Regulator's understanding of the statutory objectives of the Law. *(words in brackets added).*

QR notes that since the interpretation of the Gas Access Regime was clarified through the GasNet decision, there has been relatively disputation as to the practical application of the propose-respond model. Nor has the model resulted in a demonstrable increase in the cost of capital endorsed by regulators.

This model also is desirable to the extent that it recognises that a regulator's strength is in the assessment of the reasonableness of a position rather than to identify a correct value where no such value exists. QR believes that the comparative advantage of a regulator is to assess whether or not a proposal submitted by a service provider satisfies a criteria as opposed to "fine tuning" that proposal according to its own criteria of "correctness" when in reality there is no objective basis to prefer one person's view of correctness of a parameter over another. The propose respond model therefore better captures the natural scope for regulatory decision making.

Properly defined, it provides a strong incentive for infrastructure providers to submit values for the various regulatory parameters under consideration that are reasonable and hence able to be accepted by the regulator. It therefore changes the dynamics of the regulatory process to better and more constructively align the interests of the parties.

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88 Australian Competition Tribunal (2003) Application by GasNet Australia (Operations) Pty Ltd [2003] ACompT 6, pp.11-12.

Moreover, the propose-respond approach is preferable in terms of mitigating the risk of, and costs associated with, regulatory error by allowing the reasonable estimates of building block parameters put forward by the regulated business to apply.

In effect, propose-respond establishes a regulatory threshold whereby the regulator is bound to accept an infrastructure provider's proposal, provided it is reasonable. The interests of access seekers and the public interest are still protected by the fact that, if the infrastructure provider makes a proposal which is unreasonable, the regulator can reject it and substitute its own view.

A possible consequence of this model is that a service provider may submit an unreasonable claim at the commencement of a process and subsequently modify it following the release of a draft decision to retain the benefit of presumption. Hence, it is necessary to impose certain restrictions on the propose-respond model, including:

- as noted above, ensuring that clear and workable criteria for assessment of the regulated entity's proposal are established under the relevant access regime;
- establishing clear consequences where the criteria are not satisfied (that is, the regulator may then impose its own view);
- establishing rules for changes to the position submitted, for example, if a regulated entity changed its position on a particular component when submitting its final proposal, it would not benefit from the presumption of acceptance;
- determining the components that are considered discrete for the purposes of attracting a presumption and if and how components would relate to each other.

In turn, these issues serve to highlight the importance of recognising that the design of the regulatory frameworks must take account of the nature of the decisions it is seeking to affect. In particular, a regulatory mechanism which seeks to minimise regulatory risk so as to avoid creating a barrier to investment must similarly take account of the fact that the decisions being affected are long term sunk commitments to infrastructure.

In such an environment the credibility of the arrangements is critical – and in QR's view, the most efficacious way to provide that credibility is to establish the rights of the service provider (in terms of the rights conferred under a propose respond model) in legislation.

Similarly, measures to ensure regulator accountability are also fundamental to creating a climate that is conducive to socially desirable infrastructure investments being undertaken with minimal regulatory risk. Merits review should also be available to provide the regulated entity with an avenue of recourse. This is discussed further below.

6.6.3 Merits review

There is therefore a reasonable probability that even with the most rigorous and careful assessment, regulatory error will occur. Further, where regulator error occurs, the economic and social consequences could be significant, particularly if this results in under-investment in essential infrastructure.

Considerable power has been vested in regulators and much scope for discretion in decision-making naturally exists, particularly given the degree of judgment that must naturally be applied. This will remain the case even if the amendments suggested by QR are adopted as part of the regulatory architecture.

It is therefore important that regulators are held accountable for their decisions, and appropriate disciplines are imposed to ensure that regulatory decision-making is maintained at the highest standard. This is important given the potential for regulatory error to be made, and the adverse impact this could have on the regulated business, and more importantly, the economy.

It is therefore important to ensure that a regulated entity has some avenue for recourse where it is dissatisfied with a regulatory decision. QR currently only has access to judicial review, which allows review of the decision-making process. However, this does not provide for independent review of the decision itself.

Merits review is considered an important avenue of recourse for a regulated entity. Merits review, which focuses on the quality of regulatory decisions, provides a mechanism for making regulators more accountable. As such, it forms an important component of a regulatory framework that is consistent with the objects and principles of effective open access regimes.

Rights of merits review from regulatory decisions are very limited in Australia. Apart from Part IIIA of the *Trade Practices Act*, the Gas Access Regime is one of the few regulatory regimes currently offering merits review rights in respect of decisions by regulators (principally the ACCC) in respect of gas transmission pipelines. The rights of merits review under the Gas Access Regime are limited. In order to overturn the ACCC's decisions, it needs to be shown that the ACCC's decision involved an error of fact, or where discretion is conferred on the regulator, then that exercise of discretion was incorrect or unreasonable.

The Ministerial Council on Energy has recently decided to implement a limited merits review regime for gas and electricity.[89]

[89] Ministerial Council on Energy (2006), *op. cit.*

Nevertheless, the following three examples involve merits review of ACCC decisions by the Australian Competition Tribunal (ACT) that all resulted in the ACCC's findings being overturned:

- Moomba to Adelaide Pipeline System (MAPS)[90];
- GasNet transmission systems;[91] and
- Moomba to Sydney Gas Transmission Pipeline (MSP).[92]

These ACT decisions indicate that a balanced assessment of all of the factors required to be considered in assessing access arrangements has not always occurred. In reporting on its review of the Gas Access Regime in 2004, the Productivity Commission reaffirmed its stance on merits review:[93]

> Limitations on the grounds of appeal under s.39 of the Gas Pipelines Access Law should be removed to allow a full merits review on access arrangements drafted and approved by the regulator. This would be consistent with the grounds of merits review for coverage decisions.

Overall, the ability to have recourse to merits review of regulatory decisions promotes:

- accuracy in regulatory decision-making because of the discipline it imposes on regulators to ensure decisions are accurate and right the first time;
- enhanced public confidence in regulatory regimes because of the obligation placed on regulators to demonstrate the correctness of their decisions. This reduces the scope for arbitrary decisions to be made by regulators;
- reduction in regulatory risk thereby promoting economic efficiency and reducing the cost of funding new investment that is subject to economic regulation;
- promoting confidence in regulatory outcomes and thereby reducing regulation induced distortions to investment in the regulated sector; and
- consistency to match the availability of merits review in other areas of Australian competition law, thereby promoting equity and rigour in regulatory activity.

A number of concerns have been raised regarding merits review including that:

- merits review is poorly suited to decisions which are time-consuming and costly to repeat on review – indeed, the costs of reviews can be minimised by restricting the scope of the review to the issues that were raised during the course of the regulator's original assessment;

90 Australian Competition Tribunal, Application by Epic Energy South Australia Pty Ltd [2003] ACompT 5.

91 Australian Competition Tribunal, Application by GasNet Australia (Operations) Pty Ltd [2003] ACompT 6.

92 Australian Competition Tribunal, Application by East Australian Pipeline Limited [2004] ACompT 8.

93 Recommendation 11.4

- judicial review provides adequate accountability for regulatory decisions – however, time and again it has been shown that judicial review is a poor substitute for merits review. Indeed, the existence of judicial rather than merits review creates a bias in regulatory decision making in favour of process rather than the substance of the regulatory decision;
- merits review would adversely affect the dynamics of the regulatory process – however, QR believes that the evidence is unequivocally in favour of merits review enhancing the dynamics of the regulatory process; and
- it is better to divert more resources into securing the best decisions at first instance.

These arguments either do not address the fundamental issue of regulatory accountability or represent costs that are outweighed by the important benefits afforded by the availability of merits review. Instituting rights of merits appeal will dramatically affect the approach regulators adopt in regulatory processes. Amongst other things, it will result in a far more formal approach being adopted by regulators and increase the cost of regulatory processes. However, any increase in such costs is considered trivial relative to the avoidance of the societal costs associated with regulatory error.

6.6.4 Regulatory timeframes

COAG has agreed that regulatory decisions should be completed within a 6 month period. Whilst QR agrees that it is important that there is an appropriate degree of urgency in regulatory decision making, QR is concerned about the unintended consequences that can emerge from an excessive focus on meeting a timeframe.

In essence, QR believes that the time that is taken to reach a regulatory decision is an important factor in considering the quality of a regulatory decision, but as such is only one of the factors which properly inform such an assessment.

A regulator who chooses to truncate a regulatory process to meet a statutory timeframe is likely to do more harm to the advancement of efficiency based regulatory objective than it would do in taking more time to complete the process, even where the delays are contributed to by the infrastructure provider's inability to provide all of the information required rather than the regulator in a timely manner.

In this respect, the key criterion that should inform an assessment of the quality of a regulatory decision relates to the extent to which it meets its objective. In this respect, QR submits that it is more important to establish an environment in which infrastructure providers have confidence to invest in infrastructure (so that regulatory risk is minimised), while downstream and upstream parties have confidence in the integrity of the regulatory environment.

Therefore, the imposition of timeframes on regulatory decisions should ensure that there is time for:

- the regulator to assemble sufficient information to enable it to make a decision that is free from significant error ; and
- interested parties to be afforded every reasonable opportunity to present their case to the regulator.

6.7 The way forward

Railways are vital to the efficient performance of bulk freight transport in Australia. Inefficient regulation of road and rail infrastructure regulation diminishes the role rail can play in transport and therefore requires further reform, consistent with the recently announced COAG agenda. QR's position with respect to road price regulation has been already been stated. The reforms required with respect to investment will be discussed in the next chapter.

QR believes that regulatory reform of rail regulation must comprise:

- the need for a single regulatory objective of economic efficiency;
- the introduction of a 'propose-respond' regulatory architecture – enshrined in legislation - which will produce a more efficient regulatory framework through reduced incentives to submit ambit claims and reduced risk of regulatory error;
- the availability and scope of merits review to ensure better quality decisions; and
- ensuring that any mandatory timeframes for regulatory processes will prejudice a robust and fair regulatory process.

Chapter 7

Investment

7.1 Main Points

Price are unable to efficiently direct investment in rail and road infrastructure:

- prices are not fully cost reflective;
- institutional arrangements for the ownership and management of roads, including the receipt of revenue and allocation of funding, do not signal or facilitate efficient investment; and
- the regulation of road and rail inhibits efficient outcomes.

The reform of road pricing will require reform of the current institutional arrangements for heavy vehicle charges and the provision of road infrastructure, including the objectives of road agencies, their governance structure and their funding arrangements. Railways have made the transition from non-commercial government agencies to public and private commercial organisations. This has also been the experience in other infrastructure industries in Australia. Clearly a more commercial governance structure for road agencies should be a cornerstone of future reform.

In the absence of efficient prices, it is critically important that investment decision reflect true economic costs. Funding decisions by government need to be underpinned by cost benefit analysis.

Auslink is yet to demonstrate its effectiveness in delivering efficient investment decisions, although work is underway to improve investment analysis.

Given existing investment processes and learning from the work undertaken in Europe, the following actions are required to improve investment outcomes:

- coordination and approval for land transport investment by all levels of government to ensure that investments are consistent with economic efficiency;
- a consistent project appraisal approach based on cost benefit analysis is adopted;
- transparent corridor assessments should support all funding decisions; and
- projects are funded on the basis of their net economic benefit.

This chapter is concerned with the investment framework used in road and rail and the implications this has for the efficient stock of land transport infrastructure. It identifies those factors that will impact on investment decisions that can be reformed. Other factors may not be capable of reform given current technologies which will necessitate some form of regulatory oversight of investment of road and rail infrastructure. The current investment appraisal for land transport at the national level and within Queensland is briefly described. There has been a considerable amount of policy development within the European Community on transport infrastructure investment. Information is presented on the European approach to inform a possible direction for future reform. This submission suggests a robust cost benefit framework needs to underpin investment analysis and selection if efficient investment outcomes are to be achieved.

7.2 Pricing and investment

Prices can signal the value to users of existing capacity when they are able to rise as the value of existing capacity rises as existing capacity becomes scarce the infrastructure provider is provided with a market signal for augmenting capacity.

Prices are potentially able to signal investment in rail infrastructure because capacity rights can be defined and enforced. Moreover, coordination problems across users are surmountable as there are relatively few users of rail compared to road so that the transactions costs do not preclude individual user contracts.

These conditions do not and are unlikely to apply to roads. An enforceable property right which clearly defines the consumption of capacity is difficult to define for a road network given the number and variety of user and the multiplicity of route selections that can be adopted.

Even though capacity property rights can be defined for rail this is not in itself a sufficient basis to allow market forces alone to determine investment decisions. This is particularly the case for investments in rail infrastructure which are substitutable for road investment because of the impact of externalities (especially road based externalities).

Accordingly progress needs to be made with current road pricing not only to reduce static inefficiency but also to limit dynamic efficiency losses induced by the impact of road pricing on rail investment. It is widely acknowledged that under-charging heavy vehicles has increased demand and investment in road infrastructure and conversely resulted in under-investment in rail infrastructure. The Prime Minister's Exports and Infrastructure Taskforce, in discussing the implications of an inadequate road pricing system concluded:[94]

> If progress is not made in addressing competitive neutrality problems between road and rail, the distortions to infrastructure investment will become ever more widespread, as pricing that is out of line with costs leads to capacity expansion that poorly reflects the underlying economics.

Box 9 provides an example of the impact that road investment can have on the competitiveness of rail.

[94] [John to provide full reference]

Box 9 Competition on the Townsville – Mt Isa Corridor

There are two competing infrastructure corridors for the transport of freight between Townsville and Mt Isa.:

- The Flinders Highway (Townsville to Cloncurry) and The Barkly Highway (Cloncurry to Mt Isa)
- Narrow gauge railway from Townsville to Mt Isa (which runs parallel to the Flinders Highway)

Along this corridor the freight task comprises:

- minerals;
- livestock;
- petroleum; and
- general freight.

QR and the Department of Main Roads compete for freight traffic along these corridors.

In the case of Main Roads the strategic objectives were defined as follows:

"Within competing priorities and financial means, Main Roads will seek to provide greater coverage of access for freight-efficient vehicles across the strategic road network. Greater access will often require upgrading of the strength and width of bridges and roads, adequate maintenance and upgrades of intersections to allow freight vehicles to turn safely".(Roads Connecting Queenslanders p 59)

The highway has been upgraded to accommodate triple road trains (that is, a prime mover and three trailers). Under current road pricing arrangements there was no increase in road prices to reflect the incremental costs of the higher quality road necessary for triple road trains. Under current charging arrangements this 30 percent increase in productivity for road operators would be the change in registration costs of $1670 per annum (based on 2005 costs) and additional fuel taxes related to the increase in fuel consumption.

QR has experienced a gradual but significant loss in market share as customers progressively shift more of their business to road operators. QR accepts that it is not the role of competition or economic policy to protect QR's market share or the market share of any other operator. However, QR believes that the distortions induced by road pricing arrangements is undermining the integrity of the competitive process in the relevant transport markets (especially in the transport of commodities such as copper cathode, fuel (predominantly non distillate products), bulk acid, general freight (including mining equipment eg. pipe)) and intermediate movements of freight between rural centres.

Rail freight rates (and in turn access charges and QR's incentives to invest in network upgrades) are set by road freight operators. QR believes that the infrastructure component is not cost reflective for road transport. QR is unable to sustain a commercial case for improvement, even though it is likely that rail is the least cost form of transport along this corridor. Moreover, the risk of stranding is enhanced for its existing investment.

With respect to investment there are several issues that need to be addressed before price signals can efficiently direct investment:

- pricing is not fully cost reflective;
- institutional arrangements for the ownership and management of roads, including the receipt of revenue and allocation of funding, do not signal or facilitate efficient investment; and
- regulation of road and rail that inhibits efficient outcomes.

7.2.1 Pricing

Prices for rail and road need to be fully cost reflective to users including:

- externalities;
- the full costs of providing infrastructure; and
- the scarcity value of capacity (or the long run marginal cost).

Pricing for both modes are not fully cost reflective. In the absence of efficient prices, it is critically important that investment decision reflect true economic costs – that is – that the relevant comparison be based on the respective marginal social costs and benefits of alternatives and that the decision rule involve the selection of the project delivering the greatest net social gain.

Even if prices were cost reflective there will exist significant coordination problems that may not be overcome through market process and a role for government may exist. This can be seen more clearly when we contrast road and rail expansion – in the case of road investment, quite apart from the complexities with defining property rights to capacity, there would be prohibitive transactions costs associated with a contracting solution with individual road users.

Critical to efficient infrastructure will be a transparent and robust investment process that ensures investment decisions correct for market failure and in so doing select projects that maximise net social gain.

7.2.2 Institutional arrangements

Institutional arrangements applying to road and rail are vastly different.[95] The management and delivery of road infrastructure is not premised on commercial objectives, in contrast to rail infrastructure. Road agencies operate as a department of state pursuing a mixture of social and economic objectives.

QR also is used by its owning government to serve social objectives. However, in QR's case social services are purchased by government on commercial terms through an explicit contractual framework. For most freight traffic, QR's prices and revenue are determined by market forces (or subject to regulatory control). Road infrastructure charges are administratively determined, albeit with the (broad) intention that heavy vehicle charges achieve cost recovery.

[95] Institutional arrangements are defined to include management, governance and objectives and source of revenue. Broadly speaking road authorities managed and funded as a government department rather than as a commercial entity.

In some transport infrastructure markets (airport landing slots) as demand increases and capacity is consumed prices rise to efficiently allocate capacity and to signal to an infrastructure provider that further investment is justified. This type of approach could conceivably also apply to rail slots (although there is insufficient depth to support the auctioning of slots).

However, as discussed above this is unlikely to ever be feasible for road infrastructure. When prices do not reflect scarcity values other mechanisms have to be used to allocate capacity, such as queuing. Under current arrangements increased congestion on roads increases political pressure to provide funding to meet an inefficient level of peak demand (in the sense that the level of peak demand is not itself constrained by pricing).

Funding arrangements also distort investment decisions. Under current funding arrangements around 70% of the revenue from heavy vehicle charges accrues to the Commonwealth Government, even though it owns no infrastructure. The Commonwealth Government allocates funds to road construction through intergovernmental grants with the amount of funding determined through its budget process. The funds available for investment are allocated through the Auslink process. Similarly State funding for roads is determined through a budget process. As a consequence heavy vehicle charges play a very limited role in providing an investment signal to road agencies. Funding arrangements arguably contribute to inefficient road investment and could be alleviated if user charges flowed to infrastructure owners.

The sustainability of funding roads through government budgets was questioned several years ago in The European Community.[96]

> The cost of building the remaining infrastructure in this network [trans-European Network], the map of which was decided by the European Parliament and the Council in 1996, is today estimated at €600 billion as a minimum, including €100 billion in the future Member States. No solution has been found so far to funding these needs, which are well beyond the range of Community and national budgets. Up to now, public budgets have assumed the main burden of transport infrastructure. This option is no longer conceivable and realistic given the required levels of investment in an enlarged Europe and the current budgetary constraint.

The same problem exists in Australia. For example, the Queensland Government has provided record levels of funding for roads in recent years however it is still not sufficient to meet the backlog of demand on those parts of its network funded by the Commonwealth.[97]

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96 Commission of the European Communities (2003), *Amending Directive 19999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure*, p 9.

97 Department of Main Roads (2005), *Roads Implementation Plan 2005-06 to 2009-10*, p 26.

> It has been acknowledged at the Commonwealth level that the standard of Queensland's former NHS is the worst in Australia; ie. Queensland has the greatest needs, both in terms of existing network deficiencies and the increasing traffic demands of rapid population growth and industry expansion… Despite this, the Australian Government is not providing sufficient funding to overcome either existing deficiencies or to meet emerging demands.

This in turn has a significant and unintended effect on rail investment. Because the commercial efficacy of rail investment is itself a function of the pricing and investment environment confronting road providers and users, rail infrastructure providers face a stranding risk associated with rail investment. Simply put, under the current institutional framework the value of rail infrastructure investments can be substantially and adversely affected by socially inefficient road investments. The risk of stranding therefore increases the efficient cost of providing rail infrastructure (and potentially vice versa).[98]

Currently user revenue accrues to rail infrastructure providers and QR believes that this principle ought to be applied to road infrastructure providers. Although not part of the Commission's terms of reference, it is clear that the current institutional arrangements for heavy vehicle charges are integral to the reform of road pricing, including the objectives of road agencies, their governance structure and their funding arrangements. QR notes that as a matter of history railways have made the transition from non-commercial government agencies to public and private commercial organisations. This has also been the experience in other infrastructure industries in Australia. Clearly a more commercial governance structure for road infrastructure should be a cornerstone of future reform. QR recognises that the adoption of a more commercial focus by road infrastructure providers may also have regulatory implications.

7.2.3 Regulation

A number of factors suggest that long term intervention in investment will be required to ensure efficient outcomes.

- as discussed in chapter 6, QR is concerned that current regulatory arrangements do not allow QR to recover its full cost of delivering infrastructure services. This will in the long run further perpetuate inefficient competition between road and rail;
- externalities are not internalised for road or rail and there is little prospect of such externalities being incorporated into prices sufficiently for consideration of

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[98] Partially in recognition of minimising stranding risk, electricity transmission investment needs to pass a regulatory test before it is allowed to be undertaken. The regulatory test process essentially subjects transmission investment proposals to a form of social cost benefit analysis. The fact that transmission investments need to satisfy such a test materially reduces the stranding risk for generators.

external impacts to be considered to be fully internalised for informing investment decisions;

- with respect to road, the current regulatory arrangements for setting heavy vehicle charges are also not independent of government (although the process for determining charges by the National Transport Commission is at arms length). While QR acknowledges that efficient prices might produce outcomes that are not consistent with equity objectives of Governments, the trade-off between equity and efficiency is not transparent in the current heavy vehicle pricing determination process. The current regulatory process can only recommend the achievement of equity objectives through the adjustment (or maintenance) of prices rather than through other policy instruments (which potentially achieve equity objectives at a lower resource cost). Independent economic regulation, as applies to rail infrastructure, will also be required for road; and
- the majority of annual road costs are attributed to light vehicles and these costs are funded through taxation revenue. In practice reform of the charging mechanisms across all road users is likely to be a longer term objective. The absence of direct pricing signals will mean that shadow prices will be required for investment analysis.

Given the reality that these issues are unlikely to be addressed in the medium term, QR recognises that regulatory and administrative arrangements for investment will be required to inform efficient decisions for both road and rail investment for the foreseeable future.

In addition, QR recognises that the regulatory environment that applies to the provision of rail infrastructure services involves the regulator specifying service quality standards to be met by QR. Other regulatory environments operating in Australia (whether in rail or other utility services) comprise some form of service quality standard setting (whether by the regulatory or as part of licensing requirements) and monitoring. It is likely that the evolution of regulatory arrangements in road provision will require similar arrangements being adopted over time for road providers.

QR submits that the transparency of service provision standards would be improved if such standards were articulated even under the current institutional arrangements. However, the pursuit of corporatisation or commercialisation reform is likely to heighten the need for the development of service quality standard setting and associated independent monitoring of performance.

The existing arrangements used to consider investment in land transport infrastructure, which are considered in the next section, are not currently serving this purpose.

7.3 Existing Investment Approaches

7.3.1 Auslink Model

The AusLink National Network and its connections to the broader transport network are the focus of the Australian Government's planning and funding responsibility. The network provides the passenger and freight backbone of Australia's national land transport system. It is clear from the Auslink documentation that the Commonwealth Government has in mind a funding framework that will assess rail and road options:[99]

> the National Network includes the important road and rail links on each national transport corridor. This will enable examination of alternative approaches to managing the future transport tasks on the corridor.

The Green Paper flagged the development of an investment appraisal methodology would be:[100]

> a critical issue that will affect how project proposals are valued and ranked, the Australian Transport Council has established an inter-governmental working group to progress an evaluation framework for AusLink and report on a preferred approach. The funding regime is intended to target projects of greatest national benefit and a cross-modal funding approach for all land transport proposals. Private, Local and State Governments can submit proposals for funding.

The National Guidelines for Appraisal of Transport Initiatives, which QR understands are still being developed, will need to accord with best practice in transport cost benefit analysis. In this regard the work undertaken by the European Union to harmonise transport and costing project assessment should provide a useful benchmark for the National Guidelines.[101]

QR supports the Australasian Railways Association view that the reality to date with the Auslink process has been that political decision on investment have been made under the Auslink banner but without reference to the Auslink methodology. A larger proportion of funds are allocated to road than rail and a corridor based investment of projects is yet to emerge through a transparent process.

7.3.2 QR investment appraisal

QR's has recently completed a review of its investment framework. QR's investment framework is now more closely linked to its business strategies.

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99 DOTARS (2005), *Auslink White Paper*, p ?.

100 DOTARS (2004), *Auslink: Green Paper*, p 4.

101 Details on the project are available from http://heatco.ier.uni-stuttgart.de

In summary, business case evaluations require the identification of stakeholders, business impacts and the demonstration of how quantifiable and non quantifiable benefits will meet QR and Line of Business objectives, which are set with regard to the Queensland Government rail network strategy.

The investment appraisal process now provides for a link between State government strategy and business case approval. The criteria for comparison are not prescriptive with guidelines prepared for analysis of strategic fit, financial analysis (NPV, impact on P&L, and balance sheet), risk or capability.

QR has recently undertaken a cost-benefit study of investment in the North-Coast Line (Brisbane to Cairns). This study sought to identify the economic benefits from investment in the North-Coast Line. A similar approach is also being carried to future investment in the Central-Queensland Coal Network.

Box 10 North Coast Line Study

This analysis includes an estimate of the future transport task (based on underlying market growth rate estimates) in the corridor and identification of the economic benefits for government and society associated with investment in rail.

This analysis also provides an indication of other considerations required in terms of the question of a viable and sustainable general freight rail network such as transport pricing and funding arrangements.

An investment of circa. $300 million in a number of “Below rail” projects on the NCL could result in:

- Extraction of just over 850,000 tonnes of general freight / containerised traffic from road to rail on NCL markets
- Road accident cost savings of Present Value (PV) $43 million over 20 years
- Environmental gains valued at PV $23 million over 20 years
- Road pavement / maintenance savings of PV $94 million over 20 years from reduced heavy truck movements
- Benefits associated with better transit times, improved service reliability and improved service availability valued at PV $127 million over 20 years
- Benefits to rail operators and customers valued at PV $143 million over 20 years
- Potential reductions in rail freight costs in the range of 2% to 6% across NCL markets if gains to “above rail” operators are passed on to the customers
- An increase in GTKs on the NCL associated with additional containerised traffic of 34% ‘over and above’ underlying growth.

7.3.3 Main Roads investment appraisal

The Queensland Government acknowledges that where public investment occurs in the land transport network it should be done on a cross-modal basis.[102]

> Government has long recognised the need for a co-ordinated, integrated approach to guide transport investment. Roads investment must be consistent with, and build on the state and local government investment in, public transport systems and rail for the movement of freight. There must also be a co-ordinated approach between

102 Department of Main Roads (2005), op cit, p 9.

> the investment that the Australian, state and local governments make in the road system. Australian government investment must also complement the investment of state and local governments.

Although a broad range of factors are considered for road investments it is not clear that issues affecting land transport efficiency are given priority.[103]

> Project priorities are assessed and ranked against required outcomes, including cost-benefit assessment, improved safety and environment, and transport access and efficiency. Priority is not determined through a black box exercise. It also requires judgment and recording of evidence of project justification, where alternative solutions are proposed.

Box 11 Department of Main Roads Project Evaluation

Program effectiveness (project selection)

Projects must be consistent with the Roads Connecting Queenslanders (RCQ) and National Highway System, State Strategic Road and State Regional Road Investment Strategies.

95% of the program of projects primarily must serve an efficient and effective transport objective. (Note that the exact quantum of this parameter may be reviewed in future, given the greater emphasis being placed on safety, operational and environmental issues.)

Project priorities are to be determined through a three-stage evaluation process - strategic fit, economic benefit and social benefit.

The program of projects must address:

- the use of the network by freight-efficient vehicles and allow for the;
  - progressive introduction of B-double routes on the state strategic network;
  - progressive extension of road train routes within the state;
- completion of missing links on priority routes overtaking lanes, where warranted; and
- road operations, traffic management and road safety initiatives which ensure effective and safe utilisation of the existing road system.

Projects should enhance broad local government and industry support for the program.

The selection, prioritisation and timing of projects must take account of government commitments (including election commitments) and other stakeholder views, and meet general community

Source: Department of Main Roads (2005), Roads Implementation Plan 2005-06 to 2009-10, Appendix 4.

7.4 European Experience

International consideration of the issues discussed in this chapter appears to largely centre on the European Community. The conclusion reached by the Commission of the European Communities in a White Paper on common use transport infrastructure was that:[104]

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103 Department of Main Roads (2005), op cit, p 20.

104 Commission for the European Communities (1998), *Fair Payment for Infrastructure Use*, p 25.

> To develop efficient levels of infrastructure investment, rigorous cost benefit analysis is required, that considers all costs, including capital costs, in making investment decisions. New infrastructure that is built should then be charged in accordance with the marginal cost charging principle, unless higher charges are needed to recoup capital costs for the building of the infrastructure to be possible. This provision should allow a greater degree of private financing of infrastructure or even public funding which is required to earn a return.

However, coordination problems exist because competition exists between modes and different governments and the private sector contribute to the development of transport networks.

> A lack of co-ordination in the assessment of prospective investments can lead to major distortions. For example, the non-inclusion of some benefits to non-national EU citizens may lead to the underestimation of total benefits of viable projects and to the under provision of TENs (trans-European Networks) transport infrastructure. This is one of the justifications for the TENs budget line and intervention at Community level. Conversely, when Member States do not include the costs of new infrastructure projects to other Member States an over provision of infrastructure is likely to occur. These costs can result from a substitution from existing facilities to the new project; a development which is especially likely to occur when prices in the new facility are low. This is particularly relevant to internationally competing transport terminals, notably ports and combined transport terminals.

It was also recognised that there was benefit in harmonising European transport project appraisal by supplying a unified framework. The research is due to be completed this year.[105] The project aims to develop project appraisal guidelines based on the criteria economic efficiency and transparency. The key conclusions are detailed in Appendix D.

The principle of marginal cost pricing for use and cost benefit analysis for investment is a feature of Swedish transport policy, although it is not rigidly applied. It also highlights that road and rail infrastructure investment are assessed and funded on the same basis.[106]

> The Swedish infrastructure charging practice during the last 10-15 years is largely based on fiscal considerations, which sometimes were supported by analyses of the marginal societal cost of certain types of transport. Such analyses could probably be viewed as a means to ensure, that charges are at least roughly in line with the price relevant societal cost of each type of transport operation, which for long has been a key principle of Swedish transport policy. Undoubtedly, such cost calculations have indeed played a role e.g. for the structure of taxes/charges for heavy goods vehicles

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105 http://heatco.ier.uni-stuttgart.de

106 Henrik Swahn (2002), *Marginal cost pricing in the maritime sector Cost calculation, acceptance and Swedish infrastructure charging practice*, p16.

in Sweden. The corollary of the transport policy principle of marginal cost based charges is that investment decisions are in principle based on Cost Benefit Analysis (CBA). However, the CBA framework is only occasionally, for major investments, applied to the maritime and air sectors. Road and rail infrastructure are financed over public budgets while maritime and air infrastructure provisions are financed by user charges.

7.5 The way forward

Future rail and road investment are unlikely to be efficiently determined with existing institutional and pricing arrangements. In the long run efficient pricing could substantially reduce the need for regulatory or administrative intervention by governments in the coordination of investment. However, extensive reform of the institutional arrangements for delivering and funding road infrastructure would be required. While QR believes these reforms should be pursued, particularly corporatisation of road agencies, they are unlikely to be practically achieved for several years. Therefore it is critically important that investment appraisal correct for the existing distortions, particularly where road and rail are substitutes.

QR submits that on the basis of existing practice and learning from the work undertaken in Europe, the following actions are required:

- coordination and approval for land transport investment relating to ensure that investments are consistent with economic efficiency;
- a consistent project appraisal approach using cost benefit analysis;
- transparent corridor assessments should support all funding decisions; and
- projects are funded on the basis of their net economic benefit.

Chapter 8

Assessing the Impacts of Reform

Demand for transport services, particular road transport, is forecast to outpace economic growth over the longer term (see Appendix A for details). Existing pricing arrangements for land transport are inefficient and Australia is likely to be forgoing considerable economic wealth from maintaining current pricing arrangements. In an environment of increasing demand the forgone economic wealth will increase.

The recent decision by the Australian Transport Council (ATC) not to increase road prices despite evidence of increased costs of heavy vehicles road use highlights a need for the Productivity Commission to estimate the economic cost of maintaining the current land transport pricing arrangements.

The purpose of this chapter is to provide the Commission with QR's views on what information will be necessary to support a policy decision with respect to infrastructure pricing reform.

8.1 How should the gains be measured

The impacts of road pricing and road-rail competitive neutrality invariably lead to a discussion of modal share and comparisons of the number of trucks replaced by a train. While this is a helpful image to explain consequences of reform to the general public – and one that QR has used itself – it can distract attention from more meaningful measures of economic impact.

From QR's perspective, a major flaw with the NTC's development of the Third Determination was that it appeared to pay undue attention to modal share as a key indicator of the outcome of reform. The conclusion of its paper, *Effect of Truck Charges on Rail*, that change to infrastructure pricing is unlikely to have significant impact on modal shares is problematic because even if it is correct (a fact which QR doubts) it masks the less visible resource allocation impacts of distorted prices. Similarly, road transport operators will argue that demand for road transport is relatively inelastic and increasing prices to cost reflective levels will result in a transfer from consumers to owners of road infrastructure, with little impact on road use or modal transfer. Of course this is a partial and static view which assumes there is no adjustment to relative price changes.

In fact, businesses and consumers make decisions everyday to adjust their economic decisions when faced with relative price changes. QR can see no reason why transport operators would be a special case. Moreover, a change in relative prices against truck operators can have positive consequences for the industry in that less efficient operators may exit the industry and capital choices in terms of size and mix of fleet and operating practices (suspension, maintenance, and operating practices) are improved.

It is too simplistic to judge the results of more efficient pricing on the basis of elasticity studies that relate to an earlier time period and "number of trains per week" or "trucks taken off the road".

These "do nothing" arguments fail to acknowledge the cost of the existing misallocation of resources from failing to price heavy vehicle road use correctly. In fact, "the do nothing" argument largely reflect equity rather than efficiency considerations. The issues in defining and measuring equity are discussed in the next section.

It is clear the correct approach to evaluating the benefits and costs of reform is to measure the efficiency gains from price reform. The Bureau of Transport and Economics (BTE) has previously commented that efficiency gains can accompany small changes in modal share.[107]

> While only small change in model share can be expected, long-run efficiency gains are anticipated from improved heavy vehicle road pricing and charging for externalities.

The welfare gain should be estimated with an appropriate model of the Australian economy. Given the importance of transport to the national economy, QR believes that a general equilibrium approach is appropriate.

Modelling of price reform would assist policy development if impacts were available for:

- national output;
- national welfare (probably measured by increased consumption);
- economic variables (employment, investment, prices etc); and
- industry effects (including impacts beyond the transport industry).

Modelling of regional impacts is also critical given the concerns of some members of the Australian Transport Council for the impact on regional and remote communities.

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[107] Bureau of Transport Economics (1999), *Competitive Neutrality between Road and Rail*, Working Paper 40, p26.

Although the Commission's terms of reference do not include consideration of public finance issues, as discussed in chapter 7, QR believes the modelling of reform will need to consider scenarios for the replacement of excise revenues with individual user charges and changes to intergovernmental financial arrangements that might occur if infrastructure owners collected all revenue from heavy vehicle users.

8.2 Evaluating Equity

A concern to be addressed by the Commission is the impact of higher freight prices. Low prices brought about by efficient competition are in the long term economic interests of consumers, but it is not clear to QR that current road freight prices fall into this category.

Decisions to hold current relative prices in place are trading efficiency gains for equity outcomes. As discussed above QR believes an integral step in the reform of road prices is to quantify the potential economic income and welfare gains from moving to efficient road pricing arrangements.

The assumptions that underpin equity assessments need to be detailed and transparent. Too often assessments are conducted at an emotive level, for example an outcome is said to be "unfair". For an informed policy debate the dimensions of how an outcome is "unfair" needs to be objectively scrutinised.

For example:

- Are equity assessments to include transport operators as well as final consumers?
- Are shifts in producer and consumer surplus to be equally weighted?
- Will equity principles have a geographic dimension, that is would impacts in rural communities be weighted more than in urban areas? If so, what is the definition of a rural community?
- Will horizontal or vertical equity principles be applied to all consumers?; and
- How will ability to pay be determined – by income or wealth?

QR notes that in the NTC's considerations it has sought information on whether road transport businesses would be able to absorb price increases. Of course, as discussed in chapter 4 current road charges are already impacting rail operators by reducing freight prices below efficient levels. This question seems to imply that future impacts might be considered more important than current impacts.

In summary, QR suggests the following principles should be considered in assessing equity and efficiency trade-offs:

- equity be assessed on the final economic incidence of the price change (not the initial impact);
- equity principles applied be transparent; and
- past benefits received by road transport operators (from under-recovery of costs) receive equal consideration to any impacts of increasing charges.

8.3 Transition

Most reform processes will result in winners and losers. QR believes that effective policy implementation requires information on the available gains and a clear picture of the winners and losers from reform.

QR believes a case for phasing reform exists where:

- the immediate application of reform can be shown to increase loses compared to a phased application;
- there are no more effective instruments for winners to compensate losers from reform.

With respect to the design of transitional arrangements QR believes the following principles should apply:

- the impact on existing suppliers/industries considers forecast market growth – often assessments of price changes on existing market size rather than future markets;
- reforms are applied where rail and road transport are substitutes – QR believes the AusLink National Network should initially define that portion of the national freight network;
- transition arrangements have a defined and preferably legislated timeframe; and
- industry compensation –to the extent appropriate – is performance based.

A Road and Rail Transport

Australia has a large land mass and a small and dispersed population compared with many other developed countries. This means that the provision of road and rail infrastructure involves relatively high costs, a fact that is exacerbated by the relatively low traffic densities on major freight corridors.

The road network comprises around 330,000 kilometres of sealed road and 480,000 kilometres of unsealed road.[108] The national annual spend on roads has increased significantly in recent years. For example, over the past decade, in Queensland funding has increased by $1.03 billion (Commonwealth-funded increase of $147 million; state-funded increase of $883 million).[109] Despite this increase in spending there are many road projects that are not funded despite increasing demand and congestion. For example, in Queensland the Department of Main Roads describes one of its major challenges as:[110]

> increased community demands and ageing infrastructure – creating pressures that cannot be met within likely available funding levels

The problems also exist for the Auslink Network, which is considered to be the freight backbone of the national land transport network. [111]

> The growing demands on the AusLink network in south-east Queensland alone require an investment of more than $6.2 billion over the next eight to ten years eg. Gateway Motorway, Ipswich Motorway, Brisbane Urban Corridor (Ipswich Motorway - Gateway Motorway), six-laning north to Caboolture, and Cooroy to Gympie upgrade.

The rail network is consists of 44,000 kilometres of narrow, standard and broad gauge track. Most of Australia's railways are centred on capital cities or ports, extending to rural areas and mining regions. The standard gauge network links all the mainland state capital cities. The quality of the national rail infrastructure has declined with competition from roads reducing returns and lack of investment.[112]

> The National Land Transport Plan, in conjunction with the Government's substantial contribution to the Australian Rail Track Corporation, will begin to address the historical deficiency in the quality of rail infrastructure. This cannot be

108 BTRE (2004), *Australian Transport Statistics*, pp 12 -14.

109 Department of Main Roads (2005), *Roads Implementation Plan 2005-06 to 2009-10*, p 23.

110 ibid, p.2.

111 ibid, p 27.

112 DOTARS (2005), *Auslink: White Paper*, p 21.

> fully overcome in the short-term. But over time the AusLink framework will progressively improve the capacity of rail operators to effectively compete on their merits for a greater share of the forecast growth in freight traffic.

QR's network is maintained as "fit for purpose" and maintained to ensure safe running along the network. The standard to the track is driven by demand characteristics (eg type of traffic, speed) and upgrades of the freight network are driven by commercial considerations.

A.1 Transport as a Production Input

The following analysis is based on Queensland data but QR believes that it is likely to be representative for Australia.

Table A.1 shows the percentage of intermediate input costs for each major sector in the Queensland Economy accounted for by transportation costs. The transport sector is divided into Road Transport, Rail and Pipe Transport and Other Transport[113].

The data in Table A.1 show the significant contribution made by transport costs within the total costs for intermediate (raw material) goods. In half of the sectors, transport costs from over 10 percent of total intermediate, and exceed 30 percent for several sectors. In most sectors, with the notable exception of Coal, Oil and Gas, road transport is the most significant form of transport used.

113 A combination of air, sea and unallocated transport.

Table A.1 The incidence of transport costs, as a percentage of total intermediate costs in total for the Queensland Economy

	Transport as % of Production costs			
Sector	**Road**	**Rail&pipe**	**Oth.Tr**	**Total**
Sheep	10.00	1	3	14.00
Grains	16	8	7	31.00
Beef cattle	8	0	2	10.00
Dairy cattle and pigs	9	1	1	11.00
Other agriculture	6	1	2	9.00
Sugar cane growing	8	1	2	11.00
Forestry and fishing	2	0	1	3.00
Coal, oil and gas	1	16	1	18.00
Non-ferrous metal ores	3	1	1	5.00
Other mining	15	1	2	18.00
Food manufacturing	14	2	3	19.00
Textiles, clothing and footwear	6	2	7	15.00
Wood and paper manufacturing	7	1	8	16.00
Chemicals, petroleum and coal products	4	3	6	13.00
Non-metallic mineral products	24	9	2	35.00
Metals, metal products	4	2	4	10.00
Machinery, appliances and equipment	2	1	2	5.00
Miscellaneous manufacturing	7	1	1	9.00
Electricity supply, gas and water	1	2	1	4.00
Residential building construction	4	0	0	4.00
Other construction	5	1	10	16.00
Trade	2	1	2	5.00
Accommodation, cafes and restaurants	26	0	3	29.00
Road transport	1	0	1	2.00
Rail and pipeline transport	4	1	25	30.00
Other transport	5	2	11	18.00
Communication services	1	1	5	7.00
Finance, property and business services	0	0	1	1.00
Ownership of dwellings	2	0	7	9.00
Government administration and defence	3	1	4	8.00
Education	3	1	3	7.00
Health and community services	4	0	2	6.00
Cultural and recreational services	3	0	3	6.00
Personal and other services	4	1	2	7.00

Source: Input-Output tables for Queensland, OESR 2004, compiled within IOW

A.2 Freight Task

According to the BTRE (2006) 2.4 billion tonnes of freight was transported in 2005, with road (69%) and rail (21%) accounting for most of the domestic freight task, measured in tonnes uplifted.[114] Total road freight tonnages are projected to grow faster for road (3%) than rail (2.4%) over the period 1999 to 2025, which will result in a small increase in the share of the transport task undertaken by road.

On a tonne kilometre basis, which takes account of the distance and mass, rail carries slightly more freight than road reflecting the longer hauls performed by rail compared to road.[115]

Rail is predominantly used to transport bulk commodities. Coal and coke and metallic minerals account for most of the tonnes transported. Road transport carries significant tonnages of bulk and non-bulk commodities with non-metallic minerals and manufactured products accounting for the most tonnes transported by road.

The allocation of tasks accords with the competitive characteristics of each mode, for example rail's competitive advantage over road increases the longer the haul and for bulk commodities. Road has an advantage on shorter hauls particular where a road transport is required to achieve final delivery. However, the allocation of tasks between modes is not simply the outcome of the technical characteristics of each mode. It is also heavily influenced by current pricing and investment arrangements for land transport.

Table A.2 shows a large proportion of the total freight movements relate to local freight movements (particularly where the task originates and ends in an urban area). Interregional freight is estimated by the BTRE to account for around 30% of total freight.[116] With respect to rail the localised nature (in the sense of transport within a statistical sub division), is most evident for metallic minerals. Non-metallic minerals are the most localised traffic for road.

114 BTRE (2006), *Demand Projections for Auslink Non-Urban Corridors: Methodology and Projections*, Working Paper 66, Table 2.12, p 30.

115 BTRE (2005), *Australian Transport Statistics*, p 6.

116 *ibid*, p 30. Interregional freight refers to freight movements where the origin and destination pairs are located in different regions in the BTRE's FreightSim model. FreightSim contains 132 regions – 123 Statistical Subdivisions, 8 capital city Statistical Divisions and one region comprising the rest of the world.

Table A.2 Road and rail freight task by commodity, Australia, 1999, million tonnes [a]

	Total		Interregional	
Commodity	**Rail**	**Road**	**Rail**	**Road**
Manufactured Products	13.4	209.7	12.9	49.5
Grains and Oilseeds	13.5	49.0	9.5	5.8
Sheep Live	0.0	2.5	0.0	1.0
Cattle Live	0.2	4.8	0.2	2.1
Meat	0.3	7.1	0.3	3.5
Agricultural Products	41.2	92.1	15.1	31.6
Coal and Coke	139.4	16.7	71.5	6.7
Metallic Minerals	190.0	14.1	13.8	3.4
Non-metallic minerals[b]	7.2	753.1	5.2	76.9
Oil and Petroleum Products	2.4	48.5	2.3	12.8
Gas	0.0	2.7	0.0	1.0
Steel and Metals	4.7	57.3	4.7	12.9
Fertilisers	1.0	9.3	1.0	2.4
Cement	2.6	7.8	2.6	3.5
Timber and Timber Products	2.1	40.5	2.0	15.6
Other Bulk	2.8	3.1	2.0	0.7
	420.8	1318.3	143.1	229.2

a BTRE published comparative commodity data for 1999 only.
b This category includes barite, diatomite, feldspar, graphite, gypsum, magnesite, mica phosphate rock, salt and silica.
Source: BTRE (2006), Demand Projections for Auslink Non-Urban Corridors: Methodology and Projections, Working Paper 66, Tables 2.13 and 2.14.

A.2.1 Growth Rates

Non-bulk road freight is expected to grow at 3.3 per cent per annum between 1999 and 2025 and in aggregate terms more than double over this time. Higher growth is projected to occur in inter-regional freight. Non-bulk freight on rail is projected to increase at less than half the rate of growth for road.

Table A.3 shows BTRE estimates of the expected growth rates in non-bulk freight on the Auslink National Network corridors. This shows rail achieving higher growth rates than road on longer hauls with the general trend for a further shift of non-bulk freight to road.

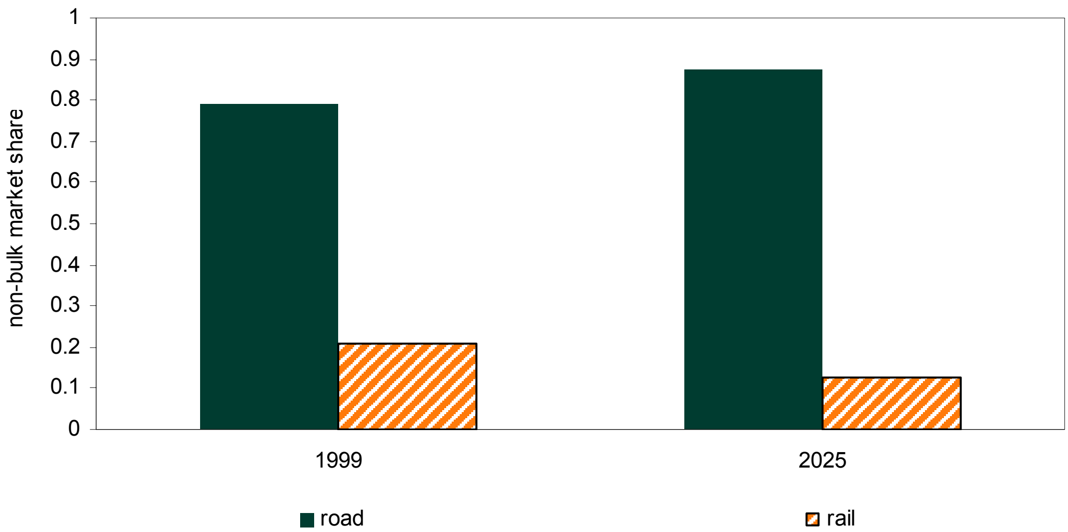
Table A.3 Rail and Road expected average annual growth rates, selected Auslink corridors, 1999 to 2025

Corridor	Rail	Road
Sydney - Melbourne	0.0	3.7
Sydney - Brisbane	0.5	4.1
Sydney - Adelaide	-0.1	3.3
Sydney - Perth	4.4	3.0
Sydney - Dubbo	-0.7	3.7
Melbourne - Adelaide	0.4	4.0
Melbourne - Brisbane	3.7	3.3
Melbourne - Perth	3.7	2.3
Melbourne - Mildura	2.6	8.0
Adelaide - Perth	3.0	1.6
Brisbane - Cairns	4.2	4.0
Townsville – Mt Isa	1.7	5.3
All Corridors	1.8	3.6

Source: BTRE (2006), Demand Projections for Auslink Non-Urban Corridors: Methodology and Projections, Working Paper 66, Table 2.16.

Figure A.1 shows the expected change in market share in non-bulk freight.

Figure A.1 Rail and road non-bulk market share, 1999 and 2025



Data source: BTRE (2006), *Demand Projections for Auslink Non-Urban Corridors: Methodology and Projections*, Working Paper 66.

According to the Business Council of Australia this will require an additional 900,000 truck trips between capital cities over the next 15 years.[117] Table A.4 shows the projected increase in average daily heavy vehicle traffic along key corridors to Brisbane from 1999-2025.

[117] Business Council of Australia (2005), *Infrastructure Action Plan for Future Prosperity*, p 12.

Table A.4 Change in average daily heavy vehicle movements along selected AusLink National Networks to Brisbane

Corridor	Increase in daily average number of heavy vehicles
Brisbane to Sydney (inland)	1946
Brisbane to Sydney (coastal)	2182
Brisbane to Melbourne	739
Brisbane to Cairns	994

Source: BTRE (2006), Deamdn Projections for Auslink Non-Urban Corridors, Table 3.2.

The increase in road transport in non-bulk freight is also reflected in the composition of the national truck fleet as shown in Table A.5. The fleet composition is changing to vehicles with higher load capacity.

Table A.5 Heavy Vehicle Fleet ('000), 1991 and 2003

Type	1991	2003
Rigid	266.7	244.4
Articulated	47.8	47.5
B-double [a]	0.5	7.3
Road Trains	2.8	4.2

a. A B-double carries twice the tonnage of a 6-axle articulated truck.

Source: BTRE (2003), *An Overview of the Australian Road Transport Industry*, p25.

A.3 Rail-Road Competition

Competition between road and rail is shaped by the responsiveness of transport customers to:[118]

- prices (freight rates); and
- service characteristics (such as punctuality, reliability, frequency, transit time and the capacity to carry specific commodities).

A report prepared for the NTC noted:[119]

- 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; 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.

Although these conclusions were based mainly on European and US studies they have some relevance to the Australian market.

[118] Productivity Commission (2000), *Progress in Rail Reform*, p 231.

[119] National Transport Commission (2005), *Effect of Truck Charges on Rail*, p 2.

The shift to road from rail over more than three decades has also been explained by increases in road productivity from advances in truck technology and investments in roads.[120]

Relative price shifts may be an important determinant in inter-modal shifts in transport.[121] A number of studies have considered these price relationships across different countries and by using different estimation techniques. A number of price sensitivities or elasticities have been estimated including:

- own-price elasticity - measure the impact on demand for a form of transport of a change in the sale price of that form of transport
- cross-price elasticity - measures the impact on the demand for one form of transport from a change in the price of another form of transport. Note the size of this estimate is a function of both relative price sensitivities and the feasibility of real substitution between the forms of transport
- coefficient of substitution - measures the technical feasibility of substitution one form of transport for another form
- cost elasticities - measures the sensitivity of providing one form of transport to changes in input costs

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120 Bureau OF Transport Economics (1999), *Competitive Neutrality between Road and Rail*, Working Paper 40.

121 BTE (1999), *Competitive Neutrality between Road and Rail.*

Table A.6 lists estimates from some of the major studies of transport elasticities. A number of common factors emerge from the estimates:

Table A.6 Empirical Studies of Own price, Cost, and Cross Price Elasticities

Study Details	Method	Rail (own price)	Road (own price)	Substitution and cost	Cross elasticity	
					Rail	Road
Oum (1989)-Canada	Translog; log-linear, Box Cox-Logit	- 1.517 to -0.598	-1.341 to -0.048		.498 to .059	.592-.403
Westbrook and Buckley (1990) USA	Translog, CESTL,BTL	-0.55 to -0.09	-.11 to -0.59	5.43- 2.44	0.04 to 0.32	0.09-0.45
Winston (1985) USA	Non-linear-			0.57 (rail)-0.895[cost]		
Oum et.al. (1990) Canada	Translog BTL-USA	-0.40 to -1.20	-.70 to -1.10	-	-	
NIEIR (1991) Australia	Time series		-0.19 to -0.55			-
BTCE (1991) Sydney-Melbourne			-0.70			
Eastern States-Perth			-3.17			
Bhat (1995) USA	ML and Heteroscdastic	-1.915	-0.68	0.345 to 0..524(road cost)		
BTCE (1995) Melbourne-Sydney	Translog		-0.7			
Hsing (1994)-USA	Heteroscedastic	-0.066 to -1.057*			0.479 to 0.814*	
Kells (1997)* Sydney-Melbourne	Econometric[122]	-2.6 to .-1.8				
Bah (2001)			-1.1 *			
Meyrick and Associates (2006) for Victoria Rail		-0.9 to -0.40				

ML = multinomial logit

BTL = Bremer Translog

Heteroscedastic-caters for Heteroscedastic relationships

* short-haul and long haul

- both rail and road transport services are normal goods in that they display consistently inverse relationships between their own price and the demand for their services;
- the results, generally indicate that demand for rail freight services is more own-price elastic than the demand for road services;

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122 Meyrick and Associates (2006), *Rail Freight Elasticities*.

- both services have high substitution and cost elasticities (although based on small number of observations).

A.4 Regulation

The regulatory framework that applies to an industry will have an impact on the way it operates and, ultimately, on its costs and competitiveness. This framework encompasses economic regulation, safety regulation (including occupational health and safety) and environmental regulation. There are significant differences in the regulatory frameworks applicable to road and rail infrastructure. This has implications for the cost structure and relative competitiveness of each transport mode.

The major forms of regulatory control applicable to QR in Queensland are summarised below.

A.4.1 Economic regulation

This is an important aspect of regulation which has a major impact on QR's business. QR is subject to a third party access regulatory regime in Queensland, which involves an external party (the Queensland Competition Authority) establishing the prices QR may charge for certain services and the terms and conditions on which they will be provided. While QR acknowledges that this may be justified on the basis of QR's position as a monopoly provider of below rail services in Queensland, this form of economic regulation is relatively invasive, with a significant impact on property rights.

QR's network was declared for third party access under the *Queensland Competition Authority (QCA) Act* in 1998. The effect of declaration for third party access is that:

- statutory duties arise for an access provider, including an obligation to negotiate with and provide information to access seekers, and prohibits the access provider from hindering or preventing access;
- an access seeker gains recourse to compulsory dispute resolution procedures;
- the owner of a declared facility may submit an access undertaking to the QCA for approval, if the owner considers it is appropriate to do so; and
- the QCA may request an undertaking be prepared by the owner if one has not been voluntarily submitted and the QCA considers it appropriate that an undertaking be in place. In certain circumstances, the QCA can draft and approve its own access undertaking.

QR currently has an access undertaking in place which establishes the negotiating framework applicable to access seekers gaining access to QR's network. QR submitted a draft access undertaking for the next regulatory period in April 2004, which is expected to be approved in the near future. QR's undertaking is extremely detailed with considerable regulatory compliance obligations. This complexity largely reflects competition concerns relating to QR's vertically integrated structure (see Box A.1)

Box A.1 Regulatory Compliance in QR's Access Undertaking

- Ring fencing/Management of Confidential Information – QR has an obligation, under the Access Undertaking (Part 3) to deal with confidential information belonging to third parties in a particular way. Network Access is audited by external consultants annually and is also subject to scrutiny by its own internal audit division.
- Linked to the concept of Ring fencing – QR is bound by obligations as set out in the Trade Practices Act 1974 not to discourage competition or hinder access to services.
- After the commencement of the 2005 Undertaking, QR will have additional obligations including:
  - a decision-making framework (3.4 UT), imposed by the QCA to ensure that decisions made by identifiable roles in QR be made accountable for decisions that affect access or ability to negotiate;
  - complaint handling (3.5.1) obligations – QR is bound to notify the QCA where third parties make complaints about our access process;
  - additional audit requirements (3.5.2) (as well as the existing audit requirements in 9.4) where the QCA has a reasonable belief that it is warranted;
  - Capacity Allocation (Queuing) Framework (Part 4) – this sets out the means by which mutually exclusive applications for capacity are allocated to third parties;
- Reporting (Part 9) – QR is obliged to report to the public and the QCA on its performance in Quarterly and Annual Reports, and it is also required to produce Annual Financial Reports, Maintenance Cost Reports and a Regulatory Asset Base Report.
- A new position of Compliance Officer (9.4) will now report to the CEO on material breaches of the Undertaking and proposed remedial action, and will also take all steps necessary to ensure QR meets its obligations as set out in the Undertaking.
- Rollingstock Registration (Part 7)
- Noise, environmental and safety obligations under a variety of legislative requirements (more specific detail can be provided upon request).

A.4.2 Safety regulation

This section outlines the safety regulation framework applicable to QR in Queensland and QR's corporate policy for compliance with this framework. In addition to its obligations in Queensland, QR has extended its operations into other states. Accordingly, QR must also comply with any state-specific rail safety regulation in these other jurisdictions. The summary below addresses the Queensland rail safety regulatory framework.

Regulatory framework

The rail safety regulatory framework encompasses accreditation of railway managers and operators, the regulation of the transport of dangerous goods by rail and the safety of employees through applicable workplace health and safety legislation. Rail safety policy is set within the framework of the following:[123]

- The *Transport Infrastructure Act 1994* – provides the statutory requirements for rail safety accreditation within Queensland;
- The *InterGovernmental Agreement on Rail Safety 1996* – establishes the framework fro the development of a consistent approach to the regulation of rail safety within Australia;
- Australian Standard *AS4292 Railway Safety Management* – provides a resource for the development of a Safety Management System within Australia;
- The *Rail Network Strategy (2001 – 2011)* – an overarching state-wide network strategy for rail that details the Government's responsibilities for the State's rail network; and
- The *QR Directions Queensland Transport Strategic Plan 2000 – 2004* – identifies overarching responsibility of the Queensland Transport department for system stewardship.

Rail safety in Queensland is regulated by Queensland Transport, which has a policy objective of providing a safe railway network within Queensland and ensuring safety performance is not compromised.[124] These objectives are to be achieved through a regulatory framework which encompasses:

- the regulation of railways through the application of a system that accredits railways as operating a best practice and appropriate Safety Management, for which they are responsible and accountable;
- the establishment and monitoring of accident/incident reporting to ensure appropriate investigations are conducted;
- implementation of appropriate safety controls in response to accidents/incidents;
- the monitoring of safety trends; and
- the conduct of safety compliance audits.

Rail safety accreditation is based on meeting the requirements of the *Rail Safety Management Within Queensland Manual*, which utilised the Australian Standard *AS 4292 Railway Safety Management*.

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123 Rail Safety Management Within Queensland Manual, February 2001, p. 1.

124 Ibid.

There are also a number of national developments with respect to rail safety regulation. The NTC has developed, and the Australian Transport Commission (ATC) has approved, a national standard for health assessment of rail safety workers. This is a new system for monitoring the health of rail safety workers which will enable the consistent application of health standards across the Australian rail industry.

The Rail Safety Regulator's Panel (RSRP, consisting of representatives from rail regulation agencies) has also developed a National Rail Safety Accreditation Package (NAP) designed to deliver a nationally consistent approach to rail safety accreditation. Australian Transport Ministers have endorsed the NAP and its implementation throughout Australia. The RSRP has also developed a National Rail Safety Accreditation Guideline and National Rail Safety Accident/Incident Reporting Requirements.

QR's compliance with safety regulation

QR's approach to its rail safety obligations is outlined in the *QR Strategic Safety Plan 2005/2010*. This plan covers six key safety areas:[125]

Employee safety – this complements QR's occupational health and safety strategies, with strategies in place for each business group;

Operational safety – this relates to the safety of rail operations on the network and is the area of safety that largely distinguishes rail from other industries;

Passenger safety – QR performance in this area remains strong, with no passenger fatalities due to QR train operations in the past 11 years. Strategies include public awareness campaigns;

Public safety – this is an area which presents the highest potential loss of life on QR's network. Public education is a key objective of QR's strategy in this area;

Security and emergency management – security relates to the prevention of deliberate, intended or illegal actions that threaten QR's workers and assets and users of QR's system. Emergency management is the process that enables QR to plan for, respond to and recover from emergency, disaster and crisis situations;

Safety systems – QR's safety systems and culture provide a platform for performance improvement sin terms of employee, operational, passenger and public safety. As QR's participation in the national rail market has grown, these systems have had to deal effectively with different operating and regulatory environments in different jurisdictions.

[125] QR Connects, 2004/2005 Annual Report, p. 36-41

A summary of QR's overall safety performance, covering employee safety, operations, passenger safety and public safety, is documented quarterly in the *Corporate Safety Report*.

A.4.3 Environmental regulation

In Queensland, QR is subject to a range of legislation aimed at environmental protection, including the:

Environment Protection Act 1994

Environmental Protection and Biodiversity Conservation Act 1999

Integrated Planning Act 1997

State Development and Public Works Organisational Act 1971

Water Act 2000

Wet Tropics World Heritage Protection and Management Act 1993

State Development and Public Works Organisational Act 1971

Fisheries Act 1994

Plant Protection Act 1989

QR aims to protect the environment by meeting its regulatory compliance requirements and adopting an innovative approach to managing strategic environmental issues. Reflecting the scope of QR's operations, it is involved, directly and otherwise, in a range of varied environmental issues. QR's environmental activities encompass:

- flora and fauna (biodiversity) protection;
- air quality;
- water quality;
- noise and vibration management;
- resource conservation and waste management;
- land preservation;
- management systems, based on ISO 14001, to minimise the environmental risks associated with QR's business through conducting risk assessments and developing controls to minimise risks; and
- sustainable development.

A.5 Governance arrangements for rail

A key area of difference between road and rail infrastructure is in the governance of these assets. Governance arrangements relate to ownership, organisational structure and objectives. Reflecting these different governance arrangements, a critical difference between road and rail is the relative importance of commercial considerations in operational and investment decisions.

QR is wholly owned by the Queensland Government. In July 1995, QR was corporatised under the *Government Owned Corporations (GOC) Act 1993* (the GOC Act) as a statutory GOC. Corporatisation placed QR's operations on a commercial footing, with statutory obligations on QR to act in a commercial manner and to pay dividends to its shareholders. QR's shareholders are the Minister for Finance and the Minister for Transport and Main Roads.

QR has a commercial board appointed under the GOC Act. The role of the Board is to include:

- responsibility for QR's commercial policy and management;
- ensuring that, as far as possible, QR achieves, and acts in accordance with, its Statement of Corporate Intent and carries out its objectives outlined in the Statement;
- accounting to QR's shareholders for QR's performance as required by the GOC Act and other laws applying to the GOC; and
- ensuring that QR otherwise performs its functions in a proper, effective and efficient way.

The shareholder relationship is managed by the Office of Government Owned Corporations (OGOC). OGOC was established for the purpose of supporting and advising shareholding Ministers in administering the Government's ownership of Government-owned corporations (GOCs) to maximise competitiveness and shareholder returns in the context of ownership expectations. These arrangements are designed to mirror, to the extent possible, the disciplines of a competitive market.

Corporatisation has meant that:

- outcomes of the annual performance contract or Statement of Corporate Intent (SCI) as well as the five-yearly Corporate Plan are negotiated between QR and OGOC;
- QR's performance is monitored by OGOC; and
- OGOC, in representing the shareholder's interests, has a role in assessing major investment proposals.

QR also has certain community service obligations (CSOs), required by the Queensland Government, which it must meet. Consistent with the corporatised governance framework, these are delivered within a 'purchaser-provider' framework, in which the Government purchases certain services from QR on a commercial basis.

Within Queensland, QR provides both below and above rail services. QR is a monopoly provider of below rail services in Queensland and, hence, access to QR's below rail network is subject to a third party access regulatory regime. Reflecting this, QR is internally structured so as to separate the regulated below rail assets (within Network Access) from the contestable above rail operations (QR National). QR also has groups which provide services internally to other QR groups (Infrastructure Services Group, Rollingstock and Component Services and Shared Services).

A.5.1 Implications of governance arrangements

As a corporatised government owned business, QR is accountable for its commercial performance. This accountability is affected through ongoing performance monitoring and the requirement to pay dividends annually to its shareholders. These commercial arrangements place a discipline on QR in terms of it operations, in particular, with regard to its costs. In addition, QR is accountable for ensuring that any investments it undertakes are commercially justifiable. These governance arrangements serve to provide QR with incentives to operate commercially. Specifically, they provide a direct link between QR's costs and the revenues it earns from its network.

This is fundamentally different to the governance arrangements for road infrastructure. In Queensland, road infrastructure is funded directly through the budget, with no comparable discipline to that faced by QR in terms of the costs of road provision and the productivity of the road network. In effect, there is a disconnect in road infrastructure provision between the costs of provision and revenue from road use.

B Rail Costs

B.1 Introduction

This chapter is concerned with 'below rail' costs, which are incurred by QR in its role as the owner/manager of a geographically widespread narrow gauge rail network. In this regard, below rail cost characteristics are identified, including usage-related capital and maintenance costs caused by the wheel on rail interface.

B.2 Distinction between above and below rail services and costs

In simple terms, rail services and their associated costs can be categorised as either 'below rail' or 'above rail'.

Below rail service costs are those associated with the construction, maintenance and renewal of the rail infrastructure (including the track and signals, overhead electricity system - where relevant, stations and platforms and the costs associated with co-ordinating traffic using the rail infrastructure (including train control and safe working procedural costs).

Above rail service costs are those associated with the provision of train services including rolling stock provision and maintenance, non-train control related communications, train crewing, terminal provision and services, and freight handling.

This attachment is focussed on below rail costs in accordance with the Productivity Commission's terms of reference for this review, which include estimating the full financial costs of providing and maintaining freight transport infrastructure on major road and rail networks.

B.3 Description of costs

The operational characteristics of the provision of below rail services are an important determinant of the cost structure of a below rail service provider. Economies of scale, density and scope are relevant with respect to the provision of below rail services and are briefly discussed in Box B 1.

Box B1 – Operational characteristics of below rail services

Economies of scale

Economies of scale exist in the provision of a given collection of below rail services where demand can be supplied by a single track manager at a lower cost than by any combination of two or more managers. As a result, long run average costs decline as output of the services increases and, for each additional unit of output provided, the marginal cost of provision is less than the average cost of provision. The source of the economies of scale are the fixed capital costs associated with the return on and of capital invested in the below rail infrastructure.

Economies of density

In contrast to scale economies, which relate to traffic volumes in respect of a given collection of services, economies of density relate to traffic volume on a particular route/line, which is more important in terms of understanding below rail cost drivers.

Below rail services are characterised by strong economies of density, such that holding route kilometres constant, the unit costs of rail services declines as their number increases. The source of economies of density are declining average capital costs per unit of service and a fall in unit operating & maintenance costs per route kilometre, reflecting the fact that capital units can only be expanded in discrete, indivisible increments whereas demand can vary in much smaller increments.

Economies of scope

Economies of scope occur where the costs of one track manager producing two below rail services (for example, for passenger and freight traffics) are lower than if two track managers produce one service each. Hence, economies of scope occur where it is cheaper to construct a line/network capable of delivering both freight and passenger services rather than construct and operate dedicated freight and dedicated passenger networks. To the extent that economies of scope exist, it is due to the indivisible characteristics of the track and associated infrastructure, such that once one service has been delivered, it can be used to deliver another service at proportionally lower additional cost.

In simple terms, there are below rail costs which do not vary with the amount of a particular below rail service that is provided (fixed and common costs) and costs that do vary in this regard (marginal and incremental costs).

B.3.1 Variable and Marginal Costs

Variable costs vary with the quantity and type of output/service provided.

In the short run, labour-related costs are generally the most significant variable cost. The capital intensive nature of QR's below rail business means that short run variable costs are relatively small relative to total costs.

In the long run, all inputs and associated costs are potentially variable because virtually all assets must be renewed or replaced. It is at the point when the below rail service provider must make a decision to replace part of, or expand, its network, that the long run variable costs of the below rail services will include all the fixed costs which will become irreversible once they are incurred.

However, there are important usage-related costs incurred by QR's below rail business as a result of the particular characteristics of the train services utilising the rail infrastructure, such as axle load and speed.

Such variable operating costs form part of the marginal or incremental cost of the production of an additional unit of the output/service of the below rail infrastructure. However, the marginal/incremental costs should also include any external costs, such as capacity constraints or congestion, as well as the direct costs.

B.3.2 Marginal costs

The marginal cost of a below rail output/service is the additional cost that would be incurred if an additional unit of the output/service were to be provided, or alternatively, the saving in total costs that would be possible by supplying one less unit of the output/service. Marginal costs include both capital and operating costs attributable to the service and in so doing provide an indication of the opportunity cost, or value in the best alternative use, of the resources tied up in providing the particular below rail output/service.

Marginal costs can be estimated in both the short and long run. Regardless, based on US evidence of substantial economies of scale and density in the freight operations of railroads, which is in accordance with QR's own experience, pricing at short run or long run marginal costs would fail to recover the majority of efficiently incurred total long run costs.[126]

B.3.3 Incremental costs

The incremental cost of a particular below rail output/service is the additional cost incurred as a result of the provision of an additional unit of the output/service, including both operating and capital costs. Incremental costs are closely associated with the concept of avoidable costs, which are those costs which would not be incurred if the train service did not operate.

Incremental costs are a well-understood concept in the Australian railway sector and have been regularly used as part of regulatory arrangements to establish access price floors. The reason for this is the commonly applied underlying regulatory principle that each traffic type should pay an access price which meets at least the incremental cost of its usage of the network. In this way, rail operators receive a price signal about the costs incurred by the below rail service provider due to their particular train service's characteristics, while the service provider receives at least the direct costs incurred in supplying the below rail service. However, incremental cost pricing does not address the issue of the below rail service provider recovering all fixed and common costs.

[126] Kessides and Willig, Restructuring Regulation of the Rail Industry for the Public Interest, World Bank, September 1995, p40.

The two most significant incremental below rail costs arise in respect of operating/maintenance activities and the cost of providing below rail capacity. These costs are discussed in detail in a later section of this attachment.

B.3.4 Fixed costs

Fixed costs do not vary with the quantity and type of output/services provided.

The existence of economies of density and scale results in high fixed costs relative to total costs. As traffic on a line/system increases, very few, if any, additional fixed costs are incurred. However, the existing costs can be spread over more traffic which facilitates cost recovery.

The high fixed costs predominantly relate to capital costs, specifically the rate of return on capital and return of capital (depreciation) with respect to the below rail asset base. A rough estimate of fixed costs can be estimated by calculating the capital charge on QR's non-current asset base, including adding depreciation and amortisation charges. Assuming a 9.0% WACC, the annual capital charge for QR's below rail services in 2004-05 was $521.1 million (a $361.4 m return on capital and $159.7m of depreciation) .

The fixed costs may also be sunk costs in that the infrastructure assets have little or no resale value or value in an alternative use. Sunk costs are discussed further in section B.3.6 below.

With the exception of below rail services provided in markets with little or no inter-modal competition, such as for coal, the rail sector in Australia has generally had difficulty recovering the fixed costs of the provision of below rail services. In practice, fixed costs have been used by regulators to establish price ceilings that have not been achievable in the market.

B.3.5 Common costs

Common costs are those costs incurred in providing an infrastructure service which cannot be attributed to any particular service at a particular point in time. The provision of below rail services is strongly characterised by the high incidence of common costs.

A large element of the fixed capital costs is usually common, along with administrative and overhead costs.

A methodology to allocate the common costs across users is therefore necessary that will not distort the various consumption patterns of users of the infrastructure services. However, it is not possible to allocate a share of fixed and common costs to the various traffics using the below rail infrastructure in a way that has a sound foundation in economics.[127] This has important implications for price setting.

[127] I. Kessides and R. Willig, ibid, p3.

B.3.6 Sunk costs

In contrast to fixed costs, sunk costs cannot be eliminated even by total cessation of service delivery. Once a cost is sunk, it is no longer a portion of the opportunity cost of production in that the associated inputs have limited or no value in an alternative use.

It is likely that a reasonably large proportion of below rail fixed costs are sunk. For example, the cost of earthworks and track sub-grade/formation are undoubtedly sunk. In contrast, rails, sleepers, ballast could potentially be moved from one rail corridor to another at considerable expense, but are unlikely to have much, if any value in non-rail uses.

For existing below rail infrastructure, it could be argued that in establishing efficient prices, sunk costs should be ignored because they have zero or very low opportunity cost. However, ignoring sunk costs in pricing could have adverse implications for investment incentives because the below rail service provider will not be able to fully recover its capital costs. In this regard, recovery of sunk costs raises similar issues as recovery of fixed/common costs.

The regulatory treatment of capital is discussed in more detail in a later section of this attachment.

B.4 Rail track design and construction

The below rail infrastructure is capable of delivering a heterogeneous range of output/services, including different output/services for different traffics, between different origins and destinations, at different times and at different service quality levels (eg. maximum permissible speed, existence of speed and load restrictions, order of priority of freight and passenger services). The heterogeneous nature of output/service provision has a major impact on the cost structure of a below rail service provider.

The nature and cost of the construction, maintenance and renewal tasks performed by the below rail service provider in respect of the track and associated infrastructure are critically dependent on:

- the geographic/climatic conditions where the track is constructed; and
- the number and operational characteristics of traffic types using the below rail infrastructure.

B.4.1 Geographic/climatic conditions

Other things being equal, harsher terrain and climatic conditions, such as on the central and northern parts of QR's network, will result in higher per unit track construction and/or ongoing maintenance costs to provide a given standard of track.

Box B 2 illustrates this point in respect of QR's North West Corridor.

Box B 2: QR's North West Corridor track

The North-West Corridor extends a distance of 979 kilometres from Stuart to Mount Isa and 68 kilometres from Flynn to Phosphate Hill.

The track is concrete sleepered from Stuart to Hughenden and steel sleepered from Hughenden to Mount Isa, with the exception of about 34 kilometres of concrete sleepers in short sections. The Flynn-Phosphate Hill branch is also concrete sleepered. Rail size varies between 41, 47 and 50 kilogram per metre.

Current traffic task requires a track standard suitable for 20 tonne axle load operations.

QR's biggest challenge lies in the track formation on the unstable black soil flood plains between Hughenden and Cloncurry. The climatic conditions here are also extreme, with a large variation between maximum and minimum temperatures. In fact, this track experiences the largest variation in rail temperatures over the entire QR network - from as low as minus two degrees to as high as 46 degrees, with rail temperatures reaching 70 degrees.

In addition, with short but severe wet seasons, often associated with heavy flooding, the end result is unstable track conditions. There have also been speed reductions in place in some sections.

Given the wide geographic spread of QR's rail network, track construction costs and maintenance program costs vary quite markedly across the network.

B.4.2 Traffic types

Different types of trains have different requirements in terms of track standard as a result of their different operating characteristics including different rolling stock. These different operating characteristics also result in each traffic type having a different impact on the wear and tear of the track. As a result, the design, construction and maintenance of the track and the associated costs are fundamentally affected by the different traffic types using the track.

The track standard is likely to vary across a network depending on the traffic mix on each rail corridor. Most importantly, track standard determines the maximum permissible and average speeds at which a locomotive and its wagons/carriages can operate (loaded and unloaded) safely on the tracks. Other things being equal, a higher quality track should be able to deliver a more reliable below rail service, measured in terms of on-time running for timetabled (passenger and intermodal freight) traffics and shorter cycle times for cyclic (heavy haul) traffics. This higher reliability could also increase the capacity of the track through potentially allowing more train services to operate in a given period.

In general, passenger trains require a higher track standard than freight trains, reflected in good track alignment, minimal curvature and sophisticated signalling/safe working systems, because of their generally faster speeds and passenger expectations about safety and comfort.

Different traffic types also have markedly different impacts in terms of wear and tear on the track. For example, heavy haul trains, like coal, have a significantly greater wear and tear impact on the track than passenger trains, resulting in significantly higher ongoing maintenance costs per kilometre.

Reflecting the different requirements of freight and passenger trains, a dedicated freight network could potentially be built and maintained to a lower track standard, and at an associated lower cost, than a dedicated passenger or dual service (passenger and freight) network. QR's network is characterised by dual service corridors.

Finally, the heterogeneity of below rail services means that traffic types using the rail infrastructure must be identified in terms of entry, passage through and exit from the network and co-ordinated with other traffics using the network. In contrast, networks delivering homogenous products where each unit is a perfect substitute for another unit, such as electricity, do not require this co-ordination. The co-ordination task necessary on rail networks creates additional operational costs through activities such as train control and scheduling, and potentially additional capital costs incurred through the on-track interaction and nature of consumption of capacity by the different traffics using the infrastructure.

The major capital and operating/maintenance costs associated with the provision of below rail services are discussed in sections B.4.3 and B.4.4 of this attachment.

B.4.3 Capital Costs

Capital costs typically account for around 55% of total below rail costs.

Land

The cost of land and easements (or right of way) associated with rail corridors can reflect a range of factors, both historical and current. Land may be leased from government, possibly for a nominal rental, or owned by a below rail service provider. For existing rail corridors, the cost of the land is the opportunity cost reflecting the next best alternative use of the land. For proposed new rail corridors, costs associated with land acquisition are likely to include compensation for land resumption and legal fees.

Earthworks

A below rail service provider must undertake earthworks throughout its corridors to prepare the terrain for the construction of the track and associated infrastructure.

Railway construction is similar to road construction in that cuttings and embankments must be created, and a finished construction surface prepared in readiness to receive the ballast, sleepers and tracks.

The cost of earthworks is determined by the amount of cut and fill necessary for the desired horizontal and vertical track alignment and gradient. The greatest constraint on railway design is the need to strictly control gradient, which affects the steepest slope over which a fully loaded train can be hauled. Track alignment and curvature also critically affects maximum permissible train speeds, as well as the level of wear on rail and rolling stock. Greater limitations on grades and curvatures exist for rail than on roads.

Track

The main components of a typical rail track structure are:

- rail;
- sleepers;
- tie-plates and cushioning pads;
- track spikes (for wooden sleepers) and elastic spring-clip fastening systems (for concrete sleepers);
- tail anchors (for timber sleepers);
- ballast (including tamping);
- sub-grade; and
- capping layer.

Box B 3 provides a brief explanation of each of these cost elements.

Box B 3: Track components

Rail

A steel wheel guide with a head, stem and base. Rails for branch lines may be as light as 21 kg/m, but the typical rail section is 41 to 47 kg/m for urban rail and 53 to 60 kg/m for heavy haul railways A larger rail size allows higher axle loads and/or faster train speeds.

The distance between the inner faces of the rail heads of the rail track is the track gauge, which can be narrow, standard or broad.

Sleeper

Anchors the rail at the correct gauge, made of wood, concrete or steel. The choice of sleeper type affects the maximum axle load of wagons, tonnage and train speed.

Tie-plates and cushioning pads

Where wooden sleepers are in use on heavy traffic lines, tie-plates are used to extend the life of the sleepers by spreading the load of the rail. For concrete sleepers, cushioning pads are used between rail and sleeper to minimise wear and tear.

Track spikes and spring clips

Track spikes (for wooden sleepers) and spring clips (for concrete sleepers) are used to fasten the rail in place.

Tail anchors

All heavy duty track is equipped with rail anchors to prevent sleepers moving out of line and developing stresses that make the track buckle.

Ballast

The coarse rocky material upon which the sleepers sit. An important requirement of ballast is its ability to pack to provide a stable track foundation. Ballast must also be free draining.

Sub-grade

The prepared earth upon which the track work is built. Also known as the track formation.

Capping

Capping is a layer of fine material that covers the sub-grade preventing the deterioration of the sub-grade by the coarse ballast.

Tamping

The process by which ballast is packed around the sleepers of a track to ensure the track is in the correct position for the location, speed and curvature.

Decisions made with respect to earthworks and track components determine the standard of the track and the forces imparted by rolling stock that the track can safely absorb. For example, the choice of sleeper type, depth of ballast and the size of the rail. Earthworks and track infrastructure are the most significant below rail cost components.

Other significant below rail cost components are:

- Civil structures
  - including rail bridges, footbridges, culverts, fencing, retaining walls and drainage.

- Signalling and communications;
  - increasingly sophisticated electronic communications or, if a comprehensive signalling system is not installed, axle-counters; and
  - radio communications to supplement the signalling system.
- Overhead electricity infrastructure (where relevant);
  - overhead contact wire;
  - catenary;
  - substations;
  - feeder cables; and
  - supporting structures.

B.4.4 Operating and Maintenance Costs

Maintenance costs

In the context of QR's network, track maintenance and renewals expenditure are the two most important components of operational expenses.[128] Civil structures, signalling maintenance, train control and signalling operations, and electrification are the other major maintenance components. Maintenance typically accounts for around 25% of total below rail costs.

Maintenance describes a wide variety of activities carried out to ensure that the below rail assets continue safely in service with the required functionality and performance. Renewals also perform this role, but they usually comprise either the replacement of the whole asset or at least of component parts of the asset. Renewals are carried out when continuing maintenance ceases to be an economic option and therefore generally differ from maintenance work in terms of scale and frequency.

In simple terms, maintenance can be broadly categorised as either routine or major.

Routine maintenance activities consist of the following:

- inspections, including regular visual inspections by section car and the measurement of track geometry and rail flaw detection by special vehicles;
- resurfacing (tamping) to restore the elasticity of the track structure and the relative position of the track;
- bridge maintenance, particularly for timber bridges, which requires the replacement of cracked or decayed sections and periodic tightening of

[128] Renewals expenditure may be charged to the capital account rather than be expensed. For example, the complete relaying of track and major sleeper renewal could be expected to be treated as capital expenditure.

components. Steel and concrete bridges require relatively minor ongoing maintenance.

- miscellaneous routine track maintenance, including track geometry corrections, fencing repairs and turnout maintenance.

One of the key characteristics of track and associated below rail infrastructure is that all of its components – except for the sub-grade – wear out and can be replaced on an individual basis. Previously undertaken mainly by manual labour, technological improvements have led to greater use of mechanical track renewal processes.

Renewals and major maintenance activities consist of the following:

- track relaying, involving the complete replacement of the track structure;
- re-railing, where worn rail is taken up and replaced but the sleepers still have reasonable life;
- re-sleepering, where bad or life-expired sleepers are singled out, removed and new ones slid into place;
- ballast replacement to remove accumulated dirt and replace broken ballast;
- resurfacing to keep track geometrically aligned[129];
- rail grinding to remove corrugations and metal flow from the rail head, as well as maintain the profile of the rail head;
- formation maintenance, including vegetation control and drainage and ancillary facilities' maintenance; and
- miscellaneous maintenance, including culvert repair and extensions and firebreak construction.

Maintenance activity over the life of a railway track has three distinct phases.[130]

The first phase commences immediately after construction when all rail components are new. Tasks include inspections and routine maintenance.

In the second phase, commencing after around 5 years, more significant regular activities such as rail grinding and resurfacing are undertaken, while inspections and routine maintenance continue.

In the third phase, after around 10 years, as track components start to wear out and ballast becomes contaminated, on-going maintenance tasks are supplemented by major maintenance or renewal tasks such as re-railing, re-sleepering (particularly if the track has timber sleepers) and ballast replacement.

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[129] Resurfacing can be of a routine or major nature.

[130] QCA, Draft Decision on QR's Draft Undertaking, Volume 3 - Reference Tariffs, December 2000, p159.

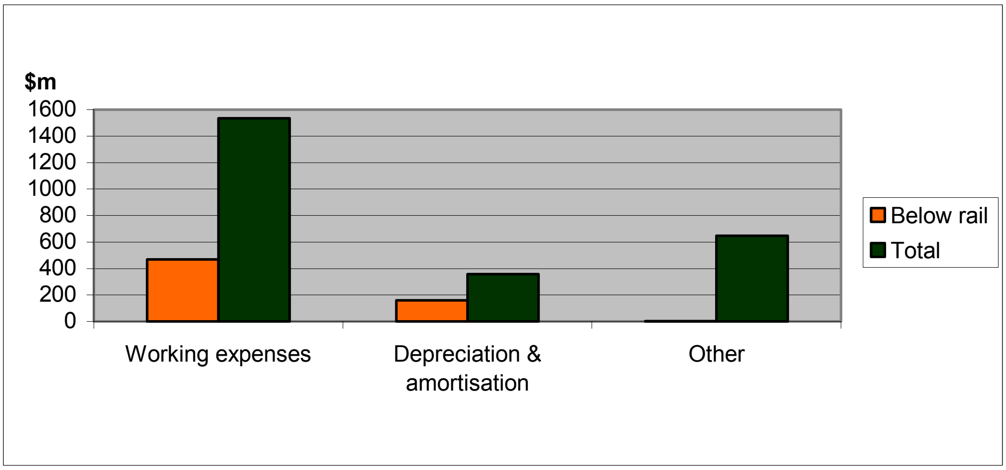
Operating Costs

Below rail management and administrative overheads typically account for around 20% of total below rail costs.

The most significant operating costs relate to train control, scheduling and safe working procedures. This includes labour to prepare the master and daily train plans and to co-ordinate real-time traffic movements in the train control centres in accordance with the daily train plan, respond to incidents and provide verbal instructions to drivers. In addition, there are management and administrative overheads associated with access provision and infrastructure management.

QR's below rail and total operating expenses for 2004-05 are shown in Figure B1.[131]

Figure B1 Value of QR's Total and Below Rail Operating Expenses in 2004-05



Source: Below Rail Services Provided by Network Access – Financial Statements 2004-05, Pursuant to the QR Access Undertaking.

Figure B2 shows QR's total and below rail assets, in current and non-current terms, in 2004-05.[132]

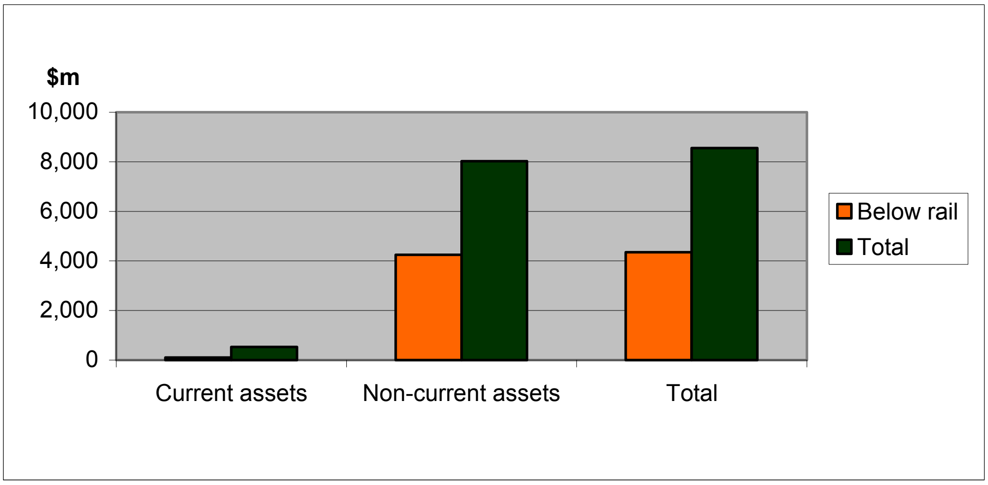
Current assets are expected or able to be converted into cash within a normal trading cycle of one year. Non-current assets are the long life assets, such as the track, signalling and earthworks infrastructure.

The capital intensive nature of the provision of below rail services is evident, with in excess of 97% of QR's below rail assets being non-current.

[131] The difference between below rail and total operating expenses is above rail expenses.

[132] The difference between total and below rail assets is above rail assets.

Figure B2 Value of QR's Total and Below Rail Assets in 2004-05



Source: Below Rail Services Provided by Network Access – Financial Statements 2004-05, Pursuant to the QR Access Undertaking

B.5 Above and below rail cost trade-off

There is a complex inter-relationship between above and below rail costs. This means that options to reduce below rail costs and/or improve below rail productivity may result in an increase in above rail costs and/or a fall in above rail productivity, and vice versa.

For example, increasing allowable speeds increases the productivity of locomotives and wagons as they can carry more tonnes in a given time. However, there is a disproportionate relationship between the force exerted on a rail and speed (ie. if speed doubles, the force exerted by the locomotive/wagon increases exponentially). This will result in a higher cost of track construction and/or higher ongoing track maintenance costs.

B.6 Incremental maintenance costs

As previously noted, the cost of maintaining and renewing below rail infrastructure is relatively high. A relatively large proportion of this figure varies with the amount and nature of traffic carried on the network.

However, many of the structures on a railway network, such as tunnels, retaining walls, embankments and cuttings do not carry the direct loads imposed by the passage of rail traffic and their maintenance and renewal costs are not considered to vary with use. In addition, time-based factors such as ageing, obsolescence and weather all generate requirements to maintain and renew the assets.

The observable nature of maintenance allows costs associated with maintenance activities to be directly attributed to line sections, potentially allowing clearer usage-related price signals to be sent to rail operators. In QR's case, an incremental maintenance charge is one component of the regulated multi-part reference tariffs applying on each of the clusters in the Central Queensland coal system.

B.6.1 Track maintenance

The overall percentage of maintenance cost that is variable varies by track standard and by traffic mix and volume.

A track built to a higher standard will generally require a higher level of ongoing maintenance for a given range of volume. However, a lower standard track (eg timber sleepers, lighter rail) can have significantly higher maintenance costs dependent on the operational characteristics of the traffic mix using the line.[133] This suggests that the design and construction of the track should be 'fit for purpose' for the traffic types expected to use the line, such that total (capital and maintenance) costs over the life of the asset are minimised.

Low volume (tonnage) lines experience proportionately little change in total cost even if volume doubles, as there is little wear and renewal, so the fixed costs will dominate variable costs. The fixed component is associated with environmental and safely-related tasks and also includes an element associated with inspection and other preventative maintenance which does not change with small use. However, a large change in use will likely trigger a new preventative maintenance regime at a higher fixed cost.

At low tonnages, only a small part of maintenance cost is variable although there is a relatively large increase in maintenance cost per kilometre for every additional tonne which steadily reduces as tonnage increases before increasing again once tonnage reaches 60 MGT and beyond.

Assuming concrete sleepered track, variable costs increase to around 20% at 5 million gross tonnes and to around 30% at 10 MGT. At 20 MGT, variability is 45% and increases steadily until they are over 80% at 60 MGT, as maintenance activity becomes increasingly tonnage-based reflecting replacement of worn out components. The variability for these lines will approach 100% as tonnage increases beyond 60MGT.[134]

The relationship between track standard and volume (measured in gross tonnes) is illustrated in Figure B3 below.

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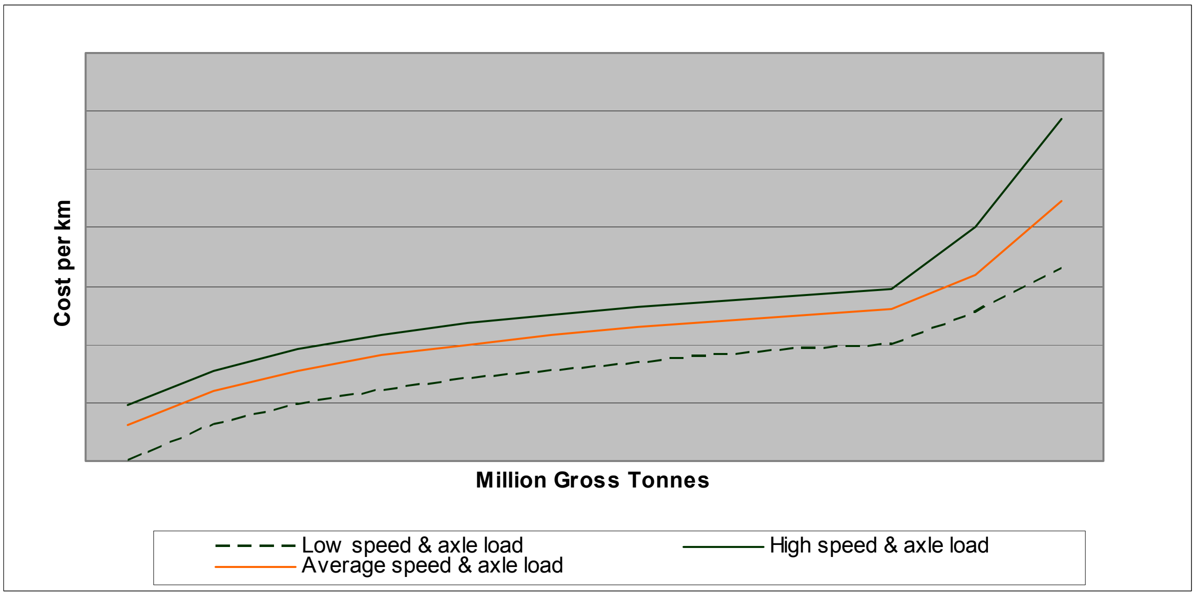
133 Track with concrete sleepers can carry significantly more tonnage – around four times - than track with timber sleepers for the same maintenance cost. Source: QCA, Working Paper 2: Usage-related infrastructure maintenance costs in railways, December 2000, p13.

134 ibid, p14.

Figure B3 Cost relationship between track standard and volume (tonnage)



In addition to tonnage, the variability of maintenance costs with respect to speed and axle load is also important.

Track infrastructure is built to accommodate the forces imparted by a train at a defined speed. Trains operating at faster speeds than this could be expected to impart more damage to the track and vice versa for slower trains measured on a time basis and per tonne basis.

Similarly, track infrastructure is built to accommodate the forces imparted by a train with a defined axle load. Exceeding these parameters could require track reinforcements to be undertaken or an enhanced ongoing maintenance regime to be established.

From the total maintenance cost curves in Figure 3, the rate of change of maintenance costs (the slope of the curve), at different tonnages can be estimated. This provides an estimate of the incremental cost of maintenance.

While the below rail service provider establishes a track standard to suit the operational characteristics of the traffic mix expected to use a rail line and can make assumptions about future maintenance cost requirements based on the cost relationships discussed above, the cost of track maintenance is heavily influenced by the condition of rolling stock. Track has been designed to absorb certain forces and the rolling stock can impart forces well above those design parameters if they are not well maintained of if they contain design flaws.

B.6.2 Civil structures maintenance

Usage related maintenance costs may be significant for some underbridges, particularly cast iron, timber and some masonry structures, related to increases in axle loads as well as the frequency with which a load is applied. Timber bridges can also be subject to significant usage-related maintenance costs.

B.6.3 Signalling & train control maintenance

There are no significant usage-related maintenance costs associated with signalling and train control.

B.6.4 Electrification maintenance

The maintenance and renewal of electrical overhead infrastructure that is in physical contact with the train, in particular, the overhead contact wire, has a significant usage-based component.

B.7 Incremental capacity costs

B.7.1 Nature of capacity consumption

As previously noted, the cost of investing in the rail network is a relatively large proportion of total below rail costs. As a result, both the track manager and rail operators need to understand how particular train service characteristics and scheduling practices affects the available capacity of the network.

Incremental capacity costs are those capital costs associated with a small increase in capacity, usually measured in terms of the number of train paths. However, for a predominantly freight network, capacity could be measured in terms of gross or net tonnes transported.

Unlike many other infrastructure sectors, such as electricity and gas, rail and road share the characteristic that a train/motor vehicle's consumption of capacity is highly dependent upon the interaction of that train/motor vehicle with others using the infrastructure. For example, train size and performance has a significant impact on capacity as slower trains tend to occupy sections of track for a longer time, as do faster trains which receive priority when operating on the network. In addition, demand for capacity may be concentrated at particular times of the day such that capacity is constrained at these times but is under or unutilised for long periods outside this constrained period. This is more likely to be the case for timetabled traffics like inter-modal freight and passengers, as opposed to cyclic traffics like coal. This interdependency of consumption places a premium on rail/road operators using configurations that efficiently utilise capacity while meeting the needs of their customers.

In QR's case an incremental capacity charge is one component of the regulated multi-part reference tariffs applying on each of the clusters in the Central Queensland coal systems.

B.7.2 Expanding below rail capacity

Railway infrastructure is an asset that inherently provides capacity in discrete quantums, with an initial investment providing a finite capacity with a fixed cost. The capacity of an established railway can be expanded at a very small incremental cost as long as duplication or multiple-tracking is not required. However, where capacity is constrained for only short periods during a given time period, this may not justify incremental investment in the short or long run.

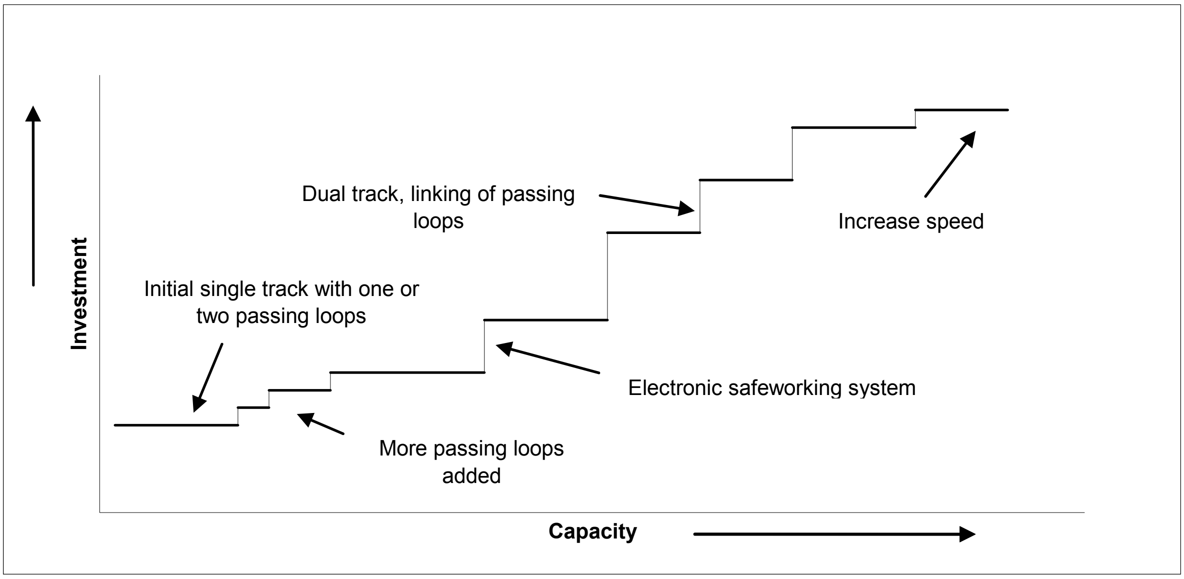
Incremental investments can progressively lift capacity until the next discrete limit is reached. For example, a single line track, with infrequently spaced passing loops, could be progressively upgraded through the provision of more loops and upgraded signalling, until a limit is reached at which point it is not practical to further sub-divide sections. Once passing loops are around 10km apart, it is generally more cost effective to duplicate sections of track, starting with those sections with the longest running times.

Doubling of sections of the track is at significantly greater cost than constructing a loop, and can continue until the whole line is double-track. However, there is a correspondingly large increase in potential capacity from this large incremental investment.

Subsequent increments in capacity become relatively cheaper through reduced signal spacing, limited only by minimum section lengths required for safe operational working.

Figure B4 illustrates a typical process of incrementally expanding below rail capacity.

Figure B4 Incremental expansion of below rail capacity



Source: QCA, Working Paper 3, Incremental Cost of Capacity, December 2000, p 9.

Options to increase below rail capacity

There is a substantial body of international research concerning capacity related problems on rail networks, as well as computer simulation tools that can be used to highlight capacity bottlenecks and propose operational and infrastructure remedies.

The basis of high level estimates of capacity on a line is relatively straightforward. The maximum capacity of the line is based on the sectional running times of the standard train, including time additions, if necessary, for completion of safe working procedures. A reduction in available capacity is made to reflect track maintenance windows.

Options to increase capacity usually start with rollingstock/train parameter optimisation because of its lower capital cost in relation to infrastructure expansion.

Assuming rolling stock/train parameter optimisation has been exhausted, factors that could be considered in relation to below rail infrastructure enhancement include:

- reduce sectional running times and increase train speed through;
  - selective curve straightening
  - selective grade easing (payload will also increase)
  - upgrading passing loop turnouts to permit faster entry and exit speeds; and
  - installing electronic signalling (transit times will also improve);
- reduce section lengths by;
  - installing extra passing loops (for single track);
  - installing double track (or long passing loops where different types of trains run at different speeds);

- increase train size through:
  - increasing passing loop length to allow longer trains to run;
  - strengthening track infrastructure to permit higher axle load locomotives and wagons to run;
  - electrification to permit higher capacity locomotives to run (transit time will also improve); and
- increase available track time;
  - including by upgrading the track standard to reduce below rail maintenance down-time.

B.8 Regulatory treatment of capital

Accurate asset valuations and capital cost allowances are critical to the development of infrastructure prices which encourage efficient network usage in the short term and efficient investment in capacity in the medium to long term.

As previously discussed, capital costs are a significant proportion of total below rail and road infrastructure costs reflecting the respective large investments in fixed assets.

However, the treatment of capital in the rail sector, including recognition of the need for a return on and return of capital to be earned on capital invested, is far more advanced than that applying in respect of the road sector. However, there are deficiencies in the regulatory approach as applied to rail in Australia, including the allowable methods of depreciation and the lack of recognition of both intangible assets and asymmetric risks.

B.8.1 Depreciated Optimised Replacement Cost (DORC) asset valuation methodology

Notwithstanding ongoing debates about its exact form and application in practice, the depreciated optimised replacement cost method of valuing fixed assets has become generally accepted in Australia for regulatory purposes across infrastructure sectors.

The DORC approach consists of four distinct steps:

- define the relevant assets and establish their effective lives;
- establish the current replacement cost of the modern equivalent assets in service through application of appropriate unit rates to a robust asset count;
- adjust the replacement cost for over-design, over-capacity and redundant assets to derive the optimised replacement cost (ORC); and
- depreciate the ORC to reflect the remaining effective life of the assets in service.

Under the building block approach to regulation, where a regulated business' efficient operating and capital costs are built up to establish allowable annual revenue/prices, the DORC valuation of the regulatory asset base is used to establish the return on capital (through application of the regulated rate of return to the asset base value) and depreciation building blocks.

Establishment of a robust asset valuation in this way allows for the explicit recognition in pricing of the opportunity cost of resources tied up in capital assets (the return on capital) and account to be taken of the capital as it is consumed (depreciation). Under the building block approach to rail regulation, this recognition of capital allowances has underpinned the establishment of access price ceilings.

B.8.2 Depreciation

For most assets, service potential diminishes over time, mainly due to ageing, use and obsolescence. There are two methods to deal with asset consumption:

- renewals annuity; and
- depreciation.

Under a renewals annuity approach, assets are treated as if their collective service potential is to be maintained in perpetuity, rather than as a collection of individual assets each with their own asset life and maintenance requirements.

Under an accounting depreciation approach, a periodic depreciation charge is made reflecting allocation of the cost of a fixed asset over the period of that asset's useful life.

The DORC valuation method is not prescriptive in respect of the choice of depreciation method that can be used to derive the DORC value of the regulatory asset base from its ORC value. However, regulators have generally used the straight line depreciation method because of its relative simplicity and general acceptability.

In contrast, in QR's view, the access provider should be able to assess the depreciation profile most suited to its business, taking into account:

- asset stranding risk;
- the need to avoid substantial price shocks as aging assets are replaced;
- capital productivity – ie. recognising that capital becomes cheaper over time due to changing technology; and

- maintenance of network productivity;
  - in the context of a rail network, it is not appropriate to assume that service potential will decline as reflected in a straight line depreciation profile. Rather, the network provider is likely to maintain the serviceability of the network. Renewals annuity may be a more appropriate approach. However, the key issue is that the regulatory framework should not preclude this possibility.

B.8.3 Asymmetric Risks

Regulated entities, such as QR's below rail business, face a range of risks that are beyond their control and asymmetric in that the distribution of expected returns is skewed. Nor are the risks recognised in the capital asset pricing model (CAPM) used by regulators to set allowable rates of return, which assumes a normal distribution of returns for the business. Asymmetric risks would not be such a problem if the risk could be insured against or diversified away.

Examples of QR's asymmetric risks are:

- derailments;
- asset standing;
- landslip;
- floods;
- residual risks including;
  - earthquake;
  - terrorism;
  - fire;
  - credit risk;
  - catastrophic failure;
  - key person; and
  - contractual and other liabilities[135]

Regulatory risk through regulatory bodies adjusting policies or regulatory frameworks, including tight regulatory controls on the potential gains from asymmetric risks not matched by equivalent protection of potential losses from such risks, is another type of asymmetric risk.

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[135] Assessment of Asymmetric Risk in the Central Queensland Coal System, A Report to QR Network Access, Synergies 30 September 2004.

Estimation of the cost of equity capital using CAPM will not include any compensation for asymmetric risks because it is assumed returns are normally distributed not skewed. However, to maintain incentives for investment, and assuming the particular asymmetric risk is assigned to the party with a comparative advantage in managing it, the regulated business will require compensation for any material asymmetric risk it faces.

Recognition of such risks could be made in the form of an insurance premium incorporated in the regulated business' opex allowances where sufficient information is available. Alternatively, where insufficient information is available, a best estimate of the exposure to risk could be carried forward to future regulatory periods as a form of self-insurance against the occurrence of the event, with any shortfalls or over-recoveries to be addressed through subsequent adjustments to access prices.

B.8.4 Intangible Assets

Intangible assets are non-physical factors that contribute to, are used in, the production of goods, or the provision of services, or that is expected to generate future productive benefits for the individuals or firms that control their use.

In recent years, intangible assets have grown in importance in both commercial activity and corporate valuations. However, intangible assets have received limited consideration in regulatory processes.

QR considers that intangible assets play a critical role in the provision of its below rail services. The key intangible assets identified for the Central Queensland coal network are:

- the value of the assembled workforce;
- the value of train control training;
- capacity management capabilities;
- infrastructure management capabilities;
- safe working systems; and
- system-related intangible assets.

Failure to account for intangible assets in the regulatory asset base assumes that QR's below rail business could costlessly and instantaneously recreate not only the asset but more importantly the capability to efficiently and safely manage and operate the asset to deliver the services provided by the below rail infrastructure. However, it is the investment in intangible assets over time that enables the below rail infrastructure to be utilised in an efficient manner.

In QR's view, past investment in intangible assets represents a legitimate sunk investment that is no different to a sunk investment in the physical below rail infrastructure. Regulatory failure to recognise intangible assets will likely adversely impact on the regulated businesses' incentive to continue making such investments into the future.

C Road Costs

C.1 Introduction

A common problem faced by infrastructure owners and managers is the allocation of costs between different classes of users. Current approaches in Australia and overseas generally rely on simplistic approaches that ignore the complex nature of the relationship between vehicle type (weight and configuration) and pavement construction and maintenance costs. Hence, more emphasis needs to be placed on the development of a road charging scheme where prices more accurately reflect the incremental costs associated with vehicle type, or externalities of pavement deterioration caused by heavy vehicles.

This chapter aims to provide a methodology for deriving an estimate of the incremental cost of road use attributable to heavy vehicles i.e. those over 4.5 tonnes. The first section of this chapter outlines the range of capital and maintenance costs associated with road use and discusses their general relationship with heavy vehicle use.

The second section looks closely at the damage caused by heavy vehicle use and the impact on maintenance and capital programs in a whole of life cost context.

The final section outlines QR's proposed methodology for quantifying the incremental cost of road use attributable to heavy vehicles and provides the results of an analysis of the incremental cost of heavy vehicle road use for two representative sections of road and traffic volumes.

C.2 Road Costs

As in most infrastructure activities, the separation of outlays into capital and maintenance costs in the context of roads is not clear cut. The following categorisation is predominantly time based wherein capital costs are the initial costs of establishment and maintenance costs relate to the on-going costs associated with maintenance of the road's service standard. In a whole of life or life-cycle cost (LCC) framework such delineation is somewhat less significant than in the case of an annualised costing approach[136].

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[136] As the title suggests, life-cycle costing models consider the totality of costs associated with a particular road over its full economic life and do not explicitly recognise the economic return on the assets involved or the depreciation of those assets. Hence, there is little or no requirement to delineate between capital and maintenance outlays. On the other hand, annual costing models require the calculation of the annual depreciation and return on investment for each component of the asset.

C.2.1 Capital Costs

Land

Land, easements and other right of way costs are largely a function of traffic volumes, environmental and safety standards, and value of the land being traversed. In certain instances road construction authorities may be required to alter approaches to urban centres or construct by-passes to minimise the impact of heavy vehicles. Also horizontal alignments may need to be altered to achieve desired performance standards for heavy vehicles. However, the impacts on land costs are not expected to be significant and it is assumed that right of way costs are largely independent of traffic composition.

Earthworks

Earthworks account for approximately 45% of the total cost of road construction. The cost of earthworks is largely a function of road alignment, both vertical and horizontal. In particular, the amount of cutting and filling undertaken to achieve a particular maximum gradient will have a significant impact on the total cost of earthworks for a particular road. Maximum gradients in turn are largely determined by target vehicle speeds, maximum loads and safety considerations.

The design criterion for roads carrying heavy vehicles would be for a maximum gradient significantly less than that for a road built only for light vehicles. This requirement therefore has a considerable impact on the cost of earthworks. Also, the greater length of heavy vehicles will necessitate the construction of roads with more sweeping curves. This will require changes to the horizontal alignment of the road and potentially increase the quantum of earthworks to be carried out.

McLean[137] concluded that a comparison of truck-based and car-based standards for earthworks design suggests that, at least in hilly terrain, the adoption of truck-based standards would result in an increase in earthworks of some 25 to 50 %.

[137] McLean, J. (2006) Earthworks Cost and Heavy Vehicle Use. Heavy Vehicle Charges Cost Allocation Workshop. Melbourne (April, 2006)

Pavements

Modern pavements can be constructed as either flexible or rigid structures. The selection of pavement type depends on a number of parameters, including:

- the standard and availability of materials, particularly the standard of the sub-grade i.e. a rigid pavement would be preferred where there is a low strength sub-grade;
- the required level of pavement performance and reliability;
- the curvature of the pavement and topography of the right of way[138] i.e. rigid pavements are preferred for straight sections, while flexible pavements are preferred for roads in built-up areas with tight cornering, roundabouts and intersections;
- the totality of capital and operating costs incurred over the economic life of the road;
- traffic intensity and composition; and
- other environmental factors, e.g. noise level.

Whilst all of these factors need to be considered in the choice of pavement design, the overriding consideration relates to traffic volume and composition. Austroads[139], for example, suggests that rigid pavements are required to carry design traffics over 1×10^6 heavy vehicle axle groups (HVAG). This level of traffic would be applicable to major arterial roads and highways.

Flexible pavements normally consist of 4 layers, including:

- Wearing Surface – this is either an asphalt or bituminous seal and provides a safe and smooth riding surface with a desired level of skid resistance and load- and non-load associated fractures and deformation. Asphalt is a mixture of bituminous binder and aggregate. It may also be a sprayed seal which is a thin layer of binder sprayed onto a pavement surface.
- Base Layer – One or more layers designed to prevent water infiltration, prevent volume change of the sub-grade and increase the structural or load–supporting capacity of the pavement. Flexible pavements can have an asphalt treated base or a granular base. These layers may be composed of fine crushed rock, natural gravel, broken stone, stabilised material, asphalt or Portland cement. Base layers can be bound or unbound. Bound layers are composed of materials incorporating sufficient amounts of chemical agents to produce significant structural stiffness

[138] A narrow length of land used for the route of a railway, electric power line, or public road

[139] Pavement Design – A Guide to the Structural Design of Road Pavement Austroads 2004 (p91)

and improve load bearing capacity. Unbound base layers comprise granular or mechanistically stabilised materials that have less load supporting capacity than bound layers.

- Subbase layer – the layer laid on the sub-grade to make up additional pavement thickness and to prevent intrusion of the sub-grade into the base. It is usually composed of coarse or fine aggregates and can be stabilised using cement like materials and is compacted to form a strong and dense layer. Granular subbase (and base) layers do not have any cement like materials but rely on compaction of aggregates only.

- Sub-grade is usually the native soil however it can be strengthened with an imported sub-grade material to achieve the desired strength. The desired strength will vary with the design traffic level and is specified in terms of the California Bearing Ratio (CBR). The CBR is the ratio of the subject load to a defined standard load and is used to determine sub-grade strength. A low CBR may necessitate sub-grade reinforcing.

Rigid pavements have a concrete base. There are a number of cement base types used in Australia, including:

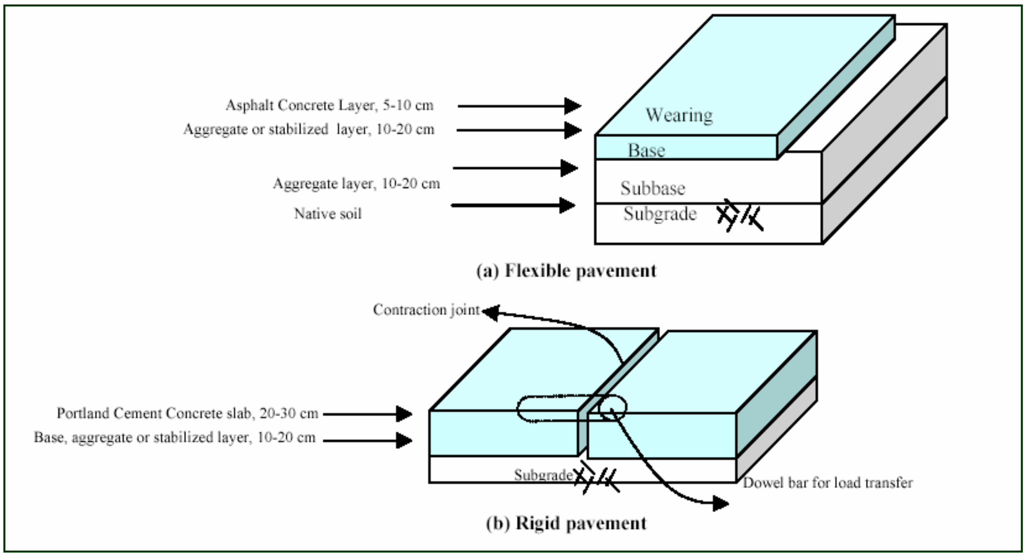
- jointed plain concrete pavements (PCP);
- jointed reinforced concrete pavements (JRCP);
- continuously reinforced concrete pavements (CRCP); and
- steel fibre reinforced concrete pavements (SFCP).

Each type has specific applications depending on the size and shape of slabs and position of the slab within the pavement eg corners, intersections, etc.

The subbase of a rigid pavement provides support to the concrete base layer and prevents erosion of the sub-grade due to traffic and environmental factors. Subbases for rigid pavements are usually bound with cement or asphalt and are at least 125 mm thick.

Rigid pavement may also be covered with a cement or asphalt wearing surface depending on the traffic speed, grade, road width and rainfall.

The basic structure of rigid and flexible pavements is shown below.



Source: A Review of Water Movement in the Highway Environment. University of New Hampshire. (2002)

Pavement costs account for 30% of total road establishment costs and include the cost of the sub-grade, subbase, unbound road base, bound road base and pavement surface. The quality and standard required for each of these components depends upon a combination of factors including:

- traffic loading (both number, type and loading of axle and tyre contact stresses);
- pavement configuration, cross section and drainage; and
- climatic conditions

Heavy vehicles generally require a rigid surface and superior quality base and subbase construction. Heavy vehicles are responsible for two forms of distress in the base and subbase/sub-grade, namely fatigue cracking of the road base and erosion of the sub-grade. Hence the thickness of these components of the pavement needs to be greater when heavy vehicles are present due to the static and dynamic forces they exert on the subbase or sub-grade material.

Three types of forces are exerted on pavements by traffic:

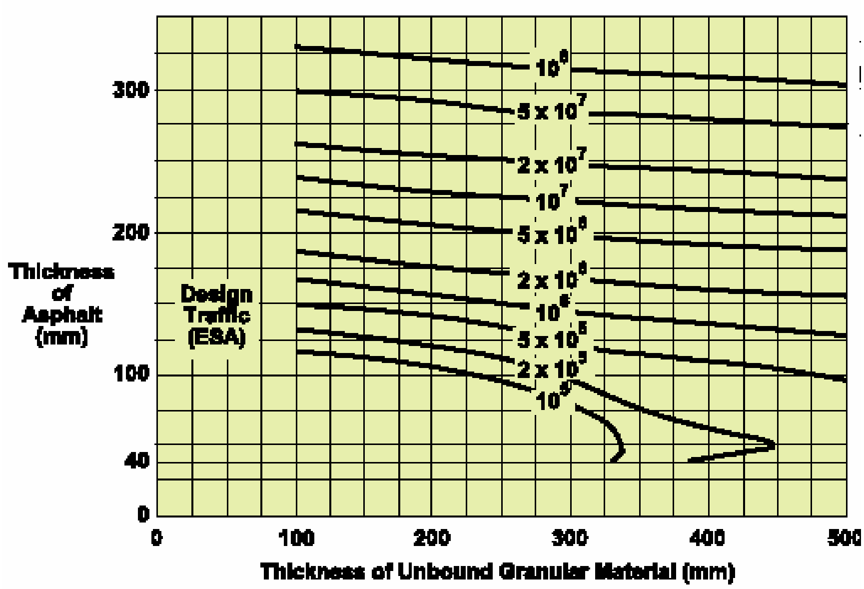
1. Vertical forces – these depend on the number and weight of axles, tyre pressure[140] and vehicle speed;
2. Horizontal forces – these depend on acceleration, deceleration and turning , and are also a function of the gradient[141] of the road; and
3. Dynamic or impact forces – these depend on the profile of the road, i.e. roughness, and vehicle characteristics eg suspension type[142]. (MRD, 2002)

[140] The higher the tyre pressure the higher the forces exerted on the pavement for a given axle loading.

[141] The effects of deceleration and acceleration will be greater on a steeper pavement for a given axle loading.

[142] Asset Maintenance Guidelines. Queensland MRD. (August, 2002) Chapter 4 p 9

Design charts are used by road authorities to determine the thickness of base layers, Asphalt thickness and standard of material used in the various layers. An example of a design chart is provided below. The main variable in these design charts is the design traffic level as measured in Equivalent Standard Axle Loads (ESAs). The relationships exhibited in these design charts is that, for a given asphalt strength, base material and sub-grade standard, asphalt thickness and road base thickness all increase in a linear (or log-linear) fashion with increased design traffic levels.



Source: Pavement Design – A Guide to the Structural Design of Road Pavement Austroads 2004

In assessing the incremental cost of pavement construction attributable to heavy vehicles it should be noted that pavements are subject to strong durability economies and long run average costs decline markedly for stronger pavements built for higher traffic loadings[143]. It has been estimated[144] that, for rigid pavements, doubling the initial investment in the pavement increases its strength by a factor of 100. In contrast, for flexible pavements in Australia the rule of thumb is that for a given level of damage, traffic volumes can be doubled if pavement depth is increased by about 10 to 15%. In order to assess the influence of these economies on the cost of road use attributable to heavy vehicles, pavement construction costs for a range of traffic tasks need to be assessed.

[143]Harvey, M. Road Pricing and cost recovery: An Economic Perspective. (2000)

[144] Newberry D.M. 1989. Cost Recovery from Optimally Designed Roads. Economica. May: 165

Access and egress facilities

The initial cost of road construction would include the construction of access and egress facilities eg. merging lanes and exit lanes. The capacity, and hence cost, of these facilities may exhibit an inverse relationship with vehicle acceleration and breaking capacity. As heavy vehicles generally have poorer acceleration and breaking capacity than light vehicle, there would be some additional cost attributable to heavy vehicle traffic associated with these facilities. Nevertheless, in the context of the total capital cost of the road system they may not be significant.

Drainage, Culverts & Bridges

The wear and damage caused by vehicles are magnified by environmental factors, particularly rainfall. The interaction between heavy axle loads and weathered road surfaces suggests that the optimum expenditure on drainage infrastructure would be significantly higher in the presence of heavy vehicles in design traffics.

It would be expected that higher axle loads would require higher culvert and bridge standards. While, this relationship needs to be quantified if incremental costs are to be measured, they are not likely to be a significant component of incremental cost of road use by heavy vehicles.

Lighting, line marking and signs

These costs are considered to be independent of vehicle type and traffic volumes.

C.2.2 Road Maintenance Costs

Road maintenance activities consist of practices that are either short-term or long-term with respect to their impact on the performance of road infrastructure. Each of these practices, as outlined in Table 1, will have a varying relationship with the composition and volume of vehicle traffic. Roads are a long-lived asset and maintenance cycles will last for several years. Hence, the impact of increased road use at a particular point in time may not be observed until many years into the future when renewal programs need to be advanced to maintain performance levels. Road maintenance is usually divided into routine and periodic (or intervention) maintenance.

Routine maintenance includes:

- pothole repair;
- cracking sealing and other minor resealing and resurfacing (limited thickness and length);
- edge repair and shoulder maintenance;
- drainage clearing;
- vegetation control; and

– maintenance of road side equipment.

Periodic or intervention maintenance includes:

– major resealing and resurfacing;
– pavement rehabilitation; and
– renewal.

The following discussion examines these two major types of road maintenance activities and briefly examines their relationship with usage and in particular the impact of introducing heavy vehicle traffic.

Routine Maintenance

The effects of routine maintenance only last for one to two years and hence expenditure levels need to be maintained at a reasonably constant level over time. Broadly speaking, there are two types of routine maintenance. The first type includes activities such as vegetation and drainage management that are largely independent of traffic volumes and composition. The second type includes minor pavement maintenance (crack sealing, pothole filling), edge repair and minor resealing, and minor culvert and bridge maintenance. This type of routine maintenance is related to both traffic volumes and loading.

Types of minor pavement damage include:

– cracking i.e. a visible crack in the wearing course eventually resulting from the propagation of cracks caused by fatigue in, or lack of support from, the underlying pavement layer;
– ravelling i.e. degradation of surface through the loss of stone and binder;
– potholes;
– edge breaks;
– rutting i.e. the longitudinal vertical deformation of a pavement surface in a wheel path; and
– an element of roughness i.e. the consequences of irregularities in the profile of a road in the direction of traffic movement with respect to the intended profile.

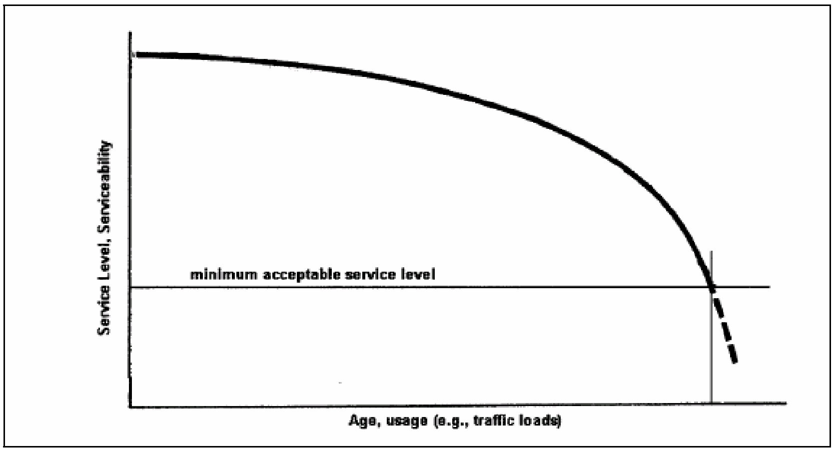
To some extent these impacts are a result of the passing of vehicles and it is this type of wear that is the main object of routine maintenance. However, if sufficient routine maintenance is not undertaken there will be long term implications for the formation of the road and the level of future intervention or periodic maintenance activities. Hence routine maintenance is usually given the highest priority by road management authorities. It is, however, the most difficult to evaluate with respect to heavy vehicle road use.

The proportion of routine maintenance that is variable with load was the subject of research undertaken by Zongzhi (2002)[145]. This research concluded that the more rigid the pavement the greater the proportion of routine maintenance costs attributable to load. The explanation of this outcome is that flexible pavements are more vulnerable to environmental factors than to traffic loading.

Periodic (or Intervention) Maintenance

Road use and particularly use by heavy vehicles results in both surface distress[146] and deformation distress[147] which undermines the bearing capacity or structural condition of the road. As the structural condition worsens the rate of deterioration and deformation increases and the greater the loads carried the faster this process of deformation occurs. The relationship is illustrated diagrammatically in Figure 1. Hence, the relationship between heavy vehicle use and the need for periodic maintenance activities is more direct than for routine maintenance.

Figure 1: Pavement Condition and Usage



Again, intervention maintenance can be separated into two main types. The first type includes actions which improve surface texture and smoothness but do not enhance the structural condition[148] of the pavement. These actions are normally referred to as resealing and are necessary to forestall more rapid pavement deterioration. Periodic resealing also includes thin overlays and crack sealing for flexible pavements and joint sealing for cement or rigid pavements.

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[145] Zongzhi, Li. A determination of load and non-load shares of highway pavement routine maintenance expenditure. (2002).

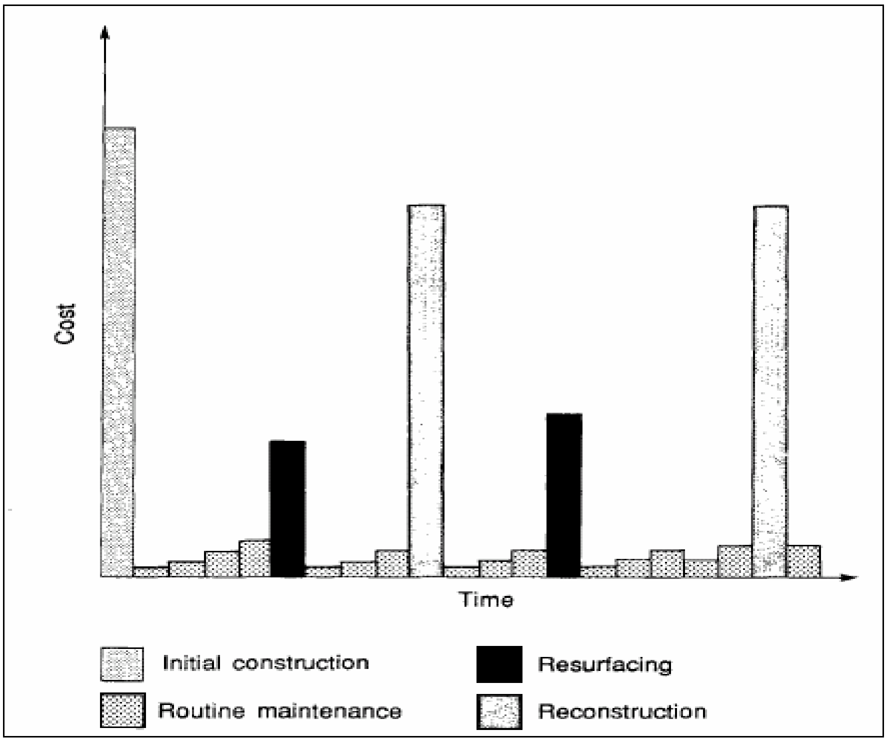
[146] Surface distress – wear and tear of the surfacing caused by the cumulative passing of numbers of vehicles or axles and damage caused by temperature variations resulting in an increase in aging/oxidation rates of the bitumen in the surface layer.

[147] Deformation distress – Damage caused by the cumulative equivalent standard axles over a point in the pavement and damage caused by water entering and softening the materials in the lower layers of the pavement eg subbase and sub-grade layers.

[148] The structural condition is the current degree of severity of the defects or of the distress, visible or non-visible, that has occurred to the lower layers of the pavement.

The second type of intervention maintenance is aimed at improving the structural condition of the road and to effect a major reduction in roughness[149]. This type includes the use of overlays and other major road rehabilitation/reconstruction practices.

Decisions on both types of periodic maintenance are normally taken in response to an assessment of the condition of the road. Hence, increased traffic volumes and loadings will result in a change in the planned maintenance cycle. A maintenance cycle is illustrated below.



Source: Pavement Management – Development of a Life Cycle Costing Technique (BTCE, 1990)

[149] Roughness is considered by both road users and road management authorities as the most appropriate criterion for measuring road deterioration. An assessment of pavement roughness takes into account a number of components including: potholing, cracking and structural deformation. Change in roughness over time is usually measured by reference to the International Roughness Index (IRI) or the NAASRA Roughness Meter (NRM).

C.3 Least cost road design and heavy vehicle impacts

As illustrated above the cost of constructing and maintaining a roadway can be viewed as a series of activities designed to maintain the performance of the asset above a specified level. Hence, decisions in regard to specific expenditures, whether capital or operating in nature, need to be based on the expected total cost of the asset over its life to achieve the target performance level. Therefore there is substantial substitutability between the various types of expenditure. For example, the construction of a high quality pavement that reduces future maintenance costs and extends the time between major pavement rehabilitation operations may be more efficient than the construction of a pavement with a low initial cost, followed by frequent low cost strengthening by overlays.

The assessment of the impact on total life-cycle costs of road infrastructure of heavy vehicle road use would need to be cognisant of this substitutability. Because of the varying relationships that exist between individual cost components and road use, the introduction of heavy vehicles may well alter the efficient mix of capital and operating expenditure. Hence the only way to quantify the incremental cost of heavy vehicles it to compare the total road infrastructure costs (both capital and maintenance) with and without heavy vehicles in the design traffic.

C.4 Pavement Deterioration and Maintenance Impacts

In this section we will examine the range of factors that lead to pavement deterioration with a view to ascertaining the relative impact that heavy vehicle usage has on the total cost of road infrastructure provision. Initially, we examine the various measures of road use with a view to determining the most appropriate usage variable to include in a pavement deterioration or damage function. Secondly, other factors will be examined to determine whether they interact with road usage to magnify or reduce its impact on a pavement. The other factors to be considered include:

- other non-heavy vehicle traffic;
- pavement strength;
- environment; and
- ongoing pavement standard or structure.

Finally, we will discuss the various measures used to indicate the condition of a road at any point in time and which are used by road management authorities to determine future road maintenance schedules.

C.4.1 Pavement deterioration defined

Pavements do not generally experience catastrophic failure. They normally fail due to the incremental accumulation of small but finite quantities of ***damage*** that exist after one or more repetitions of the loading unit. The damage may occur in terms of finite amounts of permanent deformations or in terms of finite strains sufficient to cause an incremental amount of fatigue damage. In either case, these small but finite amounts of damage accumulate to become visible and non-visible defects -- permanent deformations or cracks - throughout the pavement.

The defects which occur at the weakest points in the pavement and at points where the loading is highest are further influenced by environmental effects and through interactions with other defects. While these defects, namely those that occur at weak points in the pavement, relate to sub-grade and subbase defects, they are finally manifest in visible (or measurable) surface defects called pavement ***distress***.

For roads subject to *fatigue cracking*, pavement wear is exponentially related to wheel load, perhaps according to a fourth power relationship. The term ***pavement wear*** is sometimes applied to the deterioration of pavement surface properties such as skid resistance, but in this paper it will be used more generally to relate to visible surface defects.

C.4.2 The causes of road deterioration

Road Use

Austroads[150] stated that:

> It is well established that light vehicles contribute very little to structural deterioration and only heavy vehicles are considered in pavement design.

The significance of this finding from the point of view of heavy vehicle road user costs cannot be over-stated. In addition, there is also a material interaction between heavy vehicle use and that of other road users. The damage causes by heavy vehicles is said to be directly related to the damage caused by lighter vehicles. That is, in the absence of heavy vehicles the damage inflicted by lighter vehicles would be negligible.

Pavement damage is not only a function of gross vehicle mass but also of the manner in which the weight is distributed over the pavement. Pavement damage caused by a vehicle depends on:

- the number of axles on the vehicle;
- the grouping of the axles i.e. number of axle groups; and

[150]Austroads (2004) op cit p 7.1

- the loading transferred to the pavement via each of the axle groups (the axle group load) (Austroads, 2004)[151].

The Dynamic Interaction between Vehicles and Infrastructure Experiment (the DIVINE project)[152] found that:

> "for relatively thick pavements (160 mm of bituminous material) horizontal strains measured at the bottom of the bituminous layer were found to be almost directly proportional to the dynamic wheel force. A 10 percent increase in dynamic wheel load, for example, produced a 7 to 12 percent increase in strain. Given the accepted relationship(s) between strain and pavement material damage, this implies significantly increased pavement wear under traffic which consistently applies such loads."

While the gross weight and axle loads of the vehicle are the loading parameters which are traditionally considered when designing a road or a bridge, the effects of other parameters are being considered in the development of models of the behaviour of the vehicle-road system. These parameters include:

- tyre type – the *tyre* acts through its pneumatic and mechanical properties to envelop and absorb small disturbances, spread the wheel load over an acceptable area of the pavement surface and provide vertical springing. Tyre type has been shown to be very important to the performance of the road to which it is applied.

- suspension system – the suspension provides springing and damping between the axles and the body of the vehicle and offers a smooth, progressive deflection characteristic under load.

- *axle grouping* – *axle groups* such as tandem or tridem axles usually allow for sharing and equalising load among the axles in the group.

- Sprung mass of the vehicle – the *sprung mass* represents the portion of vehicle load carried on the suspension. It has a dominant effect on the dynamic wheel load.

These vehicle attributes will significantly affect the extent to which heavy vehicles impact on the road pavement and hence on the relationships between heavy vehicle road use and incremental costs.

Environment

The environmental factor that most significantly affects pavement performance in Australia is moisture. The strength of the unbound materials and sub-grades is materially influenced by their moisture content. As saturation levels increase, pavement components experience a loss of strength. The major sources of moisture

[151] Ibid page 7.1

[152] OECD. (1998) The Dynamic Interaction between Vehicles and Infrastructure Experiment.

infiltration are shown in Figure 2. Not all these sources of moisture can be controlled so that moisture infiltration will always be a factor in pavement deterioration.

Temperature also exerts a significant influence on the rate of flexible pavement deterioration. In particular, at high temperatures asphalt-surfaced pavements become soft and become susceptible to permanent deformation. Also, the daily and seasonal distribution of temperature has a substantial impact on pavement performance. For example, if traffic loading occurs at night when temperatures are low, and the asphalt is relatively brittle, then a considerable reduction in the life of a thin asphalt surfacing may occur due to the onset of deep cracking. However, if traffic loading occurs during periods of high temperature, this may lead to greater deterioration in the lower layers of the pavement.

Climate can also accelerate the effects of aging on the materials through oxidation and the properties of cemented layers. Rigid pavements can also be impacted by temperature variability particularly at night when temperatures are lower.

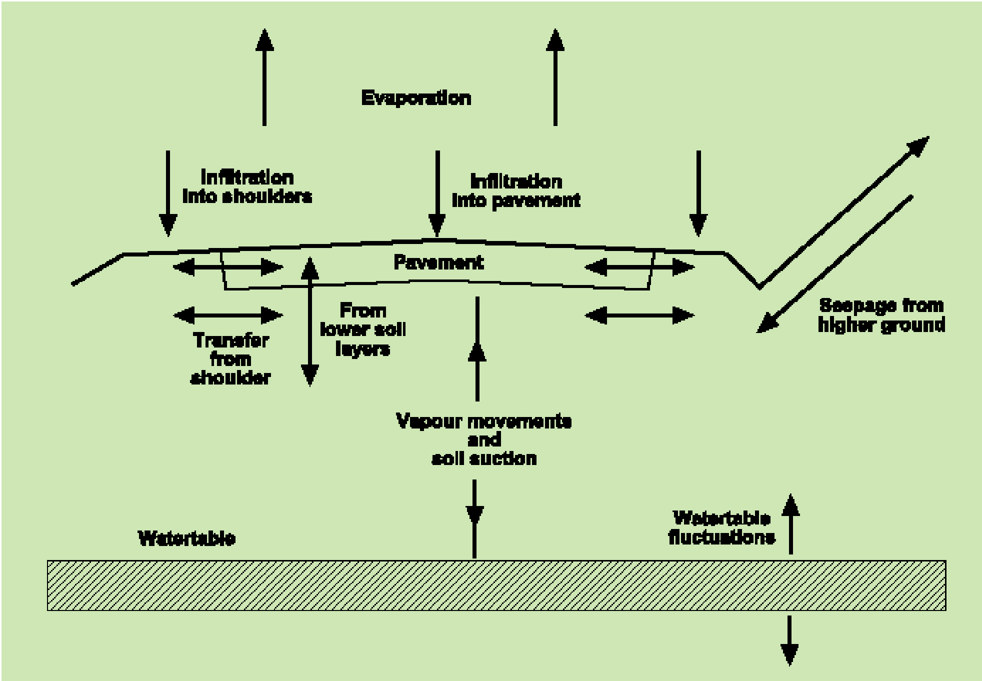
With regard to the interaction of climatic factors with road usage, the Draft Technical Report accompanying the NTC's Third Heavy Vehicle Road Pricing Determination (2005)[153] stated that surface unravelling caused by vehicle movements was exacerbated by wet and/or brittle surfaces. Bruzelius[154] (2004) also stated that the wear and damaging impact of vehicles is magnified by climate. The Queensland Mains Road Department[155] found that premature loading of waterlogged pavements will lead to reduced service life. Hence, the impact of heavy vehicle traffic will be more significant when considered in conjunction with climatic factors than if considered on its own.

[153] NTC (2005), Third Heavy Vehicle Road Pricing Determination: Draft technical Report.

[154] Bruzelius, N. (2004) Measuring the Marginal Cost of Road Use – An International Survey Pg 46

[155] MRD,(2002) opcit Part 4 Pg 10

Figure 2: Sources of Moisture Infiltration



Source: Pavement Design – A Guide to the Structural Design of Road Pavement AUSTROADS 2004

C.4.3 Measures of Road Use

Road use can be measured in a variety of ways, however not all measures are appropriate as an explanatory variable in a road damage equation. The list of road usage measures include:

- Vehicle kilometres (Veh-km) – Vehicle count times distance travelled/vehicle
- Axle kilometres – Vehicle count times Axles/vehicle times distance/vehicle
- Gross Vehicle Mass kilometres (GVM-km) – Vehicles times gross mass/vehicle time distance/vehicle
- Equivalent Standard Axle load kilometres (ESAL-km) – ESAs times distance/vehicle
- Passenger Car Unit kilometres (PCU-km) – Vehicle count times CUs/vehicle times distance/vehicle
- Passenger Car Equivalent kilometres (PCE-km) - Vehicle count times CEs/vehicle times distance/vehicle

Of these measures, Veh-km and PCU-km are more useful as measures of capacity usage rather than road usage. From the point of view of explaining road damage, these three measures implicitly assume that the impact on the road surface is the same for every vehicle, car unit or car equivalent unit respectively. The absence of any reference to vehicle loads in these measures significantly detracts from their use in the road damage function.

Similarly, the use of axle-km and GVM-km as explanators would imply that the amount of road damage was identical for every axle or gross tonne passing over the road. Research over many years has shown that this is unlikely to be the case. These measures ignore vehicle type and axle configuration which have a significant impact on the damage inflicted by a heavy vehicle. For example, a dual axle truck weighing 10 tonnes (GVM) would cause more road damage then two 5 tonne dual axle vehicles. This deficiency is overcome in the ESAL-km measure of road use.

A substantive body of research has shown that the relative damage caused by different types of vehicle can be represented by the vehicles ESAL value. ESALs are axle loads of equal damage. ESAs are calculated as the ratio of the load on an axle group to a reference load for that type of axle group, all raised to a power. One ESAL can be defined as the damage caused by an axle with 2 wheel pairs with a load of 80 kN equally distributed on the wheels. The relationship between the damage of one ESAL and that of another load is represented by the following identity:

$$ESALx = (X/80kN)^{\omega}$$

Where: X is the axle group with unknown ESALs (measured in kN)

ω is a value normally assumed to be 4 i.e. the 4th power rule

Given a vehicle's GVM, axle and wheel configuration, it is possible to establish the total number of ESALs associated with that vehicle when it is fully laden and hence the total damage it causes. For example, using the 4th power rule a fully laden heavy vehicle has an ESAL value 10,000times higher than an ordinary car (Bruzelius, 2004)[156]. Clearly, such a relationship has a major implication for the assessment of the incremental cost of heavy vehicles.

There is considerable debate in the road maintenance literature regarding the value of $\boldsymbol{\omega}$. While a value of 4 is generally accepted, its universal application for all types of pavements and traffic types has been questioned. The power of four rule dates back to the 1950s. Road construction technology and heavy vehicle suspension technology have developed considerably since then.

European studies have found that ω could range from 2 to 9[157]. A recent Australian study[158] estimated a range for ω of between 4.3 and 9.5. These studies and other research suggest that different values should be applied to different types of roads.

One ongoing problem with the application of vehicle damage factors (ESALs) is that, although they may be useful in assessing various pavement design options, they give no indication in themselves of long-term pavement performance, which is dependent on a range of other factors. Also, some of the assumptions behind the derivation of $\boldsymbol{\omega}$

156 Bruzelius (2004) opcit Pg 18

157 OECD (1988) Heavy Trucks, Climate and Pavement Damage: A Report. OECD.

158 Austroads (2005) Refinement of Road Deterioration Models in Australia. AP-R267/05 (p29)

can also be criticised, such as the premise that loads causing equal deflection (the depression produced at the surface of a pavement when a load is applied) also cause equal damage.

Because the relationships used in most road damage functions (or roughness algorithms) employ ESALs as the road usage variable, the value of ω is extremely important in determining the damage and resultant costs to be attributed to heavy vehicles. Nevertheless, as most of the design procedures and maintenance planning procedures in use today are based on ESALs, it currently provides the most appropriate basis for an initial assessment of incremental cost of heavy vehicle road use.

C.4.4 Measures of Road Deterioration/Damage

For pavements with multiple layers, three types of damage need to be considered in pavement design and maintenance:

- fatigue damage to surface layers;
- rutting and loss of surface shape; and
- fatigue damage to cemented/bound base and subbase layers.

Table 1 lists the various types of distress/damage occurring on flexible and rigid pavements and the likely causes of each type of pavement distress.

Table C1: Types and Causes of Pavement distress

Types of Pavements	Distress type	Likely Causes	Traffic Type responsible
Flexible	Rutting	Traffic Associated: • Densification – • Shoving – displacement of pavement structure by braking, accelerating or turning vehicles.	• Heavy vehicles • .Heavy vehicles
	Cracking	Traffic Associated: • Single or low repetitions of high load • Many repetitions of normal loads Non-traffic Associated: • Thermal stresses • Reflection of shrinkage cracks from underlying materials • Swelling of sub-grade material	• Heavy vehicles • Heavy and Light vehicles
	Roughness	Variability of traffic density, properties of pavement material	
Rigid	Cracking	Traffic Associated: • Repeated loading (fatigue) • Spalling at joints (excessive slab movement)	• Predominantly Heavy vehicles • Heavy vehicles

Types of Pavements	Distress type	Likely Causes	Traffic Type responsible
		Non-Traffic Associated: • Thermal stresses • Reflection of shrinkage cracks from underlying materials • Swelling of sub-grade material	
	Faulting at joints and slab tilting	Traffic Associated: • Loss of fines from under the slab Non-traffic Associated: • Slab warping • Moisture variation (shrinkage/swelling of sub-grade) • Consolidation settlement	• Heavy vehicles
	Disintegration	Associated with material deficiency or reinforcement corrosion rather than structural considerations	

Source: Pavement Design: A Guide to the Structural Design of Road Pavements, Austroads (2004).

Deterioration of a pavement can be measured by reference to a change in:

- roughness;
- structural condition/capacity; and
- riding comfort.

Roughness

Pavements become rougher over time due to weathering and this is accelerated by heavy vehicle traffic. Greater initial expenditure on stronger and deeper pavements can significantly reduce the rate of deterioration. Roughness is considered by both road users and road management authorities as the most appropriate criterion for measuring road deterioration[159]. An assessment of pavement roughness takes into account a number of components including:

- potholing;
- cracking; and
- structural deformation.

[159] Change in roughness over time is usually measured by reference to the International Roughness Index (IRI) or the NAASRA Roughness Meter (NRM). There is a linear relationship between these two measures so conversion is straightforward.

Structural Condition

The structural condition is a measure of the current degree of severity of the defects or of the distress, visible or non-visible, that has occurred in the pavement. The structural condition of the road will depend on:

- the thickness of the various layers comprising the road;
- the type and the strength of the materials contained in the pavement;
- the quality of construction of the road; and
- the variability of the quality of the layer materials along the length of the road – a road having a high degree of material variability, yet constructed with a perfectly smooth (even) pavement surface, will very quickly degenerate to one exhibiting a rough (uneven) pavement surface.

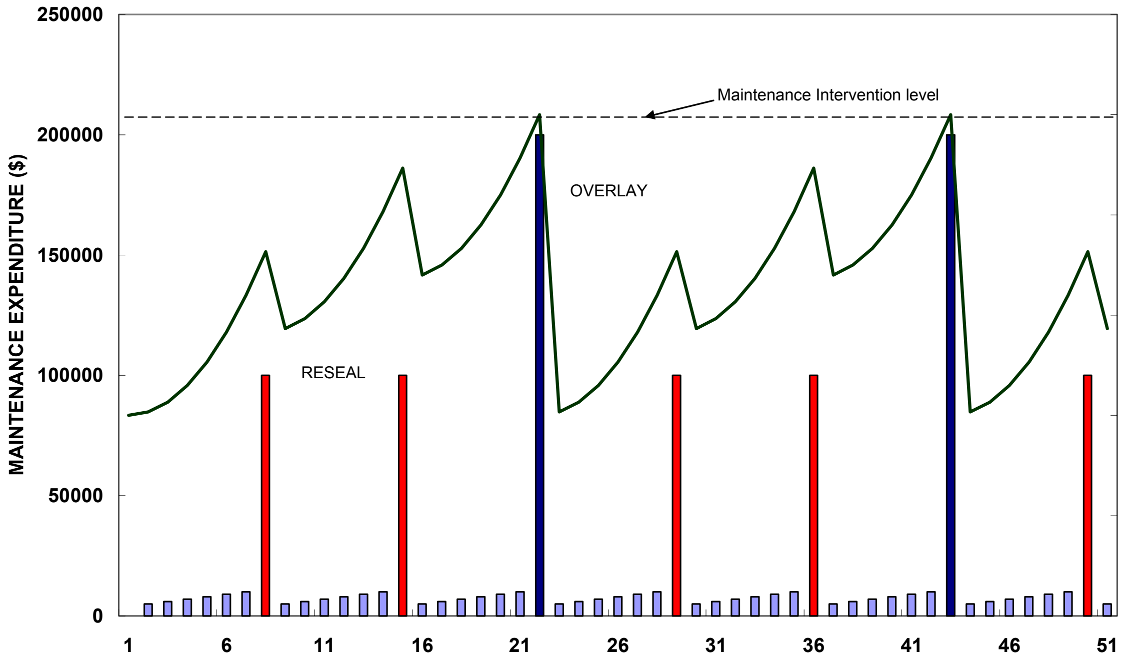
The key issue to emerge however, is that a rough (uneven) road will exhibit poor ride quality and eventually induce very high dynamic loadings which will accelerate the further deterioration of the pavement.

C.5 Application of the Damage function

The damage function can be used in conjunction with the pavement life cycle cost (PLCC) model to assess future maintenance plans. Together they form what is traditionally termed a Pavement Management System (PMS). They can be used in managing both the timing and extent of maintenance and rehabilitation expenditure and to allow the minimisation of life cycle costs. The PLCC model therefore needs to predict the performance of the pavement during both the pavement deterioration and rehabilitation phases of a pavement's life. The figure below illustrates the functioning of this type of analysis. In this example, road deterioration/damage is approximated by the roughness index (as discussed above) and maintenance and rehabilitation expenditure is scheduled to achieve a specified level of performance as indicated by the pavement's roughness.

Maintenance intervention points, as shown in this example, allow the testing of the effectiveness of various maintenance alternatives. Determination of the level of deterioration at which a particular activity should be initiated is not a trivial exercise and should be done on the basis of the costs and benefits of each level of pavement performance, including the costs of vehicle operation. For less costly maintenance activities, for example, simple reseals intervention points might well be based on time, whereas intervention points for other more costly activities could be roughness/condition based.

Figure 3 Example maintenance program without heavy vehicles



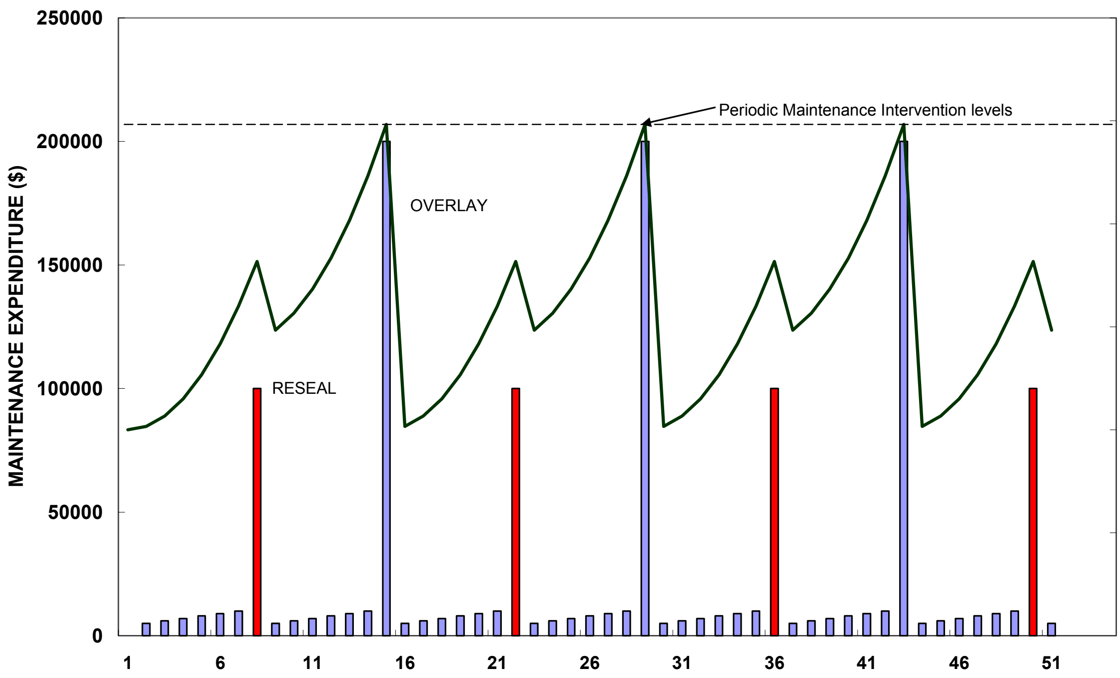
C.5.1 Impacts of heavy vehicles on maintenance activities

Clearly, different traffic types will necessitate the construction of different pavement types and different pavement types are associated with different maintenance programs including the timing, level and type of maintenance activities undertaken to achieve desired performance levels. Hence, the relationship between specific rehabilitation and maintenance practices and pavement performance will contribute significantly to our understanding and quantification of the cost impacts of heavy vehicle traffics.

As illustrated above, for a light traffic road, the impact of resealing was to marginally improve pavement condition and to lower the rate of deterioration. This significantly extended the period between major rehabilitation activities in the form of overlays. Therefore, because of the direct relationship between pavement deterioration and road usage, the frequency and cost of periodic maintenance will impact on the costs attributable to vehicle traffic.

The following diagram illustrates the impact on the maintenance program of introducing heavy vehicles into the design traffic. While resealing activity has not varied (because it is time based rather than condition based in this example) the incidence of major overlays and rehabilitation activities has increased. Hence, any change in total costs (expressed in net present value terms) between these two cases can be wholly assigned to heavy traffics.

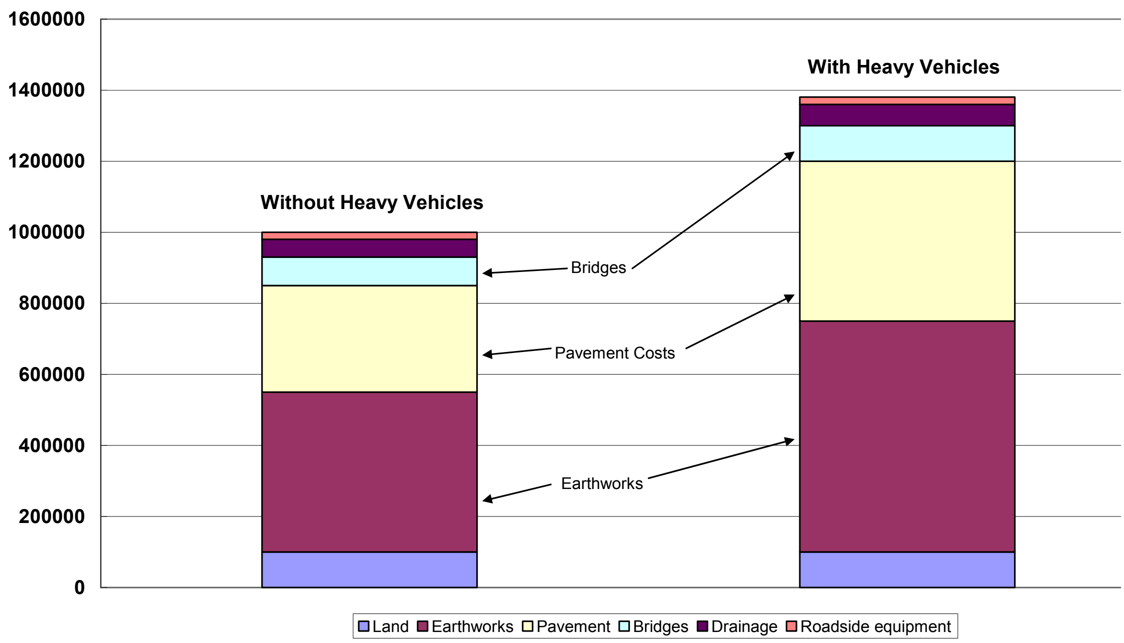
Figure 4   Example maintenance program with heavy vehicles



C.5.2 Impacts of heavy vehicles on Construction Costs

In the above example, the original structural standard of the pavement has been held constant. As discussed previously, this would not necessarily be the case. The presence of heavy vehicles would usually require more rigid and thicker pavements, higher bridge standards and involve additional earthworks. The increase in total construction costs is illustrated in figure 5.

Figure 5 Initial construction cost under different traffic assumptions



C.6 Heavy Vehicle related costs: A suggested methodology

PMS systems around the world are increasingly being used by road management agencies to analyse the economic effects of both alternative maintenance policies and investments in the road network. Generally, alternatives should be evaluated primarily according to the criterion of minimum total (whole of life or life cycle) costs. In these studies, traffic volumes and traffic loading are normally determined exogenously and are the same for each of the alternatives. The objective of these analyses is the determination of the least cost method of providing road services for a forecast traffic task in a particular part of the road network.

The methodology being proposed in this submission applies these same models to analyse a somewhat different problem. The alternatives evaluated and compared in the proposed methodology relate to two entirely different design traffic volumes and compositions:

- Design Traffic 1 – a base case that includes the expected traffic composition for a particular road, particularly in terms of the proportion of heavy vehicles in the traffic composition, that is the "with" heavy vehicle case.
- Design Traffic 2 – an alternative case that excludes all heavy vehicles from the design traffic while keeping the total number of PCUs or PCEs constant, that is the "without" heavy vehicle case.

For each of the traffic tasks modelled, the methodology requires the minimisation of costs and would consider the capital-maintenance cost substitutability discussed previously in determining the initial construction cost of the alternative road designs as well as the most cost effective maintenance and renewal program in each instance.

A comparison of the "with" and "without" heavy vehicle alternative states would yield results that could be expressed as follows:

Table C2: Comparison of Alternative Road Designs and Traffic types

Period	Traffic Volumes (ESALs)		Capital & Maintenance Costs ($'000)	
	With Heavy Vehicles	Without heavy vehicles	With heavy vehicles	Without heavy vehicles
0	13500000	3750000	118000	100000
1	13527000	3757500	5000	5000
2	13554000	3765000	6000	6000
3	13581000	3772500	7000	7000
↓	↓	↓	↓	↓
47	14769000	4102500	9000	9000
48	14796000	4110000	10000	10000
49	14823000	4117500	30000	20000
50	14850000	4125000	5000	5000
Present Values	**182,751,352**	**50,764,264**	**240,546**	**207,571**
	Incremental Traffic	**131,987,088**	**Incremental Cost**	**$32,975**
	Incremental Cost/ESAL (cents/ESAL)			**25.0**

In the above example, the incremental cost associated with providing road services to heavy vehicles is approximately $33million. These incremental costs are associated with a higher initial construction cost (i.e. $118 million for the heavy duty road compared with $100 million for the car only road) and more frequent and more expensive periodic maintenance activities (i.e. resealing and surface overlays). The incremental traffic volume, as measured in Equivalent Standard Axle Loads, is in the order of 132 million ESALs. Both incremental cost and traffic volumes are expressed in discounted present value terms. The incremental cost per incremental ESAL in this example was 25 cents which could be used in setting the variable charge component of the tariff.

C.6.1 Practical limitations

This approach has a number of practical limitations that, while necessitating caution, do not invalidate it as a viable way of measuring the incremental cost of heavy vehicle road use. These limitations include:

- the existence of significant variability in input parameters across the road network;
- reliance on a large number of assumptions concerning all aspects of traffic volume and composition, road standard and condition, maintenance intervention policies, etc;
- the lack of versatility of models used to determine whole of life cycle costs (WLCC). This limitation is particularly relevant where unrealistic scenarios are being considered and significant re-calibration is usually required; and
- the inability of models to adequately reflect changes in parameter values.

C.6.2 Demonstration of Incremental cost methodology

In order to demonstrate the practicality of the above approach to estimating the incremental cost of road use by heavy vehicles, QR contracted ARRB Group to undertake a number of hypothetical assessments for two separate sections of road. These two assessments were performed on the following:

1. A road designed to carry around 7,500 AADT[160] assuming an 8% heavy vehicle contribution.
2. A road carrying 20,000 AADT with 10% heavy vehicles.

Both of these assessments applied current design standards to the construction and maintenance practices, particularly with respect to pavement thickness and standard of materials[161].

In each of these assessments the HDM4 pavement deterioration model[162] was used to determine maintenance and refurbishment requirements for up to 20[163] years.

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[160] Annual average daily Traffic – the total yearly two-way traffic volume divided by 365 expressed as vehicle per day.

[161] An assessment of the incremental costs of heavy vehicles on an existing road should also be undertaken. It is believed that incremental costs on roads built to accommodate design traffics with fewer and lighter heavy vehicles than currently apply are materially greater than those suggested by these assessments. While the methodology is the same the valuation of the existing road needs to consider future maintenance and renewal costs in the determination of past asset consumption.

[162] The HDM4 was developed by the World Bank initially for application in developing countries; however its application has been extended and is now used generally as part of a pavement management system.

[163] ARRB advised that sensitivity analysis conducted using longer analysis periods did not substantially alter the relative costs of the 'with' and 'without' heavy vehicle states in each assessment. However, a more rigorous evaluation of differential maintenance costs over a longer period, i.e. 50 to 100 years, would be desirable.

As outlined above, two separate assessments were performed in each case, i.e. one "with" heavy vehicles in the traffic task and one "without".

Characteristics of the roads used in each of the assessments are shown in Table 3

Table C3 Road characteristics – Incremental cost assessments

Scenario	Assessment 1		Assessment 2	
	WITH HV	WITHOUT HV	WITH HV	WITHOUT HV
Section Length	100	100	100	100
Road location	Fictional	Fictional	Fictional	Fictional
Road type	2 lane 2 way	2 lane 2 way	4 lane 2 way	4 lane 2 way
Lanes	2 x 3.5m	2 x 3.5m	4 x 3.5m	4 x 3.5m
Shoulders	2 x 1m	2 x 1m	2 x 1m	2 x 1m
Surface type	Surface treated	Surface treated	Asphalt surface	Asphalt surface
Base type	Granular base	Granular base	Granular base	Granular base
Initial AADT	7,500	7,500	25,000	25,000
Traffic growth (% pa)	4%	4%	4%	4%
Heavy vehicle %	10%	0%	10%	0%
Traffic Type	General Mass Limit	Light vehicles only	General Mass Limit	Light vehicles only
Length of flat section	60km	60km	60km	60km
Length of rolling section	30km	30km	30km	30km
Length of mountainous section	10km	10km	10km	10km
Initial Roughness (IRI)	2.5	2.5	2.5	2.5
Initial Strength (SNP)	4.1	2.55	5.97	2.55

Source: ARRB Group

Capital costs

Capital costs for each of the roads have been estimated by ARRB Group. These costs include earthworks, drainage and pavement costs but exclude the cost of bridges, right of way and intersections. Total capital costs for each road are provided in Table 4.

Table C4 Total Capital Costs

	Unit Rate ($/km)	Construction factor [a]	Total Capital Cost ($M)
Assessment 1			
WITH HV	100,000	125	1,250
WITHOUT HV	80,000	124	992
Assessment 2			
WITH HV	250,000	125	3,125
WITHOUT HV	220,000	124	2,728

a The construction factor attempts to alter standard rates to account for the varying cost of construction over different topographies i.e. flat, rolling and mountainous.

Note:

- Due to the short term of this project, there was insufficient time and resources to gather full field records. Where information was not readily available, engineering assessment was applied.
- Scenario 1 is a wholly fictitious road that is based around the estimated average of a single carriageway of mid capacity.
- Scenario 2 is a wholly fictitious road that is based around the estimated average of a Dual carriageway of mid capacity.
- A length of 100km was chosen with a break up of flat, rolling and Mountainous terrain (60, 30,10). This was expected to be arbitrary across the segment.
- In both scenarios no allowance has been made for intersections and bridges.

Source: ARRB Group

Maintenance costs

On the basis of the traffic volumes and pavement designs specified above, ARRB applied the HDM4 model to calculate the Roughness Index and the structural Number of each pavement over a 20 year period. The intervention rules employed with respect to intervention maintenance and the total costs of each component of maintenance (both routine and intervention) over the 20 year analysis period are outlined in Table 5.

Table C5 Intervention rules and total costs by maintenance component (Undiscounted 2005 $s)

Scenario	Assessment 1		Assessment 2	
	WITH HV	WITHOUT HV	WITH HV	WITHOUT HV
Pothole Patching	14,799	23,161	29,330	49,002
Edge Repair	3,139,983	2,930,975		
Prep. Edge Repair	289,059	167,089		
Reseal at 9 Yrs or at 10% cracking	2,450,000	2,450,000		
45mm Asphalt Overlay at 3.0 IRI	39,200,000	19,600,000	78,400,000	39,200,000
Crack Sealing	2,786,245		5,614,740	5,053,266
TOTAL MAINTENANCE EXPENDITURE	**47,880,085**	**25,171,225**	**84,044,070**	**44,302,267**

Incremental cost Calculation

Calculation of the incremental cost of heavy vehicles requires the comparison of the total economic cost of the "with" and "without" states in each of the assessments. In order to compare costs across time periods they have to be expressed in present value terms. Applying a discount rate of 7% to the maintenance costs shown in Table 5 results in the total costs for each assessment as shown in Table 6.

Table C6 Present Value of total road related costs ($m)

Scenario	Assessment 1		Assessment 2	
	WITH HV	WITHOUT HV	WITH HV	WITHOUT HV
Capital costs	1,250	992	3,125	2,728
Total Maintenance Costs	22	14	43	25
Total Costs	**$1,272**	**$1,006**	**$3,168**	**$2,753**
Total Incremental costs		**$266**		**$415**

As shown in Table 6, the total incremental cost attributable to heavy vehicles for the two assessments are $266m and $415m respectively, or 21% and 13% of total cost in each assessment. In order to compare total incremental cost and incremental traffic volume, incremental traffic volume needs to be expressed in present value terms to ensure a valid comparison. Incremental traffic volumes and associated incremental costs are shown in Table 7. Incremental cost per unit of incremental traffic is also shown.

Table C7 Incremental costs and Traffic Volumes

Scenario	Assessment 1	Assessment 2
Total Incremental costs ($m)	$266	$415
ESALs (Millions)	7.17	11.94
ESAL-km (Millions)	717	1,194
Incremental cost/ESAL-km ($/ESAL)	$0.37	$0.35

This estimate of the average incremental cost per ESAL-km can be compared with analysis of data provided by the NTC in their Technical report[164] which showed that for a six axle articulated rig the total allocated cost per ESAL-km was in the order of $0.07. While we cannot say what level of cost this type of vehicle should bare, it is clear that they are currently bearing significantly less than the incremental cost they impose on the road network.

[164] NTC (2005), Third Heavy Vehicle Road Pricing Determination: Draft technical Report. Pages 44 and 97.

D Transport Project Evaluation

The European Commission has commissioned a long term research project to develop a harmonised European approach to transport costing and project assessment (HEATCO) which is nearing completion.

HEATCO's primary objective is the development of harmonised guidelines for project assessment for the EU. This is to be achieved through the application of a consistent framework for monetary valuation of project costs and benefits based on the principles of welfare economics. It is believed that this will ensure greater consistency in transport costing compared with current practice.

The project commenced with an assessment of current project assessment practice of EU member states (plus Switzerland). From this review, the project compared current practice with theoretical and empirical evidence from the literature, from which harmonised guidelines will be recommended.

The project identified cost benefit analysis as the most used Cost-benefit analysis (CBA) was identified as the most used appraisal methodology for transport project evaluation.

The details of the HEATCO project are available at http://heatco.ier.uni-stuttgart.ge

The following elements have been recommended for the framework:

- general issues (non-market valuation techniques, benefit transfer, treatment of non-monetised impacts, discounting and intra-generational equity issues, decision criteria, the project appraisal evaluation period, treatment of future risk and uncertainty, the marginal costs of public funds, producer surplus of transport providers, the treatment of indirect socio-economic effects);
- value of time and congestion (business passenger traffic, non-work passenger traffic, commercial goods traffic time savings and treatment of congestion, unexpected delays and reliability);
- value of changes in accident risks (accident impacts considered, estimating accident risks, valuing accident costs);
- environmental costs (air pollution, noise, global warming); and
- costs and indirect impacts of infrastructure investment (capital costs, maintenance, operation and administration costs, changes in infrastructure costs on existing network, optimism bias, residual value).

With respect to Cost Benefit Analysis the following general principles have been recommended:

- Decision criteria – the decision rules recommended were NPV, benefit cost ration and ratio of NPV and public sector support;
- Non-monetised impacts – where impacts cannot be expressed in monetary terms present in qualitative terms. Sensitivity analysis should be performed where there are a small number of non-monetised impacts. Where there are a large number of non-monetised impacts, and a decision maker wants to explicitly weighting of impacts and ranking of projects, multi-criteria analysis should be used;
- Project evaluation period – a 40 year appraisal period;
- Treatment of future risk and uncertainty – use of sensitivity and scenario analysis for non-probabilistic analysis and Monte Carlo random simulation analysis for probabilistic analysis;
- Discounting – use a common discount rate of 3%;
- Intra-generational equity issues – construct a "winners and losers" table;
- Non-market valuation techniques – technique should be dictated by impact type and the nature of the project but Willingness to Pat measures be preferred to cost-based measures;
- Value transfer – use when insufficient resources are available for primary studies;
- Treatment of indirect socio-economic effects – an economic model, preferably a Spatially Computable General Equilibrium model where indirect effects are likely to be significant. If economic modelling is not feasible then use qualitative assessment;
- Marginal costs of public funds – do use any additional cost (shadow price) for public funds;
- Producer surplus of transport providers – include estimates of producer surplus.

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