Costs, Competition and the Role of the State in Freight Transport[1]

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The paper introduces some elements aimed at defining a possible freight transport policy, according to the mainstream lines of the new Common Transport Policy (Commission of the European Communities, 2001). The paper tries to derive a synthesis of a range of (sometimes contradictory) elements and issues, introducing a few critical data to drive the analysis. The main application is to the Italian case, read on the background of the general European context, that plays an increasing role due to the relevant and growing international dimensions of the transport market.
So, on one side we consider the structural factors of the costs of transport, both as a perceived cost and as a social cost, introducing relevant external costs but also taxation levels, and the value of time, in particular in relation of the reliability of transport. On the other side, we consider some non-transport elements, as land use patterns. The main policy issue appears to be the process of liberalization of the transport system, as a necessary but incomplete route, strongly related with European actions. Liberalization is not the only topic, but it will be a possible key to several on-going phenomena. It is possible to derive some indication linked with the inherent market strength of road transport and, on the other side, the weakness of the rail mode.

1. The main characteristics of freight transport in Europe

The paper is focused mainly on long distance transport. To understand the main issues at play, and in particular modal choices, it is interesting to remind some aspect of freight transport in Europe.

The European inland transport system is mostly based on the road mode. Anyhow (Table 1), the modal split is quite different across the EU 15 Countries. Although the road mode is always the main choice, its weight changes between about 98% (Greece) and 40% (Austria); on the other side, the rail weight changes between about the 2% (Greece) and the 38% (Austria and Sweden); but this data are affected by the particular geographic conditions (and to the role of inland waterways and pipelines). So, the most interesting data are referred to France and Germany, where the rail percentage is about 15% and the road relative role stays between 68% and 75%; the difference is due to the different role of inland waterways. Apparently, the Italian situation is quite different, but, whit a more deep analysis, this is not true. In Italy, the role of the rail mode seems to be much less important than in France and Germany. This is a consequence of the different merchandise mix of the Italian productive system, that lacks both large agricultural production compared to France, and heavy industrial sectors (steel, chemicals) compared to Germany.

The historical evolution of the modal choice for the EU 15 Countries (Table 2) is meaningful. It is possible to see how, from 1997 to 1990 there is a heavy modal change between rail and road mode, but during the '90s, and in particular after 1995, the modal split appears steady: the modal split seems to have reached its equilibrium in relation to the European merchandise mix, characterized by an industrial production with high (and rising) added value. The same data can be presented showing the different weight of the main transport modes according to the length of the shipment.

State	Mode: Road tkm in %	Rail tkm in %	Inland Waterways tkm in %	Pipelines tkm in %
Belgium	67,5	16,0	13,1	3,4
Denmark	73,3	8,6	0	18,1
Germany	68,7	15,2	13,1	3,0
Greece	97,7	2,3	0	0
Spain	85,7	8,9	0	5,4
France	75,9	15,8	2,1	6,2
Ireland	93,0	7,0	0	0
Italy	88,0	8,2	0,1	3,7
Luxembourg	71,6	19,3	9,1	0
The Netherlands	47,3	3,9	42,7	6,1
Austria	39,9	37,2	5,6	17,3
Portugal	87,1	12,9	0	0
Finland	72,2	26,6	1,2	0
Sweden	61,8	38,2	0	0
UK	84,1	9,7	0,1	6,1
EU 15	74,6	13,8	6,9	4,7

Note: not including short – sea shipping

Table 1 Freight inland modal split by country, year 2000 (Source: European Commission Directorate, 2002)

Year	Road tkm in %	Rail tkm in %	Inland Waterways tkm in %	Pipelines tkm in %
1970	52,0	30,2	10,9	6,8
1980	59,9	24,2	8,9	7,1
1990	69,2	18,2	7,6	5,0
1995	73,2	14,2	7,4	5,3
1997	73,4	14,4	7,2	5,0
1998	73,9	14,0	7,1	5,0
1999	75,0	13,4	6,8	4,8
2000	74,6	13,8	6,9	4,7

Note: not including short – sea shipping

Table 2 Evolution of freight inland modal split for EU 15 (Source: European Commission Directorate, 2002)

In Table 3 and Table 4 it is possible to see the situation for the whole European Community, and in Table 5 and Table 6 it is reported the Italian case. On the shorter distances, the road has obviously a dominant role. This depends from the technical structure of the rail mode, that requires in general road links to operate. On the longest distances, the rail mode has an increased weight, because the costs of modal interchange, as the costs of the terminals, are a low percentage of the total.

The tables present two different entrance keys. Table 3 and Table 5 present the share of every distance class for every mode; so, the results for every mode are independent from the data of the other modes. Table 4 and Table 6 present the share of every mode for a particular distance class; so, the result for one mode depends on the data of the other modes.

Distance class Km	Road tonnes %	tkm %	Rail tonnes %	tkm %	Inland Waterways tonnes %	tkm %	Total tonnes %	tkm %
0-49	58,59	11,76	25,46	2,53	27,74	4,63	56,34	10,47
50-149	22,98	22,71	23,58	9,94	38,76	25,99	23,31	21,29
150- 499	15,76	45,13	38,89	48,76	30,27	54,62	17,20	45,81
>500	2,67	20,40	12,07	38,77	3,23	14,77	3,15	22,42
Total	100	100	100	100	100	100	100	100

Note: data refer mainly to the years 1996-98 depending on the Country and mode of transport

Table 3 Distance classes by mode of transport, EU 15 national traffic only (Source: European Commission Directorate, 2002)

distance class km	Road tonnes %	tkm %	Rail tonnes %	tkm %	Inland Waterways tonnes %	tkm %	Total tonnes %	tkm %
0-49	96,80	92,73	2,28	3,79	0,92	3,49	100	100
50-149	91,79	83,87	5,09	6,96	3,11	9,16	100	100
150-499	85,32	75,73	11,39	15,52	3,29	8,75	100	100
>500	78,81	69,95	19,28	25,22	1,92	4,83	100	100

Note: data refer mainly to the years 1996-98 depending on the Country and mode of transport

Table 4 Mode of transport by distance classes, EU 15 national traffic only (Source: our elaboration on data European Commission Directorate, 2002)

distance class km	Road tonnes %	tkm %	Rail tonnes %	tkm %	Inland Waterways tonnes %	tkm %	Total tonnes %	tkm %
0-49	40,28	6,54	7,51	0,90	9,30	1,80	37,87	5,77
50-149	29,74	19,39	27,75	8,41	76,80	66,50	29,66	17,95
150-499	24,64	45,29	49,57	45,46	13,90	31,70	26,43	45,30
>500	5,34	28,78	15,17	45,24	0,00	0,00	6,04	30,97
Total	100	100	100	100	100	100	100	100

Table 5 Distance classes by mode of transport, Italy 1999, national traffic only (Source: Ministero delle Infrastrutture, 2001)

The last data presented is the historical development of the modal choice in Italy during the past ten years (Table 7). The comparison between alternative modes of freight transport shows the supremacy of the road over the railway, but, at the same time, both a relative stabilisation of the transport quantities during the last five years, and, apparently, also of the modal share of rail and road. These data are also consistent to the data of Table 2 where the stabilisation of the modal split is clear for the whole European Community.

distance class km	Road tonnes %	tkm %	Rail tonnes %	tkm %	Inland Waterways tonnes %	tkm %	Total tonnes %	tkm %
0-49	98,54	97,87	1,43	2,10	0,03	0,03	100	100
50-149	92,92	93,30	6,76	6,33	0,32	0,37	100	100
150- 499	86,38	86,37	13,56	13,56	0,07	0,07	100	100
>500	81,86	80,27	18,14	19,73	0,00	0,00	100	100
Total	92,65	86,39	7,23	13,51	0,12	0,10	100	100

Table 6 Mode of transport by distance classes, Italy 1999, national traffic only (Source: our elaboration on data Ministero delle Infrastrutture, 2001)

Year	Road miotonn ekm	%	Rail miotonn ekm	%	Inland Waterways miotonn ekm	%	Total miotonn ekm	%
1990	-	0	21.885		118		122.003	
1995	174.432	87,69	24.352	12,24	135	0,07	198.919	100
1996	175.450	88,08	23.619	11,86	125	0,06	199.194	100
1997	173.353	86,91	25.917	12,99	201	0,10	199.471	100
1998	191.482	88,25	25.366	11,69	126	0,06	216.974	100
1999	177.359	87,81	24.439	12,10	177	0,09	201.975	100
2000	185.101	87,81	25.534	12,11	169	0,08	210.804	100
2001	187.250	88,31	24.618	11,61	180	0,08	212.048	100

Table 7 Freight transport in Italy, national and international flows (Source: Conto nazionale dei trasporti, 2001)

2. The role of the value of goods

The cost of time or, in a more complete way, the total logistic cost of a shipment is one of the most important element in order to analyse the structural factors of the cost of transport. It considers the effects of a transport time changing on the supply chain of that good; it can be divided into three main elements [Bruzelius, 2001]:

- The real cost of transport or the cost of using a vehicle
- The cost of goods, that reflects that goods in transit cannot be consumed, and they can also be damaged
- The "quality" costs, reflecting the fact that the transport time can change in order to some internal or external elements, in some cases not under the control of the carrier.

This approach is based on the fact that also the second and the third elements can be expressed in a monetary way, the "natural" unit of the first element, to build up a generalized transport cost.

In order to define the modal choice in the whole supply chain, the third factor is the most important one, in particular the value of improved reliability. In fact, it is important to reduce the transport cost, but the reduction is of no use if at the same time it is impossible to guarantee the scheduled transport time.

The value of improved reliability is determined by the reduction in the buffer stock made possible by a reduction in the variability in transport time. In particular, the reliability is important for "just in time" productions, where there are small stocks and it is important to have the goods when they are needed in the next phase of the productive process. At the same time, for a just in time production, the trip time has no importance "per se"; its importance arise when the production is "on order", and it is important how long the whole process takes. Obviously, the logistic element and the transport elements have some common areas: lorries usually choose the most economic route, which, in general, is the fastest route.

In Table 8 and in Table 9 it is possible to see2 values of freight time and values of improved reliability. Note that these values do not consider the different types of goods but only the modal choice. According to different surveys, it is possible to see how the value of reliability is more than an order of magnitude bigger than the value of transport time. The main problem of the reported data is the different unit; usually, the most common unit is the tonne of transported goods, but, for the road transport also the shipment is a wide used unit. These two units can be related using vehicle load factors.

Study	Year data	Mode/Country	Value	Unit Value per
Transek (1990)	89/90	Rail/S	SEK 6	hour & wagon
Transek (1990)	89/90	Road/S	SEK 20	hour & shipment
Transek (1992)	1991	Road/S	SEK 30	hour & shipment
Kurri et al. (2000)	1997	Road/SF	$ 1.53	hour & ton
Kurri et al. (2000)	1998	Rail/SF	$ 0.1	hour & ton
Fridstrøm et al. (1995)	1992	Road/N	NOK 0-70	hour & shipment
Hodkins et al. (1978)	1970s(?)	Road/Sea/AUS	AUS$ 10	day & ton
Kawamura (2000)	98/99	Road/US	$ 23.4-26.8	hour & shipment
Wigan et al. (2000)	1998	Road/AUS	AUS$0.66-0.40	hour & pallet
Wynter (1995)	90-94?	Road/F	FF 7	min.& shipment
de Jong et al. (2001)	2000	Road/F	FF 29-60	hour & shipment
de Jong et al. (2001)	2000	Rail/F	FF 17-73	hour & shipment
de Jong et al. (2001)	2000	Combined/F	FF 34-53	hour & shipment
Fosgerau (1996)	88/89	Road/DK	DKK 2.7-6.0	min. & shipment
Winston (1981)	75-77	Road/US	$125-1187	day & shipment
Winston (1981	75-77	Rail/US	$490	day & shipment
de Jong et al. (1992)	91/92	Road/NL/(99 prices)	$ 32-42	hour & shipment
de Jong et al. (1992)	91/93	Rail/NL/(99 prices)	$ 32	hour & wagon
de Jong et al. (1992)	91/94	IWT/NL/(99 prices)	$ 222	hour & shipment
Fowkes et al. (2001)	00/01	Road/UK	£ 37.2-169.3	hour & shipment
de Jong et al. (2000)	94/95	Road/UK/(99 prices)	$ 21-48	hour & shipment
Fowkes et al. (1991)	88/89	Road/UK/(99 prices)	$ 0.09-1.29	hour & ton
Viera (1992)	1990?	Rail/US/(99 prices)	$ 0.59	hour & ton
Roberts (1981)	1980?	IWT/US/(99 prices)	>$ 0.05	hour & ton
Blauwens et al. (1988)	1985?	IWT/B/(99 prices)	$ 0.1	hour & ton
Fehmarn Belt (1999)	1997?	Road/DK+D/(99 prices)	$ 21	hour & shipment
de Jong et al. (1995)	1995	Road/D/(99 prices)	$ 33	hour & shipment
de Jong et al. (1995)	1995	Road/NL/(99 prices)	$ 40-43	hour & shipment
de Jong et al. (1995)	1995	Road/FD/(99 prices)	$ 34	hour & shipment
Bergkvist et al. (2000)	1991	Road/S	SEK 14	hour & shipment
Bergkvist (2001)	1991	Road/S	SEK 34-509	hour & shipment
INREGIA (2001)	1999	Road/S	SEK 0-227	hour & shipment
INREGIA (2001)	1999	Rail/S	SEK 0	hour & shipment
INREGIA (2001)	1999	Air/S	SEK 117	hour & shipment
Small et al. (1999)	1995?	Road/US	$ 144-193	hour & shipment

Note: IWT Inland waterways transport

Table 8 Values of Freight Time (source: Bruzelius, 2001)

The values in Table 8 can be synthesized in Table 10. Excluding air transport, which role is mainly related to intercontinental transport, it is possible to see how the value of time increases according to the increase of the speed of the mode. So, it is possible to think that every mode has its own "dominant" market, with a relatively limited common area with the other modes.

Study	Year data	Mode/Country	Value	Unit Value per
Transek (1990)	89/90	Rail/S	SEK 60 same day	1 % unit & shipm
Transel (1990)	89/90	Rail/S	SEK 40 next day	1 % unit & shipm
Transek (1990)	89/90	Road/S	SEK 150 same d.	1% unit & shipm
Transek (1990)	89/90	Road/S	SEK 30 next day	1% unit & shipm
Transek (1992)	1991	Road/S	SEK 280 same d.	1% unit & shipm
Transek (1992)	1991	Road /S	SEK 110 next day	1% unit & shipm
Kurri et al. (2000)	1997	Road/SF	$ 47.47	hour & ton
Kurri et al. (2000)	1998	Rail/SF	$ 0.50	hour & ton
Wigan et al. (2000)	1998?	Road/AUS	AUS$1.25-2.56	1% unit & pallet
de Jong et al. (2001)	2000	Road/F	Not reported	1% unit & shipm
de Jong et al. (2001)	2000	Rail/F	Not reported	1% unit & shipm
de Jong et al. (2001)	2000	Combined/F	Not reported	1% unit & shipm
Winston (1981)	75-77	Road/US	$ 404	day, standard dev.
Winston (1981	75-77	Rail/US	$299-4110	day, standard dev.
de Jong et al. (1992)	91/92	Road/NL/	Not reported	1% unit & shipm
de Jong et al. (1992)	91/92	Rail/NL	Not reported	1% unit & shipm
de Jong et al. (1992)	91/93	IWT/NL	Not reported	1% unit & shipm
Fowkes et al. (2001)	00/01	Road/UK	£ 61.5-167.6	hour & spread
de Jong et al. (2000)	94/95	Road/UK	Not reported	1% unit & shipm
de Jong et al. (1995)	1995	Road/D	Not reported	1% unit & shipm
de Jong et al. (1995)	1995	Road/NL	Not reported	1% unit & shipm
de Jong et al. (1995)	1995	Road/F	Not reported	1% unit & shipm
Bergkvist et al. (2000)	1991	Road/S	SEK 165 same d.	1% unit & shipm
Bergkvist et al. (2000)	1991	Road/S	SEK 84 next day	1% unit & shipm
Bergkvist (2001)	1991	Road/S	Not reported	1% unit & shipm
INREGIA (2001)	1999	Road/S	SEK 63	1 per mille & shipment
INREGIA (2001)	1999	Rail/S	SEK 1142	1 per mille & shipment
INREGIA (2001)	1999	Air/SWE	SEK 264	1 per mille & shipment
Small et al. (1999)	1995?	Road/US	$ 371.33	hour & shipment

Table 9 Values of Reliability (source: Bruzelius, 2001)

Transport Mode	Value of Time (in euro 2002)
Road	3,10-6,60
Combined	0,80-1,30
Rail	0,25-1,00
inland waterways	0,10-0,25
see shipping	0,10-0,25
Air	3,00-5,00

Table 10 Value of freight saved time for transport mode (source: Fiorello & Pasti, 2003)

To evaluate clearly the logistic cost it is important to consider also the different type of good. Every kind of good has, in fact, a different value of time (Table 11), according to its own added value. It is reasonable to say that the goods with the lowest value of time choose the slowest transport mode.

Kind of Good	Value of Time (in euro 2002)
building materials	0,25-0,50
Chemicals	0,25-0,50
Coal	0,25-0,50
wrought metals	0,50-1,00
Oil	0,60-1,25
fertilizers and plastics	0,75-1,50
agricoltural produce	0,75-1,50
Food - not perishables	1,00-2,00
Food – fridge	2,00-4,00
Engines	2,00-4,00
Manufactured	2,00-4,00

Table 11 Value of freight saved time for different goods (source: Fiorello & Pasti, 2003)

Table 10 and Table 11 can be seen as a double face of the same point: the goods with the highest value of time are the same goods that use the road mode; the goods with the lowest value of time are the goods that use the rail mode and the water mode. This explains why it is difficult to change the modal split, and why it has seen little variations since the mid – 90s.

3. The cost of transport and other technical issues

3.1 The cost of transport

One of the most important outcome of several European researches is the bond between the freight value and the cost of transport. Assuming that the cost of transport includes feeder and hire costs, the results show that, for medium to long distances, its value is in general lower than 5% of the total freight value (Figure 1).

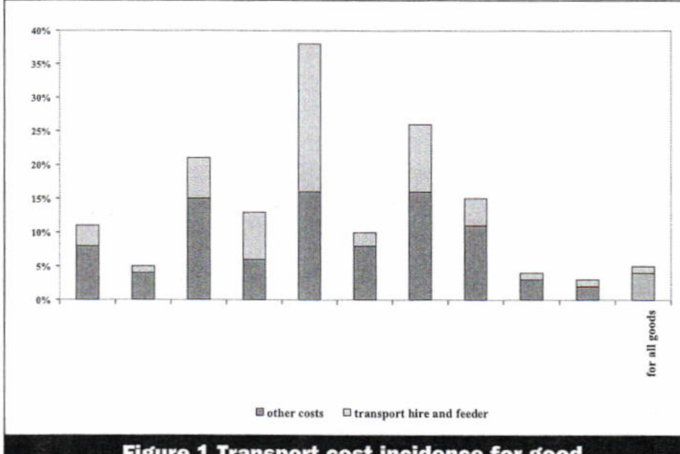

Figure 1 Transport cost incidence for good (Source: Ponti, 2001)

This result confirms the notion that the trend of the cost of transport is generally declining, and this scenario may be justified by the following factors:

- Trend of the hire costs, directly linked to the technical progress (transport with container units, trucks with more efficient engines, specific ships for each freight type)
- Increase of the "value density", i.e. the value per ton.

On this way, the reduction of the cost of transport, is confirmed not only by the increasing length of the trips, but also with the tendency of the location of industries, that presents a increasing sprawl; at the same time, the congestion costs seems not to be so relevant to define the modal choice, mainly because they are internalised by the carriers[3].

Further technical progress may change the actual scenario for road and freight modes. In the first case (road) it is possible to achieve some other advantages increasing the total gross weight for each truck, for example, introducing a second tender (see Australia and U.S.A.) and a new weight limit (for example 60 tonnes). In this way, on one side, it would be possible to obtain benefits from the reduction of congestion and air pollution per ton carried, but on the other side, and at the same time, it is possible to induce a further increase of the total road transport share. Therefore, this policy has to be accompanied by generalized road pricing schemes aimed at checking the overall externalities of this mode[4].

In the second case (rail) there are many possible strategies, not only concerning the technologies, which could modify the actual scenario; this means to enforce a new governance model (see, for example, implementing eventually the EU Directive 91/440 about the liberalization and de – regulation) where the rail infrastructure is separated from services and where these are in real competition.

The different structure of the markets of rail and road is another relevant aspect. A primary characteristic of the road transport mode is the competition between many operators, due to low entry barriers. Although, with reference to the Italian case, this element plays a quite peculiar role. Mainly, the Italian road transport market is not really price – taker, because since 1974 exists a fare regulation (Law 298/74), that defines the higher and lower value for freight tariffs ("Tariffe a forcella"). In the same time, the sector in Italy has an important share of "black market" small operators, that keep the supply under some competitive pressure. The sector as a whole seems to have a strong clout on the present government (a former union leader has became responsible for the sector within the transport minister). But the conflict with the industrial associations on tariff liberalisation remains keen.

This context is decidedly different in the rail transport mode, where in each European country there is a clearly dominant operator (in general heavily subsidised), even if a deregulatory context formally does exist, and, on international routes, some new entrant carriers are operating; at the same time, the public role appears fragmentary and conservative notwithstanding the European transport policy leads toward liberalization.

3.2 Rail load factors and the related cost[5]

The average train load plays an important role in order to define the short run and the long run perceived cost. It is important to define the fixed and the variable costs. In the short run the fixed costs can be referred to rolling stock and to staff; rail access charges and energy consumption represents variable costs. According to economic theory, in the long run every cost is variable.

freight train operative costs		kind	_/train km	_/t km	%
operative costs	Staff	fixed	3,693	0,01172	66,91
	Others	variable	0,299	0,00095	5,42
Depreciation		fixed	1,128	0,00358	20,43
Energy		variable	0,399	0,00127	7,23
Total			5,520	0,01752	100

Table 12 Operative unit cost for freight trains (useful load 315t) (Source: Manigrasso, 2003)

freight train operative costs		kind	_/train km	_/t km	%
operative costs	Staff	fixed	3,693	0,00586	59,39
	Others	variable	0,599	0,00095	9,63
Depreciation		fixed	1,128	0,00179	18,14
Energy		variable	0,798	0,00127	12,84
Total			6,218	0,00987	100

Table 13 Operative unitary cost for freight trains (useful load 630t) (Source: Manigrasso, 2003)

The implementation of more heavy trains could permit a large reduction of the average per tonnekilometre cost. As it is possible to see in Table 12 and in Table 13 the staff cost is about 67% of the total cost for a train with a useful load of 315t[6]. Assuming a fixed depreciation of the rolling stock (to be on the safe side, because the increase of the depreciation doesn't have a linear correlation with the train load, because of the different role of the engine and of the wagons), the staff cost decrease to about 60% for a train with a useful load of 630t[7]. Whit a relatively high technologic level (multiple engines with remote control), the share of the staff cost decreases even further.

Stateuseful load [tonnekm/trainkm]	
Austria	324
Belgium	412
Denmark	302
Finland	569
France	350
Germany	391
Greece	245
Ireland	112
Italy	338
Luxembourg	515
Netherlands	833
Portugal	N/A
Spain	293
Sweden	560
United Kingdom	511
EU-15	388

Table 14 Rail load factors in EU Member States in 1998 (Source: TERM 2002 30 EU)

As we can see (Table 14), the implementation of heavier trains is not an impossible aim. Although the European average level is quite similar to the Italian level, due to the weight on the total figures of the countries (Greece, Ireland, Spain, Italy) whit low international rail flows, in some case the average load factor is near to the "ideal" one of 630t of useful load. On the other side, the realization of this aim requires some changes in the rail organization, mainly referred to the role of technologies and to the availability of lines dedicated only (or mainly) to freight trains, that have needs quite different from passengers trains[8].

3.3 External costs

The road transport market presents other types of distortions. Firstly the presence of environmental externalities that obviously are not perceived by the operators (Table 15 and Table 16); the external costs of road transport (air pollution, accidents and congestion) are large in absolute terms and they have relatively higher cost per tonnekilometre than other modes.

	Road [EUR/10v_km] LDV		Road [EUR/10v_km] HDV		Rail[EUR/v_km] Freight	
	Low	High	Low	High	Low	High
Accidents	0,1	0,5	0,1	0,6	0,0	0,0
Noise	0,0	1,5	0,0	2,9	0,1	1,6
Air pollution	0,1	0,4	0,8	2,8	0,5	3,6
Climate change	0,4	0,4	0,9	0,9	2,2	2,8
Nature	0,0	0,1	0,1	0,1	0,0	0,1
Urban effects	0,2	0,2	0,5	0,5	0,0	0,0
Upstream process	0,1	0,2	0,2	0,5	0,1	0,9
Total marginal costs	1,0	3,3	2,6	8,3	2,9	9,0

Table 15 Marginal external costs freight transport by cost category and transport mode (Source: TERM 2002 25 EU – External costs of transport)

	Road freight		Rail freight	
	ECMT	Infras	ECMT	INFRAS
Accidents	21,0	11,5	1,0	
Noise	8,0	6,7	6,0	3,5
Air pollution	23,0	37,4	1,0	4,0
Climate change	10,0	16,2	1,0	4,7
Uncovered infrastructure	N/E	N/E	23,0	N/E
Nature	N/E	3,3	N/E	0,5
Urban effects	N/E	1,9	N/E	0,9
Upstream process	N/E	5,0	N/E	5,0
Total	70,0	82,0	32,0	18,6

Note: N/E not evaluated

Table 16 Comparison of the average external costs, ECMT and Infras [EUR per 1000 tonne_km] (Source: TERM 2002 25 EU – External costs of transport)

3.4 Fuel prices and taxes

Fuel taxes represent one of the ways of taxing the road mode, internalising partially or totally its external costs. In fact, fuel taxes are born originally as a instrument of fiscal policy, but now are also seen as instruments to reduce the emissions from transport, and at the same time, to make possible compensations for the polluted (at least in theory).

Every country presents a different level of internalisation of external costs, both for the road mode and (less frequently) for the rail mode (Table 17). To create a correct scenario for competition (inter – modal and intra – modal), the different modes should be subject to similar internalization policies in the whole European Union

		Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembour	Netherland	Portugal	Spain	Sweden	UK
Air pollution	Rail transport				•											
	Road–freight	•	•	•			•				•	•		•	•	•
CO2	Rail transport				•		•									
	Road–freight															
Noise	Rail transport															
	Road–freight	•					•									
Congestion	Rail transport															
	Road–freight															

Table 17 Internalisation of the external costs in EU Member States (Source: TERM 2002 26 EU)

The main point here is to understand how much externalities can be internalized by taxation. It is in fact possible to divide the emission in local pollution (NO_X, SO_X, PM) and global warming (CO_2). A truck in a rural area has a low local impact because of the absence of receptors, but has a global impact; while a truck in a urban area causes both local and global costs. But fuel taxation has the same level in urban or rural contexts. It is necessary to introduce different level of taxation in order to consider the different effects. This may be possible with a new combination of the fuel taxation and a road pricing.

In Table 18 it is possible to see the evolution of the tax share on fuel sales prices in the European Community. During the last five years there are no modifications of the tax share, both for the Euro 95 unleaded petrol and for diesel.

	Euro 95 unleaded petrol			Diesel			Fuel total		
Year	Sales price	Cost	Tax share	Sales price	Cost	Tax share	Sales price	Cost	Tax share
1980	97,9	44,6	54	79,9	47,3	41	91,9	45,6	50
1985	105,7	47,0	55	93,2	55,1	41	101,6	49,4	51
1990	79,8	28,9	64	84,7	37,0	56	80,4	29,2	64
1995	83,3	20,5	75	86,6	26,9	69	81,4	22,0	73
2000	94,8	26,1	72	103,8	37,5	64	90,6	28,8	68
2002	90,3	22,2	75	99,8	34,2	66	86,4	25,4	71

Table 18 Real fuel prices in index numbers (1986=100, EU weighted average), (Source: TERM 2002 21 EU - Fuel prices and taxes)

Table 19 shows the share of the excise duty on the fuel sale price. The tax share on diesel changes between 33,56% (Ireland) and 61,29% (United Kingdom), although it is possible to see some differences also on the production costs. Moreover, in the recent past, the Italian government intervened several times to modify the excise taxes on fuel to reduce the fiscal pressure on the road transport market. The behaviour of the government seems contradictory indeed. On one side, the flow of transfers to the national railways is in

	Euro 95 unleaded petrol					Diesel				
	Sales price	Cost	VAT	Excise duty	Excise duty %	Sales price	Cost	VAT	Excise duty	Excise duty %
Austria	821	270	137	414	50,43	696	290	116	290	41,67
Belgium	946	275	164	507	53,59	721	296	120	305	42,30
Denmark	1040	284	208	548	52,69	796	267	159	370	46,48
Finland	1004	263	181	560	55,78	783	337	141	305	38,95
France	959	228	157	574	59,85	745	247	122	376	50,47
Germany	985	225	136	624	63,35	809	257	112	440	54,39
Greece	667	266	105	296	44,38	607	268	94	245	40,36
Ireland	802	320	134	348	43,39	742	369	124	249	33,56
Italy	996	288	166	542	54,42	835	293	139	403	48,26
Luxembourg	736	285	79	372	50,54	620	286	81	253	40,81
Netherlands	1100	297	176	627	57,00	769	301	123	345	44,86
Portugal	859	390	125	344	40,05	648	308	94	246	37,96
Spain	768	266	106	396	51,56	674	287	93	294	43,62
Sweden	956	263	191	502	52,51	803	303	161	339	42,22
UK	1137	224	169	744	65,44	1214	289	181	744	61,29

Table 19 Petrol and diesel prices per EU Member State, January 2002 [EUR per 1000 litres] (Source: our elaboration on data TERM 2002 21 EU – Fuel prices and taxes)

the order of 6.000 Mio Euro per year [Ministero delle Infrastrutture e dei Trasporti, 2001], and its main goal is supposed to be the improvement of the rail transport share. But on the other side, at the same time, a set of fiscal discounts support the road transport system. The main European policy guidelines9 seem to suggest a small increase of the fiscal pressure on the road transport mode and a gradual reduction of the subsidies for rail transport.

3.5 An unexpected effect

The liberalization process should permit the entrance of new operators in the rail service market, in order to eliminate the monopolistic power of the incumbents, whit a reduction of production costs, and a modal shift from road to rail, and as a consequence, a reduction also of external costs (assuming the traditional "coeteris paribus" hypothesis for taxation and subsidies).

The European rail network presents some technical differentiations both in the various countries and within the same country. The main problem is referred to the presence of electrified and not electrified links, and of different electric power systems (direct current and alternate current), that often require polycurrent engines. In many case the new entrants must look for second-hand rolling stocks in order to lower their entry costs. Due to the previous monopolistic regime, a secondary market is far from to be really developed: the diesel engines of east European railways are perhaps the most interesting product.

These diesel engines have some advantages for the new entrants: they are immediately available with minor revamping, they have a well known technology and low maintenance costs, and, mainly, can operate on the whole European Community network (excluding Spain, Portugal and Greece, because of the different gauge). On the other

side, there is no availability of electric engines on the secondary market. So, diesel engines are the natural first choice for rolling stock for many new entrant companies.
An interesting environmental effect can be seen: as shown in Table 20 and in Table 21, the NO_x and PM unit emissions for diesel freight trains and for trucks EURO II are similar. This means that the modal shift from road to diesel rail has little relevance for this pollutants. This data may have a wide impact on the transport policy debate, in particular about the subsidy level to the new or existing rail infrastructures, against new road infrastructures, if the operations are carried out with diesel engines. Obviously, the same can not be said about electric engines, than can move the polluting emission to uninhabited areas, whit lower presence of receptors.

mode	load factor %	Low gramme Nox/tkm	High gramme Nox/tkm
Bulk carrier	50-100	0,11	0,22
Container ship	65-100	0,19	0,40
Diesel freight train	65-100	0,20	1,36
Rural truck EURO II	50-100	0,31	0,88
Highway truck EURO II	50-100	0,24	1,15
Aviation short haule	65-100	8,48	18,22
Aviation long haule	65-100	0,47	2,35

Table 20 NO_x emission in freight transportation for different modes (mid-1990s) (Source: TERM 2001 28 EU)

mode	load factor %	Low gramme PM/tkm	High gramme PM/tkm
Bulk carrier	100	0,002	0,002
Bulk carrier	50	0,004	0,004
Container ship	100	0,004	0,005
Container ship	65	0,004	0,007
Diesel freight train	100	0,011	0,050
Diesel freight train	65	0,017	0,077
Rural truck EURO II	100	0,005	0,030
Rural truck EURO II	50	0,010	0,056
Highway truck EURO II	100	0,008	0,042
Highway truck EURO II	50	0,014	0,078

Table 21 PM emission in freight transportation for different modes (mid-1990s) (Source: TERM 2001 28 EU)

These data must be taken with caution, because of the possibility of modifying some elements to change the emission levels of the two modes. In particular, it is necessary to consider the evolution of the engine technology and the possible presence of filters. On the other side, the increase of the rail load factors (very low at present), could reduce the unitary level of pollution. And the benefits related to the reduction of road congestion will remain anyway.

3.6 The role of flexibility

Another important aspect is the flexibility of the road transport system against the stiffness of the railways. This advantage arises with particular relevance for the road transport mode in proportion with the shortness of trip length. The rail transport mode can become competitive only if the trip length exceeds the distance showed in Figure 2.

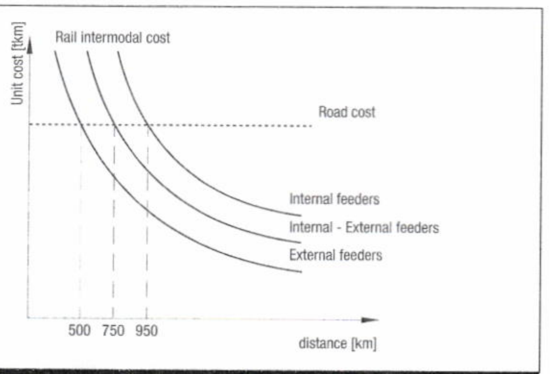

Figure 2 Unit costs for intermodal rail and road

This is the result of the need of handling activities to move the goods from the truck to the rail car and vice versa or to move the containers in the terminals. Moreover, the rail system sets a hierarchy: in space: it is possible to handle goods only in some selected points and not everywhere within the served areas. But to reach these points it is necessary to use the road mode (the implementation of a railway siding to the factories as during the 19th Century cannot be considered a possible solution). And, even when it is possible, in many cases it would necessarily need trainbuildg operations ("consolidation") in a rail hub, to reach a minimum efficient size for a freight train.
Nevertheless, the rail mode has large economies of scale and of density: the minimum efficient dimension of a trainload is tenfold (at least) the corresponding dimension of a truckload. Therefore, rail can compete with the road mode only with "dense" traffic, and when intermodal costs are either reduced or non – existent.

4 Towards a consistent transport policy

4.1 Infrastructures

In the previous paragraphs we have seen some elements that define the structure of costs and the importance of reliability against net travel time. So, in order to reduce total transport costs, it is important to plan the infrastructural upgrading aiming at improving reliability, in particular of the rail mode. In this way, a correct transport policy should in general to increase hub capacity over link capacity, so reducing delays and improving reliability. Nevertheless, many of the main projects of the Italian "Objective Law"[10] (L443/01) have the aim of building new railway lines and new motorways as new links, not solving the congestion in the principal urban hubs. But in this way it is impossible to solve some of the main bottlenecks.

4.2 Pricing

It is possible and necessary to evaluate the introduction of efficient pricing systems, not only in urban areas, but also at regional level and on inter – urban links. The actual situation presents only some tolled motorways links, and user charges on all the rail network. But this for sure is far from an efficient charging policy, because the level of pricing doesn't vary during the day and during the year, nor is related to modal allocation (in fact, it is mainly related to cost recovery objectives). The introduction of efficient pricing both on long distance routes and in large regional areas can define some new modal choices, but definitely new route assignments.

The introduction of an efficient pricing system can define a new equilibrium in the modal choice on long distances; the modal choice in turn is defined by the total perceived cost, whose main elements are: the value of time and of reliability, the short run vehicle marginal costs, and the charge for the use of the infrastructure, that has to be directly linked to efficiency objectives.

On long distances are travelling only 19% of road tonnes, but this means for 65% of road tonnekilometres (see Table 3), that is the percentage of road traffic with a trip distance longer than 150km. On shorter distances, in fact, the handling costs play a decisive role on the perceived cost. A significant modal shift is therefore unrealistic, but a more efficient use of the existing infrastructures can be achieved (see the following point).

4.3 An area-based pricing system

The change of route, to a less expensive one (considering the perceived cost), is probably the most important effects of an efficient pricing system. To solve the congestion problem on a link, the classical road pricing scheme moves the traffic flow to underused routes, or, at least, to less jammed links (or on a different mode). So far so good: the main problem is an overall efficiency problem, referred to the entire transport infrastructure network, that can face an overall worsening of congestion, accidents and pollution. It is the well known problem of "closing the system", that is the only guarantee for overall social efficiency [Litmann, 1999].

To avoid this effect, it needs to create new overall pricing schemes based on toll areas and not only on toll links (a multi – modal variation of the Newbery scheme) 11. According to this idea, it is necessary to introduce a pricing on the whole transport system within an area, in order to reach an efficient flow assignation, considering the specific flows, capacity and externalities of every link. But the idea of a whole tolled area has some political implementation problem, mostly related to the acceptance of this policy by the transport operators and the passenger car drivers in the area. Efficient pricing, in fact, could be perceived as an additional tax, if not substituting other existing taxes.

4.4 Land – use control and the role of transport costs

As we have seen, the historic success of the road mode is linked to its ability of directly reaching any location, with a minimum level of infrastructures; at the same time, for some firm and for some goods, there is the extra – advantages of the self – production of the service. This means that the road mode is a system, while the rail mode is not: in general, rail transport needs road transport at the beginning and at the end of a trip, while the road mode is self – sufficient. And it is well known how the handling in the inter – modal terminals means costs, both direct (loading and unloading) and indirect (safety for freight, time losses, complementary services generally under – utilised, etc.). The intermodal techniques (containers, swap bodies, etc.) are just the expression of the attempt of reducing the costs related with modal change. Lower intermodal costs imply direct rail links between origin and final destination: a good example, is a seaport and a rail – connected plant.

If demand density is a key factor for the long – run survival of railways, this phenomenon needs a better understanding. First of all, density has been systematically lowered in the western countries by the mere availability of extensive road transport services, mainly trucks for industrial plants. Road accessibility is almost without relevant constraints. A simple paved road is sufficient for starting up an industrial or a commercial settlement, and a basic pavement is anyway inexpensive. Land costs are lower in less central areas, and therefore the drive for the spread of locations results high and generalised, limiting the possibility of modal shifts based on concentration of economic activities.

On the other side, the presence of a well – developed and un – jammed road network seems not to be a necessary asset to permit the grow of the industrial sector (Ponti, 2003). Some example could clear the point, even if also the literature on the role of transport infrastructure on economic growth is at least inconclusive, in the sense that the causal chain is often unclear.

The region of Los Angeles suffers from one of the worst congested traffic in the world (i.e. suffers from insufficient infrastructure related to the demand): since this problem emerged about forty years ago, its rate of growth has been constant and impressive. But the same can be said for south – east Asia (Bangkok, Taiwan). Also in Italy can be find a similar situation: the Veneto region is surely one of the faster growing area in the last twenty years, and it is characterized by a really sprawled productive structure whit a jammed road network.

The economic rationale reinforcing these observations is always the same: the role of transport costs is in relative terms is declining according to the growth of the added value of the industrial production. Effective logistic chains are more valuable for modern production than infrastructure capacity, given also the fact that the cost of congestion are often "internalised" by the trucking industry, that is very competitive and specially in Italy, has a very low "market power" due to its high fragmentation.

5 Conclusions

An overall possible conclusion, if we include also these final observations, is that the public policy in this sector has to combine realism (the impossibility of large modal shifts), with some boldness in internalizing the external costs (efficient pricing systems, even "area based", in line with the European main policy recommendations). This, due to the fact that increasing freight transport costs is probably not so crucial for industrial development, and especially so if this "fiscal" cost increase is in large part compensated by reduced congestion (due to better infrastructure use). Quite a different picture from a policy aimed only to large infrastructure links (a "crowd-pleasing policy"), and subsidizing in an undiscriminating way every transport mode, either directly (rail), or indirectly via an insufficient "internalization of externalities" (also this one a "crowd pleasing policy").

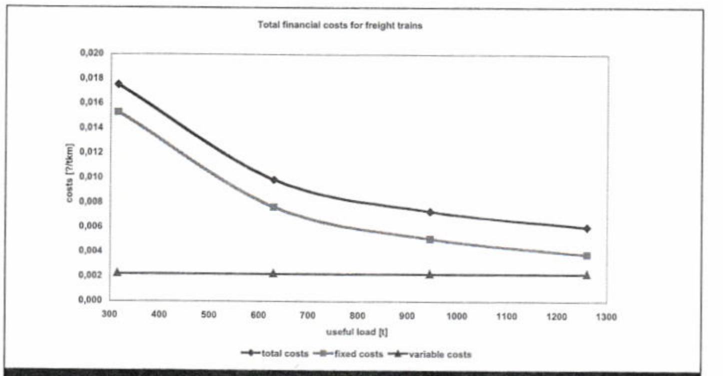

Figure 4 Total operative costs for freight trains

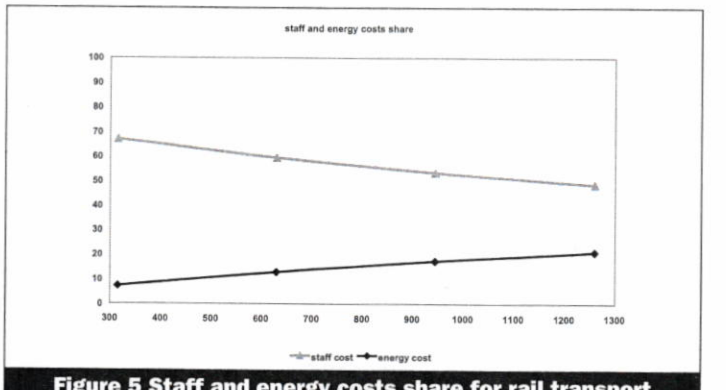

Figure 5 Staff and energy costs share for rail transport

NOTES

[1] The paper is based on the lesson of Marco Ponti at the "44th Corso Internazionale ISTIEE", Trieste 7 – 13/09/03

[2] For a complete discussion about the modalities and the models used to evaluate the reported data, see [Bruzelius, 2001] and [Fiorello & Pasti, 2003]

[3] The point (congestion and sprawl) will be explained more deeply later in this paper; see the paragraph "Towards a consistent transport policy"

[4] Also this point will be explained more deeply later in this paper; see the paragraph "Towards a consistent transport policy"

[5] The analysis consider only the European Countries (EU15), but it could be interesting to synthesize the United States situation [Laganà, 1999], in order to capture its most important elements of success. In the United States freight rail transport has a share of about 40%: this depends both from the merchandise mix and from the structural elements of the rail sector. In particular, the rail network is mainly dedicated to freight services (the passengers services are only for the cost to cost tourist services, near the main urban areas, and on the Boston – Washington link), with the warranty of a high reliability, thanks to the omothachy of the circulation. Train load factors are up to 3000t, thanks to the absence of natural and technical obstacles, that permit the so-called "double stack", where two containers are put one on the other. A train of 3000t has only two drivers, reducing staff costs.

[6] The average useful load of Italian freight trains is 315t in 1999 [Ministero delle infrastrutture e dei trasporti, 2001]

[7] For further extension of the analysis, see Figure 3, Figure 4, Figure 5

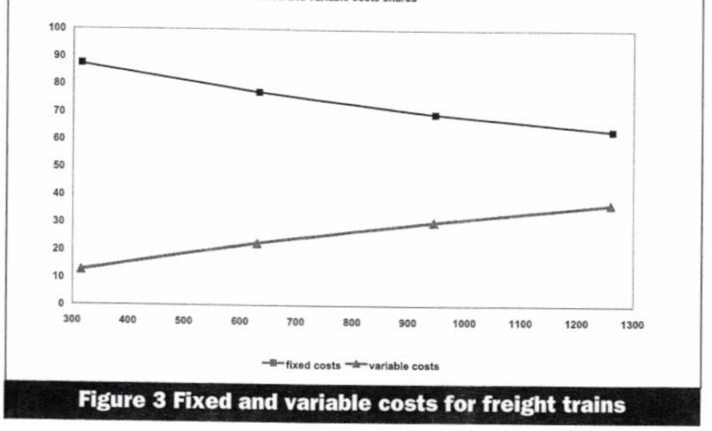

Figure 3 Fixed and variable costs for freight trains

[8] Mainly referred to the analysed role of the reliability against the peak speed

[9] Also supported by the results of some European research projects (for example, the PETS and PATS projects)

[10] The super – priority projects (CIPE, 2001) of the Italian objective law are:

1.Frejus rail tunnel and high speed line
2.Sempione rail link
3.Brennero rail tunnel
4.High speed railway line Torino – Milan – Venice – Trieste
5.Highway Milan – Bergamo – Brescia and Mestre bypass
6.Railway line Ventimiglia – Genova – Milano
7.Railway line Tirreno – Brennero
8.Highway Tirreno – Brennero
9.Venice mobile dams (Mo.Se.)
10.Nuova Romea road link
11.Quadrilateral highway system Umbria – Marche
12.Highway Cecina – Civitavecchia
13.Multimodal transport system – Rome
14.Multimodal transport system – Naples
15.Multimodal transport system – Bari
16.Higway Salerno – Reggio Calabria – Palermo (mainly revamping)
17.High speed railway line Salerno – Sicily
18.The Messina Strait bridge
19 Hydrical projects in southern ItalySome elements can be underlined. On one side, many investments were self – evident priorities, like some toll – road links bypassing extremely congested parts of the network (the new highway Milano – Brescia and the Mestre bypass,

characterized by relevant level of congestion) or were linked with the European TEN scheme (Brenner and Frejus tunnel, for example), even if this is not a valid topic to define a project as a priority. But, on the other side, excluding the projects 5 (partially), 13, 14 and 15, all the projects have, as main aim, the improving of capacity in inter urban (long distances) route, although the congestion phenomena are mainly around the biggest urban areas.

[11] For a more detailed description of the Newbery scheme, see [Newbery, 1990]

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