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THE RECOVERY OF PUBLIC COSTS DUE TO ROAD FREIGHT TRANSPORT

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ABSTRACT: *This paper addresses the issue of cost recovery in road and rail freight transport. It very briefly discusses conceptual and estimation problems in determining revenues and cost, particularly those associated with road freight activities, and examines the results of a selection of major freight studies that have been undertaken in Australia as well as discussing the impact of social costs on the estimated rates of recovery. Adjustments are made to the figures in some of the studies reviewed to allow for policy changes (e.g. world parity pricing, abolition of the road maintenance tax). Adjustments are also made to revenues, assumed in some studies to come from general taxes, which, for reasons presented in the paper, should be excluded.*

The paper concludes that revenues raised from heavy trucks contribute to a disturbingly low proportion of the costs directly associated with truck usage. The figures vary considerably between the studies reviewed. Based on separable road costs and variable revenues, cost recovery estimates vary from 32 to 103% for heavy rigid trucks and 54 to 95% for articulated trucks. When accident, but not noise, pollution and congestion costs are included, cost recovery for all heavy trucks drops to around 32 to 41%. While there is less information concerning rail cost recovery for heavy haulage movements, there are clear indications that this cost recovery is nearer 100% or greater for bulk commodities.

INTRODUCTION[1]

Efficient resource allocation between competing modes of transport, under most conditions requires that:

(i) long run marginal costs, including net costs external to the operators, be fully covered by each mode; and,

(ii) each competing mode have the same price to marginal cost ratio.

Requirement (i) is necessary to ensure no mode consumes excess resources. If requirement (ii) does not hold, then, in the absence of perfectly inelastic demand, it is always possible to increase the efficiency of resource use by transferring resources away from the mode with a lower price to marginal cost ratio, into a mode with a higher ratio. This transfer allows increased output for a given cost or the same output for a lower cost. This paper discusses problems in determining costs and revenues and reviews studies relating to requirement (i) above as well as studies that have attempted to measure the costs of accidents, pollution, noise and congestion. Little information is available regarding requirement (ii). In view of the lack of data on long run avoidable costs, most cost recovery estimates in this paper are based on separable costs in the case of road and short run avoidable costs in the case of rail.

In a recent paper, Blackshaw (1981) attempted to compare road and rail cost recovery in the Adelaide-Victorian border corridor. In doing so, he included all road operating costs along with infrastructure costs. This is required for the proper estbalishment of price/marginal cost relationships, as noted in criteria (i) and (ii) above.

In this paper only infrastructure costs and revenues are included. The rationale for this approach is that Governments provide both road and rail infrastructure and have considerable interest in the recovery of costs for the investment in and maintenance of those facilities. It is acknowledged that both the criteria for economic efficiency presented above could conceivably be satisfied for road with less than full cost recovery to government for its infrastructure contribution. This implies cross-subsidization from governments to producers and/or transporters, a matter anticipated to be of more interest to government. More importantly, government would be likely to be concerned about whether or not they are recouping their contributions to road and rail infrastructure, or whether subsidies are involved.

It should also be noted that allocation of separable costs to classes of road vehicles leaves a common cost which cannot readily be assigned to user classes. Numerous theories have been developed to allocate these costs, but they are not investigated here, although the work of The Commission of Enquiry into New South Wales Road Freight Industry (McDonell 1980) in allocating common costs is reported.

FOOTNOTE

1. The authors acknowledge the Executive Director of ARRDO for his permission to publish the paper. The authors also acknowledge comments by John Stanley.

On the rail estimates, it is worth noting that ARRDO has done considerable work on the contribution margins of freight commodities, including estimates of long run avoidable costs. However the results of this work have so far only been published in a broad strategic form (Grimwood and Stanley, 1981). Consequently, the rail cost recovery estimates are those based on the papers reviewed here.

In interpreting the studies reviewed in this paper, particular attention has been paid to the impact that the inclusion of social costs has on the estimated rate of recovery of road transport. Because of the obvious difficulties involved in assigning dollar values to social costs, few reports have included these costs. Nevertheless, the estimates made by Andrews and Lacey (1980) and McDonell (1980) provide an indication of the significance of these costs compared with separable road costs, and the results of their work are included.

PROBLEMS IN DETERMINING COSTS AND REVENUES

There are significant problems involved in determining both costs and revenues for road and rail transport. In all the studies discussed in this paper the separable pavement costs of road transport are calculated based on work conducted by the State Highway Authorities in the United States in the 1950's and 1960's. This work, which is discussed in the McDonell Report (1980, Vol. iv) found that the damage imposed by a loaded wheel is proportional to the weight of load applied by the wheel raised to the fourth power. Allocation of pavement costs to vehicle classes was accomplished using an incremental method whereby each successive class of vehicles is assigned costs based on the additional road standards that it requires.

This theory has been subjected to considerable criticism on two main grounds (Long Distance Road Transport association submission, McDonell Report 1980, vol iv). Firstly, it is aruged that in addition to axle loadings, other vehicle and road design variables influence road damage, for example, speed, tyre pressure, suspension design, total vehicular mass and road surface. Secondly, it has been noted that the AASHO tests were not conducted over a sufficient period of time to allow for longer term environmental effects, for example, flooding, frost and landslides.

Despite these criticisms, the fourth power theory has been widely used, and no better approach has so far been developed. It has been argued (Pearson-Kirk, 1980) that the fourth power theory is a fair representation of the average conditions experienced in practice on roads. It is accepted therefore with some reservations in this paper.

In the studies reviewed, a range of approaches are taken to the inclusion of revenue items in the provision of road infrastructure. The sources of revenue in question are presented in Table 1.

TABLE 1: POTENTIAL SOURCES OF REVENUE FOR ROAD CONSTRUCTION AND MAINTENANCE

	Source	Revenue type*
Paid to Commonwealth:	Fuel tax	VR
	Import duties	G
	Company income tax	G
	Personal income tax	G
	Sales tax	G
State:	Fuel tax	VR
	Road maintenance charges	VR
	Sales tax	G
	Payroll tax	G
	Motor vehicle taxes	FR
	Registration fees and taxes	FR
	Licence fees	FR
Local Government rates:		G

*G - General tax
FR - Fixed revenue
VR - Variable revenue

SOURCE: Adapted from McDonell (1980)

General taxes at all levels are not regarded here as contributions towards road costs but are taxes of the type the whole community has to bear to meet the needs of government. Support for this view may be found in McDonell (1980, vol. iv). It could be argued with some merit that, from an economic efficiency standpoint, railways should contribute to such general taxes. However this is a broader subject than can be treated here as consideration would need to be given to the financial burdens which Governments require railways to undertake, for example, passenger services. General taxes to which this argument applies are listed in Table 1.

The tax arising from the world parity fuel pricing policy, the oil levy, introduced in full in 1978 is seen as part of the economic cost of fuel, not a revenue to be used for construction or maintenance. Consequently, this tax has been excluded from the road revenue figures in the years since the policy started to take effect.

The road maintenance charges, abolished in 1979 under pressure from road transport operators, are included as revenue in several of the studies. Road maintenance charges have been excluded from McDonell's results to more accurately reflect the current situation. It should be noted that all states except NSW increased fuel taxes marginally to partially offset the abolition of the maintenance tax. This leaves taxes specifically earned on motor vehicles: fuel tax, registration fees and taxes, licence fees and motor vehicle taxes. In the short run only fuel tax is variable with usage, though in the longer term the other taxes would vary with output. In this paper these fixed revenues are excluded from comparison with short run avoidable costs. McDonell observes that fixed revenues "are commonly regarded as contributions to be offset against 'fixed' or 'common' costs" (McDonell, 1980, Vol. iv, 3/15). This seems a reasonable approach. In any event inclusion of these fixed revenues does not substantially alter the cost recovery figures presented. Where these figures are available they are presented here so the reader may observe the effect of their inclusion.

Table 2 shows the types of revenues and costs relating to the assessment of cost recovery for heavy trucks. A quick perusal of the table reveals that McDonell has adopted the most comprehensive approach, particularly in his treatment of costs.

TABLE 2: COVERAGE OF TRUCK REVENUE AND COST TYPES FOR THE STUDIES REVIEWED

	Bland	Meech	McDonell	Lonie	Andrews & Lacey
Separable costs					
- pavement	x	x	x	x	
- other[1]			x		
- accident costs	x[2]		x		x
- congestion costs					
- pollution and noise					x
Common costs			x		
Variable revenue	x	x[3]	x	x	
Fixed revenue	x		x	x	

NOTES:
1. Other separable costs include truck passing lanes, lower grades for trucks and bridge reinforcement.
2. Bland includes a sub-set of accident costs.
3. Meech includes revenue from truck usage on all roads which substantially overestimates revenue when compared with his cost estimates, which are for highway costs alone.

THE BLAND REPORT

(Board of Inquiry into the Victorian Land Transport System 1971-72).

Bland estimated the extent to which trucks with greater than four tons load carrying capacity contributed to road construction and maintenance costs attributed to heavy vehicle usage. For the year 1969-70, Bland identified relevant construction and maintenance costs of $56m. Given the assumption of truck numbers and ton-miles, this equates to a cost of .52 cents per tonne-kilometre. Against this Bland estimated revenue contributions (excluding general taxes) of $20m or .19 cents per tonne-kilometre, a cost recovery of 36%. If the road maintenance charge contribution is excluded, then contributions are reduced to .11 cents per tonne-kilometre, a cost recovery of 20%.

Some attention was directed to community and social factors but these problems were raised in a generalised fashion and were supported by little or no detailed data. The data used by Bland has been questioned too, because costs were based on expenditure in one year (Kolsen, 1973). No attempt was made to determine whether that year was representative. Also the data was based on State Highways alone which amounted to only 15% of total construction and maintenance expenditure in Victoria in that year (Kolsen, 1973). Bland did not attempt to identify avoidable costs of classes of freight traffic.

THE MEECH REPORT

(Report on Feasible and Practical Improvements to the Existing System of Road User Charging 1977)

The Meech Report was directed to examine the economic efficiency of, and revenue raising through, the road user charging systems in Australia and to advise the Australian Transport Advisory Council (ATAC) on the implementation of feasible and practical alternatives to these charges. Rail's costs and revenues were not examined. Much of the road cost information presented in the report was developed by Webber, Both and Ker (1977) of the Country Roads Board. They provided an Australia wide analysis of separable pavement costs attributable to heavy rigid trucks and articulated trucks, using the National Association of Australian State Road Authorities (NAASRA) Economics of Road Vehicle Limit Study (ERVLS) methods and data.

For the year 1975-76, the Meech Committee reported that the average avoidable pavement cost for rigid trucks with greater than four tonnes carrying capacity was .22 cents per tonne-kilometre and for articulated trucks .30 cents per tonne-kilometre. These costs make no allowance for the costs associated with providing lower vertical grades for trucks, truck passing lanes, bridge reinforcement costs or the additional pavement requirements to accommodate truck turning manoeuvres at intersections. Further, these costs do not include trucks' contribution to air pollution, accidents, noise and vibrations and delays to other road users.

Revenue contributions were estimated to be approximately $176m representing .23 cents per tonne-kilometre contributed by heavy rigid trucks and .28 cents per tonne-kilometre contributed by articulated vehicles. These amounts are substantially overestimated, however, as they represent fuel tax receipts and road maintenance contributions from travel on all roads in 1975-76, whereas the separable pavements costs are attributed to heavy vehicle usage of arterial roads only. Even under these assumptions highly favourable to road transport, 'cost recovery' is still only around 100%.

The inclusion of additional construction costs necessary for truck operation and of social costs attributable to heavy vehicle usage would considerably reduce the estimated rate of recovery as would the inclusion of only those revenues contributed from arterial road usage.

THE McDONELL REPORT

(Commission of Enquiry into New South Wales Road Freight Industry 1980).

Although this enquiry was mainly concerned with the road freight industry, one aspect of its terms of reference required it to report upon the need or otherwise for rationalization of freight traffic between rail and road transport. The report therefore conducted quite a detailed investigation into the efficiency and cost recovery of both road and rail freight transport.

The conclusions reached for rail were as follows:

- major bulk commodities such as coal, wheat, grains, iron and steel cover their direct operating costs and make a contribution to all other costs of providing freight services.
- other bulk commodities, such as limestone and concentrates, containers and some other trainload traffic more or less break even,
- revenue from all other traffic including merchandise, LCL, some specialised and small goods traffic fail to provide their directly attributable operating and capital costs, with a cost recovery of less than 50%,
- in general, LCL traffic covers 1/3-2/3 of its avoidable costs and does not cover even those parts of avoidable costs incurred in handling and accounting,
- about 55% of all LCL traffic is destined for stations off main lines and about 43% of outward flows originate from such stations, and
- average rates charged both for linehaul and through transport are at or near long run marginal costs for wagon load and full train load traffic, and economies in this form of rail transport are quite definite.

In analysing cost recovery in the road freight industry the McDonell Report compared estimates made by the Economic Road Vehicle Limit Study and the Australian Bureau of Statistics. Estimates of costs and revenues are provided in Tables 3 and 4. Revenue estimates exclude the road maintenance contribution as these charges were abolished in 1979.

McDonell qualified his results stating that the estimates of costs and revenues cannot be expected to have the precision available in other areas of economic policy making. The Report states that a principal source of variation in the estimates of costs relates to the assumption of annual distance travelled by various classes of vehicles, especially the large rigid and articulated vehicles. The Long Distance Road Transport Association were of the view that the average distance travelled by large trucks was greater than that assumed in the McDonell Report. Overall McDonell regards his cost estimates as conservative.

In estimating revenue contributed by the road freight industry, McDonell has included revenue received from the imposition of a crude oil levy. It is argued that the crude oil levy should be treated as part of the resource cost of oil rather than a contribution to road costs and, therefore, revenue from this levy is not included. However, full parity pricing was not introduced until late 1978, and the effect of part parity pricing throughout 1977-78 would be limited.

TABLE 3: ERVLS[1] COMPARISON OF COSTS AND REVENUES FOR ROAD FREIGHT VEHICLES N.S.W. 1977-78 ($M)

	Rigid Trucks >4.1tcc[2]	Articulated Trucks
COST		
Separable - pavement	34.9	52.6
- other	32.4	15.2
- sub total	67.3	67.8
Common	45.4	40.0
Total	112.7	107.8
REVENUE		
Variable revenue		
Commonwealth -		
Fuel Tax	13.8	20.2
State -		
Fuel Tax	12.4	18.4
Road Maintenance Charge	11.6	7.4
Total Variable Revenue	37.8	46.0
Fixed Revenue		
State -		
Motor Vehicle Tax	11.5	7.6
Motor Vehicle Regis.	1.1	0.3
Total Fixed Revenue	12.6	7.9
Total Revenue	50.4	53.9

1. Economic Road Vehicle Limits Study
2. tcc stands for tonnes carrying capacity

Source: McDonell, 1980, Vol iv, p. 3/43-44.

TABLE 4: ABS[1] COMPARISON OF COSTS AND REVENUES FOR ROAD FREIGHT VEHICLES NSW 1977-78 ($M)

	Rigid Trucks > 4.1tcc	Articulated Trucks
COST		
Separable - pavement	18.5	36.8
- other	32.4	15.2
- sub total	50.9	52.0
Common	26.9	31.5
Total	77.8	83.5
REVENUE		
Variable Revenue		
Commonwealth - Fuel Tax	7.2	14.0
State -		
Fuel Tax	6.5	12.8
Road Maintenance Charge	11.6	7.4
Total Variable Revenue	25.3	34.2
Fixed Revenue		
State -		
Motor Vehicle Tax	11.5	7.6
Motor Vehicle Reg.	1.1	0.3
Total Fixed Revenue	12.6	7.9
Total Revenue	37.9	42.4

1. Australian Bureau of Statistics

Source: McDonell, 1980, Vol. iv, p. 3/43-44

Table 5 shows cost recovery on a variety of bases, calculated from McDonell's work. As argued previously the most appropriate figures here are the variable revenue to separable cost percentages. On this basis heavy rigid trucks recover 27 to 39% of costs and articulated vehicles recover 52 to 57% of costs. Even on the most favourable basis for road, where total revenue is expressed as a percentage of separable costs, heavy rigid trucks recover 52 to 58% of costs and articulated vehicles recover 67 to 69% of costs. It should be noted that these rates of cost recovery appear very low, particularly when it is considered that these costs do not include accident or other external costs.

Table 6 presents costs and revenues per tonne-kilometre. These are based on McDonell's assumptions regarding the average distance travelled, truck numbers and the average payload. These numbers are instructive particularly for comparison with rail.

TABLE 5: ADJUSTED COST RECOVERY FOR HEAVY TRUCKS ($1977/78)

	Rigid Trucks > 4.1tcc		Articulated Trucks	
	ERVLS	ABS	ERVLS	ABS
Separable Costs ($M)	67.3	50.9	67.8	52.0
Variable revenue[1] ($M)	26.2	13.7	38.6	26.8
Total revenue[1] ($M)	38.8	26.3	46.5	34.7
Separable cost recovery based on total revenue (%)	58	52	69	67
Separable cost recovery based on variable revenue (%)	39	27	57	52

1. Excludes road maintenance charges

Source: based on Tables 1 & 2.

TABLE 6: ADJUSTED COSTS AND REVENUES PER TONNE-KILOMETRE

	Rigid Trucks > 4.1tcc		Articulated Trucks	
	ERVLS	ABS	ERVLS	ABS
Separable costs (Cents/tkm)	0.79	1.14	0.39	0.43
Total costs (cents/tkm)	1.32	1.74	0.62	0.69
Variable revenue (cents/tkm)	0.31	0.31	0.22	0.22
Total revenue (cents/tkm)	0.45	0.59	0.27	0.29

Source: based on Table 3 and McDonell (1980, vol. iv, p. 3/42-43) and McDonell (1979, unpublished).

McDonell concluded that rail's line haul long run marginal costs for major bulk, train load, container and full wagon load traffics are probably around 1.5-2 cents per tonne-kilometre (or 2.5-4.5 cents per tonne-kilometre on a fully allocated basis). At favourable conditions of utilisation the most efficient long distance road operators are unlikely to get much below 3 cents per tonne-kilometre, and rates sufficient to keep them in business are likely to be in the upper range of 4-6 cents per tonne-kilometre. In general, it was concluded that the scope for further technical cost saving innovations and productivity improvements in line haul road freight transport were quite limited, so these relationships are unlikely to alter in road's favour in the near future.

LONIE REPORT

(Victorian Transport Study Group 1980)

The Lonie Report was a study of all freight and passenger transport within Victoria and to and from Victoria, with the object of reporting and making recommendations on specific issues and aspects of transport in Victoria.

The 1978-79 VicRail Board Annual Report disclosed the order of contributions to fully allocated costs represented by income associated either directly or indirectly with the major business segments as follows:

Victorian Freight	:	57%
Intersystem Freight	:	96%

On examining cost recovery from road transport, Lonie quotes from a paper presented by Both (1980) of the Country Roads Board. In this paper Both has updated the separable pavement costs presented in the Meech Report, and in general concludes that all articulated trucks are paying 0.6 cents to 1.1 cents per truck-kilometre less than separable pavements costs when the crude oil levy is excluded.

The Lonie Report maintains that rail has inherent advantages over road in interstate freight transport. Of the four major commodities and six other commodities that provide a principal feature of interstate rail freight, only the manufacturers products and LCL goods fail to cover avoidable costs through revenue collection.

ACCIDENT COSTS

Accidents are the most easily identified and readily measured of external costs. They are also the most expensive in both a financial and a resource sense. In contrast to road accidents, the number of rail accidents that have effects external to the rail organisations and their customers are limited, consequently only road accidents are discussed in this section.

TABLE 7: ROAD ACCIDENTS BY LOCATION AND VEHICLE TYPE IN VICTORIA 1977 to 1979

	1977			1978			1979		
Melbourne Stat. Div.	Fatal	Injury	Total	Fatal	Injury	Total	Fatal	Injury	Total
Articulated Trucks	14	170	184	15	187	202	19	185	204
Other Trucks	34	515	549	41	500	541	32	513	545
All Vehicles	571	15401	15972	548	15989	16537	548	15663	16211
Other Cities, Towns & Burroughs									
Articulated Trucks	6	50	56	9	47	56	5	54	59
Other Trucks	5	60	65	11	90	101	12	63	75
All Vehicles	159	2914	3073	154	3033	3187	146	2838	2984
Rest of Victoria									
Articulated Trucks	31	116	147	24	94	118	20	104	124
Other Trucks	16	85	101	19	85	104	15	86	101
All Vehicles	348	2687	3035	333	1816	2149	298	2550	2848
Total									
Articulated Trucks	51	346	397	48	328	376	44	343	387
Other Trucks	55	660	710	71	675	746	59	662	721
All Vehicles	1078	21002	22080	1035	30838	21873	992	21051	22043

Source: Road Safety and Traffic Authority, Victoria.

Table 7 presents number of accidents in Victoria from 1977 to 1979 by area and vehicle type. It is difficult to present a national summary of road accident statistics as the States have differing definitions of accidents, but the number of accidents per 100,000 of mean population in Victoria is one of the lowest in Australia and the Victorian statistics provide an indication of the number of injuries and deaths that occur as a result of road accidents.

The readily identifiable cost of accidents is not limited to damage to vehicles and property, health and insurance costs but also includes lost work time, possible permanent physical disability, ambulance costs, and police costs. The McDonell Report estimated that for 1977-78, the cost of accidents in NSW attributable to heavy vehicles alone was about $38M. This estimate includes assessments of the following:

- property damage costs,
- loss of productivity and output due to fatility and injury (using a discounted value of the victim's expected future earnings),
- medical and hospital costs,
- subjective costs (pain and suffering, grief and bereavement), and
- incidental costs (legal and court costs, temporary loss of use of vehicles, and administration costs).

Using McDonell's separable road cost estimates, the inclusion of the $38M accident costs would add approximately 0.2 cents per tonne-kilometre or approximately 30% to the costs attributable to heavy trucks. Andrews and Lacey (1980) estimate that in 1978-79 the cost of road accidents involving trucks in Victoria was $35M, nearly 0.5 cents per tonne-kilometre. These costs were estimated on medical, legal, insurance and loss of production costs, and estimates of overhead costs.

CONGESTION COSTS

The economic cost of a railway or road freight movement depends not only upon the nature of that movement but also upon the flows of existing traffic on the route. How the movement in question may delay other traffic depends upon the nature of the other traffic. The distinction between delay costs for road and rail traffic is that the costs are internal to the railways and reflected in their expenses, but are external to the road operator.

According to the Commission of European Communities (1976) speed to flow relationships are as defined by equations 1 and 2 below.

$$s = a + bv \qquad (1)$$

where s is the speed of traffic,
v is the flow of vehicles along the route per unit time,
a & b are constants determined by the characteristics of the route.

and

$$t1 = \frac{bv}{(a - bv)^2} \qquad (2)$$

where t1 is increase in total time taken by all other vehicles to travel a unit distance as a result of a unit change in the flow v.

The flow v is measured in passenger car units, with trucks being represented by two or three passenger car units.

It should be noted that these formulae will apply only when the flow v exceeds some threshold level and that more complicated formulae may be used for urban traffic flow where delays occur largely at intersections.

Were appropriate data collected, the calculation of congestion costs can be readily accomplished for specific corridors. However this has not been done in any of the studies reviewed here and consequently is not included, though it clearly should be included in a comprehensive analysis of cost recovery.

NOISE AND POLLUTION COSTS

The noise level is measured in decibel units (db(A)) - which relates to responses of the human ear. As reported in the McDonell Enquiry, it has been widely accepted that noise levels which ought not be exceeded for more than 10% of the time should be:

	db(A)
Country Areas Daytime	40
Suburban Areas Daytime	45
Busy Urban Areas Daytime	50

There are no in-service noise regulations for trucks and buses in NSW, even though in-service noise regulations for cars and motor cycles were introduced there from January 1, 1979. In Victoria, maximum in-service noise levels for trucks and buses have been set at 95db(A) at 7.5 metres, a limit which has been suggested is too high.

The McDonell Report, in conjunction with Unisearch Limited and using data from the Universities of Wollongong and New South Wales, conducted its own study of noise levels. Results of the surveys in the Wollongong area indicated a disproportionate contribution of heavy trucks to levels of unacceptable noise. Data for three sites in the Sydney Metropolitan area showed that the average maximum levels differed by nearly 8db(A) between private cars, and medium and heavy trucks. It should be noted that 10db(A) is equivalent to a doubling of loudness. Results also showed that a large proportion of medium and heavy trucks were operating at very high, and in many cases, unacceptably high noise levels.

Andrews and Lacey (1980) estimated that noise pollution costs in Victoria in 1977-78 were approximately .18 cents per tonne-kilometre. They based this estimate on a UK study conducted by Llewelyn Davies Weeks et. al. (see Andrews and Lacey, 1980) which estimated that noise pollution due to trucks ranged from 3 to 5 times the corresponding costs of air pollution for different types of vehicle.

Exhaust pollution is a social cost that receives much publicity and is a cost that relates more directly to road transport. Petrol engines, whether from cars, buses or trucks, are the main source of carbon monoxide and particulate lead in exhaust gases. While diesel trucks and buses generate comparatively little of these dangerous compounds, the heaviest diesel truck may emit 10 times as much smoke and particulate pollution as a car, and much more under particularly adverse conditions. Obviously, the problem of pollution from exhaust fumes is most pronounced in metropolitan areas. While diesel locomotives also contribute to pollution, their numbers and frequency of use are much less than road transport. Similarly, the rail infrastructure is more confined than the road network. Andrews and Lacey (1980) estimated the average cost of air pollution attributable to instrastate road freight as being .06 cents per tonne-kilometre. However, they indicate that this estimate is based on an attempt to relate US data to Victorian conditions and recognise that there may be quite substantial errors in such an approach.

Noise and pollution costs are of course most significant in urban areas and country towns through which heavy vehicles pass. Part of these costs should be included in rail costs, where the road vehicle provides a feeder service to the rail service. Costs in urban areas for heavy trucks are clearly a cost of heavy vehicle operation which should be recovered to meet the criteria for economic efficiency.

In this paper, where comparison with rail line haul is being undertaken, it is more appropriate to delete the noise and pollution costs incurred on trips within urban areas. As the split of costs between urban trips and rural trips is unknown, and as the estimates are somewhat dubious, these costs are not included in any of the comparative tables to follow.

Other social costs are principally experienced in urban areas and country towns. While the effects of social impact can readily be described and measured, they are notoriously difficult to measure in dollar terms (for example, see Rattray and Stanley, 1978).

A COMPARISON OF COST RECOVERY RESULTS

Table 8 summarises the range of separable road costs and variable revenues attributable to heavy vehicle usage estimated by the studies reviewed in this report. For ease of comparison, all values have been converted to 1979/80 prices using the weighted average of the Consumer Price Index for seven capital cities.

TABLE 8: ESTIMATES OF SEPARABLE ROAD COSTS AND VARIABLE REVENUES ATTRIBUTABLE TO HEAVY VEHICLE USAGE

1979/80 PRICES

	COSTS Cents/tkm			REVENUES Cents/tkm			RECOVERY %		
	Rigid	Artic-ulated	Total	Rigid	Artic-ulated	Total	Rigid	Artic-ulated	Total
(i) Pavements cost only included.									
Meech (National)	.33	.44	.39	.34[2]	.42[2]	.39	103	95	100
McDonell (NSW)	.49	.36	.41	.37	.26	.29	69	72	71
(ii) total road separable costs included									
McDonell (NSW)	1.16	.48	.68	.37	.26	.29	32	54	43
Bland (Victoria)	-	-	1.36	-	-	.68	-	-	50

1. Values presented are the average of ERVLS and ABS estimates.
2. The revenues shown are overestimated as they are based on total national revenue from the truck class indicated.

Some of the disparities that are apparent in these estimates can be explained through the different elements of costs that are included in each case. The Meech Report only included separable pavement costs and did not include additional expenditures necessitated by heavy vehicle operation. Revenue in the Meech report is overestimated as it includes revenue from all heavy vehicle operation whereas costs are based on travel on arterial roads only. Although all reports indicate that neither heavy rigid trucks nor articulateds are recovering separable costs, there are significant differences in estimated rates of recovery.

The addition of accident costs to these cost estimates considerably reduces the rates of cost recovery, as presented in table 9.

TABLE 9: ESTIMATES OF COST RECOVERY OF ALL HEAVY TRUCKS AFTER INCLUDING ACCIDENT COSTS

1979/80 PRICES

	COSTS cents/km	REVENUES cents/km	RECOVERY %
Bland (Victoria)[1]	1.93	.68	35
Meech (National)[1]	.96	.39	41
McDonell (NSW)[2]	.91	.29	32

Notes: 1. Costs include estimates of accidents made by Andrews and Lacey (1980).
2. Costs include accident costs estimated by McDonell (1980, Vol. v).

Based on cost estimates presented in this paper, heavy trucks would need to increase their rates by from .6 cents per tonne-kilometre ($1979/80) to 1.2 cents per tonne-kilometre or by approximately 60% to 65% to fully recover separable costs. Rail, on the other hand is thought to recover avoidable costs for long haul bulk freight. McDonell concluded that of the rail freight traffic, only less than car load, specialised small goods and some merchandise goods fail to recover costs. Major bulks and trainload traffic cover avoidable costs and make a contribution to fixed costs. The VicRail Board Annual Report 1978/79 supported this finding indicating that within country freight operations, intersystem freight recovered 95% of its fully distributed costs.

Perhaps the most appropriate comparison of road and rail's cost efficiency for long haul bulk freight was made by McDonell where he concluded that rail's line haul long run marginal costs for major bulk, trainload, container and full wagon load traffics are probably around 1.5 to 2.0 cents per tonne-kilometre. Road operators, on the other hand, are unlikely to get much below 3 cents per tonne-kilometre and rates sufficient to keep them in business are likely to be in the upper range of 4 to 6 cents per tonne-kilometre.

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