International Transport Forum

What is Rail Efficiency and How Can it Be Changed?

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Louis S. Thompson
Thompson Galenson & Associates,
Saratoga, CA, USA

Heiner Bente
Civity Management Consultants,
Hamburg, Germany

OECD

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Louis S. Thompson
Thompson Galenson & Associates
Saratoga, CA
USA

Heiner Bente
Civity Management Consultants
Hamburg
Germany

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Abstract

Assessing railway efficiency is complex for a number of reasons. Railways produce a wide range of outputs including passenger service, freight service and, in some cases, separated infrastructure access services. Railways that differ in scale or in the mix of these services inherently differ in their apparent "efficiency." Railway data sets, though probably more detailed than in other modes, are fraught with issues of quality, consistency and cost and asset allocation. Assessing "efficiency" necessarily requires both cross-sectional indices to put each railway into proper context and time series data to show changes in performance over time in response to changes in the railway's economic and policy environment.

This paper assembles a wide database of railway data relating to operating scale and various indices of performance over the period of 1970 to 2011. We show, as expected, that railways differ widely in scale and mix of services, which may partly explain differences in ranking by performance indices. We show also that railway performance has changed greatly over time and that, in some cases, changes in performance can at least partly be attributed to reforms in structure, ownership and management incentives.

1. Defining Efficiency in a General Sense

In the abstract, what we mean by "efficiency" or productivity (we will use these terms essentially interchangeably) is maximizing the outputs from a set of inputs or maximizing the ratio of outputs/outputs. Efficiency is not a standalone concept, however; efficiency is always dependent on a comparative context. We need to know how a given performance compares with others.

Defining and measuring efficiency or productivity in the railway context is a complex problem because:

- Size and scale matter. Large railways and highly dense railways have a potential advantage in efficiency because some parts of railway operations are subject to returns to scale, at least over the range below the very largest systems.

- The mix of services matters. Most measures of productivity appear to show that passenger service is less "productive" than freight. That is, a passenger-km tends to require more resources to produce than a tonne-km: after all, many countries operate 10 000 tonnes (or greater) unit freight trains while passenger trains carrying more than 1 000 passengers are rare (see Mumbai commuter trains, however). Moreover, freight is generally considered to be "commercial" and market-driven and managers have an opportunity to set reasonably clear management objectives: passenger services are typically justified by social as well as financial performance, leading to political involvement and mixed, even contradictory management objectives.

- Evaluating railway efficiency therefore requires a number of different types of indices relating to scale, asset productivity (including labor), financial indices (revenue-cost) and economic measures that include social costs and social benefits. No single index can ever be dispositive. Instead, we will need to look at a collection of indices to see which railways tend to fall at the bottom of the pack and which tend to rise to the top.

- The complexity of measures makes it important to have two types of indices, cross-section (comparing railway systems at a single point in time) and time series (change over time). There can well be reasons for a lower ranking on various cross-sectional indices, especially when some railways are forced by government to provide large quantities of politically driven regional or commuter services (whether or not compensated by PSO payments), or where regulation suppresses tariffs and harms financial performance. Even where a plausible case can be made for lower comparative performance, though, adverse changes over time are harder to explain.

2. Indicators Available From Published Data[1]

Indicators of efficiency or productivity can be developed at many different levels. The objective of this paper is to identify indicators that can be developed from publicly available data. We recognize that some measures would require much more detailed information, such as a comparison of the costs of DB versus Network Rail in maintaining a Km of electrified line with comparable traffic levels. Unfortunately, information at these detailed levels is either not collected or not reported publicly.[2] Appendix A contains a detailed discussion of the sources of data used in this paper. The dataset developed covers the period 1970 to 2011 (in some cases later) for time series purposes and furnishes a complete cross-sectional set for 2011. The data set includes all EU railways (separated between the EU15 and EU10) along with Switzerland and Norway. In addition, for comparison we include China, the U.S. (Class I freight railways and Amtrak), Canada (freight railways and VIA), Japan and, in some cases, Indian Railways (IR).

- The basic indices of size and scale are (see Table 1 for a key to the countries, railways and groupings employed in this analysis and Table 2 for summary data):

[1] Unless otherwise specifically indicated, **all data are expressed in metric terms – Tonnes and Kilometres**. Unless otherwise specified, Tonnes means net Tonnes.

[2] The International Union of Railways (UIC) sponsored a series of studies of relative efficiency of track maintenance among a number of railways. Unfortunately, the identity of railways in the dataset was concealed, depriving outside analysts of the ability to put the relative performance of each railway into context. This also deprived governments of the ability to assess the performance of their own railways and to decide whether the public was getting value for money. Beck *et al.*, 2012 suffers from the same “confidentiality” restrictions. An explicit objective of this study is to rely only on data sets that are publicly available.

- Passenger data: Passengers carried[3], Passenger-Kms, Gross Tonne-Kms for passenger trains, Passenger Train-Kms, Coaches, DMUs and EMUs;
- Freight data: Tonnes carried, Tonne-Kms moved, Gross Tonne-Kms of freight moved, Freight Train-Kms and Freight Wagons[4];
- Common or joint assets: Locomotives, Labor, Kms of Line;
- Financial and economic performance: Total Operating Cost, Total Operating Revenue, Passenger Revenue, Freight Revenue.

- Ratios of efficiency and productivity developed from the measures above:
  - Average trip length for passengers (Passenger-Kms/Passengers), and average length of haul for freight (Tonne-Kms/Tonnes). Table 3.
  - Passenger share of Traffic Units (TU): Passenger-Kms/(Passenger-Kms + Tonne-Kms). Table 4.
  - Passenger share of Gross Tonne-Kms: (Passenger GT-Km/(Passenger GT-Kms+Freight GT-Kms). Table 4.
  - Passenger share of Train-Kms: Passenger Train-Kms/(Pass. Train-Kms+Frt Train-Kms). Table 4.
  - Traffic density: TU/Line Kms, Gross Tonne-Kms/Line Kms and Train-Kms/Line Kms. Table 5.
  - Coach Productivity: Passenger-Kms/(Coaches+ DMUs+EMUs). Table 6.
  - Wagon Productivity: Tonne-Kms/Wagon. Table 6
  - Locomotive Usage: TU/(Locomotives + MU factor)[5] Table 6.
  - Labor productivity: TU/Employees, Gross Tonne-Kms/Employees and Train-Kms/Employees. Table 7.
  - Operating Ratio: Operating Cost/Operating Revenue. This is a commonly used measure of financial performance and an indication of the railway's ability to cover its financial obligations.[6] Table 8.

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[3] We highlight the fact that there can well be double counting on passengers carried and freight tonnes carried since the same passenger (or tonne) can cross a railway border and be counted each time. Passenger-km and Tonne-km are not subject to double counting. Given that the average trip length of most EU railways is quite short, this issue may not be as significant for passengers as for freight.

[4] Numbers of freight wagons are also affected in countries where there are significant numbers of lessor or shipper owned wagons that do not appear as railway-owned assets. For example, only one-third of U.S. freight wagons are owned by railways.

[5] Measuring locomotive productivity is complicated by the presence of DMUs and EMUs that have their own tractive effort. We attempt to correct for this by calculating effective locomotives by dividing DMU or EMU numbers by a factor that represents the average length of a DMU or EMU train. We acknowledge that this is at best an approximation. Of course, on freight-only railways or railways without MUs it is not a problem.

- Average Revenue per Passenger-Km and per Tonne-Km. These are measures of the railway's average tariffs and give an indication of the railways cost levels combined with government subsidy policy. These measures show performance from the customer's point of view – how much do I have to pay? In addition, they give a good indication of the railway's charges compared with competing modes. These measures are presented in constant 2011 Purchasing Power Parity Adjusted (PPP) international dollars. This involves several revenue conversions: 1) into constant local currency (which requires conversion from local to Euros in those countries joining the Euro); 2) into USD at 2011 conversion rates; and, 3) into PPP $. Although this chain of conversions clearly introduces potential errors at every stage, we believe it is interesting because it furnishes a general comparison of amounts that users actually pay in various countries and especially because it shows the impact (if any) on railway users of the various reform programs. Table 9.

- Market shares for passenger and freight from OECD data of freight and passenger traffic for all modes since 1970. This is the best available measure of how the railway has performed in competition with highway, water and air traffic and is a measure of the impact of reforms on the railway's competitive position. Table 10.

3. Initial Rankings Based on Cross-Sectional Comparisons and Initial Discussion of Time-Series Data

The data available are far too extensive for a detailed review of every railway. Instead, we can briefly summarize the highlights of the basic performance indices illustrated in Tables 1-10.

- **Table 1** provides a listing of all railway entities on which at least partial data have been collected and show how the Tables distinguish among EU 15, EU 10 (and Croatia), Norway and Switzerland, and all other railways. It also provides the railway abbreviations that are used throughout this paper.

- **Table 2** shows Employees (Labor Force), Line Kms, Passenger-Kms and Tonne-Kms. There are some railways, notably China, U.S. Class I freight, Indian Railways and Japanese railways that are immense industrial undertakings by any measure. SNCF, DB AG, PKP, FS and the UK rail system appear at the upper end of the ranges as well. By comparison, many of the EU's smaller railways are one-one thousandth (or less) of the size of the largest railways. Although there have been studies arguing that returns to scale in railways taper off beyond a certain size (and some of the largest appear to be at or beyond this point), there is little question that many of the smaller railways will inherently be on the less efficient end of the scale. This has to be considered when assessing their performance.

[6] The Operating Ratio includes depreciation and amortization but excludes payments to acquire and compensate sources of capital.

- **Table 3** shows the average trip distance for passengers and the average length of haul for freight. Railways with a longer average trip are in a different market segment than those with mostly short trips. CR, Amtrak and VIA, for example, operate numerous long-haul trains with sleepers and diners and, for Amtrak and VIA, are partly in the cruise business and partly compete with air travel. A critical characteristic of most of the EU railways is their very short average length of passenger trips, which means that they operate mostly short intercity trips or commuter services. At these trip lengths, auto and bus are the main alternatives. Somewhat the same phenomenon shows up even more strongly in freight where U.S. Class I, CR, Canada and IR operate with lengths of haul long enough to fully capture the economic advantages of long haul, heavy loading freight traffic. By comparison, most of the EU railways are constrained to operate at lengths of haul where trucking becomes more competitive. We highlight here that there is a real possibility that the EU lengths of rail freight haulage (and passengers to a lesser extent) may be distorted to appear lower than actual by double counting of the tonnes handled when traffic crosses national borders.[7] This also highlights the need for better Origin to Destination rail traffic data in addition to that reported by the individual railways.[8]

- **Table 4** shows the role of passenger traffic in the total traffic of each railway, first as a percent of Traffic Units (the sum of Passenger-Kms plus Tonne-Kms), then as a percent of Gross Tonne-Kms and then as a percent of Train-Kms – three different aspects of rail service. Traffic Units give a basic picture of the relative markets the railway serves, Gross Tonne-Kms gives at least an indication of the relative maintenance burden imposed by each type of service, and Train-Kms gives a rough picture of the relative usage of line capacity, which is the basic limitation on the ability of the railway to provide service. By these measures, the EU 15 railways tend to be passenger dominant, the EU 10 railways less so, Japan is highly passenger dominant, and the U.S., Canada and CR are freight dominant. It is also significant to note that the passenger share of Train-Km tends to be higher than TU or Gross Tonne-Km, indicating that measures of efficiency of system use should look at all three measures in order to account for services, wear and tear in the system and usage of capacity.

- **Table 5** then looks at measures of line traffic density according to TU/Km, Gross Tonne-Kms/Km and Train-Kms/Km. It is interesting that CR and U.S. Class I tend to rank higher by the first two measures whereas the EU railways rank higher by the third. We could say that the U.S. Class I railways, for example, are more efficient at using their tracks to move volumes of freight, but the EU railways are more efficient at moving trains carrying passengers. From another viewpoint, we could argue that the focus in the EU on using line capacity to emphasize Train-Kms may well limit the ability of the systems to move freight that requires fewer Train-Kms but can interfere with passenger trains because of the speed difference between freight and passenger trains.

- **Table 6** provides a series of measures of the productivity of rolling stock. The measure for Coaches is Passenger-Km/coaches including MU Coaches. Wagon productivity is shown as Tonne-Km/Wagon fleet. Locomotive productivity is TU/Locomotives plus an adjusted number of MUs to reflect the fact that MUs provide tractive effort. The adjustment factor used divides the number of MUs by 6: we recognize this as at best an approximation. In fact, while the Coach measure pertains only to passenger service and the wagon measure pertains only to freight, and are

[7] This could be corrected if railways distinguished between tonnes originated as opposed to total tonnes handled and tonnes originated off line and terminated off line.

[8] A similar problem appeared in the US Carload Waybill Statistics in the early years of waybill reporting because each railway in a multiple railway shipment could report the same tonnage. This has since been corrected. See McCullough 2012 for a detailed discussion of the issue.

thus reasonably separable, the locomotive measure necessarily includes both services (except for railways that provide only freight or only passenger service) since locomotives are often used interchangeably. Once again, in terms of locomotive usage intensity, the major freight railways tend to predominate. IR, CR, SBB and Japan stand well above the rest in Coach productivity.

- **Table 7** shows output per employee as measured by TU/Employee, Gross Tonne-Kms/Employee and Train-Kms/Employee. The U.S. Class I and Canadian freight railways stand far above the pack in TU and Gross Tonne-Kms per employee, but are in the middle of the pack for Train-Kms/Employee. This reflects the same difference in focus where, in order to reduce labor costs, the U.S. and Canada run fewer, but long and heavy trains whereas the EU systems run higher frequencies of shorter trains primarily because passengers place a higher value on service frequency than do freight shippers.

- **Table 8** shows the Operating Ratio, which is the ratio of total Operating Costs (excluding costs of debt and equity) to total Operating Revenues and is a basic measure of financial performance. Railways running an Operating Ratio above approximately 85% are much less likely to cover their total cost and will require increasing outside support as the ratio becomes higher – they are financially "inefficient" (though they may be economically efficient if they are rendering a social service at low cost and with adequate compensation). By definition, an Operating Ratio above 100% means that the railway cannot survive without outside assistance. The critical observation is how few railways even approach being self-sufficient financially. This may be well within the fiscal boundaries established by governments, but it does ensure that railways are enmeshed in the annual politics of public finance: note, for example, that the U.S. Class I railways are profitable (Operating Ratio of 73.2%) whereas Amtrak (Operating Ratio of 150.2%) is dependent on public finance. It is also interesting to see that the Operating Ratios of RHK (900%) and BV/Trafikverket (250%) reflect the stated policies of the Finnish and Swedish governments to collect only marginal costs of infrastructure provision from users. By comparison, an estimate of the Operating Ratio for DB Netz is 86.9%, reflecting the stated goal of the government to collect the full cost of operations from users. The reported Operating Ratio of RFF (78.7%) is also surprisingly low, and perhaps explains the complaints of SNCF that access charges were too high. It will be interesting to see what happens to this ratio when RFF is re-merged with the SNCF parent company. The Annual Reports of Network Rail stated an Operating Ratio of 64.5%, which would again reflect a policy of collecting full cost from users. We emphasize, though, that these measures are particularly sensitive to accounting issues and to the transparent accounting (or lack thereof) for public support.

- **Table 9** shows the most important index of efficiency from the point of the view of the customer – prices charged. In Table 9, we have converted average revenues per Passenger-Km and per Tonne-Km into 2011 USD at Purchasing Power Parity (PPP). Because this involves conversion of currencies first into constant terms, then into a common currency, and then into PPP terms, it is clearly subject to a range of error. With this acknowledged, it is interesting to see that the average passenger tariffs of many EU railways are well into the range of low-cost airlines as well as costs of auto operation, which does not bode well for competition except in congested urban environments. Similarly, many of the EU railways charge average freight tariffs that are roughly comparable to trucking costs and thus subject to intense competition. Extremely low passenger tariffs on some railways (IR) reflect a desire to use freight income to pay for passenger losses caused by politically suppressed passenger fares.

- **Table 10** shows the market share (percent of Passenger-Km) of rail transport in the passenger sector in competition with autos and buses. It also shows the rail market share (percent of Tonne-Km) vis-a-vis the entire surface transport market (trucks, water and pipeline) and then rail market share vis-a-vis trucks only. In a direct sense, this is not so much a measure of rail efficiency as it is a measure of the **result** of rail efficiency (or lack thereof) in the overall market. An inefficient railway will perform poorly, an efficient railway has a chance to perform well. We argue that the competition of rail versus trucks is probably the best measure of rail's performance in the transport markets. As this Table shows, rail plays a very different role in some countries than in others. For example, rail plays practically no role in U.S. and Canadian intercity passenger transport but is predominant in Japan.

Because the amount of information to be presented would be too large, we selected a few indicators and a few countries to display a sample of the time-series information that is available. We show only the years 1970, 1975, 1980, 1985, 1990, 1995, 2000, and 2005-2011 (interim years are available in the underlying database). We select France (SNCF), Germany (DB through 1995 and DB AG for 1995-2011), and the UK (old BR before 1995, ATOC, UK freight and Network Rail afterward): these railways together account for about 60 percent of all EU 15 railway traffic. We show the Czech Republic (CD) and Poland (PKP) as these represent about 60 percent of traffic in the EU 10 and because the data available are not complicated by changes in corporate structure . We also show the U.S., Japan and Switzerland (SBB) to represent railway activity outside the EU We use 1980 and 1995 as base years: 1980 is a point in the development of the EU when railways began to be affected by the overall economic changes, and is also the year before deregulation in the US; 1995 is close to the beginning of the Commission's attempts to restructure the EU railways.

- **Table 11** gives an overall picture of how railway traffic has developed over time. Notable from this Table is the fact that rail passenger traffic grew faster in the UK than in SNCF and DB, especially after 1995. UK freight traffic also grew faster. Rail traffic has been shrinking in the EU 10 and had, at best, stabilized by 2011. Swiss traffic trends essentially mirrored those of the EU 15, while Japanese passenger and freight traffic were stagnant or slowly shrinking. U.S. passenger traffic grew slowly while freight traffic grew strongly, especially from the base in 1980.

- **Table 12** shows the evolution in Operating Ratios and Labor Productivity (using TU/Employee). There is a mild improvement in Operating Ratio in most countries, with a marked improvement in U.S. Class I freight railways and in Japan. With this said, it is interesting to note the difference between the U.S. Class I railways (73%) and Amtrak (150%). Labor productivity improved in all countries, with the greatest growth rate in the U.S. Class I freight railroads, UK and Japan.

- **Table 13** shows the side of the railways that the consumer sees – average tariffs. There was an apparent trend upward in average passenger tariffs in every country from 1980 and in all but one (Japan) from 1995. Average freight rates were stable or trending downward in most countries; but, only in the U.S. Class I railroads do they appear to be well below competitive trucking rates. We stress again here that the calculation of average rail tariffs is inherently an approximation because of all of the conversions involved. We do believe that they are usefully indicative both as to levels and changes over time, but they do need to be viewed with some caution.

- **Table 14** shows the evolution in market shares in passenger and freight markets. The rail passenger share of the EU 15 railways (~7%) has changed little since 1980 and 1995 whereas the rail passenger share in the EU 10 countries has rapidly fallen to EU 15 levels. Rail passenger traffic has an insignificant share in the U.S. and that has not changed.[9] Japanese rail passenger shares have been stable at a level much higher than the EU, while Swiss rail passenger shares have

[9] This is to some extent the result of exclusion of the traffic of U.S. commuter railways (which is included in the EU, Swiss and Japanese results). U.S. commuter railways carry slightly more Passenger-Km than Amtrak, so the U.S. share would double, but still remain below 1% if auto traffic is included.

grown slightly and are about twice the EU levels. The picture for rail freight is quite different: EU 15 rail freight shares have fallen since 1980 but have remained stable since 1995. EU 10 rail freight shares have fallen dramatically since 1980 and 1995, though they may now be stabilizing at a level slightly above that of the EU 15. Interestingly, the Swiss rail freight market share is much higher than in the EU, though it has fallen somewhat since 1980 and 1995. The U.S. rail freight market share has stabilized since 1980, though it was falling rapidly before then (it was 78% in 1950 and 67% in 1960).

At this point we can answer the first issue posed in this paper. Yes, there are measures of efficiency or productivity that can be developed from publicly available data. The measures we have developed do give an overall picture of the performance of the selected railways both in cross-section (2011) and over time (1970 to 2011). It is possible from these measures to identify the more efficient railways: China in both freight and passengers, U.S. and Canadian Class I railways in freight, and Japan for passenger service. Within Europe, SBB seems to measure up quite well while the EU 15 and EU 10 railways present a mixed picture. It would also be possible to use the data developed to assess the efficiency of a specified railway and track its progression over time if that were desired.

With this said, these measures could be greatly improved in the EU by having a regulatory body that could specify the data to be reported by every railway, verify its accuracy and require its production annually.[10] It is possible that many of the gaps identified in the database could be filled by reference to Annual Reports or other national documents, but there is no single point of reference for complete and consistent reports.

In fact, the EU data gaps and consistency problems underline an important challenge in measuring and comparing railway efficiency – most railways either do not see the need for detailed information for internal management purposes or do not think it is in their interest to release such information to permit public comparisons to be made. For example, as mentioned earlier the data in "Railway Efficiency," (Beck 2012) conceals the identity of the railways in the comparison, significantly vitiating the use of the results. This has long been the practice of the UIC in making comparisons of relative performance of its members. Under what circumstances should public entities, supported by public funding, be allowed to conceal information that would facilitate public analysis and evaluation of their performance? This will be a point to consider in the analysis of the interaction among ownership, structure and performance measurement discussed below. It is also a critical point in assessing whether the Commission's railway objectives – transparent accounting for infrastructure to ensure fair access and financial stability of the infrastructure agency accompanied by separated accounts for passenger and rail services – can ever be met.

We argue that the information that the Commission would need to ensure implementation of its Directives with respect to financial transparency of infrastructure, passenger and freight operations simply does not yet exist, and should be added to the task of a designated authority. In addition, one important piece of information – where do passengers and freight shipments **actually originate and terminate** – is not yet available in the EU and awaits collection of passenger ticket and waybill information. The same issues were described in more detail in "Railway Accounts for Effective Regulation," (Thompson 2007).[11] The data collected and reported by the U.S. STB, including

[10] For railways, this requirement might also be met by encouraging all railway service providers, including infrastructure entities, to complete the existing data requirements of the UIC.

[11] See also "Workshop Report - Measuring Investment in Transport Infrastructure," ITF, Paris, France, February 9 and 10, 2012, where exactly the same data issues arise.

"Analysis of Class I Railroads" and "Public Use Carload Waybill Statistics" would be a useful model for EU agencies to consider.

4. How Can Efficiency Be Changed?

It is all very well and good to define and measure efficiency (however approximately), but the effort expended in defining, collecting and reporting data will have no payoff if there is nothing that can be done to change the railways' performance.[12] Fortunately, if railways are willing, and the political will exists, efficiency can be changed.

One way to change efficiency, much favored by traditional, engineering-dominated railway managements, is increased investment (increasing capital intensity). One of the arguments in favor of added investment – making up for deferred maintenance – can well have some justification, although it sometimes simply reflects neglect of a facility that lost its economic role long ago and should be taken out of service. Where legitimate deferred maintenance needs exist, good management (and good public policy) will deal with it. Another argument – replacing old with new without regard to payoff – tends to appear when the railway does not face any commercial objectives. In either case, this paper does not look at increased investment alone, although we acknowledge its role in improving efficiency when a good financial or economic case can be made, especially when the success of a new structure depends on a fresh start from years of past investment neglect.

We instead look at various structural or organizational innovations that aimed at changing the underlying objectives or incentives faced by railway management and use the time series data in outlining those changes that seemed to have "worked" and those that have not been as successful.

In general terms, we can identify changes in **structure**, **ownership** and **incentives**, though these can be combined and can work together:

- **Structural** change means movement along the spectrum that begins with monolithic form (all assets owned by the railway and all services provided by the railway). The Ministry of Railways in China has long been an example of a monolith. China recently separated China Railways (CR) from a newly created Ministry of Railways, so Indian Railways (IR) is the only remaining major railway that is still fully monolithic. There are railway structures where the dominant operator is in control of infrastructure while other operators are tenants on the infrastructure and pay for access (either marginal costs or a negotiated fee). This can include either competing operations in

[12] Indeed, the experience of the authors suggests that railway management often resists collecting information, and especially reporting it, on the grounds that they can't do anything with the results anyway. Of course, it could also be because they are concerned that better information might support efforts to change the rules of the game they face (or in fact change them). As a rule of thumb, public ownership and management under political control seem to be antithetical to collection of transparent information, even where the information is for public use. To be fair, private corporations also try to restrict public reporting but, as the STB example demonstrates (ORR in the U.K. is a demonstration of passenger information) these objections can be overcome. Moreover, private corporations are not usually spending public money and, when they are, they are required to report in greater detail.

the same market (freight trackage rights on a freight operator's lines, which covers 27% of U.S. freight lines) or non-competing operators (passenger) on freight lines (Amtrak and VIA) or, indeed, freight operators on passenger lines (JR Freight). The U.S, Canada and Japan are examples where the dominant operator controls the infrastructure and tenants pay for access. The complete form of structural change is full vertical separation, with an infrastructure provider offering neutral access to all operators in accord with published access charges. The EU Commission's Directives have been aimed at creating vertical separation of infrastructure but the process has been fragmented, inconsistent across member countries and, in many cases, remain incomplete.

- **Ownership** change means movement along the range from fully public to fully private. U.S. and Canadian freight railways are now fully private, though the Canadian National (CN) was only privatized in 1995 and Conrail was privatized in 1987. Amtrak is a publicly owned corporation. The old Japanese National Railway was broken up (structural change) and the three largest passenger operators privatized in 1987. Most EU railways remain fully public, but the private sector is increasingly being allowed to provide some operating services, both in the passenger and freight markets. The UK was at one time an extreme case of virtually full privatization, but that has evolved back into a public/private balance.

- Changes in **incentives** ("rules of the game") include situations in which the management of the railway is given more freedom to operate commercially and is given objectives that include at least some degree of risk for cost control or net revenue maximization or both. Management contracting is a starting point, but the process can extend through gross cost or even net cost franchising.[13] In the U.S. context, deregulation completely changed the ability of freight railways to work directly with shippers to set rates and services that met shipper needs without interference from the regulator.

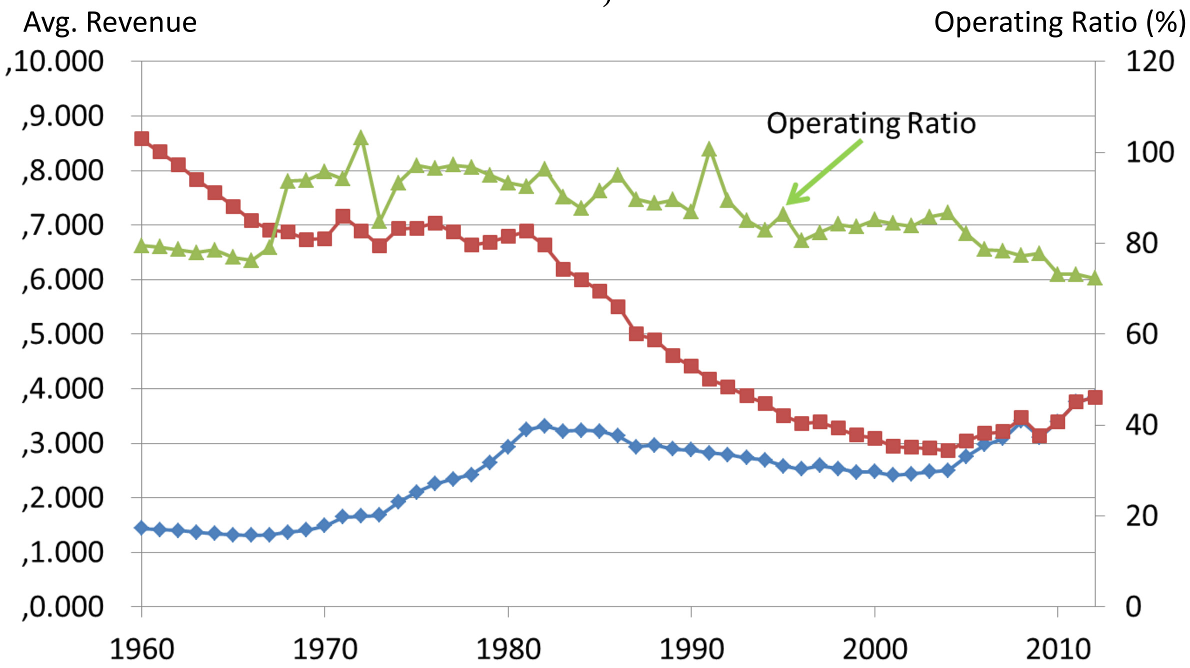
5. Did Any of These Changes Work?

The reform process in the US actually had three parts: formation of Amtrak in 1972 order to free the private freight railroads of the burden of passenger deficits (and, in the minds of some, to free passenger service from the indifference of freight company management); combining the bankrupt freight railroads in the mid-west and northeast part of the country into one entity, refinancing and rebuilding it, and subsequently re-privatizing it in 1987; and deregulation in 1980 (the Staggers Act). As Tables 11 and 12, and Figure 1 show, these reforms were highly successful in stabilizing market share, lowering rates, increasing traffic and improving essentially all indices of efficiency.[14] The comparison with changes in Amtrak is interesting. Amtrak rates went up (Table 13), service grew slowly (Table 11), and productivity was stagnant (Table 12). Operating Ratios improved for freight and were stagnant (and high for Amtrak). With this said, the essential purpose of Amtrak – to save the freight railways that were staggering under the burden of passenger deficits– was achieved.

[13] See ECMT 2007 for a discussion of gross cost and net cost franchising.

[14] See McCullough 2012 for a detailed discussion of the impact of the Staggers Act on U.S. rail freight tariffs and on the profitability of the Class I Railroads. Basically, rates went down and profits went up because productivity increased even more rapidly, especially as a result of contract tariffs.

Figure 1. **US Class I Railroads Operating Ratio (%) and All Commodity Average Revenue/** Ton-Mile (U.S. cents/ton-mile
)

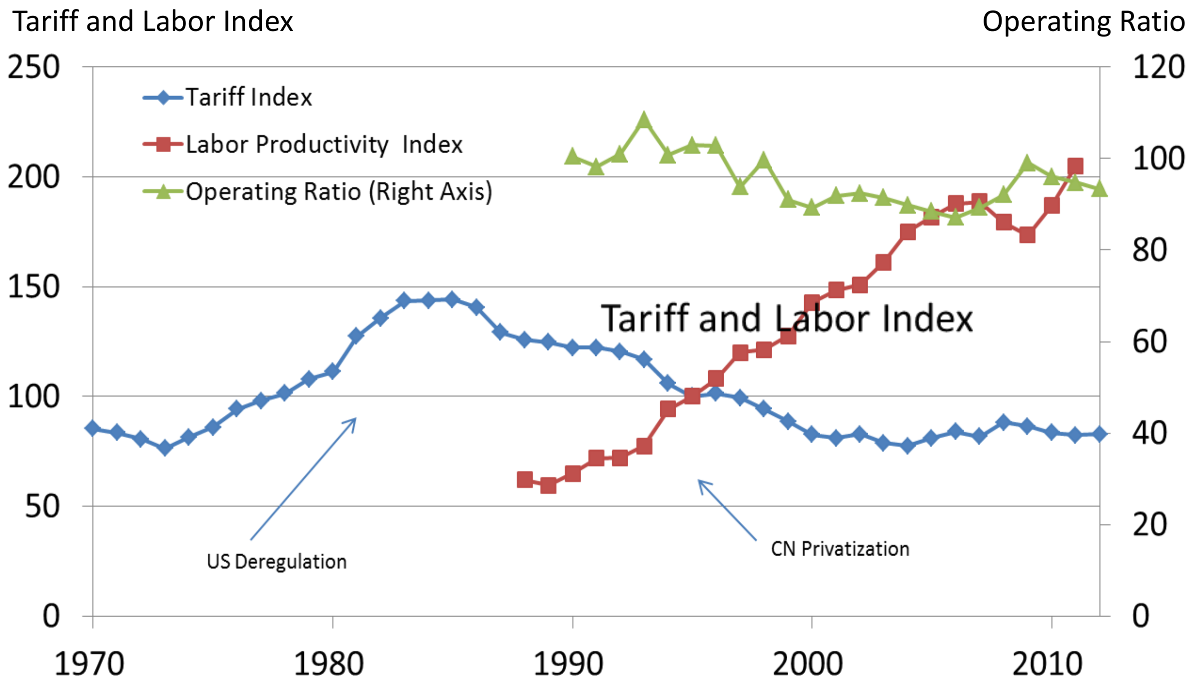


Source: Analysis of Class I Railroads and U.S. Bureau of Economic Analysis (GDP Deflator).

In Canada, privatization of CN produced a change in relative productivity of CN with CP (always private), though the shift was not dramatic. In sum, though, Canadian rail freight rates declined steadily both before and after CN privatization while labor productivity improved rapidly. Operating Ratios also improved after 1995. Comparing Figure 2 with Figure 1, it is also apparent that the Canadian experience was at least partly driven by deregulation of the U.S. freight railways, with which the Canadian railways both compete and cooperate.[15] VIA offers the same comparison with the Canadian freight railways as Amtrak does with the Class I U.S. freight railroads: VIA's labor productivity is low (Table 7) and is little changed since establishment in 1980. VIA's Operating Ratio (185.5 – see Table 8) is high although its average tariffs are well below Amtrak and are about at the EU average, but for a very different traffic mix (see Table 3, where VIA has the third longest average length of trip, reflecting the importance of long-haul trains).

[15] A recent OECD report (ITF 2014) showed that changes in the structure and ownership of the Mexican railways had a similar effect.

Figure 2. **Canadian Freight Railways**
(Tariff index and Labor Productivity Index 1995=100)

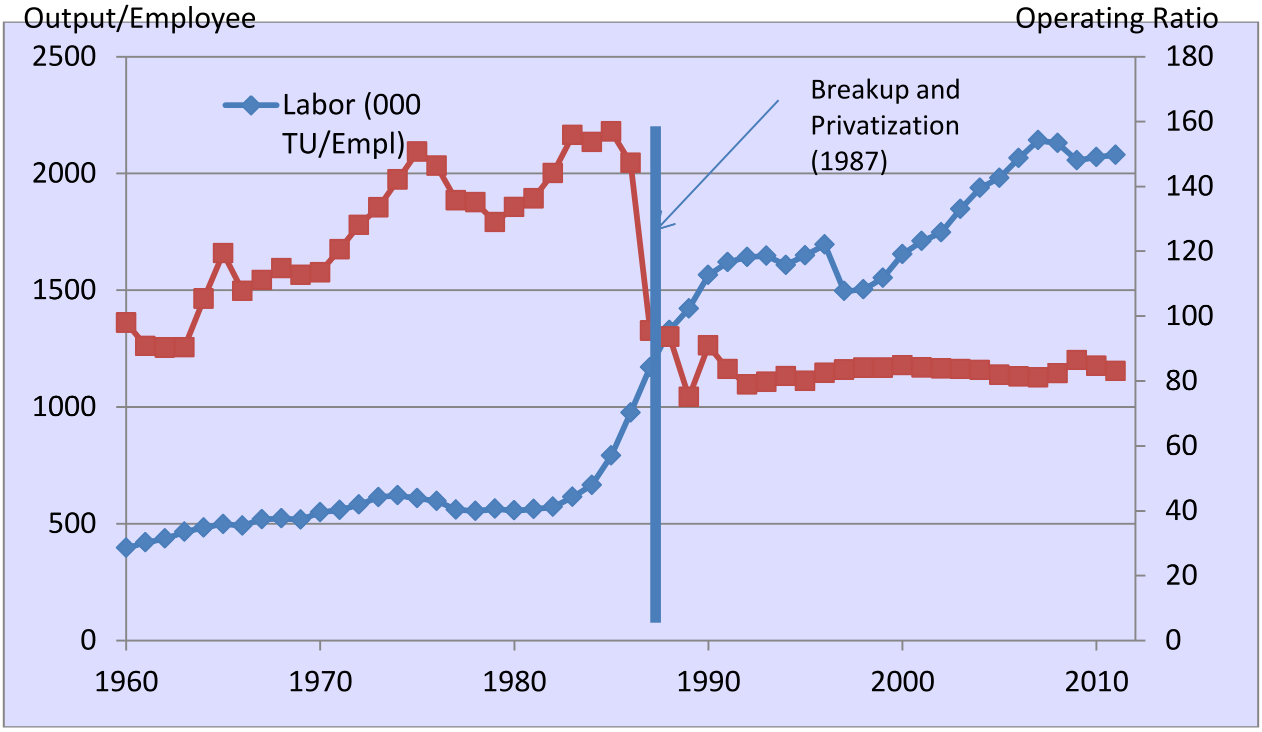


Source: Railway Association of Canada.

In brief, the Japanese reforms involved breaking up the old monolithic Japanese National Railways (JNR) into 6 new passenger companies and a freight company that operates much like a "freight Amtrak" – it pays access charges and uses the narrow gauge lines of the passenger companies (the high-speed lines – Shinkansen – are standard gauge and are not used for freight). The three large passenger companies (JR East, JR West and JR Central) were subsequently privatized by sale of their stock. An explicit goal of the reform was to break the control of the unions over the politically oriented management. As Figure 3 shows, the reforms were highly successful in improving labor productivity and the Operating Ratio for the system.[16] This was accomplished while tariffs were held stable (Table 13) and total traffic actually remained almost the same over the last 20 years. Performance of JR Freight is harder to pinpoint. What is clear is that traffic has declined while tariffs have been held stable, roughly at EU levels. In perspective though, JR Freight has faced a problem similar to that of Amtrak: as the traffic of the dominant operator has grown there is less room for the tenant. This has caused Amtrak's on-time performance to plummet and has restricted JR Freight's ability to handle its traffic. It is probably a risk inherent to dominant/tenant schemes (or, arguably, where some operators have closer linkage to infrastructure management than other operators).

[16] The Operating Ratios shown are actually for the entire system, and are lowered by the performance of the three smaller railways and the freight company (JR Freight). The Operating Ratio for the three larger companies by themselves would be more favorable.

Figure 3. **Changes at JNR at Privatization**
[Operating Ratio (%) and Labor Productivity`]



Source: Author's analysis and UIC Railway Time Series, 1970-2000.

Experience in the EU is much more complex to assess. In overall terms the Rail Liberalization studies by Kirchner[17] suggest that the Commission's structural reforms have gradually been implemented, though the degree differs among members as Table 15 shows. Although the indices are arguable on a number of grounds and are, in any case, only partly objective, Kirchner argued that the market is now more liberal and that the degree of competition has increased.

Table 15 does indicate that the Liberalization Index as computed by Kirchner had improved over the time period (2002, 2004, 2007 and 2011) studies. This appears to have been much more applicable to freight service than passengers, probably because the interaction between public support and passenger service is stronger than in freight. Governments find it hard to allow competition for their supported services, though this has changed in some countries.

It is also significant that Kirchner divided his index into three parts: LEX (legal change); ACCESS (whether the infrastructure agency actually allowed access to take place in accord with the new laws); and COM (a measure of the actual degree of competition that had emerged. Looking at the COM index on Table 15, even by 2011 there was only one country (UK) that had an "advanced" COM index, and only four (Germany, Netherlands, Denmark and Estonia) that were considered "on schedule." It is also interesting that DB AG owns the major freight carrier in Germany, NL and DK (and in the UK), so the apparent degree of freight competition in these countries may be less than

[17] Kirchner 2011, but also 2002, 2004 and 2007.

indicated. Estonia essentially exchanges traffic only with Russia (Its Baltic connections are either "delayed" of "pending departure"), so competition would be of limited value.
The relatively slow development of intra-rail competition combined with the slower pace of liberalization in the passenger sector should alert us to have lower expectations for the impacts of the EU reforms, especially in countries slower to adopt the reforms. This effect can be multiplied by the fact that a country might well be aggressive in its reforms only to see the impact muted by slow change in countries to which it connects.

This overall picture of a slow pace of reform in the EU railways developed by Kirchner is supported by the results in Tables 11 and 14. The EU 15 railways do not demonstrate a particularly dynamic performance either measured by freight or passenger traffic growth or by market share. We acknowledge that the outcome could have (we argue would have) been worse without reform, but it is not possible to argue that the reforms have had (to date, at least) anything like the positive impact of the reforms in the U.S., Canada and Japan. It is also possible to argue (as the Kirchner indices suggest) that the restructuring reforms have not actually been implemented yet to the degree necessary to have an impact on efficiency.

The picture for the EU 10 railways (and Croatia) is even harder to assess, partly because they are more recent members and, more important, because they were subjected to the wrenching transition from central planning to market structure, which would have had a devastating impact on both passenger and freight traffic no matter what changes in structure had occurred. With this said, it is at least interesting to point out that new, private freight operating companies are already carrying nearly 25 percent of freight traffic in Bulgaria and are carrying about 50 percent of the freight traffic in Romania. Clearly this would not have happened without vertical separation. It will be interesting to see if these companies eventually operate at higher levels of productivity and efficiency.

It is difficult to use the efficiency indices to draw any dispositive conclusions about the performance of DB AG and SNCF. They are both in the upper middle of the pack in size and outputs. Despite the emphasis on developing HSR services, SNCF has an average passenger trip of only 79 Km, while DB AG is even shorter at 40 Km, suggesting that the efficiency of both is heavily influenced by the economics of short haul passenger service. Well over 70 percent of SNCF's traffic output is passenger service while DB AG's passenger service ratio is in the high 40 percent range. In operations, though, 89 percent of SNCF's train-km are passengers and as are 75 percent of DB's operations: both railways are clearly using most of their capacity for passenger service, and (as with the U.S. and Japanese cases) when one service dominates, the others suffer for lack of priority access to capacity. Both are in the middle of the pack as to line traffic density, with DB AG slightly above SNCF. SNCF appears to make somewhat better use of its rolling stock fleet, though neither is at the top of the productivity rankings. However measured, the labor productivity of SNCF is lower than DB AG, although the productivity measures for both SNCF and DB AG (especially) are probably reduced by the inclusion of non-rail employees in the totals.[18] SNCF reports a better Operating Ratio than DB AG in 2011, but this would not have been true in most of the earlier years reported. DB's average passenger fare is about 30 percent higher than SNCF, but its average freight tariff is about 10 percent lower than SNCF. SNCF's market share is higher than DB AG for passengers but lower for freight. SNCF's passenger traffic has grown slightly faster than DB AG's, but SNCF's performance in the freight market has been very poor, worse than DB AG and actually worse than the EU 10 countries. DB AG's improvement in labor productivity has been significantly better than SNCF, but neither did as well in

[18] SNCF would be raised by about 25 percent and DB nearly doubled if non-rail employees are excluded from the productivity measures. Unfortunately, though the data exist to do this separation in later years, the information is not available for earlier years.

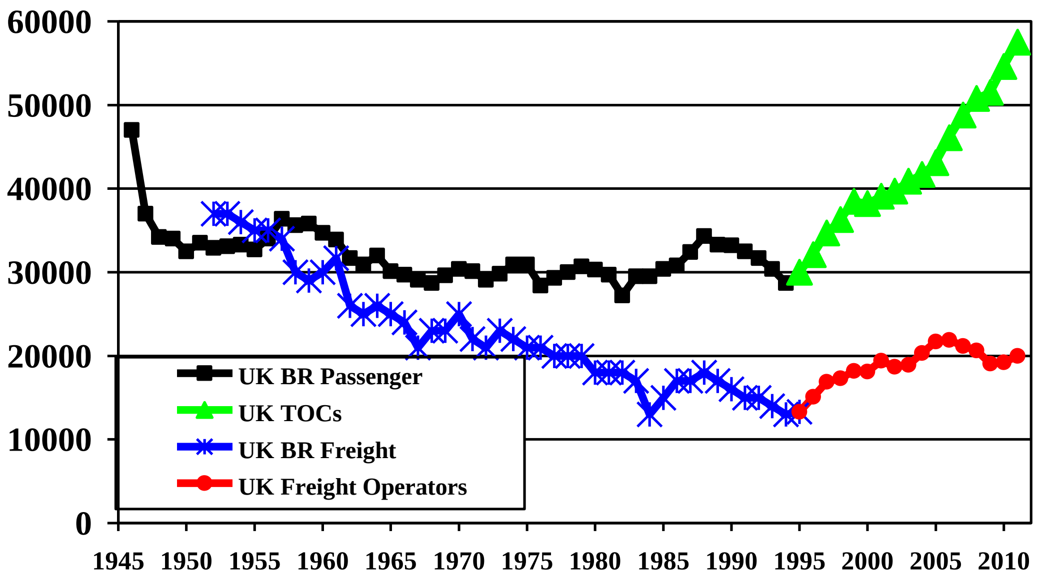
this index as any of the other railways listed in Table 12 (except Amtrak). Passenger tariffs on both SNCF and DB AG are higher than in 1990, by 50 percent for SNCF and 34 percent for DB AG. By comparison, both saw a significant reduction in freight tariffs since 1990.
It has been shown that vertical separation adds some costs of coordination and reporting as well as internal accounting and negotiation, although the exact degree of the added costs is around 5 percent or so.[19] The counter question -- have these costs produced offsetting benefits, for example through added competition that reduces tariffs (as it did in the U.S.) certainly has an apparent answer: no for passengers and mixed for freight. Essentially every EU 15 and EU 10 railway has the same or higher passenger tariffs as in 2000 or 1995. There is no discernable pattern in average freight tariffs, with some higher and some lower in 2011 than in 1995 or 2000.

The UK presents a significantly different picture. Although we defer to the paper by Nash and Smith to survey the UK case in more detail, Figures 4 and 5 give a useful picture in comparison with other EU experience. As shown in Figure 4, both passenger service and freight service reacted strongly to the restructuring, with passenger service reaching levels not seen since the end of World War II. In fact, as Table 11 shows, passenger service in the UK grew faster since the restructuring in 1995 than either SNCF or DB AG, and far faster than the EU 15 average. The same is true for freight in the UK The UK's rail market shares for both passenger and freight increased faster than the EU 15 average while the average passenger tariff has been nearly stable in constant terms.

There has been spirited debate in the economics academic community as to whether the positive UK rail results have been due to privatization or to restructuring or were primarily driven by strong GDP growth. This is an argument that cannot be resolved, but Figure 5 clearly shows that **something positive** happened upon reform: it would be very difficult to attribute all of the change to growth in the economy.

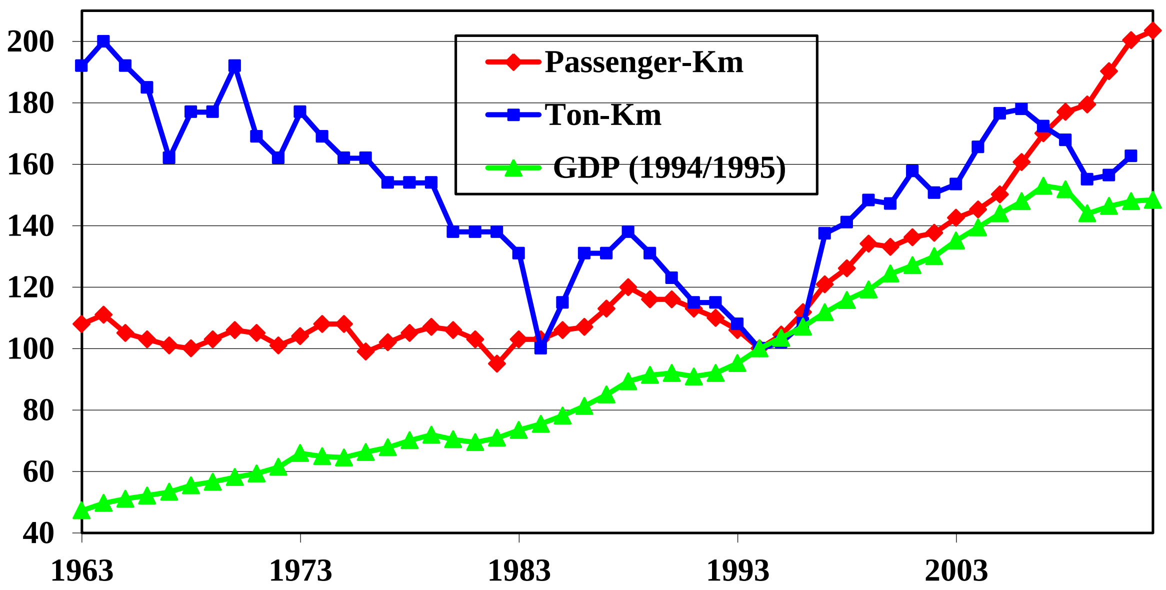
[19] See, e.g., Nash (2013), at pp. 6 and 7.

Figure 4**. Rail Traffic in the UK**
(000,000 passenger-km and ton-km)



Source: SRA 2002c and SRA, 2003a, WDI, UIC, ORR.

Figure 5. **UK Passenger-Km, Ton-Km and GDP**
(Index, 1994=100, GDP index constant £1994-1995)



Source: SRA and UK Treasury website.

6. Conclusions

No simple attempt to measure railway system efficiency can be expected to provide meaningful answers, both because the ambiguity and inherent challenge in defining what is meant by the term "efficiency" and because the structural complexity of rail organizations and the heterogeneity of railway services and offerings limits the value of any single index. Differing perceptions and purposes for attempts to measure "efficiency" will therefore require appropriate, tailored approaches

Among the various purposes for measuring "efficiency," the following need to be distinguished in particular:

- A government's interest to determine or monitor the overall performance of its railway system, e.g. with respect to value-for-money, modal competitiveness, operational cost-efficiency or financial viability;
- A government's policy analysis to define and review the success of railway restructuring or market organization initiatives;
- An audit of railway management performance (be it in a domestic or an international context);
- An inter-governmental policy evaluation and benchmarking effort

There are fundamental practical issues about "efficiency" measurement that need to be resolved before more high-level conceptual questions can effectively be addressed, including:

- Robust, internationally comparable reporting standards do not exist (note, while mandatory standards apply in the U.S. and Canada, Europe has nothing close to a homogeneous format. On a global scale, the UIC has the "best available" database, which could nevertheless be improved. In fact, though, the UIC's data may be at risk of losing quality and coverage;
- Transparency - Railways frequently resist reporting data to "their" governments, even when (and this appears to be the "default option" in Europe) substantial amounts of taxpayers' money is deployed to fund infrastructure and "public-service obligations"
- Off-Balance Sheet Items - Subsidies paid to railway systems are in many cases very substantial, but are not clearly reported. They typically come through one, or a combination of, infrastructure investment grants, passenger tariff surrogates and operations support and also special purpose vehicles for "legacy staff" obligations. Such items are often not included in railway balance-sheets and official reports, and these off-balance sheet items can have a strongly distorting effect on financial "efficiency" measurements
- Last but not least, definitions of parameters, be they rather of technical/operational, service performance or financial nature, often lack clarity and uniformity, which is a prerequisite for valid international comparisons

As a consequence, and to the frustration of many industry observers, cross-sectional measurements of railway "efficiency" are often more subject to distortion and misunderstandings than meets the eye in the first place. This fact imposes a significant caveat on any interpretation of face-value comparative measurements. With this is mind, time-series evaluations can strongly buttress comparisons of how individual railways have developed over time and provide far greater reliability for interpretation. Even so, discontinuities in reporting or the organizational set-up of railways over time can also be a source of ambiguity (albeit less critical than in the case of cross-sectional comparisons)

From a "good public corporate governance" perspective, full reporting including "shadow assets" and financial flows to special purpose vehicles should be the norm. This is essential to give full accountability to the public on the deployment of funds and to inform policy makers responsibly.

Acknowledgment of the above mentioned limitations in data availability, quality and meaning leads to a cautious note on the use of econometric models to describe railway efficiency, for a number of reasons:

- Inconsistency of input data, including unclear definitions;
- Structural scarcity of data ("no big data") due to small and unstable samples of observed / observable railways systems, with inevitably inadequate sample sizes for statistical evaluations;
- An inability of econometric models to discriminate between "good" or "poor" corporate governance and management, which in practice can have an overriding impact on actual railway "efficiency";
- Most railway systems in the world show signs of protracted under-investment, especially in infrastructure, because "pro-forma" statements of steady-state investment requirements (i.e. future cash flows to be set aside) are rarely reported accurately. As a result, such backlogs go often undetected, leading to a real risk of a mis-assessment of the condition of infrastructure or other long-lived assets.

Qualified and informed judgment is always required in conjunction with even the best available and most sophisticated supporting "efficiency" measurement analyses. As a high level common denominator (an entry point) to measuring railway "efficiency," a balanced scorecard approach should be used that allows for some standardization and is broad enough to cover different aspects and measuring purposes in a 360 degree manner. A "Balanced Railway Efficiency Scorecard" (BRESC) should at least contain the following elements on a first-tier level (each and all open for greater in-depth analysis):

- Scope of the railway system;
- Asset utilization of infrastructure and fleet;
- Human resource deployment;
- Operational Performance;
- Financials;
- Customer Centric Performance (i.e. performance in the market).

Railways are very asset intensive systems and economic analysis shows that under real-life conditions, asset utilization, which is highly disparate for different systems around the world has an major impact on overall system profitability or "efficiency". To a very large extent, asset utilization is a result of historically developed networks with vastly different traffic density coupled with above-rail operations that are more or less focused on sufficiently high demand services (where "demand" can have both a political as well as a market dimension). It is immediately and demonstrably clear that such disparate "operating conditions" affect railways' economics by orders of magnitude, asset utilization is therefore a structural determinant for a system's (in)ability to make profits or losses.

No other single factor is more important for economic railway "efficiency" than asset utilization. Hence, from an "efficiency" measurement purpose standpoint it is vitally important to separate the impact of those parameters that are primarily imposed by governments and other political stakeholders from those that are a good "proxy" for the performance of railway management.

A good and highly aggregate "efficiency" measurement from an overall perspective is railway market share ("modal share"); however, in cases where public subsidies are applied to provide services (the norm in Europe), subsidies can literally "buy" market share: thus, market share and system funding provisions need to be understood in close connection. As a direct result, "efficiency" measurements of a railway system may not suffice to describe the performance of railway management due to the overriding impact of economic "legacy factors" -- parameters, such as politics, which are exogenous to railway management.

Good proxies for direct management performance are the normalized full cost per train-kilometer in above-rail operations and the normalized full cost of maintaining and operating a unit piece of network infrastructure (e.g. a kilometer of line or a kilometer of track) in infrastructure management organizations. Various other dedicated or sometimes more global analyses exist to measure management performance in infrastructure and above rail operations, many of them in confidential or anonymous form, but it is not always clear that proper distinctions between what management can influence and what is given by "system legacy" are made. More work is needed if the effort to measure railway "efficiency" is to be promoted further.

Last but not least, almost all of the global railway "efficiency" measuring work is devoted to technical/operational and financial aspects and the customer perspective (which one could arguably consider the ultimate measure of "efficiency") appears to be a neglected area. Market-level questions to be analyzed are for instance, "how efficient is the travel or shipment solution offered by a railway in the eyes of the passenger or the shipper?" or "how competitive is the price of using a railway service as compared to other modes?" From a government perspective this also means to address aspects of public welfare.

There is reason to assume that the customer perspective has been neglected so far, because it poses a challenge to describe and measure; however this should not be an excuse, not to attempt it (note that emerging "big-data" applications may represent breakthrough opportunities to capture customer-centric information)

Looking at the data and indices, per se, it is clear that the policy and structural changes in U.S., Canada and Japan worked in almost all dimensions and one can strongly argue that the changes would not have occurred absent the reforms.

It is far beyond the scope of this paper to review all of the EU railways individually. The experience in the EU is much more complex because most services at base are social rather than commercial, legitimately increasing the role of government, and there is no good annual reporting on the value of social benefits and costs generated by the railways.[20] The result was a much less clear definition of objectives and incentives along with unstable, often inadequate financial support reflecting the vicissitudes of annual public budgeting. Attempts to change the situation were impeded by political resistance from unions and other interest groups and, in many cases, a complete lack of transparency of the actual performance ("efficiency") of the railway that made scrutiny by the public, including the academic sector, impossible. We also have to deal with the null hypothesis – what would have happened without reform -- though SNCF performance may give an indication. It is also possible to argue that DB AG has resisted the actual implementation of most of the significant aspects of the EU's reform objectives, at least with respect to railway structure in Germany.

It seems clear that the UK government overshot its target by smashing the old BR and privatizing it completely at the outset: but, gradual reform since 1995 has produced a system that certainly seems better than the old BR. In France, the attempts to reform (without actually doing so) have clearly not been very productive. RFF never fully emerged from SNCF control, and recombining them into a new agency will mostly have the effect of turning back the clockl. The DBAG holding company approach produced a conflict of interest between DB Netz and the operators vis a vis potential entrants, a conflict that will remain until DB Netz is truly separated.

[20] This information could be added to other reporting requirements, at least in a prescribed, approximate form.

Annex 1

TABLES

Table 1. **Sample Key**

Country	Railway name and date of inception
EU 15	
Austria	GKB
	ÖBB
Belgium	SNCB/NMBS
Denmark	DSB
	BDK (1997)
Finland	VR
	RHK/FTA (1995)
France	SNCF
	RFF (1997)
	Veolia
DB Germany	Prior to reunification
DR Germany	Prior to reunification
Germany	DBAG (1994)
Greece	OSE
Ireland	CIE
Italy	FNM
	FS
Luxembourg	CFL
	CFL Cargo (2007)
Netherlands	NS
	Pro Rail (1998)
Portugal	CP
	CP Carga
	REFER (1997)
Spain	RENFE
	ADIF (2005)
	Euskotren
	FEVE
	FGC
Sweden	SJ
	Green Cargo (2002))
	BV/Trafikverket (1988)
United Kingdom	BR
	ATOC (1995)
	Freight (1995)
	Railtrack/NR (1995)
	NIR

Country	Railway name and date of inception
EU 10 + Croatia	
Bulgaria	BDZ
	BDZP
	BDZ Cargo
	NRIC (2003)
	BRC
	Bulmarket
Czech Republic	CD (2003)
	SZDC (2003)
Slovakia	ZSSK
	ZSSK Cargo
	ZSR (2002)
Former Czech.	CSD (End 1992)
Estonia	EVR
Hungary	Floyd
	Gysev
	MAV
	MAV Cargo (2006)
	MAV Start (2007)
Latvia	LDZ
Lithuania	LG
Poland	PKP
Romania	CFR
	CFR Calatori (2006)
	CFR MARFA (2006)
	CFR SA (2006)
	GFR
	Servtrans
	TFG
	Unifertrans
Slovenia	SZ
Croatia	HZ
Other Railways	
United States	Class I
	Amtrak (1972)
Canada	Freight
	VIA (1980)
China	CR
Japan	All
India	IR
Norway and Switzerland	
Norway	NSB
	Cargonet (2002)
	JBV (1996)
Switzerland	BLS
	BLS Cargo
	SBB/CFF/FFS

Table 2

Basic Indicators of Size and Scale of Operations of Railways in the Overall Sample (2011 data)

EU15	EU10	CH/NO	All Other

Railway	Employees	Railway	Line Km	Railway	Pax Km	Railway	Tonne-Km
CR	2 051 100	US Class I	153 249	IR	978 508	CR	2 562 635
IR	1 328 000	CR	66 041	CR	815 699	US Class I	2 526 444
US Class I	158 623	IR	64 460	Japan	245 612	IR	625 723
SNCF	139 501	Canada Frt	52 002	SNCF	86 094	Canada Frt	372 264
DBAG	137 482	Amtrak	37 000	DBAG	77 567	DBAG	111 980
Japan	127 900	DBAG	33 570	ATOC	57 500	PKP	37 189
PKP	100 942	RFF	29 616	FS	39 368	Green Cargo	24 000
FS	76 417	Japan	20 131	RENFE	21 398	SNCF	23 241
ATOC	49 405	PKP	19 725	SBB/CFF/FFS	17 156	Japan	20 256
ÖBB	45 352	FS	16 726	NS	16 808	UK Freight	20 000
MAV	37 034	Network Rail	15 759	PKP	15 740	ÖBB	16 890
SNCB/NMBS	36 453	ADIF	13 945	SNCB/NMBS	10 848	LDZ	16 550
Network Rail	34 130	VIA	13 490	Amtrak	10 331	LG	15 088
Canada Frt	33 106	CFR	10 777	ÖBB	10 300	CD	12 123
CD	31 846	BV/Trafik.	10 014	DSB	10 102	FS	11 547
SBB/CFF/FFS	28 586	SZDC	9 470	CD	6 635	VR	9 395
CFR SA	23 951	MAV	7 387	SJ	6 381	MAV Cargo	8 000
Amtrak	20 047	RHK/FTA	5 944	MAV Start	5 561	SBB/CFF/FFS	7 656
ZSR	15 820	ÖBB	4 826	CFR Calatori	4 814	RENFE	7 564
CFR Calatori	14 269	JBV	4 154	VR	3 882	ZSSK Cargo	7 290
RENFE	13 955	NRIC	4 072	CP	3 750	CFR MARFA	6 658
NRIC	13 825	ZSR	3 624	NSB	2 663	SNCB/NMBS	5 500
ADIF	13 433	SNCB/NMBS	3 578	ZSSK	2 413	NS	5 000
HZ	12 468	SBB/CFF/FFS	3 040	BDZ	2 068	EVR	5 000
LDZ	11 665	Pro Rail	2 886	CIE	1 638	GFR	4 805
SZDC	11 631	REFER	2 794	HZ	1 486	SZ	3 584
BDZ	10 637	HZ	2 722	VIA	1 369	Cargonet	3 000
LG	10 505	OSE	2 534	OSE	1 300	BDZ	2 497
CFR MARFA	9 145	BDK	2 130	FNM	1 100	HZ	2 438
VR	8 967	CIE	1 919	BLS	865	CP Carga	2 064
SZ	8 886	LDZ	1 864	FGC	821	DSB	1 800
ZSSK Cargo	8 701	LG	1 767	SZ	773	BLS Cargo	1 104
DSB	8 084	SZ	1 209	LG	389	Servtrans	781
NS	7 653	FEVE	1 192	CFL	349	Gysev	775
BV/Trafik.	6 758	EVR	792	Euskotren	279	BRC	671
ZSSK	4 862	BLS	430	EVR	243	CFR SA	614
CIE	4 198	FNM	318	Gysev	200	OSE	500
Pro Rail	3 954	Gysev	284	FEVE	183	FEVE	388
JBV	3 600	CFL	275	LDZ	84	Unifertrans	362
OSE	3 262	FGC	270			CFL Cargo	200
REFER	3 237	Euskotren	226			Bulmarket	123
Green Cargo	3 200					CIE	105
NSB	3 183					FGC	49
CP	3 132						
CFL	3 077						
SJ	3 037						
VIA	2 899						
BLS	2 722						
GFR	2 603						
FNM	2 200						
BDK	2 000						
FEVE	1 957						
EVR	1 796						
Gysev	1 354						
RFF	1 353						
FGC	1 298						
Euskotren	863						
Servtrans	792						
CP Carga	665						
Unifertrans	270						
BRC	253						
TFG	130						
RHK/FTA	120						
Bulmarket	80						
BLS Cargo	79						

Source: See Appendix A

Table 3. **Average Length of Haul (Km)** (2011 data)

EU15	*EU10*		CH/NO	All Other
Railway	**Passenger**		**Railway**	**Freight**
CR	529		**US Class I**	1 477
Amtrak	355		**Canada Frt**	1 199
VIA	331		**CR**	805
LDZ	250		**IR**	679
SJ	205		**Japan**	654
IR	128		***CFR SA***	483
CFR Calatori	90		**RENFE**	437
OSE	87		***GFR***	392
PKP	85		**SNCF**	371
LG	84		**Green Cargo**	353
SNCF	79		***BRC***	324
FS	75		**DBAG**	318
BDZ	71		***LG***	288
VR	57		***LDZ***	279
NS	54		**FS**	276
ZSSK	53		**VR**	270
NSB	52		***PKP***	265
EVR	51		***Bulmarket***	259
MAV Start	50		**DSB**	240
ÖBB	49		BLS Cargo	237
SZ	49		***Unifertrans***	237
SBB/CFF/FFS	49		**CP Carga**	226
SNCB/NMBS	47		**Freight**	222
DSB	46		***SZ***	220
RENFE	46		***BDZ***	215
CIE	44		***Servtrans***	207
Gysev	41		***HZ***	207
DBAG	40		***EVR***	200
CD	40		***MAV Cargo***	200
ATOC	39		**ÖBB**	199
HZ	30		***ZSSK Cargo***	194
CP	30		***Floyd***	190
Japan	28		***CD***	182
FEVE	21		***CFR MARFA***	181
CFL	19		**CIE**	172
BLS	17		SBB/CFF/FFS	163
Euskotren	11		**OSE**	147
FGC	10		**FEVE**	142
			Gysev	141
			SNCB/NMBS	138
			FGC	63
			CFL Cargo	32

Source: See Appendix A.

Table 4

Passenger Shares (%) Measured by

EU15 | ***EU10*** | CH/NO | All Other

	% of TU		% of Gross Tonne-Km		% of Train-Km
ZSSK	100	**CIE**	100	**DSB**	100
MAV Start	100	**FNM**	100	**NS**	100
Amtrak	100	**NS**	100	***ZSSK***	100
VIA	100	**NIR**	100	***MAV Start***	100
NSB	100	***ZSSK***	100	Amtrak	100
Euskotren	100	***MAV Start***	100	VIA	100
FGC	94	**VIA**	100	**Euskotren**	100
CIE	94	NSB	100	**FGC**	98
Japan	92	**Euskotren**	98	**CIE**	98
DSB	85	**FGC**	93	Japan	92
SNCF	79	Japan	81	**SNCB/NMBS**	89
FS	77	**SNCF**	73	**CFL**	89
NS	77	**RENFE**	70	**SNCF**	89
ATOC	74	**SNCB/NMBS**	67	**RENFE**	88
RENFE	74	**CP**	62	**FEVE**	88
OSE	72	SBB/CFF/FFS	61	**FS**	88
SBB/CFF/FFS	69	**CFL**	59	**OSE**	87
SNCB/NMBS	66	**FEVE**	49	SBB/CFF/FFS	83
CP	64	***BDZ***	46	**CP**	82
CFL	64	**SJ**	46	***CD***	82
IR	61	***CD***	43	***BDZ***	75
BLS	44	***Gysev***	42	***HZ***	75
DBAG	41	**DBAG**	42	**DBAG**	75
BDZ	39	***HZ***	35	***CFR Calatori***	74
ÖBB	38	IR	35	***Gysev***	74
HZ	38	**VR**	35	BLS	73
CD	35	***CFR Calatori***	34	**VR**	70
FEVE	32	**ATOC**	33	***PKP***	69
PKP	30	**ÖBB**	32	**ÖBB**	69
VR	29	BLS	31	**IR**	64
CFR Calatori	28	***PKP***	24	***SZ***	60
CR	24	***SZ***	19	CR	44
SJ	21	**CR**	17	***EVR***	38
Gysev	21	***LG***	4	***LG***	36
SZ	18	***EVR***	4	***Servtrans***	15
EVR	5	***LDZ***	1	US Class I	7
LG	3	Canada Frt	1	***LDZ***	6
LDZ	1				
US Class I	1				

Source: See Appendix A

Table 5

Measures of Line Traffic Density (2011 data)

EU15	***EU10***	CH/NO	All Other		
	TU/Km (000)		**Gross T-Km/Km (000)**		**Train-Km/Km**
CR	51 155	CR	72 238	SBB/CFF/FFS	45 663
IR	24 887	US Class I	29 585	**NS**	39 369
US Class I	16 553	IR	24 356	**FGC**	38 007
Japan	13 207	SBB/CFF/FFS	24 342	Japan	37 355
LDZ	8 924	***EVR***	17 249	BLS	37 072
LG	8 759	***LG***	16 365	**CFL**	32 724
SBB/CFF/FFS	8 162	***LDZ***	15 510	**UK**	32 631
NS	7 556	Japan	13 853	CR	30 817
Canada Frt	7 185	**ÖBB**	13 749	**FNM**	28 346
EVR	6 620	Canada Frt	12 930	**ÖBB**	28 212
DBAG	5 646	**DBAG**	11 703	**DSB**	27 809
ÖBB	5 634	**NS**	11 499	**DBAG**	25 772
DSB	5 588	**SNCB/NMBS**	10 900	**SNCB/NMBS**	24 427
UK	4 918	**CFL**	8 844	**Euskotren**	23 367
SNCB/NMBS	4 569	BLS	6 977	***Gysev***	18 824
SNCF	3 692	**SNCF**	6 970	**FS**	16 474
SZ	3 604	***Gysev***	6 810	***SZ***	16 443
FNM	3 459	***SZ***	6 699	**SNCF**	15 659
Gysev	3 433	***ZSSK***	5 832	***CD***	15 598
FGC	3 222	**FNM**	5 346	**IR**	14 629
FS	3 044	**FGC**	5 293	**RENFE**	13 087
PKP	2 683	***PKP***	5 289	***MAV***	12 574
ZSSK	2 677	**VR**	4 937	**CP**	12 554
VR	2 234	***CD***	4 784	***ZSSK***	11 591
CP	2 081	**RENFE**	4 545	***HZ***	9 102
RENFE	2 077	**UK**	3 996	**CIE**	9 051
BLS	2 012	**CP**	3 761	***LG***	8 671
CFL	1 996	***CFR***	3 495	***PKP***	8 645
CD	1 981	***MAV***	3 374	**VR**	8 592
MAV	1 836	**Euskotren**	3 133	***EVR***	8 415
CFR	1 616	***HZ***	2 868	**FEVE**	8 270
HZ	1 442	***BDZ***	2 289	**OSE**	8 208
BDZ	1 316	**FS**	1 495	***BDZ***	7 737
Euskotren	1 235	**CIE**	1 407	***CFR***	7 578
CIE	908	**FEVE**	1 102	***LDZ***	5 293
OSE	710	**Amtrak**	1 047	US Class I	4 491
FEVE	479	**OSE**	1 026	Amtrak	1 629
Amtrak	279	JBV	849	VIA	785
VIA	101	**VIA**	321	Canada Frt	204

Source: See Appendix A

Table 6

Measures of Productivity of Rolling Stock (2011 data)

EU15	*EU10*	CH/NO	All Other

Railway	Passenger-Km/Coach + MUs	Railway	Tonne-Km/Wagon	Railway	TU/Locomotive + adjusted Mus*
IR	223 404	*Gysev*	8 424	IR	178 950
CR	60 049	Canada Frt *	5 429	CR	172 449
SBB/CFF/FFS	47 132	CR	3 983	Japan	159 473
Japan	44 820	Green Cargo	3 429	Canada Frt	134 780
SJ	35 450	IR	3 276	SJ	104 038
CFR Calatori	20 227	*LDZ*	2 702	US Class I	102 161
DSB	18 434	Japan	2 328	DSB	83 231
BDZ	14 563	*BRC*	2 207	*LDZ*	82 347
FS	14 399	US Class I	2 005	Green Cargo	76 190
SNCF	14 170	*GFR*	1 848	*MAV Start*	75 489
HZ	13 759	*EVR*	1 677	*EVR*	69 907
VR	11 155	*LG*	1 634	*LG*	58 294
Gysev	11 111	SNCF	1 144	RENFE	56 566
Amtrak	8 777	*SZ*	1 141	NS	55 942
CP	8 601	DBAG	1 049	CP Carga	46 909
ÖBB	7 768	ÖBB	958	NSB	40 146
PKP	7 301	SBB/CFF/FFS	925	FGC	29 326
SNCB/NMBS	7 251	VR	907	ATOC	28 975
LG	6 707	*MAV Cargo*	727	SNCF	28 931
ZSSK	6 557	CP Carga	651	DBAG	27 558
MAV Start	6 277	*Unifertrans*	635	VR	26 741
OSE	5 078	RENFE	613	*BRC*	25 808
CFL	4 847	*PKP*	571	SNCB/NMBS	25 438
CD	4 570	*Bulmarket*	542	*Floyd*	24 300
EVR	4 500	*BDZ*	514	*SZ*	23 962
FGC	3 873	SNCB/NMBS	500	BLS Cargo	22 080
BLS	3 794	*Servtrans*	485	CP	21 887
DBAG	3 778	*CD*	444	*Gysev*	21 429
NS	3 560	FS	405	*GFR*	21 167
ATOC	2 677	*HZ*	402	ÖBB	20 711
CIE	2 452	FEVE	340	FS	18 742
FNM	2 444	FGC	239	CIE	18 220
NSB	2 245	CIE	209	SBB/CFF/FFS	17 791
VIA	1 720	*CFR MARFA*	167	*PKP*	16 133
SZ	1 528	OSE	158	*HZ*	15 812
Euskotren	1 125	CFL Cargo	51	*Unifertrans*	12 067
LDZ	420	Euskotren	3	FNM	11 640
				FEVE	10 774
				BDZ	10 666
				CD	10 451
				ZSSK Cargo	10 353
				ZSSK	9 923
				OSE	9 262
				VIA	9 229
				CFL	9 184
				Euskotren	9 152
				Bulmarket	8 786
				CFR MARFA	7 671
				BLS	7 588
				CFR Calatori	5 762
				CFL Cargo	3 448

* Canada's apparent high productivity may be due to exclusion of non-railway owned wagons.

Source: See Appendix A

Table 7

Indicators of Output per Employee (2011 data)

EU15 | ***EU10*** | CH/NO | All Other

Railway	TU/ Employee (000)	Railway	GT-Km/ Employee (000)	Railway	Train-Km/ Employee
US Class I	15 927	US Class I	28 339	**NS**	14 846
Canada Frt	11 245	Canada Frt	20 179	**SJ**	13 303
Green Cargo	7 500	**Green Cargo**	7 813	**RENFE**	13 078
Floyd	3 857	***EVR***	7 606	**ATOC**	10 408
CP Carga	3 104	**SJ**	6 915	**CP Carga**	9 335
EVR	2 919	**CP Carga**	6 027	**CP**	9 217
NS	2 850	***BRC***	4 593	NSB	8 840
BRC	2 652	**RENFE**	4 541	**NIR**	7 931
SJ	2 101	**NS**	4 336	**FGC**	7 906
Japan	2 079	***Floyd***	3 857	**DSB**	7 327
RENFE	2 075	**VR**	3 272	**OSE**	6 376
GFR	1 846	***GFR***	3 069	***ZSSK***	6 319
CR	1 647	**DBAG** **	2 857	**DBAG** **	6 292
Bulmarket	1 538	***LG***	2 753	***Floyd***	6 222
VR	1 481	SBB/CFF/FFS	2 589	**Euskotren**	6 119
LG	1 473	***Unifertrans***	2 574	Japan	5 880
DSB	1 472	***LDZ***	2 478	SBB/CFF/FFS	5 868
LDZ	1 426	CR	2 326	BLS	5 856
DBAG **	1 378	Japan	2 180	**VR**	5 695
Unifertrans	1 341	**CP**	2 075	**FEVE**	5 037
IR	1 208	NSB	2 007	US Class I	5 007
CP	1 197	***Servtrans***	1 948	***CD***	4 638
ATOC	1 164	Amtrak	1 932	***CFR Calatori***	4 260
Servtrans	986	***ZSSK Cargo***	1 682	**CIE**	4 137
SBB/CFF/FFS	868	***CFR MARFA***	1 607	**FNM**	4 097
ZSSK Cargo	838	***Bulmarket***	1 538	***Gysev***	3 948
NSB	837	**VIA**	1 494	***BRC***	3 806
SNCF *	784	**SNCF** *	1 480	***EVR***	3 711
CFR MARFA	728	**ÖBB**	1 463	VIA	3 652
Gysev	720	***Gysev***	1 428	**FS**	3 606
FGC	670	***CD***	1 423	**SNCF** *	3 326
FS	666	***ZSSK***	1 337	***Bulmarket***	3 225
ÖBB	600	**NIR**	1 213	Amtrak	3 007
CD	589	**IR**	1 182	**ÖBB**	3 002
OSE	552	BLS	1 102	***BDZ***	2 847
PKP	524	**FGC**	1 101	***GFR***	2 471
Amtrak	515	**SNCB/NMBS**	1 070	**SNCB/NMBS**	2 398
FNM	500	***PKP***	1 033	***SZ***	2 237
ZSSK	496	JBV	980	***Servtrans***	2 091
SZ	490	***SZ***	911	***HZ***	1 987
VIA	472	***CFR Calatori***	893	***Unifertrans***	1 922
SNCB/NMBS	448	**Euskotren**	820	***PKP***	1 689
BDZ	429	**OSE**	797	***LG***	1 459
CIE	415	**FNM**	773	***CFR MARFA***	1 370
NIR	354	***BDZ***	755	***ZSSK Cargo***	1 297
CFR Calatori	337	**FEVE**	671	**CR**	992
Euskotren	323	**CIE**	643	***LDZ***	846
BLS	318	***HZ***	626	**IR**	710
HZ	315	**ATOC**	425		
FEVE	292	**FS**	327		
CFR SA	26				

* SNCF adjusted for non-rail employees (1.079)

** DB AG adjusted for non-rail employees (2.053)

Source: See Appendix A

Table 8

Operating Ratios (%)

EU15	***EU10***
CH/NO	**All Other**
Railway	**Operating Ratio***
RHK/FTA	900.0
OSE	553.6
FEVE	442.5
BV/Trafik.	250.0
VIA	185.5
FGC	171.3
Amtrak	150.2
CP Carga	143.5
REFER	143.4
CP	136.0
CFR SA	131.4
SNCB/NMBS	120.0
Servtrans	114.0
NRIC	112.9
BDZ Cargo	109.5
MAV Cargo	108.0
MAV	105.6
CFR MARFA	105.1
ZSR	105.0
HZ	104.1
ADIF	103.9
CIE	103.0
Green Cargo	103.0
JBV	103.0
DSB	101.3
ZSSK	100.3
PKP	100.2
NSB	99.7
SZ	99.6
SJ	99.2
CFR Calatori	98.8
BLS	98.3
VR	98.1
CD	97.4
ZSSK Cargo	95.4
DBAG	95.0
Canada Frt	94.8
SBB/CFF/FFS	93.4
Pro Rail	93.0
LDZ	92.8
FS	92.7
NS	92.5
GKB	91.8
SZDC	91.2
ÖBB	90.5
RENFE	90.3
Unifertrans	90.0
SNCF	89.3
LG	88.5
DBAG **	86.9
Japan	83.1
RFF	78.7
CFL	76.4
US Class I	73.2
Gysev	69.9
EVR	69.0
Network Rail ***	64.5

* Operating Ratio is defined as Operating Expenses/ Operating Revenues (%). Operating Expenses include Depreciation and Amortization, but exclude costs of capital (principal and interest on debt and equity.

** Estimated from DB Annual Reports. See, e.g. 2010 Annual Report at pg 60

*** Taken from Network Rail Annual Report. See pg 1 of 14 of 2010/2011 Annual Report.

Source: See Appendix A

Table 9

Average Revenues Expressed as Constant 2011 US PPP $ per Passenger-Km or per Tonne-Km

EU15	***EU10***	CH/NO	All Other
Railway	**Average Passenger Revenue/ Passenger-Km**	**Railway**	**Average Freight Revenue/ Tonne-Km**
CFL	0.7520	***Unifertrans***	0.1593
LDZ	0.3979	**ÖBB**	0.1501
CFR Calatori	0.2950	***Gysev***	0.1357
Amtrak	0.2899	BLS Cargo	0.1224
DBAG	0.2560	**CIE**	0.1087
Gysev	0.2453	***CFR MARFA***	0.1077
NS	0.2240	**FS**	0.1056
SNCB/NMBS	0.2063	**FGC**	0.1035
ÖBB	0.2041	***GFR***	0.1029
CIE	0.1997	***Servtrans***	0.1020
SNCF	0.1931	***BDZ***	0.0975
ATOC	0.1878	***CD***	0.0842
FS	0.1682	SBB/CFF/FFS	0.0830
VIA	0.1647	**DBAG ***	0.0825
BLS	0.1552	***BRC***	0.0817
NIR	0.1525	***PKP***	0.0813
Japan	0.1502	IR	0.0760
SBB/CFF/FFS	0.1456	**SNCB/NMBS**	0.0682
LG	0.1396	**SNCF**	0.0626
VR	0.1375	***LG***	0.0609
HZ	0.1338	**Japan**	0.0573
SZ	0.1329	***SZ***	0.0566
NSB	0.1155	***ZSSK Cargo***	0.0558
MAV Start	0.1084	**FEVE**	0.0458
RENFE	0.1076	**VR**	0.0435
SJ	0.1044	***LDZ***	0.0417
FGC	0.1019	**CP Carga**	0.0362
PKP	0.0955	**RENFE**	0.0347
FEVE	0.0831	US Class I	0.0257
Euskotren	0.0818	Canada Frt	0.0236
CD	0.0810	CR	0.0232
CP	0.0720	***EVR***	0.0142
BDZ	0.0604	***HZ***	0.0100
DSB	0.0590		
ZSSK	0.0483		
CR **	0.0469		
IR	0.0201		

* The UIC data for DB AG freight Revenues are probably contaminated by trucking revenues generated by Schenker The average revenue shown here is taken from data for the DB AG rail freight business group as shown in the DB AG Annual Report for 2011.

** Estimated from 2008

Source: See Appendix A

Table 10
Rail Market Shares for Passengers and Freight *

Country	Rail Passenger Share (% Pass-Km) of Rail, Bus and Auto Traffic	Country	Rail Share (% Tonne-Km) of Truck Barge and Pipeline Traffic	Country	Rail Share (% Tonne-Km) of Rail and Truck Traffic Only
Austria		Austria	34.9	Austria	41.6
Belgium	7.4	Belgium	13.7	Belgium	16.8
Denmark	9.2	Denmark	14.6	Denmark	17.9
Finland	5.0	Finland	25.8	Finland	25.9
France	9.3	France	14.4	France	16.1
Germany (DBAG)	8.1	Germany (DBAG)	22.3	Germany (DBAG)	25.9
Greece	3.8	Greece	1.7	Greece	1.7
Ireland		Ireland	1.0	Ireland	1.0
Italy	5.6	Italy	7.8	Italy	8.3
Luxembourg		Luxembourg	2.9	Luxembourg	3.0
Netherlands	10.7	Netherlands	6.8	Netherlands	15.1
Portugal		Portugal	15.0	Portugal	15.3
Spain	5.5	Spain	3.6	Spain	3.7
Sweden	8.8	Sweden	40.6	Sweden	40.6
UK	7.4	UK	11.3	UK	12.0
EU 15	7.0	EU 15	15.4	EU 15	17.5
Bulgaria	17.5	Bulgaria	12.5	Bulgaria	13.4
Czech Rep.	8.2	Czech	19.9	Czech	20.7
Slovakia	7.2	Slovak	21.0	Slovak	21.5
Estonia	9.9	Estonia	48.8	Estonia	48.8
Hungary	10.2	Hungary	17.9	Hungary	20.9
Latvia	27.2	Latvia	59.5	Latvia	63.8
Lithuania	1.2	Lithuania	40.6	Lithuania	41.2
Poland	5.2	Poland	18.1	Poland	19.7
Romania	30.1	Romania	27.6	Romania	35.8
Slovenia	2.7	Slovenia	63.3	Slovenia	63.3
EU 10	7.3	EU 10	23.8	EU 10	25.9
Croatia	32.1	Croatia	18.0	Croatia	21.5
Norway	4.6	Norway	15.0	Norway	17.2
Switzerland	17.5	Switzerland	39.4	Switzerland	39.7
US	0.2	US	32.3	US	39.0
Canada	0.3	Canada	44.4	Canada	64.6
China	36.4	China	26.8	China	36.4
Japan	84.2	Japan	7.9	Japan	7.9
India	14.1	India	33.2	India	35.6

* Note: This is taken from OECD website data

Source: See Appendix A

Table 11

Development of Railway Traffic Over Time

Total Passenger-Km		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	CAGR 1980 to 2011 (%)	CAGR 1995 to 2011 (%)
France	SNCF	40 979	50 696	54 660	62 070	63 761	55 311	69 571	76 559	79 483	81 487	86 664	85 697	84 860	86 094	2.2	4.1
Germany	DBAG*	62 362	66 177	63 637	65 157	61 024	70 334	74 015	72 497	74 738	74 677	76 929	75 579	77 221	77 567	0.9	0.9
UK	BR/ATOC/Frt	30 409	30 256	31 704	30 256	33 191	30 000	38 200	43 100	46 100	48 800	50 800	51 500	54 600	57 500	2.9	6.1
EU 15		219 183	244 950	250 263	258 071	269 593	273 724	298 945	299 741	313 374	315 847	334 435	344 443	344 800	349 668	1.6	2.3
Czech Rep	*CD*						8 023	7 266	6 631	6 887	6 855	6 759	6 462	6 553	6 635	na	-1.7
Poland	*PKP*	36 891	42 819	46 324	51 978	50 373	20 960	19 706	16 742	16 971	17 081	17 958	16 454	15 715	15 740	-5.0	-2.6
EU 10		101 034	109 558	119 213	133 724	131 326	68 520	54 290	47 105	47 674	46 339	46 165	40 264	38 871	38 920	-5.2	-5.0
US	Amtrak		6 031	7 637	8 042	9 769	8 924	8 970	8 660	8 706	9 309	9 943	9 476	9 518	10 331	1.4	1.3
Japan	Japan	189 726	215 289	193 143	197 463	237 551	248 993	240 657	245 957	249 029	255 201	253 555	244 235	244 591	245 612	1.2	-0.1
Switzerland	SBB/CFF/FFS	8 168	7 984	9 167	9 381	11 049	11 712	12 835	13 830	14 267	15 132	16 142	16 182	16 868	17 156	3.0	3.5

Freight Tonne-Km (000,000)		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	CAGR 1980 to 2011 (%)	CAGR 1995 to 2011 (%)
France	SNCF	67 586	63 473	68 815	55 121	50 667	48 136	55 352	40 701	40 924	40 634	35 932	26 482	22 840	23 241	-5.0	-6.4
Germany	DBAG *	109 963	103 114	118 988	120 493	101 166	69 442	76 815	81 722	88 407	92 077	91 178	72 257	80 378	111 980	-0.3	4.4
UK	BR/ATOC/Frt	24 550	20 960	17 640	16 047	15 986	12 537	18 090	21 700	21 880	21 180	20 630	19 060	19 230	20 000	0.6	4.3
EU 15		387 140	361 684	404 831	393 535	354 582	219 743	249 703	237 664	253 120	251 712	246 595	178 880	183 365	240 223	-2.5	0.8
Czech Rep	*CD*						22 634	17 220	14 385	16 364	16 972	15 951	12 616	11 921	12 123	na	-5.5
Poland	*PKP*	98 233	127 505	132 576	118 863	81 776	68 206	54 015	45 438	42 651	43 548	39 200	29 941	34 327	37 189	-5.9	-5.4
EU 10		267 495	330 140	350 849	340 652	253 261	168 657	144 489	140 046	138 913	140 534	131 839	96 287	98 572	122 353	-4.9	-2.9
US	Class I	1 117 386	1 101 962	1 342 598	1 281 274	1 510 629	1 907 610	2 141 768	2 478 477	2 588 741	2 586 767	2 596 542	2 256 650	2 470 556	2 526 444	3.1	2.6
Japan	Japan	61 482	46 030	36 961	21 383	26 803	24 747	21 800	22 632	23 014	23 166	22 100	20 432	20 255	20 256	-2.8	-1.8
Switzerland	SBB/CFF/FFS	6 592	5 139	7 385	7 049	8 303	8 156	10 658	8 571	8 439	13 368	12 531	4 181	7 778	7 656	0.2	-0.6

* Before 1993, this is the sum of DB and DR.

Table 12

Evolution of Operating Ratio and TU/Employee Over Time

Operating Ratio %		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
France	SNCF	100	105	104	113	107	107	98	96	96	96	96	100	93	89
	RFF	-	-	-	-	-	-	-	95	95	101	104	78	77	79
Germany	DBAG *	109	122	114	111	117	99	98	95	93	92	93	94	95	95
UK	BR	88	97	103	100	102	92	-	-	-	-	-	-	-	-
Czech Rep	CD	-	-	-	-	-	110	109	102	101	100	111	101	102	97
Poland	PKP	113	131	103	91	91	102	116	112	105	101	110	111	106	100
United States	Class I	96	97	93	91	87	86	85	82	79	78	77	78	73	73
	Amtrak	-	210	238	198	154	180	-	156	147	146	142	-	153	150
Japan	Japan	114	151	134	157	91	80	85	82	61	81	82	86	85	83
	SBB/CFF/FFS	100	127	122	107	100	99	95	101	95	97	94	93	94	93

TU/Employee		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	CAGR 1980 to 2011 (%)	CAGR 1995 to 2011 (%)
France	SNCF **	358	405	485	484	566	571	713	704	739	758	774	717	707	727	1.9	2.2
Germany	DBAG **	261	269	323	348	339	474	832	700	712	721	700	616	658	671	3.5	3.2
UK	BR/ATOC	200	202	204	260	363	333						1 037	1 099	1 164	8.6	12.1
Czech Rep	CD						297	284	322	395	420	467	490	505	589	na	6.4
Poland	PKP	375	475	492	452	393	371	403	487	474	491	470	410	470	524	0.3	3.2
US	Class I	1 973	2 259	2 929	4 244	6 980	10 135	12 721	15 258	15 448	15 470	15 790	14 856	16 268	15 927	8.4	4.2
US	Amtrak		685	357	364	407	374	350	450	467	490	518	493	480	515	1.8	2.9
Japan	Japan	546	608	556	791	1 364	1 422	1 654	1 981	2 065	2 142	2 130	2 055	2 070	2 079	6.5	3.5
Switzerland	SBB/CFF/FFS	363	321	431	443	513	593	831	863	891	1 125	1 126	798	876	868	3.4	3.5

* Prior to 1995, DB AG is the older DB

** Both SNCF and DB AG are affected by the presence of a large number of non-rail employees, which cannot be corrected for 1980 and 1995. If later years include a higher percentage of non-rail than earlier years, then TU/Employee will look too low, and productivity growth will also look too low.

Table 13

Evolution of Railway Average Tariffs Expressed in Constant 2011 PPP$

Average Passenger Revenue/Passenger-Km Expressed in 2011 PPP International Dollars

		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
France	**SNCF**	0.0478	0.0611	0.0877	0.1257	0.1249	0.1090	0.1234	0.1767	0.1761	0.1764	0.1793	0.1905	0.1908	0.1931
Germany	**DBAG ****	0.1079	0.1673	0.2015	0.1993	0.1906	0.1808	0.1852	0.2167	0.2080	0.2043	0.2045	0.2193	0.2266	0.2560
UK	**BR/ATOC**	0.0332	0.0483	0.0947	0.1238	0.1479	0.1661	0.1609	0.1591	0.1615	0.1635	0.1715	0.1842	0.1832	0.1878
Czech Rep	***CD***						0.0419	0.0749	0.0768	0.0750	0.0754	0.0722	0.0827	0.0808	0.0810
Poland	***PKP***					0.0041	0.0558	0.0687	0.1004	0.1032	0.0855	0.0882	0.1051	0.0997	0.0955
US	Amtrak		0.1174	0.1389	0.1451	0.1602	0.1510	0.1705	0.2171	0.2340	0.2505	0.2935	0.2791	0.2790	0.2899
Japan	All	0.1265	-	0.2164	-	-	0.1739	0.1682	0.1580	0.1553	0.1518	0.1522	0.1573	0.1502	0.1502
Switzerland	SBB/CFF/FFS	0.1107	0.1355	0.1428	0.2244	0.1304	0.1356	0.1158	0.1569	0.1247	0.2016	0.1969	0.1589	0.1449	0.1456

Average Freight Revenue/Tonne-Km Expressed in 2011 PPP International Dollars

		1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
France	**SNCF**	0.0458	0.0584	0.0758	0.1116	0.0942	0.0792	0.0528	0.0569	0.0546	0.0544	0.0584	0.0646	0.0642	0.0626	
Germany	**DBAG****	0.1372	0.1755	0.1610	0.1513	0.1161	0.0900	0.0601		0.0471	0.0475	0.0536	0.0535	0.0544	0.0564	0.0587
UK	**BR/Frt**	0.0356	0.0538	0.1075	0.1094	0.1161	na	na	na	na	na	na	na	na	na	
Czech Rep	***CD (2003)***						0.0988	0.1336	0.1062	0.0910	0.0845	0.0819	0.0751	0.0946	0.0842	
Poland	***PKP***					0.0232	0.0724	0.0825	0.0835	0.0839	0.0803	0.0846	0.0854	0.0810	0.0813	
United States	Class I	0.0342	0.0416	0.0458	0.0413	0.0306	0.0243	0.0185	0.0190	0.0200	0.0207	0.0232	0.0213	0.0232	0.0257	0.0263
Japan	All	0.1193	0.1229	0.1718	-	-	0.0800	0.0674	0.0575	0.0565	0.0557	0.0564	0.0600	0.0573	-	
Switzerland	SBB/CFF/FFS	0.2121	0.2823	0.2235	0.2111	0.1574	0.1279	0.0925	0.0954	0.0949	0.0753	0.0780	-	0.0883	0.0830	

** Before 1995, this uses the old DB data (DR not included). Freight rates are recalculated from DB Annual Reports to remove apparent Schenker distortion.

Table 14

Evolution of Railway Market Shares

Rail Market Share (% Passenger-Km) of Rail, Auto and Bus Passenger Traffic

	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
France	11.0	11.2	10.0	10.5	8.8	7.0	8.1	8.3	8.6	8.7	9.3	9.2	9.1	9.3
Germany	8.8	7.7	7.1	7.4	6.3	7.4	7.7	7.6	7.7	7.7	8.0	7.9	8.0	8.1
UK	8.1	7.5	6.7	6.0	5.1	4.3	5.4	5.7	5.9	6.3	6.6	6.7	7.1	7.4
EU 15	10.4	9.5	8.5	8.1	7.0	6.6	6.9	7.0	7.2	7.3	7.6	7.9	7.8	7.0
Czech Republic						10.9	9.1	7.9	8.0	7.8	7.7	7.4	8.1	8.2
Poland	55.9	48.3	48.5	36.1	30.6	12.7	9.8	7.3	6.9	6.8	6.3	5.7	5.3	5.2
EU 10	50.1	40.1	35.8	32.6	29.1	16.2	12.3	9.0	8.6	8.3	7.8	7.3	7.0	7.3
US	0.4	0.1	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Japan	50.4	47.3	42.2	40.3	31.2	30.4	28.8	29.5	30.1	30.6	30.9	30.4		
Switzerland	16.9	14.2	12.9	12.3	14.8	14.4	13.6	16.1	16.4	16.9	17.0	17.3	17.5	17.5

Rail Market Share (% Net Tonne-Km) of Rail Plus Truck Traffic

	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
France	50.5	42.1	39.8	39.1	30.2	22.9	23.1	17.0	17.2	17.1	17.1	16.2	14.7	16.1
Germany	47.5	36.1	33.9	32.3	37.8	22.9	21.6	23.5	24.5	25.0	25.3	23.8	25.5	25.9
UK	22.4	18.6	16.2	13.7	10.7	8.3	10.5	11.4	11.6	10.9	11.5	12.0	10.8	12.0
EU 15	32.2	23.6	21.5	20.5	20.3	15.4	15.6	14.3	15.2	15.2	15.4	14.3	14.8	15.4
Czech Republic						44.9	30.9	25.5	23.9	25.3	23.3	22.2	21.0	20.7
Poland	86.3	79.9	75.2	76.7	67.5	57.1	41.9	29.4	28.2	25.4	23.0	18.5	18.5	19.7
EU 10	78.4	74.4	69.3	69.4	63.8	48.0	40.0	29.0	27.5	26.0	24.8	22.1	22.4	23.8
United States*	65.1	62.5	62.7	59.5	59.7	59.9	56.4	57.5	59.0	58.0	54.8	54.5		
Japan	31.7	26.6	17.3	9.6	9.0	7.9	6.6	6.4	6.3	6.2	6.0	5.8	7.7	7.9
Switzerland	59.0	52.7	53.2	47.8	44.0	42.2	44.9	42.6	43.3	41.3	41.5	38.4	39.4	39.7

* US calculated on different basis using AAR statistics for rail versus intercity truck only. OECD does not provide similar data for other countries.

Table 15

Rail Liberalization Index for EU Railways

>800	Advanced
600 to 800	On Schedule
300 to 600	Delayed
<300	Pending Departure
	No data

LEX, ACCESS and COM Details

	Overall Liberalization				2007		2011		LEX				ACCESS				COM			
Country	2002	2004	2007	2011	Frt.	Pass.	Frt.	Pass.	2002	2004	2007	2011	2002	2004	2007	2011	2002	2004	2007	2011
UK	805	781	827	865	848	798	862	852	960	940	969	980	740	715	791	837	780	580	793	866
DE	760	728	826	842	844	809	875	814	840	750	905	935	840	720	807	819	520	505	555	615
SE	760	729	825	872	908	742	896	855	800	680	857	960	760	760	817	850	720	510	633	577
NL	720	695	809	817	887	732	884	779	760	670	865	887	820	710	795	799	460	455	509	680
AT	430	579	788	806	852	727	873	761	680	530	819	895	410	600	781	784	240	232	349	575
DK	720	693	788	825	811	757	851	808	860	790	821	925	770	650	780	800	480	390	498	655
CH	650	677	757	741	848	662	850	680	600	605	670	678	770	710	778	756	440	495	459	509
PL		549	739	737	786	692	826	699		600	783	803		530	728	720		175	490	518
CZ		549	738	738	798	679	783	705		530	839	786		560	713	726		215	279	422
RO			722	726	797	650	834	650			822	783			697	711			440	487
PT	380	668	707	737	797	619	847	676	700	820	829	884	290	605	676	701	220	190	200	434
SK		458	700	738	756	643	793	702		535	853	857		430	662	708		260	381	381
NO	390	589	698	729	836	574	861	652	580	570	777	769	410	595	679	719	140	135	274	482
EE		257	691	729	727	667	781	701		380	728	840		205	680	702		245	704	629
LT		222	684	592	744	624	703	530		260	820	730		210	650	558		165	184	120
IT	560	688	676	737	734	617	809	706	660	740	819	795	680	670	640	722	240	225	293	470
SI		326	665	672	743	585	799	590		550	622	655		230	675	676		120	153	337
BG			652	718	761	557	806	668			722	839			635	688			241	421
LV		516	650	587	733	576	747	500		580	683	780		485	642	539		225	313	411
BE	395	461	649	753	780	518	881	663	380	425	740	820	500	475	626	737	180	180	201	424
HU		366	637	658	740	533	780	592		485	731	822		320	613	616		125	275	522
FI	410	542	636	672	732	540	753	661	620	640	732	729	440	505	612	657	160	140	145	156
ES	195	148	630	583	785	486	770	485	300	250	711	701	180	105	610	554	140	110	151	333
LU	280	467	581	585	688	474	742	508	520	530	551	669	220	440	588	564	152	120	115	104
FR	340	305	574	612	727	431	772	521	340	360	595	650	430	280	568	602	152	130	178	334
GR	210	162	559	592	690	429	698	559	260	305	619	859	240	100	544	525	100	100	133	136
IE	295	149	333	467	458	206	603	399	520	180	332	414	280	130	338	481	100	100	115	120
Sample	17	25	27	27	27	27	27	27	17	25	27	27	17	25	27	27	17	25	27	27
EU 15	484	520	681	718	769	592	808	670	613	574	744	807	507	498	665	695	310	264	325	432
EU 10	-	405	688	690	759	621	785	634	-	490	760	790	-	371	670	664	-	191	346	425
EU 25		480	683	706	765	604	799	655		545	751	800		454	667	683		239	333	429
2011 pg				12			66	67				52				59				63
2007 pg.		32	57		71	78					59				64				68	
2004 pg										27				29				3		
2002 pg	5								7				9				11			

Note: 2002 Indices were visually estimated from graphs. Numbers shown were then calculated by multiplying the original numbers by 4, 2 and 4 respectively.

Source: Rail Liberalization Index report of indicated year

Appendix A

A Note on the Sources of Data for This Paper

The good news with railway data -- as opposed to trucking, air and water transport data -- is that railways probably report more information in more detail than other modes. Depending on the country and the railway (and the year) it is possible to collect all the data used in this paper along with even more detailed data on types of service, commodities, etc. The bad news is that data taken from different sources purporting to represent the same thing (passenger-km in a particular year) are not always (or even often) consistent. In addition, not all railways report all data in any given year and some railways do not bother to report at all. In some cases, restructuring has meant that most information is lost on those parts of the railway that are established separately (Green Cargo and UK freight operators). The net result is that most of the apparently precise information in rail data sets has to be taken with a grain of salt and that there is a real need for action by governments and the EU to take action to improve the quality and amount of rail data reported to the public. Thompson 2007 discusses this issue in more detail, and it should be an issue for this conference.

The basic source of EU railway information is the International Union of Railways (UIC). This includes "Railway Time-Series Data 1970-2000," "Railway Time-Series Data 2008" (the electronic form was used) and various issues of the "International Railway Statistics" for 2002 through 2011. Some of these data were manually transcribed, which may have introduced errors attributable only to the authors and not the UIC.

The source of U.S. data for Class I freight railways is "Analysis of Class I Railroads" as published by the Surface Transportation Board (STB). This report has existed essentially in its current form in an unbroken series since the beginning of the 20th century. We have also used the "Public Use Carload Waybill Sample" with added calculations of variable costs at the two-digit Standard Transportation Commodity Code (STCC) level as furnished by the STB and processed by the Association of American Railroads (AAR). In some cases we have used data from "Railroad Facts," a statistical compendium of Class I freight railroad activity published by the AAR. Amtrak data were taken from various Amtrak statistical reports, notably the "Monthly Performance Report" for September of various years that contain annual fiscal year data along with various Amtrak Annual Reports.

Canadian data were taken from various issues of "Railway Trends" published by the Railway Association of Canada (RAC) and data taken from Statistics Canada as processed by the RAC.

UK data are taken from UIC reports and from various editions of "National Rail Trends Yearbook" published by the Office of the Rail Regulator.

Chinese data are taken from "China Railways Facts 2008 edition" published by the Statistics Center of the Ministry of Railways along with updated figures provided to us by the Ministry.

Data on Tonne-Kms and Passenger-Kms used for calculation of market shares were taken from the OECD website.

Data on inflation indices, currency values and PPP conversion factors are taken from the World Bank's "World Development Indicators" that generally cover all countries over the period 1960 to present.

For reasons of space and brevity, we have not included the full set of 33 Excel spreadsheets covering 81 railway entities (26 existing or former countries) over 41 years. These are available on request from the authors (lou.thompson@gmail.com). The Tables presented are extracted from these supporting spreadsheets.

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International Transport Forum
2 rue André Pascal
75775 Paris Cedex 16
itf.contact@oecd.org
www.internationaltransportforum.org