1. Introduction

The New Zealand Government's Transport Strategy[1] recognises the importance of transport to the nation's economic and social development, and focuses on developing a sustainable transport system (in social, environmental and financial terms) that will contribute to the nation's economic growth. An important aspect of the Strategy is the establishment by the Government of an appropriate regulatory, pricing and investment policy framework that will enhance the efficiency and sustainability of the transport system.

This paper reports on the methodology and results of a 'baseline' study of the costs and charges associated with the NZ road and rail systems, using data from 2001/02: the study was designed to provide a much-improved foundation for the development of regulatory, pricing and investment policies affecting these two main land transport modes. This study is known as the New Zealand Surface Transport Costs and Charges Study (STCC): it was undertaken for the NZ Ministry of Transport by Booz Allen Hamilton and associated consultants[2] over the period 2002-04, and publicly released in March 2005[3].

The principal focus of the paper is on the findings of this baseline study and their main implications for future policy development. Given the wide-ranging scope of the study, space does not allow here for description of the methodology adopted in each of the areas of analysis (the study methodology is detailed in 16 working papers and 5 additional 'case study' papers prepared during the study). However, we do provide a brief overview of the theoretical framework and concepts under-pinning the study.

The paper is structured as follows. Section 2 outlines the study context and scope. Section 3 summarises the theoretical framework and concepts used in the analyses. Sections 4 and 5 present the key results for road and rail transport: Section 4 covers the Total and Average Cost findings, Section 5 the Marginal Cost findings. Section 6 then summarises the main findings and draws out the key implications for policy development.

2. Study context and scope

2.1 Current NZ transport system provision

The land transport sector in New Zealand involves several different forms of ownership and control. In brief:

- Roads are provided as a collective good, owned by public bodies: Transit New Zealand manages the state highways on behalf of the Government, and territorial local authorities manage their local roads.
- The rail system land and infrastructure are now owned by the Government (although at the time of the study analyses, the infrastructure was privately owned). Operations are provided by a single private owner (with the exception of the Auckland urban passenger services).

[1] 'New Zealand Transport Strategy'. December 2002 (www.beehive.govt.nz)

[2] Sub-consultants involved were Institute for Transport Studies University of Leeds; Montgomery Watson Harza; MM Starrs Pty Ltd; and Fuels & Energy Management Group. Peer reviews were provided by the Australian Bureau of Transport and Regional Economics (BTRE) and the NZ Institute of Economic Research.

[3] Two reports have been published: Surface Transport Costs and Charges: Summary of the Main Findings and Issues (Ministry of Transport); and Surface Transport Costs and Charges: Main Report (Booz Allen Hamilton and associated consultants). These are available on the MoT web site (www.transport.govt.nz). .

- Passenger transport services (predominantly bus and train) are generally privately owned and operated. However, regional councils regulate (by defining services and fares), contract for and subsidise a large proportion of local public transport services in most urban centres.
- Freight transport services (truck and train) are privately owned and operated.

In the broad, New Zealand is moving towards a similar model to that prevailing in Australia and elsewhere, whereby road and rail infrastructure are under some form of public ownership and control, but transport operations are undertaken largely by private companies (or, in some cases, government commercial entities).

2.2 Current NZ transport pricing policies

Road and rail **transport services** in New Zealand are currently provided by private operators on a commercial basis, with the exception of some 'social' urban public transport services. There are no price controls and no restrictions on entry for privately-operated transport services, other than basic health and safety requirements. The freight and long-distance public passenger transport markets are competitive, with prices largely being dictated by the market. Road transport operators' costs comprise the resource costs of their operations plus charges for the use of infrastructure (which are in turn reflected in the fares and rates they set).

In the case of the New Zealand **railway system,** the pricing of the rail infrastructure was (until its recent renationalisation) an internal issue for the rail operator. The operator's aim was to maximise its financial return, by pricing traffic based on 'what the market will bear' given the competitive situation.

In the case of **road transport,** the infrastructure is funded through a so-called 'pay as you go' (PAYGO) system, which recovers from road users each year the total public sector financial expenditure on the road system that year. Revenues come from petrol tax, road user charges on diesel vehicles, vehicle registration and relicensing fees, and a contribution from local authority rates. The New Zealand (PAYGO) system is a particular example of what is commonly known as a **fully allocated cost (FAC)** approach to the pricing of public road infrastructure, which is widely used internationally. Particular features of the New Zealand road funding system are that:

- Charges from the various revenue instruments are set to recover the total expenditure on roading (both maintenance and capital projects) in the year in which it occurs.
- As capital investments are recovered from annual revenues, no future depreciation or interest is charged.
- Total expenditures are allocated between different vehicle types using an allocation model based on principles of attribution and equity.
- No attempt is made to directly recover non-financial costs (e.g. environmental costs) from road users.

This current system of paying for roads in NZ is deficient in several respects (which are shared by road charging systems in most other countries):

- It is economically inefficient, as the charges are system-wide averages which bear little relationship to the costs imposed by particular users on particular routes.
- It may be regressive in nature, because of the substantial fixed component of charges (principally motor vehicle registration and relicensing costs, and local rates charges).
- Charges take no account of the 'externality' costs that road users may impose on other road users or society at large.

In the past such broad, averaged pricing policies may have been unavoidable because of the impracticality of monitoring and charging for road use in detail. However, technological improvements such as electronic road pricing now make more sophisticated pricing technically feasible.

2.3 Previous NZ work – Land Transport Pricing Study

The NZ Land Transport Pricing Study (LTPS), undertaken in the mid-1990s, was intended to place the pricing and regulation of the land transport system (the roading system in particular) on a more rational and sustainable basis. The study found (*inter alia)* that NZ road charges took little account of efficient pricing principles and that charging policies were inconsistent between road and other (principally rail) modes. However, the study's intended development and assessment of improved pricing and regulatory policies was never completed, in large measure because of a change in Government. In many respects, the STCC study picks up where the LTPS left off, in particular involving:

- updating the LTPS work
- giving greater attention to the rail sector
- having a primary focus on economic (rather than accounting or institutional) issues
- including more detailed assessment and quantification, especially in regard to externalities (principally environmental, congestion and accidents).

2.4 British Surface Transport Costs and Charges Study

In developing the terms of reference for the STCC study, MoT commissioned the Institute for Transport Studies, University of Leeds (ITS) to prepare a Scoping Report: ITS had recently completed a similar study for the British Government (Department of Environment, Transport and the Regions).[4] While the Scoping Report envisaged that the NZ study would be of similar scope and approach to the British work, once the NZ study started the opportunity was taken to extend its scope and sophistication in a number of ways beyond those incorporated in the British report. For example, enhanced features of the NZ study included:

- Incorporation of all cost components associated with the use of the road system, rather than just the external cost components in the GB work (this provides a much-improved perspective for examining the significance and impacts of any pricing changes).
- More detailed case studies for the main situations of inter-modal competition (eg. bus v train v car in major urban areas).
- More sophisticated approach to estimating marginal accident costs.
- Wider estimation of environmental impacts.

2.5 Study objectives, scope and issues

As noted in the Introduction, the purpose of the STCC study was to provide 'baseline' information on the costs and charges associated with the NZ road and rail systems in 2001/02, in as disaggregated a form as possible. The study covered both passenger and freight transport by road and rail, but did not address coastal shipping or air transport modes.

The study was intended to identify:

- the (economic) costs that road and rail users impose on society as a whole

[4] Sansom et al. 'Surface Transport Costs and Charges Study: Great Britain 1998'. Report to Department of Environment, Transport and the Regions, 2001.

- the charges that these users are paying
- any costs of the land transport system paid by other parties
- the implications of these findings for the development of future pricing, investment and regulatory policies.

Particular 'drivers' behind the commissioning of the study included:

- The release of the NZ Transport Strategy, with its requirement to establish an appropriate regulatory, pricing and investment policy framework to enhance the efficiency and sustainability of the NZ transport system.
- The unfinished work of the LTPS (refer above), which had gone part way towards establishing such a framework.
- The British Surface Transport Costs and Charges Study (refer above), which had demonstrated that the required work was technically possible and could achieve useful outputs to underpin policy development.
- The financial difficulties being faced by the fully-privatised NZ railway system, which gave urgency to addressing whether the road v rail 'playing-field' was level, or whether policy changes were needed to level it, with the potential to improve the rail system viability.
- Views that the charges being imposed on long-distance heavy truck traffic were excessive relative to the costs they impose.

The study was designed to provide an information base to underpin the development and assessment of future pricing, investment and regulatory policies for the road/rail sectors. This subsequent policy development stage (which does not form part of the STCC work) would need to consider questions such as the following:

- Should the transport system and its users (overall and by mode, market segment etc) take responsibility for all the costs imposed on society as a whole, having regard to the sustainability and other objectives of the NZTS?
- To the extent that parts of the system do not pay their full costs at present, what are the economic, financial and environmental consequences of this?
- In the development of more efficient and sustainable policies, what are the roles of Government policies relating to prices, investment, regulation and funding (recognising the mix of public and private players in the sector)?
- How should pricing and investment policies best incorporate both economic criteria (based on marginal cost pricing principles) and financial criteria (through cost recovery policies)?
- What would be the implications of alternative policies for the financial viability of the NZ railway system; and hence for the future development, funding and institutional arrangements for the railway sector?

3. Theoretical framework – Costing, Pricing and Investment Aspects

3.1 Government interests in the transport sector

Governments traditionally have a range of interests in the transport sector. These include providing for appropriate regulation of market failures, such as monopolistic behaviour and externalities, a role in the management of road networks, and sometimes an equity stake through investments in infrastructure. Governments also have an interest in ensuring competitive conditions among transport services, to achieve appropriate transport outcomes without imposing undue costs on society.

One of the 'drivers' of the study was a concern that the mix of public and private transport providers, together with their different approaches to pricing and investment, might be causing inappropriate consumer choices and producer investment decisions. Improving the efficiency of transport pricing so that it more accurately reflects transport costs would improve national welfare by, for instance, reducing the incentive for transport choices that result in trips that do not cover the costs they impose on the transport system or the wider community. Improving the consistency of transport pricing between modes would help ensure that travel choices are based on the actual costs of transport modes, rather than being the result of unwarranted differences in charging policy.

In a fully commercial environment, prices would be set by the interaction of many producers and consumers ('the market'). However, there are a number of features of the transport sector that lead governments world-wide to intervene in transport markets, in order to correct for market failures, to ensure that prices take account of wider social factors, or to constrain charges where the provider has a monopoly. Such reasons provide a *prima facie* case for some form of government involvement or regulation, which may be justified if the resulting improved outcome is demonstrably worth more than the regulatory costs involved.

3.2 Alternative costing concepts as the basis for pricing

Table 3.1 sets out four distinct costing concepts that are commonly used or advocated as the basis for pricing (for road or rail use). The study was required to focus principally on two of these concepts - Fully Allocated Costs (FAC), which are the basis of the present (PAYGO) road charging system, and Short Run Marginal Costs (SRMC). The following two sections of the paper examine the results of the study FAC analyses (Section 4) and SRMC analyses (Section 5).

However, the other two concepts were also examined: Long Run Marginal Costs (LRMC) were seen as most relevant to long-term investment decisions, although they also provide guidance on the equilibrium value of SRMC over time; 'Marginal Cost Plus' (MC+) was seen as an appropriate approach for achieving defined cost recovery targets with minimum distortion from SRMC pricing, and has been the subject of some preliminary analyses (not reported here).

3.3 Treatment of capital costs

3.3.1 Relevance of capital costs for pricing

The treatment of the costs of existing assets is often a controversial element in the formulation of pricing policies. The study concluded that:

- The costs of historic capital assets are relevant to FAC (but in the PAYGO version, these costs are replaced by new capital expenditure as it is incurred).
- The costs of historic capital are **not** relevant to the other costing concepts. In these cases, the only relevant capital costs are those relating to future asset expansion (eg. to optimise infrastructure in the LRMC case) or asset replacement (eg. to replace vehicles in the SRMC case).

The following discussion therefore is only relevant to the FAC case. It sets out the basis used for valuing historic capital assets; and the basis for then calculating an appropriate return on these assets, for price-setting purposes.

Table 3.1: Alternative Costing Concepts

Costing/Charging Concept	Definition	Notes, Comments
Fully Allocated Costs (FAC)	Allocations of total costs between users on some basis that is regarded as equitable.	▸ Emphasis is usually on financial cost recovery (often relates to financial costs only) ▸ Total costs are split (by vehicle type etc) on some basis that is reasonably simple and neutral. ▸ Most common approach adopted internationally to charging for roads. ▸ Current NZ roads 'PAYGO' approach is a particular case of FAC.
Short Run Marginal Costs (SRMC)	Change in total social cost resulting from a unit increase in demand, based on the current level of infrastructure provision.	▸ Relevant costs include those incurred by public authorities (eg. road maintenance), by transport users (eg. congestion) and by society at large (eg. environmental). ▸ SRMC is generally advocated in the economic literature as the basis for pricing, as it provides a guide to the most efficient use of existing infrastructure. SRMC pricing does not guarantee achievement of any particular cost recovery target.
Long Run Marginal Costs (LRMC)	Change in total social cost resulting from a unit increase in demand, allowing for optimal adjustment of capacity and infrastructure provision.	▸ LRMC is primarily relevant to long-term investment decisions. ▸ LRMC provides a good guide to the equilibrium value of SRMC over time.
'Marginal Cost Plus' (MC+)	Approach whereby charges are set to cover all costs in a way that minimises differences in mode shares and total transport task from what would occur if prices were set equal to SRMC.	▸ Involves adjustment to SRMC charges to meet a given cost recovery or revenue target, in the least distortionary way. ▸ May involve Ramsey pricing and/or use of two-part tariffs.

3.3.2 Approach to asset valuation

For reasons discussed in the STCC Main Report, the depreciated replacement cost (DRC) basis was adopted as the preferred approach to asset valuation: such estimates were readily available and provide a reasonable indication of the value of the resources currently deployed in the transport sector. These DRC estimates were split into three separate components:

- Recoverable depreciating assets, such as track, signalling and telecommunications equipment for rail;
- Recoverable non-depreciating assets, principally land (valued on the basis of adjacent land values); and
- Non-recoverable 'sunk' cost assets, including formation, tunnels and bridges (both road and rail).

The view was taken that a return on the third component would not be included in the main analyses: this component relates to items which have no significant opportunity cost and do not require periodic renewal. However, a return on the other two components (plus any allowance needed for depreciation on the first category) would be included, as this would be required for a viable ongoing business.

3.3.3 Cost of capital

To estimate an appropriate target rate of return on NZ road and rail infrastructure assets in the study context, we reviewed evidence from a range of sources and studies by regulatory authorities and others (principally in NZ and Australia) on the weighted average cost of

capital (WACC) appropriate to such situations. All these sources applied a Capital Asset Pricing Model (CAPM) approach to estimating WACC values (although different model variants were used in different cases).

Based on this review, we selected a best estimate WACC rate of 7.0% in real, pre-tax terms (with a range for sensitivity testing of 6.0% to 8.0%).

3.4 Pricing and investment rules across public and private sectors

The study examines the pricing and investment rules that a government would adopt if its policy were to maximise net economic benefits from the transport system, and compares these with the pricing and investment rules that a profit-maximising company would adopt. The pricing and investment rules are considered separately: pricing is essentially a short-term efficiency issue, whereas investment is a long-term efficiency issue.

Pricing. Private companies will try to price above SRMC when they can, because their long run survival depends on covering their full costs. Budget-constrained public agencies will also want to recover their full costs, and raise revenue to do so with minimal distortion in activity. Our analyses show that, if the government agency were to set prices on the 'MC Plus' basis, this could result in an economic pricing rule very similar to the financial pricing rule of a private company, **provided that any externality charges are dealt with similarly in both cases**. This approach should also ensure that consumer behaviour is as close as possible to that under the theoretically optimal SRMC, provided that private companies operate in a competitive or contestable market. This is likely to be the case for rail and road in New Zealand.

Investment. In the case of investments, no such similarity of rules can be identified. Private investments are guided by financial appraisals of an investment's expected profitability and return, with only items that affect the investors' liabilities appearing in the analysis. Public investment decisions are guided by social cost-benefit analysis, which has broader coverage and includes as a benefit the cost savings to existing customers (the change in 'consumer surplus'), which cannot, in general, be captured by private operators. This implies a role for schemes such as New Zealand's 'Alternatives to Roading' programme [5], under which private rail investments that can demonstrate favourable national net benefits can receive subsidy in place of further investment in public roads, thus improving the balance between public and private sector investments.

4. Key results – total/fully allocated costing

4.1 The road system

4.1.1 Overview

The Total Costs and Charges analysis of the existing NZ road system and its operation is summarised in Table 4.1. The total economic costs are estimated at $34.1 Billion pa, comprising two main categories:

- User resource costs ($30.4 Billion) – resource cost components paid directly by individual users

[5] Evaluation procedures for such schemes are provided in Land Transport NZ (1999, updated). 'Evaluation Procedures for Alternatives to Roading'. Manual No PFM5.

- Provider/external costs ($3.7 Billion) – resource costs paid by or experienced by wider society, including public agency costs and externalities.

4.1.2 User resource costs

These account for almost 90% of total road system resource costs. The three largest components are:

- vehicle operating (including ownership) costs
- travel time costs (based on 'standard' travel time valuations)
- accident costs (non-financial costs experienced by road users).

4.1.3 Provider and external costs

These costs (total $3.73 Billion best estimate) may be divided into three groups:

- Recurrent financial costs to public agencies, with main components being road maintenance ($0.77 Billion), emergency services operation ($0.22 Billion) and transport sector administration ($0.16 Billion).
- Return on infrastructure assets. This comprises two components – the return on recoverable assets, principally land ($0.75 Billion) and the return on non-recoverable assets ($1.86 Billion). As discussed above (Section 3.3.2), the latter figure has not been included in the total cost assessment.
- Externalities[6], comprising two main components:
  - environmental (local and global) costs ($1.17 Billion)
  - accident externality costs ie. the component of accident economic costs borne by society at large ($0.67 Billion).

4.1.4 User and related charges

The charges levied on road users total $2.63 Billion, and may be divided into four main components:

- Vehicle use-related charges ($1.67 Billion), ie. fuel excise (principally on cars) and road user charges (principally on trucks)
- Vehicle fixed charges ($0.57 Billion)
- Local authority roading rates ($0.29 Billion) – not directly a charge on road users, but most appropriately included here
- Other charges ($0.10 Billion).

Figure 4.1 presents a graphic summary of the main user charge components and compares these with the provider/external cost components. If a policy of full recovery of **economic** (as distinct from financial) costs were to be pursued, then the total user charges should cover the total provider/external costs of $3.73 Billion (best estimate). The analysis shows that road users paid only 62% of these costs ($2.34 Billion) and local ratepayers a further 8% ($0.29 Billion).

Under the present 'PAYGO' charging system, the shortfall of some $1.10 Billion between the user charges and the provider/external costs may be attributed primarily to three cost components:

- Environmental externality costs – while some of these may be paid for through the health system (eg. a proportion of air pollution costs), most are not currently charged for (eg. climate change costs).

[6] Externalities are the costs (or benefits) that arise from the activity of a consumer of a good or service, that are not directly paid for by that consumer and affect other members of society.

Table 4.1: Total Road System Costs And Charges Summary

Item	Annual Figures - $ Billion (2001/02)		
	Best Estimate	**Likely Range**	**Notes**
User Resource Costs			
Vehicle operating and ownership costs	16.8		Includes vehicle capital charges and insurance costs.
Travel time	11.0		Includes time costs of congestion.
Parking (CBD)	0.4		
Accidents (covered by users)	2.2		Includes non-financial costs of accidents met by users (pain, grief, suffering etc)
Total User Costs	**30.4**		
Provider/External Costs			
Road System Operation and Maintenance:			
Maintenance	0.77	0.75 to 0.85	Direct financial costs of road system maintenance.
Operations and Administration	0.38	0.38 to 0.38	Includes emergency services, system administration.
Accident Externalities	0.67	0.33 to 1.34	Accident costs imposed on society at large.
Environmental Costs	1.17	0.60 to 2.40	Largest components relate to air pollution (0.44), climate change (0.32), noise (0.29).
Road Infrastructure Capital Return – Recoverable Assets	0.75	0.30 to 0.98	Principally value (opportunity cost) of land occupied by roads.
Total Provider/External Costs	**3.73**	**2.36 to 5.95**	
Road Infrastructure Capital Return – Non-recoverable Assets	*1.86*	*0 to 2.42*	*Most of value of road system (DRC) in this category – not included in totals*
Grand Total System Economic Costs	**34.1**		Excludes return on non-recoverable assets.
User and Related Charges			
Fuel Excise	1.09		Levied on petrol (principally cars). Includes component ($0.53 Billion) transferred to general Crown Account.
Road User Charges	0.58		Levied on diesel vehicles and other vehicles over 3.5 onnes GVM (based on axle configuration/mass weighting and distance travelled).
Motor Vehicle Fees	0.57		Fixed (annual etc) charges.
Other	0.10		Includes police fines, fire service insurance levy.
Roading Rates	0.29		Amount raised by local authorities through household rates for roading purposes.
Total	**2.63**		

Table 4.2: Average road system economic cost recovery by vehicle type and road type

Vehicle/Road Type	Ratio User Charges: Provider/External Costs	
	Excl Local Rates	**Incl Local Rates**
All	63%	70%
Vehicle Type:		
Car	64%	-
Truck	56%	-
Road Type:		
State Highways – Urban	88%	88%
State Highways – Rural	86%	86%
Local Roads – Urban	50%	56%
Local Roads – Rural	51%	73%

- Accident externalities – a substantial proportion of these will again not be charged for (eg. pain, grief and suffering suffered by third parties).

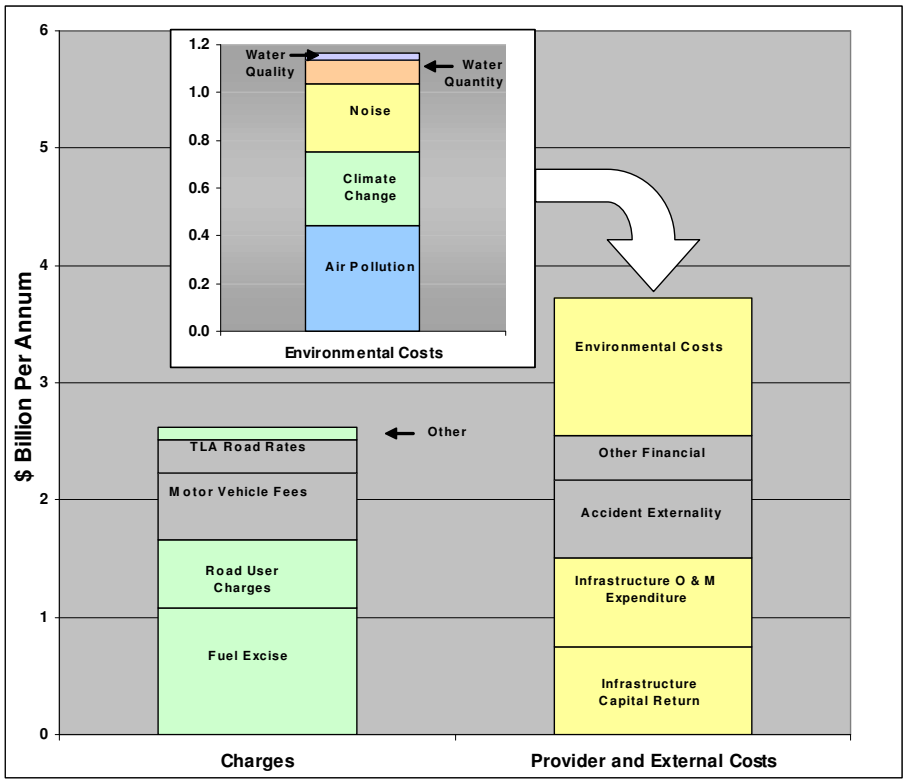

Figure 4.1: Total road system costs: user charges and provider/external costs

- Return on infrastructure assets – under the PAYGO approach, users are not charged for this amount, but do pay a (lesser) amount based on the capital expenditure on road improvements in the year concerned.

Two further points should be made here relating to these costs versus charges comparisons:

- The comparisons relate to economic (resource) costs; but, as just noted, not all these costs involve financial costs borne by the Government sector. A comparison of **financial** provider/external costs borne by Government with the charges raised by Government would give significantly different results (but is not a trivial task).
- While the NZ PAYGO system generally hypothecates road user charges to expenditure on the road system, some $0.53 Billion of the fuel excise charges were transferred to the general Crown Account (in 2001/02). The overall economic cost shortfall of some $1.10 Billion arises despite this component being included in the charges shown.

4.1.5 Fully allocated costs and charges by vehicle type and road type

A breakdown of the total Provider/External Costs and User Charges (from Table 4.1) has been undertaken, in two separate dimensions:

- By vehicle type – principally between cars and trucks (data limitations prevented a further breakdown by truck type, or good estimates for other vehicle types).
- By road type – by state highways/local roads, with each further broken down between urban and rural areas.

It should be emphasised that these analyses involved a large number of allocation assumptions in splitting costs which, in many cases, are not readily separable (eg. infrastructure capital return and maintenance expenditure are not, in general, separable by vehicle type). Thus the results should be regarded as giving broad indications only, rather than indicating under or over-recovery of costs for particular vehicle or road types.

The results are given in Table 4.2, which shows figures with and without local authority rates being included as a user charge. Key conclusions, subject to the above caveat, are:

- By vehicle type, recovery of economic costs from trucks is lower than from cars. (A key assumption in this analysis relates to the allocation of road maintenance expenditure and capital return between the two vehicle types: these allocations have been based on the Road Cost Allocation Model used by the NZ Government's transport agencies).
- By road type, recovery of economic costs is much higher from state highways than from local roads; but is similar for urban and rural roads in each category (before counting the local rates contribution).

4.2 The rail system

4.2.1 Overview

At the period (2001/02) to which the study analyses relate, the railway system in NZ comprised:

- A vertically-integrated freight railway, owned by the private company Tranz Rail Ltd (TRL). TRL had purchased the business and all related assets (except land) from the NZ Government in 1993.

Urban passenger services in Auckland and Wellington, also operated by TRL under contract to and subsidised by the relevant regional councils.

- Long-distance passenger services operated on TRL's network by Tranz Scenic Ltd, a company partially owned by TRL.

Since that time a number of ownership and organisational changes have occurred:

- The NZ Government has taken back ownership and operational/maintenance responsibility for the rail track and related infrastructure.
- Toll NZ Ltd has purchased the freight business and the Wellington urban passenger business from TRL, plus the long-distance passenger business from Tranz Scenic.
- The Auckland urban passenger business has been acquired by the region's local authorities and is now operated by Connex on their behalf.

However, these changes should not affect the principles of the analyses undertaken in the study, which focus on the underlying economic position of the railway as a whole, independent of organisational arrangements.

But the vertically-integrated form of the railway in 2001/02 did mean that the rail system appraisal differed in some respects from the road system appraisal. In the rail system, the infrastructure and operations occurred within a single organisation (TRL) and thus issues of charging for infrastructure were internalised: therefore the 'User Resource Costs' and 'Provider/External Costs' categories used in the roading analysis (Table 4.1) had to be combined together, and the resulting total resource costs compared with the total user (and related) charges.

4.2.2 Total system costs

Table 4.3 shows the total economic costs estimated for the whole rail system in 2001/02. Of these total costs ($527.7 million), some $11.3 million relates to environmental externalities and the remaining $516.4 million to costs borne by the railway operator. These comprise three components:

- Recurrent (operating/maintenance) costs $321.7 million

- Rollingstock annualised capital charge $64.3 million: this amount is required over the medium/long run to purchase or refurbish rollingstock to retain the fleet in broadly its current age and condition.
- Infrastructure annualised capital charge $130.4 million: this is calculated at 7% on the depreciated replacement value of recoverable depreciating assets, principally track and signals (this amount would need to be earned by a commercial railway over the long run to replace such assets).

4.2.3 Total charges and viability

The lower part of Table 4.3 summarises the revenues earned by the railway system in 2001/02. The total revenue of $432.0 million includes a subsidy of $25.8 million for the urban passenger services.

From the economic viewpoint, the total revenue earned from rail users ($406.2 million, excluding public subsidies) covers only 77% of the total economic costs associated with the rail system ($527.7 million).

From the viewpoint of the commercial railway business, the total revenue received by the rail operator ($432 million) covers only 84% of the long-run rail system financial costs ($516.4 million). The revenue is sufficient to cover the recurrent costs plus the rollingstock capital charges, but only around one-third of the infrastructure capital charges. This analysis indicates that the railway as then structured would not have been viable in the long run. This is consistent with TRL's experience that it was unable to generate sufficient margins to avoid progressive deterioration of the railway's assets; and consistent with the NZ Government's decision to re-nationalise the track and effectively thereby to subsidise the railway system (at least in the shorter term).

Further analyses were undertaken to disaggregate these results across the four main business sectors ie. freight, long-distance passenger, urban passenger–Wellington, and urban passenger–Auckland. Because of space constraints, these are not presented here.

Table 4.3: Total rail system costs and charges summary

Item	$ million, 2001/02	Notes
Rail System Costs		
Total Recurrent Costs	321.7	
Rollingstock Capital Charge	64.3	Annual charge (interest rate 7%) to retain approx present condition of rollingstock
Infrastructure Capital Charge	130.4	Annual charge (interest rate 7%) to retain approx present condition of recoverable infrastructure assets.
Sub Total	516.4	
External Costs		
Environmental Externalities	11.3	Principally air pollution and climate change.
Total Rail Costs (Economic)	527.7	
Commercial Revenue		
Freight Revenue	357.3	
Passenger Revenue	48.9	
	406.2	
Other Revenue		
Government Funding	25.8	For AKL/WLG urban passenger services, under contract to regional councils.
Total Rail Revenue	432.0	

5. Key results – marginal costing

5.1 Overview

In this section we present results of the short-run marginal cost (SRMC) analyses, ie. the marginal social costs of additional travel (on the present road/rail system) and the charges currently levied on such travel. As discussed earlier (Section 3), SRMC provide the appropriate starting point for the formulation of pricing policies based on economic efficiency considerations.

These analyses focus on the results from a number of case studies in situations with the main potential for inter-modal competition, ie:

- Urban passengers – car, bus, train
- Long distance passengers – car, coach, train
- Long distance freight – truck, train.

Similar to the Total Cost analyses, in each case these analyses provides marginal cost and charge estimates associated for:

- A: User/Operator Resource Costs (directly incurred)
- B: User/Operator Charges
- C: Provider and External (Social) Costs.

From these estimates are derived:

- A+B = Total (marginal) costs faced by the user/operator
- A+C = Total marginal economic costs (SRMC)
- C-B = Difference between marginal provider/external costs imposed and charges levied.

This last term (C-B) is of particular interest, as it involves comparisons between provider/ externality costs imposed by the marginal trip and charges levied on the trip maker (user/operator). The term (A+B) is also of interest, as it reflects the total costs experienced by the marginal user, which are relevant to their mode choice decision.
It should be noted that, for short-run marginal costing, historic capital expenditures (and a return on them) are of no relevance: the only capital costs of relevance are where infrastructure expenditure may be brought forward as a result of increased traffic volumes, or where additional (or replacement) rollingstock may be required.

5.2 Urban passenger transport

The study analysed SRMC for typical trips by car, bus and train in both Auckland and Wellington, based on:

- Travel between suburban areas and CBD
- Peak (commuter) trips and off-peak trips
- User pays full costs for parking
- Range of car occupancy levels (1-2 people/car).

The Auckland case study is used to illustrate the results here. Figures 5.1A/B present, for peak and off-peak periods:

- A: User resource costs (travel time, vehicle operating cost, parking charges)
- B: User charges (fuel duty, public transport fares)
- C: Provider/external social costs (including congestion externalities, environmental externalities, road infrastructure (marginal) costs, public transport operations costs).

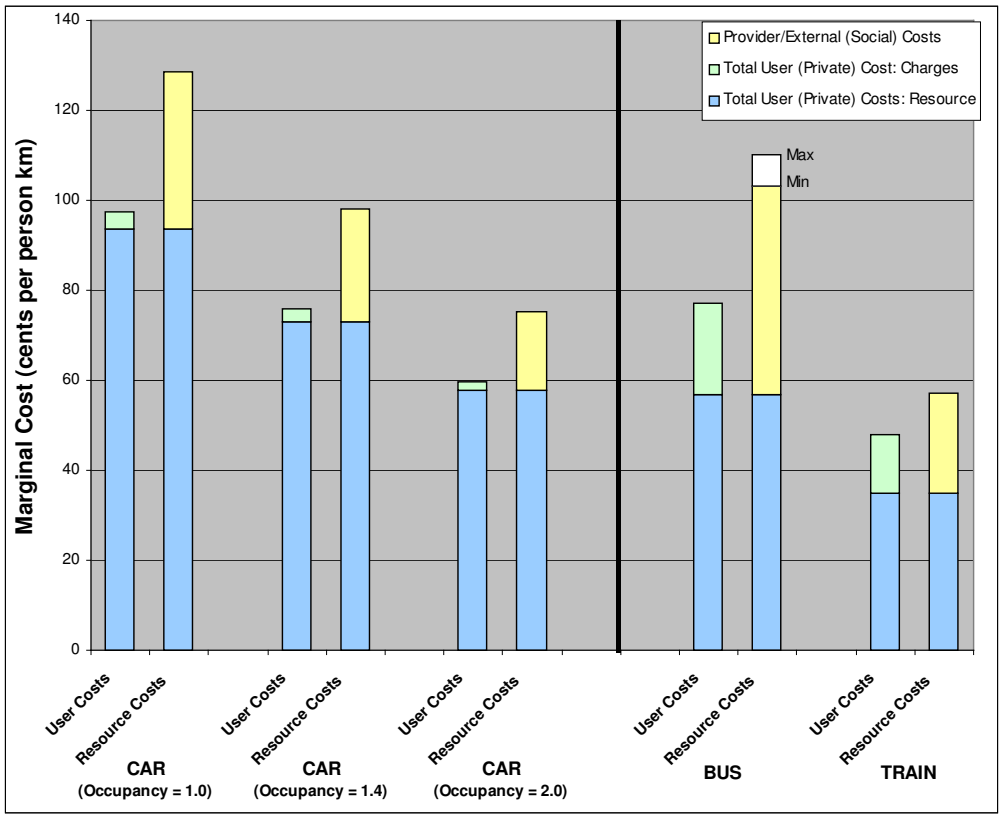

Figure 5.1A: Urban Passenger Marginal Costs and Charges
Auckland – Peak

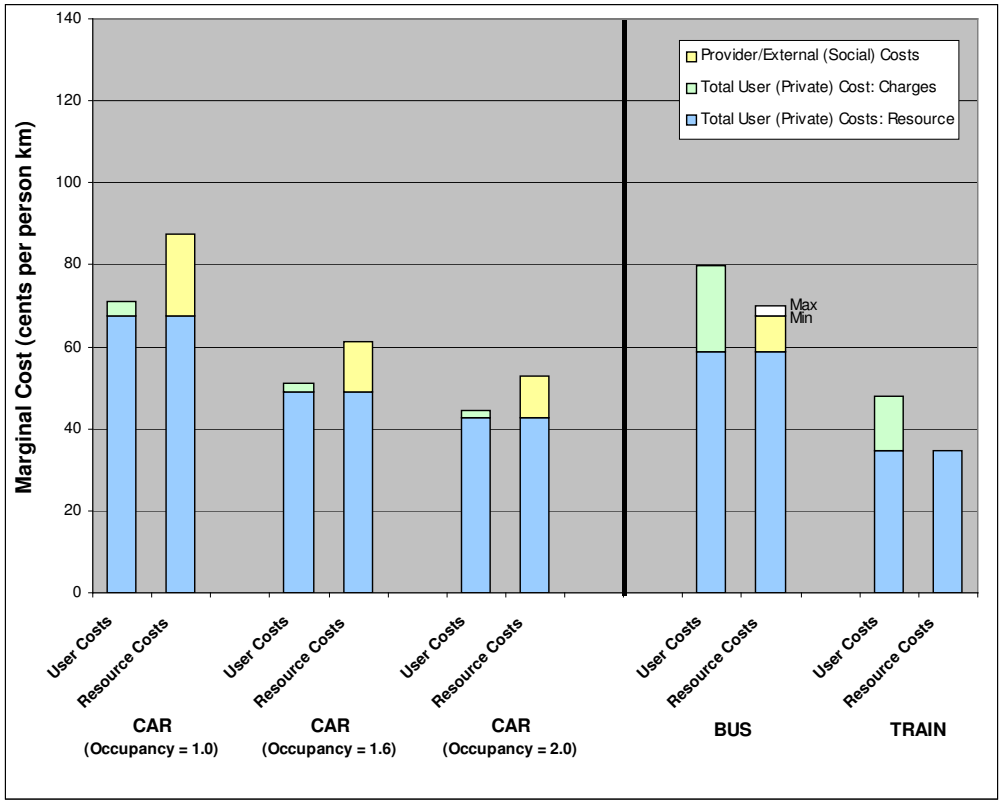

Figure 5.1B: Urban Passenger Marginal Costs and Charges
Auckland – Off peak

They also show:

- Item A+B, represent total (marginal) costs as perceived by users, which underpin their mode choice decisions
- Item A+C, representing the marginal economic costs to society, reflecting optimal mode choice from a societal viewpoint.

As noted above, the comparisons between items B and C are of particular interest for the development of pricing policy. These are shown in more detail for the Auckland case study in Figures 5.2A/B. Key findings include:

Car

- For car travel, the congestion externality is the dominant component of provider/external costs, including in off-peak periods. All other components (accidents, environmental, road infrastructure) are relatively small.
- The charges levied (fuel duty) represent only a small proportion (generally 10%-30%) of the provider/external costs, in both peak and off-peak periods.

Public transport

- For public transport travel, operations costs are generally the dominant component of provider/external costs, with all other components (congestion, environmental, road infrastructure, accidents, user economies of scale[7]) all being considerably smaller.
- In peak periods, current user charges (fares) are around 40% of marginal provider/external costs for bus services, but a higher proportion (50%-75%) for train services.
- In off-peak periods, current charges are substantially greater than marginal provider/ external costs (which are close to zero for off-peak train services).

The urban passenger comparisons between user charges and provider/external costs are summarised in Table 5.1.

5.3 Long-distance passenger transport

The case study analyses were based on trips between Auckland and Wellington and between Christchurch and Picton, by car, coach/minibus and train. Car travel was considered at a range of occupancy levels (1 to 3 people/car).

The main findings in terms of comparisons between marginal provider/external costs and charges were (refer Table 5.1):

Car

- Charges are less than (on average about two-thirds) the marginal provider/external costs. However, both provider/external costs and charges are small, typically around 5% of total travel costs for the private car user.

Public transport

- For coach travel, user charges (fares) are less than marginal provider/external costs, whereas for train travel, charges are significantly greater than the marginal costs (reflecting that for trains, marginal costs are significantly below average costs).

[7] 'User economies of scale' (the Mohring effect) represents the benefits from increased public transport patronage to other public transport users through increased frequencies: it is treated as a positive externality.

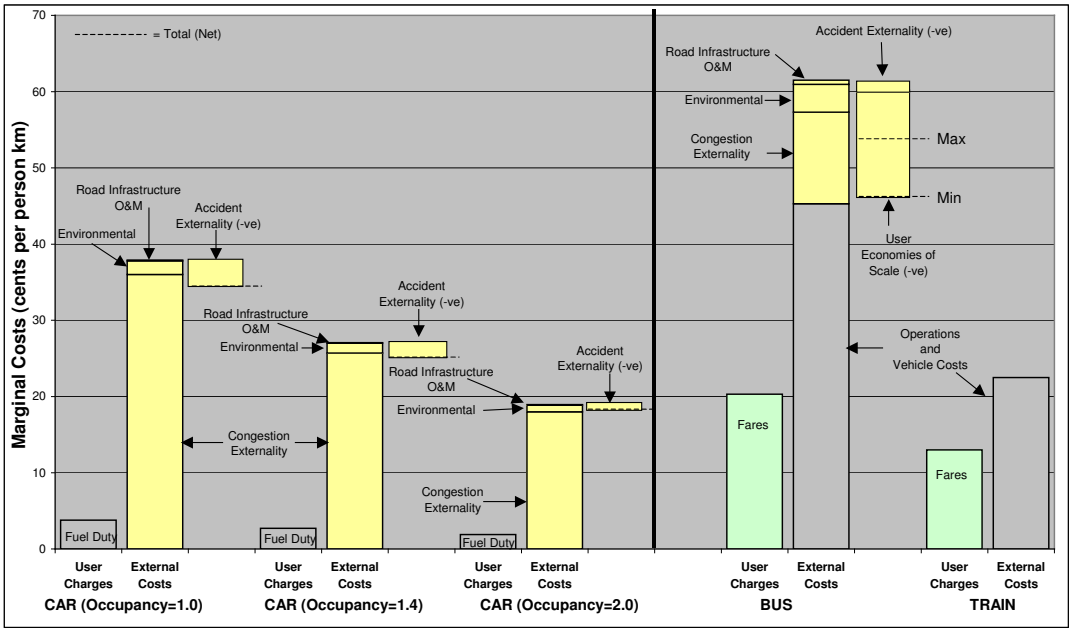

Figure 5.2A: Urban Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs
Auckland - Peak

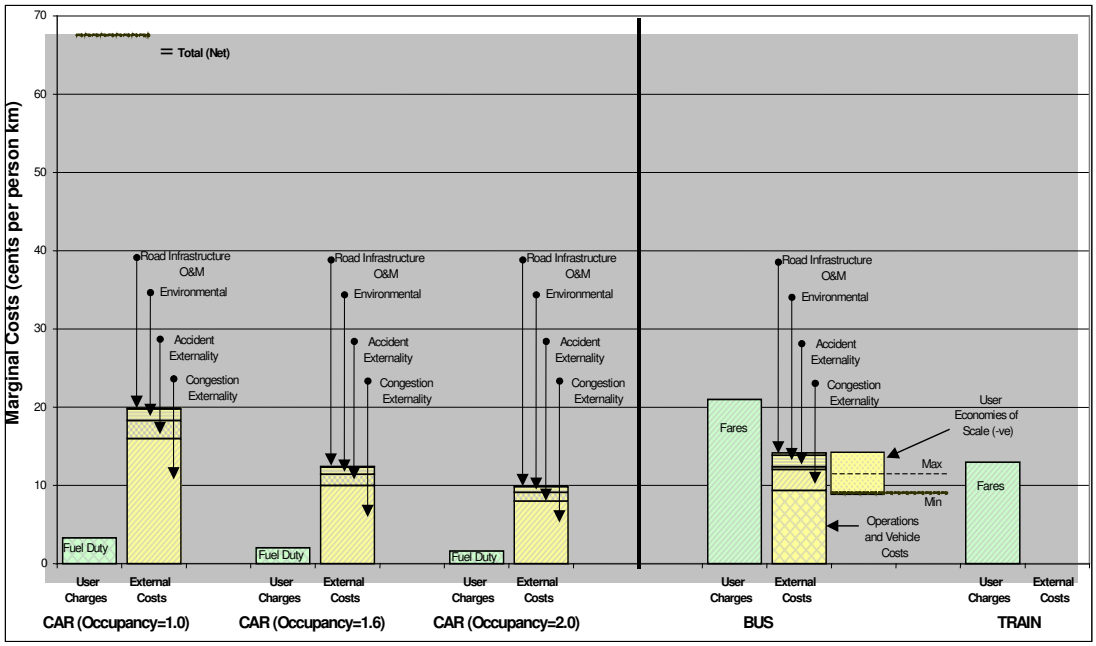

Figure 5.2B: Urban Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs
Auckland - Off-Peak

5.4 Long-distance freight transport

The study analyses focused on two main types of medium/long-distance freight movements, for which road/truck and rail/train are competitive modes: general freight movements (eg. Auckland - Wellington), and specialised product movements (eg. bulk logging/forestry between Napier - Gisborne and Kinleith - Tauranga). The conclusions differ in some respects between these two types of movements.

The main freight analyses were conducted primarily from the viewpoint of the freight service operator rather than that of the end-use customer with goods to dispatch. As well as estimating Operator Resource Costs, Operator Charges and Provider/External Costs, the analyses also present a fourth item, End User charges, which are the freight rates offered by the freight operator, and hence provide the perspective of the end use customer.

TRL's operating expenditures internalise costs such as infrastructure maintenance, safety management and traffic co-ordination, so the only significant externalities from rail included in these estimates are environmental impacts. Consequently, rail freight tends to have higher operational costs but low external costs; whereas road freight has lower operational costs but higher external costs, comprising impacts of additional trucks on road wear, congestion, accidents and environmental effects.

Figure 5.3 illustrates the long-distance freight results, for Auckland - Wellington general freight movements, while Table 5.1 provides a broad comparison between provider/external costs and current charges for long-distance freight movements. The main findings in terms of these comparisons are:

Truck

- Current charges (mainly RUC) are greater than the level of marginal provider/external costs (principally accident externalities and marginal road wear) in the specialised freight examples (Gisborne-Napier, Kinleith-Tauranga), but less than external costs in the general freight example (Auckland-Wellington).

Train

- The main marginal external cost associated with rail freight transport is from environmental impacts, although these are small relative to other cost items (most other costs are internalised within the rail business). Hence the short run marginal social cost exceeds the marginal operator cost by a small amount (the marginal cost of environmental damage) in all examples of rail freight.

Two other findings from the freight appraisal are also worth noting:

- For the primarily rural movements analysed, the environmental impact costs (per net tonne kilometre), are low relative to other cost items, and of broadly similar magnitude for both modes.
- For typical longer-distance general freight movements, which can be served by the rail network, both the operator cost rates and the marginal economic rates are quite similar for the two modes. This indicates that the choice of mode will often be finely balanced where it is dictated by either user cost considerations or economic considerations.

Table 5.1: Summary of marginal externality costs and charges comparisons. All figures in ¢/pass km or ¢/net tonne km

	Car/Truck			Bus/Coach			Train		
	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %
Passenger Urban [1]									
Peak	2-3	20-40	c 10%	17-20	44-54	c 40%	9-15	12-24	50-75%
Off-peak	2-3	4-12	20%-50%	17-21	7-11	c 200%	9-15	0	1000% +
Passenger – Long Distance[2]	1-2	1-2	c 65%	8-11	10-12	c 80%-90%	12-171	6-8	c 150% - 240%
Freight – Long Distance	2-6	2-3	c 60%-200%				-	0.1-0.8	-

Notes: [1] *Relates to Auckland (general), Wellington (general) and Waitakere – Auckland CBD. Car figures focus on average car occupancies.*
[2] *Based on Auckland-Wellington and Picton-Christchurch travel. Car figures focus on average car occupancy (1.7)*

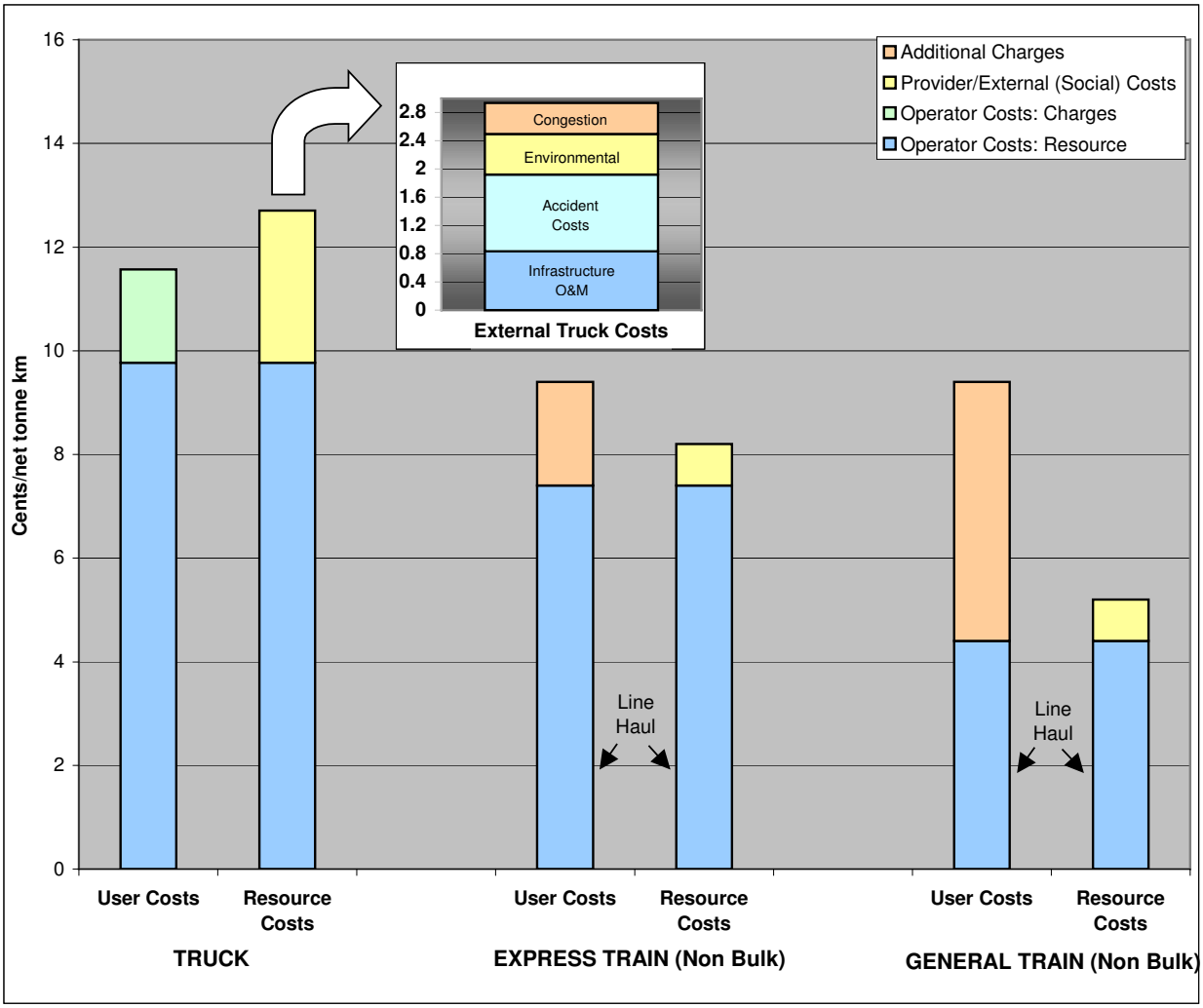

Figure 5.3: Auckland to Wellington Freight – Marginal Costs and Charges

6. Summary of findings, policy implications and potential directions

This concluding section summarises the findings and policy implications of the STCC work to date and outlines further areas of research following from or related to this work. (Note that some of this material goes beyond the published STCC findings and does not necessarily reflect the views of the NZ Ministry of Transport).

6.1 What the main study analyses tell us

6.1.1 Total/fully allocated costing

The main results for the **road system** were presented in Table 4.1 and a breakdown of the cost recovery on provider/external costs was given in Table 4.2. Key findings from these results include:

- Almost 90% of the total economic costs associated with the road system are paid directly by users, with the remaining 10% funded by public agencies and recovered through user charges or borne by society at large.
- However, a large proportion of the 90% is fixed charges associated with vehicle ownership; and hence user charges represent considerably more than 10% of user

variable costs, which are relevant to decision-making on particular trips. Plausible changes in user charges may thus have quite substantial effects on the choice between modes, and rather lesser effects on total travel demand.

- User charges overall cover around two-thirds of total provider/external economic costs (including a return on recoverable assets); while if the user resource costs are added overall economic cost recovery on the road system is around 96%. It is far from straight forward to compare user charges with the **financial** costs borne by Governments, as there are difficulties in estimating the proportions of economic costs (eg. for accident and environmental externalities) that are borne by Governments in one way or another.
- An allocation of economic costs by vehicle type and road type suggests recovery of these costs through user charges is higher for cars than for trucks; and is higher for state highways than for local roads.

For the **rail system,** key findings (Table 4.3) include:

- The total **economic** cost recovery proportion for the whole rail system is some 77%, compared with some 96% for the road system (above). The corresponding economic cost recovery figures for freight alone (but involving cost allocations) are some 82% for rail freight, compared with 94% for road freight overall.
- From the viewpoint of the commercial railway business (prior to renationalisation of the track), total revenue covered 84% of long-run rail system financial costs. This highlights that a fully commercial railway in the current NZ environment and with the current policy settings and levels of efficiency is not financially viable over the long term (it does not earn enough revenue to replace its assets).

The results indicate some implications of moving towards a full economic cost recovery policy for the road sector (road freight in particular). Such a policy would involve an increase in truck charges (which are largely levied through the Road User Charges system) equivalent, on average, to around 6% of total road freight costs. If this increase applied to those truck types which principally compete with rail, this would allow the rail operator to increase rail freight rates by a similar proportion without loss of market share (rail is the 'price taker'), and would improve the financial viability of the rail system – although not to the extent of being fully commercially viable.

6.1.2 Short run marginal costing

For urban passenger transport in the main centres, the key findings for the existing situation are (refer section 5.2):

- For car travel in peak periods, user charges (principally fuel duty) are only a small proportion (in the order of 10%) of marginal externality costs (principally relating to congestion); whereas in off-peak periods this proportion is higher, in the order of 50%.
- For public transport travel, in peak periods user charges (fares) are in the order of half marginal externality costs; while in off-peak periods charges are substantially higher than externality costs.

Thus, any moves towards pricing based on SRMC rates in such situations would involve:

- Substantial increases in car user charges, particularly in peak periods.
- Some increases in public transport fares in peak periods, some reductions in off-peak periods.

Preliminary analyses suggest that such changes would result in some mode switching from car to public transport, with greater impacts likely in peak than in off-peak periods.
In the case of **long-distance passenger transport:**

- For car travel, user charges (principally fuel duty) are typically around two-thirds of externality costs, but both comprise only a small proportion of total user costs.

- For public transport travel, fares are typically slightly greater than the marginal costs for train travel, but rather less than marginal costs for coach travel.

The effects of moving towards marginal cost pricing would be small in this sector: such moves would tend to increase car user costs slightly relative to public transport charges, but little change in mode shares would result.

In the case of **long-distance freight** (where rail and road are competitors, for example Auckland – Wellington general freight):

- For trucks, charges (principally RUC) are typically rather less than the externality costs (principally infrastructure maintenance, accident externalities and environmental costs).
- For trains, external charges are minimal but there are some, relatively small, external costs (principally environmental).

The pursuit of a marginal cost pricing policy on both modes would thus see charges rise somewhat in both cases; however changes in relative user costs would be quite small, and hence major changes in mode shares would be unlikely in general.

6.1.3 The significance of externalities

On the **total cost** analyses for the road system, the true externality costs comprise two main components – environmental costs of $1.17 Billion and accident externality costs of $0.67 Billion (Table 4.1, Section 4.1.3). The composition of these environmental costs associated with road traffic is:

- Local air pollution ($442M) – relevant primarily in urban areas, and linked strongly to traffic volumes and congestion. Commercial (generally diesel) vehicles account for some two-thirds of these costs.
- Greenhouse gas emissions ($317M) – arise from traffic in all areas (in proportion to fuel consumption), with cars accounting for some 70% of total emissions.
- Noise pollution ($289M) – again relevant primarily in urban areas, with cars accounting for some 70% of the total.
- Water quality and run-off costs ($126M).

The corresponding environmental costs associated with rail traffic are an order-of-magnitude less than those for road traffic, largely reflecting the much lower rail traffic volumes.

On the **marginal cost** basis, in the main urban areas the dominant road system externality cost relates to congestion (refer Figure 5.2): environmental and accident externality costs are considerably smaller than congestion costs, although still significant. However, outside the urban areas, congestion costs are small, so environmental and accident cost impacts are of greater relative importance (refer Figure 5.3).

Currently NZ transport users do not directly pay for any of the above externality cost components, and therefore have no incentive (beyond altruism) in taking them into account in making their travel decisions).

6.2 Some further policy implications and issues

6.2.1 Should transport users pay for all transport system costs?

The study has identified that, overall, transport system users are paying directly less than the economic costs of their use of the system. This conclusion applies in both Total/Fully Allocated Cost terms and SRMC terms, in the roads sector at least (although not necessarily to all sub-sectors). The economic costs that are not met directly by system users either are funded in other ways through tax and rate-payers (eg. some hospital costs); or in some

cases are not funded at all (eg. greenhouse gas emission costs – although this will change with the proposed introduction of a carbon tax).

The study prompts the question as to whether transport system users should pay (at point of use) for all the costs they generate, rather than substantial costs being met by tax and rate-payers: the former approach would tend to result in improved economic efficiencies, but would not necessarily result in higher taxes/charges in the economy as a whole (increases in transport sector charges could be off-set by reductions in taxes in other sectors).

6.2.2 Policy instruments to address the imbalance between costs and charges

The study has highlighted the significance of externalities and the present areas of imbalance between economic costs and user charges, whether on a Total/Full Allocated Cost or SRMC basis. The existence of such imbalances does not imply that charges should necessarily be adjusted, but rather that a range of policy instruments to correct the imbalance should be appraised: these include regulation, design and education as well as charging policies. For instance, the study has identified and quantified the substantial costs of air emissions from road (and rail) transport: changes to the diesel fuel specifications that will come into force in early 2006 will substantially reduce the NZ diesel emissions from trucks and locomotives, and hence the economic costs of these emissions. Similarly, the proposed introduction of a carbon tax to 'internalise' GHG emission costs should provide an impetus towards more fuel-efficient vehicles and have some influence on people's travel decisions.

6.2.3 Restructuring of charges for road use

The study has clearly demonstrated that, if road use charges are to be better aligned with economic (marginal) costs, then they need to be restructured to better reflect congestion externalities in particular – as noted above, congestion accounts for the largest component of marginal externality costs, primarily in urban areas. This prompts the need for some form of road pricing that reflects different levels of congestion, ie. with charges varying at least by time period and location. Alternative road pricing schemes for Auckland (NZ's largest and most congested city) are currently being assessed in detail in a separate study (see below).

A related, and easier, measure to better align road use charges with costs would be to convert current fixed charges (eg. motor vehicle registration fees, local authority rates) to use-related charges: this could be achieved in a revenue-neutral manner, through adjusting fuel duty and RUC rates. However, these fixed charges account for only a small proportion of current total charges (Table 4.1), so the effects of this measure would be relatively modest.

As noted above, the restructuring of charges should not be the only means of addressing externality costs, including congestion. A wide range of measures is being taken in New Zealand to address the problem – including enhancement of public transport systems, promotion of environmentally-friendly modes, land-use intensification measures and other non-price demand management measures.

6.2.4 The viability of the rail sector

Previous sections (4.2.3, 6.1.1) have highlighted that:

- The NZ rail system as a whole is not financially viable, on a fully-commercial basis, over the long run.
- The pursuance of a full (economic) cost recovery policy in the roads sector may help to improve rail's financial viability, but most likely not to fully commercial levels.

Aside from the long-standing regional council subsidies to the Auckland/Wellington urban passenger services, the NZ Government has recently re-taken ownership of the track and is now effectively subsidising the rail system to a limited extent. No decisions have yet been

taken on any ongoing Government funding to the railway. However, consistent with the study's conclusions on appropriate investment rules across the road (public) and rail (private) sectors (Section 3.4), the Ministry of Transport is currently undertaking work to develop an assessment framework for considering the funding of major rail projects involving public good components.

6.4 Where to from here?

As noted at the start of the paper, STCC is a 'baseline' study of the costs and charges associated with the NZ road and rail systems in 2001/02. It is not itself concerned with policy development, but provides a much-improved foundation for the subsequent development of enhanced regulatory, pricing and investment policies.

Following on from or related to the STCC work to date, a number of projects are now in progress or being contemplated by the NZ Ministry of Transport. In brief, these include:

- Regular updating of the STCC 'baseline' study. Regular (eg. annual) updating will enable new policy developments (eg. standards to reduce diesel emissions) to be incorporated into the study assessments, and ensure policy formulation is founded on updated data.
- Auckland Road Pricing Evaluation Study – this more detailed evaluation of road charging options for Auckland is due to report around the end of 2005.
- Electronic Road User Charging (ERUC) project – current MoT project to evaluate possibilities of introducing an electronic version of the current heavy/diesel vehicle RUC system, potentially allowing much greater flexibility in terms of charging structures beyond distance/average weight/vehicle configuration.
- Assessment Framework for Major Rail Projects – a further current MoT project, as noted above.

It is clear that we live in interesting times in terms of the development of land transport policy in New Zealand, Watch this space in 2006!

7. Acknowledgements

We would like to thank our colleagues John Bolland (Booz Allen Hamilton), David Lupton (Booz Allen Hamilton associated consultant) and Glenda Irving (Ministry of Transport) for their major contributions to the study and the preparation of the two study reports. We also thank the Ministry of Transport for supporting the presentation of this paper.

9. References

New Zealand Government (2002). *New Zealand Transport Strategy*.

Booz Allen Hamilton & associated consultants (2005) *Surface Transport Costs and Charges: Main Report.*

Ministry of Transport (2005). *Surface Transport Costs and Charges: Summary of the Main Findings and Issues.*

Land Transport NZ (1999). '*Evaluation Procedures for Alternatives to Roading'.* Manual No PFM5 (updated).