AUSTRALASIAN TRANSPORT RESEARCH FORUM

Australian Road Track Cost Allocation

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Abstract:

ARRB is currently undertaking research aimed at refining a national pay-as-you-go (PAYGO) road track cost allocation process. The research initially involved a review of several overseas road track cost allocation practices. All the practices reviewed use some form of cost-occasioned PAYGO road costing approach to fund their annual road track expenditure. The annual road user charges are based on assignment of the separable and non-separable road track costs. Using a common set of road track costs, a comparison between the overseas cost allocation methods showed a wide variation in the portion of the costs treated as separable. Future Australian cost allocation research should confirm the separable and non-separable road track cost portions, and provide a sound basis for separable cost allocation.

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Introduction

The Australian Road Research Board (ARRB) is currently undertaking research aimed at refining a national pay-as-you-go (PAYGO) road track cost allocation process. This research is a consequence of the former Inter-State Commission (ISC) recommendations (ISC 1990) on national road user charging. The ISC requested the commencement of a PAYGO based road user charge system from July 1992.

The first step in refinement of the Australian road track cost allocation process involved a review of the road track cost allocation practices of New Zealand, South Africa, the United Kingdom and the United States (Martin 1991). The review examined the methods, objectives and relevance of overseas practice to Australian arterial roads.

Most of the terms used below are defined in a glossary at the end of the paper.

Overseas practices: general findings

Revenues and charging

All the overseas practices reviewed use some form of cost-occasioned PAYGO road costing method to either fully or partially fund the total annual road track expenditure on their road networks. The road user charges for each vehicle class are a result of the allocation of the separable and non-separable road track costs to them. All the PAYGO practices use an average cost-occasioned approach to allocate the separable road track costs. The non-separable road track costs are allocated arbitrarily to achieve complete allocation of all road track costs.

Marginal cost approaches to the allocation of separable road track costs are difficult to apply because of their obvious estimation difficulties in either the short or long-run. Even the New Zealand road costing approach is strictly not a marginal cost method, as the average cost-occasioned impact of each heavy vehicle class is only weighted by the actual distance each vehicle travels.

Marginal costing aims to achieve economically efficient resource allocation, while PAYGO aims to achieve annual recovery of all the road track costs. Marginal separable road track costing could be incorporated into the PAYGO road user charges, but the non-separable road track cost allocation component of the road user charge would probably mask the marginal separable road track costs.

Most of the overseas cost allocation processes usually include a taxes/charges component on new vehicles and equipment in their road user revenue stream. The UK and the US apply the general principle that where a sales tax or excise duty is greater than the general level of taxation (relating to sales or excise), the excess is treated as a specific road user charge. New Zealand has no taxation on road users above the general services taxation (GST) level.

Total road track costs

Overseas cost allocation practices consider that the capital, maintenance, operating and administrative expenditures comprise the total road track cost. External costs, such as noise and air pollution, are not included, implying that overseas practices regard external costs to be extremely difficult to quantify and allocate on a cost-occasioned basis. This is contrary to OECD policy (OECD 1986) which recommends including the indirect social and environmental costs of the service provided by roads. However, New Zealand and the US are currently considering road user charge proposals that include the marginal cost of congestion (van Geldermalsen 1991, Small et al 1989).

The South Africa PAYGO approach converts past and present capital road infrastructure expenditure to an equivalent annual capital cost assuming a given economic life and annual discount rate (Prins 1988, SA DOT 1991). The other PAYGO practices treat capital expenditure as a current cost to be written off in the year of its expenditure, assuming the infrastructure's depreciation and opportunity costs are approximated by the annual construction and reconstruction expenditure

When capital is treated as a current cost and quantum changes in annual capital expenditure occur, the annual capital expenditure cannot always be equivalent to the infrastructure's annual depreciation and opportunity costs. Marked annual changes to the estimates of road infrastructure depreciation and opportunity costs are not realistic. The current cost approach to annual variations in capital expenditure can also cause significant fluctuations in the estimated annual road user charges, unless the capital expenditure variations are offset by corresponding changes in the annual maintenance expenditure.

Preliminary calculations show that the South African equivalent annual capital cost approach has the following features:

(i) When the real discount rate is greater than 7%, the equivalent annual capital cost is higher than the annual average capital expenditure, *assumed to be the average of each year's capital expenditure over the life of the road infrastructure*. The conventional PAYGO road user charges under compensate for the cost of capital in this scenario;

(ii) When the real discount rate is less than and equal to 7%, the equivalent annual capital cost is lower than annual average capital expenditure. The conventional PAYGO road user charges over compensate for the cost of capital in this scenario;

The South African treatment of road infrastructure capital expenditure is the closest approximation to a theoretical approach that includes allowances for depreciation and opportunity cost over its economic life (Haritos 1975 and 1979, Gittings 1987, Button 1987).

Table 1 Cost allocation parameters against ATAC road track activities

Road Track Activity ATAC Description	% Separable Costs				% Non-Separable Costs		
	VKT	GVM	ESA	% Total	PCU	VKT	% Total
A Servicing & operating expenses							
B Road Maintenance • Pavement and shoulder activities, excluding reseals • Reseals/enrichments • Other							
C Bridge Maintenance, Rehabilitation & Strengthening • Load or impact related • Other							
D Pure Road Asset Rehabilitation • Pavement reconstruction and reshaping							
E Traffic Management/Low Cost Safety, Capacity, Improvements							
F Minor Asset Extensions or Improvements • Significant intersection upgrades, excluding signals • Pavement component of auxiliary lanes, other widening, major realignment or regrade • Bridge widening • Other							
G Major Asset Extensions • Pavement component of new routes, significant new lane lengths, new carriageways or interchanges • New or replacement bridges • Other							
H Other Miscellaneous Activities • Miscellaneous works expenditure • Corporate services • Administration of vehicle registrations • Administration of driver licensing (where applicable)							
Totals							

Road track cost allocation

The UK and South Africa apply a general form of the road track cost-occasioned allocation process (general aggregated cost allocation method) to different road classes. Other practices apply a specific cost allocation process (specific aggregated cost allocation method) to each road class. Both these methods assign road track costs to road users with cost allocation parameters selected by empirical evidence and judgement. Cost allocation is achieved by applying varying portions of the allocation parameters to each road track expenditure activity. The US uses incremental cost allocation methods to allocate Federal capital expenditure (US DOT 1982, 1988). The US State of Indiana uses incremental cost allocation methods to allocate separable capital and maintenance road track costs (Fwa et al 1990).

Increased transparency of cost allocation is evident where the road track activities are arranged on the basis of whether they are capital or maintenance and operational activities. This approach is practised in the UK, the US and South Africa. Currently the Australian Transport Advisory Council (ATAC) cost allocation template does not clearly distinguish between these divisions of activity in its layout. In particular, it is not clear whether work activities D and F in the ATAC template are either capital or maintenance works or a combination of both (see Table 1).

Comparisons between overseas road track cost allocation methods

Separable costs

The overseas cost allocation methods were compared using the ATAC road track activity template as the common reference for allocating separable and non-separable road track costs. This involved establishing equivalencies between the ATAC and the overseas road track activities (see Appendix G, Martin 1991).

The overseas cost allocation methods were applied to the Australian arterial road track expenditure of 1988/89 (ISC 1990) to compare the variation in the separable cost defined by each method. All costs were expressed as a percentage of total road track expenditure. The separable cost defined by the overseas methods varied from 16.3% to 52.4% of the 1988/89 road track expenditure (see Table 2). This variation indicates significant differences in overseas definitions of separable costs. Some of this variation may, however, be due to inconsistencies in the equivalencies established between the ATAC and overseas road track activities.

The load related portion of the separable costs, regarded as ESAs or ESA-kms, allocate on average, 58% of the separable costs and over 21% of the total costs (see Table 2). The cost allocation methods all consistently determined ESAs on the basis of the fourth power law. The issue of the fourth power law, used to distribute 58% of the separable costs to the heavy vehicle classes, is a second order concern in this context where there is such dramatic variation in the defined separable costs.

The 1988/89 Australian arterial road track expenditure was separated into the percentage expenditure on capital and maintenance activities (see Table 3). Between 20% and 59% of the 1988/89 capital expenditure is treated as a separable cost by the overseas allocation methods. Load related parameters (ESAs or ESA-km) allocate on average 56% of the separable cost portion of the capital expenditure. Less variation is observed in the treatment of maintenance expenditure where 40% to 62% of the 1988/89 maintenance expenditure is treated as a separable cost. The load related parameters allocate on average 70% of the separable cost portion of the maintenance expenditure.

ESAs are a significant allocator of separable maintenance and capital expenditure. As a greater portion of the future Australian road track expenditure is expected to be on maintenance, the accurate determination of load related cost allocation parameters, such as ESAs, will become more important. Under these circumstances it will be necessary to consider power laws that vary with the nature of pavement distress (Paterson 1987) when calculating ESAs.

On average, the allocation of the separable maintenance expenditure by overseas cost allocation processes requires a greater proportion of load related allocation parameters than that required for the separable capital expenditure. The New Zealand allocation processes are the only ones that are contrary to this trend (see Table 3). Load related parameters are the most significant in allocating separable maintenance and capital expenditure. Capacity related parameters, such as PCUs, are not used significantly in allocating separable costs (see Table 4). The overseas practices distinguish between separable and non-separable expenditure by determining what is load and non-load related road track expenditure.

Table 2 Proportion of separable and ESA based costs. Allocation of Australian arterial road track expenditure for 1988/89[1]

Cost Allocation Method	Percentage of Total Costs		
	Separable Costs (i)	ESA Based Costs [2] (ii)	(ii)/(i) %
US State and Local Roads, Indiana	39.2	28.7	73
UK, Motorways	42.5	24.1	57
UK, Trunk Roads	34.8	18.9	54
UK, Principal Roads	33.6	17.6	52
South Africa, National. Provincial	16.3	13.5	83
Roads and Municipal Roads	–	–	–
NZ, State Highways	52.4	20.0	38
NZ, Local Authority Roads	50.9	26.0	51
AVERAGE	**38.5**	**21.3**	**58**

Notes:

1. Expenditure sourced from ISC 1990 Vol. 2 using weighted average percentages of Australian Road Authority costs.
2. These were either ESA-km or ESAs treated as separable costs by the cost allocation method

Table 3 **Proportion of separable and ESA based costs for capital and maintenance activities of Australian Arterial Road Track Expenditure for 1988/89** [1]

Cost Allocation Method	% of Capital Activities [2]			% of Maintenance Activities [3]		
	Separable Costs (i)	ESA Based Costs [4] (ii)	(ii) / (i) %	Separable Costs (i)	ESA Based Costs [4] (ii)	(ii) / (i) %
US State & Local Roads, Indiana	49.3	27.4	56	59.3	58.5	99
UK, Motorways	36.3	24.6	68	62.2	45.6	73
UK, Trunk Roads	24.8	11.0	44	57.0	42.6	75
UK, Principal Roads	26.1	11.3	43	53.3	39.6	74
South Africa, National Provincial & Municipal Roads	20.2	15.1	75	25.2	23.7	94
NZ, State Highways	59.0	24.6	42	50.4	18.9	38
NZ, Local Authority Roads	47.6	29.9	63	40.0	15.9	40
AVERAGE	**37.6**	**20.6**	**56**	**49.6**	**35**	**70**

Notes:

1. Expenditure sourced from ISC 1990 Vol. 2 using weighted average percentages of Australian Road Authority costs.
2. Capital costs considered to be ATAC categories F and G.
3. Maintenance costs considered to be ATAC categories B, C and D.
4. These were either ESA-km or ESAs treated as separable cost by the cost allocation method.

Table 4 Cost allocation parameters
Applied to Australian arterial road track expenditure for 1988/89[1]

Cost Allocation Method	Percentage of Total Costs													
	Separable Costs								Non-separable Costs					
	Max GVM -Km	Av. GVM -Km	GVM[2] -Km	ESA -Km	VKT	PCU -Km	ESAs	GVM	Veh Pop.	Power Veh. Pop.	GVM	ESAs	VKT	PCU -Km
US State and Local Roads, Indiana	-	-	-	-	3.7	3.6	28.7	3.2	-	-	-	-	60.8	-
UK, Motorways	5.5	12.9	-	24.1	-	-	-	-	-	-	-	-	27.5	30
UK, Trunk Roads	6.5	9.4	-	18.9	-	-	-	-	-	-	-	-	29.8	35.4
UK, Principal Roads	7	9	-	17.6	-	-	-	-	-	-	-	-	31.6	34.8
South Africa, National, Provincial and Municipal Roads	-	-		13.5	2.8	-	-	-	-	-	-	-	38.8	44.9
NZ, State Highways	-	-	19.2	20	13.2	-	-	-	12.3	13.1	12.6	9.6	-	-
NZ, Local Authority Roads	-	-	17.2	26	7.7	-	-		21.7	7.4	11.4	8.6		

Notes:

1. Expenditure sourced from ISC 1990 Vol. 2 using weighted average percentages of Australian Road Authority Costs

2. GVM-Km is equivalent to Av. GVM-Km under average costing.

On average, the allocation of the separable maintenance expenditure by overseas cost allocation processes requires a greater proportion of load related allocation parameters than that required for the separable capital expenditure. The New Zealand allocation processes are the only ones that are contrary to this trend (see Table 3). Load related parameters are the most significant in allocating separable maintenance and capital expenditure. Capacity related parameters, such as PCUs, are not used significantly in allocating separable costs (see Table 4). The overseas practices distinguish between separable and non-separable expenditure by determining what is load and non-load related road track expenditure.

Allocation parameters and non-separable costs

The range of cost allocation parameters used by the overseas methods for the allocation of separable and non-separable 1988/89 Australian road track costs is shown in Table 4. A wide variation in the parameters used is apparent; the same parameters are occasionally used to allocate the separable and non-separable costs in some allocation methods. The most commonly used separable cost allocation parameters in descending order of use are ESA-km, GVM-km and VKT. For non-separable costs, the most commonly used allocation parameters in descending order of use are VKT and PCU-km. In Australia, the allocation of non-separable costs on an economic efficiency basis has been proposed (Luck and Martin 1988).

The exclusive use of separable cost parameters, such as ESAs, PCU-km, GVMs and VKT, to allocate all non-separable costs is not consistent with cost allocation based on a cost-occasioned process. Most overseas practices adopt a short-run approach in which the non-separable costs are the sum of the joint and common costs. Common costs are cost-occasioned and allocated by separable cost parameters. However, joint costs are not cost-occasioned so they cannot be allocated by separable cost parameters. The practice of only using separable cost parameters to allocate non-separable costs therefore does not have a theoretical basis.

The above practice confirms that the allocation of the non-separable joint costs is a fairly arbitrary process. Non-separable costs can be arbitrarily allocated to road users on either an equity or beneficiary basis. The common overseas practice of using VKT and PCU-km to allocate non-separable joint costs indicates that these allocators are selected on an equity basis. The use of vehicle population as an allocator of non-separable joint costs in the New Zealand process is evidence of the beneficiary approach applied to non-separable cost allocation.

Future cost allocation research in Australia

Fundamental requirements

The research requirements are based on the assumption that the initial Australian road track cost allocation process will be an aggregate cost allocation method, applicable only to rural and urban arterial roads at either a State or national level. Roads used for local access are excluded.

Initially the Australian cost allocation process will require the assignment of individual road track activities into portions of separable and non-separable cost. This assignment is contentious for capital and maintenance road track activities.

The division of capital expenditure into separable and non-separable road track cost can be objectively achieved with a sound understanding of Australian road design and construction practice. This approach assumes that the road infrastructure has a minimum standard that would meet the non-load requirements of environment and general traffic capacity, and therefore defines the non-separable costs. The road infrastructure load and specific capacity requirements consequently define the separable costs.

The division of maintenance expenditure into separable and non-separable cost should be based on determining what is load and non-load related road track expenditure. This division is difficult to make because of complex site specific load and non-load interaction effects. Studies of load and non-load related deterioration of road infrastructure (including interaction effects) under varying conditions of road use, environment and maintenance practices are therefore required to do this.

The allocation of separable road track expenditure is the next step in the Australian cost allocation process. Separable capital expenditure can be allocated by incremental cost allocation methods that are refined sufficiently to equitably deal with pavement thickness (Fwa and Sinha 1985), pavement width (US DOT 1982), and bridges (US DOT 1982, Tee et al 1986). Studies of the general effect of these allocation methods on capital expenditure are required to develop an Australian aggregate cost allocation method.

Once the separable pavement maintenance and rehabilitation expenditure has been determined it can be allocated by incremental cost allocation methods (Fwa and Sinha 1985 and 1986). Other forms of separable maintenance expenditure require a more arbitrary approach. Studies of the general effect of these allocation methods on maintenance expenditure are required for an Australian aggregate cost allocation method.

The significance of ESAs in the allocation of separable capital and maintenance expenditure is evident from the review of overseas practice. Long term studies of the appropriate power laws in the calculation of ESAs for various conditions of pavement distress are currently underway in Australia and overseas. However, it is expected to be at least four to five years before conclusive evidence is available on this issue (Paterson 1990).

Research proposed

ARRB is currently undertaking an historical study of road deterioration on a sample of urban and rural arterial roads. This study is aimed at refining an Australian arterial road track cost allocation process by providing preliminary assessment of the separable and non-separable cost portions of road maintenance expenditure. The study will review road deterioration (defined by pavement surface roughness) and the corresponding traffic load (cumulative ESAs, GUMs, PCUs), under different environmental conditions and maintenance practices, over a five year period. A report on this study is expected by March 1992.

A two to three year extension of the above study is planned by annually monitoring the road roughness and traffic load on the road sample selected. This study should provide up to eight years of continuous road performance data. The eight year period is expected to "capture" significant road deterioration and/or improvement in its response to maintenance, traffic and environmental factors. The information from this study should allow further refinement of an Australian arterial road track process.

The confirmation of separable and non-separable road capital expenditure portions is mainly a design and construction matter. A study of current capital works will be initiated to determine the non-separable cost portion on a design basis. The separable capital cost allocation parameters will be estimated using incremental cost methods.

Future cost allocation refinements

Separable cost allocation

All the overseas PAYGO approaches use some form of average costing in the allocation of separable road track costs. There are equity problems with this approach as all vehicles within the same class do not have the same cost-occasioned impact on the road network. This limitation can be partly overcome by increasing the number of individual vehicle classes, thereby reducing the cost-occasioned impact differences between individual vehicles within the same class.

Accurate estimation of each vehicle's cost-occasioned impact on the road network are possible in the future if the current advances in electronic hardware are maintained. However, the limitations to this approach are political concerns about privacy, and the possibly high establishment and administration costs. However, improved estimates of separable road track cost may not be warranted when the arbitrary nature of non-separable cost allocation is considered.

Road track costs: capital

The South African treatment of road track capital expenditure is the most realistic treatment of capital of all the overseas practices reviewed. Once decisions are made about the economic life and discount rates that are appropriate to Australian road infrastructure, the equivalent annual capital cost treatment could be incorporated into an Australian cost allocation process.

Conclusions

ARRB has recently completed a review of four overseas road track cost allocation processes as part of the refinement of an Australian PAYGO road track cost allocation process. The following summarises the overseas approach to road track cost allocation:

(i) PAYGO is used to either fully or partially fund the annual road track expenditure;
(ii) The annual road track cost covers capital, maintenance and operating expenditures. External costs are currently excluded;
(iii) PAYGO is applied to all roads in the network, except roads used for local access;
(iv) Average costing is the basis for allocating the cost-occasioned separable road track costs. An arbitrary approach is adopted for the allocation of non-separable road track costs;
(v) All overseas practices treat their annual capital expenditure as a current cost, except South Africa;
(vi) When comparisons are made between the overseas cost allocation methods, wide variations occur in the portion of the annual road track cost that is defined as a separable cost.

The overseas review demonstrated that the following factors should shape the future Australian PAYGO road track cost allocation process:

(i) The determination of the portions of road track cost that are separable and non-separable;
   - The separable portion of capital expenditure can be assessed from a study of Australian road design and construction practice.
   - The separable portion of maintenance expenditure can be assessed from studies of road infrastructure deterioration in response to traffic load, environment and maintenance practices;

(ii) The allocation of separable capital and maintenance expenditure. Studies applying incremental cost allocation methods to the separable road track expenditure can be used to develop an aggregate road track cost allocation method;
(iii) A realistic commercial treatment of the annual capital road track expenditure. The South African equivalent annual capital cost approach is worth considering.

Glossary of terms

Common Costs are those that are attributed to two or more road user groups (vehicle classes) in determinable proportions, on a cost-occasioned basis.

Cost-occasioned road track costs are those that are directly caused by the road users.

ESA, equivalent standard axle, is the measure of the relative effect of any load and axle configuration on a road pavement in terms of the number of passes of a standard reference axle.

GVM is the gross vehicle mass.

Joint Costs cannot be avoided even if any one road user group (vehicle class) is not present in the traffic stream. They cannot be directly attributed to road user groups on a cost-occasioned basis, and therefore any cost allocation to the road user groups is technically arbitrary.

Non-separable Costs are only joint costs, excluding common costs, in the long-run. However, in the short-run, common costs are not variable with road use so they are included with the joint costs as part of the non-separable costs.

PCU, passenger car unit, is a measure of the amount of road space occupied by a vehicle under given conditions relative to a standard passenger car.

Road Track Costs are the sum of the annual capital, maintenance and operations expenditures associated with the road infrastructure.

Separable Costs are the sum of the directly and uniquely attributable costs of particular road user groups and the common costs in the long-run. Common costs are responsive to changes in road use in the long-run so they are separable. However, separable costs include only the directly and uniquely attributable costs of particular road user groups in the short-run. Common costs are neither variable with road use nor separable in the short-run.

VKT is vehicle kilometres travelled.

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