ASSESSING THE PERFORMANCE OF EUROPEAN RAILWAYS

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INTRODUCTION

There are two main reasons why comparisons of railway performance may be valuable to researchers and policy makers. In the first place, discovering which railways perform well, and why, is a useful prelude to in-depth studies of working practices and productivity. But in the second place, it may be possible to relate performance to the institutional and regulatory environment in which the railway operates. In other words, such studies may help to assess the costs and benefits of alternative policies towards the rail transport sector.

The aim of this paper is to examine the degree to which recent advances in the methodology of assessing performance in North America may be applied to European railways. In the next part we discuss the policy changes that are leading to renewed interest in performance assessment in the European context. We then discuss in more depth the economic characteristics of rail transport, before examining briefly the North American literature, to see both what methodologies and what relevant empirical results it has to offer. Following that, we discuss a project to compare the performance of European railways on which we are currently working. Finally we draw some interim conclusions.

2. THE ROLE OF PERFORMANCE MEASUREMENT

For the last two decades, the rail transport industry has been seen as one of the big problem areas of the European community (Nash, 1991). Community policy has been to restructure railways into commercial organisations, with social obligations minimised, and direct compensation paid for bearing them where they are absolutely essential. The effectiveness of this policy has been open to considerable doubt.

A number of factors have led to the belief that railways are frequently very inefficiently run. Firstly, one may point to the vast range of productivity and financial performance, even within a relatively homogeneous area such as Western Europe (Nash, 1985). For instance, Table 1 shows an enormous range in terms of simple measures of labour productivity and financial performance.

Whilst part of these differences may reasonably be explained by factors external to the railway (for instance, the mix of traffic types and geography of the country) it is hard to avoid the conclusion, for instance, that Netherlands railways is much more efficient than Belgian Railways or that French Railways is more efficient than Italian.

A second factor is the continued loss of market share in a buoyant transport market (Table 2). Whilst this may be partly explained by external circumstances (increased car ownership, changing industrial structure from heavy industry towards high value manufactured goods and services) the failure of rail companies even to perform well in those sectors in which they have a comparative advantage, such as long distance international passenger and freight traffic, and the perpetual complaints about the price, quality of service and inflexibility of rail transport leads to doubts about the quality of rail marketing. For instance, the rail share of international intra-community freight fell from 14% in 1975 to less than 10% in 1987 (COM(89) 564 FINAL paragraph b).

Although rail now only carries less than 10% of passenger and 20% of freight within the Community as a whole, it remains very important in certain markets. For commuting in large congested urban areas there is no realistic alternative (for instance over 70% of the million daily commuters into Central London arrive by rail.) For inter city business trips over distances of 200-300 km rail remains dominant, and with higher speeds the ability to compete with air over longer distances is growing. Rail is also important in the long distance leisure travel market. For freight, its ability to carry large volumes of traffic quickly and economically between the private sidings of major customers means that it has a dominant role in bulk traffics except where the even cheaper option of water transport (sea or canal) is available. For traffic in unit loads, the traditional approach of handling these in individual wagons requiring marshalling en route is looking less and less able to provide the cost or quality of service available from road haulage. However, growth of intermodal systems able to reduce the cost and delay problems of transferring goods between modes is making rail more able to compete for general merchandise over longer distances.

With growing concern about congestion and the environment, rail should have a bright future in these sectors. Indeed, rail investment in now running at enormous levels. A recent study concluded that the railways of Western Europe plan to spend a total of some £120-150b including £20b on urban rapid transit by the turn of the century (Table 3). Given both the opportunities and the level of investment now taking place in rail transport, it has become more important than ever to ensure that the arrangements for regulation and control of the sector are conducive to efficient marketing and operation. We turn to this subject in the next section.

One result of this situation has been a renewed examination of the organisational and regulatory arrangements surrounding rail transport. As always, eyes have turned to events in North America, where, the US railroad industry was deregulated in 1980, and the Canadian railroad industry was liberalised in 1987 (Grimm and Rogers, 1991). Within Europe, there has been a tendency towards deregulation of both road and rail transport, and there have been important organisational reforms in, amongst others, Britain and Sweden (see, for example, Nash, 1990). In both Britain and Sweden, the intention is to allow competing operators into the market; in both Britain and Japan it is intended to privatise existing operators. Furthermore, in a policy statement issued in

1989, the EC outlined details of a Community rail policy which includes proposals to separate infrastructure from operations and to allow access to the infrastructure to competing operators (Nash, 1991). The latter issue is now the subject of an EC Directive. Legal rights of access to railway infrastructure in EC countries have been established for:

- international groupings of railway undertakings - defined as two or more operations from different countries wishing to run international services between the Member States where the undertakings are based
- to any railway undertaking wishing to run international combined transport good services between any Member States.

Given these impending changes, it is clear that performance comparisons are needed not just to identify best practice at the level of the individual railway, but also to see to what extent economies of scale, density or scope may be at stake if major organisational changes are implemented.

3. ECONOMIC CHARACTERISTICS OF RAILWAY INDUSTRIES

Rail operators are traditionally responsible for providing their own infrastructure, principally track, signalling and terminals and as a result fixed costs form a large element of total costs. Studies suggest that between 50% and 80% of infrastructure costs are fixed in the short run (University of Leeds/BRB, 1979), whilst the capacity and signalling systems remain unchanged. Moreover, this infrastructure has a long asset life and is geographically-specific, it can not be re-deployed elsewhere and has minimal scrap value. In other words, it represents a sunk cost. In addition, even in the longer run, when capacity and signalling can be adjusted, it is subject to major indivisibilities (as are the vehicles used) and economies of scale. Moving from single track to double track involves a less than double cost increase, but, due to the removal of vehicle conflicts, often quadruples capacity, although further increases in track capacity exhibit less marked economies (Nash, 1982). It should also be noted that increasing the capacity of an existing route by laying extra tracks in a built up area can be very costly indeed.

The other main feature of railways is that they are a multi-product industry involved not only in serving different origins and destinations but in providing for different types of passengers and freight. Given fixed costs and indivisibilities, this means that there are a large number of joint costs which are difficult to allocate between products. It also gives rise to expectations of marked economies of scope, although the evidence here is more mixed.

As a result of these economic characteristics, the railway industry has usually been thought of as one with declining cost, and hence a natural monopoly requiring unitary ownership at the network level and either public control or ownership. This is the way that the industry has evolved in most countries of the world (although, not necessarily for the reasons given above). However, this view has come to be questioned on a number of counts. Firstly, the theory of contestable markets provided 'an uprising in the theory of industry structure' (Baumol, Panzar and Willig, 1983) that suggested that natural monopoly no longer automatically justified public control or ownership. Secondly, a body of empirical evidence has emerged that questions the conventional wisdom concerning scale economies in the rail industry. Thirdly, there has been both theoretical and empirical concern that the conventional forms of railway organisation lead to what has been termed X-inefficiency (Liebenstein, 1966). This empirical evidence will be reviewed in section 4.

We now turn to empirical evidence relating specifically to the rail industry.

4. RECENT EMPIRICAL EVIDENCE

Table 4, derived from Caves et al, 1985, indicates that a number of econometric studies of the rail industry have found constant returns to scale with respect to firm size for 'all but the smallest railroads' (Dodgson, 1985). However, these studies are exclusively North American, involving, predominantly, long haul freight with a high degree of specificity of rolling stock. Moreover, they tend to concentrate on the larger railroads, which are likely to have achieved minimum efficient scale. An earlier econometric study in the US, carried out when average firm size was much smaller, did suggest increasing returns to scale (Klein, 1953).

In contrast to the evidence on firm size, there is strong evidence of there being economies of scale with respect to density, as Table 4 illustrates. Moreover, work by Brauetigam et al (1984) indicates that if quality of service measures are included these economies of density are even more pronounced. This result should not be too much of a surprise. Declining average costs do not occur because a rail company is big, per se, but because it is making intense use of its fixed assets. However, economies of density are related to size. For a given fixed cost, a rail operator will usually have lower costs the greater its output, but there are clearly limits to this. For example, Table 2 shows there are diseconomies of density for NS and CFF, both heavily trafficked networks (although the results for FS and to a lesser extent, OBB are more difficult to explain). Similarly, Dodgson (1989) found diseconomies for the most densely trafficked railways.

Given their importance, the underlying causes of these economies of traffic density need to be fully understood. Keeler (1983, p130) conjectured that a 'large part of economies of traffic density ... are achieved by larger trains and better utilisation of the equipment and crews ... rather than a better utilisation of the fixed track'. Grimm and Harris (1983) noted that increasing density not only allows for longer trains, but also makes it possible to provide direct train connections between an increasing number of terminals. Keaton (1991) examined the economies of density of general carload freight for three US rail networks of between 5,500 and 9,000 km route length. He found that at the highest density examined average operating cost per car mile was about half that of the lowest density. Around 60% of this reduction was due to spreading crew costs over a larger number of cars (ie. operating larger trains), 10% of this reduction was due to reduced marshalling and 30% due to savings in car time (ie. operating more direct services). If service levels are allowed to vary (ie. operate more direct services as well as longer trains) the estimated returns to density are below the 1.7 to 1.9 range computed in four of the six studies given in Table 4 at around 1.23 for US Class 1 railroads average density (but this is similar to Friedlander and Spady's finding). These results do not seem to vary with length of haul and network structure. If service levels are held constant (ie. only run longer trains), the estimated economies of density are greater ranging from 1.90 to 2.65 and is positively correlated with length of haul. Other types of freight traffic are also considered: unit train operations of bulk commodities may not enjoy the same economies but intermodal operations should experience some economies of density.

These economies of operating longer trains and more direct services are also likely to be relevant to the passenger business and, where traffics are service sensitive, are likely to have revenue as well as cost implications. Some elements of what we have so far referred to as economies of density may be thought of as being economies of scope. As a result of producing a network of services (ie. having multiproduct output) cost efficiencies can be achieved, particularly as a result of better utilisation of staff and vehicles. One possible exception may be the joint operation of passenger and freight services. Empirical work suggest that there may be some diseconomies of scope here although the reasons are not clear (Brown et al, 1979, Hasenklamp, 1976, Oum and Yu, 1991). Perhaps they relate to congestion, and the delays caused by operating trains of very different characteristics in terms of speed and acceleration over the same tracks.

Turning now to more directly organisational issues, the most common form of organisation for the railway industry involves some form of public control, normally nationalisation. It has been argued by Liebenstein and others that this will lead to technical inefficiency due to employee motivational inefficiency and lack of understanding of the firm's production function due to the regulated environment in which railway firms operate.

There have been a number of international studies that have examined the efficiency of railway operators including work undertaken on European railways at Leeds University (University of Leeds/BRB, 1979, Nash, 1985). These early studies showed that there were large variations in partial factor productivity measures and these differences could often be attributed to government policy but the degree of causation was difficult to quantify.

However, advances in the estimation of total factor productivity indices based on the translog cost function and, latterly, data envelopment analysis techniques have allowed some useful insights. In an early study, Caves and Christensen (1980) compared publicly and privately owned Canadian rail operators and concluded that there was little difference statistically between ownership types; in fact there was weak evidence for suggesting that public firms might be more efficient. Further evidence on organisational effects is given by Oum and Yu (op cit) in an international study of 17 rail operators. They find weak evidence that increased subsidy decreases total efficiency and rather stronger evidence on subsidy's effect on partial productivity measures. An increase in the subsidy ratio of 10% might reduce labour productivity by 1.2%, energy productivity by 1.3% and rolling stock productivity by 0.8%. There is also some evidence that if railways are provided as a government agency they will be 11% less efficient and if they are provided as a quasi public corporation (eg. Amtrak) they may be 20% more efficient than the organisational 'norm'. Similar findings have been produced by Gathon and Pestieau (1991) who composed indices of managerial autonomy for 19 European rail operators and found that this explained around one third of the variation in technical efficiency.

More generally, it should be noted that the development of linear programming based techniques, such as data envelopment analysis, has allowed estimation of a richer, more diverse set of behaviour, even when compared to flexible econometric techniques such as the translog cost function. Both increasing and decreasing returns to scale in different sectors of the production function may be inferred from data envelopment analysis estimates (Banker, Conrad and Strauss, 1986). Moreover, the method is not immune from conflicting results. For example, in Oum and Yu's study DSB is one of the top performers in terms of productivity and efficiency but in Gathon and Pestieau's study it is the worst. However, small variations may produce large changes in rankings as Oum and Yu estimate that in 1988, 7 out of the 15 operators for which gross indices could be estimated were producing on the technically efficient frontier.

We may thus identify two key barriers to entry that may be of relevance in the rail transport field:

1. Economies of scale in both infrastructure and operations. Contestability theory suggests that the traditional view of this as a barrier to entry is incorrect. However, the fact that an entrant may need to supplant the incumbent rather than simply take a small market share surely remains something of a barrier to entry.
2. Sunk costs of infrastructure. This means that the provision of rail infrastructure must almost certainly be seen as an uncontestable natural monopoly.

On the other hand, there is a lack of clear evidence of economies of scope and of economies of firm size beyond some efficient minimum. Hence the current interest in structures which combine a monopoly provider of track (at least for a particular area) with competitive operations.

5. EUROPEAN RAILWAY COMPARISONS

Most of the literature discussed above relates exclusively to North American conditions. European studies are rendered much more difficult by a number of factors:

(i) European railways have a greater diversity of output. Whereas North American railways are dominated by long haul freight traffic, European railways are extensively involved in inter city, suburban and rural passenger traffic. Adding together traffic of such diversity in the form of passenger or freight tonne kilometres is clearly misleading

(ii) Whereas North American railways prepare their accounts on a comparable basis, there is a wide diversity of practice within Europe, making comparisons difficult. Particular problems surround the measurement of depreciation and capital stock, interest charges, and pensions and social security liabilities.

(iii) Government policy generally greatly affects fares, services operated and competition. This makes the most meaningful comparisons of performance those which look at the cost of achieving a given level of service. Comparisons of load factors or market share tend to be meaningless as measures of management performance, although they may reveal interesting information for judging government policy.

(iv) The variety of geographical circumstances in terms of climate, terrain and the need to incorporate ferry crossings in some journeys (eg. in Denmark) also make comparisons difficult.

Despite these problems, we are currently engaged in a study which aims to estimate cost and production functions for European railways. To this end, we shall be seeking to gather unpublished data on variables such as product mix, investment and capital stock. Our starting point, however, is the data published annually in the UIC volume of International Railway Statistics. One of our students has already made a preliminary attempt to estimate a translog cost function using this data (Vigouroux, 1989) and we shall now briefly describe his results. A number of shortcomings of the analysis should be noted. Firstly, in the absence of any comparable data, the costs simply exclude capital costs. The dependent variable is thus operating costs, and the independent variables are the mean prices of labour and energy, train kilometres, route kilometres, a time trend and a country specific dummy variable. Cross-section data for 13 railways for the period 1971 to 1987 is used in a pooled cross-section/time-series analysis. Estimation is by ordinary least squares without restrictions. Results are shown in Table 5. In terms of size alone, the suggestion is that the largest railways (France, West Germany, Britain and Italy) are too big, and the smallest railways (Ireland, Denmark and Norway) too small. The optimal sized railways appear to be Austria and Finland, with a network of around 6,000 route miles. Economies of density exist for the less densely used railways, with the reverse for the most heavily used.

It is tempting to regard the railway specific dummies as some sort of measure of average performance over the period, after allowing for differences in terms of prices, size and density of traffic. However, they will also pick up any systematic differences in the measurement of costs between countries. For this reason we prefer not to report them until further verification of the cost data has been undertaken.

The next stages of the project will be:

- to update and verify the dataset, and to extend it to include unpublished data.
- to apply more appropriate methods of estimation.

It is hoped that some further results will be available to report by the time of the conference.

6. CONCLUSIONS

European railway comparisons are considerably more difficult to undertake than comparisons of the railways of North America. Yet they are of great importance, not just to identify examples of best practice from which other railways may learn, but also - and more importantly - to identify the costs and benefits of policies which change the organisational and regulatory structure. Preliminary work suggests that the North American experience of economies of scale only up to some minimum efficient size appears to be replicated in Europe, but that the greater train density on European track means that a number of European operators have exhausted economies of density. It is hoped to produce further results by the time of the conference.

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Table 1
Comparison of Labour Productivity and Financial Performance

	Labour productivity (train km per member of staff)		Financial performance (% of total expenditure covered by self generated revenue)	
	1987	1977	1985	1975
Britain (BR)	*2796	*1817	73.8	71.0
W. Germany (DB)	2333	1750	66.0	55.8
Denmark (DSB)	3300	2242	64.7	69.4
Italy (FS)	1419	1411	# 30.7	31.3
Netherlands (NS)	4238	3909	58.2	65.2
Belgium (SNCB)	2071	1800	+ 51.7	24.7
France (SNCF)	2203	2096	63.3	71.1

Sources: Labour productivity:- 1987: UIC: International Railway Statistics 1987; 1977: BR/Leeds University: A Comparative Study of European Rail Performance (1979); Financial performance 1985: Com (88) 12 Final. Sixth biennial report from the Commission on the economic and financial situation of railway undertakings; 1975: Com (77) 214 Final. First biennial report on the economic and financial situation of railway undertakings Note: * includes BREL staff; # 1984; + includes a high proportion of receipts other than from traffic revenue.

Table 2
Comparison of Rail's Passenger and Freight Traffic Shares

	Rail passenger traffic share (% passenger km exc metros)		Rail freight traffic share (% tonne km by rail, road, water and pipeline)	
	1978	1988	1978	1988
Great Britain	8.2	7.4	12.6	9.3
Belgium	9.6	7.5	23.3	19.5
Denmark	6.3	7.0	8.1	9.1
FR Germany	6.6	6.5	23.9	21.8
France	10.2	9.6	28.0	22.9
Italy	9.2	7.3	11.8	8.7
Netherlands	6.5	5.7	* 5.5	* 5.4
Spain	10.7	8.6	11.8	8.3

Source: Transport Statistics Great Britain (1978-88) Note: * excludes pipeline

Table 3
Investment prospects to 2000 (£m, 1989)

National Rail Total 1989-2000	118000-137000
Local Rail Total 1989-2000	19700-25900
Overall Total 1989-2000	137700-162900

Source: Kennedy Henderson (1990)

Table 4
Comparison of returns to scale and density from various rail studies
(computed at the sample means)

Study	Returns to Density	Returns to Scale	
		Fixed haul and length	Increased haul and length
Friedlander & Spady 1981	1.16	0.88-1.08	1.07-1.37
Caves et al 1980		1.01	1.13
Harmatuck 1979	1.92	1.01	1.02
Harris 1977	1.72	0.93	1.02
Keeler 1974	1.79	1.01	
Caves et al 1985	1.76	0.98	1.00

Source: Caves et al (1985)

Table 5
Companies of returns to scale and density for 13 European state railways

Operator (state)	Length of line (km-1987)	Elasticity of rail costs with respect to:		Return to scale
		Total train km	Total train km per length of line	
BR (UK)	16630	1.17	-0.45	0.86
CFF (Switzerland)	2990	0.74	0.12	1.35
CIE (Eire)	1944	0.66	-0.30	1.51
DB (W. Germany)	27427	1.29	-0.72	0.78
DSB (Denmark)	2476	0.69	0.01	1.45
FS (Italy)	15983	1.21	0.56	0.83
NS (Netherlands)	2809	0.69	0.20	1.46
NSB (Norway)	4217	0.87	-0.55	1.15
OBB (Austria)	5747	1.04	0.44	0.96
SJ (Sweden)	11194	1.13	-0.83	0.88
SNCB (Belgium)	3568	0.81	-0.07	1.23
SNCF (France)	34646	1.39	-0.96	0.72
VR (Finland)	5884	0.97	-0.79	1.04

Source: Vigouroux-Steck, 1989