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SoFTiCE
Survey on Freight Transport Including Cost Comparison for Europe

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Annexes

Publications:

A. Musso: SOFTICE - Analisi e confronto dei costi del trasporto merci in Europa - Seminario scientifico
SIDT. Cagliari, October 21st, 1998

Conferences/Presentations:


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2. Executive Summary

SOFTICE is the acronym of a research project conducted on behalf of the European Commission (DG VII), in the 4th Research and Development Framework Programme (Road Transport Research, task 7.1/5).

The Consortium was composed by 7 partners coming from Universities/Research Institutes; the study started January 1st 1998 and ended September 30th, 1999.

The aim of SOFTICE project was to achieve a better understanding of freight transport costs throughout Europe, particularly in relation to certain important questions such as:

- What is the present situation in Europe, which factors affect freight cost structure and demand?
- How might a change in transport policy affect the costs of transport and consequently the relative competitiveness of the industry in the different countries?

More clear goals of SOFTICE were:

- Identification of the existing interactions between production costs, transport costs and transport demand for freight, and demonstration of the benefits of harmonised freight transport costs.
- Analysis of the consequences of different policies for taxation and internalisation of costs on spatial production organisation.
- Provision of a framework for discussions at the European level and for the development of comprehensive policies on freight transport at the Community level.

The achievement of these goals has been carried out by 4 WP which constitute the workflow diagram of the research:

WP1 gives an overview of the costs of transport in the European countries, based on national sources, and a specific survey, carried out for the purpose of SOFTICE, in different countries.

WP2 deals with the methodology which is thus in a central position in between the first and the third workpackages: the methodological choices for segmentation of WP 2 have been used to structure the survey of WP 1, and the components of the transportation system described herein have been used as variables for medium and long term analysis (WP3).

WP 3 gives some outlooks on how transport costs might affect economic trade and productivity in the future, with the development of scenarios projections.

Finally WP 4 has validated the methodology developed during WP2 through a Revealed Preference Analysis and a Stated Preference Analysis.

The approach in SOFTICE starts from an analysis of freight transport costs in order to better understand what might happen if the structure of costs is changed as regards industrial competitiveness as well as the competition between road and other modes of transport.

The activities developed in the WP 1 can be summarised as follows:

- Identification of the main parameters affecting freight cost structure
- Collection and comparison of some relevant examples of factors of freight costs by country
- Map covering various types of industries, illustrating the weight of transport costs as a proportion of their overall production costs
- Organisation of a 1st Shipper Panel Survey to check the reliability of cost data collected
- Identification of main factors affecting freight transport demand.
Furthermore an extensive survey on current working hours regulations in different European countries has been provided.

The cost factors analysis shows that the cost factor drivers’ wages for the collection and distribution truck operation differs remarkably from the others. This cost factor is on average for all the data 50.4% of the total operating cost. Next come three much smaller cost factors nearly equal, the cost of administration (11.6%), the depreciation (10.9%) and the fuel (10.3%). For the long distance haulage truck operation there is no such high difference between each specific cost factor though some are obviously higher than others. The highest cost factor is the drivers’ wages as for the collection and distribution truck operation. The average value is 33.0% of the total operating cost. Next largest cost factor is the fuel with average value of 20.4%. It can be derived, from comparing these two businesses, that it is the drivers’ wages that is the most significant cost factor. The second most important factor is the fuel cost, especially for the long distance haulage truck operators.

The tax analysis covers two different categories of taxes; the main direct taxes and the main indirect taxes. The analysis shows that the direct taxation on the truck operation, i.e. vehicle tax and road charges, amounts to just a small percentage of the total cost. This varies between countries but the vehicle tax is on average for collection and distribution 1.2% and long distance haulage 1.5% of the total operating cost. Different road charging systems exist, both privately and governmentally operated, and do account for 1.4% to 8.8% of the total operating cost.

The level of excise duty on the fuel price in the different countries varies between 55% (Austria) and 76% (Great Britain). The average value is 62% and despite the extremes of few countries it seems that there is a trend for convergence.

The total tax costs in form of indirect taxes as fuel tax and direct taxes as vehicle tax or road charges vary substantially between countries. The lowest values of these taxes in the EU member states are found in Denmark and Belgium, only 10.7% and 11.3% of the total operation cost of long haulage trucks. The highest tax values of the total operation cost for long distance truck operation can on the other hand be found in three different countries; Italy (24.7%), Great Britain (24.5%), and Spain (24.4%). The different reasons for these high values does make comparison of the effects of different changes in taxation difficult to accomplish. If the total value of the discussed taxes would be increased by 10% the results will be 2.5% increase in total operation costs for the three countries with highest taxation. At the low end a 10% increase in taxation would result in 1.1% increase in total operations cost. On average a 10% increase in the total taxation would increase the total operation cost of the long distance haulage operators in the EU member states by 1.7%.

For the collection and distribution truck operation the effects are different. As the drivers’ cost factor is about half of the total operation cost, the fuel cost about 10% and very limited road use charges the effects of 10% tax increase is limited to about 0.75% increase in the total cost on average.

A classification of goods transported was also made in order to relate transportation costs by mode to production costs. This was done by carrying out an analysis of input-output tables from the Netherlands. The main conclusion from this analysis is that transportation costs are very small fraction of total production values. The largest one shows that Mining paid 1.9% of its total output value to transport by pipeline. This phenomenon warrants the expectation that industries generally will be fairly insensitive to price changes in the transportation services, since transportation plays such a minor part in their total turnover.

It was observed that it is possible to map the transportation services by mode in relation to the production value of different industries. However, the hypothesis that higher quality goods having higher value density demand higher quality transportation services could hardly be empirically verified.

According to the analyses carried out in the East European Countries, in the 1 tonne pallet and the one tonne non-pallet segments, it was observed large differences between the countries analysed, with highest prices in Lithuania and lowest in Poland. Hungary and Czech Republic have medium level prices. For these cases (1 tonne), the differences between European and East European prices are similar both for the pallet and non-pallet segments.
For 100 km distance, European prices are between 3 and 8 times higher than in the East European countries, and for 300 km and 500 km, up to 10 times greater than the prices in Poland.

Considering the FLT (Full Load Truck) segment, it has been observed that Poland still has the lowest prices per tonne, then Czech Republic, Hungary and Lithuania. In this segment, the prices are closer to West European average prices.

Analysing the cost structure, we saw that the share of wages is less significant in the East European countries (approximately 15 %) than in the EU (approximately 30 % for long distance haulage and 50 % for collection and distribution). This is one of the most important factors which will affect competition between European carriers.

However, more important factors are the fuel, the depreciation and the administrative costs. Concerning vehicle taxation, tolls and user charges, these countries do not have a similar approach in levying taxes and duties on transport operators.

In order to check the data on road freight costs already collected by hauliers organisations, to investigate the influence of regulations on working hours and on factors influencing the demand for transport, a 1° Shippers Panel Survey was organised.

A questionnaire was sent to 64 European Shippers, and 39 of them returned it duly compiled in all its parts (companies in France, Germany, Italy, Portugal, Spain, Switzerland and Sweden).

The main results of the survey can be stressed as follows:
- Cost of transport varies according to the shipper’s country of residence
- Most of the cases under study refer to FLT shipments and regular deliveries: this is an expected result, since FLT transports generally optimise shipping costs
- The economic activity does not seem to have a marked effect on the actual cost of transport.

Based on the survey with questions about expected effects of a reduction on allowed number of working hours, 3 types of answers were obtained:
- 33% of the answers indicated «No effect»;
- 58% indicated, «Cost increases only»;
- 9% indicated «lower demand for road transport and / or modal shift».

In Northern Europe, the expected effects of working hours regulations are stronger then in Southern Europe. A strong effect is also expected in shippers with own account transport representing more than 20% of their total transport, or those for whom transport costs represent more than 3% of total sales revenues.

For working and driving hours regulations, it seems that there is a trend for convergence between the four East European countries analysed and the EU members, with the adoption of the European Agreement EU3820/85 on working hours regulation (AETR) for international road transport.

WP 2 whose main objective was to develop a methodology for the appraisal of costs, suitable for the analysis of the present distortions in Europe and adaptable for different policy scenarios dealt in the beginning with the estimation of the transport cost share in the value of the products using national accounts of different countries. Also a macro-economic approach to transport costs using data collected from transport operators and segmenting the transport chain between collection, distribution and long-haul was developed. Finally the methodology focused on qualitative aspects which also influence logistics organisations and raise the problem of external costs which are not included in the transport costs.

The segmentation principle was used as a basis for all the work carried out in this workpackage. Not all criteria resulting from the segmentation were considered in the different cost approaches, depending on the task and the aim required.
The impact of the cost of transport obviously differs from one market segment to another, although it does not depend only on the value of the good. Indeed, most of the studies segment the market according to the type of product, with in many cases 10 or 20 groups corresponding to the NST\textsuperscript{1} definition. In this analysis, it was considered that these criteria are not sufficient, and as a result the issue of the shipment size was highlighted since freight costs result from a door-to-door transport which takes part of a complex logistic system. Otherwise, products were distinguished as intermediate or finished goods and of low or high value, taking into account when possible the size of the shipper.

In the door-to-door approach, it was considered more particularly the importance of the shipment weight in road transport costs from the haulier’s point of view. Obviously the issue of shipment size refers to different notions, and it has not been considered in the same way by the shipper and by the haulier. For the shipper, this is a decision which depends on multiple parameters, whereas for the haulier it is essentially an operating problem and a question of know-how, which is linked to the haulier’s requirements (transit time, price, quality of service, annex services etc). The shipper needs to attain an optimum between production, inventory and transportation costs, thus implying that the size and frequency of shipments are linked to the value of the product. Arbitration between the size and the frequency of the shipment also depends on the link of the transport chain concerned, i.e. the origin and the destination of the transport shipment (these could be a manufacturing plant, a depot, a retail outlet etc). This decision-making process for shippers will have an effect on the transport organisation and imply specific costs. Even if the shipper is not concerned by the haulier’s organisation, changes in his demand affect the segmentation of transport supply, with for example the well-known just-in-time process.

The main conclusions from this workpackage are:

- The road unit transport cost decreases sharply with the rise of the shipment size, and smaller shipments probably leave wider margins to transport operators;
- Quality factors must be considered in parallel with transport costs and can be sometimes a decision factor. The transport cost reaches 10% or more of the value of an intermediate product, when it is usually below 1% for a finished product. Nevertheless, quality is not only a strong requirement for high value products, e.g. results from a freight value-of-time survey in the Netherlands (De Jong et al., 1992) showed that intermediate products, which may be less valuable than finished products, had a higher value of time than for finished products. This was explained by the fact that a delay can disrupt the production process;
- Comparisons between small and medium-sized shippers companies and large shippers companies’ transport requirements remain difficult to characterise. They often do not address the same distribution market or the same transport requirements and no simple conclusion, could be drawn from this point of view;
- Transport costs and quality changes will influence industrial production processes of intermediate goods. In many cases, quality requirements may be more important than costs for intermediate products since they face tight industrial supply chain constraints.
- There does exist flexibility in transport logistics evolution, under the influence of transport costs and quality criteria evolution. This will concern:
  - new locations for restructured distribution centres;
  - different choices of consolidation points;
  - choice of the size and type of vehicles.

The last point raised in WP2 deals with “External Costs and Ways of Internalisation”.

\textsuperscript{1} Nomenclature Statistique Transport (standard goods classification for transport statistics)
Social costs of transport have been agreed to comprise all costs originating in the provision (investment, construction, operation, maintenance) of transport infrastructure and its proper use by transport activities, and not being internal to the users economically (having direct budgetary effects).

For the most common types of external costs various recent studies have been analysed and values for an inclusion into a cost accounting have been extracted. These values differ partly but strongly throughout Europe. The goals of internalisation, among which are outstanding:

- Optimal use of existing capacity,
- Abolishing of subsidies which are not justified by public good characteristics of the transport system,
- Allocation of the costs to the agent who is responsible for their production – polluter should pay,
- Achieving defined long-term environmental/safety quality standards,
- Better balance of regional development,
- Better balance of social development,
- Developing new markets and new technology with lower consumption of natural resources.

The search for the best instruments of internalisation policy led to basically four instruments:

- Information and moral suasion,
- Economic incentives,
- Regulatory instruments,
- Government provided infrastructure and services.

WP 3 (Medium and Long Term Impact) analysed first the consequences of different policies for taxation and internalisation of costs on spatial production organisation along three different scenarios: a Reference Scenario (BAU) dealing with the continuation of liberalisation particularly profitable for road transport; an Alternative Scenario (Harmonisation and Liberalisation) dealing with the achievement of political goals (safety, environmental, social) trough CTP actions and a second Alternative Scenario (TEN Policy) which emphasizes the achievement of a Trans European network (TEN) for transport.

The second task of this WP “Impact on Different Segments and Modes” describes some evidence on how attributes of possible future scenarios would impact on key ratios describing the movement of freight in various European countries. The analysis is divided into three parts, reflecting the scope of research employed: a macro analysis, a micro analysis, performed at a firm level, and finally two case study analyses, one about the effects of Swiss transport policy, the second on the impacts of illegal operations on costs.

The macro analysis focused first on the mode choice between road and rail. Previously derived monetary valuations of attributes affecting this choice were generalised across a pseudo-origin/destination matrix for three different cargo types. The main non-cost attributes were taken to be scheduled journey time and reliability, with an Alternative Specific Constant taking up all other factors.

A later stage of the work analysed available data on what McKinnon (Campbell and McKinnon, 1997) has termed ‘key ratios’, mainly using UK data kindly supplied by him. Time and efforts were spent investigating French data and, to a much lesser extent, Swiss data. However, inconsistencies and sparseness in these sources led to the recommendations being based almost exclusively on the UK data. Considerable attention was paid to Handling Factors, i.e. the number of times goods were lifted after production, up to the point of consumption. A new key ratio was conceived for this report, namely the Generation Factor, which divides the Handling Factors by the Value Density of output (in real terms) so as to give the tonnes lifted (by all modes) for each £1 million worth of Domestic Production plus Imports.

The other remaining output was the derivation of elasticities for tonne-km with respect to Gross Domestic Product and articulated lorry freight rates that, superficially at least, seemed to fit the data. Based on UK evidence, the elasticity of tonne-km with respect to GDP appeared to be in the range 1.0 to 1.5 and the one with respect to cost around -0.1.

The micro analysis, on the other hand, focused on the firm level. It used the results of the Second Shippers’ Survey for creating the outputs intended to feed the Systems Dynamics Model.
Finally, the case studies' sections investigated two questions of interest for political decision making: the first part tried to isolate the effects of political decisions on road transport in Switzerland, the second part discussed the impacts of violation of legal regulations by road hauliers on costs of road freight transport. The focus was on long distance road transport. The estimation of the impacts of the traffic rules violations shows that illegal operations can significantly decrease the operating costs born by the hauliers and thus unfairly increase the productivity of the road transport. The different kinds of violations were analysed separately with respect to their impacts on operating costs. If several rules are infringed at the same time, the cost reductions sum themselves up. For this reason, in some countries, the reduction of the costs per ton-km can be up to 30-40%. Those values must be considered as an upper limit of the real saving, as it has been assumed systematic violations of the traffic rules throughout the year.

The 2° Shippers Panel Survey was carried out in order to assess attitude towards evolving conditions of freight transport, i.e. how they think they would react when facing conditions for the transport of their goods that are significantly different from the current ones. The purpose of this survey was also to validate the methodology developed in WP2.

The general organisation of the survey was on the «stimulus – response» model. In order to facilitate the treatment of the available data, the first step was to summarise the stimuli in four types aggregating the questions considered more closely related. The aggregation and the referred questions were as follows:

- **Group I- Local restrictions:**
  - Circulation restriction due to social and environmental impacts;

- **Group II – Troubles in the supply transport services:**
  - Unreliability of deliveries;
  - Cost increasing due to congestion;

- **Group III - Pricing**
  - Cost increasing due to urban congestion (tolls in central areas);
  - Cost increasing in motorways (road tolls);
  - Cost increasing due to environmental reasons (fuel taxes);

- **Group IV - Troubles in the production**
  - Cost increasing due to lack of flexibility;
  - Cost increasing for not very regular shipments.

Specific conclusions on the survey are as follows:

- In more general terms, it seems that toll payments are not an obstacle for almost all the shippers interviewed, who accept to pay more without any particular resistance (or think that any alternative behaviour, like avoiding toll motorways, should be not favourable for them);

- The «accept and pay» reaction, which is strong as an answer to other stimuli, is weak in front of the «cost increasing due to urban congestion» stimulus: this aspect could appear like an anomaly, but it is probably due to the fact that most of the selected shippers are barely involved in moving their products inside the urban areas (with the exception of the distributors);

- It is remarkable that the reactions which are associated to a «moderate flexibility» behaviour are more relevant for the SME (Small Enterprise) segment, underlining its higher flexibility in comparison to the LE (Large Enterprise) segment (this is, in any case, an expected result);

- There are stimuli like «unreliability of deliveries», «cost increasing due to lack of flexibility» and «cost increasing for not very regular shipments» that show a lower flexibility from the shipper’s side: these are probably situations where flexibility is requested (or expected) from the haulier side.
When analysing the thresholds of intensity of the stimulus that would induce a reaction, in general the thresholds for reactions of a short term type (accept and pay, change delivery times) are rather low, frequently with strong concentrations around 20%, whereas the thresholds for more radical reactions, like reorganise production or relocate show much higher values, with a majority of responses around a stimulus of 100% of change (in terms of costs).

The last matter analysed during the WP3 deals with the definition of an optimal country-related time path for the implementation of harmonisation policy. To minimise the imbalances occurring in such a process, any investigation in possible future development has to consider the differences and discrepancies above mentioned.

The identification and assessment of such acceptable paths has been based on a Systems Dynamics Model (SDM), developed for this project, including 3 levels:

- **on the macro level:**
  - Production & Import of Goods
  - Freight Transport Volume (tonnes)
  - Freight Transport Production (tonne-kms)
  - Determinants of Modal Split
  - Freight Modal Split Calculation
  - Infrastructure Load
  - Environment & Safety

- **on the meso level:**
  - Hauliers' Economic Performance
  - Hauliers' Market Entry and Competition

- **on the micro level:**
  - Road Haulage Costs
  - Drivers' Conditions
  - Stimuli (External to Shippers)
  - Shippers' Reactions to Stimuli

As a result of the Systems' Dynamics Modelling performed (in which the amount or volume of goods transported distinguished by type of commodity is a variable that is not subject to change during the modelling period, until 2020), it is possible to conclude that the larger the amount of goods transported in a given O-D pair, the higher the percentage of traffic that non-road modes can gather. For the three different types of commodities considered: bulk goods – intermediate goods – consumer goods the modal relations are quite stable. Moreover, the longer the average distance goods are transported, the higher the percentage of traffic that non-road modes can gather.

Except for bulk goods, where output and transport volumes are decreasing, goods produced and imported transport volumes increase along with the predicted growth rates of GDP. Differences between the types of commodities will occur, in correspondence with the development of their value densities. Intuitively, following technological improvements and cost reductions in the manufacturing process and the trend towards miniaturisation for most kinds of manufactured goods (also in order to minimise material input and storage and transport costs) it can be observed higher value densities in general. Intermediate and consumer goods are more likely to experience increased value densities over time.

Consumer products show a very high affinity to road transport from the beginning. As volumes of bulk goods transported decrease by 1% annually, road can increase its share. On the other hand, road loses market share in intermediate goods where the opposite effect, higher transport volumes and longer transport distances benefit non-road. For consumer goods road can hold its very high share. – It is expected that an increase of transport volumes and performance affects road transport times more strongly than in other modes, given the higher saturation levels in the present. However, we also have to count on a relief of around 15 to 20 percent of the traffic load on the road (lorries), caused by higher
productivity, i.e. less empty running and higher payloads. Rail network load more than doubles, as no productivity gains for rail are modelled.

- As a result of those two counter-acting effects on the road, somewhat longer transport times by road are to be expected. Hence, an inclination to modal shift away from road should be expected, with its intensity being reduced towards the end of the modelling period, as transport times for rail also increase when saturation levels become more significant.

More general conclusions on this WP are as follows:

- With the application of internalisation measures all freight transport modes are expected to become more expensive, but to different extents. The effect on modal split is hard to estimate, as in the past the markets did not have to face changes in prices of this scale, and the own-elasticities as well as the cross-elasticities of the different modes are thus hard to analyse. The market performance of the different modes during and after an internalisation of their specific external costs will mainly depend on their strategies for adjustment.

- Though it is likely that there will be no major shift in modal split, the market segments' shares might be re-distributed, as a consequence of an organisational change, concerning the modes as well as the single actors. The highest gain in efficiency in the road freight sector will come from increased productivity per vehicle-kilometre, as the use of infrastructure and environment shall be charged rather than the amount of goods transported. Thus, increasing load factors and improving organisational performance is likely to be the foremost strategy for road.

- As for rail, one might imagine efforts to get a higher share in the market segment of high-value commodities. This, as well as for road, will mainly depend on rail operators' abilities to take advantage of the chances offered to them by the rise in costs for the road sector and to occupy market segments that, by application of internalisation instruments, have lost their exclusive affinity to road transport. This may occur by adjusting even better to shippers' needs, e.g. by considering to offer additional logistics services, as can be seen in the road sector, where hauliers have successfully started to offer these services to their customers.

- Eventually the rail freight market will have to change in a way, that rail operators will act similarly to road freight operators, i.e. to adopt an atomistic market structure; until now in most countries one single (stagnating) rail operator faces innumerable flexible road operators. Real competition may occur if the two markets for rail and road pervade; the organisation of transport will no longer be a question of an unequal competition between road and rail but true and fair competition between operators using and profiting from the respective advantages of each mode.

- There is a certain likelihood that the road transport sector will face a partial depression, but no guarantee can be given that on the other hand the rail freight operators will profit automatically. This situation, which seems to be a desirable solution at the moment, lies beyond the influence of internalisation, but in the field of intra-modal competition policy, in the environment of restructuring the European railways. Internalisation measures represent a ‘push’-strategy away from road, the corresponding ‘pull’-measures towards the environmentally more sustainable modes are discussed separately.

- To give a conclusion, it is obvious that the highest effectiveness in terms of decreasing the negative effects of freight haulage on natural environment and human society will be reached if both policy fields are dealt with complementarily in relation to each other.

One of the aims of the WP 4 (Validation and dissemination of results) was to validate the methodology developed in WP 2 through a Revealed Preference Analysis made upon two European corridors (the North-South Transalpine Corridor and the East-West European Corridor). Concerning the influence of the distance, for some products (manufactured, agricultural, minerals, and fertilisers), rail competitiveness appears to increase with the distance up to 800-1000 km, while decreases for
longer movements (due to lower volumes to move and less available rail services). The factor “distance” affects also the market area’s dimension for goods with high transport costs with respect to the value, such as cement and wood.

The analysis of the modal split evolution has shown that the competition between modes is the main explanatory factor of the rail decrease to the benefit (mainly) of road, both for the transalpine and the East-West European corridor. The transformation in the good structure took place but its effect has been less important, affecting significantly only the transalpine traffic from North to South.

Looking at the SOFTICE segmentation, the available data allow to analyse three dimensions: the type of the products, its value, and the size of the shipper. The segments obtained seem to have specific characteristics in terms of transports.

Only two segments are clearly road-dominated: high value bulks and high value consumer goods. In the other segments some competition between road and rail still exists, while sea transport is important for low value bulks. The dimension of the “shipper’s size” seems to be very important, because the modal shares for SMEs and for large companies are quite different for the same group of products (in terms of type and value).

As regards the international flows of some specific goods examined in WP2, the revealed preference approach confirms most findings about the modal split and the value per tonne.

Finally, for the transalpine transport, the analysis of the evolution of the split by crossing country and by mode provides clear evidence of the lack of harmonisation: one third of the traffic traversing the French and Austrian crossings of the central Alps consists in fact of lorries heavier than 28 t, which by-pass Switzerland because of the Swiss weight limit.

A Stated Preference Analysis had also been made through the Second Shippers Panel Survey to validate the methodology (WP2) as well as the conclusions on harmonisation on WP 3, as mentioned before.

An Advisory Board made of a panel of 10 experts representing Hauliers and Shippers Organisations has assisted the consortium during the whole duration of the project and specifically to help in conducting the two Shippers Panel Surveys. The dissemination has been undertaken firstly among the members of the Advisory Board and after through several promotional activities: a booklet in English presenting key results of the research is being produced and will be widely distributed, a Website, etc.. A wide dissemination of SOFTICE results will also be made through national promotion co-ordinated by the members of the consortium.

3. Objectives of the project

The objectives of SOFTICE project is to demonstrate the interaction between production cost, transport cost and transport demand for freight, and to demonstrate the benefits of harmonised freight transport costs.

To achieve this main objective, the consortium identified five intermediate objectives that have been covered progressively during the project life cycle:
- An identification of the main parameters affecting freight cost structure in EU members States plus Switzerland and some CEEC countries and of the factors affecting freight transport demand.
- A collection and comparison of some relevant examples of factors of freight costs by country, checked by a Shippers Panel Survey.
- A map covering various types of industries, illustrating the weight of transport costs as a proportion of their overall production and distribution costs, as well as, the conditions of their preference of each transport mode (or combination of modes).
- Development and validation of a “four stages” methodology for the analysis of the present distortions in Europe and adaptable to different possible policy scenarios.
- Analysis of the consequences of different policies for taxation and internalisation of costs on spatial production organisation.
4. Means used to achieve the objectives

In a preliminary stage it has been advisable to draw up a state of the art of the research, especially related to freight cost structure and cost data collection: this inventory, among other things, made it possible to detect deficiencies and inadequacies and to make recommendations for the orientation of later work.

A methodological approach was proposed based on the development and validation of a “four stages” methodology for the appraisal of costs, suitable for the analysis of the present distortions in Europe and adaptable to different policy Scenarios. Different cost level analysis have been carried out in order to have a better understanding of the interactions between the different types of costs.

Two shippers Panel Surveys were also carried out along the whole duration of the research in order to relate the different points of view of final users (shippers and hauliers) with the methodological approach.

Finally, for the identification and assessment of an optimal country-related time path for the implementation of harmonisation policy a Systems Dynamics Model (SDM) has been developed for this project.

5. Scientific and Technical Description of the Project

The research is composed by four workpackages for each of them an overview of the work carried out is presented.

5.1 WP1 - State of the Art and First Cost Analysis

The objectives of this workpackage were:

- identification of the main parameters affecting freight cost structure in EU member states plus Switzerland and of the factors affecting freight transport demand;
- collection and comparison of some relevant examples of factors of freight costs by country;
- map covering various types of industries, illustrating the weight of transport costs as a proportion of their overall production and distribution costs, as well as the conditions of their preferences for each transport mode (or combination of modes);
- organisation of a First Shippers Panel Survey to check the reliability of cost data collected and make an assessment of the users needs and requirements.

The state of the art has been surveyed in an extensive literature study, referencing an annotated bibliography that covers most of the literature found in Europe and some outside Europe, including national publications, with special reference to deliverables from other European Commission research projects that had a bearing on this project.

The scope of the project did not allow the consortium to collect data from market practice. Rather, the literature was screened for data, with two exceptions. One is that cost breakdowns of truck operations and working hours regulations were collected from national hauliers’ associations. These costs and working hours regulations have been compared between different European countries and analysed. Special attention was paid to taxes, transaction costs and costs of legal matters, although the literature and the survey of national hauliers associations did not yield much in the latter respect. An empirical check of the hypothesis that goods in the early stages of the supply chain require low quality transport (as provided by ships and railroads) whereas goods approaching the end of the supply chain, when their value density increases, demand higher quality transport (as supplied by road and air transport) was attempted. Input-output tables from the
Netherlands were used for this analysis, which was only successful to a limited extent. The harmonised input-output tables compiled by EUROSTAT have too little detail to distinguish between transport modes.

The second exception to the rule that data would only be collected from the literature is the cost data collection that was developed with two kinds of surveys:

- a specific survey addressed to the hauliers to know their prices on some selected shipment sizes and length of trips;
- a First Shippers Panel Survey addressed to 50 selected shippers firms, to check the results of the preceding cost collection, and to get more information on some specific topics, as factors affecting demand and working hour regulations.

Each partner was responsible for the data collection in his home country. As shown in the Table 1 most of them had also the responsibility for their neighbouring countries.

Table 1  Responsibility for data collection

<table>
<thead>
<tr>
<th>Countries investigated</th>
<th>Information to be gathered by</th>
<th>Responsibility for compilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden, Denmark, Finland</td>
<td>CTT</td>
<td>CTT</td>
</tr>
<tr>
<td>Switzerland</td>
<td>EPFL</td>
<td>EPFL</td>
</tr>
<tr>
<td>France, Belgium, Netherlands, Luxembourg</td>
<td>INRETS</td>
<td>INRETS</td>
</tr>
<tr>
<td>Portugal, Spain</td>
<td>IST-CESUR</td>
<td>IST-CESUR</td>
</tr>
<tr>
<td>Great Britain, Ireland</td>
<td>ITS</td>
<td>ITS</td>
</tr>
<tr>
<td>Germany, Austria</td>
<td>IWW</td>
<td>IWW</td>
</tr>
<tr>
<td>Italy, Greece</td>
<td>DITS</td>
<td>DITS</td>
</tr>
<tr>
<td>Poland, Hungary, Czech Republic, Lithuania</td>
<td>INRETS</td>
<td>INRETS</td>
</tr>
</tbody>
</table>

The WP1 went one step beyond a first cost analysis in that an initial analysis was made of factors affecting the demand for freight transport, i.e. costs to the shippers besides all other factors. Special attention was paid to the possibility of influence on these factors by policy makers. Although the SOFTICE project falls within the research area of road transport, perspectives were also provided on other transport modes.

Policy makers in particular tend to wish to have an influence on the choice of transport mode, rather than on the volume of the demand for freight transport per se. The analysis was made in a three-tier structure: proceeding from trade volumes to production and distribution modes and down to transport solutions. An example of the application of an econometric model was made for the estimation of modal split for the land-based transport of different types of goods between regions of Germany.

5.1.1  Analysis of the present cost structure

5.1.1.1  Objective of the analysis

The objectives of this part of the project was to identify the main parameters affecting freight cost structure in the EU member states, Switzerland and some CEEC countries, as well as to illustrate the weight of transport costs as a proportion of various industries overall production and distribution costs.
To fulfil these objectives the following activities were carried out:

- list of cost factors involved in road transport operation was collected;
- analyse the transaction costs in freight transport fares;
- make overview of the taxes and legal matters affecting the freight transport fares;
- classify the goods transported in order to relate the transportation costs to the production costs and
  the quality of the transport demanded to the value density of the goods transported;
- describe and analyse the existing working hours regulation in the EU member states.

5.1.1.2 Cost breakdown

The cost breakdown analysis in this project was divided into three different parts. The first is a cost factor
analysis where the actual cost factors, affecting truck operation in most of the involved countries, are
described. The second is an analysis of the transaction costs involved in the truck operation. Finally the third
part gives an overview of the main taxes and legal matters that directly and indirectly affects the freight
transport fares.

Cost factors analysis

The technical approach for the first cost analysis was to take two examples from the transport chain and
analyse them. These examples are long distance road haulage of general cargo from one terminal to another
with distance of at least 500 km in-between and local collection and distribution of goods to and from these
terminals.

Transaction costs analysis

The transaction costs involved in the road transport activities are difficult to measure, both because these are
small factors and collection of these varies between operators. In most cases the transaction costs are not
collected separately but included in the administration costs. In the administration cost accounts there are cost
factors like order booking, invoice handling and different administrative work carried out in the office,
operated within the firm. The transaction costs like mobile phones, mail costs, computers and software costs,
etc. are therefore often included in these accounts.

Overview of taxes and legal matters affecting transport fares

The cost factor analysis showed that in most countries one or more cost factors are direct taxes paid by the
truck operators to respective governments. Additionally indirect taxes are also included in many other cost
factors. Overview of both the main direct and main indirect taxes, affecting the transport fares structure, in
each of the involved country were given here. Quantitative analysis for each country was carried out as the
collected data allows, followed with a qualitative analysis.

5.1.1.3 Transportation costs in relation to production costs

A classification of goods transported was made in order to relate transportation costs by mode to production
costs and to relate the quality of the transport demanded to the value density of the goods transported.

It was intended to make a European comparison of what percentage of total expenditure of different
industries in different countries is spent on transportation. This comparison would be made on the basis of the
harmonised input-output tables compiled by EUROSTAT for the different EU countries. The latest reference
year for the EUROSTAT harmonised input-output tables is 1985. That is thirteen years before the time of this
research and nine years before the base year of the detailed input-output tables of the Netherlands on which
our analysis was based. For this reason an European comparison was not made.
Unfortunately, most individual member states input-output tables have a too high degree of aggregation to allow analysis of transportation costs by mode in relation to total production value of different industrial sectors.

Hence only the Netherlands input-output tables remain to perform the required analysis. The Netherlands input-output tables with reference to the year 1994 distinguish 93 intermediate, i.e. industrial, sectors. The transportation sector is particularly detailed: nine transport branches are distinguished.

5.1.1.4 Working hours regulations

One of the objectives of the SOFTICE project was to analyse the effects of the expected working hours regulations. To do this, firstly, an analysis of the exiting regulations was conducted and secondly, open-end questions about these possible effects were addressed during the First Shippers Panel Survey.

Only one case study could be made, which still was largely hypothetical, about a change in working hours regulations in Portugal. It was argued that an extra constraint in working hours regulations can never lead to an efficiency improvement that could not otherwise have been achieved.

The aim of the shippers questionnaire was to collect a sample of original raw data about freight transport including a cost-comparison for Europe. The questionnaire was spread over European countries, branches of industry, large and small and medium enterprises. The number of completed questionnaires was 39.

Since the sample was small, it was not sensible to make a refined classification of the attributes. In each case, a simple dichotomy of the explanatory attributes was considered satisfactory. Considering the responses to the two open-end questions, it is possible to conclude that the response to the first question is in almost all cases along the same lines as the response to the second question. So the question “What is the effect of existing working hours regulations?” is answered in the same vein as the question “What will be the effect of a further tightening of the working hours regulations?” Taking the answers to both questions together, it is possible to classify them in three categories:

- **None.** Working hours regulations have no effect on the respondent. As a shipper, the respondent may presume that working hours regulations is the haulier’s problem and he should cope with it. Any additional costs due to a tightening of working hours regulations should be absorbed by the haulier or compensated for by efficiency increases elsewhere.

- **Cost.** A tightening of the working hours regulations will increase costs only. The haulier will experience an increase in costs and raise the price rates of the transportation services. The shipper in his turn experiences an increase in costs, which he may try to pass on to the customer. But in the respondent’s opinion, the increase in costs does not lead to any decrease in the demand for transport services or, for that matter, to a modal shift. In other words, demand is totally price-inelastic.

- **Demand.** A tightening of the working hours regulations will, through higher costs and price rates, lead to a diminished volume of demand for transport services and/or to a modal shift.

First of all, counting the results of the effects of working hours regulations, it was found that:

- 11 respondents, or 33% do not expect any effect of working hours regulations at all; these shippers evidently expect the hauliers to absorb the effects of working hours regulations that they experience;
- 19 respondents, or 58% expect (indirect) cost increases, i.e., the hauliers experience direct cost increases, they raise their prices, hence the shippers experience cost increases in their turn;
- a mere 3 respondents, or 9% expect a decrease in the volume of their demand for road freight transport or will possibly switch to another transport mode as a consequence.
The conclusion must be that the impact of working hours regulations on shippers’ demand for road freight transport is very limited. If working hours regulations were to be considered as a tool for implementing a policy of discouraging the demand for road freight transport, then this tool would be used in vain.

Simple statistical tests were made to investigate if some appropriate attributes of the shippers company could “explain” the effect of working hours regulations on the demand for road freight transport.

The following seven hypotheses were tested:

**Hypothesis 1. Region**
Working hours regulations have more impact in countries of Northern Europe than in countries of Southern Europe. This hypothesis is based on the assumption that working hours regulations are more controlled and enforced in Northern countries and are less effective in Southern countries.

**Hypothesis 2. Products**
Working hours regulations have more impact on intermediate goods industries than on final goods industries. Since intermediate goods have on average a lower value density than final goods, a given transport mode will contribute a larger percentage of costs to the intermediate goods than to the final goods and hence have a relatively larger impact. For lack of further evidence, all branches of industry covered by the questionnaire were classified as intermediate products, except for Distribution and Food products, which have been classified as final products.

**Hypothesis 3. Size of the enterprise**
Working hours regulations have more impact on large enterprises (LE’s) than on small or medium enterprises (SME’s). This hypothesis is based on the assumption that large enterprises ship more often on their own account and will thus experience the impact of working hours regulations more directly, whereas small and medium enterprises ship more often by third party hauliers, who may absorb the impact of working hours regulations and not pass it on to them. On the other hand there is an alternative hypothesis that the reverse is true: working hours regulations have more impact on SME’s than on LE’s, because SME’s have a weaker bargaining position.

**Hypothesis 4. Own account**
If the shipper uses a significant own account park for more than 20% of the consignments, he is more liable to experience effects from working hours regulations, because they hit him more directly than in the case when he outsources all of his transportation to a professional haulier.

**Hypothesis 5. Transport cost**
If the estimated percentage of sales revenue spent on transport is relatively high, the shipper is more sensitive to working hours regulations, because they directly or indirectly affect a larger proportion of his total costs. The borderline between a high and a low percentage of sales revenue spent on transport is put at 3.0%.

**Hypothesis 6. Distance to market**
If the average distance to market of the shipper’s products is long, working hours regulations will have more effect on him than if the average distance to market is short. This is because working hours regulations are organisationally more difficult to cope with in long-haul transportation than nearer to the home base. If the estimated average distance to market is 500 kms or more the distance to market was classified as long, otherwise as short.

**Hypothesis 7. Price priority**
If price plays a major part when the shipper chooses a transport mode and organises his transports, working hours regulations will have relatively more effect. This hypothesis is based on the questionnaire item where
the shipper is asked to determine a hierarchy of five aspects influencing his transportation decision: price of transport; cost of warehousing including capital costs for stored products; time of transport; reliability (including safety and punctuality) of transport; flexibility (in function of the demand variation). If the priority level of the price of transport is 1 or 2, the importance of price is considered high; if the priority level of price of transport is 3, 4 or 5, the importance of price is considered low.

None of the hypotheses was contradicted by the test results. In four cases, the evidence was neutral: it neither strengthened nor weakened the hypothesis. Nevertheless, this may be regarded as a weakening: if the hypothesis were true, the test results ought to support it. Three hypotheses were supported by the evidence:

- Working hours regulations have more effect on the demand for road freight transport in the North of Europe than in the South of Europe;
- If the shipper uses a significant own account park for more than 20% of the consignments, he is more liable to experience effects from working hours regulations;
- If the estimated percentage of sales revenue spent on transport is relatively high (over 3%), the shipper is more sensitive to working hours regulations.

5.1.1.5 Conclusions

The cost factor analysis shows that the cost factor drivers’ wages for the collection and distribution truck operation differs remarkably from the others. This cost factor is on average for all the data 50.4% of the total operating cost. Next come three much smaller cost factors nearly equal, the cost of administration (11.6%), the depreciation (10.9%) and the fuel (10.3%). For the long distance haulage truck operation there is no such high difference between each specific cost factor though some are obviously higher than others. The highest cost factor is the drivers’ wages as for the collection and distribution truck operation. The average value is 33.0% of the total operating cost. Next largest cost factor is the fuel with average value of 20.4%. It can be derived, from comparing these two businesses, that it is the drivers’ wages that is the most significant cost factor. The second most important factor is the fuel cost, especially for the long distance haulage truck operators.

Analysing the cost structure of some of the CEEC countries, it was noticed that the share of wages is less significant (approximately 15%) than in the EU countries. This is one of the most important factors that will affect competition between European carriers. However, more important factors are the fuel (approximately 25%), the depreciation (approximately 17%) and the administrative costs (approximately 18%).

The tax analysis covers two different categories of taxes; the main direct taxes and the main indirect taxes. The analysis shows that the direct taxation on the truck operation, i.e. vehicle tax and road charges, amounts to just a small percentage of the total cost. This varies between countries but the vehicle tax is on average for collection and distribution 1.2% and long distance haulage 1.5% of the total operating cost. Different road charging systems exist, both privately and governmentally operated, and do account for 1.4% to 8.8% of the total operating cost. One of the main indirect taxes, the fuel tax, as a percentage of fuel pump prices is pictured in Figure 1, excluding VAT.
The level of excise duty on the fuel price in the different countries varies between 55% (Austria) and 76% (Great Britain). The average value is 62% and despite the extremes of few countries it seems that there is a trend for convergence.

The total tax costs in form of indirect taxes as fuel tax and direct taxes as vehicle tax or road charges vary substantially between countries. The lowest values of these taxes in the EU member states are found in Denmark and Belgium, only 10.7% and 11.3% of the total operation cost of long haulage trucks. The highest tax values of the total operation cost for long distance truck operation can on the other hand be found in three different countries: Italy (24.7%), Great Britain (24.5%), and Spain (24.4%). The different reasons for these high values does make comparison of the effects of different changes in taxation difficult to accomplish. If the total value of the discussed taxes would be increased by 10% the results will be 2.5% increase in total operation costs for the three countries with highest taxation. At the low end a 10% increase in taxation would result in 1.1% increase in total operations cost. On average a 10% increase in the total taxation would increase the total operation cost of the long distance haulage operators in the EU member states by 1.7%.

For the collection and distribution truck operation the effects are different. As the drivers’ cost factor is about half of the total operation cost, the fuel cost about 10% and very limited road use charges the effects of 10% tax increase is limited to about 0.75% increase in the total cost on average.

A classification of goods transported was made in order to relate transportation costs by mode to production costs. This was done by carrying out an analysis of input-output tables from the Netherlands. The main conclusion from this analysis is that transportation costs are very small fraction of total production values. This phenomenon warrants the expectation that industries generally will be fairly insensitive to price changes in the transportation services, since transportation plays such a minor part in their total turnover.

It was observed that it is possible to map the transportation services by mode in relation to the production value of different industries. However, the hypothesis that higher quality goods having higher value density demand higher quality transportation services could hardly be empirically verified.

5.1.2 Data Collection by Country

The Cost Data Collection was mainly performed through a direct investigation among the hauliers, and not by collecting existing data in the literature. This choice was a consequence of the differences found between data collected from literature and the real market prices, as in the case of Switzerland, where data from literature are 20-25% higher than those collected.

Two kinds of surveys were developed during the whole length of this task:
• a specific survey addressed to the hauliers to know their prices on some selected shipment sizes and lengths of trip and on some international long distance routes;

• a First Shippers Panel Survey addressed to 50 selected shippers firms, to check the results of the preceding cost collection and to gather information on factors affecting demand and working hour regulations (see the previous paragraph 5.1.1).

The structure of this part of the SOFTICE is represented and resumed by the flow chart of Figure 2.

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**Figure 2** Data Collection by Country Flow Chart

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5.1.2.1 **Analysis of the Data collected by the Hauliers**

The results of the survey addressed to the hauliers can lead to the following observations:

- Considering the 1 tonne pallet segment we can see a difference in the data from Belgium, France and Switzerland respect to the other countries. Belgium and France in fact are positioned at a lower level than the others, whereas Switzerland is positioned above. It should be noted also that Portugal presents the highest value for 500 kms segment. The analysis of the data as a whole in a unique group and the attempt to define a linear regression equation led to unsatisfactory results: the $R^2$ coefficient is, in this case, equal to 0.54. By excluding Belgium, France and Switzerland from this analysis better statistical results have been obtained (the $R^2$ coefficient of the linear regression passed from 0.54 value to 0.83). Probably these results are caused by differences in services offered by hauliers in each country, which may include or may not include some components like handling or warehousing.

- Regarding the 1 tonne non pallet segment, the results showed a trend which is substantially the same of the previous one, with a slight less random order, thus the same considerations can be done. It is important to observe that for more than one country the prices for carrying a 1 tonne pallet shipment are the same as those requested for a 1 tonne non pallet shipment. We should suppose that costs for these two kinds of transport are very similar for hauliers, even if this aspect could be also better analysed.

- Finally, the FLT segment results were strongly influenced by the different law regulations on maximum truck weight in each country (considering that the data were normalised to 1 tonne). Trying to analyse the
total data led to the impossibility to define a linear regression equation (the attempt led to an $R^2$ of 0.27). The high costs of Denmark, Sweden and Switzerland are remarkable. The attempt to divide all the data in categories led to define three main groups: an “high costs” group (Denmark, Sweden and Switzerland), a “medium cost” group (Germany and Netherlands) and a "low cost" (all the others).

According to the analyses carried out in the East European Countries, in the 1 tonne pallet and the one tonne non pallet segments, it has been observed large differences between the four countries (Lithuania, Poland, Hungary and Czech Republic) analysed, with highest prices in Lithuania and lowest in Poland. Hungary and Czech Republic have medium level prices. For these cases (1 tonne), the differences between European and East European prices are similar both for the pallet and non pallet segments.

For 100 km, European prices are between 3 and 8 times higher than in the East European countries, and at 300 km and 500 km, up to 10 times greater than the prices in Poland.

Considering the full truck load segment, we see that Poland still has the lowest prices per tonne, then Czech Republic, Hungary and Lithuania. In this segment, the prices are closer to West European average prices.

Analysing the cost structure, we see that the share of wages is less significant in the East European countries (approximately 15 %) than in the EU (approximately 30 % for long distance haulage and 50 % for collection and distribution). This is one of the most important factors which will affect competition between European carriers.

However, more important factors are the fuel, the depreciation and the administrative costs. Concerning vehicle taxation, tolls and user charges, these countries do not have a similar approach in levying taxes and duties on transport operators.

5.1.2.2 The data collected during the First Shippers Panel Survey: a statistical analysis

The collected data have been ordered in a database and later on analysed with statistical software. The first analyses were made by means of linear regressions, but an attempt to identify linear trends between distance and cost did not always correspond with the results obtained for single data sets: the value of the coefficient of determination ($R^2$) often tends to be low. For this reason a number of non-parametric statistical tests were carried out to ascertain whether any significant differences could be determined between full load truck shipments and the group of other shipments. Boxplot representations were used in order to visualize the first, third and median quartile of the distributions taken into consideration. In these diagrams, the minimum and maximum values observed are represented by the lower and upper horizontal lines; the median (or central value) is represented by a small square, and the values from 25% to 75% of the distribution by the bigger "box". Therefore, the boxplot approach offers a good idea not only of the global variability of the data and its range, but also of its concentration in the middle of the distribution. Moreover, since the median is much more stable and reliable (i.e. less affected by outliers) than the average, this analysis provides useful support to the examination of more traditional indicators such as average and standard deviation.

With a few exceptions, the average unit cost of shipment was between 1 and 2 ECU/Km for all data sets constructed in the basis of the shipper's country of establishment. A geographical representation of costs for each country is given in Figure 3.
It is much more difficult to identify specific data sets on the basis of a shipper's economic branch of activity. Food and industrial products (Figure 4) would seem to entail higher unit costs of transport (i.e. average cost greater than 2 ECU/Km), but their variability is quite large. In addition, the mode of transport affects the average cost considerably by defining a more uniform sub-set, lowering both the average and standard deviation values. On the other hand, textiles usually involve lower costs.

These impressions are confirmed by a boxplot analysis (Figure 5).
Another feature that could affect the cost of transport is the size of the shipping company. The size of such a company can typically be gauged both in terms of the number of employees and annual revenue (i.e. sales in MECU). Tests performed on selected subsets of the database relative to these two variables revealed that the average cost of transport per Km can vary significantly with respect to the size of a shipping firm. When the size is measured in terms of the total number of employees, SMEs (Figure 6) register an average 2.96 ECU/Km, while medium and large size firms register much lower values (i.e. between 1.26 and 1.61 ECU/Km).

The situation changes radically when only full load truck (FLT) shipments are considered within these data sets (Figure 7). The lowest unit costs are associated with the SMEs, while the costs of medium and large size firms are higher, albeit not that different from the ones calculated above. This could mean that the mode of transport has a strong impact on costs, especially when SMEs and short distances are involved.
Similar results are obtained when the analysis is conducted on the basis of the annual sales of shippers in MECU (Figure 8). Unlike before, there was no dramatic change in the situation when FLT shipments were considered on their own, even though there was a reduction in average unit costs as could be expected.

On the basis of the results obtained for data sets based on the volume of consignments (tons), no particular trends were noticed, except for the fact that the average unit shipment cost decreased as volume increased from the set of shipments under 20 tons, and between 20 and 100 tons, and then increased when shipments passed the 100 tonne mark.

Required at this point would be a closer examination of the different distance categories (i.e. short <= 500 Km; medium 500 <= 1000 Km; long >1000 Km). The average cost for short distances was 2.57 ECU/Km, while it was approximately 1.01 and 0.93 ECU/Km for medium and long distances respectively.

Out of the total number of shipments, 104, there were 57 that involved FLT. As mentioned above, in some data sets the kind of transport (FLT or LTL, Light Truck Loading) affected the unit cost of shipment. In fact, when considering all the observations reported, FLT shipments tended to record significantly lower cost per Km values. The boxplot in Figure 10 represents the median and quartile values for both FLT and LTL. In the case of FLT, the median is the same (approximately 1 ECU/Km) as in the case of other kinds of transport, but 75% of the distribution presents lower values, and the distribution is much more concentrated.

![Boxplot by Kind of Transport](image1.png)

**Figure 10** Unit shipment cost by kind of transport (ECU/Km). Boxplot

The boxplot representation is a useful way to highlight the distribution differences which are more informative than the average differences, especially when no assumption on normality may be accepted, and/or the number of observations was limited. In some cases the distinction between FLT and LTL has determined a significant difference in the unit cost per Km, as reported in Figure 11, where the food sales example is reported.

![Boxplot by Group](image2.png)

**Figure 11** Unit shipment cost for food sales (ECU/Km). Boxplot

5.1.2.3 A comparison between the First Shippers Panel Survey and the cost data collected among the hauliers

The cost data collected during the First Shippers Panel Survey was compared with the values previously collected among the hauliers. On the basis of the collected and processed data it was considered appropriate to focus the comparison on the FLT shipments, which present the best characteristics of homogeneity.

In the following Table 2 all the shipments on distances less of 1000 kms (average values from Shippers Panel Survey, normalised to 300 kms - the average distance of this group of shipments is 386 kms) are presented and compared with the prices offered by the hauliers for shipments on a 300 kms distance. It is interesting to observe that the Shippers’ costs are always lower than the prices declared by the hauliers, with more relevant differences from Portugal (-34%) and Switzerland (-66%). The fact that almost all the shipments considered during the Shippers Panel Survey are regular ones can be one of the causes of this difference, but probably the presence of fares which are only theoretical and not respected by the hauliers can also realistically explain this discrepancy.

<table>
<thead>
<tr>
<th>Distance Range</th>
<th>Shippers Cost</th>
<th>Hauliers Price</th>
<th>Portugal</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1000 Km</td>
<td>3.24 ECU/Km</td>
<td>4.35 ECU/Km</td>
<td>-34%</td>
<td>-66%</td>
</tr>
<tr>
<td>300 Kms</td>
<td>2.97 ECU/Km</td>
<td>3.50 ECU/Km</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the following Table 2 all the shipments on distances less of 1000 kms (average values from Shippers Panel Survey, normalised to 300 kms - the average distance of this group of shipments is 386 kms) are presented and compared with the prices offered by the hauliers for shipments on a 300 kms distance. It is interesting to observe that the Shippers’ costs are always lower than the prices declared by the hauliers, with more relevant differences from Portugal (-34%) and Switzerland (-66%). The fact that almost all the shipments considered during the Shippers Panel Survey are regular ones can be one of the causes of this difference, but probably the presence of fares which are only theoretical and not respected by the hauliers can also realistically explain this discrepancy.
Table 2  Shippers Panel Survey and Cost Data Collection comparison for FLT shippings

<table>
<thead>
<tr>
<th>Country</th>
<th>Shipping distance</th>
<th>&lt;1000 kms</th>
<th>300 kms</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) (ECU)</td>
<td>(2) (ECU)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRANCE</td>
<td>282</td>
<td>360,4</td>
<td>-22%</td>
<td></td>
</tr>
<tr>
<td>GERMANY</td>
<td>379,5</td>
<td>428,5</td>
<td>-11%</td>
<td></td>
</tr>
<tr>
<td>ITALY</td>
<td>329,4</td>
<td>396,5</td>
<td>-17%</td>
<td></td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>245,1</td>
<td>370</td>
<td>-34%</td>
<td></td>
</tr>
<tr>
<td>SWEDEN</td>
<td>317,4</td>
<td>365</td>
<td>-13%</td>
<td></td>
</tr>
<tr>
<td>SWITZERLAND</td>
<td>272,7</td>
<td>805</td>
<td>-66%</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) average values from Shippers Panel Survey, normalised to 300 kms
(2) values from Cost Data Collection

5.1.3 Factors affecting demand for freight transport

Demand for freight transport depends first and foremost on trade - commercial relations involving material goods - and on how those goods are transported. During the analysis it was tried to identify the groups of factors that influence demand for freight transport in a structured way, but in doing so it was dedicated a variable level of attention to factors, depending not only to their relevance but also (and especially) to the possibility of intervention upon them by policy makers in the field of transport.

International trade and the associated transport flows constitute a very complex subject, not only because of the presence of many factors and their interrelations, but also because many of those factors are actuated by agents in distant and unfamiliar environments, thus making their perception of circumstances very different from the one that can be developed in the relatively homogeneous European field, and so their actions and reactions difficult to anticipate by an interested observer located in Europe.

Our approach to the problem was organised in a three tier structure, starting with the issue of trade volumes at the top level, then passing to production and distribution schemes at the second level, and finally treating the question of transport solutions at the bottom level. Developments in all these three levels are inter-related, but the structure facilitates presentation of the argument.

Since the aim of the SOFTICE project was to develop a better understanding of factors that intervene on decisions of modal choice for freight transport, the description of the higher tiers of the structure was made in order to provide a framework, but the focus of our attention was be given to solutions and strategies at the bottom level.

The main types of models used for decisions concerning transport solutions were introduced after presentation of the main factors and their interrelations, both under a fixed production and distribution scheme, and in a case of joint consideration of production and transport decisions.
An econometric model was presented with an application to the estimation of modal split between land-based modes in a multi-region, multi-product freight O/D matrix, showing that interesting results can be achieved through modelling.

The set of factors influencing freight transport demand was reviewed using a three-tier approach:

- Trade volumes;
- Production and Distribution Models;
- Transport Solutions.

and have tried to develop a systematic presentation of such factors, in such a way that will facilitate later work in this project.

Concentrating then on the specific mission of the SOFTICE project, which is dedicated to the question of induction of changes in modal split of freight transport, the literature for models dealing with this issue was reviewed, covering aggregate models (region to region freight) and disaggregate models (one firm decisions), the latter both in a transport-only approach and in an approach that tries to combine transport and inventory management.

In addition, an example of application of an econometric model has been made for the estimation of modal split for the land-based transport of different types of goods between regions of Germany.

The results achieved with the model indicates that an acceptable level of precision may be achieved for the estimation of modal split, even using a relatively rough set of explanatory variables (here it was distance, fare and travel time by mode, total quantity of freight for that pair of regions, and group of goods considered).

However, this result is applied for trade in one particular year, with reasonably constant values of the values above referred as “indirect factors influencing demand”, such as regulations, technology, etc. Thus, it is impossible to know on the basis of these runs to what extent would changed in those variables affect the previously existing modal split (or even quantities transported).

5.2 WP2 - Methodology

The first workpackage has given an overview of the costs of transport in the European countries, based on national sources, and a specific survey was carried out for the purpose of SOFTICE in different countries. Workpackage 3 gives some outlooks on future possible impacts of various measures affecting transport costs, with development of scenarios. Workpackage 2 is thus in a central position in between the two: the methodological choices for segmentation of Workpackage 2 were used to structure the survey of Workpackage 1, and the methodology for the appraisal of road transport costs, developed in the Workpackage 2, is used for long term projections in Workpackage 3.

The first part of the methodology deals with the estimation of the transport cost share in the value of the products using national accounts of different countries. The second part is a macro-economic approach to transport costs using data collected from transport operators and segmenting the transport chain between collection, distribution and long-haul. The third part focuses on qualitative aspects which also influence logistic organisations and raise the problem of external costs which are not included in the transport costs; these aspects are essential for policy makers.

5.2.1 Market Segmentation and Transport Costs

The segmentation principle was used as a basis for all the work carried out in this workpackage. It was also the starting point of the SOFTICE survey, and thus was defined early in the progress of the project. Not all
criteria resulting from the segmentation were considered in the different cost approaches, depending on the
task and the aim required.

The impact of the cost of transport obviously differs from one market segment to another. Most of the studies
segment the market according to the type of product, with in many cases 10 or 20 groups corresponding to
the NST definition. In our analysis, it was considered that these criteria are not sufficient, and as a result the
issue of the shipment size was highlighted since freight costs result from a door-to-door transport which takes
part of a complex logistic system. Otherwise, products were distinguished as intermediate or finished goods
and of low or high value, taking into account when possible the size of the shipper.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Parcels</th>
<th>Pallets</th>
<th>3 T – 25 T</th>
<th>Full load truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate</td>
<td>Low value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finished</td>
<td>Low value</td>
<td>Small and medium-sized companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High value</td>
<td>Small and medium-sized companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large companies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 12 SOFTICE Segmentation

5.2.1.1 The Size of the Shipment

In the door-to-door approach, the importance of the shipment weight in road transport costs from the
haulier’s point of view was considered more particularly. Obviously the issue of the shipment size was not
considered in the same way by the shipper and by the haulier. For the shipper, this is a decision which
depends on multiple parameters. He needs to attain an optimum between production, inventory and
transportation costs, thus implying that the size and frequency of shipments are linked to the value of the
product. Arbitration between the size and the frequency of the shipment also depends on the link of the
transport chain concerned, i.e. the origin and the destination of the transport shipment (these could be a
manufacturing plant, a depot, a retail outlet etc). This decision-making process for shippers will affect the
transport organisation of the haulier, and the segmentation of transport supply. For the haulier, the shipment
size is essentially an operating problem and a question of know-how, which is linked to the haulier’s
requirements (transit time, price, quality of service, annex services etc.).
From the haulier’s point of view, it is known that the shipment size has a strong influence on transport rates, this can be illustrated with a curve drawn from the results of the SOFTICE shippers survey (see Figure 13, non valid data were discarded). Moreover, in the 1988 French shipper survey, the coefficient of correlation between the shipment weight and the price of transport was 0.85, i.e. higher than that between the value of the shipment and the price of transport (0.74) (Gouvernal et al., 1996).

Indeed, road transport rates increase linearly with distance, but when related to the weight of shipments they reveal the existence of certain thresholds. Thresholds can be explained by handling costs which are very significant for smaller consignments and by the fact that they require different systems of transport organisation, and also as it is possible to see in the second section (paragraph 5.2.3.4), consolidators benefit from a wider margin on smaller shipments. We refer here to a shipment size measured in tonnes, because of the available data, but the haulier obviously has to calculate several ratios in terms of surface area, volume, and weight in order to optimise the load of the lorry. Some of these dimensions may now be more pertinent due to the decreasing density of products.

5.2.1.2 The Type of Products
The type of products is reflected in different logistic organisation and cost structure. A first distinction has been made between intermediate and finished products which are defined as follows:

Intermediate goods (and services) are the goods (and the services) that companies buy from each other and use as inputs in the goods and services they sell to the final users, i.e. in their finished products. Intermediate goods are, therefore, purchased for further reprocessing and resale, whereas finished goods are sold to ultimate users. It is difficult to unequivocally identify ‘pure’ intermediate good producers or ‘pure’ finished good producers. In fact, even industries that are generally considered as typical representative of intermediate production do not produce only intermediate products, and vice-versa. Moreover the same good may be intermediate or finished according to whom it is sold.

Further disaggregation per type of product is relevant for more precise comparisons, but this cannot be done with a coverage of all the industrial activities. To proceed progressively, it can be interesting to distinguish low value and high value goods, before specifying in more detail the type of product.
Small, medium-sized and large companies have quite different logistic organisations and choices of transport organisations for the same type of product. However this kind of data is not often available, though it was taken into account when possible.

5.2.2 Transport Costs as a Proportion of Total Production Value: Input-Output Tables

The value of one unit of output (i.e. of a good) is the sum of the costs of the intermediate goods necessary to produce it and the value added per unit of product. Input-output tables of national accounts make possible to compare the total output of each economic sector with the value of the consumed inputs. However, only transactions between firms are taken into account, ignoring thus expenditure due to transport services performed by firms with their own freight fleets. For this reason, for-hire and own account services were studied separately, using additional statistics to estimate the impact of own account operations upon production costs. Another difficulty was that passenger expenditures are included in certain figures, and it had not been possible to correct this.

Input-output tables for Switzerland, France and Italy were studied. But only those for France and Switzerland are presented herein as for Italy the most recent available data are for 1988 (and since they were found to be too aggregated, additional data for 1980 were used).

5.2.2.1 Switzerland

The main available data are for the year 1990 (input-output tables) and 1993 (own-account road transport performances). For-hire transport data were aggregated with the valuation of own-account transport into 8 macro-sectors of production in order to make possible a complete estimation of the weight of freight transport costs on the economy. From these results, some inferences can be drawn:

- the transport costs as a percentage of total output represent on average nearly 3%, and do not exceed on average 7%;
- but this percentage varies considerably according to the economic sectors, the transport cost-intensive branches are ‘food and beverages’ and ‘other products’ (i.e. clothing, paper, leather etc.), while ‘vehicles and machinery’ and ‘electric power, gas and water’ are the least intensive;
- own-account road transport expenditures are not negligible as their total share of production is 0.63%, and they represent roughly 22% of the total transport expenditures; but a calculation of transport costs based only on input-output tables data can lead to serious underestimation of these costs;
- cost-intensive own-account transport sectors are especially ‘agriculture and forestry’ and ‘food and beverages’;
- it is difficult to get findings about the difference between intermediate and finished products, but the available data seem to indicate that in the sectors producing finished products the for-hire transport is predominant, while own-account operations are very important in the branches that concern principally raw materials and intermediate products;
- the percentage of transport costs vs. production price may also be high for certain sectors, particularly those concerning finished products, like the ‘other products’ branch which groups clothing, furniture,

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2 All the input-output tables and the methods of valuation of own-account transport can be found in the annexes of the SOFTICE Deliverable D2, ‘Methodology for freight transport costs in Europe’. The aggregated data presented herein can also be found in the D2 synthesis report.
etc. Therefore the distinction between the ‘raw materials and intermediate goods’ sectors and the ‘finished products’ sectors does not seem very relevant considering the transport cost intensity, at least at this level of aggregation that is possible to analyse with macro-economic data.

5.2.2.2 France

The base year for estimation is 1996. As for Switzerland, separate estimations of for-hire and own-account transport costs were made, because of the different sources of the data (input-output tables for for-hire transport, tonne-kms transported for own-account transport). The high level of disaggregation (94 economic sectors) of the input-output table allows appreciation of the differences of transport cost-intensity, even between branches usually considered as very similar from the transport viewpoint. However the estimation of own-account transport requires aggregation of the data into 7 macro-branches. At this level of aggregation, transport costs as a percentage of total output are on average near 3%, as Switzerland, and do not exceed 6%. As expected, this percentage is not constant for every economic branch (intermediate products then consumer goods are the most transport cost-intensive branches as opposed to ‘agriculture’, the ‘food industry’ and ‘energy’).

5.2.3 Segmentation of Transport Supply and Operating Costs

Statistics in freight transport usually refer to tonnes and tonnes-kilometres, however they fail to show the heterogeneous market which was highlighted in an important French survey of shippers in 1988. This survey revealed that shipments under 1 tonne represent 73% of all shipments but only 17% of the tonnage, and on the opposite side shipments over 20 tonnes represent only 5% of shipments but 43% of the tonnage (Guilbault, 1995).

The knowledge of the transport cost depends to a large extent on the understanding of the transport organisations which refer to the following activities: groupage, consolidation, and full truck load. The latter is well identified, and the costs can be analysed with the cost breakdown given in the workpackage 1 of the SOFTICE project. However, the 1988 shipper survey showed that only 1 shipment in 4 for hire-and-reward transport is a single route transport and therefore 3 out of 4 shipments involve more complex transport operations such as groupage and consolidation. These organisations and their costs are described using the results from the French shipper survey of 1988, and a few interviews carried out with hauliers and consolidators in France and in Italy.

5.2.3.1 Segmentation of Transport Activity

The description of the market herein deals with road freight transport in France, nevertheless it is possible find similarities within Europe. The main activities in road freight transport are: parcel services (groupage), consolidation, full truck load. In relation to general cargo and according to the size of the shipment, the following segments can be distinguished:

- **parcel services** which include parcels and pallets with a weight limit of 3 tonnes, but in practice they are usually under 1 tonne or 500 kg;

- a **consolidation** activity which includes collection and distribution activities, the weight of lots is between 500 kg and 15 tonnes, yet most of the time these lots are under 7 tonnes;

- **Full Load Truck (FLT)**, i.e. shipments that allow use of the entire capacity of a truck.

The segmentation of the parcel services supply is becoming increasingly complex, as it has evolved in terms of weight and delivery time and also geographically. Services are sometimes not easy to distinguish, particularly for smaller consignments. For example, in France, a new service for small parcels, i.e. under about 30 kg, has appeared 10 years ago. Dimension limits of the parcels are well defined and enable operators to introduce automated and standardised processes, and to use light vehicles that do not need
specific equipment such as hatchback. In fact some services, which may appear similar to the shipper, reveal different organisations of transport that allow operators to make productivity gains with certain shipments.

5.2.3.2 Operating Costs from Interviews with Hauliers

The aim of this section was to give a basic knowledge of the costs and their share in a multiple route road transport. The figures come from six interviews carried out in France with important hauliers / consolidators, five of which have national and international activities, and two companies in Italy.

First of all, it is necessary to bear in mind that transport costs and rates have to be differentiated. It is well known that hauliers may accept carrying goods at low prices to avoid unladen kilometres or even to complete the load of a truck. The weight and the distance of shipments explain a large part of the variance of rates, but it was also proved that regions affect rates (Brion, 1995). This influence is essentially due to the flow imbalances which exist between regions. Such a result shows that rates do not only reflect costs.

Nevertheless, hauliers usually use internal rates as a basis for their quotations, representing their average costs, determined from the analysis of fixed and variable costs expressed in currency by kilometre and either by hour or day. Average costs given in this sub-section are taken from these internal rates, which are often used within the company.

5.2.3.3 Parcel Services

The two companies interviewed in France have a similar organisation, the average weight of a shipment is between 70 and 80 kg. Collection and distribution are made with light trucks during the same trip by each office. After being grouped in the office, parcels are carried in a heavy vehicle to a platform for sorting.

It results from interviews and the from the FFOCT (French Association of Transport Organisers), which follows the evolution of these costs since 1992, that collection and distribution represent about 45% and line-haul 20%. Other costs are handling, sorting, administration etc. Even if collection and distribution costs are not distinguished, distribution is usually more expensive, sometimes 2 or 3 times higher (Crédit National, 1995). Indeed, missing consignees oblige the haulier to return sometimes up to 3 times in urban areas or to wait a long time, and one shipment may also be constituted of parcels intended for several consignees.

For small parcel services (about 30 kg), collection costs (handling included) have been found between 19% and 44%, and distribution costs (handling included) were found to be between 46% and 66% of the total consignment costs. In this case, the share of collection and distribution is overwhelming in comparison to the line-haul cost.

In general, the significance of collection and distribution costs may be explained by several factors:

- the operating costs of a light vehicle are proportionally higher than a line-haul truck;
- the handling costs of small shipments are proportionally higher;
- frequent expensive deliveries in urban areas.

5.2.3.4 Consolidation

The cost split appears less clear in consolidation activity than in parcel services due to differing systems of organisation by hauliers. According to interviews, the weight of the average lots stands between 3 and 5 tonnes, but companies strive to decrease it as margins are higher from smaller shipments. It seems that the line-haulage cost (handling excluded) represents not more than 10% of the total costs of consignment on distances up to 500 km. For distances up to 1 000 km this figure comes closer to 20%.

According to the 1988 French shipper survey, this market represents about 20% of the tonnage and 10% of the shipments, and thus cannot be neglected. In addition, consolidation offers a very open perspective in
terms of market organisation. On one hand, some hauliers which act also as a forwarding agent keep on contracting out transports, most of the time to single vehicle operator, at unrealistic price levels, and this kind of service appears cheaper and more flexible. But on the other hand, according to interviews with truck manufacturers, some hauliers now carry goods in light trucks (from less than 3.5 tonnes up to 10 tonnes) even on long distances. This recent organisation really needs further research.

5.2.4 Integration of Transport in the Logistic Chain

5.2.4.1 Distribution Structures

Traditional Distribution Structures

The traditional distribution structure contains all four levels of distribution paths:

- from the factories to the central warehouses (CW) which are first-level distribution centres and may have a national or supranational market coverage;

- from the central warehouses to the regional warehouses (RW) which serve as destinations of trunk transports from the factories or from the central warehouses and as starting points for short-distance deliveries to lower-level warehouses, customers or manufacturers. Regional warehouses can be therefore first or second-level distribution centres;

- from the regional warehouses to the local warehouses (LW) whose function is to cover local markets with differences in culture, taste, consumer preferences and environmental regulation. Local warehouses are usually fed from central warehouses or regional warehouses and can be second or third-level distribution centres;

- from local warehouses to the customers or manufacturers.

Distribution networks can have different configurations dependent on factors such as the size of the company, the location of manufacturing facilities, the levels of expansion and demand of customers and manufacturers as well as product characteristics such as value, volume etc. Obviously, several combinations of these factors exist, resulting in a significant number of network configurations. Since distribution is considered as a value-added process, companies are striving to design effective distribution networks, suitable to their businesses, in order to reduce the total logistic costs and at the same time increase the customer service.

As a result, many different distribution structures can be distinguished. A distribution network can be characterised as centralised or decentralised, considering the intermediate distribution centres between producer’s facilities and customers or manufacturers. A highly centralised network involves only one distribution centre while in a decentralised network the number of intermediate distribution sites reflects the degree of decentralisation. Distribution structures are affected by two main types of transport costs: the trunking-costs, for the delivery from production sites to warehouses or transhipment points, and the delivery costs, from warehouses to customers. Traditionally, distribution structures have been quite decentralised because delivery costs drew the distribution warehouses closer towards the markets (see the following Figure 14).
Transhipment points (Figure 14) have the same function as the central warehouses or regional warehouses without keeping any stock. Transhipment points can be first or second-level distribution centres.

Finished and intermediate products are moving from producers to customers and from producers to other manufacturers respectively. The degree of centralisation of the distribution structure depends also on the type of product. In most cases, intermediate products are delivered either directly or through one distribution centre (i.e. a warehouse or a transhipment point) to the manufacturers. On the other hand, finished products usually pass through several distribution centres before reaching the customers and they are seldom delivered directly.

Long Distance Primary Distribution

Primary distribution is one of the key links in the supply chain. It tends to involve the longest hauls, and the lowest unit cost in terms of tonne-kilometres or Euros per pallet-kilometre. Research into mode choice for long distance movements, mainly primary distribution, of a selection of UK industries was undertaken ten years ago which gives in-depth information concerning the service specifications required by 50 firms in ten sectors. These are listed in the following table, together with a synopsis of the data collected.
<table>
<thead>
<tr>
<th>Commodity</th>
<th>Cement</th>
<th>Metal Tubes</th>
<th>Oil Products</th>
<th>Fertilisers</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Cost as % of Value</td>
<td>18.7%</td>
<td>2.0%</td>
<td>6.0%</td>
<td>6.4%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Transport cost ECU per tonne km</td>
<td>0.049</td>
<td>0.088</td>
<td>0.069</td>
<td>0.039</td>
<td>0.087</td>
</tr>
<tr>
<td>Average length of haul (km)</td>
<td>290</td>
<td>255</td>
<td>431</td>
<td>285</td>
<td>255</td>
</tr>
<tr>
<td>Range (km)</td>
<td>177-395</td>
<td>161-371</td>
<td>190-839</td>
<td>248-377</td>
<td>193-468</td>
</tr>
<tr>
<td>Frequency of despatch (per week)</td>
<td>-</td>
<td>2.5</td>
<td>6</td>
<td>16</td>
<td>4.5</td>
</tr>
<tr>
<td>Range</td>
<td>-</td>
<td>-</td>
<td>5-11</td>
<td>-</td>
<td>1-12</td>
</tr>
<tr>
<td>Value (ECU per tonne)</td>
<td>77</td>
<td>1098</td>
<td>500</td>
<td>177</td>
<td>2,470</td>
</tr>
<tr>
<td>Range (ECU)</td>
<td>58-91</td>
<td>151-2,273</td>
<td>126-1,212</td>
<td>151-182</td>
<td>1,088</td>
</tr>
<tr>
<td>Flow pa (tonnes)</td>
<td>41k</td>
<td>28k</td>
<td>5.9k</td>
<td>27k</td>
<td>-</td>
</tr>
<tr>
<td>Range (tonnes)</td>
<td>6-99k</td>
<td>0.25-135k</td>
<td>0.5-11.2k</td>
<td>12-48k</td>
<td>-</td>
</tr>
<tr>
<td>Delivery day</td>
<td>AM.2</td>
<td>2</td>
<td>AM.2</td>
<td>AM.2</td>
<td>AM.2</td>
</tr>
<tr>
<td>Reliability %</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Range</td>
<td>-</td>
<td>90-99</td>
<td>95-99</td>
<td>90-99</td>
<td>95-100</td>
</tr>
<tr>
<td>Mode Used: Road</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Rail</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Consignee: Customer</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Depot</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Commodity</td>
<td>Electrical Equipment</td>
<td>Chocolate</td>
<td>Domestic appliances</td>
<td>Chilled foodstuffs</td>
<td>Brewery traffic</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------</td>
<td>-----------</td>
<td>---------------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Transport Cost as % of Value</td>
<td>0.8%</td>
<td>0.8%</td>
<td>0.9%</td>
<td>1.6%</td>
<td></td>
</tr>
<tr>
<td>Transport cost ECU per vehicle km</td>
<td>0.143/pallet km</td>
<td>0.066/pallet km</td>
<td>1.01</td>
<td>1.48</td>
<td>1.29</td>
</tr>
<tr>
<td>Average length of haul (km)</td>
<td>205</td>
<td>295</td>
<td>308</td>
<td>308</td>
<td>282</td>
</tr>
<tr>
<td>Range (km)</td>
<td>161-322</td>
<td>193-484</td>
<td>258-403</td>
<td>268-342</td>
<td></td>
</tr>
<tr>
<td>Frequency of despatched (per week)</td>
<td>-</td>
<td>19</td>
<td>11</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Range</td>
<td>-</td>
<td>0.2-30</td>
<td>-</td>
<td>1-37</td>
<td></td>
</tr>
<tr>
<td>Value (ECU per load)</td>
<td>3,788/pallet</td>
<td>36,800</td>
<td>48,500</td>
<td>23,300</td>
<td></td>
</tr>
<tr>
<td>Range (ECU)</td>
<td>0.539-23k/pallet</td>
<td>15-76k</td>
<td>-</td>
<td>10-38k</td>
<td></td>
</tr>
<tr>
<td>Flow pa (tonnes)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Range (tonnes)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Delivery day</td>
<td>AM.2</td>
<td>AM.2</td>
<td>AM.2</td>
<td>PM.1</td>
<td>AM.2</td>
</tr>
<tr>
<td>Reliability %</td>
<td>96</td>
<td>98</td>
<td>96</td>
<td>99.66</td>
<td>95</td>
</tr>
<tr>
<td>Mode Used:</td>
<td>Road</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Rail</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Consignee:</td>
<td>Customer</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Depot</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
</tr>
</tbody>
</table>

The data show that there is a wide variation in the percentage which the primary transport cost forms of the value of the commodity, the range being from 0.8% for domestic appliances and electrical equipment, which are both high value goods, to 18.7% in the case of cement. These variations can also be explained by the fact that some commodities need special vehicles, and there are different requirements in service levels. Though some of these goods are delivered direct to the final customer, most incur further transport costs for delivery as well as warehouse and inventory costs. There is not only a wide variation in the value per tonne between the different commodities, but also within the product categories. This is because of specialist products within many industries. In the electrical equipment category the most valuable load was forty two times that of the lowest.
Secondary Distribution and Small Consignments

Secondary distribution, or final delivery, is often undertaken in a multidrop delivery round, where unit costs are dependent primarily on the density of delivery sites rather than the commodity being moved. It is much more effective to move goods in full vehicle loads, and on larger vehicles. However, most deliveries are done in less than vehicle loads, in a way that allows cost effective operations, given constraints such as unloading time restrictions, and lorry bans. The main strategies that firms adopt in secondary distribution are the direct supply in vehicle loads, multi-drop depot delivery rounds, consolidated loads, and groupage. Secondary distribution costs will be highest where delivery sites are dispersed, e.g. in rural as opposed to urban areas.

5.2.4.2 Logistics Trends in Europe

European Distribution Networks

Until recently most firms treated each country within Europe as a separate national market, with its own supply and distribution chain. This often included a National Distribution Centre and in many cases a network of Regional Distribution Centres in each country. As the EU grew, and in particular with the development of the single market, firms started to consider distribution of goods within Europe on a continental scale, or at least multi-national scale, instead of a national scale.

Though Europe may become a single market in commercial terms, natural physical barriers appear to limit the extent to which many firms adopt a unified distribution system for the EU countries. Clearly the British Isles form a distinct geographic area. Even with the Channel Tunnel the costs of distributing from locations on the European mainland are likely to be higher and more time consuming than using depot facilities within Great Britain. Other parts of Europe are separated from the centre of Europe by geo-physical barriers, as well as distance. Scandinavia is separated by sea, the long overland route via Russia not being an attractive alternative. Many firms are serving Norway from facilities in Sweden even though the former is not a member of the EU. The Iberian peninsula is separated from the rest of mainland Europe by the Pyrenees and many firms retain facilities in either Portugal or Spain, but are less inclined to treat them as separate national markets. Italy is separated from the rest of mainland Europe by the Alps, which combined with transport constraints in Austria and Switzerland, mean most firms are likely to serve Italy from local facilities. Greece is even more remote and is currently the most difficult market to integrate into an European distribution strategy because of the problems of access via the former Yugoslavia.

Aside from the geo-physical barriers, all the above countries form the periphery of Europe. The densely populated core of Europe can be supplied cost effectively with most goods from one or two facilities located in Germany, France or the Benelux countries, and there are a number of examples of firms adopting such distribution strategies.

A key message from a survey made by P-E Consulting (O’Sullivan, 1997) regarding 300 multinational companies of various continents that own plants located in Europe, is the dramatic reduction in the number of facilities. This is one of the effects of manufacturing and distribution rationalisation, and nearly half the companies surveyed have reduced the number of manufacturing sites. Furthermore, there has been a significant decrease in the number of warehouses dedicated to within-country movements with an increase in the number of warehouses serving more than one country.

As far as manufacturing is concerned, the general trend is towards a reduction in the number of facilities. With regard to distribution, the overall trend is towards an increase in the number of warehouses serving more than one country and a reduction in the number of warehouses dedicated to within-country movements.

The companies, participating in the survey, were asked what their ideal distribution structure would be if a greenfield site were possible. The most popular structure, almost irrespective of business sector, is a single central European warehouse with a limited number of inventory holding regional distribution centres in support.
Intermediate Products
Many different types of goods can be grouped within the category ‘intermediate products’. These products have specific characteristics concerning production regions, markets, logistic organisation, technical requirements for transportation and storage, etc. Some of them were analysed individually, despite their characteristics some general trends can be highlighted:

- reduction of the order size with the development of just-in-time practices;
- decrease in the number of facilities with notably more centralised warehousing which leads, with the first point, to a decrease in inventory costs;
- closer location of stock sites to customers;
- longer average length of haul;
- higher specialisation in production;
- rise of the modal share of road transport because of higher requirements for flexibility.

Finished Products
There are typical trends in new distribution structures for finished goods, reducing supply chain costs by optimising load consolidation. European production concentrated as a result of Single Market policies such as the elimination of border formalities, the removal of product specifications and technical harmonisation. Because of this, central warehouses have now greater importance, with transport implications: the sorting of products for specialised factories is done at central warehouses, and then are moved longer distances to reach customers. Also, the position of customers has strengthened as markets become more competitive. Customers now demand better distribution services, with shorter delivery times and smaller amounts delivered, and leading suppliers to keep higher stocks. These difficult tasks have induced many producers to use specialised logistics companies. Another recent trend is Europe-wide sourcing, as increased use of information technology reduces communication problems that can arise in long-distance transport.

5.2.4.3 Sample of International Transport Services

Presentation of a Survey
A survey of shippers carried out in the UK in 1997 included five flows of international traffic. Three of these were the movement of finished goods, where the cost of the international transport as a percentage of the value of the goods varied from 0.3% to 5.6%. In the case of an inter-factory movement of components the transport cost was 11.2% of the value of the goods. The fifth flow was of international mail, but it is not presented herein.

A breakdown of the values and service specifications of these flows are given in the following Table 4. The transport rate per kilometre varies from 0.82 ECU (ex.3) to 1.52 ECU (ex.1) reflecting the balance of traffic on the routes concerned, and the value placed on quality of service. The operators providing a high degree of reliability and short transits obtain much higher rates per kilometre, whereas the lowest rate applies to a high volume flow of LoLo container traffic, thought to be a return load operation coupled with the large purchasing power of the shipper.
## Table 4  International Transport Specifications

<table>
<thead>
<tr>
<th>Example</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise</td>
<td>Large</td>
<td>Large</td>
<td>Large</td>
<td>Large</td>
</tr>
<tr>
<td>Value</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Full/Part Load</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Origin</td>
<td>Herts (GB)</td>
<td>Scunthorpe(GB)</td>
<td>Merseyside(GB)</td>
<td>Staffs(GB)</td>
</tr>
<tr>
<td>Destination</td>
<td>Warsaw (PL)</td>
<td>Bjur (S)</td>
<td>Frankfurt (D)</td>
<td>N.Italy (I)</td>
</tr>
<tr>
<td>Distance (km)</td>
<td>1617</td>
<td>900</td>
<td>933</td>
<td>1680</td>
</tr>
<tr>
<td>Rate (£)</td>
<td>1625</td>
<td>725</td>
<td>503</td>
<td>1230</td>
</tr>
<tr>
<td>ECU</td>
<td>1027</td>
<td>458</td>
<td>318</td>
<td>777</td>
</tr>
<tr>
<td>Cargo</td>
<td>Reprographic materials</td>
<td>Confectionery</td>
<td>Cereals</td>
<td>Ceramics</td>
</tr>
<tr>
<td>Value of load (£)</td>
<td>516,000</td>
<td>40,000</td>
<td>9,000</td>
<td>11,000</td>
</tr>
<tr>
<td>ECU</td>
<td>326,100</td>
<td>25,300</td>
<td>5,700</td>
<td>6,950</td>
</tr>
<tr>
<td>Weight (tonnes)</td>
<td>14-16</td>
<td>19.4</td>
<td>12</td>
<td>12.5</td>
</tr>
<tr>
<td>Volume</td>
<td>53-54 m³</td>
<td>60 m³</td>
<td>63.4 m³</td>
<td>45 m³</td>
</tr>
<tr>
<td>Depart</td>
<td>A</td>
<td>am A</td>
<td>A</td>
<td>pmA</td>
</tr>
<tr>
<td>Arrival</td>
<td>0800D</td>
<td>pm D</td>
<td>0800D/1600D</td>
<td>amD</td>
</tr>
<tr>
<td>Reliability (%)</td>
<td>100</td>
<td>95</td>
<td>95</td>
<td>75</td>
</tr>
<tr>
<td>Regularity</td>
<td>10/month</td>
<td>5/month</td>
<td>35/month</td>
<td>4/month</td>
</tr>
<tr>
<td>Mode</td>
<td>ARGV</td>
<td>Lo Lo</td>
<td>Lo Lo</td>
<td>ARGV</td>
</tr>
<tr>
<td>Transport cost (%)</td>
<td>0.3</td>
<td>1.8</td>
<td>5.6</td>
<td>11.2</td>
</tr>
</tbody>
</table>

### Analysis of the Results

Example 1 is a regular flow of very high value goods for which the shipper is prepared to pay a high rate for a reliable and secure service using an accompanied road goods vehicle (ARGV). The high freight rate per kilometre partly reflects the service and that goods on the return leg do not stand high freight rates. Modal choice is unlikely to be influenced by changes in costs resulting from higher taxes, though transport costs will be increased in the long term.

Examples 2 and 3 are non-perishable foodstuffs carried in LoLo containers. Some of the traffic to Frankfurt is carried by rail from Rotterdam. The rate per kilometre is much higher in the case of the Swedish traffic, which uses a long North Sea ferry route. The main reason the German flow gains a very low rate is because it is back loading containers, the volume is relatively high at one or two containers per working day, and the
transit time required is modest. The main constraint is the booked arrival times. The flow in example 3 provides an attractive base load traffic for an international transport operator.

The first three flows are of finished products being moved from a manufacturing or food processing facility to a major distribution point in another European country, one of which is not a member of the EU. The costs of this international movement form only a small percentage of the value of the goods, between 0.3% and 5.6%. Further transport and distribution costs are subsequently incurred in the delivery of the products to the consumer in the destination countries. They have been supplied to the distribution hub based on the cost of production and transport to that point and additional delivery costs are likely to be similar to goods produced within the respective countries. A significant increase in international road transport costs may affect the sourcing of some products rather than have a major impact on choice of mode, depending on the costs and quality of service offered by alternative modes.

Example 4 is different from the other international flows in a number of ways. It represents the movement of goods within the supply chain (though not on a just in time basis). The vehicles are in fact hired by an associate company in Italy for a round trip loaded both ways, the two companies splitting the charges. The UK company is in fact paying above the market rate because of competition for Anglo-Italian traffic to fill southbound lorries, and is being given a fairly slow and unreliable service. They are cross-subsidising their Italian associate company to a small extent. As a result the cost is relatively high at 1.11 Euros per kilometre, and the movement costs form 11.2% of the value of the goods.

If the above example is typical, indicating that transport costs form a much greater proportion of the value of semi-finished goods, then there may be implications for increases in transport costs. One potential effect of significant cost increases may be a long term concentration of production where suppliers are located close to final assembly facilities. The locations selected are more difficult to predict as they will be chosen not only on costs, but availability of suitable labour, and any public funds which may be given to attract industrial location. However, such a process of concentration has occurred in Japan for some industries. The main driving force has been JIT rather than cost because suppliers must be able to deliver to production plants on very short order lead time cycles.

5.2.4.4 Quality and Sustainable Development

It has been recognised for a long time that cost is not the only determinate of the choice of freight transport services. Virtually all movements are subject to consideration of cost, transit time and reliability of on time delivery, these forming the basic attributes of any service offered. The importance of each attribute varies not only between products, but also for movements of the same product, often constrained by the position regarding stock holding, customer demand and distance to market. Other attributes are also important for certain commodities when they pose particular security risks, or are fragile or hazardous goods.

In the case of urban transport, quality requirements may take account of the quality of service of road freight transport, i.e. the customers’ needs together with the issue of the quality of life in cities. This ‘quality’ issue may often be the origin of the implementation of restrictions on access to the urban centres.

The issue of quality and sustainable development imply taking into account those costs of freight transport that do not have direct budgetary effects upon the participants, but are addressed as the external cost, imposed by making use of an asset without paying for it, thus creating an advantage for the user and putting someone else at a disadvantage, creating an economic inefficiency, which cannot be balanced by direct market processes.

Definition of the Quality of Service

The notion of quality of service, although widely used in industry and services, is very difficult to define because it refers to subjective judgements. Quality of service can be defined as the ability to meet customers’ requirements. Another more informal definition but more specific to freight transport draws up a list of technical qualities that shippers must offer at an appropriate price level. The criteria considered as a reference are reliability, time, flexibility, safety, equipment availability, and shipment information systems.
Quality Criteria

The first group of quality criteria are attributes that can be considered universal in the transport field. The first is **transit time**, normally measured from the point of shipment loading at the origin to the unloading at the destination. It depends on the efficiency of the overall door-to-door transport organisation. The second is **reliability**, which is the carrier’s ability to respect transit time arrangements, normally interpreted in terms of punctuality. Lack of this attribute can have serious consequences in inventory and production management, especially in just-in-time systems. The third attribute is **flexibility**, which is the haulier’s level of responsiveness to the shippers’ demand for a non-planned transport. Small and medium-size hauliers seem to be more able to respond in a short time. The fourth attribute is **security**, usually evaluated by a loss and damage rate. The final attribute in this group is the degree of **shipment information systems**, which allow shippers to be kept informed of the status of their shipments and also to be warned about the occurrence of problems.

Other attributes, although well known, cannot be listed systematically or are specific to certain shippers’ needs or modes. One of these is the **frequency of service** which is reflecting in the average waiting time between the need for transport and the availability of the transport to load the shipment in cases where the shipper is dependant on pre-scheduled services, as is very common for rail or regular lines of road services. **Accessibility** is also a very important attribute in intermodal transport as total costs, transit time and the choice of mode depend on the accessibility of terminals. Also, **geographic coverage** can lead shippers requiring international transport to choose large hauliers. **Special equipment** is also an attribute valued by shippers with special products or specific packaging needs. The **hauliers’ attitude towards customers** can be a more important quality criterion than might be expected, as shippers need to keep in contact with people responsible for the overall transport line, so as to permit rearrangements if circumstances change. This last criterion exemplifies the diversity of the quality criteria taken into account by shippers.

Recent surveys (IQ, 1998) have shown that reliability and flexibility are the two criteria which appear as those needing the most improvement. Also, the surveys have shown that road transport services seem to supply a generally satisfactory level of quality according to reliability and flexibility criteria, and also for the majority of the criteria presented above. This means that, for example, road will be able to gain traffic in situations (such as long distance) where rail has a cost advantage.

Evolution of Quality of Service in Road Freight Transport

Road freight transport has been characterised by continuous quality improvements. Not so long ago, there was a clear difference between classical road freight transport and express services, which were faster and more reliable. Differences between these levels of quality of service have tended to become smaller, as firms take advantage of advanced information systems, improved vehicles, and new technology. As a result, segmentation has increased and many hauliers now offer specific services tailored to shippers’ needs.

At the same time, manufacturers have undertaken some ‘total quality management’ programmes in which logistics play a central role, thus involving the suppliers of products and services. Since the implementation of the just-in-time practice, hauliers have supported an essential link in the production process, as it requires high quality transport. Recent surveys consider quality improvement critical, leading companies to implement quality standards.

At present, the ISO 9000 series are the world-wide standards for quality management systems, and are aimed at achieving customer satisfaction by preventing non-conformity at all stages. The most widely used standard is the ISO 9002, defined as ‘a model for quality assurance in production, installation and servicing’. Certification is defined as ‘a voluntary approach by which a third party gives a written assurance that a product, an organisation, a process, a service or the skills of a person comply with specified requirements’. Certification should help to provide customer satisfaction and confidence in the level of quality of the service. However it takes a lot of time, effort, and expense to gain certification, and extra-expense is incurred by the consequent paperwork and checking thereafter. According to carriers, certification does not increase their market share, although it allows them to be effectively distinguished from other operators. Certification is usually set up to respond to customers’ demands.

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Quality Requirements in Urban Freight Transport

The main objectives of an urban freight transport policy are improving accessibility and at the same time reducing its adverse implications. This can be pursued by reducing the number of kilometres driven, minimising the use of large vehicles, reducing the presence of delivery traffic at peak hours, minimising the possibility of vehicles stopping on traffic lanes for deliveries, and minimising the negative impacts of vehicle use.

Bulk goods and building materials form a large share of total transport volumes in terms of tonnes in many cities, but distribution goods lead to the most important effects on the urban traffic. Distribution goods can be defined as finished goods that are to be transported to shops. Small vehicles transport the majority of these goods, but the endpoint of the distribution process does not end up at the shops, as normally considered in many transport studies. The last link of the transportation is from shops to homes, and this journey is becoming even less likely to be made on foot.

The basic logistic concepts are still changing from direct transport in the 50’s, where goods are directly transported from their origins (factories or import warehouses) to their destinations, to indirect transport with the use of intermediaries (distribution centres of retailers, wholesaler or logistic service suppliers) in the 80’s. Other types of distribution are chain distribution where deliveries are made to stores owned by the same company, and pick-up and delivery services where origins and destinations are mixed, that is, in one single trip goods can be collected and distributed.

The urban freight transport problem is inherent to cities as a form of social and physical organisation of human activity (Lindkvist and Swahn, 1997), and there is evidence that the manifest nature of these problems has in various ways restricted and hampered the development of cities, and caused environmental and health problems. The evolution of the logistic concepts will continue in order to take into account the integration with cities.

The quality requirements in urban freight distribution can be seen in two levels. In the first there are those linked with customers’ needs. The most significant are the punctuality and the reliability of deliveries. In the second level, there are features of service that customers do not demand, but which they could be willing to pay for (the capacity of hauliers to answer difficulties, reduced time in communications with hauliers, etc.), they are considered as competitive advantages.

The main problems for the implementation of measures to satisfy customers’ requirements are inadequate facilities for reception of deliveries at customers’ sites, negative effects produced by urban freight transport and their perception by society, and a lack of vision and ‘amateur’ perspective of many customers and hauliers.

In the long term there are several improvements that can be implemented, such as adopting systems that facilitate night deliveries, maximising utilisation of trucks, promoting technological innovation, and underground freight transport.

Valuation of Transport Attributes

Some recent studies have attempted to value the different attributes of transport service. Many researchers have used stated preference (SP) techniques which use hypothetical situations in order to assess the behavioural aspects of choice decisions. This is because there is a relatively small number of decision makers, and most data is confidential. Results based on real choices using revealed preference (RP) are few in number.

Fowkes et al. (1989) conducted a Stated Preference study of mode choice attributes for long distance unitised freight movements and bulk traffic (within Great Britain), 50 firms were interviewed. First, they estimated the coefficients of costs and other attributes (transit time, reliability, use of intermodal system). Then they divided each coefficient by the coefficient of cost to obtain the value of each attribute. This approach is very useful because it indicates how much firms are willing to pay for specific improvements in transport attributes.
Results\(^3\) show wide variations in the value of some attributes according to the type of goods transported (which are chocolate, beer, oil products, cement and lime, fertilisers, metal tubes, consumer durables, automotive electrics and paper), e.g. the value for a half day longer transit time, ranging from 7\% to 32\%. All values of reliability are significant (ranging from 1\% to 6\%) except for small chocolate firms. Almost all firms appear to require a discount in order to shift change to the use of intermodal systems, but most of the values obtained were not statistically significant from zero (except for metal tubes and consumer durables which are susceptible to damage when lifted). Many large chocolate firms attempt to minimise packaging for transit purposes. As a result, they are reluctant to allow the goods to be transshipped; hence the valuation of 42\% of the freight rate for each additional lift.

The valuation of transport attributes varied according to the type of product transported, and the country studied. Many studies found that reliability is the most important factor in determining modal choice, and that there is a considerable resistance to change from road transport to other modes.

De Jong et al. (1992) obtained the value of time in goods transport in Holland. The hourly value-of-time found is 25.5 ECU for an average shipment. Shippers were perceived to be almost indifferent between some percentual change in travel time and the same percentual change in transport costs or rates. Perhaps surprisingly, the value of time for raw materials and semi-finished goods is higher than for finished, and this is explained by the higher costs incurred by delays disrupting production processes. The VOT for finished goods with potential for loss of value (such as perishable goods) is higher than for finished goods without loss of value.

The estimates of the values of freight transport attributes can be used for a variety of purposes, e.g. indicating the real value of one mode over another. One reason for shippers reluctance to use rail intermodal services is claimed to be that the quality of service is lower than that offered by road freight operators. New models have been applied to explain the effect on break-even distances of taking into account service quality issues. It has been found that improving the quality of rail services may be more effective than reducing costs and freight rates for reducing the average break-even distance for intermodal services.

External Costs and Ways of Internalisation

Social costs of transport have been agreed to comprise all costs originating in the provision (investment, construction, operation, maintenance) of transport infrastructure and its proper use by transport activities, and not being internal to the users economically (having direct budgetary effects). Two concepts are distinguished:

Technological externalities costs occur whenever a damage is imposed by one individual producer or consumer on another, putting the latter at a disadvantage, unintentional yet not necessarily unaware, and not planned as or as a part of the ‘main’ activity. Here, a correcting third-party force can be regarded as necessary.

Pecuniary externalities are addressed today when external benefits are captured by individuals or firms, and costs external to a given group can be seen to be processed by markets if the boundaries of the group are enlarged. In contrast to the technological externality, nobody is put to a disadvantage, and no third-party intervention is necessary.

For the most common types of external costs various recent studies have been analysed and values for an inclusion into a cost accounting have been extracted. These values differ partly but strongly throughout Europe. In this summary the average values for Europe are given, but it is strongly recommended to consider the regional differences.

\(^3\) Results in percentages of the freight rates can be found in the SOFTICE D2 report.
• **Accidents**, with the usual cost categories (damage of property, administrative costs, medical treatment, costs for recovery, re-integration and replacement, production losses, human suffering). From the analysis of various studies the conclusion can be drawn that (marginal) external costs of road freight transport concerning accidents in Europe amount to about 21 ECU/1,000 tkm (INFRAS/IWW, 1995), thus exceeding the value for rail freight with about 0.75 ECU/1,000 tkm by a factor of 28.

• **Noise**. A number of studies on the field of noise emission costs come to values showing considerable differences; yet the values of about 12.7 ECU/1,000 tkm for road freight transport and 4.7 ECU/1,000 tkm for rail freight transport (INFRAS/IWW, 1995) are within a reasonable range.

• **Air pollution**. Air polluting substances investigated are those with local or regional impact: nitrogen oxides (NO\(_x\)), particles, carbon monoxide (CO), volatile organic compounds (VOC’s), sulphur oxides (SO\(_x\)), and ground level ozone. Monetarised costs are 10.25 ECU/1,000 tkm for road freight transport (ECMT, 1998), 5.2 ECU/1,000 tkm for diesel freight trains and 0.3 ECU/1,000 tkm for electric freight trains.

• **Climate Change – CO\(_2\)**. Here values on the base of transport performance can hardly be found. Using emission coefficients on the base of kg CO\(_2\)/vehicle-km and a value ECU 50 per tonne of CO\(_2\) emitted, estimates can be derived for the costs in ECU/1,000 tkm, using a value of 0.028 ECU/vehicle-km (ECMT, 1998) and various load factors for road transport. For freight trains the resp. value is ECU 1.08/1,000 tkm.

• **Infrastructure costs**. In principle two approaches of valuating infrastructure costs are analysed: marginal cost pricing and average cost pricing. The application of either of the two depends on whether a short-term or a long-term cost coverage is pursued. – For road infrastructure resp. the use of it by road freight transport values are given as follows: long-run marginal costs amount up to about ECU 35/1,000 tkm (ECMT, 1998), short-run marginal costs are in the range of about ECU 14/1,000 tkm. For rail freight, both values are around ECU 20/1,000 tkm.

Internalisation of Externalities of Transport

The study first asks for the goals of internalisation, among which are outstanding:

1. optimal use of existing capacity,
2. abolishing of subsidies which are not justified by public good characteristics of the transport system,
3. allocation of the costs to the agent who is responsible for their production – polluter should pay,
4. achieving defined long-term environmental/safety quality standards,
5. better balance of regional development,
6. better balance of social development,
7. developing new markets and new technology with lower consumption of natural resources.

This then raises the question of how these goals can be achieved and what restrictions apply, coming to the following conclusions:

1. there should be more winners than losers, and considerable losses should be compensated for by a package of political measures;
2. there should be benefits from the beginning, not only at the end of the implementation of the internalisation programme. A well-designed transition path, consisting of piecemeal policy actions, is politically more important than an optimal final solution after some decades;

3. it has to be clarified for which purposes the revenues from pricing policy are to be spent, and the institutions which are capable of performing operation, investment and financial management for the sector concerned have to be created.

The search for the best instruments of internalisation policy leads to basically four instruments:

- Information and moral suasion,
- Economic incentives,
- Regulatory instruments,
- Government provided infrastructure and services.

Effects of the Internalisation of External Costs on Freight Transport Competition

Internalisation of transport externalities with the measures discussed will affect above all the price level of transport, and it will affect it in several ways: price increases can be caused by tighter technical standards and higher use- or consumption-charges. Lower fixed charges and increased efficiency will lead in the opposite direction. Examples of cost reduction caused by increased efficiency are a reduced accident rate and higher utilisation of infrastructure capacity. The determination of the net effect on the economy as a whole might turn out to be rather complex and in detail is not an output of this study.

Internalisation of external costs will in any case change the cost structure in the freight transport market and subsequently in the whole industrial sector. The industrial sector is mainly affected in three ways if internalisation measures are considered and implemented:

- rise of distribution costs as a consequence of higher transport costs, resulting from higher user charges and stricter vehicle standards;
- a reduction of fixed costs, which are not directly linked to transport, but are included in the concept of a "green tax", e.g. employers’ share of social security contributions;
- a reduction of costs related to congestion and production losses following traffic accidents.

The net effect on the industrial sector can be expected to be positive, as higher user charges and compensatory contributions for the external effects sketched above should be compensated for by lower taxes, and because the sector in general benefits from other cost reductions.

Transport operators facing increasing yet differentiated prices for the use of the infrastructure and environmental goods, may adapt to the new situation with different strategies. (It has to be confirmed that there must be no over-night change, but measures taken have to be announced, together with a time-path, allowing all market partners to adjust.) These strategies will depend highly on the market segment. Markets for bulk goods will react differently from markets for high-value consumer goods; in general, the ratio of transport costs to the value per weight or volume unit will be decisive.

Transport costs for road freight transport can be expected to increase by 18% in rural areas and 30% in urban areas (ECMT, 1998), for rail freight by about 80%, if full cost coverage for infrastructure costs is included. This, however, is not a likely scenario, as this would imply practically the end of rail freight service. More likely, is that governments will take a considerable share of the rail infrastructure in the interest of regional development and under synergy arguments with passenger transport, especially for commuter transport, in this way subsidising rail freight services. Yet, as a tendency, rail freight is likely to concentrate
on highly profitable links, such as transports from seaports to the hinterland and between industrial agglomerations on a European scale over long distances.

Apart from pure monetary instruments other measures have been discussed. Their impacts are less straightforward and depend even more on the segment considered and its prevailing conditions. Presuming that, according to the cost figures given above, the paramount aim is to reduce the negative effects of road freight transport while at the same time keeping up the general quality of supply to industry and consumers, the expectation is justified that on the other hand the road transport business in a free economy will not take the spectator’s part, but will further be attempting to keep up and even enlarge its market share. Considering this it is not easy to predict reactions to non-monetary instruments.

With the application of internalisation measures, all freight transport modes are expected to become more expensive, but to different extents. The effect on modal split is hard to estimate, as in the past the markets did not have to face changes in prices of this scale. The market performance of the different modes during and after an internalisation of their specific external costs will mainly depend on their strategies for adjustment. The economy’s need for transport will not vanish, and as the main goal of internalisation is to increase overall economic efficiency, the players on the market will have to find their respective new positions themselves. – Though it is likely that there will be no major shift in modal split, the market segments resp. shares might be re-distributed, as a consequence of an organisational change, concerning the modes as well as the single actors. The highest gain in efficiency in the road freight sector will come from increased productivity per vehicle-kilometre, as the use of infrastructure and environment shall be charged rather than the amount of goods transported. Thus, increasing load factors and improving organisational performance is likely to be the foremost strategy for road.

As for rail, one might imagine efforts to get a higher share in the market segment of high-value commodities. This, as well as for road, will mainly depend on rail operators’ abilities to take advantage of the chances offered to them by the rise in costs for the road sector and to occupy market segments that, by application of internalisation instruments, have lost their exclusive affinity to road transport. This may occur by adjusting even better to shippers’ needs, e.g. by considering to offer additional logistics services, as can be seen in the road sector, where hauliers have successfully started to offer these services to their customers. Eventually the rail freight market will have to change in a way, that rail operators will act similarly to road freight operators, i.e. to adopt an atomistic market structure; until now in most countries one single (stagnating) rail operator faces innumerable flexible road operators. Real competition may occur if the two markets for rail and road pervade; the organisation of transport will no longer be a question of an unequal competition between road and rail but true and fair competition between operators using and profiting from the respective advantages of each mode. A dilemma of the instrumentarium sketched above becomes visible here: there is a certain likelihood that the road transport sector will face a partial depression, but no guarantee can be given that on the other hand the rail freight operators will profit automatically. This situation, which seems to be a desirable solution at the moment, lies beyond the influence of internalisation, but in the field of intra-modal competition policy, in the environment of restructuring the European railways. Internalisation measures represent a ‘push’-strategy away from road, the corresponding ‘pull’-measures towards the environmentally more sustainable modes are discussed separately.

To give a conclusion, it is obvious that the highest effectiveness in terms of decreasing the negative effects of freight haulage on natural environment and human society will be reached if both policy fields are dealt with complementarily in relation to each other.

5.2.5 The main results of Workpackage 2

The investigations of Workpackage 2 show a very wide range of situations concerning the transport costs. Data have been collected from various available sources, input-output tables, surveys and logistic monographs. In complement, in depth interviews have been conducted for the specific purpose of SOFTICE, with a focus on the estimation of operating costs of transport hauliers throughout Europe. A qualitative analysis of trends in logistics, referring to different sources, has given a consistent updated overview of this question.
Understanding of the structure of the costs has been improved; it is therefore now possible to pinpoint different types of consequences if a change in the cost structure occurs, and from this methodological approach, scenarios can be simulated.

On average, the cost of transport is about 3% of the value of the product, a percentage which can be considered as fairly low. A macro-economic approach and the analysis of input-output tables of several countries confirm this order of magnitude, taking into account transport for own-account which remains important (with at least one third of total road costs). But this workpackage shows also that an average estimation does not help very much because the range is wide, with less than 0.5% of the value of the product, up to more than 10% according to the type of branch considered.

According to our results and the segmentation of SOFTICE, the following points can be stressed:

- The road unit transport cost decreases sharply with the rise of the shipment size, and smaller shipments probably leave wider margins to transport operators.

- From the transport supply side, different forms of operating systems have been identified which are dependant upon the size of the shipment and the process of consolidation.

- This diversity of transport organisation, the decrease of shipment size and the just-in-time requirement might result in the introduction of new forms of transport, with in particular a generalisation of a direct door-to-door transport with smaller trucks; i.e. on long distance light duty vehicles can be profitable and allow high speed.

- Quality factors must be considered in parallel with transport costs and can be sometimes a decision factor. The transport cost reaches 10% or more of the value of an intermediate product, when it is usually below 1% for a finished product. Nevertheless, quality is not only a strong requirement for high value products, e.g. results from a freight value-of-time survey in Netherlands (De Jong et al., 1992) showed that intermediate products, which may be less valuable than finished products, had a higher value of time than for finished products. This was explained by the fact that a delay can disrupt the production process. In conclusion, transport costs and quality changes will influence industrial production processes of intermediate goods. In many cases, quality requirements may be more important than costs for intermediate products since they face tight industrial supply chain constraints.

- Comparisons between small and medium-sized shipper companies and large shipper companies’ transport requirements remain difficult to characterise after this study. They often do not address the same distribution market or the same transport requirements and no simple conclusion could be drawn from this point of view. Trade-offs between frequency and consolidation remain the most important problem and more detailed intra-branch analysis is necessary.

- But independently of this industrial production context there does exist flexibility in transport logistics evolution, under the influence of transport costs and quality criteria evolution. This will concern:

  - new locations for restructured warehouses and distribution centres,
  - different choices of consolidation points,
  - choice of the size and type of vehicles.

- The internalisation of external costs could significantly change the cost structure of freight transport. Also it is stressed that the adjustment will be progressive, the part of the economy linked to physical collection/distribution being affected. For road, transport costs in urban areas can be expected to increase much more than in rural areas (30% increase compared to 18%).

However, the consequences of internalisation of external costs on modal shift is not at all clear. A transfer to rail would require either a significant reduction of rail costs mainly on long distance for high volume
shipments or an improvement in the quality of rail service to reach a level comparable to road quality. Intermodal transport can be an answer but it has been so far limited to specific routes serving main ports or crossing natural barriers.

5.3 **WP3 - Medium and long term Impact**

The SOFTICE Workpackage 3 presents in its first part an analysis of the present situation concerning the demand for freight transport, considering socio-economic context and competitive environment, describes the supply side of freight transport and discusses and defines possible scenarios for future development.

The second part consists of an analysis of main key ratios driving the key dimensions of transport production, such as tonne-km, vehicle-km and modal split. A first analysis of the results of the Second Shippers' Panel Survey concerning shippers' reactions on changes in certain conditions on the freight transport market is also included. Studies on the impacts of the use of policy instruments on road freight transport and on the impacts of infringements against road freight regulations are presented.

In the third part a computer model using System Dynamics Modelling (SDM) is presented, putting together the different parts achieved, in order to give the possibility to validate and to reproduce developments of the past and to check future impacts of various measures subject to political decisions. These decisions will be subject to the goals of European Policy: sustainable and harmonised development throughout Europe, avoiding imbalances between regions and social and environmental strains.

5.3.1 **Scenario Development**

The objective of this part of the project SOFTICE was to develop various freight transport scenarios using existing results from European projects such as SCENARIOS and EUFRANET of which INRETS was responsible for co-ordinating all the tasks.

The first of the next sections deals with the freight demand by making a description of the future socio-economic context and the competitive environment of the transport sector in Europe. The second section focuses on transport supply, and in the third section two kinds of scenarios are discussed: a reference scenario based on the continuation of the liberalisation policy and two alternative scenarios. The first alternative scenario takes into account the CTP actions in favour of a sustainable development while the second one considers the achievement of the Trans-European Transport Network (TEN).

5.3.1.1 **Demand**

**General Economic Growth**

In order to measure economic growth, some indicators were estimated for EU countries and some CEE countries at the horizon year 2005 or 2020.

For GDP, it is noticed that the ranking of the countries according to their GDP as a percentage of the European total is actually the same in 2005 as in 1994. Then at the horizon year 2020, some GDP projections are made for EU countries and three Central and Eastern European (CEE) countries (Czech Republic, Hungary and Poland) according to three variants. It appears that all countries experience continued economic growth even for CEE countries despite their unstable political context. Germany, France, Italy, the United Kingdom and even Spain are expected to have the highest GDP. Nevertheless, apart from Spain, these countries should not reach large growth rates, whereas Portugal, Ireland, Luxembourg, Finland and Norway could enjoy high annual increases in growth up to 2020.

GDP estimations are also given by industry origin and show that in the coming years (2005) a decrease of intermediate goods is expected, while primary goods, bulk products and high value products will increase thus raising the value of tonnes transported.
At least, forecasts on exports and imports (in value) up to 2020, based on the opening of national economies at the European level, revealed that trade growth rates are greater than GDP growth rates.

Traffic Projections and Competitive Environment

The introduction of the ‘Euro’ at the beginning of the year 1999, the homogenisation of the European market, the reorganisation of European logistics and the dynamism of the Member States’ external trade should increase European traffic flows in the coming years.

Some estimates, coming from EUFRANET project, are given up to 2020 for traffic flows (tonnes) and performance (tonne-km) at national and international level, per product and mode.

European traffic volumes (tonnes) raise by 0.9% a year with a significant progression of international transport (2.2% per year), but a slight increase of national transport (0.7%). By commodity groups, a predominance of manufacturing, minerals, food and chemicals is expected which is more or less reflected in growth rates. Indeed at national level, growth rates range from -1.6% for solid fuel to 1.3% for manufacturing. The structure of international transport well reflects the trend in international trade with significant growth rates ranging from 0.2% for solid fuel to 3.5% for manufacturing. Chemicals, food, agricultural products and metal reach rates between 2% and 2.9%.

EUFRANET also proposes a ‘reference forecast 2020’ for modal split based on the mean assumption that road transport prices are decreasing by 1% per year, but it is also based on the current quality levels in rail freight transport. It results in high growth rates for road (30.95%) and combined transport (35.87%) in tonnage, although the latter continues to have a weak share in the modal split. For conventional rail transport and inland navigation, volumes are not expected to change a lot.

The European traffic demand in billion tonne-kms for the period 1992 to 2020 is expected to show a significant evolution for international transport (2.5% per year). But during the same time national transport will progress more rapidly (1.5% per year). Global performance raises by 1.9% a year, this is much higher than the growth rate of the volumes given previously (0.9%). This means that the average transport distance is increasing.

 Modal split in the performance of the transport sector is estimated according to the hypothesis that road transport prices are decreasing by 1% per year. Road performance increases considerably (86%) whereas combined transport grows more moderately (53%). For conventional rail transport and inland navigation, performance increases respectively by 13 % and 19 % from 1995 to 2020.

5.3.1.2 Supply

Supply deals with the evolution of transport supply and focuses on road and rail transport. First it examines two major predictable evolutions in transportation systems, i.e. an increase in the maximum authorised weight of duty vehicles and the implementation of a European freight railway network with the freight freeways. Secondly, telecommunications and information technologies applied to road freight transport (the so-called road transport telematics) are highlighted.

Transportation Systems

An increase in the weight limit (fixed by EC since 1985), from 40 tonnes to 44 tonnes, has to be discussed as a probable EU policy change. Impacts will result from vehicle utilisation due to new dimensions and from the modal share evolution. Productivity gains can be expected but impacts on the environment need further analysis as emissions of pollutants can be reduced, but surveys show that there is simultaneously a modal shift from rail to road.

For rail, the implementation of European freight freeways is expected in the next coming years. It could sharply decrease operating costs, by up to 30% thanks to improved interoperability and commercial co-operation. Furthermore the implementation of a freight freeways network will play an important role in the

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development of intermodal transport, as it can help to develop a more competitive offer, and especially since an important potential of organisational innovations is expected in freight intermodal transport.

Road Telematics
Road telematics will have major impacts on transport as it can improve transportation system efficiency and performance. Its applications are numerous and benefits will be found in many areas such as interurban and urban traffic management, aids to drivers, freight and fleet management, environment, etc. However the Member States will have to work on the interoperability, interconnection and continuity of the systems.

Among the applications of road telematics are automated highways that will improve infrastructure use, increase efficiency and productivity. However, technologies have to be chosen at a European level and standards defined, and public and private investments balanced against benefits.

5.3.1.3 Transport Policy
Two kinds of scenarios were developed. The reference scenario considers the continuing CTP policy of liberalisation which is strongly influencing the evolution of transport, while the first alternative scenario takes into account the CTP objective of sustainable development, and the second alternative scenario the CTP objective of achievement of a Trans-European Transport network (TEN).

Reference Scenario (BAU Scenario)
This scenario focuses on the continuation of liberalisation, promoted especially since 10 years, in the transport sector and open access within Europe for all transport modes (road, rail, air, inland waterways and short sea shipping). It appears particularly profitable for road transport.
### Table 5  Reference scenario (Liberalisation)

<table>
<thead>
<tr>
<th>FREIGHT</th>
<th>% Change in total cost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Long distance</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ in productivity (with +30% more if 44t is generalised) and ↑ in quality of service</td>
<td>- 1%</td>
</tr>
<tr>
<td>• quick adaptation to logistics changes</td>
<td></td>
</tr>
<tr>
<td>• decrease in prices due to strong competition at national and international level</td>
<td></td>
</tr>
<tr>
<td><strong>Road:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Short distance</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ cost of local transport due to weaker competition (monopoly situation of trucks)</td>
<td>+0.5%</td>
</tr>
<tr>
<td>• More difficult traffic flow in dense areas</td>
<td></td>
</tr>
<tr>
<td>• ↑ in costs due to congestion</td>
<td></td>
</tr>
<tr>
<td><strong>Rail:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Long distance</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ competition (particularly with road transport) and development of commercial strategy</td>
<td>+2%</td>
</tr>
<tr>
<td>• ↑ in infrastructure charges (budget equilibrium)</td>
<td></td>
</tr>
<tr>
<td>• improvement of operating systems (long trains, better use of wagons, network specialisation)</td>
<td></td>
</tr>
<tr>
<td><strong>Waterways:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Long distance</strong></td>
<td></td>
</tr>
<tr>
<td>• liberalisation and ↓ in price for some specific traffics where competition is possible (main waterway basins)</td>
<td>+1%</td>
</tr>
<tr>
<td>• ↑ in infrastructure charges</td>
<td></td>
</tr>
<tr>
<td><strong>Maritime and ports</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ productivity with use of bigger containerships and information technologies</td>
<td>-1%</td>
</tr>
<tr>
<td>• strong competition</td>
<td></td>
</tr>
<tr>
<td>• significant ↓ in freight prices</td>
<td></td>
</tr>
<tr>
<td>• liberalisation of short sea shipping</td>
<td></td>
</tr>
<tr>
<td><strong>Combined transport</strong></td>
<td></td>
</tr>
<tr>
<td>• improvement in transhipment terminals (maritime and inland) - low cost overall</td>
<td>+1.5%</td>
</tr>
<tr>
<td>• adaptation to market requirements in logistics</td>
<td></td>
</tr>
<tr>
<td>• but significant ↑ in rail infrastructure charges</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Pilot SEA D 1 (INRETS, 1999)*
Alternative Scenarios

The first alternative scenario focuses on the impacts of CTP measures in favour of harmonisation and sustainable development after the liberalisation policy. These measures concern notably social and safety conditions for workers, levels of taxes or pricing to internalise external costs.

Table 6  Alternative scenario 1 (harmonisation and internalisation)

<table>
<thead>
<tr>
<th>FREIGHT</th>
<th>% Change in total cost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Long distance</strong></td>
<td></td>
</tr>
<tr>
<td>• Harmonisation of social condition</td>
<td></td>
</tr>
<tr>
<td>• ↑ fuel taxes to internalise external costs (affects local traffic more than international/interregional traffic)</td>
<td>+1 %</td>
</tr>
<tr>
<td>technological improvements → diminution of external effects</td>
<td></td>
</tr>
<tr>
<td><strong>Road:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Short distance</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ fuel taxes to internalise of external costs (5% of cost over 10 years)</td>
<td>+1.5 %</td>
</tr>
<tr>
<td>• More stringent conditions for urban circulation.</td>
<td></td>
</tr>
<tr>
<td>• Increase in salaries (up to 50% of total costs)</td>
<td></td>
</tr>
<tr>
<td>• development of light trucks and increasing development of city logistics</td>
<td></td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td></td>
</tr>
<tr>
<td>• harmonisation of tariffs and social costs at European level</td>
<td>0 %</td>
</tr>
<tr>
<td><strong>Waterways</strong></td>
<td></td>
</tr>
<tr>
<td>• development of specialised logistics for bulks or containers</td>
<td>0 %</td>
</tr>
<tr>
<td><strong>Maritime and ports</strong></td>
<td></td>
</tr>
<tr>
<td>• Internalisation of costs</td>
<td></td>
</tr>
<tr>
<td>• improved quality in ports</td>
<td></td>
</tr>
<tr>
<td><strong>Combined transport</strong></td>
<td></td>
</tr>
<tr>
<td>• ↑ in road terminal transport in dense areas</td>
<td></td>
</tr>
<tr>
<td>• harmonisation of rail tariffs at European level</td>
<td></td>
</tr>
</tbody>
</table>

Source: Pilot SEA D 1 (INRETS, 1999)

The second alternative scenario is the achievement of a Trans-European network (TEN) for Transport that should be the last stage of the European transport policy (after liberalisation, harmonisation and internalisation). It could significantly promote spatial and environmental goals.

The Pilot SEA project developed the TEN scenario according to three main concepts: interconnectivity, intermodality and interoperability.
Table 7  Alternative scenario 2 (TEN Policy)

<table>
<thead>
<tr>
<th>Long distance (%) change in costs</th>
<th>INTERCONNECTIVITY improved links with ports</th>
<th>INTERMODALITY development of intermodal terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREIGHT ROAD</td>
<td>0</td>
<td>-0.5%</td>
</tr>
<tr>
<td>FREIGHT RAIL</td>
<td>-2%</td>
<td>-1%</td>
</tr>
<tr>
<td>MARITIME FREIGHT</td>
<td>-0.5%</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Short Sea Shipping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATERWAYS FREIGHT</td>
<td>-1%</td>
<td>-0.5%</td>
</tr>
</tbody>
</table>

Source: Pilot SEA D 1 (INRETS, 1999)

The three scenarios developed have provided inputs for the Systems Dynamics Model. They considered the main EU policies to be developed in the next 20 years with their impacts on transport costs. Benefits are expected in particular from the TEN policy which is the achievement of a Trans-European Network for transport after policies in favour of liberalisation and sustainable development (harmonisation and internalisation of externalities). Impacts of these various policies were further analysed with the Systems Dynamics Model (see paragraph 5.3.3.2).

5.3.2  Impacts on Different Segments and Modes

This section describes some evidence on how attributes of possible future scenarios would impact on key ratios describing the movement of freight in various European countries. The report is divided into three parts, reflecting the scope of research employed: a macro analysis, a micro analysis, performed at a firm level, and finally two case study analyses, one about the effects of Swiss transport policy, the second on the impacts of illegal operations on costs.

The macro analysis focused first on the mode choice between road and rail. Previously derived monetary valuations of attributes affecting this choice were generalised across a pseudo-origin/destination matrix for three different cargo types. The main non-cost attributes were taken to be scheduled journey time and reliability, with an Alternative Specific Constant taking up all other factors.

A later stage of the work analysed available data on what McKinnon (Campbell and McKinnon, 1997) has termed ‘key ratios’, mainly using UK data kindly supplied by him. Time and efforts were spent investigating French data and, to a much lesser extent, Swiss data. However, inconsistencies and sparseness in these sources led to the recommendations being based almost exclusively on the UK data. Considerable attention was paid to Handling Factors, i.e. the number of times goods were lifted after production, up to the point of consumption. A new key ratio was conceived for this report, namely the Generation Factor, which divides the Handling Factors by the Value Density of output (in real terms) so as to give the tonnes lifted (by all modes) for each £1 million worth of Domestic Production plus Imports.

The other remaining output was the derivation of elasticities for tonne-km with respect to Gross Domestic Product and articulated lorry freight rates that, superficially at least, seemed to fit the data. Based on UK
evidence, the elasticity of tonne-km with respect to GDP appeared to be in the range 1.0 to 1.5 and the one with respect to cost around -0.1.

The micro analysis, on the other hand, focused on the firm level. It used the results of the Second Shippers’ Survey. In reality each shipper reacts differently depending upon the general framework in which he is involved and the particular constraints to his business. Consequently, the answers from the Second Shippers’ Survey, where respondents were confronted with different sort of stimuli, were analysed and aggregated to classes, reflecting direction and degree of individual reactions. Based on this, models are developed creating the outputs intended to feed the Systems Dynamics Model.

Finally, the case studies' sections investigated two questions of interest for political decision making: the first part tried to isolate the effects of political decisions on road transport in Switzerland, the second part discussed the impacts of violation of legal regulations by road hauliers on costs of road freight transport.

5.3.2.1 The Macro Analysis: Mode Choice and Key Ratios

The Mode Choice Decision

Findings regarding the choice of mode between road and rail are summarised in three matrices, each showing a monetary valuation for 9 cells in a pseudo Origin-Destination matrix (see Table 8 at page 54), broken down by three commodity types and three journey types, i.e. 81 entries. The entries are all monetary valuations expressed as a percentage of current movement cost (i.e. the ‘freight rate’). The first matrix gives the penalty for an extra half a day on the scheduled journey time. The second matrix gives the penalty for one percentage point less of arrivals being on time (punctuality). The third matrix gives the penalty relating to all other attributes of using rail.

For travel time the percentage penalties may be multiplied to convert to other lengths of time, e.g. two days additional scheduled transit time will have four times the percentage penalty shown. The figures apply on average; i.e. some traffic in the cell will be more time sensitive and others less so.

For reliability, if mode 1 has x% on-time arrivals and mode 2 (x + k)% on-time arrivals, the monetary penalty to mode 1 is k times the tabulated penalty values, and similarly for other differences in percentage of reliability. For example, if rail has 90% reliability and road 95% reliability then the difference is 5 percentage points. For non-agglomerated non-congested international journeys the tabulated penalty is 4% for consumer goods, implying that, all else equal, rail would need to undercut the road price by 20% to be considered equally attractive to road.

For use of rail, the penalties are fixed percentages, which apply whenever rail is used. They indicate the point at which the average user would be indifferent between rail and road, all else held equal (i.e. with rail and road having the same scheduled transit times and reliability). For example, for bulk commodities moving internationally from an agglomerated congested zone to a non-agglomerated non-congested zone, with no differences between road and rail in terms of journey times and reliability, a 2.5% discount by rail on the road cost would be required on average. If the railways gave this discount they could expect to receive 50% of the traffic. At lower discounts rail would still probably receive some traffic, but less than 50%. Hence even where a greater than 100% penalty is shown for rail there may still be some traffic choosing rail.

More generally, comparing the two modes one will add on to the rail penalty any penalties for transit time and reliability. For example, again for agglomerated congested to non-agglomerated non-congested, for international bulks, if rail was 4 hours quicker but 2% less reliable, the overall penalty against rail would be as follows:

\[ \text{rail penalty} + \text{reliability penalty} - \text{travel time penalty} \]

\[ 2.5 + (1.5 \times 2) - \frac{(6 \times 4)}{12} = 3.5 \% \]
# Table 8  Pseudo matrix of trip attribute valuations

| Travel time: Penalty as a % of the freight rate for half a day longer travel time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Origin | Cargo type | Destination | Local | Domestic | International | Local | Domestic | International | Local | Domestic | International |
| Agglomerated Congested | Bulk | Agglomerated Congested | 28 | 7 | 6 | 21 | 7 | 6 | 21 | 7 | 6 |
| | Intermediate | | 112 | 28 | 23 | 84 | 28 | 23 | 84 | 28 | 23 |
| | Consumer | | 56 | 14 | 12 | 42 | 14 | 12 | 42 | 14 | 12 |
| Agglomerated Non congested | Bulk | Agglomerated Non congested | 21 | 7 | 6 | 14 | 7 | 6 | 14 | 7 | 6 |
| | Intermediate | | 84 | 28 | 23 | 56 | 28 | 23 | 56 | 28 | 23 |
| | Consumer | | 42 | 14 | 12 | 28 | 14 | 12 | 28 | 14 | 12 |
| Non agglomerated non congested | Bulk | Non Agglomerated Non Congested | 21 | 7 | 6 | 14 | 7 | 6 | 14 | 7 | 6 |
| | Intermediate | | 84 | 28 | 23 | 56 | 28 | 23 | 56 | 28 | 23 |
| | Consumer | | 42 | 14 | 12 | 28 | 14 | 12 | 28 | 14 | 12 |

| Reliability: Penalty as a % of the freight rate for 1% less on time arrival |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Origin | Cargo type | Destination | Local | Domestic | International | Local | Domestic | International | Local | Domestic | International |
| Agglomerated Congested | Bulk | Agglomerated Congested | 2 | 1 | 1.5 | 1.5 | 1 | 1.5 | 1.5 | 1 | 1.5 |
| | Intermediate | | 8 | 4 | 5.5 | 6 | 4 | 5.5 | 6 | 4 | 5.5 |
| | Consumer | | 6 | 3 | 4 | 4.5 | 3 | 4 | 4.5 | 3 | 4 |
| Agglomerated Non congested | Bulk | Agglomerated Non congested | 1.5 | 1 | 1.5 | 1 | 1 | 1.5 | 1 | 1 | 1.5 |
| | Intermediate | | 6 | 4 | 5.5 | 4 | 4 | 5.5 | 4 | 4 | 5.5 |
| | Consumer | | 4.5 | 3 | 4 | 3 | 3 | 4 | 3 | 3 | 4 |
| Non agglomerated non congested | Bulk | Non Agglomerated Non Congested | 1.5 | 1 | 1.5 | 1 | 1 | 1.5 | 1 | 1 | 1.5 |
| | Intermediate | | 6 | 4 | 5.5 | 4 | 4 | 5.5 | 4 | 4 | 5.5 |
| | Consumer | | 4.5 | 3 | 4 | 3 | 3 | 4 | 3 | 3 | 4 |

| Use of Rail: Penalty as a % of the freight rate for the use of rail |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Origin | Cargo type | Destination | Local | Domestic | International | Local | Domestic | International | Local | Domestic | International |
| Agglomerated Congested | Bulk | Agglomerated Congested | 28 | 7 | 2.5 | 14 | 7 | 2.5 | 14 | 7 | 2.5 |
| | Intermediate | | 56 | 7 | 2.5 | 28 | 7 | 2.5 | 28 | 7 | 2.5 |
| | Consumer | | 112 | 14 | 5 | 56 | 14 | 5 | 56 | 14 | 5 |
| Agglomerated Non congested | Bulk | Agglomerated Non congested | 14 | 7 | 2.5 | 7 | 7 | 2.5 | 7 | 7 | 2.5 |
| | Intermediate | | 28 | 7 | 2.5 | 14 | 7 | 2.5 | 14 | 7 | 2.5 |
| | Consumer | | 56 | 14 | 5 | 28 | 14 | 5 | 28 | 14 | 5 |
| Non agglomerated non congested | Bulk | Non Agglomerated Non Congested | 14 | 7 | 2.5 | 7 | 7 | 2.5 | 7 | 7 | 2.5 |
| | Intermediate | | 28 | 7 | 2.5 | 14 | 7 | 2.5 | 14 | 7 | 2.5 |
| | Consumer | | 56 | 14 | 5 | 28 | 14 | 5 | 28 | 14 | 5 |
Hence if road cost is 100 and rail cost is 96.5, then rail and road would each receive half the traffic, in the situation described.

**Key Ratios for UK: All Cargo Types**

From the REDEFINE project were received UK data for 1985, 1990 and 1995, broken down by three sectors: bulks, intermediates, and consumer goods.

Growth rates of Gross Domestic Product over the previous years, in 1985, 1990 and 1995 respectively were 3.76%, 0.40% and 2.46%. They were 17.74% (i.e. 3.3% p.a.) for 1985 to 1990 and 6.03% (i.e. 1.2% p.a.) for 1990 to 1995. – Note that GDP includes the service sector, which is not included in the All Cargo Types figures (see below).

The All Cargo Types Domestic Production figures reflect this development. Imports rose greatly between 1985 and 1990, but remained at that level in 1995. Exports showed strong growth throughout the period. Tonnes lifted by all modes grew strongly from 1985 to 1990 and then fell back. Given the Production and Import tonnages, these figures imply a strong increase in Handling Factors, by 7% between 1990 and 1995 for example.

A new key ratio, Generation Factor, is introduced here for the first time. Its purpose is to show how much freight tonnage each million pounds worth of Domestic Production generates. This varies with inflation, and so Value Density in constant prices is given additionally in the tables, and is used divide into the Handling Factor to get the Generation Factor. Table 10 (see next page 56) shows that, for All Cargo Types, this increases strongly over time. A projection of this trend is suggested.

Due to the experience in the bulk sector, Mode Split of road traffic actually fell between 1990 and 1995. Road Tonnes Lifted had risen 18.6% between 1985 and 1990, when real GDP had risen 17.7%; but fell 2% between 1990 and 1995 when GDP only rose 6%. Further light can be shed by Table 7.1 of the report of Task 1 of SOFTICE D2. It shows data on UK articulated lorry operating costs and freight rates (i.e. price), summarised in Table 9 below, together with the GDP data just discussed.

### Table 9 GDP, articulated lorry operating costs and freight rates for the UK (all figures in constant price terms)

<table>
<thead>
<tr>
<th></th>
<th>% Change 1985 to 1990</th>
<th>% Change 1990 to 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>+18%</td>
<td>+6%</td>
</tr>
<tr>
<td>Articulated Lorry Operating Costs</td>
<td>-6%</td>
<td>+1%</td>
</tr>
<tr>
<td>Articulated Lorry Freight Rates</td>
<td>-16%</td>
<td>-11%</td>
</tr>
</tbody>
</table>

### Source: SOFTICE Deliverable D2

Table 9 shows that the 1985 to 1990 period not only had rapid real GDP growth, but also reduced operating cost for articulated lorries and great pressure on road freight rates, which is quite surprising at a time of greatly increasing demand. The period 1990 to 1995 saw poor economic growth, slight increases in lorry operating costs, but a continuing sharp fall in road freight rates.

Table 10 shows Total Road Vehicle Kilometres rising 30% between 1985 and 1990, and 5% between 1990 and 1995. Road tonne-kms are shown as rising 32% between 1985 and 1990, and 10% between 1990 and 1995. Comparing back to Table 9, it appears that these may be explained by elasticities to GDP and freight rates. The Tonnes Lifted growth rates (+19% for 1985-1990 and -2% for 1990-1995) cannot be explained that way. The Average Length of Haul appears to be increasing in a not easily explicable way. Consequently it is possible first to argue what elasticities might explain the tonne-km figures.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Production (£'000,000 current prices)</td>
<td>273,190</td>
<td>363,568</td>
<td>352,240</td>
<td>0.969</td>
<td></td>
</tr>
<tr>
<td>Value Density (£/tonne, current prices)</td>
<td>253</td>
<td>321</td>
<td>343</td>
<td>1.069</td>
<td></td>
</tr>
<tr>
<td>Retail Price Index (1995 = 100)</td>
<td>63</td>
<td>84</td>
<td>100</td>
<td>1.190</td>
<td></td>
</tr>
<tr>
<td>Domestic Production (£/tonne, 1995 prices)</td>
<td>433,635</td>
<td>432,819</td>
<td>352,240</td>
<td>0.814</td>
<td></td>
</tr>
<tr>
<td>Value Density (£/tonne, 1995 prices)</td>
<td>401</td>
<td>382</td>
<td>343</td>
<td>0.898</td>
<td></td>
</tr>
<tr>
<td>Domestic Production (tonnes '000)</td>
<td>1,081,641</td>
<td>1,132,973</td>
<td>1,027,134</td>
<td>0.907</td>
<td></td>
</tr>
<tr>
<td>Imports (tonnes '000)</td>
<td>107,434</td>
<td>182,996</td>
<td>185,976</td>
<td>1.016</td>
<td></td>
</tr>
<tr>
<td>Export (tonnes '000)</td>
<td>90,900</td>
<td>127,700</td>
<td>167,953</td>
<td>1.315</td>
<td></td>
</tr>
<tr>
<td><strong>Transport by all modes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonnes Lifted (all modes)</td>
<td>1,786,585</td>
<td>2,117,793</td>
<td>2,092,902</td>
<td>0.988</td>
<td></td>
</tr>
<tr>
<td>Handling Factor (all modes)</td>
<td>1.50</td>
<td>1.61</td>
<td>1.73</td>
<td>1.072</td>
<td></td>
</tr>
<tr>
<td>Generation Factor (all modes, tonnes per £'000,000, 1995 prices)</td>
<td>3747.77</td>
<td>4212.61</td>
<td>5030.80</td>
<td>1.194</td>
<td></td>
</tr>
<tr>
<td><strong>Transportation by Modes Other Than Road</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modal Split (%)</td>
<td>20.4%</td>
<td>20.3%</td>
<td>20.8%</td>
<td>1.021</td>
<td></td>
</tr>
<tr>
<td>Tonnes Lifted ('000, non-road)</td>
<td>364,417</td>
<td>430,811</td>
<td>434,498</td>
<td>1.009</td>
<td></td>
</tr>
<tr>
<td><strong>Road Transport</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonnes Lifted ('000) of which</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>1,422,168</td>
<td>1,686,982</td>
<td>1,658,404</td>
<td>0.983</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>543,593</td>
<td>716,667</td>
<td>797,220</td>
<td>1.112</td>
<td></td>
</tr>
<tr>
<td>Average Length of Haul (km)</td>
<td>71</td>
<td>79</td>
<td>88</td>
<td>1.222</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>120</td>
<td>128</td>
<td>136</td>
<td>1.061</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>41</td>
<td>42</td>
<td>45</td>
<td>1.050</td>
<td></td>
</tr>
<tr>
<td>Tonne-kilometres ('000,000)</td>
<td>100,542</td>
<td>132,968</td>
<td>146,714</td>
<td>1.103</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>65,143</td>
<td>91,740</td>
<td>108,280</td>
<td>1.180</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>35,399</td>
<td>41,232</td>
<td>38,435</td>
<td>0.932</td>
<td></td>
</tr>
<tr>
<td>Average Maximum Payload (tonnes)</td>
<td>13.4</td>
<td>13.9</td>
<td>14.5</td>
<td>1.040</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>21.0</td>
<td>21.8</td>
<td>21.6</td>
<td>0.992</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>8.4</td>
<td>8.2</td>
<td>8.1</td>
<td>0.993</td>
<td></td>
</tr>
<tr>
<td>Lading Factor (%)</td>
<td>65.6</td>
<td>63.3</td>
<td>62.9</td>
<td>0.993</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>69.3</td>
<td>66.3</td>
<td>66.2</td>
<td>0.999</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>59.9</td>
<td>57.5</td>
<td>55.6</td>
<td>0.966</td>
<td></td>
</tr>
<tr>
<td>Average Payload (tonnes)</td>
<td>8.8</td>
<td>8.8</td>
<td>9.1</td>
<td>1.033</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>14.6</td>
<td>14.5</td>
<td>14.3</td>
<td>0.990</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>5.1</td>
<td>4.7</td>
<td>4.5</td>
<td>0.959</td>
<td></td>
</tr>
<tr>
<td>Empty Running (% for all commodities)</td>
<td>31</td>
<td>30</td>
<td>29</td>
<td>0.967</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>29</td>
<td>28</td>
<td>28</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>32</td>
<td>31</td>
<td>30</td>
<td>0.968</td>
<td></td>
</tr>
<tr>
<td>Total Vehicle Kilometres ('000)</td>
<td>16,599,597</td>
<td>21,520,550</td>
<td>22,672,442</td>
<td>1.054</td>
<td></td>
</tr>
<tr>
<td>articulated</td>
<td>6,292,371</td>
<td>8,813,350</td>
<td>10,503,470</td>
<td>1.192</td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td>10,307,226</td>
<td>12,707,200</td>
<td>12,168,971</td>
<td>0.958</td>
<td></td>
</tr>
</tbody>
</table>
Fowkes, Nash and Tweddle (1993) confirmed past understanding that road tonne-kilometres appeared to have a unit elasticity with respect to GDP, though they doubted that this would necessarily continue. SOFTICE first took a value of 1.5 as best guess of the elasticity with respect to GDP and -0.1 as the elasticity with respect to Articulated Lorries' Freight Rates, giving predicted changes in tonne-kms as:

<table>
<thead>
<tr>
<th>Period</th>
<th>Elasticity GDP</th>
<th>Elasticity Articulated Lorries</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985-1990</td>
<td>1.5 (18)</td>
<td>-0.1 (-16)</td>
<td>+29%</td>
</tr>
<tr>
<td>1990-1995</td>
<td>1.5 (6)</td>
<td>-0.1 (-11)</td>
<td>+10%</td>
</tr>
</tbody>
</table>

Hence, these elasticities are reasonably consistent with the data if there are no other major effects at work (e.g. trends). Freight rates for rigid vehicles presumably fell less fast than for articulated lorries, accounting for the switch of traffic from rigid vehicles to articulated lorries evident in Table 10. Furthermore, a significant proportion of the UK freight movements is own-account, in which case the ‘Operating Costs’ figures from Table 9 would be more relevant. Also, to some extent the effect of new road building will have fed into the articulated lorries' freight rate data, and part may be confounded with the GDP effect, but nevertheless it may be expected that part of the observed increase in tonne-kms was due to road improvements. As there is no immediate way of including this effect, it is suggested to use the conventional GDP elasticity of 1.0 and to assume that some of the tonne-km growth in 1985-1990 was the result of road building, which slowed in the 1990s.

The figure for Average Maximum Payload has been growing by 4% for each for the 5-year periods under review. The introduction of the 38 tonnes gross vehicle weight articulated lorry in the mid-1980s accounted for some of the increase in the first period, but in the second period the increase is entirely due to the increased proportion of articulated lorries in the fleet. In the future, further increases in Average Maximum Payload can be expected, as lorry weight restrictions are eased (with 41 tonnes gross allowed in the UK from 1.1.99, for example) and with a continued switch from rigid vehicles to articulated lorries.

Figures for Lading Factor show falls over time for rigid vehicles, articulated lorries and the total, but the 1990 and 1995 changes are small. It is assumed to remain constant in the future. If that is the case, then Average Payload (of loaded lorries) will follow the same pattern as Average Maximum Payload. Table 10 shows only a 3% increase over 10 years. McKinnon and Marchant (1999), quoting REDEFINE figures for 1980 to 1995, report an 8% increase in Average Payloads (of loaded vehicles) for the UK over that period, but 38% for the Netherlands and 30% for Sweden. French data provided showed a 10% increase from 1990 to 1995. It therefore seems that the 1985 to 1995 period for the UK experience might give a serious underestimate if applied for all years to all of Europe. An increase in Average Payloads (of loaded vehicles) of 2% p.a. looks like a more typical figure. The French figure was reduced to 2.6% for the 5 years; the corresponding figure for Switzerland shows that, for the 19 years 1974-1993, there the Average Payload has fallen by 1%.

Empty Running figures show a slight decline, of about 3% for each 5-year period. Again this Key Ratio is treated as a trend effect, as no policy-linked effects could be identified. Empty Running was combined with Average Payload (loaded or not), showing little change between 1985 and 1990, but an increase 5% between 1990 and 1995. Consequently, Vehicle Kilometres grew almost as fast as tonne-kms between 1985 and 1990, but at only half their rate between 1990 and 1995. The recommendation is to forecast tonne-kms using the elasticities discussed earlier and then trends applied to determine the increase in Average Payload (loaded or not), so as to derive estimates of Vehicle Kilometres.

The analysis (at individual firm level) used the results of the Second Shippers Panel Survey. A more complete description of the Second Shippers Panel Survey structure and results will be given in the next section (see paragraph 5.4.5).
5.3.2.3 The Case Study Analyses

Measurability of Effects of Swiss Policy Decisions on Freight Transport

The Swiss laws regarding goods transportation by road are rather different from those of the European Union. Therefore it was suggested to verify by experience the effect of some Swiss decisions in order to foresee the possible impact of similar decisions in case they would be made in the European Union.

As a matter of fact the most original decisions of Swiss policy either have been made too long ago for drawing conclusions today (prohibition of night heavy traffic in 1934, prohibition of Sunday heavy traffic in 1963, last increase of permissible maximum weight in 1972), or are not yet in force (heavy goods vehicles tax depending on the permissible weight as well as on the emissions and proportional to the covered kilometres). The only decisions whose impact could reasonably be checked by experience are a number of minor decisions, which were sometimes made nearly at the same time.

The really usable statistics for checking the impact of a measure by comparing the "before" and the "after" state are very few. They are mostly goods vehicles fleet size statistics. The statistics for traffic and goods transport volumes are based on surveys carried out approximately every 10 years; the results are interpolated by complex models for the intermediate years; therefore these statistics can hardly be considered to be the rough and experimental data that are necessary to assess the effects of a decision. Unfortunately for the decision-makers, the effects on the fleet size are not as interesting as those on traffic and transportation.

The examination of the few existing statistics merely suggests that the purchases of new goods vehicles are strongly related to the evolution of the gross domestic product. The relationships to the political decisions made at the same time are far from being obvious.

This difficulty in highlighting the impacts of minor political decisions starting from poorly adequate statistics does not prove the absence of any effect of these actions (and a fortiori of more significant actions!).

Impacts of Illegal Operations in Road Freight Transport on Costs

This part aims to examine the impacts on operating costs of road transport due to the infringements to existing traffic rules. Speeding, driving more than authorised or overloading the lorry allow a haulier to reduce important factors of cost per unit of transport produced (annual fixed cost for operating a lorry, such as depreciation and insurance, drivers wages, etc.) and thus to increase productivity of vehicle fleet and labour force.

The rules taken into account are those affecting more the operating costs borne by the hauliers. They are the following:

- maximum driving time
- speed limits
- maximum permissible weight.

A fourth kind of rule affecting the operating costs (restrictions on lorry traffic during night and/or weekend) has not been considered because of lack of data about infringements.

The focus is on long distance transport, as the violation of rules on speed limits or the maximum driving time concerns mostly this type of transport. In short distance operations the respect of those rules is induced by its nature: short journeys mean more frequent stops for loading/unloading, travelling through congested areas, and violations concerning speed or driving time are less frequent and have less impact on the operating costs.
Six countries are considered: Belgium, France, Germany, Italy, Switzerland and The Netherlands. They have been chosen on the basis of the availability of data about the magnitude of the violations to the above mentioned rules.

Estimations of the impacts of the traffic rules' violations show that illegal operations can significantly decrease the operating costs borne by the hauliers and thus unfairly increase the productivity of road transport.

Different kinds of violations are analysed separately with respect to their impacts on operating costs. If several rules are infringed at the same time, the cost reductions sum up. Thus, in some countries, the reduction of the costs per tonne-km can be up to 30-40%.

The values given should be considered as upper limits of the real saving, as systematic violations of the traffic rules throughout the year are assumed.

In principle two parameters influence the estimation presented here: the magnitude of the infringement and the relative weight of the different cost factors with respect to the total operating costs.

For the first parameters the knowledge is very limited, due to the lack of systematic surveys. Here the existing literature has been examined to find some data at all, but as stated they are heterogeneous in period of time, collection method, etc.

The operating cost breakdown also affects the estimation, and it depends on the characteristics of the "typical" truck considered for each country.

In view of these considerations, the results presented are valid as far as the data on violations and costs are correct.

Table 11 presents a summary of the results.

<table>
<thead>
<tr>
<th>Country</th>
<th>Real driving time (h/week)</th>
<th>Reduction of total annual costs (%)</th>
<th>Excess of speed (km/h)</th>
<th>Reduction of cost per km (%)</th>
<th>Overload (%)</th>
<th>Reduction of cost per tonne (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>65</td>
<td>10.65</td>
<td>5</td>
<td>3.95</td>
<td>20</td>
<td>12.52</td>
</tr>
<tr>
<td>France</td>
<td>55 - 62.5</td>
<td>4.76 - 7.34</td>
<td>10</td>
<td>6.80</td>
<td>5</td>
<td>3.4</td>
</tr>
<tr>
<td>Germany</td>
<td>70 - 87.5</td>
<td>12.61 - 17.15</td>
<td>N/A</td>
<td>-</td>
<td>28</td>
<td>13.74</td>
</tr>
<tr>
<td>Italy</td>
<td>75</td>
<td>15.72</td>
<td>N/A</td>
<td>-</td>
<td>20</td>
<td>12.22</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>60</td>
<td>9.30</td>
<td>15</td>
<td>10.56</td>
<td>20</td>
<td>11.15</td>
</tr>
<tr>
<td>Switzerland</td>
<td>60</td>
<td>8.70</td>
<td>2</td>
<td>1.90</td>
<td>N/A</td>
<td>-</td>
</tr>
</tbody>
</table>

5.3.3 Effectiveness and Harmonisation per Country and Area

This task's idea was to show a path of implementation of differentiated measures to harmonise regulations concerning freight transport throughout Europe. A differentiation has been acknowledged as necessary, as the European countries are experiencing different levels of state's involvement in the transport sector. Therefore
the situation from which a harmonisation policy should start differs considerably across these countries. Although it has been widely recognised that a cost-internalisation and harmonisation policy shall be appropriate to increase overall wealth throughout Europe, there will be winners and losers in that process. So it will not be easy to define an optimal country-related time path for the implementation of harmonisation policy. To minimise the imbalances occurring in such a process, any investigation in possible future development has to consider the differences and discrepancies mentioned.

A corresponding model must first provide a regional differentiation. Second, the model should consider the various levels of activity determining freight transport:

- **the macro level** with its global indicators, such as the share of the production and import of goods in Gross Domestic Product (in opposite to services' share), the absolute value and amount of goods produced and imported, and the resulting transport production volume; the relations between and the shares of the modal alternatives on a global level (even if imposed by historic development): presupposing road freight transport as the ubiquitous but in terms of externalities most expensive mode, the chances of substitution by less costly alternatives; or, in case of these alternatives turning out to be even more expensive (infrastructure), the necessity of an overall re-organisation of physical distribution;

- **the micro level**, analysing the relations between (representative) singular market entities, such as shippers and hauliers, hauliers and forwarders, or even between employers and employees in the transport sector, if the social dimension of working hours and fair wages is included.

And, third, this model will have to differ from conventional transport modelling insofar as it will have to allow for the inclusion of dynamic elements, i.e. considering the interrelations between its elements on the time axis, and here explicitly the possibility of the occurrence of time lags between cause and effect.

### 5.3.3.1 Main Issues of Harmonisation

One of the main goals of European policy actions is harmonisation of social, environmental and economic conditions throughout Europe.

Concerning freight transport a remarkable imbalance concerning problems and approaches to cope with them can be found between different geographical regions.

When considering policy actions, one has to be aware of the differences in the starting-points for different modes. Following the SOFTICE approach, the main issues concerning road and rail (in terms of "non-road") are presented.

For road there exists a variety of technical and organisational matters to be influenced by policy action:

- road vehicle safety,
- emissions,
- characteristics of construction,
- working hours regulations in the haulage industry,
- speed limits,
- weight limits and limits to dimensions of vehicles,
- taxation on fuel and vehicles in operation,
- regulations concerning market access.
For rail, one has to consider the major barriers of technical and/or organisational nature existing in today's European railway landscape, most of which are a heritage from history.

Efforts to overcome these barriers have been undertaken in the past years, yet there is a lot to be done. With increasing scope of action of recently liberalised and privatised railway companies in some European countries, co-operation in the fields of technical and organisational matters is started, as the companies themselves have a major interest to improve their economic perspectives. Yet, for the phase of transition from state-owned, welfare-oriented to private, business-oriented companies, public institutions must provide regulations to ensure fair competition, when new small competitors show up in the rail freight market. Protection against ruinous competition from the part of the former monopolistic companies must be granted, for example a strict organisational separation of infrastructure provision and operational services.

5.3.3.2 The SOFTICE Systems Dynamics Model

The following points present the framework of the SOFTICE Systems Dynamics Model, in terms of its main elements.

Segmentation
As segmentations were chosen:

- modal alternatives: road, rail, inland waterway;
- commodities: bulk goods, intermediate goods, consumer goods (finished products);
- regions: cohesion countries, ecologically sensitive areas, agglomerations, other countries;
- links: between: agglomerations congested, agglomerations non-congested, non-agglomerations non-congested;
- type of movement: local/regional, long-distance domestic, long-distance international;

Main Components; Sectors
The structure of the SOFTICE SDM is presented in Figure 15. It consists of the following sectors:

- on the macro level:
  - Production & Import of Goods
  - Freight Transport Volume (tonnes)
  - Freight Transport Production (tonne-kms)
  - Determinants of Modal Split
  - Freight Modal Split Calculation
  - Infrastructure Load
- on the micro level:
  - Stimuli (External to Shippers)
  - Shippers' Reactions to Stimuli
"Production & Import of Goods" is fed via external development, with assumed growth factors for the value resp. volumes of goods produced and imported; by nature these elements are depending on GDP.

"Freight Transport Volumes" is the amount of goods lifted, as described in the chapter on key ratios. It is accounted from "Production & Import of Goods" via handling factor and value density, both of which are derived as time series from past data; reasonable forecasts on their development are proposed in the corresponding sections (see above). In this sector the volumes are split on the different modes, hence the input arrow from "Modal Split Freight".

"Freight Transport Production" accounts the product of "Freight Transport Volume" (by mode) and average transport distances (by mode). "Average transport distance" is understood as a key ratio and hence treated as an external input, though it is certainly not an independent dimension, as described in the corresponding chapter on key ratios. – The key ratios "empty running" and "average payload" were also put in this sector; all of them are treated as external inputs via time series and corresponding forecasts, though the same as for "average transport distance" will hold for them as well. – As factors they have influence on the freight vehicle performance calculated from the freight production (for road) and on the road transport costs.

"Modal Split Freight" is driven by four variables. The determinants of the modal split model are:

- average annual freight volume on OD-pairs, change ratio driven by "Production & Import of Goods";
- average transport distance, accounted as the minimum distance of all modes, directly linked to the key ratio in "Freight Transport Production";
- the ratio of transport fare for rail to transport fare for road, as time series for past periods and forecasts for the future, resp. depending on dimensions in other sectors;
- the ratio of transport time for rail to transport time for road, as time series for past periods and forecasts for the future, resp. depending on dimensions in other sectors.
"Stimuli (External to Shippers)" and "Shippers’ Reactions to Stimuli": here the findings from the first results of the Second Shippers Panel Survey (see chapter 5.3.2.2) were included.

5.3.3.3 Results per Scenarios

General findings can be resumed as follows:

- Except for bulk goods, where output and transport volumes are decreasing, goods produced and imported transport volumes increase along with the predicted growth rates of GDP (invariant between scenarios). Differences between the types of commodities will occur, corresponding with the development of their value densities. Intuitively, following technological improvements and cost reductions in the manufacturing process and the trend towards miniaturisation for most kinds of manufactured goods (also in order to minimise material input and storage and transport costs) will lead to higher value densities in general. Intermediate and consumer goods are more likely to experience increased value densities over time. They undergo manufacturing processes, other than bulk goods, where that trend is limited by physical properties (a tonne of iron ore will always be a tonne of iron ore, with its price mainly determined by supply and demand, whereas a tonne of electronic devices may have a much higher actual value in a subsequent period, determined by the products' properties).

- Transport performances are calculated using the transport volumes and transport distances by modes. Under the prevailing assumptions, non-road modes can increase their shares during the modelling period, benefiting from the increase of volumes and transport distances for bulk goods and intermediate goods. Consumer products show a very high affinity to road transport from the beginning.

Table 12 gives the corresponding shares for road modal split (transport performance).

<table>
<thead>
<tr>
<th></th>
<th>BAU</th>
<th>ALT1</th>
<th>ALT2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULK</td>
<td>0.69 / 0.80</td>
<td>0.69 / 0.74</td>
<td>0.69 / 0.74</td>
</tr>
<tr>
<td>INTERMEDIATE</td>
<td>0.83 / 0.60</td>
<td>0.83 / 0.58</td>
<td>0.83 / 0.58</td>
</tr>
<tr>
<td>CONSUMER</td>
<td>0.97 / 0.97</td>
<td>0.97 / 0.97</td>
<td>0.97 / 0.97</td>
</tr>
</tbody>
</table>

As volumes of bulk goods transported decrease by annual 1 %, road can increase its share from 69 to 80 % in the reference scenario and even to 74 % in the alternative scenarios (absolute volumes decrease very slowly, but non-road takes all the loss). On the other hand, road loses market share in intermediate goods where the opposite effect, higher transport volumes and longer transport distances benefit non-road. For consumer goods road can hold its very high share of 97 % throughout all scenarios. – Road infrastructure load (for freight transport) experiences a relief of around 15 to 20 percent, caused by higher productivity, i.e. less empty running and higher payloads. Rail network load more than doubles, as no productivity gains for rail are modelled. Thus, transport times for rail increase towards the end of the modelling period.

Finally, the findings of the 2nd Shippers' Panel Survey were included in order to model the shippers' reaction level over time to the stimuli proposed.

The reactions are triggered by the stimulus levels, which again are triggered by other model elements, like change of transport times or costs. 

Results, by scenarios (assumed that stimulus-levels are non-decreasing over time, i.e. shippers do not "forget" any previous activation of the stimulus):
• **Reference scenario**: the only stimulus activated (by 2% / 5% annual level rise) is "Trouble in the supply transport services". Reactions and time, when probability of reaction reaches 50%:

<table>
<thead>
<tr>
<th></th>
<th>2%</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Change delivery time&quot;:</td>
<td>11 years</td>
<td>4 years</td>
</tr>
<tr>
<td>&quot;Relocate&quot;:</td>
<td>3% reaction probability at end of modelling period</td>
<td>16 years</td>
</tr>
<tr>
<td>&quot;Reduce frequency of dispatches&quot;:</td>
<td>15 years</td>
<td>6 years</td>
</tr>
<tr>
<td>&quot;Accept and pay&quot;:</td>
<td>9 years</td>
<td>3 years</td>
</tr>
<tr>
<td>&quot;Reorganise production&quot;:</td>
<td>14 years</td>
<td>6 years</td>
</tr>
<tr>
<td>&quot;Change haulier&quot;:</td>
<td>8 years</td>
<td>3 years</td>
</tr>
</tbody>
</table>

• **Alternative 1 scenario**: the stimuli activated (by 2% / 5% annual level rise) are "Local restrictions" and "Troubles in the production". Reactions and time, when probability of reaction reaches 50%:

<table>
<thead>
<tr>
<th></th>
<th>2%</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Change delivery time&quot;:</td>
<td>11 years</td>
<td>4 years</td>
</tr>
<tr>
<td>&quot;Relocate&quot;:</td>
<td>0% reaction probability at end of modelling period</td>
<td>16 years</td>
</tr>
<tr>
<td>&quot;Accept and pay&quot;:</td>
<td>12 years</td>
<td>2 years</td>
</tr>
<tr>
<td>&quot;Reorganise production&quot;:</td>
<td>13 years</td>
<td>4 years</td>
</tr>
<tr>
<td>&quot;Change haulier&quot;:</td>
<td>0% reaction probability at end of modelling period</td>
<td>10 years</td>
</tr>
</tbody>
</table>

• **Alternative 2 scenario**: no stimulus was activated.

### 5.4 WP4 - Validation and dissemination of results

The aim of this Workpackage is to validate the methodology developed in WP 2 through a Revealed Preference analysis made upon two European corridors (the North-South Transalpine Corridor and the East-West European Corridor) and through a Stated Preference Analysis (the Second Shippers Panel Survey) to validate the conclusions on harmonisation on WP 3. The dissemination was undertaken firstly among the
members of the Advisory Board and will continue after through several promotional activities (i.e. a booklet in English presenting key results of the research, a Website, etc.) A wide dissemination of SOFTICE results will also be made through national promotion co-ordinated by the members of the consortium.

5.4.1 The Corridor analysis

The study of the international freight traffic in Europe can be an effective way to understand the weight of transport cost and of other factors on transport decisions. In the following two sections, an analysis of the freight flows observed on two European corridors (transalpine and East - West Europe) is carried out for validating the methodology developed in the WP2 by examining the observed choices of the decision-makers involved in freight transport, i.e. revealed preferences data, as well for detecting possible impacts of the lack of harmonisation between mode and countries.

The main methodological findings of the WP2 can be summarised as follows:

- the most important dimensions for choice in freight transport are: the type of good (nature, value, logistic organisation for its distribution) and the size of the shipment (also related to the logistic organisation). A segmentation of the transport market were proposed considering these dimensions as well as the size of the shipper;

- the factor “distance” is also significant, for two reasons: firstly, for many goods, there will be a break-even distance where rail becomes competitive with road. Secondly, distance influences the size of the market areas, setting limits that are important especially for goods having high transport cost with respect to the value;

- the distribution structure is influenced by the type and the value of the product, as well as by the volume, the frequency, and the regularity of the shipments;

- service quality requirements play also an important role in transport decisions.

Most data available are aggregate in nature. This implies some limits in the feasible analyses to validate the WP2. Classical econometric approaches are not used here, because data about some of the factors affecting demand are not available. Besides, this type of analysis is not appropriate considering the approach used in WP2.

Four different type of analysis have been realised:

- Analysis on how (and for which goods) the distance affects transport choices:
  - examination of the modal split by categories of distance and by type of good;
  - for some transport cost-intensive goods, check of the limits of their market areas (being not profitable to supply them over long distances).

- Assessment of the effects on the modal split evolution of the transformation in the structure of the demand (in term of types of goods to be moved) and of those due to the change in the competitiveness of transport modes;

- Validation of the pertinence of the SOFTICE segmentation proposed in the WP2;

- Specific analysis on harmonisation: effects of the existing Swiss restrictions.

Most of these analyses have been carried out for both the selected corridors. Due to the lack of enough disaggregate data, the analysis concerning the influence of the distance was not possible for the East – West corridor.
5.4.2 North – South Transalpine corridor

5.4.2.1 Effect of the distance on freight transport

The parameter “distance of transport” is analysed from two points of view, as determinant factor of the modal split and as limiting factor for the market area dimension of transport cost intensive goods.

Analysis of the modal split by categories of distance and by type of good

To see how the distance affects the choice of the transport mode, the transalpine flows have been subdivided by categories of distance (origin – destination), and by type of product. Then the modal split has been calculated for each group of flows of the same product transported over the same (category of) distance, on the basis of the transalpine freight traffic database gathered by the Swiss Transport Department for 1994.

According to the findings of WP2, for many goods there will be a break-even distance where rail begins to be competitive with road. For bulk goods with high transport cost relative to value, this competition exists also over short distance. The results of the analysis for distances up to 1000 km confirm basically this statement. The modal share of rail transport (wagonload and combined) for manufactured goods (NST-R 9) increases from 17% (< 200 km) to 53% (800-1000 km), but decreases for longer distances (Figure 16).

\[
\text{NST-R9 - Modal share of rail transport} \\
(\% \text{ of tonnes transported through the Alps in 1994})
\]

![Figure 16](image)

Rail share with respect to the total tonnage of manufactured goods (NST-R 9) transported through the Alps in 1994, by categories of distance

That reduction can be explained by the volume of the flows transported over distance above 1000 km: most of them are too small to justify an economically viable rail transport and are therefore moved by road. Another reason is possibly the moderate quality (or availability) of the rail service for such long-distance movements.

Considering a typical bulk product such as ores and metal waste (NST-R 4), the rail share is important also over short distances (Figure 17). That confirms that rail transport can compete also over short distances for transport cost intensive goods such as most bulks are.

---

4 About 50 Mio t of manufactured goods were transported in 1994, 38% of the total transalpine traffic.

5 About 7,5 Mio t of ores and metal waste were transported in 1994 through the Alps (6% of the total).
For most bulk product (solid fuels: NST-R 2, oil derivatives: NST-R 3) the trend of the rail share is comparable to the one showed for the group NST-R 4: rail is competitive over short distances, there is no clear relationship between rail share and distance. Intermediate goods such as metal products (NST-R 5) and chemicals (NSR-R 8) present a similar situation, with significant rail shares also above 1000 km; the same is also true for food products (NST-R 1), but with very low rail share for any category of distance.

For the remaining group (NST-R 0: agricultural products, NST-R 6: crude minerals and building materials, NST-R 7: fertilisers) the rail share increases up to 600-800 km, and then decreases more or less slowly. Even if there is no evidence of an unequivocal relationship between modal split and distance, it seems that rail is more competitive on medium-high distances (400-1200 km for agricultural goods, 600-1500 km for crude minerals, 400-1000 km for fertilisers) than over the short ones. Rail transport loses a part of its share over very long distances due to the low volumes to be transported and to the quality and availability of the rail services. For these three groups, the trend is broadly similar to that one of manufactured goods.

Analysis of the market area of transport cost intensive goods

The WP2 stated that some kinds of good (such as cement, wood, printed matter, etc.) are not supplied over long distances because of the importance of the transport costs. Therefore it can be expected that the international flows of them are absent or negligible.

The flows of two among these products (cement and wood) are estimated from the database of the Italian international trade for 1996 gathered by the Italian statistical office. In line with the purpose of this task, the study focuses on transalpine flows (i.e. trade between Italy and the country north/west of the Alps). The other flows have also been taken into account, in order to confirm that the international flows are so small as expected.

Cement and lime (NST-R 641-642) are bulk goods with relatively high transport cost with respect to the value of the product (about 5-15% depending on the country). Italy is a big producer of cement and lime, but the export is very small with respect to the total production: only 0.6 Mio t exported through the Alps, and 1.3 Mio t on the whole. Main movements are over short distance such as Friuli – Austria and Lombardy – Switzerland among the transalpine flows, and Apulia -

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Albania among the others. Transalpine import of cement and lime to Italy is also almost negligible (0.2 Mio t); some cement is imported by sea from Greece (0.7 Mio t) and by rail or road from Croatia and Slovenia (0.3 Mio t).

The commodity group “wood and cork” (NST-R 05) comprehends a range of different goods. As stated in Deliverable D27, the percentage of the transport cost regarding the product value varies considerably by type of wood; highest transport costs are for pulp paper wood (18% the value), fuel wood (37.8% of the production costs) and wood waste (29% of the value).

The import flows of these three products are mostly over medium or short, but not very short, distances, because the production site localisation influences the origin of the flows. Italy has not a large wood production and needs to be supplied from abroad, even if the transport costs become relatively elevated. The total imported volumes are rather small, as expected: on the whole 1.3 Mio t of paper pulp wood and 0.5 Mio t of fuel and waste wood. Rail transport is the dominant mode for pulp paper wood and it is fairly important also for the fuel and waste wood.

The Italian export of wood has not been analysed because negligible (0.05 Mio t for the whole group NST-R 05).

5.4.2.2 Structure of the demand and modal competition

During the last decades, international freight traffic increased considerably: for instance, since 1970, the transalpine traffic more than trebled. Simultaneously the modal split is substantially changed: the growth of the road traffic has been much higher than the one of the rail (in the period 1970-1998, through the Alps8 on the average the road traffic increased by 8.4% per year, while the rail one only by 1.9% per year).

The explanatory factors of that evolution can be classified in two categories: the changes in the production sector (such as the decline of some industries, the growth of other branches, and the resulting changes in the type of goods to move) and the competitiveness of the transport modes. The influence of each of these two factors on the modal split can be assessed by the so-called “Constant-Market-Share” (CMS) analysis. CMS technique compares – under a given period – the real evolution of the total share for each mode with the expected trend of that share. The expected trend is the total share a mode would have if it had kept, for each type of good, the same share of tonnage as in the basic year.

Since it was not possible to obtain a time series under a significant period of time for the whole transalpine traffic, the analysis were focused on the traffic between France and Italy, for which a database is available by the French Minister for Equipment and Transport.

The considered data are the annual tonnages of each kind of product (grouped according to the classification NST-R 2-digit) transported by each mode for the period 1980-1997.

The results of the CMS analysis for the freight traffic from Italy to France show that the considerable decline of the rail transport (from 21%, in 1980 to 5% in 1997) was mostly due to the decrease of its competitiveness: the rail share would have decreased only to 19% if rail would have kept the market share it had in 1980 for each type of product. Correspondingly, the road growth was almost entirely due to the improvement of the competitiveness of that mode. In fact the good structure did not change so much during this period. The drop of the rail share was especially important for agricultural goods, iron metallurgical products, transport and agricultural equipment, and machinery and manufactures of metals. The share lost by rail was taken mostly by the road transport, and also by sea transport in the case of iron products.

7 Annexes, Task 1, chapter 6.1.

8 The rates of growth concern the traffic (in tonnes) through the crossings of the central part of the Alps, i.e. between the Mt. Cenis and the Brenner.
The difference between the real and the expected CMS trends for rail transport are showed in Figure 18. The difference between the share in the basic year and the expected CMS share is the effect of the change in the good structure, i.e. in the mix of goods imported in France from Italy. The effect of the modal competition is the residual between the CMS curve and the actual trend.

![Figure 18](image1.png)

*Evolution of the rail share for the freight transported from Italy to France*

The evolution of the modal split was somewhat different for the freight traffic from France to Italy, because the good structure effect played a more important role. Though the rail still transports a significant part of the freight volume, its share decreased (from 45% to 23%). The transformation in the good structure explains 2/5 of this reduction (the 1997’s expected CMS-share is in fact 36%), the remaining part being due to the modal competition.

![Figure 19](image2.png)

*Evolution of the rail share for the freight transported from France to Italy*

The most important change in the good structure was the decline of the flow of iron/steel waste and blast-furnace dust that were traditionally transported mainly by rail. At the same time, however, the rail share for this commodity group decreased to the benefit of road haulage. Rail share dropped also for the flows of agricultural goods, and paper pulp and waste paper. The rail share’s reductions were mainly to the benefit of road transport, and also of the maritime transport in the case of the agricultural goods. Rail declined but remained the dominant mode for the transport of iron metallurgical products, crude minerals and building
materials, and machinery and manufactures of metal. Again road took most of the share lost by rail, while the
sea transport grew for iron products. The share of sea transport was principally influenced by the fluctuation
of the flows of petroleum derivatives.

Summarising, the modal competition is the main explanatory factor of the decline of rail transport to the
benefit of road, while the good structure transformation is important only for the traffic from France to Italy.
In the last twenty years, road transport has been able to penetrate all the markets, even some usually
considered as typically “rail-oriented”, such as iron ores and waste, metal products, fertilisers, etc.

Concerning the likelihood to extend these results to the whole transalpine traffic, a study carried out by
Bertschi (1985)\(^9\) about the freight traffic Italy-Germany (the other big component of the transalpine traffic)
for the period 1969-1982 arrive at similar results: modal competition as main reason of the rail drop, with
good structure having a significant effect only for the flow from Germany to Italy.

5.4.2.3 Pertinence of the SOFTICE segmentation of the transport market

According to the methodology developed in WP2, the transport market can be segmented on the basis of four
dimensions: type and value of product, size of the shipper, and size of the shipment.

In Deliverable D5 is presented in detail the market segmentation for the freight flows between Italy and the
countries of Europe situated north or west of the Alps. No information was available about the size of the
shipper and the size of the shipment, so only two dimensions of the segmentation have been considered: type
and value of the goods.

Low value bulks (LVB) are the most important segment both for import and export. For almost all the
segments the export flows are quite significant, while the imported freight is mainly LV products. Thus, on
average the value per tonne is higher for the exported goods.

The road transport is the leading mode in every segment except the import of low value bulk, and its
prevalence is even higher in terms of value: road is able to attract the most profitable markets. Rail is the
17.5% of the import and only the 7.2% of the export, partly because of the higher percentage of low value
goods for the import, but also for other factors (Italian shippers less willing to use rail; Italian export flows
having low volumes and origins scattered over the territory). Maritime is the main mode for the import of
LVB.

Summarising, both dimensions seem to influence the transport decisions, the modal split being quite different
for each segment. It is not possible, however, to restrict the modal competition in specific segments,
considering the others as oriented to one particular mode. Due to its flexibility and cheapness, road transport
has penetrated all the segments; at the same time, rail is still significant for some high value products
(intermediate).

A more accurate assessment of the pertinence of the segmentation were carried out for the flows from France
to Italy (and from France crossing Italy but directed to elsewhere) on the basis of the French customs’
database, which provides data also on the shipper’s size.

Concerning the modal split, the dimension of the “shipper’s size” seems to be very important, because the
modal shares are quite different for the same group of products (in terms of type and value). The SMEs, in
particular, ship around the 90% of their goods by road, except for the LVB, which are moved mainly by rail.
The large shippers of intermediate goods are much more willing to use the rail transport than the small ones.
In the case of consumer products, the modal split does not change too much with respect to the shipper’s size.

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\(^9\) Hans-Jörg Bertschi, Der Alpenquerende Verkehr dargestellt am Ausbau einer neuen Eisenbahntransversale
durch die Schweiz, Bern, 1985
The maritime transport is chosen by large shippers of low value bulk and intermediate goods, as well as by small-medium companies exporting low value bulk.

Coming to a conclusion, it seems clear that the three dimensions that were considered in this chapter (type and value of the product, shipper’s size) represent significant factors that influence the choice of the transport mode and therefore are pertinent for the segmentation of the transport market. As a result, the SOFTICE segmentation can be considered as a suitable way to subdivide the transport market.

Besides, it appears in general that the modal splits for the same segment differ according to the direction of transport (in the case of transalpine flows, the share of non-road modes is higher for the traffic towards Italy). That depends probably on the local accessibility and quality of non-road modes, as well as on the attitude of the shippers.

5.4.2.4 Analysis of the freight flows of specific products

In WP2 of SOFTICE some long distance and international flows of specific products were analysed. The flows through the Alps of these products have been analysed in order to check the findings of that analysis.

The Italian trade with the European countries located north or west of the Alps has, for some of the goods considered in WP (beer; cocoa, chocolate and sugar confectionery; perishable foodstuffs; fuel derivatives; tubes, pipes, iron and steel castings and forgings; fertilisers; electrical machinery, apparatus, appliances, engines; paper and paperboard).

In most cases, the results of the WP2’s analysis of specific products are confirmed by the observation of the transalpine flows originating from or directed to Italy, in particular with regard to the value per tonne, the modal split, and in general the transport organisation (details of this analysis are presented on Deliverable D5).

5.4.2.5 Analysis of the existing level of harmonisation among modes and countries

As regards the transalpine freight transport, the present lack of harmonisation is especially due to the restrictions for the heavy good vehicles (HGV) that are in force in Switzerland and not in the other Alpine countries: night traffic prohibition between 10.00 p.m. and 5.00 a.m. and permissible maximum weight of 28 tonnes.

During the last 30 years, the evolution of the transalpine traffic has been quite different in the three transit countries; considering freight transported through the central part of the Alps (from Mont Cenis to Brenner), Switzerland has lost its position as main transit country to the benefit of Austria and (even more) France. This is due to the substantial growth of the road traffic through these two countries, while for Switzerland the restrictions have limited that increase. Thus, rail transport still is 71.5% of the transalpine traffic through Switzerland, while it is 26.1% for France and 26.5% for Austria (1998).

A recent study of the French Transport Department on transalpine traffic examines the route choice of the drivers of HGVs of less than 28 t for the flows between each origin and destination, and assign the flows of the heavier vehicles as if they were routed alike. The diverted traffic is then the difference between the real traffic and the one resulting from this hypothetical assignment. This method has the advantage to estimate the potential traffic without the 28 t limit taking into account the real choice of the drivers. According to the results of this study, more than one third of the transalpine traffic through both French and Austrian crossings (central segment of the Alps) is diverted from Switzerland.

Therefore, the observation of the freight traffic through the transalpine corridor shows clearly the effect of the lack of harmonisation: the splits both by mode and by transit country are influenced strongly by the particular restrictions that are in force in Switzerland.

Looking at the effect of this lack of harmonisation on transport costs, recent estimation (see Deliverable D5) shows that bypassing Switzerland is profitable when the kilometric surplus is less important with respect to
the total distance. In some cases (such as Strasbourg-Milan) the transit through Switzerland with a 28 t lorry can even be the cheapest solution, but the lorries cross anyway the Alps in France every time that the transport of full load of more than 12-15 t is needed.

5.4.3 East – West European corridor

Due to the limited availability of data, it has not been possible to analyse all the freight traffic characteristics that were examined for the transalpine corridor. The analyses carried out were focused on the flows between France or Italy on the one hand, and some CEEC countries on the other hand.

5.4.3.1 Structure of the demand and modal competition

The “Constant-Market-Share” technique has been used to analyse the modal split evolution taking into account the effects of the transformation of the good structure and of the modal competition; with focus on the traffic France – Hungary and France – Poland, for which the data are available. Detailed results are shown in Deliverable D5.

As regards the freight traffic between France and Hungary, the rail share decreased drastically during the period 1980-1997, mainly to the benefit of road transport. Most of this decline was owing to the modal competition, while the transformation of the good structure had a little effect. In the direction Hungary to France, the decline of some rail-oriented goods, such as fertilisers, were compensated by the growth of the trade of other products previously transported mostly as wagonload: e.g. chemicals and machinery. Nevertheless, the weakening of the rail competitiveness caused an impressive decrease of its modal share: from 74% in 1980 to 8% in 1997.

The French export to Hungary had important fluctuations during the considered period. Some transformations in the good structure, such as the reduction of the importance of the “other chemical products” (NST-R 89), penalised the rail transport; once more, however, the main cause of the rail share’s decrease was the modal competition.

A complete different evolution had the modal split of the freight transport between France and Poland. Both rail and road transport increased their shares, which were very low in 1980, at the expense of sea transport.

In the direction France to Poland, the driving factor of that trend was the transformation of the good structure with the development of the trade of some goods “rail-oriented” such as iron metal products and transport equipment. Road transport grew because of its competitiveness and the development of the flows of products such as food and manufactured products. The rail share rose also in the opposite direction (from 2% in 1980 to 12% in 1997). Solid mineral fuels, salt, pyrites and sulphur, and fertilisers constitute most of the Poland export. The effect of modal competition was less important than for the flow France to Poland.

5.4.3.2 Pertinence of the SOFTICE segmentation of the transport market

The SOFTICE segmentation was applied to some East – West European flows with the aim of estimating the transported volume and the modal split for each segment.

For the trade France-Hungary and France-Poland, the available database allows one to take into account only the “type of product” dimension. In both cases (France – Hungary, France – Poland) the trade of consumer goods is increasing and is moved almost entirely by road (sea transport has significant share in the direction France to Poland). For the other two segments, rail share is everywhere decreasing but remains significant in some cases (intermediate goods and French import of bulks), while maritime transport is still the dominant mode for the trade of bulk goods between France and Poland.

The flows Italy-Hungary and Italy-Poland have also been analysed to assess more significantly the pertinence of the SOFTICE segmentation: the available database allows one to consider two dimension of the segmentation: type and value of the product.
The freight traffic between Italy and Hungary is constituted mainly by low-value bulk and intermediate goods. As regards the modal split, the rail share is very important for the low-value intermediate goods (in both directions) and for the low-value bulks exported from Hungary, the other segments being dominated by road.

Concerning the Italian-Poland trade, the segment of low-value bulk goods is by far the principal one. Rail transport represents around 1/3 of the traffic of most segments of the traffic from Italy to Poland. The rail share is also high for intermediate goods moved from Poland to Italy of, while sea transport dominates the low-value bulk segment.

As observed also for the transalpine traffic, road transport is used to move goods with higher value than those transported by the other modes.

The two dimensions here considered (type and value of product) seem to influence the transport decisions, without identifying, however, clearly distinct segments in terms of modal split. Two segments (high-value bulks and high-value consumer goods) are dominated by road, respectively because of the low tonnage (HVB) and the nature of the goods (HVC). In the other segments the road – rail competition takes place; maritime transport is very important for (low-value) bulks where available (traffic to/from Poland).

5.4.3.3 Analysis of the freight flows of specific products

The findings of the WP2 on long distance and international flows of some specific products (perishable foodstuffs; fuel derivatives; pipes, iron and steel castings; fertilisers, electrical machinery; paper and paperboard) have been analysed in this chapter for the traffic between Italy and East Europe. Generally speaking, it can be stated the analysis of the traffic of specific products between Italy and East Europe confirms the findings of the WP2 about the long-distance freight traffic, especially with regard to the modal split and in general to the organisation of the transport. Detailed results of this examination are presented in Deliverable D5.

5.4.4 Conclusions

An investigation of the freight traffic observed on two European corridors has been carried out to validate of the SOFTICE methodology developed in the WP2.

Concerning the influence of the distance, for some products (manufactured, agricultural, minerals, and fertilisers), rail competitiveness appears to increase with the distance up to 800-1000 km, while decreases for longer movements (due to lower volumes to move and less available rail services). The factor “distance” affects also the market area’s dimension for goods with high transport costs with respect to the value, such as cement and wood.

The analysis of the modal split evolution has shown that the competition between modes is the main explanatory factor of the rail decrease to the benefit (mainly) of road, both for the transalpine and the East-West European corridor. The transformation in the good structure took place but its effect has been less important, affecting significantly only the transalpine traffic from North to South.

Looking at the SOFTICE segmentation, the available data allow us to analyse only three dimensions (out of four): the type of the products, its value, and the size of the shipper. The segments obtained seem to have specific characteristics in terms of transports (Table 13)
### Table 13 – Characteristics of the modal split for the SOFTICE segments

| Type of product | Value of product | Size of the shipper | Italian import from West-Europe | Italian export to West-Europe | Hungary to Italy | Italy to Hungary | Poland to Italy | Italy to Poland | Hungary to France | France to Hungary | Poland to France | France to Italy or to other country and crossing Italy |
|-----------------|------------------|---------------------|-------------------------------|-------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------------------------------|

ROAD = road share > 90%; otherwise the modes having a share > 10% are indicated

Only two segments are clearly road-dominated: high value bulks and high value consumer goods. In the other segments some competition between road and rail still exists, while sea transport is important for low value bulks. The dimension of the “shipper’s size” seems to be very important, because the modal shares for SMEs and for large companies are quite different for the same group of products (in terms of type and value).

As regards the international flows of some specific goods examined in WP2, the revealed preference approach confirms most findings about the modal split and the value per tonne.

Finally, for the transalpine transport, the analysis of the evolution of the split by crossing country and by mode provides clear evidence of the lack of harmonisation: one third of the traffic traversing the French and Austrian crossings of the central Alps consists in fact of lorries heavier than 28 t, which by-pass Switzerland because of the Swiss weight limit.

### 5.4.5 The Second Shippers Panel Survey

The purpose of the Second Shipper Panel Survey was to validate the methodology developed in WP2 and the conclusions on harmonisation of the WP3. Therefore no additional conclusions were achieved, but previously available indications were reinforced, subject to doubt or simply interpreted in a new angle. A special focus was given to factors such as external costs and quality of service seen in different perspectives per each shipper coming from different countries and economic segments. As yet specified (see paragraph 5.3.2.2) the first results of the Second Shipper Panel Survey were also used as inputs for the SOFTICE Systems Dynamics Model.

The questionnaire of the Second Shipper Panel Survey was sent not only to the shippers involved in the first survey, but also to some others in order to exclude the shippers that could not answer to the first one and to guarantee an adequate number of answers for the following analysis.

#### 5.4.5.1 Structure of the Questionnaire

The main goal of this questionnaire was to check on responses from shippers, concerning their activities and the ones referred to their hauliers and logistics providers when confronted with stronger changes of the main trends or expected policy changes in relation to road freight transport in Europe.

The interviews were mostly made to the shippers but the other agents of the freight transport sector (hauliers and logistics suppliers) may have different perspectives on the current conditions and on the possible evolutions. Thus the purpose was to know not only their preferred reaction to this stimulus, but also what would be the most adequate answers for their business taking into account the other agent’s positions to solve their problems resulting from that stimulus.
For each stimulus a series of expected possible responses and also some background information including an example of application of that stimulus were identified. Of course, these examples must necessarily be a generic framework of the stimuli since the number of shippers and referred type of business was very high.

Besides the list of pre-defined responses, one open line was left for an additional type of response considered as very likely for adoption either by their company or by the other agents.

Finally, to facilitate the interpretation of the answers coming from a high number of shippers (from different countries and economic sectors) with different perspectives about the thresholds of the responses to the various stimuli, the shipper was asked to state the level of stimulus that will lead to a “very likely” change of his current behaviour in the sense of that reaction.

5.4.5.2 The results

The shippers’ survey confronted respondents with eight different types of stimuli. As yet specified in the previous paragraph, for each stimulus (question) the questionnaire presented a list of possible reactions, for the shippers themselves and for the hauliers with whom they have business agreements. For each reaction, respondents were also asked the likelihood they would consider to realise that type of reaction (on a scale between 1 – very unlikely and 5 – very likely).

In order to facilitate the treatment of the available data, the stimuli were aggregated into four groups according to their matter:

- **Group I- Local restrictions:**
  - Circulation restriction due to social and environmental impacts;

- **Group II - Troubles in the supply transport services:**
  - Unreliability of deliveries;
  - Cost increasing due to congestion;

- **Group III- Pricing:**
  - Cost increasing due to urban congestion (tolls in central areas);
  - Cost increasing in motorways (road tolls);
  - Cost increasing due to environmental reasons (fuel taxes);

- **Group IV- Troubles in the production:**
  - Cost increasing due to lack of flexibility;
  - Cost increasing for out-of-schedule or very urgent shipments.

Eight generic types of possible reactions on these stimuli were suggested:

- Change delivery times;
- Relocate;
- Reduce frequency of dispatches;
- No change;
- Accept and pay;
- Reorganise production;
- Change haulier;
-Modal shift.
These as well have been aggregated according to the grouping by matter of the stimuli.

Methodology

It was firstly assessed the likelihood of the shippers for each reaction to the stimuli proposed and then tried to model the reaction thresholds.

In the first part of the analysis an approach was developed, highlighting the likelihood of each reaction through a tri-dimensional visual scheme (see, as an example, Figure 20) including the number of answers available and the different reactions proposed to the shippers.

![Level of interest of each reaction](image)

*Figure 20  Shippers reaction to potential local restrictions (tri-dimensional visual scheme)*

The second part was based on the following steps:

- Calibration of a logistic curve considering the percentage variation of the stimulus (threshold's level) as the independent variable to that cumulative probability distribution;

- The logistic curve takes values between 0 and 1, and was thus be used in the System Dynamics model as a proxy for the probability of reaction, given a certain level of stimulus. The expression of the logistic curve with \( x \) as the stimulus is:

\[
y = 1 - \exp \left( -\frac{x}{\beta} \right)^\alpha
\]

The calibration was done by least square estimation.
Analysis of the Results
The following lines present only a short summary of the results. The SOFTICE deliverable D4 contains a complete analysis and description of the outputs.

- **Group I – Local restrictions**

  *Reorganise production* and *Relocate*, especially the last one, presented a very low level of interest while the alternatives *Accept and pay* and *Change delivery times* had a reasonable and more stabilised level of interest. Despite the number of answers considering it with a low rate of interest *Changing delivery times* seems to be the alternative considered first.

- **Group II – Troubles in the supply transport services**

  This aggregated stimulus representing possible problems related with the supply of transport services showed that when shippers face this type of problems they try to avoid *Relocating* and even *Changing delivery times* and *Reorganising production* are not seen as feasible solutions.

  Due to the fact that the level of non-response in this question was relatively high and also because the shippers didn’t favour any of the alternatives (and even not proposed any other) it seems reasonable not to indicate a direction of intention for this stimulus.

- **Group III – Pricing**

  The level of non-response for the alternatives *Change delivery times* and *Accept and pay* was very high which could indicate some indifference to such sort of reaction, ignorance or at least uneasiness about the information needed to react to this stimulus or even a level of interest lower than 1. *Relocating*, again, doesn’t generate much enthusiasm among the shippers.

  Opposite, *No change* or a *Modal shift* are the most stimulating reactions. Nevertheless there is a low level of enthusiasm for the latter.

- **Group IV – Troubles in the production**

  The most attractive reactions for eventual over-pressure in the production are *Change haulier* and particularly *Accept and pay*.

  For this stimulus also there is a high level of non-response, especially concerning the suggested response *Relocate* and *Reorganise production*. This was foreseeable, since these alternatives involve a long-term approach while the other two *Change haulier* and *Accept and pay* are easier to implement in the short-term.

Logistic Model for the Thresholds Reactions
Through the figures containing the cumulative distribution of threshold levels for each reaction it is possible to know how many shippers have the same threshold level when reacting to the stimuli proposed.

- **Group I – Local restrictions**

  Possible answers were:

  2a – Reorganise production
  2b – Relocate
  2c – Accept and pay
  2d – Change delivery times
The first two alternatives have cumulative distributions of thresholds quite similar to each other, just as the other two. While for the first and second the shippers concentrate their threshold levels next 100%, they are much more spread for the third and fourth. This occurs mainly because the former are possible reactions to be implemented in a long-term view, which is not true for the other two alternatives.

Figure 21 gives an example of the logistic analytic modelling, also providing the distribution's parameters.

Figure 21 Observed and modelled logistic curve to the thresholds of reaction "Reorganise production": \( a = 2.1177; b = -0.0362 \)

- **Group II – Troubles in the supply transport services**

The conclusions of the first group are appropriate for this type of stimuli as well. Nevertheless it is necessary to stress that the majority of the shippers only considered the alternative *Relocate* if the costs increases by 100%. In one case the responding shipper answered with even a higher level of threshold (200%).

- **Group III – Pricing**

Again the previous conclusions are reasonable in this case. The reactions *Accept* and *Pay* and *Reduce frequency of dispatches* are by far the most likely to be implemented since their average level of threshold is relatively low (less than 20%). However, there was one shipper considering this reaction with a very high threshold (200%) for a change in behaviour.

- **Group IV – Troubles in the production**

Once more the previous conclusions are suitable for this stimulus. Curiously, despite the fact that the reaction *Change haulier* is not an alternative to be implemented in the long term it presents a high number of shippers considering it with a high threshold level.

Firms react to the various stimuli in different ways and the analysis conducted has attempted to provide the Systems Dynamics Model with suitable expressions summarising these reactions.

**5.4.5.3 Some short conclusions on the results of the Second Shippers Panel Survey**

On the basis of the answers collected during the survey, it is possible to make the following final observations:
• It is possible to say that, generally the shippers prefer short-term solutions to solve their problems rather than long-term alternatives. This is probably due to the fact that these short-term solutions have a lower value of investment related and also because doing this way the shippers don’t have to make significant changes in their operation logic;

• This can be observed with the level of thresholds that will lead to change in their behaviour as well: a short-term solution is generally associated with a lower level (of threshold for reaction) while a long-term solutions is associated with a higher level. Concerning the possible reaction of the hauliers to the several stimuli proposed the same line of thinking could be applied;

So, there seems to be clear indication that market forces, in particular those pushing towards restructuring of production processes, are much stronger than those forces that could come from justifiable price increases of road haulage.

6. Conclusions

6.1 Main conclusions

6.1.1 The general picture

• Based on a small number of different statistical sources, relatively consistent values can be obtained for the weight of transport costs as a percentage of total industrial production outputs: at a relatively high level of aggregation of industrial sectors (11 to 18 sectors, depending on the country and source), this percentage normally falls between 3% and 6%, although it is clear from direct knowledge that some sub-sectors will have significantly larger proportions of their costs for transport operations (food and beverages, clothing, furniture, etc.);

• Own-account transport operations, which normally are not visible in transport statistics, can have a significant role: for the available data sets, it is estimated that they represent between 14% and 22% of the total transport costs. By type of good, this form of operation seems especially important for intermediate goods and raw materials;

• Freight transport by road exhibits a very strong diversity of production processes and cost structures, in a clear demonstration of its adaptability to different requirements from its clients and to different regulatory (if different enforcement of similar rules are included) and economic backgrounds. This diversity and adaptability virtually prevent the production of quantitative estimates of elasticity-type indicators of reactions to policy action unless they are computed separately for rather fine segments of this sector (for which the data is not readily available ex-ante);

• Statistics in freight transport usually refer to tonnes and tonnes-kilometres, however they fail to show a heterogeneous market. In an important French survey of shippers in 1988, it was revealed that shipments under 1 tonne represent 73% of the shipments but only 17% of the tonnage, and on the opposite side shipments over 20 tonnes represent only 5% of shipments but 43% of the tonnage. These results imply different methods of organisation of transport (even if the above shares of tonnage and consignments continue to evolve), which correspond to the segmentation of services offered by road haulage: parcel services, consolidation, and full load transport. This survey showed that only 1 shipment in 4 for hire-and-reward transport is a single route transport, therefore 3 in 4 can imply more complex transport operations such as groupage, consolidation and collection / distribution.

• Comparing the data collected for the first Shipper Panel Survey and the data from the Cost Data Collection which was previously undertaken among the hauliers it is interesting to observe that the prices quoted by the hauliers are lower than those declared by the shippers. The fact that most of the shipping examples collected during the first Shipper Panel Survey are regular ones can explain this aspect (usually lower prices are negotiated for these movements). In any case reported differences in Switzerland (-34%)
and in Portugal (-66%) are very high. These values can be explained considering that in the analysed data set a certain quantity of "outliers" can be present, but also by the presence of price lists for the transport of goods which are not respected for various reasons (heavy competition mainly).

- The cost of transport varies according to the shipper's country of residence, and differences can be remarkable when, for example, Germany is compared to Portugal. This may be due to different costs of labour in these countries (e.g. salaries, working hours, etc.), but it would be interesting to expand this project's purview to include investigation into whether cost differences may depend on different logistical organisations of the transport chain, a bigger/smaller share due to storage and handling, different highway fees and tolls, different maintenance costs and regulations, or other factors more directly related to transport as such.

- Most of the cases under study refer to FLT shipments and regular deliveries. This result was expected since FLT transport generally optimises shipping costs, and shippers ordinarily work with regular production cycles. In fact, the data analysis shows that FLT shipments tend to yield a significantly lower value of cost per Km, and this holds true especially over short-medium distances.

- The branch of economic activity of shippers does not seem to have a marked effect on the actual cost of transport. Even though cost values differ significantly between textiles and food, the median values (much less affected by outliers as discussed earlier) are more or less all concentrated around 1 ECU/Km for all branches of activity. More than by the shipper's economic branch of activity, the cost factor may probably be affected by the kind of commodity transported and the actual type of cargo (e.g. liquid/solid bulk, container, pallets, swap bodies, self-propelled units, refrigerated, etc.), especially when special vehicles are needed or no back load can be transported.

- In the last decades, improved infrastructure, improved carrier efficiency due to better communication systems, removal of trade barriers, the rise of third-party carriers who combine truck movements as well as deregulation have resulted in reduction of transport costs, drawing companies to re-evaluate their distribution structures. This has resulted in considerable savings and there is much evidence that companies move toward more centralised structures eliminating intermediate distribution centres. This kind of change allows the reduction of supply chain costs by optimising the load consolidation. Primary transportation costs (plants → warehouse) increase because of longer distances, but the load factor of vehicle can increase. Besides important savings arise in inventory costs. More frequent deliveries into each market become possible and therefore customer service is improved.

- From the valuation of transport attributes, it is possible to assess the relative importance of different attributes of quality of service (namely reliability and transit time) for each market segment. Reliability seems to be the most important criterion for both shippers and carriers according to the numerous surveys (carried out in Europe and in the United-States) in which respondents are asked to rank the criteria. Price of the transport and reliability fight for the first place in these surveys in most segments.

- As computer aids become cheaper and ubiquitous, significant gains of commercial efficiency are still to be expected. Also on the side of productive efficiency, the expected increase of maximum vehicle tonnage and of computer aide in traffic management on the most charged road links should also lead to important contributions towards congestion relief, which possibly could compensate the aggravation of that congestion induced by economic development and increasing trade volumes;

- There are some markets (segmented by distance, type and value of product, and shipper size) where railways can achieve interesting market share, but these are far from enough to justify positive expectations about road congestion relief. On an aggregate level, it is possible to see that road transport continues to gain market share, and that such evolution is not due to a change in the structure of the freight market, but rather to the increasing competitiveness of road haulage with regard to railway (i.e. SMEs seem to be less willing than Les to use modes other than roads probably because of lower volumes to move and lower easiness to access to the other modes;
6.1.2 Working Hours regulations

- Stricter regulations on working hours in the road haulage industry must not be seen as an effective instrument towards modal shifts. If indeed they are to be enforced, that should be on account of workers’ well being and not on these indirect consequences, which probably will not be enacted as the shippers’ panel survey indicates. The effect on costs of the violations has been estimated in a cost reduction of 10 – 15%.

6.1.3 Internalisation of External Costs

- Internalisation of external costs of road transport is increasingly considered not only as a fair principle but also as an effective instrument to fight congestion, as drivers will try to avoid recurrent use of congested (more expensive) components of the network. However, the expected magnitude of price increases in interurban transport is not such that it will cause massive modal transfers;

- The parts of the transport sector where cost increases will be higher after internalisation of external costs are connected to collection / distribution in the large urban areas, but there are no modal alternatives for significant shifts of market shares. Those problems have to be dealt with mainly in the transport – land use interface;

- In spite of the mentioned gains of efficiency in road haulage, it is not clear how fast the move towards a less congested interurban road system will be, as those gains will be counteracted by the expected increases of international trade;

- Physical limitation (for example through specification of the maximum number of heavy vehicles that can pass a certain road section) is one type of measure that local and regional authorities may feel inclined to adopt if and when they conclude that prices alone will not deter the growth of traffic volumes;

6.1.4 Evolutions in Logistics and Shippers’ behaviour

- In most sectors, transport costs (for the shipper) represent a very small part of the total production cost, and as long as transport cost increases are introduced in a way that is seen as fair and equitable, they will probably be partly compensated by efficiency gains on the haulier’s side, and partly accepted by the shipper without any major impact on the solutions adopted;

- When faced with several stimuli reflecting increasing difficulties or costs in keeping their current transport solutions, shippers more willingly consider measures like increasing transport prices or changes in shipping times than anything that has to do with modal transfers;

- That unwillingness to change is largely attributed to the bad experience with other transport modes, no matter whether that experience has been directly suffered or just reported from other colleagues. Poor performance and lack of competence to satisfy evolving needs from the clients seems to be still entrenched in the organisations involved in the other modes;

- The declared willingness to adaptation of behaviour from the part of the shippers indicates that the market forces, in particular those pushing towards restructuring of production processes, are much stronger than those forces that could come from justifiable price increases of road haulage.

Thus, there is the presence of two types of forces of considerable differences in reach and strength:

- Stronger competition in wider markets, forcing long-term restructuring of production / distribution processes;
Disturbances in the transport supply, through congestion delays and irregularities, or higher prices for environmental reasons, which can be tolerated within the overall production / distribution process, possibly with some short term adjustment like changes of delivery times, use of alternative routes, acceptance of higher costs, etc.

The prevalence of the first type of forces seems to be so clear that the consequence in terms of policy should also be clear: it is not through type (and intensity) of stimulus considered that significant changes in modal split can be achieved. A strong improvement of efficiency from the other modes would be necessary in parallel for the shippers to consider the scale of modal transfers thought desirable by policy makers.

6.2 Recommendations

6.2.1 On Pricing

- Internalisation of external costs is considered by most as a fair principle and an effective instrument against congestion, but should not be expected to lead, by itself, to significant modal transfers in favour of the railways. Still, the frequency of intolerable situations of gridlock will diminish, and the system will become more sustainable. Decisions could and should be taken quickly in this direction;

- The most effective instrument identified in order to reduce transport-induced CO₂-emissions are fuel taxes and speed limits. Whereas fuel taxes still vary considerably across Europe, the maximum speed for trucks has been widely harmonised. A further general reduction is unlikely, as it is questionable whether a further reduced maximum speed for trucks would improve the overall performance in view of environmental aspects, as truck engines' fuel consumption has been optimised with the prevailing speed limits. Other instruments with high effectiveness can also be applied: emission standards by technical regulations (realised by EURO III and EURO IV) and urban traffic bans.

- It is not necessary or even convenient to move immediately towards a system of «perfect» prices. The underlying principles should be announced and progressively implemented, giving time to all agents to prepare their strategy for adaptation. Successive rounds of consideration of further items of external costs to be internalised will be better managed on the basis of earlier experience.

6.2.2 On harmonisation of conditions of production

- Similarly, harmonisation of conditions of production on the road transport sector is important, not only because this is an important rule of competition in the internal market, but mainly because some of the key factors in this case have a profound effect on road safety. Strict enforcement of driving hours, speed limits and maximum loadings is necessary, and electronic systems may give a decisive help in this direction;

- The most effective measures identified for the improvement of traffic safety are the already mentioned working hours regulations, speed limits and their enforcement, alcohol limits and their enforcement (less relevant for professional drivers) and appropriate insurance/liability systems (bonus/malus system). For the latter a general problem occurs in freight transport, when the driver is not directly liable for injury and damage caused by the vehicle.

6.2.3 Other areas of policy action

- Transport, telecommunication and energy supply infrastructure are subject to plans on Trans-European networks. – Regulations have been found necessary in most countries after liberalisation of the telecommunications market to ensure fair competition between new suppliers and the formerly state-
owned incumbents. Similar schemes may turn out to be appropriate for the transport infrastructure, in close linkage to infrastructure cost recovery: public-private partnerships can guarantee a business-type cost accounting in the provision and administration of transport networks and therefore guarantee a more efficient use of the existing infrastructure.

The setting-up of such private-public partnerships will rise conflicts: On the one hand these institutions will have to aim at a budget equilibrium between expenses and revenues, and therefore guide capital into the most profitable investments. On the other hand there is the goal of shifting traffic away from road towards rail, inland waterway or any form of combined transport, but their infrastructures are more expensive in construction and maintenance than road infrastructure with equal capacity. Following this logic, most of the investments would be guided to the extension and improvement of pay-per-use roads, further widening the gap between the supply levels of road and non-road infrastructure.

Thus the public partner will have to decide on how and to what extent

⇒ road tolls are levied to fulfil both the goals of budget equilibrium on the one hand and internalisation of external costs on the other hand;

⇒ non-road infrastructure, respectively their users, are subsidised by charging them less than the full costs.

- Industrial companies and transport operators will by themselves make systematic efforts of adaptation to current and foreseeable conditions of the markets, including conditions of transport. Some of the most important functions of governments in this context are the production and dissemination of messages which allow those economic agents to fully understand the policy orientations that are prevailing and the modalities foreseen for their pursuit;

- Another key vector of government intervention is the creation of conditions that will force the railways to adopt more commercially oriented behaviour, and to actively look for additional clients. One of the main types of action contributing towards this goal is the facilitation of entry of new rail freight operators into the market.

- An interesting possibility in this direction would be to allow the road hauliers / logistic providers to become organisers of charter or regular rail services, even if the actual traction is to be provided by the traditional railway companies. These logistics providers would naturally transfer to rail significant parts of their traffic on the heaviest trunks of their networks, and could do the freight handling either at their own terminals or be granted access as operators to terminals owned and managed by the railway infrastructure companies. If co-operation of railway operators is not adequate for this type of market, there could be room for a more open regime of access to the market as railway operator (directive 95/18), so that companies with their basis as road hauliers and logistics suppliers could make the transition and become themselves intermodal operators.