Negative Investment in Transport Facilities with Reference to Rural Railway Goods Services

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ABSTRACT

The paper postulates that the normal private firm practice of selling off unprofitable assets is, in effect, negative investment, and that similarly, the closing down of publicly-owned transport facilities may be regarded as negative investment. It examines an example of rural railway facilities which may be closed down while yet the remaining system would provide a better service to the user at lower cost to the railway operator.

A FIRM AND ITS ASSETS

Private enterprise firms are normally established in business by raising finance to buy assets to produce goods and services. In turn the prices paid for the goods and services cover the operating and maintenance costs of the asset, the interest on borrowed capital, taxation and the shareholders' profits.

If an asset produces goods or services which fail to cover those items, leaving no profit for the shareholders, the firm is obliged to examine inter alia the possibility of selling the asset as an alternative to accruing further losses.

In many cases of course, such action may be a last resort for the firm. This is specially so if the asset is the firm's only investment. A firm having some remnant assets still has the chance of continued profitability by concentrating on the output of those remaining assets. Even the single asset firm, before selling off the asset and cutting its losses, will examine alternative production for the asset.

NEGATIVE INVESTMENT

If all the alternatives appear unprofitable and the firm decides to sell the asset at market value, a negative investment occurs. Immediately there are savings:-

(i) The operating cost;
(ii) the maintenance cost;
(iii) the taxation elements of the above, and
(iv) some or all of the capital interest charges.

Additionally, there may be some cash in hand available for alternative investment. The revenue derived from the asset is lost of course, but since this was not covering the cost, there is a net saving.

So far, the matter is normal for private firms. In Australia, private transport firms are involved in providing services on roads, in the air and at sea. Passenger services are provided by bus companies, taxi and hire car services, airlines, shipping companies and ferry companies. Goods transport is provided by road carriers, air cargo services and shipping companies. All or most of these use facilities provided by the State: the roads, the airports, the harbours, navigational aids, and wharves.

The State is also involved in the supply of transport for both passenger and goods movement. Railways, Trans Australia Airlines, Australian National Line and government ferry services are examples of State enterprises which actually transport goods and/or passengers.

NEGATIVE INVESTMENT IN TRANSPORT FACILITIES

Public passenger transport in major cities is also provided by State or publicly-owned enterprises. None of these publicly-owned urban passenger transport services are currently covering their operating and maintenance costs from the fare-box revenue.

Notably, most of the State-owned railways similarly operate at a loss. Indeed, as the Australian Minister for Transport recently indicated, some of them are not covering their salary and wages from traffic revenue. (Jones, C.K., 1975)

Private transport firms frequently sell rolling stock, plant and equipment, whose output is no longer profitable. In some cases this is done without replacement by new assets.

Attempts to close State-owned transport services or facilities almost invariably lead to political action opposing the attempts. Whether such opposition is well or ill-advised is undocumented. Usually the efforts to inform the bodies opposed to the closure consists of statements showing how little the services are used and how much State finance is lost by running the service. The usual response is to say "But it's a public service to me the taxpayer". Each side then seems to adopt an "honour is satisfied" shrug of the shoulders and leaves it to the politicians to decide.

Significantly, between 1941 and 1971 only 2212 miles of line (approximately 8 per cent) out of 27 234 government owned railways in Australia were closed to traffic despite a general history of increasing financial losses. It should be possible to show in many cases, that closing the rail service will result, not only in savings to the operator, but also better service to many users. This apparent paradox is the result of the inherent character of railway operations.

Railway trains operate most efficiently under bulk demands; either bulk numbers of wagons or wagons full of bulk loading. A large proportion of the train operating cost per mile of haul is independent of the load or number of wagons on the train. The crew's wages is a typical such part of the train operating cost. Consequently, trains are not scheduled to run unless there is a likely loading heavy enough to justify the running. Road carriers on the other hand, operate their trucks with much smaller loads.

The end result is that on many branch line railways, the service on the line is well below 5 or 6 trains per week; while on main lines, more than 6 trains per day are available to stop. On such branch lines, the users frequently find that only on 2 or 3 days per week, are trains available to them and that even so, a road carrier is prevented by regulation from supplying an alternative more frequent service. Table 1 shows a recent set of typical values of annual average goods train headways.

ALTERNATIVES AND POSSIBLE BENEFITS

There appears to be a prima facie case for further integration of the road carrier and the rail services in such cases. Indeed, it may be worthwhile examining the integrated services as an alternative to the combined main line and the branch line railway services.

The use of road carriers as feeders to the mainline railway rather than as feeders to branch lines, would lead to significant user benefits. Notably, among these is the ability to send and receive consignments on any day rather than only on nominated loading days or train arrival days respectively.

The degrees of feeder service and of mainline service require rational means of designation or identification.

RATIONALE

Transport is a network activity spread over a more or less complicated web of links and nodes wherein nodes represent origins, destinations and junctions, and links represent the tracks or activities between the nodes.

Taking as our sample case goods movement between origins and destinations, as operated under regulations in Victoria as they existed at the time of Sir Henry Bland's Inquiry into Land Transport in that State, 1971 (Victoria 1971/72), a typical movement may be described as follows:-

From origin to rail station by road	(access)
Unload, hold, load on rail at origin station	(transfer)
Line haul on rail to destination station	(line-haul)
Unload, hold, load on road truck at destination station	(transfer)
From rail station to destination	(egress)

It can be seen that there are five distinct parts to the movement.

These can be represented on a traffic network quite readily so that a study of traffic flowing in the network appears possible as a step toward a rational analysis of goods flow on the network. Figure 1 shows a typical example of a network suited to such a study.

VICTORIAN RAILWAYS GOODS TRAIN RUNNING
ARARAT DISTRICT 1969/70

Section		Number of trains two-way, annually	Annual average headway between trains, one-way (days)
From	To		
Ararat	Dimboola	5030	0.14
Dimboola	Serviceton	3650	0.20
Lubeck	Marnoo	166	4.4
Marnoo	Bolangum	95	7.7
Murtoa	Hopetoun	398	1.84
Hopetoun	Patchewollock	110	6.64
Horsham	Carpolac	346	2.1
Dimboola	Yaapeet	405	1.8
Jeparit	Yanac	171	4.28
Ararat	Hamilton	2280	0.32
Hamilton	Portland	1790	0.41
Hamilton	Coleraine	272	2.68
Hamilton	Casterton	318	2.3
Heywood	S.A. Border	1049	0.7
S.A. Border	Mt Gambier	1045	0.7
East Natimuk	Balmoral	454	1.61
Balmoral	Hamilton	223	3.28

SOURCE: Train running statistics 1969/70. Accountancy Branch, Victorian Railways Commissioners, Melbourne.

TABLE 1

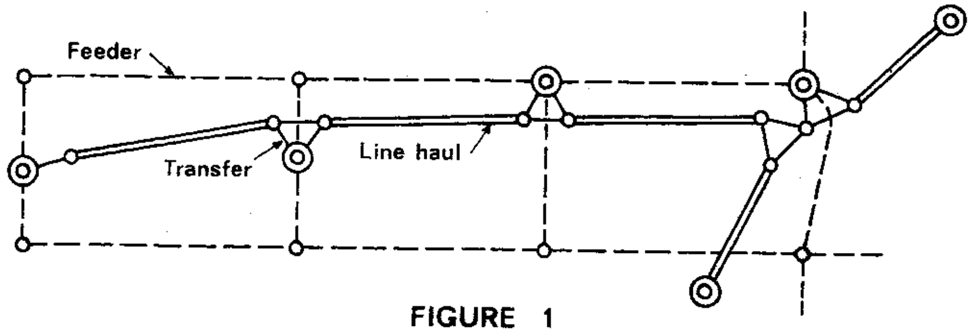

FIGURE 1
NETWORK REPRESENTATION OF LINEHAUL AND FEEDER TRANSPORT SYSTEM

The railway portion of the network is generally vinelike with only a few cross-connexions. The road portion of the network is more meshlike and has a multitude of optional paths between nodes.

Having a network of activities associated with the traffic flow, it should be possible to analyse the flows, and as a result, suggest an alternative and possibly a better or best way of directing that flow. The criteria which determine "better or best" will normally be set by the community in the case of publicly-owned transport. In a recent study it was assumed that to minimise the total cost of resources committed to the total transport task is the criterion. The report of this study is not yet complete but some results are quoted below.

If the cost of each activity is directly proportional to the traffic flow through the activity, it is fairly obvious that the optimum solution is given by the flow arising from each origin to destination demand travelling via its minimum cost path through the network. The optimum answer will be given by the normal "all or nothing" minimum cost path traffic assignment.

But, as will be shown later, the costs are not merely unit costs per unit load of goods. The costs are usually mixtures of marginal and fixed costs and to complicate matters even further, the goods flow through one activity link will, in many cases, affect the costs on other activity links.

Mathematicians have sought the solution to this problem of optimising the flow through networks. Notably, the works of Stella Dafermos (1971), both alone and with Frederick Sparrow (1969), have shown that under certain circumstances of flow versus cost functions, optimum flows can be achieved.

According to Dafermos, to determine optimal flows of goods through the network will require that the cost functions possess positive second derivatives. That is to say, "The marginal cost per unit flow increases as a function of flow". If we can find suitable reliable cost functions of this type, we are well on the way to a proven optimum flow in the network. If not, another way must be sought. It may be that a demonstration of an improved flow rather than a proven optimum will be the best offering at the end of the search.

Sonia Stairs (1968) faced this problem and concluded that there appeared little hope of proven mathematical solutions in the foreseeable future.

RAIL SYSTEM AND ROAD FEEDER/ALTERNATIVE

Railway stations do not all exist solely to transfer goods between the rail mode and the feeder mode. The running of train services are not yet automated on railways in Australia. The working of trains on lines has to be monitored and this has been achieved mainly by station staff in association with train control instructions from central offices. Therefore, railway stations have two categorical functions concerning goods traffic:- transfer of loadings and monitoring of train services.

It will be also necessary to fully identify the activities associated with passenger movement, both at stations and on the line-haul. The effect of these activities must be assessed and allowed for in any analytical study of goods flow on the network. To be effective, the activities represented by the various links will have to be expressed in common terms. For example, the action of transferring goods from one mode to another and the line-hauling of goods on the other mode are different, yet are all part of the network. To express these in common terms, the money value or cost of committed resources appears to be the most, if not the only, likely common base.

If it were a matter of mere unit cost per ton or per ton mile, the study might proceed relatively easily, except that the unit costs themselves are not known to any great degree of certainty. The railway costs are hidden in a most unwieldy costing system and further shielded by a considerable public misunderstanding of how railways are operated and maintained.

An example of such misunderstanding is the question of the importance of passenger services to track maintenance and signalling standards.

In suburban areas, especially Sydney and Melbourne, the passenger services certainly set the standard of signalling and track maintenance. The costs of meeting those standards are almost entirely due to passenger services' demands. The close headways between trains; the relatively high acceleration of the trains; the heavy braking and the aim for higher schedule speeds, are the chief factors leading to the need for high standards of track and signalling.

But in rural areas and on many main and interstate lines, the passenger services are by no means critical. The majority of trains on such lines are goods trains. The axle loads of goods train vehicles are higher than those of passenger trains, 15½ tonnes and 12½ tonnes being common values respectively.

An important reason for the goods train's being the critical factor for track maintenance, is the four-wheel wagon so common to the Australian railway scene. These wagons, by virtue of their wheelbase and rigid suspension, require track maintained to close limits of cross-level if the wagons are not to derail in running.

Similarly, in rural areas, the passenger services require very few extra platform staff over and above that required for goods services. In the Ararat district in Victoria, only one man would be redundant station staff were passenger services to cease. Engine crews, train guards and conductors are of course directly concerned with passenger train working, and fortunately, the costing system identifies and records these costs. The Railways of Australia Classified Accounts, when related to train running statistics, enables these costs to be separated.

Cost Functions

The cost accounting system of the railways is designed to enable the railway board or commissioners to report their annual receipts and expenditure and satisfy the Auditors-General that nothing has been spent without due authorisation, and that all receipts have been accounted. The system does this remarkably well.

Unfortunately, in doing so, it commences to aggregate expenditure records so far down the data processing system that it is extremely difficult for the railway operators to relate the costs to the activities and locations associated with carrying out the transport task.

A recent study of the 1969/70 cost records, train running records and freight statistics for the Ararat district of the Victorian Railways developed the following set of cost functions for rail activities associated with goods traffic on that railway network:-

(i) <u>For line-haul links</u>

$$y_5 = 0.00417x_5 + 2410$$

where y_5 = annual operating cost (dollars per mile)

x_5 = annual two-way loading (tons)

Correlation coefficient (r) = 0.934, and

Standard error S_r = 8.4 per cent of r.

(ii) <u>For railway station operating</u>

$$y_s = 0.441x_2 + 0.0230x_3 + 1136$$

where y_s = annual station operating cost (dollars)

x_2 = annual loading on and off (tons)

x_3 = annual loading on rail through station (tons)

Multiple correlation coefficient is 0.55.

Both these functions were derived statistically using a least squares best fit. In the line-haul case, each observed pair of y_5 and x_5 were weighted in proportion to the length of the link. The first function appears to explain a large part of the variations and should be reliable.

The station cost function has a relatively low correlation and might be worthy of suspicion. However, as data is currently recorded, it is as good as can be. For example, it is not possible to separate out the train running costs for each individual station, but only for groups of stations on line sections as shown in Table 1. Track costs are available only at track gang length level and can only be estimated by length of main-line and siding track. In short, the aggregated data re station costs is chunky rather than particular.

If y_2 = the estimated annual operating cost of the station attributable to on/off loading, and
y_3 = the estimated annual operating cost of the station attributable to through-loading,

such that for any station $y_s = y_2 + y_3$, and distributing the residual or annual fixed cost elements between y_2 and y_3 in proportion to y_2 and y_3, we have

$$y_2 = 0.441x_2 + (1136 \times 0.441x_2/ (0.441x_2 + 0.023x_2)),$$

and $$y_3 = 0.023x_3 + (1136 \times 0.023x_3/ (0.441x_2 + 0.023x_3)).$$

In order to allow for the separation of the transfer and the monitoring tasks at the stations, the network description has the station represented by three links: the through-link and two on and off links at the station (see Figure 1).

In the network we have five link categories:-

1. Road line-haul links (feeder)
2. Rail station on-off links (transfer)
3. Rail station through-links
4. Rail station dummy links
5. Rail line-haul links

The rail station dummy links are introduced at junction stations to ensure that traffic assigned to the network does not bypass irregularly any activities at that station.

In the study, the costs of operating and maintaining the road line-haul links proved quite impossible to derive. Researchers in this field know full well the reluctance of road carriers to reveal their costs and the road authorities tend to estimate road maintenance and traffic management costs in terms of values per vehicle mile rather than in terms of goods ton miles or person miles. Indeed, reliable records or goods movement on roads is extremely rare.

Road carriers do quote prices. The study's few respondents out of a sample one hundred commercial vehicle licence-holders on the records in the Hamilton and Horsham offices of the Transport Regulation Board, described their pricing system.

The study simulated the effect of the railway operator becoming a freight forwarder using whichever mode - road or rail - suited him best over any part of the combined road and rail network to satisfy the annual demand for rail goods movement. The railway operator would pay the road carrier his marginal price per ton mile for the extra cartage from the closed station to the open station.

It was considered that reiterative assignments of the goods traffic to the network with an adjustment of the average costs on each link for each assignment may lead to a goods flow arrangement which differed from the current usage of branch line railways in the Ararat district.

From the above cost functions the following average cost functions were derived:-

For category 1 - the road line-haul links - the pertinent average price rate per ton per mile in dollars is given by

$$\frac{y_1}{x_1} = 0.046$$

For category 2 - the rail station on/off links - the average cost rate per ton in dollars is given by

$$\frac{y_2}{x_2} = 0.441 + \frac{501}{(0.441x_2 + 0.023x_3)}$$

For category 3 - the rail station through load links - the average cost rate per ton in dollars is given by

$$\frac{y_3}{x_3} = 0.023 + \frac{26.1}{(0.441x_2 + 0.023x_3)}$$

For category 4 - the dummy links at stations - the average cost rate per ton in dollars is given by the same

$$\frac{y_3}{x_3} = 0.023 + \frac{26.1}{(0.441x_2 + 0.023x_3)}$$

For category 5 - the rail line haul links - the average cost rate per ton mile in dollars is given by

$$\frac{y_5}{x_5} = 0.00417 + \frac{2410}{x_5}$$

After four iterations the successive reiterations were identical. The method had locked on to a particular set of values and appeared to have minimised the transport costs in doing so.

This method was referred to as reiterative sublimation inasmuch as at each iteration, the average cost rate was sublimed to a new value for the next assignment. Because of the nature of the cost function, no proof of optimality can be shown.

The study indicated that some 42 per cent of the rail lines lost all their traffic to the road carrier as feeder to the busier main railway lines (see Figure 2) and that the result was an improvement upon existing practice.

To close these railways and use the feeder road carrier at the carrier's marginal price would give the railways' operator a net cash saving of approximately $430,000 per year at 1969/70 values. To enable the road carrier to serve the rail operator in this way would require considerable amendment to the commercial vehicle regulations as they were in 1969/70. The Bland Report has made recommendations in this matter but they have referred more particularly to a few specific locations (e.g. Portland) rather than to a general quantified basis for the changes.

That inquiry appears to have suffered badly from a lack of quantified input as to the costs of transport and this is reflected in the report. Nevertheless, the Bland Report recommendations are a beginning and they indicate a need for further studies of the type reported here.

The 25 mile restriction on commercial vehicle operation from home base would require waiving and at least complete freedom to operate throughout the Ararat district would be required by the road carriers.

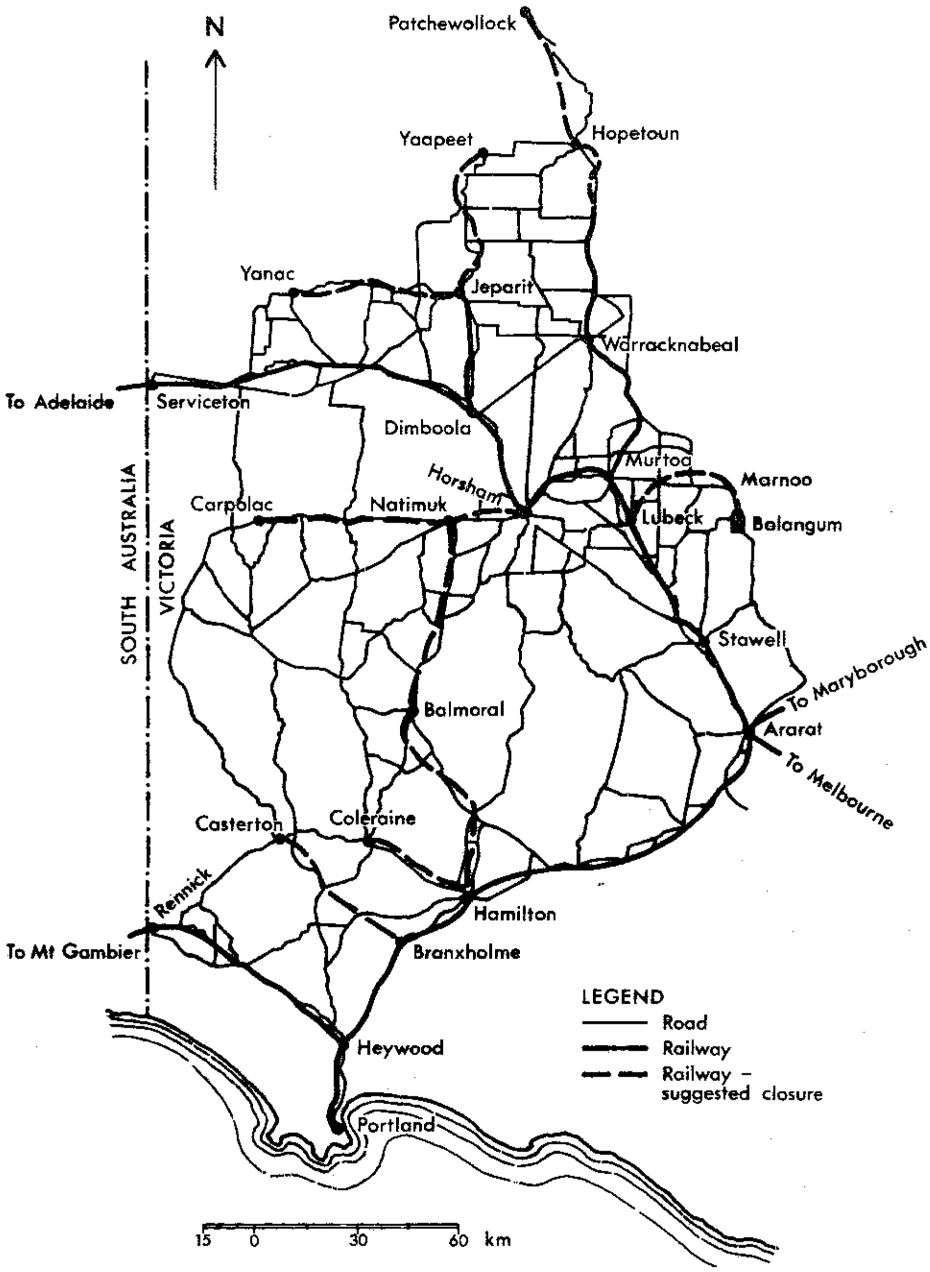

FIGURE 2
VICTORIA - ARARAT DISTRICT
RAIL AND ROAD SYSTEM

NEGATIVE INVESTMENT IN TRANSPORT FACILITIES

RAIL LINE CLOSURE AND THE USER

In the suggested rationale for closing the railway branch lines, the user is still required to pay rail freight charges as though the closed stations were still operating. It is a basic premise of the study that all or most goods travel to or from the railway by road vehicle. In the Ararat district this is surely the case.

From the position of the closed rail station until the goods reach the open rail station on its optimum path, the rail operator accepts financial responsibility for the cartage at the local road carrier's marginal price.

A benefit coming to the user is the great increase in frequency of service. Inspection of Table 1 will show that all the lines suggested for closure have long headways between trains, as follows:-

Section			Headways (days)
Lubeck	-	Marnoo	4.4
Marnoo	-	Bolangum	7.7
Hopetoun	-	Patchewollock	6.64
Horsham	-	Carpolac	2.1
Jeparit	-	Yanac	4.28
Hamilton	-	Coleraine	2.68
Hamilton	-	Casterton	2.3
East Natimuk	-	Balmoral	1.61
Balmoral	-	Hamilton	3.28
Jeparit	-	Yaapeet	3.16 approx.

It is noteworthy that even some of the lines in the Wimmera wheatlands carried too little bulk grain to justify their remaining open.

Generally, the headways on the lines suggested for closing were less than those on lines to remain open. Only the East Natimuk to Balmoral section had a headway less than any of the remaining lines. This was because the trains on that line had a low average net train load of approximately 110 tons compared with 195 tons on the Dimboola to Yaapeet line.

So, in summary, the system in the Ararat district would better have met the demand for rail goods movement were some lines closed and the Railways Commissioner operated as freight forwarders.

Closing the railways (some 42 per cent of the lines in this case) would, in effect, be negative investment. Assets would be put out of use. It may have been worthwhile to have sold the materials at scrap value and put the land to alternative uses.

Further, the study indicated that the closure of those railway lines would have saved the Railways Commissioners some $889,000 in railway operating costs. Against this, they would have had to pay $458,000 in trucking fees to the local carriers for the extra road cartage miles. This represented a net saving of $431,000 to the Commissioners for operations at the 1969/70 level.

It should be stressed that the study applied particularly to the Ararat district of the Victorian Railways and that to apply the cost functions elsewhere on that or any other system would be extremely hazardous.

Similar methods of studying facilities such as ports, aerodromes, and even roads, appear to hold out some hope of at least leading to improved allocations of scarce resources in transport facilities, if not finding that mythical absolute optimum.

REFERENCES

Dafermos, Stella C. and Sparrow, Frederick (1969), "The traffic assignment problem for a general network" in Journal of Research National Bureau of Standards; Bureau of Mathematical Sciences, Vol. 73B, No. 2.

Dafermos, Stella C. (1971), "An extended traffic assignment model with applications for two-way traffic" in Transportation Science, Vol. 5, pp. 366-389.

Jones, Hon. C.K. (1975), "Towards a prosperous Australian railway" in Railway Gazette International, Vol. 131, p. 18.

Stairs, Sonia (1968) "Selecting an optimal traffic network" in Journal of Transport Economics and Policy, Vol. 2, pp. 218-231.

Victoria (1971/72), "Report of the Board of Inquiry into the Victorian Land Transport System", Melbourne, Government Printer.