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APPRAISAL OF RAIL PROJECTS

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ABSTRACT

This paper reviews the particular characteristics of rail investment projects, taking as a starting point four examples ranging from decisions on individual routes to national rail investment programmes. The motivation for rail investment, and the interdependence of projects are examined, before turning to the identification of base case and options and the measurement of costs and benefits. It is argued that the main problems in rail investment appraisal are not technical ones relating to measuring costs and benefits but are contextual ones relating to the interdependence between rail projects and with decisions in other sectors of the economy. For this reason it is essential that rail projects be appraised with an appropriate planning framework.

1. INTRODUCTION

The rail sector has some important differences from the rest of the transport sector:

a. It is usually run as an integrated organisation covering infrastructure and operations, although recent proposals by the Economic Commission suggest a separation of these two activities (this has already happened in Sweden and is proposed as part of the privatisation of British Rail - see Nash and Preston, 1992).

b. It is typically a curious mix of commercial and social, with some activities (usually long distance passenger and freight services) operated on a commercial basis, and others (suburban and local passenger services) subsidised. Needless to say, this complicates the appraisal of investments which benefit both types of service.

c. It is a multiproduct organisation and production of the various products interacts to a much greater extent than in road transport. For instance a bus company can schedule its individual services largely independently, without worrying whether the infrastructure can accommodate them. For rail services, track capacity has to be allocated; therefore all the services operated by a rail operator are interdependent to the extent that they share the same infrastructure.

All of these factors lead to the rail sector having its own particular problems when it comes to project appraisal. The first makes it difficult to define an individual project; any investment in infrastructure is liable to have direct implications for the rolling stock and vice versa. The second means that we typically have a mixture of financial appraisal, financial appraisal subject to political constraints as to what is feasible and social cost-benefit analysis. Also broader considerations of transport and land use planning may need to be taken into account. The third means that appraisals typically have to consider the future of a whole range of services rather than a single one in isolation.

In what follows we shall first describe briefly a set of four case studies, ranging from modernisation of a relatively minor part of the London commuter network to investment planning for the entire Australian main line rail system. These case studies will be used to illustrate the points made in the rest of the paper. Then we shall consider the various motivations for investment in rail transport and the way in which projects are generated. We then discuss the problems the characteristics of rail transport lead to in defining first the base case and then the options to be considered. We shall discuss the important issue of interactions between investments, and consider particular problems which arise in valuing costs and benefits. Finally, we reach our conclusions on the issues that arise in determining an appropriate methodology for rail project appraisal.

2. CASE STUDIES

a. `Networker' trains for Kent

The rail network in Kent serves a set of communities ranging from the boundary of Greater London to the coast some 80 miles away. From this area a total of some 140,000 people commute daily into central London (British Railways Board, 1991a, page 14). The services in Kent form part of the Network Southeast sector of British Rail. This has an obligation placed on it by the government under the 1974 Railways Act to provide a service `broadly comparable to that which existed in 1974' and to achieve certain quality standards concerning reliability and crowding. It is provided with a subsidy, although this has been reduced through the 1980's, and there is a heavy emphasis on improving financial performance.

Most of the infrastructure and rolling stock used for these services is elderly, the rolling stock being largely between 30 and 40 years old, and is becoming unreliable and expensive to maintain. In the 1980's, contrary to previous forecasts, traffic on the system rose substantially, placing a further strain on rolling stock and track capacity. At the same time, opening of the Channel Tunnel would place a further strain on the capacity of these routes by requiring them to accommodate some 28 high speed passenger trains and 35 freight trains per day between Britain and the continent.

The solution to these problems was seen to be in investment in a new generation of high capacity high performance rolling stock - the `Networker'. At the same time, the infrastructure was to be upgraded for instance by lengthening station platforms to take longer trains and by resignalling. The result would be to raise both the capacity of individual trains and - because of the higher performance - the number of trains that could be run. The first phase of this investment would involve introducing 400 `Networker' coaches, and cost a total of £700m (British Railways Board, 1991b, page 14).

b. The passenger service to Kings Lynn

Kings Lynn is situated around 100 miles north of London on the Norfolk coast; it is the main railhead for the Borough of Kings Lynn and West Norfolk, which has a population of some 130,000. It represents the end point of a Network South East commuter line from London through Cambridge, but most of the commuter traffic is from closer to London. Until the late 1980's, it was served by locomotive hauled main line trains at approximately two-hourly intervals. But there were a number of problems with this pattern of service. Firstly, because the bulk of the traffic was from further south, load factors over the northern part of the route were very poor (A.S. Fowkes and C.A. Nash, 1987). Secondly facilities had to be retained for locomotives to run round their trains at Kings Lynn, adding to the cost. Thirdly, the decision had already been taken to electrify the southern part of the line from Cambridge; taking advantage of this would require a change from electric to diesel traction or vice versa at Cambridge. Fourthly, the diesel locomotives were approaching 30 years old and were becoming unreliable and expensive to maintain.

The range of options for this rather minor part of the London commuter network was astonishing. Initially the local authority was very keen to see electrification through to Kings Lynn so that the existing pattern of service could continue, but using electric locomotives throughout. However, this would have involved a continuation of existing low load factors. One option, based on electric multiple units which could more readily be coupled and uncoupled en route so that only part of the train worked right through to Kings Lynn, seemed attractive; this might permit a doubling of services to hourly. In either case, electrification would be accompanied by reducing the route from double to single track, although an additional passing loop would be required if the service were increased to hourly.

If the route were not to be electrified, the existing service could continue, with replacement of the diesel locomotives in due course. Or the diesel locomotives could be replaced by diesel multiple units, running either hourly or two hourly, and either running right through to London or connecting with electric trains at Cambridge; alternatively the section of line from Cambridge to Ely could be electrified and the connection made there. In all some 17 options were identified. Ultimately, the decision was to electrify and provide an hourly electric multiple unit service, although this was only permitted by the agreement of the local authority concerned to contribute towards the costs.

c. The Australian national rail investment programme

In 1982, the Australian Railway Research and Development Organisation was commissioned to undertake a study to identify the level of investment in the national rail system that would be commercially justified over the coming 5 years (Norley and Kinnear, 1983). The rail system remained a very important part of the Australian freight transport network at the time of the study, carrying some 37,000m tonne kilometres of traffic, almost as much as road (Nash, 1985). Moreover this traffic had doubled in the preceding 15 years, largely as a result of a boom in coal and mineral exports. In the passenger sector, however, rail had dwindled to insignificance except for suburban passenger services in the main cities.

It might be thought that this boom in bulk freight haulage would have shielded Australian railways from the financial problems which had afflicted railways throughout the world. Not so. From a position in which they had covered working expenses from earnings up to the late 1960's, financial performance had declined until they only covered some 70% of working expenses. This was due to the retention, required by government, not just of loss making passenger services but also of many loss making freight services carrying car loads or less than car loads of general merchandise. At the same time, much of the operation was inefficient, and the assets elderly and of poor quality. The main line network consisted of single track routes with passing loops, traditional semaphore signalling, low speed limits and severe weight and speed restrictions on many bridges.

The approach taken in this study was as follows. First, the future demand for rail transport was forecast, allowing for likely shedding of unprofitable traffics. A rail network model was utilised to turn this into an estimate of future capacity requirements from which expansion investment needed could be identified. Replacement investment requirements were analysed by examining the condition of existing rail assets and utilising the results of past studies on issues such as locomotive replacement. The identification of revenue generating and cost-saving projects relied heavily on the proposals of the individual railways, although some issues (eg. centralised traffic control, electrification) were suitable for a more systematic analysis, in which breakeven volumes for the investment in question could be identified. The network model was then run again to assess the costs of handling the appropriate demand matrix under each investment programme.

It was decided to test four basic investment programmes. Programme A would be a minimum programme to keep the main line rail system operating at its existing quality and capacity. Programme B would be sufficient to enable all commercially viable traffic to be handled. Programme C would contain the most profitable additional investment and programme D would contain the full range of projects believed to be viable at a 10% rate of discount.

Why was it necessary to test investment programmes, rather than simply put together alternative packages of individually tested projects? The answer is clearly that it was considered there were so many sources of interdependence between projects that we could not regard the return on a package as being simply the sum of the returns on individual projects.

d. British Rail electrification plan

In the late 1970's, the British Rail system was unusual by European standards in still relying heavily on diesel rather than electric traction for its main lines (only 23% of its route system was electrified (British Railways Board 1979)). At the time, BR was developing a strategy for long term rolling stock investment, and it appeared to them that main line electrification was a sensible long term option. Yet individual schemes for particular routes appeared very marginal by the standard of the required commercial rate of return, which was then 7%. It seemed likely that an examination at the network level might find a stronger case for electrification of a whole network of lines than existed for any one line, since many routes would share common tracks and terminals and these would only have to be electrified once.

The approach taken was to postulate four alternative levels of electrification; a base case, a modest programme concentrated on a couple of major routes; a medium level covering the key trunk routes and bringing the level of electrification up to 50% of the route system, and a large network including secondary routes forming extensions of these routes (British Railways Board, 1981). Costs of operating the system were then estimated using forecast levels of traffic and assuming that the existing set of services was retained. The results indicated that the highest net present value was for the largest network, and that the internal rate of return was lowest for the smallest network - all the larger networks showed an internal rate of return of the order of 11%. This supported the view that examining a network plan for electrification was more appropriate than looking at individual schemes in isolation.

3. THE MOTIVATION FOR INVESTMENT IN RAIL TRANSPORT

Having briefly described these case studies, we now seek to identify a number of issues that commonly arise in rail project appraisal. Firstly, we consider the motives for investment. Investment in rail transport may in principle be divided into the following categories.

a. Replacement investment

The main assets of the rail transport industry have long lives. Railway rolling stock typically has a life of some 30 years; whilst track renewals may need to take place more frequently than that; structures have even longer lives. Nevertheless, a very large part of rail investment takes the form of renewal of existing equipment. This may take place simply because as equipment ages it becomes more difficult and expensive to maintain. But replacement investment almost always has an element of `betterment' as well, in as much as obsolescence occurs as designs that are more attractive to the consumer or more economical to the operator (or both) become available. All the case studies considered have a strong element of replacement in them, but they all involve betterment too. The need for replacement is the most common trigger of a rail investment decision.

b.Expansion

Whilst in aggregate on a world scale the tendency has been for rail demand to stagnate, this hides many traffics and areas which have seen rapid growth in rail demand, and a need for investment simply to cope with growth. This was true of the `Networker' proposals in Kent and of the Australian national investment proposals, for example.

c. Revenue gathering

Investment may be undertaken in order to improve an existing service or to introduce a new one which is commercially attractive. All of the above proposals were expected to generate increased income.

d. Cost cutting

Technical change or changes in the characteristics of demand may mean that a different form of equipment to that currently operated would be more economical, or it may just be that the historic pattern of service is inherently wasteful (as in the case of the service to Kings Lynn).

e. Social

Investment may be desired to upgrade the service or introduce a new one not on commercial grounds but on social grounds, in terms of benefits to users, relief of road congestion, economic regeneration or environmental improvement. This was a consideration in Kent, for instance, where existing targets for overcrowding were not being met.

Having introduced these motivations, which obviously play a part in generating proposals for investment, it must immediately be said that almost any investment may serve several or all of these purposes. As an example, consider again the proposals for the introduction of new `Networker' rolling stock on commuter services between London and Kent. Fundamentally this is replacement rolling stock for ageing equipment which is expensive to maintain. But it will also increase capacity to cope with growth of commuting in this part of the country. Improved performance and more attractive coaches will attract increased revenue, particularly in the off peak. Technological developments will make it cheaper to operate. And finally the set of services in question is subsidised in order to relieve congestion in London; a purely commercial operator would raise fares rather than expanding capacity in the face of growing demand.

The above example immediately introduces some of the complexity of rail investment planning. This will become more apparent when one tries to define the base case for any particular project appraisal.

4. IDENTIFYING THE BASE CASE

Much of the confusion surrounding the rates of return earned by rail investment arises because of the difficulties in defining the base case. Essentially, the base case represents the best estimate of what will happen in the absence of the investment in question. The problems are immediately apparent from the range of alternatives that could be taken.

a.The service could be assumed to close. But to the extent that it shares costs with other services (freight services operating over the same tracks; other passenger services sharing the same rolling stock, staff, terminals depots) the costs (and revenues) that will be avoided by this action clearly depend on what is assumed to happen to these services. In any event, very few railways have the power to withdraw passenger services without reference to the political process; in the case of London commuter and other local services in Britain, there is a specific obligation placed on British Rail by the government to keep the service running at `broadly' its existing level. Thus whilst closure (with or without substitute buses) may be worth analysing as an option to consider, it will often not be feasible even if it is commercially or even socially the most profitable course of action.

b. Fares could be increased to commercial levels, reducing the need for capacity. Again this will usually depend on political decisions, and will not necessarily be a feasible option, although it should clearly be considered in the course of an appraisal.

c. A cheaper `minimum renewals' option could be assumed. In the past, much British Rail investment has been appraised against an assumption of minimal renewals. The problem is that minimum renewals have often been taken to cost almost as much as the options under consideration, so that in this way the majority of investment escapes appraisal altogether.

d. The service could continue to operate with the existing assets. Rail assets rarely disappear in a cloud of rust; they usually can continue in service at a price. In the case of rolling stock, that usually means greater maintenance costs and reduced reliability; for infrastructure it typically means steadily more severe speed and weight restrictions. If one considers indefinite postponement of renewals, then the appraiser may be involved in trying to estimate what would happen if assets were kept beyond the life of any previous experience. Moreover, indefinite postponement of replacement is rarely a sensible option. The much more important question, as in most appraisals, is usually whether to replace now or in say five or ten years time.

Now all that the above discussion illustrates is that the choice of base is to a large extent arbitrary. In any given appraisal it will be necessary to consider many if not all of the above options. It follows that it is highly misleading to talk of a rail investment yielding a particular rate of return of x%, without making it clear with what it is being compared. This has led to confusion whenever rates of return on rail investment are quoted without clearly explaining what the base case is with which the investment is being compared.

5. IDENTIFYING THE OPTIONS

In effect, then, we may already have a number of options in the form of alternative base cases before we start to consider the investment possibilities in question. These will cover a range of different types of equipment and different combinations of rolling stock and infrastructure. For instance, in the particular example of Kent commuter services, the decision was to expand capacity by a combination of operating longer trains and higher performance stock to increase track capacity. Clearly, an alternative (although probably in this case a very costly one) would be to lay extra tracks; another alternative (difficult but not impossible within the restrictive British loading gauge) would be to use double-deck trains.

The range of alternatives deserving attention in even a simple case can be quite large. For instance, consider the example of the service to Kings Lynn, where no fewer than 17 serious options were identified. In this case it would have been very easy to miss all the best options since they involved simultaneous changes in service specification, rolling stock and infrastructure.

It is highly likely that the type of rolling stock used on a particular service will influence the service level operated, the fares charged and the infrastructure required. Thus investment appraisal in rolling stock cannot be considered as a separate task from service planning as a whole. It is also the case that often it is worth investing in new rolling stock for one route and transferring the rolling stock from that route to another route. For instance, the proposed electrification programme for British Rail would have released modern high speed diesel trains which would have been redeployed to replace older locomotives and coaches elsewhere. Sometimes quite complicated `cascades' of rolling stock can be planned before the oldest rolling stock emerges to be scrapped. This used to be very much a feature of BR rolling stock investment in the 1970's, when investment was concentrated on the allocation of the most modern units to the most profitable inter city routes, and the rest of the system made do by shuffling around existing stock. In the 1980's however this has been perceived as an expensive solution involving the operation of a lot of stock on services for which it was not designed, and a greater degree of specialisation of rolling stock has been seen as appropriate.

6. INTERACTIONS BETWEEN INVESTMENTS

Again the section on identification of options has already introduced this issue, inasmuch as rolling stock options interact with infrastructure options, and infrastructure options interact with other services using the route. For instance, part of the case for the `Networker' investment in Kent is that it will release track capacity for new passenger and freight services between Britain and the continent via the Channel Tunnel.

Interdependence formed a major issue in case studies c and d, the Australian national investment plan and the BR network electrification studies. Again it is useful to categorise interdependence in a number of ways:

a. Technical interdependence

This is where one investment positively requires another investment. For instance, investment in electrification is aborted if electric rolling stock is not also provided; locomotives and wagons which operate at heavier axle weights may require investment in new track and strengthening of bridges; more powerful locomotives may be pointless without lengthening loops to accommodate longer trains. All these issues arose in the Australian study.

b. Technical substitutes

Investments may be direct substitutes to the point where it is clearly nonsensical to undertake the two simultaneously; eg. electrification and the purchase of new diesel rolling stock for the same route.

c. Economic complements

One investment may improve the case for another one without requiring it. For instance electrification of one route may require terminals and sections of track used by other services also to be electrified, thus reducing the cost of converting those routes as well. Or the cost of electrification itself may be reduced by simultaneously remodelling the track layout to remove excess capacity; this will then require some resignalling and might make it sensible to renew the signalling simultaneously as well. Of course this means again that the level of service on all services using the infrastructure should also be examined at the same time.

d. Economic substitutes

One investment may reduce the case for another one. The most obvious case of this is where parallel routes exist; upgrading one reduces the case for upgrading another. Similarly, in the case of the Kent `Networker', by providing additional capacity on existing routes this investment reduces the case for increasing track capacity by constructing a new line between London and the Channel Tunnel.

The implication of these interdependencies is clear. Often investments interact in such a way that it will not be adequate to appraise them in isolation from each other. As a consequence, packages of investments - or investment plans - will need to be considered as well as independent projects.

7. VALUING COSTS AND BENEFITS

The costs and benefits of rail investment are not very different from those of investment in other sectors of the transport industry. They may be grouped as follows (Nash and Preston, 1991):

a. Cost savings to rail operators
b. Increased revenue to rail operators
c. Reduced generalised cost of travel to users
d. Reduced congestion on roads
e. Reduced environmental impact of roads
f. Economic development benefits.

Obviously for a purely commercial investment it is only the first two items that are relevant, and the question then becomes one of how far the remaining items can be converted into revenue (this is also true in Britain in the case of investments which qualify for Central government grant aid under Section 56 of the 1968 Transport Act, where reduced generalised cost to users is not allowed as part of the case for subsidy). The scope for doing this is rather limited by the relatively high price elasticities of demand for rail transport, particularly for leisure travel (Owen and Phillips, 1987). It has often been postulated that an improvement in the quality of rail services should reduce the price elasticity of demand and make pricing up more attractive but there seems to be little firm evidence on this. What is clear is that, where prices are subject to a degree of political control (as in the London commuter network), improved quality of service can make pricing up more politically acceptable. Whether the extra revenue from a price increase that would have been commercially worthwhile even without the investment should be credited to that investment seems doubtful.

The most obvious item of reduced generalised cost to users from a rail investment is that of time savings, and here the same techniques of valuation may be applied as in other parts of the transport sector (MVA et al, 1987). However, other more qualitative elements of generalised cost may be more important for rail transport than for some other modes. For instance in the case of commuter services it is often the degree of overcrowding and unreliability that leads to complaint rather than mean journey times. Valuations for these items have been estimated by using stated preference techniques in much the same way as in the study which derived the current Department of Transport values of time (Fowkes and Nash, 1991). These pose questions as to which would be preferred out of hypothetical choices between different combinations of fare, journey time and degree of overcrowding or unreliability, and yield results in the form of differential values of time, for instance for travel in a crowded train or standing, and for unscheduled delay as opposed to scheduled travel time.

The principal issue that arises in estimating the effect on road users and the environment of rail investment is that of the degree to which extra rail traffic has actually diverted from road. Examination of a number of urban rail investments suggested that this may typically be 25% or less (Nash, 1991), although this may understate the long term effects; rail investment may influence not just the choice of travel mode for existing workers but also the home and workplace locations of those newly locating. This must be the explanation for the very large increases in commuter traffic recorded following electrification of many London commuter routes. Similar conclusions arise from studies of the impact of new high speed rail services, where some 50% of traffic was generated rather than diverted (Bonnafous, 1987) and the potential for diverting freight from road to rail also appears relatively small except in particular markets (bulk commodities, and general merchandise travelling long distances (Fowkes, Nash and Tweddle, 1991).

What this seems to imply is that even though there is evidence that the volume of rail traffic can be significantly influenced by providing more attractive fares and service level packages, this course of action will only make a modest contribution to solving the problems of road and air traffic growth. If we do take the congestion and environmental problems posed by the transport sector seriously, then we have to discourage the growth of car and air traffic more directly. The sort of measures which might be considered are higher prices (especially for motoring in cities and for air travel), widespread traffic calming and parking controls. These measures all sound very negative. But if they are seen in that way, there is a danger that all that will happen is the further decentralisation of the population away from cities into smaller towns where the use of the car is not so restricted. If cities are to be places where people actually want to live and work, then we need to create developments in which the attractive environment these controls bring will make them welcome. Such cities would encourage the use of walking and cycling for shorter journeys, and of bus and train for longer journeys. In other words the role of rail in an integrated transport policy may be much greater than the evidence of diversion from isolated investments implies.

Economic development benefits also are increasingly seen as a motivation for rail investment, either by encouraging jobs to locate in a particular urban centre (eg. in Docklands) or by opening up new journey to work opportunities for residential areas (eg. many proposed reopenings of local rail services, such as Leicester-Burton or Nottingham-Mansfield, have been designed to make access to jobs in the city accessible to people from areas of high unemployment). The principles of economic evaluation in such cases are well known; the economic benefits of such effects represent the additional surpluses earned by employers, government or workers over and above what would have been earned in the absence of the investment. The problem is again one of forecasting - not just how many jobs will be attracted or how many residents in the area will find jobs, although that is hard enough, but also how far the jobs would otherwise simply have located elsewhere, or the jobs have been filled by other people. In other words it is any net increase in employment and incomes brought about by the scheme that is important, not the gross income.

Such evidence as exists suggest that, in a developed country such as Britain, economic development benefits of transport infrastructure tends to be very limited (Parkinson, 1981). Yet the issue remains politically enormously influential. For instance it is argued that investment in the commuter rail network in London is essential to maintain London's position as a centre of European finance and banking; that good links to the regions from the Channel Tunnel are important to their economic prospects and so on.

What this section suggests is that a narrow approach to the benefits of rail investment will be inappropriate. Rail investment has to be seen as part of the overall transport system of a city or region, and plans for rail investment integrated with land-use and economic development plans. In many countries this takes place to a far greater extent than in Britain (SDG, 1992).

8. CONCLUSIONS

We have seen in this paper many of the difficulties that surround project appraisal in the rail sector. To a large extent these are not technical problems of forecasting and valuing the effects of rail schemes, although uncertainties do remain there, especially regarding the broader economic impact of rail investment. The biggest problems concern the context within which the appraisal is undertaken. We have encountered problems regarding definition of the base case, regarding definition of the potentially large number of options to be examined, regarding the interaction between individual rail projects and regarding the effects on the appraisal of assumptions about future price and service levels both for the services directly affected by the investment and those other services within which these interact.

What seems clear from this is that, even for a commercial railway, project appraisal cannot be seen as a separate activity isolated from the general business planning of the organisation. Sensible project appraisal requires a clear vision of the objectives of the company, and of the future mix of services, fares and quality to which it aspires.

When social considerations are also brought into the picture the situation becomes even more complicated. Rail investment decisions then become intertwined with decisions on other modes of transport, on land use planning and on planning for economic development. Almost always this will involve a number of agencies other than the railway itself. Without a sensible institutional framework within which planning can take place, rail project appraisal is inevitably to a large extent based on guesswork as to what the other agencies involved will do.

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