Road and rail compared

This analysis compares rail with the road network as a whole, the motorway and trunk road network, subsequently called the strategic network, and with the motorway network alone. Summary data provides the ten year averages ending in 2018. Also available is time series data back to the year 2000. All financial data is at 2018 prices unless otherwise stated.

Sources are Network Rail’s Regulatory accounts, Transport Statistics Great Britain, The Office of Rail and Road’s data set, and the Office of National Statistics. The parameters used are listed below along with explanations and results, also summarised in the attached tables. The details of the calculation are in the supporting spreadsheet except where stated.

A point of interest is that over the period 2000 to 2005 the DfT’s de-trunking programme reduced the length of the strategic road network from 11,700 km to 8,700 km, after which there has been little change with the length standing at roughly 8,500 km in 2018. Hence the data has been represented for the strategic network as it stood in each year, network (1) and for a ghost network representing matters as they would have been had there been no de-trunking programme, networks (2). The traffic flows on the ghost network were calculated by inflating the values in the base year of 2000 by the growth in the relevant car and HGV flows for the road network as a whole. The costs were estimated by inflating the actual costs according to the ratios of the relevant lane lengths.

The supporting spreadsheet is a resource enabling updates and sensitivity test on assumptions to be carried out where national data does not exist.

Summary

Except where noted the following is taken from the attached tables copied taken from source spreadsheet. The ratios in those tables show the road networks outperform rail in all vectors, productivity both in terms of use of track and use of finance, except when rail is compared with the entire road network where average flow are higher by rail.

1. **Route lengths**: The rail network is roughly 16,000 km long, one-20th the length of the road network, 350,000 km, 30% longer than the strategic road network as it now stands, 12,000 km, the same length as the strategic network prior to the de-trunking programme, and four times as long as the motorway network, 3,600 km.

2. **Track and (traffic) lane lengths**: Track lengths for rail are set to double the published route lengths including route open to freight alone. Lane lengths are provided for the strategic and motorway networks only. There are two estimates, namely, (a) for the running lanes (these estimates ignore hard shoulders, verges on dual carriageways and central reserves) (b) including those items. An average of seven running lanes has been assigned to motorways, 4.5 lanes to dual carriageways and 2.25 lanes to single carriageways. Those assumptions are in the absence of national data. The effect of changing the values can be easily tested. Lane lengths (a) are the more appropriate when estimating costs per lane. Lengths (b) are the more appropriate when estimating average flows per lane.

   The data shows that rail provides a track length roughly half the lane length of the strategic road network prior to de-trunking, ignoring hard shoulders, verges and central reserves.

3. **Passenger journeys**: This statistic is available for rail and for the road network as a whole. (Passenger journeys for the strategic network or motorway networks have no meaning since trips are scarcely ever contained wholly within those networks).

   The data shows that the rail network carries one thirtieth as many passenger journeys as does the road network providing a rail to road ratio of 3.6%.
4. **Passenger-km, tonne-km, and the sum of the two.** The TSGB source provides these for the road network as a whole. Estimates for the strategic and motorway networks were made by multiplying the data for the network as a whole by the ratios of the relevant vehicle-km.

   The data shows that the railways carry (a) one-twelfth as many passenger-km as do the roads, providing a rail/road ratio of 8.6% (b) one-eighth as many tonne-km, providing a rail/road ratio of 13% and (c) one-eleventh of the (passenger + tonne)-km providing a rail/road ratio of 9.3%.

5. **Average flows.** These are calculated by dividing passenger-km, tonne-km, and the combination by route, track or lane lengths. Estimates using lane lengths (b), see 2 above, are the most appropriate.

   The data shows that rail uses its right of way twice as intensively as does the road network as a whole. However, the data also shows that rail uses its track, at most, half as intensively as does the strategic road network with respect to its traffic lanes where hard shoulders, soft verges and central reserves are included as lanes. That arises despite the rail network serving the hearts of our towns and cities whereas the strategic road network peters out on the approaches to most urban areas. Moreover the road network, in addition to carrying traffic, carries statutory services such as gas, water and electricity, and provides access to every property in the land. In contrast, rail provides access only to its railway stations and terminals.

6. **Government expenditure.** The subsidy to rail was set to the sum of (a) the grant reported by the ORR Table 1.6, excluding grant to HS2 and Crossrail but including freight grants plus (b) the difference between expenditure and income available from Network Rail’s Regulatory Accounts. The latter is a proxy for borrowing which will never to be repaid from income. Grant within those accounts is counted as income.

   The values for the road network as a whole and for the strategic networks as they exist, networks (1), were from the TSGB. The values for (a) the strategic networks as they would have been without the de-trunking programme, networks (2) and for (b) the motorway network were estimated by multiplying the value for the strategic network (1) by the ratio of the relevant lane lengths using item (a) at 2 above.

   The data shows that the rail network cost the taxpayer close to £8 billion per year or £297 for every household in the land. In comparison the road network cost £10 billion, equivalent to £377 per household, the strategic network at its pre de-trunking size, cost £4.5 billion or £169 per household and the motorway network, £1.9 billion or £73 per household. Similarly the rail network costs the taxpayer £250,000 per year per track-km compared with £77,000 per lane-km for either of the strategic networks or for the motorway networks.

7. **Tax taken from road users.** Tax was estimated as the sum of (a) the duty on fuel plus road tax available from the TSGB and (b) an estimate of the VAT paid on fuel, new vehicles and vehicle maintenance.

   The ten year average at 2018 prices without VAT amounts to £34.3 billion. VAT increased that to £57.7 billion, i.e. by 68%.

   The estimates of VAT on fuel (and fuel duty) rely on TSGB estimates of total fuel purchased, its cost per litre and the VAT rates. The calculation provided a ten year average of £9.8 billion.

   VAT on new cars was estimated by multiplying the number of new vehicle registrations available from the TSGB by an informed guess as to the average price of a new vehicle and then applying the VAT rates. For new cars the prices (including VAT) were set to £12,000 in the year 2000 and to £15,000 in the year 2018. Values for intervening years were by interpolation. The cost per vehicle for
HGV’s was set to ten times the value for cars. The calculation produced VAT of £9.5 billion.

VAT on maintenance was calculated by multiplying the number of annual registrations provided by the TSGB by estimates of the annual maintenance cost and applying the VAT rates. For cars the maintenance cost was set to £450 in the year 2000 and to £500 in the year 2018. As with new vehicles, costs for the intervening years were interpolated and values for HGVs were set to ten times those for cars. That produced £4.1 billion.

Sensitivity tests may easily be carried out by varying the assumptions apparent in the spreadsheet.

The tax was apportioned to the strategic and motorway networks according to the relevant vehicle flows.

8. **Unit costs**, namely the costs per route-km, per track-km, per lane km, per passenger journey, per passenger-km, per tonne-km and for the combination were calculated by dividing the costs by the relevant parameters.

   **The data shows** that rail costs the taxpayer (a) 21 times as much per passenger journey (b) 3.25 times as much per track-km as does the strategic network per lane-km and seven to ten times as much as road per (passenger + tonne)-km as do the various road networks.

9. **Net tax**, i.e. Tax minus expenditure (obtained by difference). It represents the profit to the Government from the road system.

   **The data shows** a ten year average without VAT of £24.3 billion. Adding VAT provided £47.6 billion. The latter is equivalent a net contribution of £1,790 per household. It compares with rail subsidy of £7.9 billion per year. Likewise the strategic network as it stood prior to de-trunking made a profit of £16.9 bn per year, or £637 per household or of roughly £300,000 per lane-km, when costs are assigned to running lanes, or to roughly 80 pence per journey or to 5 pence per (passenger + tonne)-km.

**Other data not in the summary tables include:**

10. **The vehicle flow per track** on the rail network which would arise if the rail function were discharged by express coaches and lorries. The ten year average, using a 300 day year is below 400 vehicles per day, a flow so trivial it would pass in half an hour, on one lane of a motor road. (The calculation assumed (a) 25 and (b) 20 passengers per coach and lorries carrying average loads of 15 tonnes (30 tonnes out back empty).

11. **Central London:** In the peak hour and in central London the surface rail network is, in highway terms, used to between one fifth and one seventh of its capacity, see topic 15. Outside the peak the network is a place of dreams. Paving the network would enable countless lorries and other vehicles to divert from the unsuitable roads and streets. That would bring in untold environmental benefits. Firstly the vehicles would avoid congestion and hence use much less fuel. Secondly the vehicles would be segregated from people and relatively remote from the shops and houses fronting the roads used previously.

12. **The average passenger journey length** by rail is less than 40 km. The range is from 6.8 km for London Overground to 300 km for c2c, the intercity service.

13. **The average line haul** for rail freight is close to 200 km, double the 100 km by road.

14. **The average number** of passengers per train has risen from 89 in the year 2000 to 127 in 2018.
15. **Safety:** The railway lobby claims the railway is uniquely safe. That claim depends on comparing (a) deaths to passenger killed in train accidents, i.e. due to trains crashing, with (b) all the casualties on the road network as a whole. The statistic exaggerates in favour of rail on two counts. Firstly by a factor of over 11 by ignoring usage – the roads carry 11 times as many passenger-km as much as does rail, let alone exposures to pedestrians and cyclists. Secondly it ignores the vast majority of deaths by rail, namely, trespassers and those who die at level crossings etc. When these are taken into account and when suicides are excluded, we find rail killing more people per passenger mile than does the strategic road network, see Facts Sheet 2.

16. **Fuel consumption:** We find that replacement express coaches and lorries using rail’s right of way, managed to avoid congestion, would use up to 35% less fuel than do the trains, Facts Sheet 5. There would also be incalculable savings from the lorries and other vehicles which could transfer from the unsuitable city streets and rural roads which they now clog – a thing which would also reduce the casualty rates.

17. **Widths:** The railway lobby claims the railways are too narrow to be converted to motor roads. However the clear distance between tunnel and viaduct walls on double track formations is 24 feet or 7.3 metres, the same as the carriageway of a two-way trunk road shorn of marginal strips. Outside those limits the railway formation offers 28 feet or 8.6 metres, and more on bends. Hence a converted line would offer widths similar or better than those commonly met with and vastly superior alignments. Likewise with headroom, see Fact Sheet 3. On the approaches to stations and terminals the widths are vast.

**The Spread Sheet**

The spread sheet upon which the summary tables in this text depend contains the following separate sheets.

1) GDP deflators – these convert the outturn financial data to the latest price base.

2) Summary: This sheet provides a summary of the route and track/lane lengths along with usage and costs and ratios of rail to road as in the tables below.

3) (3a) Road stats adjusted is generated from (3), road stats, both provide the data from previous sheets and the calculations of the various parameters (3a) deals with the motorway and trunk road network as it would be if there had been no de-trunking programme. Sheet (3) deals with the networks as they are. Both, and all subsequent sheets, provide time series data back to the year 2000. In all of them the data for 2018 and for some items for 2017 is provisional, awaiting the publication of the relevant statistics.

4) (4a) Road expenditure and taxes provides that data for roads. It is taken forward to sheet (3) and (3a). Sheet (4) is the source for (4a).

5) Road freight, provides estimates the tonne- km due to foreign freight. That, added to domestic freight, provides the total taken forward to sheets (3a) and (3).

6) Trips by mode provides trips that data. Its purpose is to enable the annual trips by road to be estimated and taken forward to sheets (3a) and (3).

7) Rail Stats unit costs provides unit costs etc. for rail also take forward.

8) Lengths, provides estimates of track length for rail and lane lengths for roads

9) provides the 2018 or current costs of rail themselves calculated from sheet 10

10)provides the outturn financial data for Network rail enabling subsidy including borrowing to be estimated.
<table>
<thead>
<tr>
<th>Summary: lengths and use 10-year averages to 2018</th>
<th>Lengths and use</th>
<th>Ratios: Rail to road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Route length km</strong></td>
<td>RAIL</td>
<td>ALL ROADS</td>
</tr>
<tr>
<td>15,773</td>
<td>345,155</td>
<td>12,077</td>
</tr>
<tr>
<td><strong>Lane/track length km (a) ignoring hard shoulders, verges and central reserves</strong></td>
<td>31,547</td>
<td>51,942</td>
</tr>
<tr>
<td><strong>Lane; track length km (b) including as (a) above</strong></td>
<td>31,547</td>
<td>73,038</td>
</tr>
<tr>
<td><strong>USAGE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Veh-km (bn)</td>
<td>-</td>
<td>504</td>
</tr>
<tr>
<td>Heavy goods veh-km (bn)</td>
<td>-</td>
<td>27</td>
</tr>
<tr>
<td>Other Veh-km (bn )</td>
<td>-</td>
<td>477</td>
</tr>
<tr>
<td>Pass-journeys ex pd and cys bn</td>
<td>1.58</td>
<td>44</td>
</tr>
<tr>
<td>Pass-journeys inc pd and cys bn</td>
<td>1.58</td>
<td>60</td>
</tr>
<tr>
<td>Passenger-km (bn) (P)</td>
<td>61</td>
<td>707</td>
</tr>
<tr>
<td>Tonne-km</td>
<td>19</td>
<td>150</td>
</tr>
<tr>
<td>([P]+[F])-km bn</td>
<td>80</td>
<td>857</td>
</tr>
</tbody>
</table>

**Average daily flows - e.g. Passenger-km divided by route, track or lane length**

| On route length Passengers + freight | 13,921 | 6,805 | 73,872 | 63,609 | 155,909 | 2.05 | 0.19 | 0.22 | 0.09 |
| On lane lengths (a) - Ignoring hard shoulders, verges and central reserves | | | | | | | | | |
| Passengers | 5,269 | 11,957 | 11,267 | 14,966 | - | 0.44 | 0.47 | 0.35 |
| Tonnes | 1,691 | 5,220 | 4,848 | 7,307 | - | 0.32 | 0.35 | 0.23 |
| Total | 6,960 | 17,177 | 16,114 | 22,273 | - | 0.41 | 0.43 | 0.31 |
| On lane lengths (b) - Including hard shoulders, verges and central reserves | | | | | | | | | |
| Passengers | 5,269 | 8,503 | 8,208 | 10,476 | - | 0.62 | 0.64 | 0.50 |
| Tonnes | 1,691 | 3,712 | 3,532 | 5,115 | - | 0.46 | 0.48 | 0.33 |

(1) This data relates to the actual Motorway and Trunk Road network
(2) This data relates to the Motorway and Trunk road network as it stood in the year 2000 but with usage factored according to the ratio of the later year passenger or tonne-km on the road network as a whole to the base hear values and with cost factored from the actual costs according to the ratio of lane lengths in 2000 to those in the relevant year
<table>
<thead>
<tr>
<th>Summary. Costs and unit costs, 10-year averages to 2018</th>
<th>Costs and unit costs: 2018 prices</th>
<th>Ratios: Rail to road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households millions</td>
<td>RAIL</td>
<td>ALL ROADS</td>
</tr>
<tr>
<td>Households millions</td>
<td>26.6</td>
<td>26.6</td>
</tr>
<tr>
<td>Government Spend £mn</td>
<td>7,911</td>
<td>10,032</td>
</tr>
<tr>
<td>Tax from road users £mn</td>
<td>Zero</td>
<td>57,676</td>
</tr>
<tr>
<td>Net tax income £mn</td>
<td>Zero</td>
<td>47,644</td>
</tr>
</tbody>
</table>

**UNIT COSTS Govt Expenditure**

- Pounds per household: 297, 377, 151, 169, 73, 0.79, 1.97, 1.76, 4.09
- Thousands of pounds per route-km: 502, 29, 332, 298, 541, 17.26, 1.51, 1.69, 0.93
- Thousands of pounds per lane-km (a): 251, 77, 76, 77, - 3.25, 3.29, 3.25
- Pence per passenger-journey ex pd and cy: 501.0, 22.99, - - - 21.79 - - -
- Pence per passenger-journey inc pd and cy: 16.73, - - - 29.95 - - -
- Pence per passenger-km: 13.04, 1.42, 1.77, 1.85, 1.42, 9.19, 7.36, 7.04, 9.16
- Pence per tonne-km: 40.63, 6.68, 4.06, 4.30, 2.90, 6.08, 10.02, 9.44, 14.02
- Pence per [(P) + (F)] km: 9.87, 1.17, 1.23, 1.28, 0.95, 8.44, 8.01, 7.70, 10.38

**NET TAX TAKE per item**

- Pounds per household: 1,790, 582, 637, 356
- Thousands of pounds per route-km: 138, 1,284, 1,122, 2,647
- Thousands of pounds per km of lane (a): 299, 287, 378
- Thousands of pounds per km of lane (b): 212, 209, 265
- Pence per passenger-journey ex pd and cy: Zero 109.20
- Pence per passenger-journey inc pd and cy: 79.45
- Pence per passenger-km: 6.74, 6.84, 6.98, 6.92
- Pence per tonne-km: 31.71, 15.67, 16.22, 14.18
- Pence per [(P) + (F)] km: 5.56, 4.76, 4.83, 4.65

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