MOTORWAYS VERSUS RAIL
(In France)

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Rather than comparing rail with road in general, this paper compares rail with autoroutes concédées subsequently referred to here as motorways. The comparisons are in terms of output, productivity, and public finance. The output of the motorways is about double that of rail, if measured in physical terms, and six times that of rail when measured in monetary values. Capital and labour inputs are roughly comparable. That means that the productivity of capital and labour when applied to motorways is 2 to 6 times greater than when applied to rail. Whereas the annual cost of rail to the taxpayer is 60 billion francs, the motorways contribute nearly 30 billion to the exchequer.

The rest of this translation is by Transport Watch
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Comparisons between the two major modes of transport are usually between rail and road. There are at least three reasons why such comparisons are difficult to make. Firstly, there is an asymmetry in that: rail transports passengers and freight from station to station whereas roads transports goods and people from origin to destination. Hence rail transport, at least in respect of goods, needs road transport, while the converse is not the case; instead road transport is sufficient in itself. Secondly, roads are used much more intensively than rail so weakening other comparisons. Thirdly, an argument often put forward by the proponents of rail is that rail pays for its infrastructure while road infrastructure is funded by the State.

Hence, it is probably more sensible to compare rail with motorways than with roads as a whole. That eliminates at least two of the above problems. The intensity of use of rail is much more comparable to that of motorways. Motorways, or at least “autoroutes concédées”, vis a vis their infrastructure, are in a situation that is similar to that of rail, on first analysis. The third objection is still strong, but it is somewhat mitigated. The motorway is carrying passengers and goods from entry point to exit point, rail, station to station. Of course, asymmetry is not erased completely. The segment from the motorway entrance to the origin or destination is much faster and less expensive than the segment that runs from the station to the origin or destination, because road transport does not involve reloading.

The railway and motorway infrastructures

The rail network is about five times longer than the motorway network: about 31,800 km of railways against 6500 km of motorways (not including nearly 2,000 km of unconceded motorways). However, a significant portion of rail network is little used, so that the difference between the two networks is less important than it seems. The length of the electrified network is 14,200 km, just over double the length of motorway, and the length of network reserved for freight is about 7800 km, which is similar to the motorway network, serving both passengers and cargo.

The activity and the usefulness of the two modes

It is not easy to estimate the activity and utility of transport. Traditional measures are measures in physical quantities, which have their uses but are partial and do not allow aggregation. Those measures should be complemented by measures of value. Table 1 presents the elements of comparison.

Table 1 — Activity and utility of conceded motorways and rail, France, 1997

	Motorways	Rail	Ratio
Estimates of physical quantities			
Freight:			
G wagon-km	10,8(a)	2,5(a)	4,3
G tonne-km	122(b)	53(c)	2,3
Passengers:			
G passenger-km)	81(d)	62(e)	1,3
Combined			
G unit-km	203	112	1,8
Estimated values:			
Merchandises:			
Effective payments (G F)	179(f)	12(g)	14,9
Passengers			
Effective payments (G F)	71(h)	22(g)	3,2
Combined:			
Effective payments (G F)	250(i)	44(i)	5,7

Sources and notes

G = billion

(a) URF pp. 34 & 55; in goods-vehicle-km for motorways and in wagon-km for rail.

(b) INSEE p. 24 for the transport of goods by road (237 G tonnes-km), allocated to motorways in proportion to the movement of goods vehicles on motorways (see note (a) above) to the movement of such vehicles on the all the roads given in URF on p. 55 (20,9 G vehicle- km), namely 52%.
(c) INSEE p. 24.
(d) INSEE p. 30 for passenger transport by road (685 G pass.km), allocated to motorways in proportion to the flow of cars on motorways according to INSEE p. 35 (56,6 G véh.km) compared with the flow on all roads (a) according to the same source (514 G veh.km), namely 11%.
(e) INSEE p. 30.
(f) URF p. 67 available estimates of business expenditure for freight by road are from INSEE (737 GF), and are allocated to motorways using the same principles as at (b) above.
(g) URF p. 81; the figure is for 1996.
(h) URF p. 67 available estimates of household expenditure by road are from INSEE (644 GF), and are allocated to motorways using the same principles as at (d) above.
(i) = the sum of the two previous lines.
(j) The ratio of the price per tonne-km to the price of the passenger-km amounts to 1.67 for motorways and to 0.64 for rail; we used the ratio of one to enable tonne-km to be added to passenger-km in order to provide a single unit. This ratio was also used by WEIBEL (1998, p.5)

The first three rows of Table 1 show that motorway usage is about double that of rail when measuring in terms of physical quantities. The difference is less than that for passengers: about 30%. However, for rail the passengers include those in the Paris suburbs. If they are removed the difference amounts to nearly 50%. For freight the motorways carry two to four times as much as does the SNCF, (depending on whether we measure by wagon-km or tonne-km). It is not obvious how tonnes-km and passenger-km can compared. It could be done by weighting according to the ratio of unit prices of both types of transport. That approach is not adopted in this report. Instead, if we propose, a little arbitrarily, a ratio of one passenger to one tonne so as to express the activity of the two modes in a common unit (equivalent tons-km). On that basis the fourth line of the table shows that that the motorways are used almost twice as much as is rail.

However, the physical quantities do not fully reflect the social utility of the two modes. Nobody would dream of comparing the social utility of raw materials with the utility of finished manufacture by reference to tonnage. The amount that households or businesses pay for their goods is a better indicator of the value attached to transport than the tonne-km carried. In any event the amount paid is a minimum estimate of utility since some people would be willing to pay more, and consequently enjoy a surplus. However, there is no reason to believe surplus depends on the mode or, putting it another way, that the elasticity of demand for transport by highway differs from the elasticity of demand for transport by rail.

Evaluated in this way, the utility of the motorway is five or six times greater than that of rail. In more detail, it is about three times higher in respect of passengers, and fifteen times more for freight.

Why do comparisons based on value increase the importance of highways with respect to rail, compared with comparisons based on physical quantities? Because the value of tonne-km transported by rail is considered (by users, not by us) to be less than the value of tonne-km transported by motorways. A tonne-km my rail is not equal to one tonne-km by motorway. The transport of one tonne-km by road is transported faster, more reliably, and above all without reloading. Consequently that tonne-km is six-times more useful than is the equivalent tonne-km by rail – users being prepared to pay six times as much for the motorway option. For passenger transport, the benefit of the motorway compared with rail is less overwhelming, but remains very important.

In total, therefore, in respect to transport, motorways in France in 1997 were two to six times more important than rail.

The productivity of two modes

It is important to try to relate the previous estimates of productivity of two modes with the resources that are mobilized. Such a comparison is made difficult by the fact that motorway transportation is largely by car, at least with regard to passenger transport. Users of the

highway using their own vehicles and also their own time. The capital value of cars used on motorways can be estimated as the same as the value of rolling stock used by the SNCF. Rail transport also uses time. But it is a time which leaves more freedom to the traveller, which is somewhat less expensive than the time of driving. This qualitative dimension was not taken into account here. Instead we are content to try to estimate the various factors of production used in both modes. The results of this exercise are presented in Table 2.

Table 2 — Factors of production used by motorways and rail, 1997

	Motorways	Rail
Capital value		
With Infrastructure of operating companies (in G F)	206[a]	248[a]
without infrastructure of operating companies (in G F)	Nil	149[b]
Industrial vehicles (in G F)	46[c]	Nil
Private cars (in G F)	180[d]	Nil
Total (in G F)	432	397
Employment		
Employees of operating companies (K)	15[e]	177[f]
Employees as users (K)	251[g]	Nil
Total (K)	266	177
Energy		
Electricity (G toe??)	Nil	1,6[h]
Oil (G toe??)	6,9[i]	0,3[h]
Total (G toe??)	6,9	1,9
From table 1 [j]		
Physical quantities (G equivalent tonnes-km)	203	112
In value (G F)	250	44

Sources et notes

G = millions; K = thousands

(a) investments from 1980 à 1997 according to INSEE 1998 p. 179 deflated by the GDP deflator and expressed as F 1997, this approach heavily underestimates the capital stock of the railways since it ignore the infrastructure completed before 1980, which are obviously more important in the case of rail in the case of motorways.

(b) previous row multiplied by the ratio of GFCF excluding infrastructure to infrastructure, which has evolved, but remains close to 0.6.

(c) INSEE 1998 p. 156 business investment in road transport of goods over the past five years is allocated to the motorways in proportion to the movement of vehicles on motorways under URF 1998 p. 34 to the movement of vehicles on all roads in FIU given p. 55 (20.9 G véh.km), or 52% multiplied by 2 to take account of own-account transport.

(d) urf 1998 p. 25 the number of passenger cars and light commercial vehicles (30.2 million) multiplied by the average value of a vehicle 7 years estimated at 50 k F, allocated in proportion to the motorways in proportion to the traffic on motorways according to INSEE p. 35 (56.6 G véh.km) compared with the traffic on the roads according to the same source (514 veh.km G) or 11%.

(e) URF 1998 p. 79.

(f) INSEE 1998 p. 130.

(g) INSEE 1998 p. 130: the number of employees of the branch road freight transport (241 K) allocated to the highways as in footnote c above.

(h) As (g)

(i) INSEE 1998 p. 140 the energy consumption of road freight (8.54 billion toe)allocated to the highways as in footnote (c) above, and the energy consumption of road transport of passengers allocated to the highways as the note above.

(j) Table 1

The figures in Table 2 should be considered with caution because they incorporate a number of simplifying assumptions (detailed in the table notes) and can certainly be refined. But the order of magnitude which we arrived at is probably significant. What do they imply?

The data shows that the capital for motorways is almost equal to that for rail. In fact, given how the capital for infrastructure has been estimated (the sum of investment in infrastructure from 1980 to 1997), the capital for the motorways is certainly smaller than the capital for rail.

It follows that, since road transport is two to five times larger than rail's, (depending on the way to estimate the importance of these two activities), the productivity of the capital employed in motorways is two to six times as great as that employed in rail, reference the last two rows in Table 2.

Is this greater productivity of capital offset by lower labour productivity? Not at all. Transportation by motorway employs, directly and indirectly, approximately 50% more workers than rail but, as we have seen, the motorway system is used more than the rail system. Hence, when output is measured in value, the motorway transport uses labour nearly 3 times as productively as does rail, see the last row in table 2 above.

Only when considering energy (measured in tonnes of oil equivalent, or toe) does rail appear more efficient than the motorway. It takes twice the energy to move a tonne-km by motorway than by rail. But this advantage disappears if, as is usual, we measure the product by value rather than by physical quantities. On that basis, the motorway is 60% more productive than rail. It should be noted however that the tonnes of oil equivalent are equivalent in energy terms, not in economic terms. The toe used by the rail transport is from nuclear power whereas the toe used by road transport is from oil. The units are equivalent in that they represent the same amount of energy. Furthermore they are interchangeable for uses, such as heating or industrial production. In these cases, the cost to the user of the two forms of energy may be close. But the cost to the user is the price after taxes, not the resource cost. Because three quarters of the cost of oil used in road transport is tax it follows that the resource cost of a toe used by road transport is much less than the resource cost of the toe used by rail transport.

These results are summarized in Table 3 below.

Table 3 — Partial Productivities of the two modes, 1997

	Motorway	Rail	Ratio motorway/rail
Productivity in physical quantities			
Capital (tonnes-km per Franc)	0,47	0,28	1,7
Labour (eq. Tonnes-km per worker)	763	632	1,2
Energy (K tonnes-km per toe)	29	59	0,5
Productivity in value			
Capital (F produced per Franc)	0,58	0,11	5,3
Labour (K Franc produced per worker)	940	249	3,8
Energy (K F produced par toe)	36	23	1,6

Source: Table 2

The cost to public finances of the two modes

What is the impact on public finances? To answer that we attempt to analyse the taxes and subsidies associated with the two modes.

For rail transport the assessment is for 1995 (Prud'homme 1997). At that time Rail transport was operated as a single company (SNCF) owned by the state. Hence, it was sufficient to identify costs and to subtract the revenue paid by consumers. The difference is made up by government subsidies and increasing debt. Since there is no possibility debts being repaid, the debts are equivalent to a public subsidy. Against that background we set out the following.

Tableau 4 – Subsidies and taxes associated with rail transport, 1995

	(Billions of Francs)
Taxes paid by rail transport	3,5
Income (contributions from users):	
Passengers	23,8
Freight	11,3
Other (advertising revenue, etc.)	10,3
Total receipts	45,1
Expenditure	
Salaries and wages	-43,9
Purchases (energy, etc.)	-21,7
Net interest	-17,5
Investments	-19,3
Taxes	-3,5
Total expenditure	-105,9
Hence total subsidy[a]	-60,8
Balance from public finances	-57,3

Sources and notes: Prud'homme 1997; [a] including increased debt

It is not easy to produce a similar table for 1997. The creation of Réseau Ferré de France, wrote off part of the railway's debt and rendered the position less clear. That enabled some people to claim that "the railway had almost reached break even." In reality nothing had changed. No expense had been substantially reduced (salaries and wages, for example, rose from 43.9 GF to 44.7 GF, according to INSEE 1998) and there had been no increase in revenue[1]. The burden on public finances in 1997 can therefore be little different from the 1995 value. We can therefore say that rail transport costs the taxpayer about 57 billion francs per year. (In itself, this does not condemn rail, and it is not unreasonable to attempt to justify the cost, in the same way as we justify the cost of national defence or justice. However, to justify the cost is one thing. To deny it another.

This subsidy of 57 billion francs is at best an approximation. For example, it fails to take account of the contribution by public finances to the SNCF pension scheme. It is difficult to estimate this without separating the "unfavourable demographic developments" from the so-called "differential generosity" of the SNCF pension scheme. However, according to an evaluation by the SNCF that contribution amounted to 14 billion francs per year. If accepted, that figure would increase the subsidy to rail to 71 billion francs.

The results of the financial analysis for motorway transport are in Table 3. The values are easy to estimate since the companies which operate the conceded motorways have no subsidies and receive no capital payments. The figures only include the expenditure for the motorway police, estimated to be at 0.7 billion Francs in 1996. However that expenditure was repaid by the motorway companies via a tax that we include in the revenue associated with motorway transport.

The revenue associated with motorway transport is more difficult to estimate. It is raised partly from the tax paid by the conceded companies, which is easy to identify, and partly by taxes paid by users. These taxes are of two types namely (a) the VAT paid by households purchasing and repairing their vehicles and by transport companies (or their customers) and by firms involved in transport on their own account (b) specific taxes, which affects transport activities alone, e.g. "vignette" axle tax, insurance subsidy for social security, mandatory insurance surcharges and especially taxes on petroleum products. The total tax take for the

[1] One can only hope that in the future the dichotomy will improve the effectiveness of rail, especially in the choice of infrastructure investment, but the impact on the public finances will necessarily be slow.

entire road transport system has been allocated to motorways in proportion to the vehicles-km driven. That amounts to 11%, see the note (d) to table 5.

Table 5 — Public expenditure and revenue associated with motorway transport, 1997

	(en GF)
Tax revenue paid by motorway transport	
By the motorway societies	5,9[b]
By households	13,6[d]
By freight haulage companies	6,0[e]
By companies engaged in transport on own account	6,0[f]
Specific taxes on road transport	23,4[g]
Total	54,9
Public expenditure on road transport	
Capital ??	nil
Revenue	nil
Security (police)	-0,7[h]
Total	-0,7
Balance	54,2

***Sources and notes*:**
(a) GF = billion francs;
(b) URF 1998, p. 80 This figure includes the tax known as land development plan assigned to FITTVN and is consistent with INSEE 1998 p. 43.
(d) INSEE 1998 p. 50 for household spending on transport by car (602 GF) multiplied by the rate of VAT (0.206) and allocated to the motorways in proportion to the traffic on motorways according to INSEE 1998 p. 35 (56.6 billion veh-km) compared to the total traffic from the same source (513.8 billion veh-km) or 11%;
(e) INSEE 1998 p. 156 for the value added (55.8 GF) multiplied by the rate of VAT (0.206) and allocated to the motorways in proportion to the movement of vehicles on motorways under URF 1998 p. 34 (10.8 billion veh-km) to the movement of vehicles on all roads under URF 1998 p. 55 (20.9 billion veh.km) or 52%.
(f) Assumed equal to the figure of the previous line.
(g) URF 1998 p. 72 for specific taxes (212.4 GF) including the TIPP, the “vignette”, the payments to social security, obligatory insurance surcharges, allocated in proportion to traffic on motorways estimated by INSEE 1998 p. 35 (56.6 Billion veh.km) compared with the total traffic on all roads using the same source (513.8 billion veh-km) or 11%;
(h) URF 1998 p. 72

The estimates are approximations only. In particular the tax revenue associated with motorways is likely to be underestimated since the proportion of goods vehicles is greater on motorways than on roads in general and the tax contribution of goods vehicles per km driven is greater than for private cars.

It could be argued that the estimated contributions (positive or negative) to public finances by the two modes ignore the indirect contributions made to the "general expenses" of the State and local authorities, such as are made by e.g. textiles or food. We do not necessarily reject this concept by saying that motorways contribute to the tune of 50 billion Francs to the state budget. Indeed one may want, for the sake of symmetry, to consider both the direct and indirect contributions to state funds made by the motorway and rail systems – such as spending for primary education of motorways users or the SNCF drivers or in connection with the expenses of the courts which try traffic offences etc. However, the estimation of these costs would be extremely difficult. For that reason the data in table 6 represents only the direct contributions of the two modes to public finances- considering the expenditure and revenue and taxes that are specific to transport alone.

Table 6 — Specific expenditure and revenue associated with the two modes of transport

	Motorways 1997 (in GF)	Rail 1995 (in GF)
Transport revenue	23,4[a]	-4,0[b]
Tax for land development plans	2,2	
Tax for the traffic police	0,7	
Total	26,3	
Expenditure	-0,7[a]	-60,8[c]
Balance available for public finances	+25,6	-64,8

Sources et notes:
(a) Table 5.
(b) VAT at 5% rather than the standard rate of 20.6% for passengers is a tax expenditure that can be analysed as a negative revenue.
(c) Table 4.

The magnitudes of the balance to public finances are not modified for the rail, but are for motorways. The results of the comparison, however, are not substantially affected. In terms of public finance, transport by rail makes a large loss, while transport by motorway makes a large profit.

Conclusion

The comparison of rail with the motorway system (rather than the road network as a whole) shows quite clearly three important points.

The first is that, in France, motorways transport carries much more than does rail: twice as much if we measure in physical quantities, six times as much if measured in value, as it is more sensible (although less common). Furthermore, the figures produced underestimate the relative importance of motorway transportation, because, in the case of rail, there are costly transhipments functions at depots, that have not been considered.

Secondly, the productivity of motorway transportation is far greater than rail's. For the same amount of activity or for the same value, less, or a great deal less capital, and of labour is required by motorway transport than by rail. The explanation for the superiority motorways is likely to be both technological and organizational. As in most other areas the most modern technology (in this case road transport) is the most effective. Furthermore, the flexibility of road transport compared with the rigidity of the railway monopoly is a factor affecting efficiency and productivity.

Thirdly, concerning public finance even when we consider only the specific costs and revenues, motorway transport is a significant net contributor to the exchequer whereas rail is heavily subsidised after allowing for the taxes paid.

The above are averages not marginal values. For policy decisions, it is the marginal costs that matter. Motorways are more productive in general, but we can not conclude that they are more productive for the marginal or additional passengers or good carried. Neither can we conclude the opposite. The same probably applies to the effect on public finances. Whilst we can be sure that an annual increase in the motorway transport of 10% will bring the public finances more than 10% per year, or about 3 billion francs (because income and expenditure is proportional to the amount of transportation by highway) we can not say that a 10% increase in transport by rail would increase costs by 10%, i.e. add about 6 billion to public budgets. The increase in revenue could be as important as the cost increase, or even more important. It would be useful to know that but we do not.

The analysis also ignored the externalities associated with transport. Regarding accidents, the number of people killed on motorways in 1997 was 430. The number of people killed by rail is 79 or 117 if we include accidents on level crossings (INSEE 1998 p. 182). The reported activity on motorways is two or three times that of rail if it is expressed in physical quantities and six times that of rail if expressed in value. Hence the deaths per unit on motorways is less than that for the rail.

Regarding pollution, emissions associated are certainly much larger from motorways than from rail. But the damage depends on the location of the emissions. Pollution is an urban problem. Most pollution from conceded motorways is in open country and does not change the concentration much in the areas traversed. This argument does not apply to the greenhouse gas emissions, which have a global effect, but nobody is able to estimate the damage they cause.