ELASTICITIES AND POLICY IMPACTS IN FREIGHT TRANSPORT IN EUROPE

Gerard de Jong[1]
RAND Europe

1. INTRODUCTION

The European Commission's White Paper on **European transport policy in 2010 'Time to Decide'** calls for new packages of policies to check the huge growth in road traffic that could come from the removal of legal, physical, financial and administrative barriers to free movement between EU member states. Behind this goal lies the desire to minimise the negative effects of road (and air) traffic growth, particularly environmental pollution, accidents, and the societal cost of road congestion, which can arise from the increasing numbers of cars, lorries and heavy goods vehicles on the roads.

Many types of such policy measures have already been identified and suggested; however, selecting *which* policies at *what* level of intensity to put into a package to 'optimise' results requires additional insights. In the recently completed EXPEDITE project, carried out for the European Commission, a considerable amount of existing and new evidence on the impacts of transport policy on demand for passenger and freight transport has been assembled and integrated. This paper will present an overview of results on the policy effects for freight transport. Another paper will deal with passenger transport.

Within the EXPEDITE Consortium, a large number of policy runs have been carried out with the **SCENES European transport model** and with **four national models** for freight transport:

- the Swedish model (SAMGODS);
- the Norwegian model (NEMO);
- the Belgian model (WFTM);
- the Italian model (SISD).

The first three models are all built up around a so-called network model (this is a model that searches for the modes and routes that minimise transport cost on the network). The Italian model is based on discrete choice theory (explaining choices between alternatives such as modes on the basis of utility maximisation), as in a number of national models for passenger transport.

To the maximum possible extent, the same runs were done with each of the models. The outcomes were expressed in the form of elasticities. These were used to construct the EXPEDITE meta-model for freight transport.

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1 This paper is based on the EXPEDITE project carried out for the European Commission DG-TREN by RAND *Europe*, Stratec, ARPA, Transek, TØI, HBVC, Imperial College and ETH Zürich.

The innovations in EXPEDITE were in the **merging** of international and national models, and in the development of an **ultra-fast approximation** to computationally demanding network-based models. The merge included transferring results from countries that had developed models to countries that did not.

The EXPEDITE meta-model for freight transport can be interrogated in a multitude of ways, to look at the types of commodity and length of haul of the road freight consignments. In EXPEDITE, a number of policies and packages to reduce road freight transport have been evaluated in terms of effectiveness (modal shift to other modes), impact on internal and external costs and required investment, operation and maintenance costs.

Section 2 of this paper includes a comparison of time and cost -direct and cross- elasticities of tonnes and tonne-kilometres by mode, from the underlying national models, the SCENES European model and the existing literature. An overview of the policy simulations carried out with the EXPEDITE meta-model for freight transport, focussing on the impact on the modal split in 2020 relative to the Reference Scenario, can be found in section 3. Finally, section 4 provides the conclusions.

2. COMPARISON OF ELASTICITIES

All elasticities in this section give the impact after all reactions to a change in transport cost or time have been effectuated, and the new equilibrium situation has been reached. Therefore the elasticities can be regarded as long run elasticities. The results from the runs in EXPEDITE with the national freight transport models of Sweden, Norway and Belgium (Walloon region) give mode choice changes only. The Italian freight transport model and the SCENES European model can include feedback effects of travel time and cost on distribution. In model runs done in practice, these distribution effects turn out to be very small, so the European elasticities in this paper can be seen as mode choice responses. No assumptions about effects of changes in fuel efficiency or load factors on elasticities are made her- these are kept constant. The elasticities presented here (or rather ‘shrinkage ratios’: the % change in the response variable divided by the % change of the stimulus variable), both from EXPEDITE nationals models and from the SCENES model, were calculated at a 10% increase of the stimulus variable. Runs for different % changes in the stimulus variables, including increases and decreases, were carried out in EXPEDITE as well. Separate results for different commodity classes and distance classes are available in EXPEDITE and are used in the meta-model, but the comparison in this section will use elasticities averaged over commodity classes and distance classes. The elasticities from the Belgian model in this paper are very similar to those in Beuthe et al. (2001) and Beuthe (2002), which are based on runs with the same model.

The elasticities for the effect of changes in the operating cost of road transport on the transport volume in tonnes are in Table 1. The own price elasticity of road transports in the European national models is rather small (in absolute values) on the short distances, but a bit larger on the long distances. Cross-elasticities are hard to compare, because these depend on the market shares. Here, the cross elasticities are quite high, because of the large market share of road transport. For all distance bands together, the Italian model yields much smaller direct road transport cost elasticities. This is due to the large amount of road transport below 100 km that is included in this model and that is not sensitive to cost changes, because there are no viable alternative modes. The runs with the SCENES model in EXPEDITE also give a low direct road transport operating cost elasticity and sizeable cross-elasticities. The review of Oum et al. (1992) includes two tables on freight transport. The North-American studies cited in there give higher road cost elasticities (in absolute values). This is also true for Abdelwahab (1998), which is based on US data and includes the effect on both mode and shipment size choice. Rail is more competitive in North-America than on the European freight transport market. For the Italian model and Abdelwahab (1998) a range of values is given, which are for different commodities or combinations of region and commodity.

Table 1. Road transport operating cost elasticities of the number of tonnes transported

<table>
<tr><td>Mode</td><td>Belgium</td><td>Italy</td><td>SCENES</td><td>Oum et al</td><td>Abdelwahab</td></tr>
<tr><td>Road</td><td>-0.40</td><td>-0.01</td><td>-0.13</td><td>-0.69 - -1.34</td><td>-0.80 - -2.53</td></tr>
<tr><td>Conventional rail</td><td>1.51</td><td>0.60 -1.36</td><td rowspan="2">1.63</td><td></td><td rowspan="2">0.93 – 2.53</td></tr>
<tr><td>Combined road-rail</td><td>2.27</td><td>0.68 - 0.75</td><td></td></tr>
<tr><td>Inland waterways</td><td>0.92</td><td></td><td>0.94</td><td></td><td></td></tr>
<tr><td>Sea</td><td></td><td></td><td>0.37</td><td></td><td></td></tr>
</table>

The impacts of changes in the travel time by road are in Table 2. In the Belgian model these are slightly smaller than the cost elasticities and in the Italian model these are slightly larger than the effects of changing the road transport cost. The long distance elasticities exceed the short distance ones (not shown). The general picture is that there is some room for substitution from road to rail and inland waterways by changing the road cost and time, but the impact on the number of tonnes transported by road will be rather limited, certainly for transports below 100 km.

Table 2. Road transport time elasticities of the number of tonnes transported

Mode	Belgium	Italy
Road	-0.32	-0.01 - -0.03
Conventional rail	1.25	0.93 – 2.22
Combined road-rail	1.91	1.35 – 1.51
Inland waterways	1.09	

Changes in the operating cost of the train (Table 3) have a negligible impact on road transport at distances below 100 km. At larger distances, the impacts on the use of road transport are not so small. The direct cost elasticity of rail transport is quite high (also more for the long than for the short distances), which is confirmed by the outcomes of the SCENES simulation runs done in EXPEDITE. The upper bound of the literature in Oum et al. (1992) also represents a large direct elasticity. In the runs with the Belgian model, the cost changes applied to both conventional train and combined road-rail transport (effectively this also goes for the runs with SCENES). This explains why both modes get a negative elasticity. In the runs with the Italian model, the cost change only referred to conventional train, and this gives some substitution to combined road-rail. Abdelwahab (1998) finds considerable cross elasticities for the US where rail freight is more competitive than in Europe.

Table 3. Train operating cost elasticities of the number of tonnes transported

Mode	Belgium	Italy	SCENES	Oum et al.	Abdelwahab
Road	0.09	0.00 - 0.01	0.10		0.90 – 2.43
Conventional rail	-1.87	-0.82 – -1.51	-1.97	-0.09 - -1.52	-0.91 - -2.49
Combined road-rail	-1.05	0.04 – 0.06			
Inland waterways	0.78		0.52		
Sea			0.00		

In Tables 4 are the elasticities for changes in train travel time. In Belgium these are similar (just a bit lower) to the ones for train cost; in Italy the sensitivity to train time changes is bigger than the sensitivity to a train cost change by the same percentage. Again the direct elasticities are quite high. The impacts on road transport are small for short distances (not shown), but not so small (Belgium) or quite substantial (Italy) for long distance road transport. There is also some substitution with inland waterways transport (not much between conventional rail and combined transport according to the Italian model). In general the outcomes indicate that making rail transport cheaper and/or speeding it up can have a large impact on rail transport itself and also some impact on long distance road and inland waterways transport.

Table 4. Train travel time elasticities of the number of tonnes transported

Mode	Belgium	Italy
Road	0.08	0.02 – 0.03
Conventional rail	-1.59	-3.56 – -4.68
Combined road-rail	-1.08	0.13 - 0.24
Inland waterways	0.70	

The effects for changes in the cost or time of combined road-rail transport (not shown) are similar to that of changing the cost or time of conventional train transport. Time changes have a bigger impact here than cost changes. On the longer distance segments there is some potential for substitution from road to combined transport.

Changes in the cost or time of inland waterways transport (not shown) also only have a non-marginal effect on other modes (notably road and conventional rail) for distances above 100 km. A 10% change in the inland waterways cost has a slightly bigger impact than a 10% change in the travel time by inland waterways. The direct elasticities are smaller than the direct elasticities for conventional rail and combined road-rail transport.

The above tables were for the impacts on the number of tonnes transported. The tables that follow are for the impacts on the number of tonne-kilometres. In the passenger transport models of EXPEDITE, differences between the two were mostly due to destination choice effects, which became visible when studying the kilometrage elasticities. For freight transport in the EXPEDITE models, the effects on tonnes can differ from the effect on tonne-kilometres because of differences in the sensitivity of trips at different distance classes (e.g. long distance trips more sensitive) and difference in the market shares measured in tonnes or tonne-kilometres. Differences due to destination choice effects are not of any practical importance here.

In Tables 5 and 6 are the effects of changes in the operating cost and time of road transport. In the Belgian model the impacts of road cost or time changes is bigger in terms of kilometres than in terms of tonnes (long distance trips are more sensitive). According to this model, raising the road transport operating cost, or an increase in road time, can substantially (especially for long distances) reduce the number of road tonne-kilometres, at the benefit of all the other modes. The direct road cost elasticity is also high in Norway and substantial in Sweden. The effects of road transport cost on road tonne-kilometres is substantial according to all four sources (including the SCENES model).

Table 5. Road transport operating cost elasticities of the number of tonne-kilometres

Mode	Belgium	Norway	Sweden	SCENES
Road	-0.95	-1.01	-0.40	-0.62
Conventional rail	1.72	3.26	0.70	2.41
Combined road-rail	1.57		0.66	
Inland waterways	0.83			0.93
Sea		0.43	0.80	0.37

The impact of a change in the transport time (Table 6) by road transport on road tonne-kilometres is also sizeable in Sweden, but rather small in Norway. Short distance direct elasticities are generally low for both time and cost changes.

Table 6. Road transport time elasticities of the number of tonne-kilometres

Mode	Belgium	Norway	Sweden
Road	-0.73	-0.09	-0.63
Conventional rail	1.25	0.35	1.33
Combined road-rail	1.29		1.04
Inland waterways	0.66		
Sea		0.02	0.07

The Belgian, Norwegian and Swedish freight models indicate that changes in the train cost or time (Tables 7 and 8) have a limited influence on the number of tonne-kilometres by road transport. The direct elasticity might be large (Norway, train cost), but road is so dominant, especially on the short distances, that it is hardly affected by this. The overall direct cost and time elasticities are substantial. There is some shift between rail and inland waterways, between rail and road and only a limited substitution between rail and sea transport.

Table 7. Train operating cost elasticities of the number of tonne-kilometres

Mode	Belgium	Norway	Sweden	SCENES
Road	0.27	0.36	0.18	0.39
Conventional rail	-1.40	-3.87	-1.95	-2.66
Combined road-rail	-0.76		1.71	
Inland waterways	0.79			0.52
Sea		0.29	0.14	-0.02

Table 8. Train travel time elasticities of the number of tonne-kilometres

Mode	Belgium	Norway	Sweden
Road	0.26	0.08	0.33
Conventional rail	-1.26	-0.69	-2.15
Combined road-rail	-0.77		1.36
Inland waterways	0.75		
Sea		0.06	0.12

For the long distances, the direct elasticities of changes in cost or time by combined road-rail transport (not shown) are large and the substitution effects with road and inland waterways transport are non-marginal. Shifts to/from sea transport remain small.

Changes in the cost of inland waterways transport and its travel time results in direct elasticities (not shown) that are smaller than those of rail (conventional and combined road-rail). The impacts on road transport are rather limited (though not negligible). The impacts on conventional rail transport are slightly larger. Combined road-rail and sea transport are hardly affected at all.

Changing the sea transport cost and time gives direct elasticities (not shown) for the short distances that are low and cross-elasticities of zero or close to zero. In long distance transport there is some substitution with road and relatively more with rail transport.

The outcomes of the all the EXPEDITE national model runs were averaged in the EXPEDITE meta-model for freight transport to give consistent reactions to the different policy changes. Outliers (very high or low elasticities) were truncated, to prevent over-reaction in the meta-model, and non-availability of certain modes (e.g. sea transport in Austria) was taken into account.

In Table 9 and 10 are examples of such average elasticities from the EXPEDITE meta-model.

Table 9. Road transport cost direct and cross elasticities for bulk and general cargo at different transport distances for the EU

Mode	Distance range			
	500 to 1,000 km		More than 1,000 km	
	Bulk	General cargo	Bulk	General cargo
Road transport	-0.5	-0.7	-1	-0.8
Inland waterway	1	0.5	0.6	0.2
Train	1.5	1.1	1.7	1.2
Combined transport	0	1.1	0	1.2
Short sea	0.3	0.2	0.3	0.1

Increases in road transport costs for general cargo and especially for bulk goods on transport distances over 500 kilometres have a substantial effect on modal choice. According to the meta-model, raising road transport costs will lead to a modal shift in bulk transport away from trucks mainly to rail and inland waterway transport, while for higher-value general cargo the shift will mainly take place from truck to rail and intermodal combined transport. For trips up to 500 km, the elasticities are considerably smaller, between 0 and –0.3 for the road transport cost elasticity of transport of bulk products by road, and between 0 and –0.5 for general cargo.

High-value goods are usually more time-sensitive than lower value goods. In Table 10, general cargo deliveries show at distances over 1000 km a sharp increase in the elasticity value. This may be explained by a critical distance at around a 1000 km. At an assumed average truck speed of 70 to 80 km/h, a distance of about 1000 km is an upper limit which can no longer assure timely overnight delivery. At distances below 500 km, the time elasticities of truck ton-km are smaller: between 0 and –0.25 for bulk goods and between 0 and –0.5 for general cargo.

Table 10. Road transport time direct and cross elasticities for bulk and general cargo at different transport distances for the EU

Mode	Distance band			
	500 to 1,000 km		More than 1,000 km	
	Bulk	General cargo	Bulk	General cargo
Road transport	-0.55	-0.7	-1.2	-1.4
Inland waterway	0.8	0.4	0.5	0.15
Train	1.8	1.0	2.0	1.0
Combined transport	0	1.3	0	1.4
Short sea	0.04	0.1	0.03	0.1

3. POLICY SIMULATIONS WITH THE EXPEDITE META-MODEL FOR FREIGHT

The meta-model for freight transport

In the EXPEDITE meta-model for freight transport, the amount of freight transport by mode, distance band and commodity class for 1995 and the 2020 reference is taken from the SCENES model (for the current fifteen member states of the EU) and the NEAC model/database (for the accession countries, Switzerland and Norway). The EXPEDITE meta-model can only give the impact in terms of tonnes and tonne-kilometres of changes in policy variables such as the transport time ands cost by mode, on top of the levels provided by SCENES (SCENES Consortium, 2001) and NEAC (Chen and Tardieu, 2000). For this, the EXPEDITE meta-model for freight contains almost 3,000 elasticities, which are unweighted averages of elasticities from the four national models and the SCENES model.

The modes considered are:
- road transport;
- conventional train;
- combined road-rail transport;
- inland waterways transport;
- maritime transport.

In the meta-model, some modes were made unavailable in some of the countries (e.g. maritime transport for countries without seaports, or inland waterways transport for countries without significant inland waterway networks.

Furthermore the model distinguishes between NUTS2 zones (which can be aggregated, e.g. to countries), distance class and commodity class (bulk, petroleum and petroleum products, general cargo).

The scenario-forecast results generated by EXPEDITE for this project were restricted to one single scenario, a scenario in which the population and the economy were assumed to grow more or less in lines with past trends in the 90's. Costs of travel were assumed unchanged from 1995, and it was assumed that provision of new road capacity would be such as to maintain speeds at 1995 levels. Changing any of these assumptions would change our output travel demand consequences.

For the period 1995-2020 (under the reference Scenario, without major policy changes), large increases in the use of road transport are predicted. In the period 1995-2020, in the Reference Scenario, the number of tonnes lifted in the study area (EU15, Norway, Switzerland, 8 countries in Eastern Europe) will increase by 44% (road transport +39%) and tonne-kilometrage will grow by 79% (road +89%). The biggest increases percentage-wise are all in the east of Europe.

The evaluation module

To evaluate policies, we have tried to use an approach as close to cost-benefit analysis as it was possible in the EXPEDITE framework. Impacts have thus been as much as possible evaluated in monetary terms.

The costs we included in this analysis are the following:
- The direct cost of transport, i.e. the cost of running the vehicles;
- The cost of time spent travelling;
- External costs:
- Emissions (pollutants and greenhouse gases);

- Noise;
- Accidents, safety;
- Road damage cost;

Investment, maintenance and operating costs: in this case, monetary valuation was not possible in the context of EXPEDITE, because the policies simulated (e.g. 'intermodality' or 'road pricing') are not specific localised projects, but are measures of a more general nature. We have therefore provided only a qualitative judgment on the magnitude of these costs.

Standard costs and speeds were used (and vehicle load factors), in combination with the forecasts of the meta-model in terms of tonnes and tonne-kilometres.

Policies simulated

The policy measures simulated with the meta-model were mainly taken from documents of the European Commission on the Common Transport Policy (CTP), including the recent 'Time to Decide' White Paper (European Commission, 2001). The selection of policy measures was also discussed with experts at a number of THINK-UP workshops and seminars. The focus in the simulations is on policies that might lead to a substitution in freight transport from road to rail and sea and inland waterways-based modes. The policy measures and the way these were translated into input variables for the meta-model are given in Table 11.

Table 11. Policy measures in freight transport and translation of policy measures for simulation in EXPEDITE (IWW=inland waterways transport).

Policy	**Simulation (for 2020)**
Intermodality	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/IWW/sea –3%, -5%
Interconnectivity	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/IWW/sea –3%, -5%
Fuel price increase	Road transport cost +10%, +25%
Congestion and road pricing	Road transport cost +25%, +40% in densely populated area types
Parking policies	Road transport cost +25% for trips <100 km in/from densely populated area type
Infrastructure tariff	Road transport cost +10%, +25% and rail cost +10%, +25%
Rail and fluvial interoperability	Rail/combined times -5% and cost -5%, and IWW times -5% and cost –5%
Market liberalization (rail)	Rail cost –5%, -10%
Cost internalisation	Road transport costs +25%, +40%
Maximum speed limits	Road transport time +10%, +20%
Vignette, Eco-points, km charge	Road transport cost +3%, +5%, +10% for trips > 200 km
Sea motorways	Sea time –10%, -20%
Harmonisation of inspections and controls	Road transport cost +3%, +5% and road time +3%, +5%
Harmonisation of rules on speeding	Road transport time +5%, +10%
Deregulation for sea and IWW	Sea and IWW cost –5%, -10%

The EXPEDITE meta-model for freight transport was used to simulate the amount of tonnes and tonne-kilometres in 2020 for each of the policy measures in Table 11. The outcomes (in tonne-kilometres by mode and country) were used in the evaluation module. Table 12 contains the main results of the evaluation.

For each policy run done with the meta-model for freight, four changes are given in Table 12:

- The sum of the change in driving cost, time cost and external cost;
- The change in driving cost (the monetary cost of the mode used);
- The change in time cost (the transport time change multiplied by appropriate values of time);
- The change in external cost (emissions, noise, accidents, road damage).

All costs in Table 12 are measured in millions of ECU (now EURO) of 1995. A negative % change means that the costs to society are reduced; in this respect the lowest value (most negative) is the best.

The policies that involve an increase in the road transport cost were found to be effective in terms of substitution from road to other modes (this is not destination switching as happened in passenger transport, but pure modal shift). The implied overall cost elasticities on road transport tonne-kilometrage are in a range from –0.4 to –0.7. But in Table 12 we can see that these policies (congestion and road pricing, parking policies (but this one was not particularly effective), infrastructure tariff, cost internalisation, vignette/ecopoints/kilometre charging and a fuel price increase) all lead to an increase in the internal plus external cost of transport, of sometimes more than 10%. This is caused by an increase in the driving cost: all road transports that do not shift to unaffected modes have to pay a higher cost. For these policies this is not compensated by the decrease in the time cost and the external cost. The time cost decrease here because the value of time is mode-specific: substitution from road to rail, combined, sea or inland waterways transport means that the shipment will use a slower mode, but also a mode with a lower value of time. If we would have used a fixed value of time for the substitution (not mode-specific), then the time cost would have increased as well for these policies. The external costs are reduced if tonne-kilometres are shifted from road to the other modes, but this is not sufficient here to reduce the total cost. On the other hand, in these policies there will also be a benefit for the government (higher revenues from fuel tax, or other form of charging), which is not accounted for in the above total cost change. This is a shift from the transport users to government. In a first-best world (without externalities), such a shift is a distortion of the free markets, that reduces overall welfare. In a second-best situation, where externalities already distort the picture, such shifts might be justifiable.

Table 12. Main evaluation results for the policies for freight transport (% change w.r.t. the 2020 Reference Scenario) (IWW-inland waterways transport)

Policy	**Change in inputs**	**Total Costs**	**Driving Costs**	**Time Costs**	**External Costs**
1. Intermodality	1 Handling and storage costs -5% (rail, combined and sea)	-1.8%	-2.0%	-1.1%	-1.7%
	2 Handling and storage costs -10% (rail, combined and sea)	-3.5%	-4.1%	-2.3%	-3.4%
	3 Travel time -3% (rail, combined, IWW and sea)	-0.5%	-0.5%	-0.7%	-0.5%
	4 Travel time -5% (rail, combined, IWW and sea)	-0.9%	-0.8%	-1.1%	-0.8%
2. Interconnectivity	1 Handling and storage costs -5% (rail, combined and sea)	-1.8%	-2.0%	-1.1%	-1.7%
	2 Handling and storage costs -10% (rail, combined and sea)	-3.5%	-4.1%	-2.3%	-3.4%
	3 Travel time -3% (rail, combined, IWW and sea)	-0.5%	-0.5%	-0.7%	-0.5%
	4 Travel time -5% (rail, combined, IWW and sea)	-0.9%	-0.8%	-1.1%	-0.8%
3. Congestion and road pricing	1 Road transport costs +25%; area types 1,2,3,4	11.6%	17.7%	-0.8%	-0.9%
	2 Road transport costs +40%; area types 1,2,3,4	18.4%	28.0%	-1.3%	-1.4%
4. Parking policies	1 Road costs +25%; area types 1,2,3,4; trips <100km	12.3%	18.5%	-0.5%	-0.3%
5. Infrastructure tariff	1 Road and rail transport costs +25%	9.1%	15.8%	-4.5%	-4.9%
	2 Road and rail transport costs +10%	4.3%	7.2%	-1.5%	-1.6%
6. Rail and fluvial interoperability	1 Rail combined IWW travel time and transport costs -5%	-1.8%	-2.1%	-1.1%	-1.3%
7. Market liberalisation	1 Rail transport costs -10%	-1.7%	-2.2%	-0.5%	-1.1%
	2 Rail transport costs -5%	-0.8%	-1.1%	-0.3%	-0.5%
8. Cost internalisation	1 Road transport costs +25%	6.1%	11.4%	-4.5%	-6.2%
	2 Road transport costs +40%	8.2%	16.0%	-7.3%	-10.0%
9. Maximum speed limits	1 Road transport time +10%	0.0%	-2.3%	6.6%	-2.6%
	2 Road transport time +20%	-0.1%	-4.7%	12.7%	-5.3%
10. Vignette Eco-points	1 Road transport costs +3%	1.0%	1.6%	-0.4%	-0.6%
	2 Road transport costs + 5%	1.6%	2.7%	-0.6%	-1.0%
	3 Road transport costs +10%	3.0%	103.0%	203.0%	303.0%
11. Sea motorways	1 Sea travel time -10%	-0.6%	-0.5%	-0.8%	-0.4%
	2 Sea travel time -20%	-1.2%	-1.0%	-1.7%	-0.8%
12. Harmonisation of inspections and controls	1 Road transport costs and travel time +3%	0.9%	0.9%	1.5%	-1.5%
	2 Road transport costs and travel time +5%	1.5%	1.5%	2.5%	-2.5%
13. Harmonisation of rules on speeding	1 Road transport time + 10%	0.0%	-2.3%	6.6%	-2.6%
	2 Road transport time + 5%	0.0%	-1.2%	3.4%	-1.3%
14. Deregulation for sea and IWW	1 Sea and IWW transport costs -5%	-0.9%	-1.2%	-0.3%	-0.4%
	2 Sea and IWW transport costs -10%	-1.8%	-2.4%	-0.6%	-0.7%
15. Fuel price increase	1 Road transport cost +10%	2.8%	5.1%	-1.8%	-2.5%
	2 Road transport cost +25%	6.1%	11.4%	-4.5%	-6.2%

Intermodality and interconnectivity were also quite effective in influencing the modal split (road transport tonne-kilometrage is reduced by between 1% and 6%) and these policies lead to a reduction of the total internal and external cost of transport. So, unlike the policies that increase the road transport cost, mentioned above, these policies combine effectiveness with low cost for the transport users. But intermodality and interconnectivity require a substantial amount of investment in infrastructure and do not generate government revenue, whereas the policies on road transport cost require lower investment costs and produce revenue for the government.

The policies that try to make the non-road modes cheaper and/or faster (rail and fluvial interoperability, rail market liberalisation, sea motorways and deregulation for sea and inland waterways) had a limited effect on the transport volumes by mode and also have a limited effect on the total internal and external cost of transport. The cross elasticities of road transport tonne-kilometrage are generally between 0 and 0.2

The policies that make road transport slower also had a sizeable impact on the mode split (implied overall time elasticities of road transport tonne-kilometrage between –0.4 and –0.7), but the cost impacts are rather small. There is an increase in the time cost (since all road transport is affected, also the lorry transports that stay on the road), but this is completely or largely compensated by gains in driving cost (because of substitution to cheaper modes) and in external cost.

The above results are summarised in Table 13.

For freight transport policy, the best options do seem to be to improve intermodality and interconnectivity. Tightening regulations on speed and on working practices for road freight are next most effective. Parking policy is irrelevant here. Improving water-based freight is ineffective as means to reduce road freight.

4. CONCLUSIONS

Our analysis of freight transport yields the following conclusions

- Most of the elasticities from the runs of the national freight transport models in EXPEDITE and from the runs done within EXPEDITE with the European SCENES model are of the same order or magnitude and lead to the same conclusions. Please note that in this comparison all commodities are lumped together. The effects may be different for different commodities.

- The impact of the road transport operating cost or time changes on tonnes transported by road and especially on road transport tonne-kilometres is in general of a substantial magnitude. There is a potential to shifts away from road transport, but not for transport below 100 km where road is really dominant and insensitive. For distances above 100 km, increases in road transport cost and time can increase the market shares of both rail (conventional and combined road-rail) and inland waterways transport.

Table 13. Overall assessment of the policies for freight transport

	Effectiveness (modal shift from road to other modes)	**Change in internal and external transport cost**	**Required investment and operation and maintenance cost**
Intermodality	High	Small user cost reduction	Medium
Interconnectivity	High	Small user cost reduction	Medium
Congestion and road pricing	High	Big user cost increase	Low and government revenues
Parking policies	Low	Big user cost increase	Low and government revenues
Infrastructure tariff	High	Big user cost increase	Low and government revenues
Rail and fluvial interoperability	Medium	Small user cost reduction	Medium
Market liberalisation (rail)	Medium	Small user cost reduction	Low
Cost internalisation	High	Big user cost increase	Low and government revenues
Maximum speed limits	High	No change in user cost	Low
Vignette, Eco-points, km charge	High	Small user cost increase	Low
Sea motorways	Low	Small user cost reduction	Low
Harmonisation of inspections and controls	High	Small user cost increase	Low
Harmonisation of rules on speeding	High	No change in user cost	Low
Deregulation for sea and IWW	Low	Small user cost reduction	Low
Fuel price increase	High	Big user cost increase	Low and government revenues

- Unlike the situation in passenger transport, the long-run impact of cost and time changes on kilometrage in the models used is not due to destination shift, but mode shift.

- In passenger transport we found that the impact of a percentage change in travel time generally exceeds that of the same percentage change in cost. This regularity does not hold in freight transport: cost impacts can be bigger, smaller and comparable to time effects.

- Changing the cost or travel times by train (conventional train or combined transport) has a large impact on transport volume and tonne-kilometrage for the mode directly affected. For short distance transport, the impacts on other modes, including road transport, are generally very limited. The impacts for transport above 100 km is often not so limited (though not large): road freight tonne-kilometrage can be reduced somewhat according to the models used by making rail transport cheaper of faster. This will also cause substitution from inland waterways transport to rail.

- Changing the cost or time of inland waterways transport and especially those of sea transport have less influence on road transport than changes in rail transport cost or time. For the long distances, there can be some substitution between inland waterways transport and rail, between sea transport and rail, and between sea transport and inland waterways transport.

In the period 1995-2020, under the EXPEDITE Reference Scenario, the number of tonnes lifted in the EU15 and Central and Eastern Europe is expected increase by 44% (road transport +39%) and tonne-kilometrage will grow by 79% (road +89%). A higher growth is predicted for the Central and Eastern European Countries.

The most effective policy measures to reach substitution from road to other modes are (it does not follow that these are the best policies for society; that depends on the outcomes of the overall evaluation; see below):

- Increases in road transport cost for all or the higher distances (congestion and road pricing, infrastructure tariff, cost internalisation, kilometre charging, fuel price increase);

- Increase in road transport time (maximum speed limits, harmonisation of rules on speeding);

- Decrease in non-road handling and storage cost (intermodality and interconnectivity).

Policies that make the non-road modes cheaper or reduce the travel times on the non-road networks are less effective for reducing road transport tonne-kilometrage; often they also lead to substitution between the non-road modes. Decreasing the non-road travel times and cost can only have a substantial effect on substitution away from the road mode if the bundle includes measures that make all non-road modes more attractive. Otherwise, there will be a large amount of substitution between the non-road modes.

To make policies effective the target segment should be transports above 100 km. Also policies targetted at bulky products are more effective for substitution from road to the other modes than policies focussing on other commodities.

Increasing the road transport cost (one of the three effective types of policy mentioned above) leads to increases in the cost for the users of transport, which according to the evaluation carried out, are not compensated by the reduction in external cost. On the other hand this type of policy increases the government revenues.

Policies that increase the transport time by road (another of the three effective types of policies) increase the time cost of transport users, but decrease the driving cost of the user and the external cost. The total internal and external costs remain more or less the same, according to our evaluation.

Intermodality and interconnectivity, simulated as a decrease in handling and storage cost (the third of the above effective policies) reduce both internal user cost and external cost of transport. These policies however require substantial investments in infrastructure and do not generate government revenues.

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