Deliverable D7

SCENES Transport Forecasting Model: Calibration and Forecast Scenario Results

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Executive Summary

The development of the SCENES European Transport Model is a key output of the SCENES project. This passenger and freight model is based on the model developed during the preceding STREAMS project. The STREAMS model was essentially a prototype or pilot model, used to develop and experiment with the techniques required for strategic transport modelling at the European scale.

Within SCENES, this model was rebuilt using new data and improved modelling techniques – in particular there was a greater incorporation of country specific parameters, and thus more detailed input data. The passenger element of the model was also expanded to include eight Central and Eastern European Countries (CEEC), these being the states bordering the EU plus the Baltic States. The SCENES model is calibrated for a base year of 1995. Here, the results of this calibration and validation are reported, together with the results of four 2020 Transport Scenarios, developed for both the passenger and freight models.

The modelling structure developed is essentially a comprehensive 'Framework' for modelling at the European scale, in that all aspects of the transport market are accounted for in one shape or form within the model. It is built up using inputs from the detailed zonal level. Many parameters and data inputs within the model are also specified at the country level, and all aspects of both passenger and freight transport are included. This amount of detailed input would ideally be met by an harmonised European data set, collated with this application in mind. Of course, this level of data is not currently available. Hence many of the model inputs are estimated from the best data available at the time. It in this way that the model is potentially an initial Framework, which could be updated and improved over time as data becomes available.

Currently the model is calibrated to reproduce in many cases national aggregate totals of travel by mode, and known international patterns of passenger and freight transport. The sub-national pattern of passenger and freight traffic is entirely generated by the model (i.e., it is 'synthetic'). It is based on typical distributions of travel by distance. The availability of more detailed base year input data would allow for a more localised geographical validation to take place. This would also allow for greater use of the model to analyse particular transport policies pertinent to certain sectors, and also enable the model to be used at the sub-national, or even corridor level.

The Deliverable reports the results of the 1995 base year model, and four Scenarios each for the passenger and freight transport models. These Scenarios are designed to demonstrate a range of eventualities regarding the evolution of transport costs by mode through time, together with assumptions for the future development of population, GDP, car ownership, employment, and future transport networks. This report is not therefore intended to produce a definitive view of the future – rather its role is to demonstrate the model as a tool which can be used in the context of producing forecasts, and give indications of the evolution of European transport based on different sets of assumptions.

For the 1995 base year, the passenger model is built up from the zonal level using demographic and socio-economic population groups, together with detailed trip rate data by purpose. At each stage of the modelling process through Generation – Distribution – Modal Split - Assignment, the level of aggregation of population group / trip purpose increases, starting from a highly disaggregate structure. The behaviour of each segmented group within these stages of the model is always examined and seen to be reasonable. In this way, the aggregate model is built up from many small groupings, all of which behave in line with expectation in as far as can be established from the data or indeed 'common sense'.

During the calibration process, the volumes of travel resulting from these micro level travel characteristics are then reconciled with national level aggregate totals for volumes of travel by mode. The model reproduces the following known general characteristics of passenger travel:

- Number of trips per person (per day / year) by purpose,
- Number of trips per person (per day / year) by purpose, over different distance ranges,
- Number of trips by mode (car, bus, rail, slow, and air),
- Number of international 'tourism' trips, by country pair,
- Modal share over different distance ranges.

At the aggregate level, the main validation factor is:

- Person kilometres travelled by mode (car, bus, train, air) by country

The freight model structure is very different from that of the passenger model. National Accounts data and Input-Output tables are used for each of the 15 EU countries to establish the pattern of trade by sector for national and international trade. Estimates of Final Demand by sector are made at the zonal level, kicking the process off. This demand creates intermediate demand within the input-output structure (representing inter-industry linkages), and these demands are met by production by sector, which is constrained in the base year at the zonal level. Ultimately a matrix of monetary trade is produced by the model. This is matched at the intra-EU international level to known trade matrices.

Other known international matrices of observed monetary trade and trade by volume, are used in combination with known national trade and tonnes data, to produce a series of value to volume ratios. These ratios translate the modelled monetary trade matrix into a matrix of volume (tonnes). The model calibration process then refines this matrix of tonnes to recreate the known volumes of tonne-km movements. The main validation 'targets' are for the model to reproduce known:

- National tonnes by commodity type (Transport Flow),
- International tonnes by country pair and Transport Flow (including EU imports / exports),
- National tonne-km by Transport Flow, mode and country, and
- Tonne-km on EU transport networks, by mode and country.

The base year model therefore comprises the total amounts of observed passenger travel and freight movements for the EU and for travel and movements to and from the EU. The passenger model also contains travel within and between eight CEE Countries. These total volumes of travel and movement are also in line with more disaggregate data at the country-pair and national level. This provides a good basis for forecasting future passenger and freight travel at the national and EU level.

The SCENES forecasts scenarios for 2020 are firstly based on one 'External' Scenario, which comprises forecasts of population by age, employment, GDP and car stock, all by country, and also a revised transport network which includes planned infrastructure improvements. Secondly, four 'Transport' scenarios are developed for both the passenger and freight models. These represent four different views on how differential transport costs by mode will develop between 1995 and 2020. A range of assumptions are made for these Scenarios, from 'trend' style developments in transport costs, to more 'intervention' type approaches. The purpose of the Scenarios is to illustrate how the models responds to these Scenarios, rather than make a quasi-official forecast.

The results from each of the Scenario tests can be presented at very detailed levels. The limitations caused by the lack of detail in the base year input data however, mean that caution must be exercised in the interpretation of the forecasts, particularly at the more detailed spatial levels. Here, results are mainly reported at the EU and nation state level. In terms of the main results, the growth rates for person-km travelled and tonne-km moved are reported by mode, and differentiated by the type of movement (e.g., national / international).

Overall person-km travelled is forecast to grow at between 1.1% and 1.7% per annum, when all modes are considered for travel within and between EU countries. The smallest growth rates arise from a Scenario where transport costs for all modes rise in line with income growth, and the largest growth rates occur where transport costs for all modes are kept constant in real terms, whilst incomes rise.

For freight transport, the growth rates for tonne-km travelled on EU transport networks ranges from 2.3% to 2.6% per annum. Conversely, the growth in overall tonne-km is greatest in the interventionist Scenario where truck costs rise ahead of other modes. This causes freight to divert away from Truck onto cheaper, yet less direct modes, such as coastal shipping and train.

The modelling structures developed for the SCENES model have been demonstrated in producing four different forecast Scenarios for both the passenger and freight markets for 2020. Many detailed results have been produced and presented. These Scenarios illustrate competing visions of the level of transport likely to arise in the EU in 2020 based on assumptions regarding population, employment, economic and trade growth, car ownership, transport infrastructure, and transport costs by mode. The logical next step would be to develop the model further in the context of a set of more ‘official’ or agreed forecasts for transport in Europe. These could be reconciled with existing national level ‘Scenarios’ into one over-arching model for Europe in line with existing projections, where they exist, and providing projections where they do not exist.

1. Introduction

This Deliverable contains the results of the SCENES European Transport Forecasting Model forecasts for 2020 for passenger and freight transport. The development of this model is one of the main objectives of the SCENES project – the project itself deals with a wide range of European transport issues at the strategic scale. The Deliverable also includes a report on the calibration and validation of both the passenger and freight models. Detailed descriptions of the model structure and specification are not included here – these aspects were reported in SCENES Deliverable 4 'SCENES European Transport Forecasting Model and Appended Module: Technical Description'. Some important elements of structure are re-capped in this Deliverable however, to allow it to be read as a free-standing document.

The SCENES transport model comprises separate passenger and freight demand modules, and a compatible passenger and freight transport model. It was itself a development of a model developed during the preceding STREAMS project. The model built in that project was essentially a test-bed, developed to experiment with the methodologies and approaches required to model the totality of European transport within one over-arching framework. The structure of the SCENES model is in essence that of a traditional four-stage model. However, the costs and times of travel which are output from the transport model feed into the demand model in the form of 'disutilities' – thus the systems encompasses a full feedback between the two modules. In this way, changes in the transport model, be it through transport cost or infrastructure changes, have a bearing on the demand for travel. Note that this feedback effect will not apply to the number of trips made, or tonnes moved, but to the length of trips, and thus person kilometres and tonne kilometres moved.

The model is designed to produce in the first instance European transport forecasts. Comprising as it does, of a wide range of demographic, economic, socio-economic and transport factors, and being built as a 'bottom up' model from the zonal level, a much greater level of detail is possible, and indeed many country and sector specific results are reported here.

The 15 European Union countries and eight countries of central and eastern Europe (CEEC), comprise the 'internal' modelled area. That is, all travel within this area is modelled. The rest of the world is treated as external, that is travel to and from the rest of the world is modelled. The internal modelled area is represented by 244 zones based on the NUTS2 definitions, and the external area is represented by 17 'European' zones with 4 zones representing the rest of the World. The exception is that freight traffic within the CEEC area is not modelled – only freight traffic between the CEEC and the EU.

The passenger demand module combines highly segmented, zonal level socio-economic and behavioural data to produce a matrix of travel. There are 20 population groups specified in each zone and 10 trip purpose categories. The freight demand module is based on a spatial adaptation of financial input-output structure in order to represent linkages between industries. Some 24 economic sectors are used in producing a matrix based on value, which is converted to volumes in an interface module. This volume matrix is combined with the passenger travel matrix and assigned to the common transport module.

The transport module contains a representation of the costs and times of travel by different modes (at the country level) between all of the model zones, for passenger and freight traffic. This is achieved using comprehensive and detailed multi-modal transport networks for road, rail, air, shipping, inland watereway and pipeline. An innovative treatment of intra-zonal travel for both passengers and freight allows the characteristics of even the shortest trips to be represented.

Many of the detailed information regarding the model structure and its underlying data can be found in SCENES Deliverable 4 – 'SCENES European Transport Forecasting Model and Appended Module: Technical Description.

The purpose of this Deliverable is to demonstrate the model structure, both in terms of the 1995 Base Year and the 2020 Forecast Scenarios. These Forecast Scenarios are designed to illustrate the nature of the forecasting process which can be undertaken with the model, rather than form a definitive set of European Transport Forecasts – in this way they do not constitute any ‘official’ view of the future. In order to achieve the latter, forecasting assumptions and model outputs would have to be developed and analysed in much more detail, in the context of and in consultation with, existing national level assumptions and forecasts.

Chapter 2 now goes on to describe a few of the SCENES model’s more innovative aspects and discusses the overall scope of the model. Chapters 3 and 4 then re-cap on the model structure used, then report the calibration and validation process for the Passenger and Freight model respectively. The traffic levels on road network which result from the calibrated base year model are then reported in Chapter 5. Chapter 6 then specifies the 2020 Forecast Scenarios which were developed to demonstrate the model as a forecasting tool. The results of these forecasts are then described in Chapters 7 and 8, for the Passenger and Freight models respectively. Chapter 9 reports the traffic on EU road networks associated with the 2020 Forecast Scenarios, before some general conclusions from the SCENES modelling exercise, together with some suggestions as to how this type of work could be developed in the future, are drawn in Chapter 10.

2. Key features and Model Scope

The SCENES model is in essence a strategic model which is built up from detailed modelling structures, specified at the zonal level. The scope of the model is that it is set up to reproduce the base year levels of transport in the EU and CEEC8, built on the best data available at the time of the model's development. Given the detailed nature of the input data, much of has had to be estimated or collated from various, sometimes conflicting sources. This means that although the model produces reliable transport volumes at the more aggregate levels, detailed model outputs cannot simply be extracted as a substitute for more detailed models.

In this way, the model provides a starting point or Framework which could be developed further with better local data. The addition of localised data would make the model more suitable for localised applications. There are a number of features incorporated in the model structure which facilitate this 'Framework' approach. Some of these are highlighted in this Chapter.

The main 'key feature' of the model which allows this Framework approach is its comprehensive nature. This means that European transport in its' totality is incorporated within the model structure, and the key transport indicators of total person kilometres travelled and tonne kilometres moved are readily output by the model. Also, because all aspects of transport are incorporated, it means that more detailed analysis of any transport sector can be accommodated largely within existing structures, with the addition of more detailed data and calibration.

The comprehensive nature of the passenger model is illustrated in that, although it is a strategic level model, it incorporates all travel. This is possible because the disaggregated National Travel Survey (NTS) data, from which it is built, includes even the shortest trips and indeed all slow modes. In addition, a *key feature* of the model is that it uses a 'dummy zone' system to represent intra-zonal travel of different distances and by different modes. This is necessary since between 90% and 95% of passenger trips in the modelled system are intra-zonal, given the zoning system of 206 EU zones, and 38 CEEC zones. The model treats these dummy ones as any other zones, and a different number of dummy zones are connected to any given zone centroid, depending upon the size of the zone in question. The dummy zones represent travel distances of: 0-1.5km, 1.6-3.2km, 3.2-8km, 8-16km, 16-40km, 40-80km, and 80-160km.

The links which connect the dummy zones to the zone centroids allow different speeds to be attributed to intra-zonal trips of different distances and by different modes. These speeds also vary depending upon the nature of the urban settlements within the zones – there are six zone classifications in the model set-up, representing the full scope of zone types, from Metropolitan centres to highly dispersed, rural areas. Finally, the links are differentiated by country.

The structure set up for intra-zonal passenger travel is a good example of this Framework approach which underlies the model. If detailed and consistent data were available, the intra-zonal travel characteristics could be coded by mode for each individual country, and by zone type within each country. With current data limitations, UK-sourced information is used for average speed (in-vehicle and total journey) by mode and by settlement type (detailed in SCENES Deliverable 4).

The representation of transport supply is another area of the model which can be regarded as a *key feature*. A highly detailed set of 'Main' modes and their component 'Network' modes mean that all the constituent stages of a particular journey or consignment can be modelled. There are 9 Main passenger modes which are comprised of over 20 Network modes, mainly differentiating so-called feeder modes from the main mode used in the journey. In the freight transport model, there are 14 Main modes, which split a typical mode (e.g., rail) into 'bulk' or 'unitised'. There are around 30 Network modes for freight, accounting for example for, port activities.

Supporting this highly disaggregated modal structure is a set of network links which are defined by type. There are approximately 600 different link types defined in the model, and this gives rise to approximately 45,000 individual one-way links in the transport networks themselves. This level of network detail, in combination with the cost functions specified in the model means that travel between any zone pair should be well represented in terms of travel time, cost and the multi-modal paths available for the trip.

The final *key feature* highlighted here is the use of so-called residuals in the modelling of international freight movements and international passenger travel. In the freight model, this allows the correct pattern of tonnages between country pairs within the EU and between EU countries and countries in the rest of the World. For the passenger model, the method is used to match a matrix of international tourism trips.

The principle underlying these residuals is that they account for non-transport or other non-modelled factors. A model of this nature can only include so much explanatory power and there are many e.g., historical and cultural factors which will influence that pattern of trade and travel. A program within the model structure creates a matrix of residuals based on the non-residual model output, and the observed international data set. This matrix of residuals is the incorporated within the Distribution element of the model, a travel matrix is then produced by the model in line with the observed data set. Without this feature, the model would have great difficulty in reproducing, e.g., the pattern of holiday trips with many trips having their destination in France and Spain. Also, historic trade patterns can be represented with the use of residuals.

This brief Chapter has highlighted a few of the more innovative aspects of the model structure developed for SCENES. Chapter 3 now goes on to describe the base year Passenger model calibration and validation process.

3. Passenger Calibration and Validation

The main steps and processes which were undertaken to calibrate the base year model are outlined in this section. The fundamental approach is very much ‘bottom up’. The methodology adopted is to build up the base year passenger demand model from the zonal level, using segmented data to account for key age, employment and car ownership factors. This demand is then aggregated to country level, and compared to ‘observed’ aggregate indicators of transport demand by country.

3.1 Passenger Model Structure

It is easiest to consider this process with reference to each of the four modelling stages – Trip Generation, Trip Distribution, Modal Split and Assignment. Table 3.1 overleaf shows the disaggregated structure of the passenger model with respect the first three of these stages.

Trip Generation is built up from the zonal level using population groups based on age, employment and personal car availability, and disaggregated trip rates. Detailed data were extracted from the UK National Travel Survey (NTS) during the STREAMS project concerning trips rates by purpose for different population groups. After analysis of other European NTS, it was established that there were not significant differences in behaviour between countries. The trip rates extracted from the UK NTS were used in STREAMS – for some countries all rates were factored up or down by say 5% or 10%, but the relativities between different purposes and population groups were retained.

These trip rates have been carried over into the development of the SCENES model, with the exception of ‘holiday’ trips. Separate country specific trip rates for both domestic and international holidays were developed based on the very different national characteristics which were seen to apply in this case.

The first two columns of Table 3.1 overleaf show the 20 population groups and 10 travel purposes for which data were originally obtained. This data is all trips per person per year. The population groups combine age (>16, 16-64, 65+) with employment (employed full time / employed part time / not in employment) and car availability. The employment category only applies to persons in the 16-64 age group. Personal car availability is based on the number of adults and the number of cars in the household, and is defined as follows:

- 1 or more adults, 0 cars [0 car availability]
- 1 adult, 1 or more cars [full car availability]
- 2 or more adults, 1 car [part car availability]
- 2 or more adults, 2 or more cars [full car availability]

Table 3.1: SCENES passenger model structure – Generation, Distribution, Mode Spilt

Original Population groups	**Original purposes**	**Trip Generation Stage – SCENES Purposes**	**Trip Distribution Stage – SCENES Travel Groups [purpose / population group]**	**Mode Split Stage – Flows**
1. Under 16 yrs / 1+ adults / no car		**SHORT<40km**	**SHORT<40km**	**SHORT<40km**
2. Under 16 yrs / 1 adult / 1+ cars	Commuting	**a**. Commuting / business	c&b – all / 0 car [**a / 1, 5, 9, 13**]	1
3. Under 16 yrs / 2+ adults / 1 car	Business	**b**. Shopping / personal business / education / other escort	c&b - FT emp / part car [**a / 7**]	2
4. Under 16 yrs / 2+ adults / 2+ cars	Education	**c.** Visiting friends and relatives / day trip / sport & entertainment	c&b - FT emp / full car [**a / 6, 8**]	3
5. 16-64 employed / 1+ adults / no car	Shopping	**LONG >40km**	C&b - not FT emp / part car [**a / 3, 11, 15, 19**]	2
6. 16-64 employed / 1+ adults / 1+ cars	Personal business	**d**. Visiting friends and relatives / sport & entertainment	c&b - not FT emp / full car [**a / 2, 4 10, 12, 14, 16, 18, 20**]	3
7. 16-64 employed / 2+ adults / 1 car	Sport & entertainment	**e**. Day trip / shopping / personal business / education / other escort	Shop&pb&ed - <15 / all [**b / 1, 2, 3, 4**]	4
8. 16-64 employed / 2+ adults / 2+ cars	Visiting friends and relatives	**f**. International holiday	Shop&pb&ed – adult / 0 car [**b / 5, 9, 13, 17**]	5
9. 16-64 PT / 1+ adults / no car	Day trip	**g**. Domestic holiday	Shop&pb&ed – adult / part car [**b / 7, 11, 15, 19**]	6
10. 16-64 PT / 1 adult / 1+ cars	Other / escort	**h**. Commuting / business, 40-160km	Shop&pb&ed – adult / full car [**b / 6, 8, 10, 12, 14, 16 ,18, 20**]	7
11. 16-64 PT / 2+ adults / 1 car	Holiday	**i**. Commuting / business, >160km	Visits&other – all / 0 car [**c / 1, 5, 9, 13, 17**]	5
12. 16-64 PT / 2+ adults / 2+ cars		**j**. International business (1+ night)	Visits&other – all / part & full car [**c, 2-4, 6-8, 10-12, 14-16, 17-20**]	6
13. 16-64 not in employment / 1+ adults / no car			**LONG >40km**	**LONG >40km**
14. 16-64 not in employment / 1 adult / 1+ cars			vfr – all / 0 car [**d, / 1, 5, 9, 13, 17**]	8
15. 16-64 not in employment / 2+ adults / 1 car			vfr – all / part & full car [**d / 2-4, 6-8, 10-12, 14-16, 17-20**]	9
16. 16-64 not in employment / 2+ adults / 2+ cars			Day trip & other – all / 0 car [**e, / 1, 5, 9, 13, 17**]	8
17. 65 & over / 1+ adults / no car			Day trip & other – all / part & full car [**e / 2-4, 6-8, 10-12, 14-16, 17-20**]	9
18. 65 & over / 1 adult / 1+ cars			Dom hol – all / 0 car [**g / 1, 5, 9, 13, 17**]	14
19. 65 & over / 2+ adults / 1 car			Dom hol – all / part car [**g / 3, 7, 11, 15, 19**]	15
20. 65 & over / 2+ adults / 2+ cars			Dom hol – all / full car [**g / 2, 4, 6, 8, 10, 12, 14, 16, 18, 20**]	15
			Int hol – all / 0 car [**f / 1, 5, 9, 13, 17**]	12
			Int hol – all / part car [**f / 3, 7, 11, 15, 19**]	13
			Int hol – all / full car [**f / 2, 4, 6, 8, 10, 12, 14, 16, 18, 20**]	13
			c&b mid distance – all [**h, 1-20**]	10
			c&b long – all [**i, 1-20**]	10
			c&b int – all [**j, 1-20**]	11

Further analysis of the NTS allowed the 10 original travel purposes to be split into 20 separate trip rates - for trips less than 40km and trips greater than 40km for each purpose. Purposes with similar characteristics were then grouped together to form 10 new purposes, split into 3 'short' distance and 7 'long' distance purposes – these purposes are shown in the third column of Table 3.1. It is this group of 10 purposes for which a trip rates is applied to each of the 20 population groups.

The zonal population groups, used in conjunction with the trip rates, are obtained from Eurostat in the main although some adjustments and estimates were required to obtain consistency. Car stock per zone was also obtained from Eurostat – again this data suffered from inconsistency. The model internally divides each of the 5 population groups at the zonal level into estimates of the 4 car availability / household composition categories (making the 20 groups in each zone), as this detailed level of data is clearly not available at the European NUTS2 level.

Turning to **Trip Distribution**, it would in theory be possible to calibrate each of the 200 (20 times 10) population group / trip purpose combinations individually. However, this would be intensely demanding both in terms of computing power and data, so instead these 200 groups are aggregated into 24 'Travel Groups', shown in the 4th column of Table 3.1. In the Table, the group names are shown in abbreviated form, together with the constituent travel purposes (a-j) / population groups (1-20) which comprise this each travel group.

Trip distribution, for each of the 24 Travel Groups in the demand model is then governed by published data on the spread of trips / person / year over different distance bands. In the model, calibration parameters are used to set up this spread of trips, and constraints are used over the short distances to control some of the very large number of trips which occur over the shortest distances, and are intra-zonal in the model. Attractors such as GVA, population and tourism arrivals are used in determining the inter-zonal pattern of trips, together with transport disutilities and the calibration parameters. The distribution model is based on a logit model formulation.

This marks the output of the 'demand model' and the end point of this stage is a matrix of trips / annum, expressed in terms of these Travel Groups. This matrix is then transformed in an interface program into a matrix of trips / day, expressed in terms of Transport Flows. This new matrix is used in the transport model, where mode split and assignment are undertaken. The Transport Flows are an aggregation of the Travel Groups, and are shown in the 5th column of Table 3.1 and listed below:

'Short Trips'

1. Commuting & business, all population groups / no car available
2. Commuting & business, all population groups / part car available
3. Commuting & business, all population groups / full car available
4. Shopping / personal business / education / visits / day trip, children / all car availability groups
5. Shopping / personal business / education / visits / day trip, all >15 / no car available
6. Shopping / personal business / education / visits / day trip, all >15 / part car available
7. Shopping / personal business / education / visits / day trip, all >15 / full car available

'Long Trips'

8. Visiting friends and relatives / day trip / other, all population groups / no car available
9. Visiting friends and relatives / day trip / other, all population groups / part & full car available
10. Commuting and business long, all groups
11. International business (1+ night), all groups

12. Domestic holidays, all population groups / no car availability
13. Domestic holidays, all population groups / part & full car availability
14. International holidays, all population groups / no car availability
15. International holidays, all population groups / part & full car availability

In order to undertake the mode split and assignment, there needs to be a full representation of the transport opportunities and costs faced by all the travellers in the modelled system. To this end, transport cost functions are specified in the transport model for each mode of travel, namely:

- car,
- business car,
- local bus,
- long distance coach,
- train (1st and 2nd class),
- high speed train,
- air (business and leisure),

These cost functions are specified for each of the 23 internal countries in the passenger model. These functions are based as much as possible on 'baskets' of fares and fuel prices for each of the countries. In addition, values of time (based on average incomes by country) by purpose are also specified for each of the 23 countries – these costs and values of time feed back into the distribution model from the transport model.

In addition to the inter-zonal network costs and characteristics, the intra-zonal network is differentiated by:

- 6 zone types, representing settlement patterns, and typical transport conditions therein
- number of intra-zonal dummy zones connected (representing zone size)
- intra-zonal link speeds vary with distance, mode, and zone type – in vehicle and whole journey times are explicitly represented, and
- modal availability, determined by zone type.

All of the above, together with model calibration parameters input the modal split calculations, based on a multi-level logit formulation. Finally, a further aggregation to only 4 groups is used for **Assignment**. These are as follows:

- no car availables, Transport Flows 1, 5, 8, 12, 14
- part car availables, Transport Flows 2, 4, 6, 9, 13, 15
- full car available only, Transport Flows 3, 7
- long business travel, Transport Flows 10, 11.

3.2 Approaches to Passenger model calibration

As outlined above, the main thrust of setting the model up (calibration) has been to essentially reconcile two things:

1. the average trip making characteristics of different population groups for different trip purposes (which we know from National Travel Surveys) and,
2. the aggregate transport indicators of person kilometres travelled by mode at the European Union nation state level, and at the overall European level.

Much of the detailed data relating to travel behaviour (by purpose, mode, distance etc.) comes in the first instance from UK National Travel Survey data. This is used to establish the broad behavioural characteristics of the model. After this stage, it is necessary to make adjustments to match the circumstances in each country – using the UK data as a context. In general however, it is inevitably necessary to use an element of judgement as to what is a sensible pattern and what is not on many occasions.

Each country is also examined in terms of mode split by distance band for each purpose, and the composition of trips in terms of purpose at different distance bands, for all trips originating in each country. This is to ensure there are no absurd patterns of modal split by distance, rather than attempting to match know detailed data – as again, there is very little data of this nature.

Each country's results are then examined for known aggregate transport indicators (person-km by mode). Adjustments are made to costs / trip rates / disutility function parameters (by transport flow, country and mode) to bring the aggregate transport results by country and mode into line with the 'observed' totals.

International 'tourism' trip rates (defined as a trip of any purpose which requires at least one overnight stay), are generated from an 'observed' matrix of tourism trips (derived from World Tourism Organisation statistics) and this pattern is controlled internally within the modelling structure (using 'residuals'[1]). Constraints are used to control tourism arrivals by zone to known totals. This means that the main patterns of international holiday and business trips are well represented in the model.

All the main characteristics of passenger travel are represented within the model structure. These can be reported using the type of measures typically associated with the reporting of the NTS which are undertaken in several countries throughout Europe. Typical measures are:

- Number of trips made, by purpose
- The transport modes used
- Trip purpose by distance
- Modal split by distance

In this section, there are therefore many charts which illustrate the behaviour of the model with respect to these key elements of passenger travel. Some of these are quite detailed, but it is important to demonstrate that the model produces results which, although cannot always be directly compared with observed data, do at least align with *ex ante* expectation. All distances shown in these figures are in kilometres.

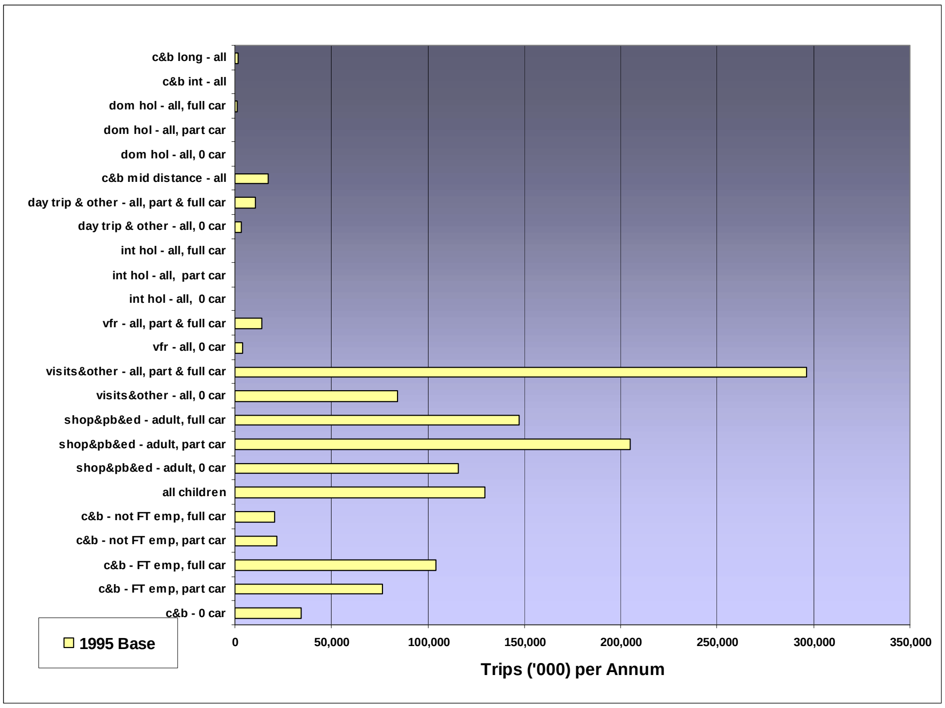
3.2.1 Number of Trips, by purpose

The first aspect of the model output considered here is the number of trips in the modelled system, and the purposes of these trips.

[1] These 'residuals' are used to account for non-transport or non-modelled factors which influence the pattern of travel, e.g., climate (for tourism).

Figure 3.1 below shows the total number of trips per annum for each of the 24 demand model Travel Groups, that are used at the Distribution stage of the model. These Travel Groups are combinations of trip purpose, age / employment status, and car availability groups. The figures here contain all the countries which are 'internal' to the model, i.e., the EU15 and CEEC8. The top 13 groups below refer to 'long' trips, these have an approximate lower 40km cut off point. The bottom 11 groups are 'short' trips, the overwhelming majority of which are less than 40km long. The numerical dominance of short trips is clear from this chart.

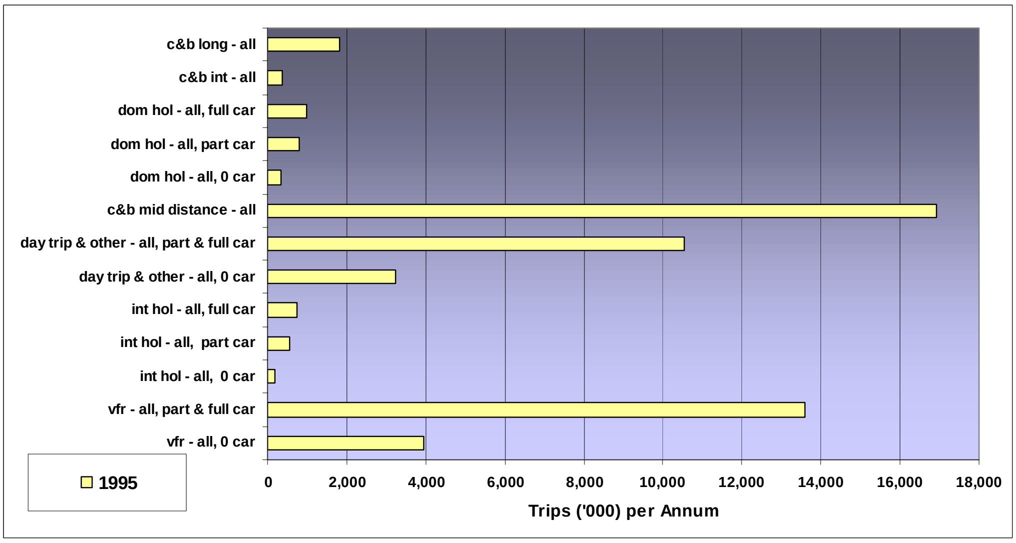
Figure 3.1: Passenger trips / annum, by Travel Group, 1995 EU and CEEC8 *



* c&b – commuting and business, dom hol – domestic holiday, int hol – international holiday, vfr – visiting friends and relatives, shop – shopping, pb – personal business, ed – education, FT emp – employed full time

The 'long' trips are shown in isolation in Figure 3.2 below, for greater clarity. This shows that middle-distance commuting and business trips, and visiting friends and relatives trips by those with full and part car availability are the most significant travel groups here.

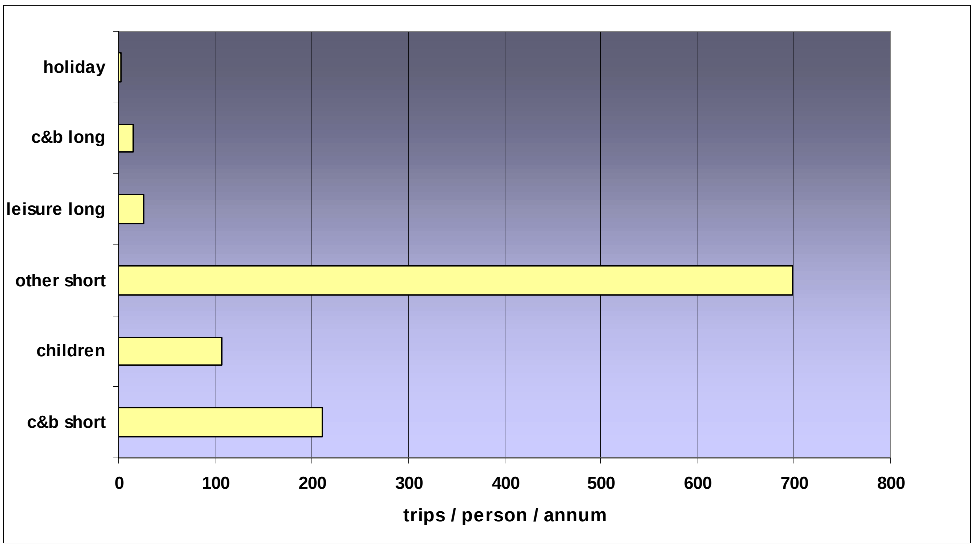
Figure 3.2: Passenger trips / annum, 1995 EU and CEEC8 – 'Long' Travel Groups *



* c&b – commuting and business, dom hol – domestic holiday, int hol – international holiday, vfr – visiting friends and relatives, shop – shopping, pb – personal business, ed – education, FT emp – employed full time

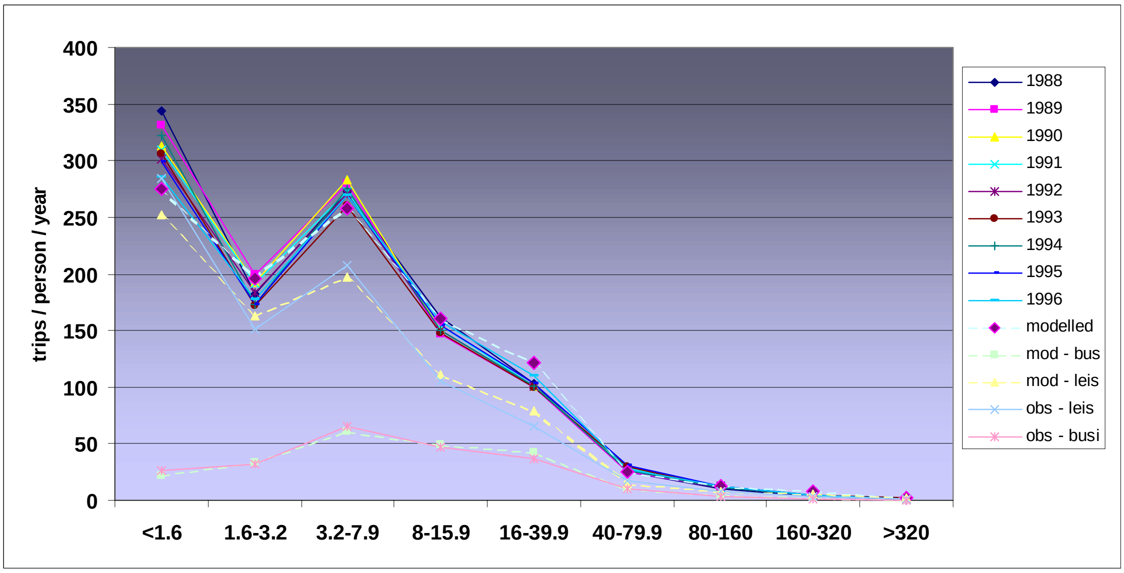
These absolute number of trips are converted into trips / person / year and shown below in Figure 3.3, for aggregated trip purpose. Again this serves to illustrate the types of trips in the model. These figures would be broadly compatible with any of the European NTS.

Figure 3.3: Passenger trips / person per annum, by purpose, 1995 EU and CEEC8



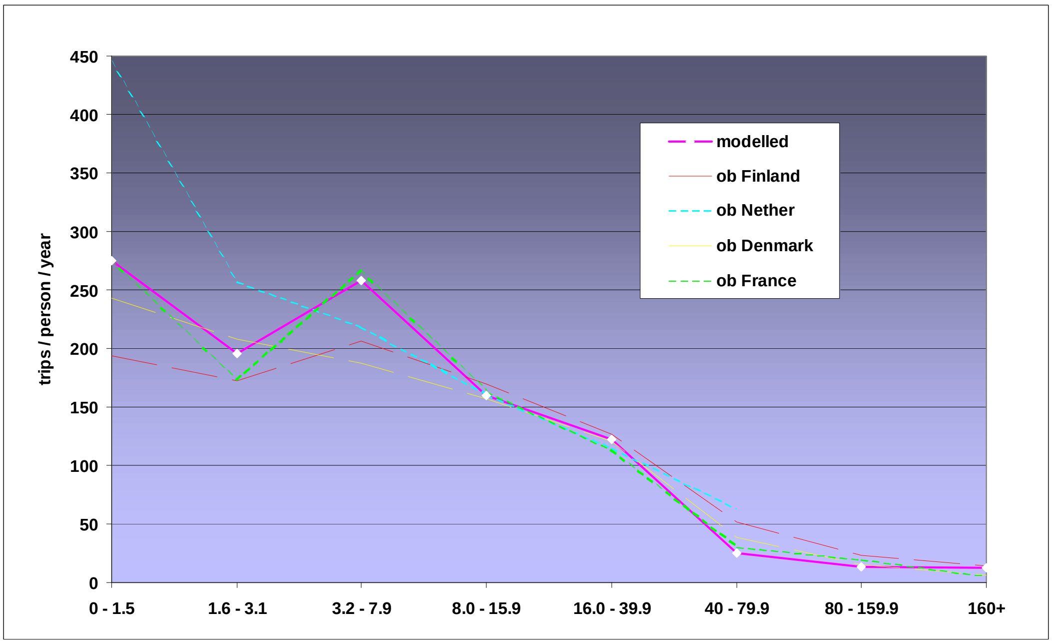
The final aspect concerning the overall number of trips is the distribution of these trips by distance. Figure 3.4 below shows UK NTS data (1988-96) and the modelled number of trips per person for each of these distance bands. The modelled and observed trips (for 1995) are also aggregated into commuting / business and leisure trips for clarity. This NTS data was used in the model calibration to ensure that the trips at this lower end of the distance scale (which account for the huge majority of trips made) are well represented in the model. The observed data in this chart shows that fewer of the shortest distance trips have been made as the years have progressed, between 1988 and 1996.

Figure 3.4: Detailed UK NTS and modelled trip rates by distance band



The measure of trip rates by distance is also shown below in Figure 3.5. Here, broadly comparable trip rates for Finland, the Netherlands, Denmark and France are shown together with the modelled values. It is clear that the modelled values follow an acceptable pattern, when compared with these other countries' NTS data. The exception is the high number of very short trips in the Netherlands. It is suspected that this is down to a quirk in the methodology used in the Netherlands NTS rather than real differences in behaviour.

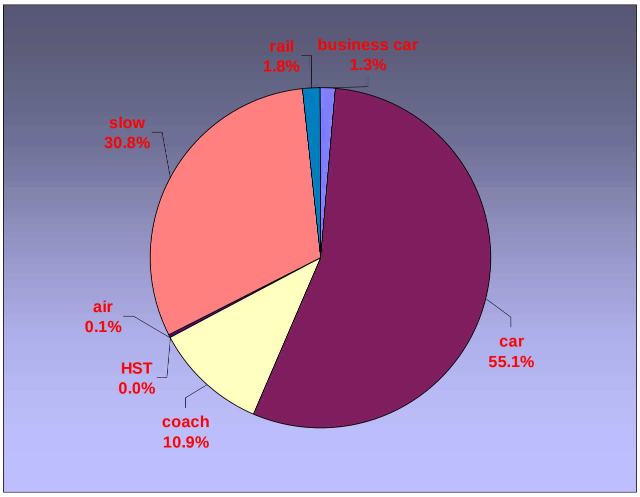
Figure 3.5: Trips / person per annum, modelled and other NTS data



3.2.2 Basic Modal Split

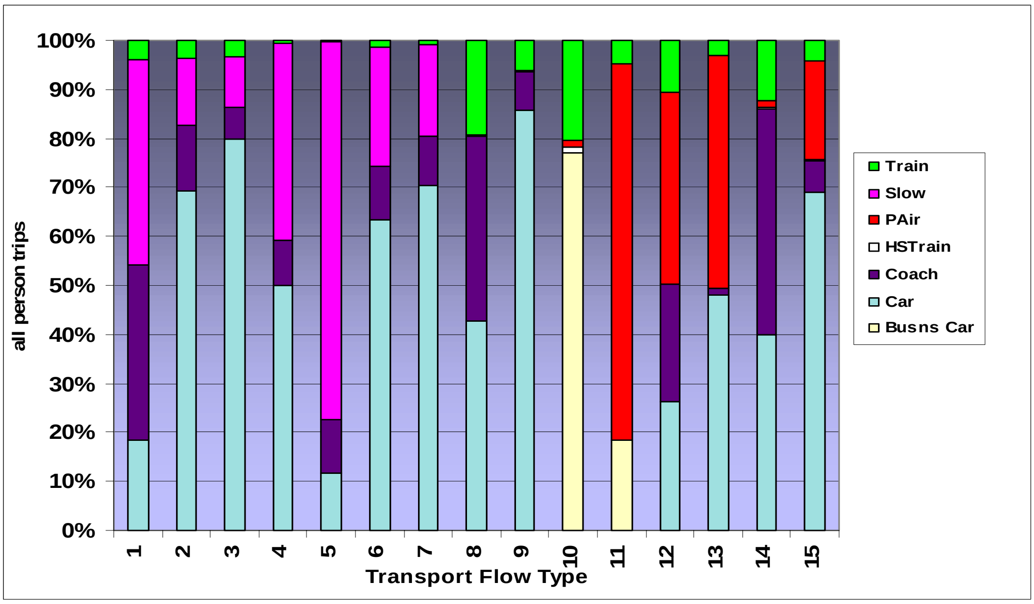
Having looked at the overall number of trips in the model, Figures 3.6 and 3.7 below shows the modal share for all trips in the model, and each of the Transport Flows within the model respectively, in terms of number of trips. The definitions of the transport flows are reproduced below Figure 3.7. When all trips are considered, car and slow modes make up over 85% of all trips made. The distinction between 'car' and 'business car' is that 'business car' incurs the full cost of car travel, whilst 'car' only incurs the fuel costs (so-called 'out of pocket' costs). 'Business car' is only used by the longer distance trips – it is assumed that the majority of short commuting and business trips are commuting trips – thus not undertaken in employer's time, therefore not incurring the full cost.

Figure 3.6: Overall modal share (% trips), 1995 EU and CEEC8



A very clear pattern emerges looking at the Transport Flows with particular regard to car use. Clearly those transport flows with a lesser degree of car availabilty undertake a smaller proportion of their trips by car. They tend to make more trips by bus / coach and slow modes in particluar. There is also less of a difference in car use between those with partial or full car availability, than between those with zero and partial car availability.

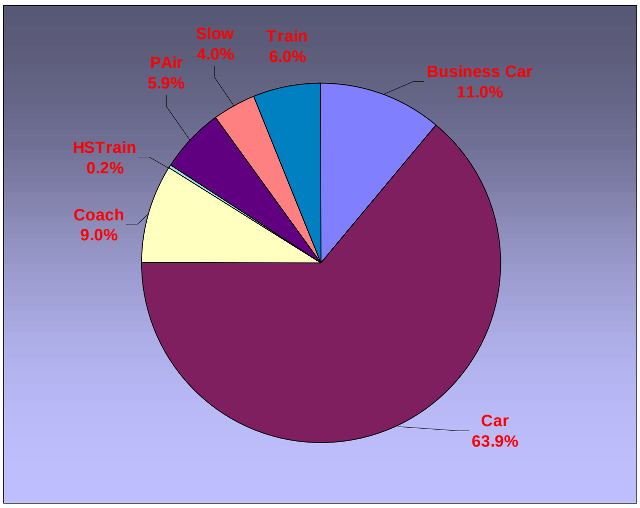
Figure 3.7 Modal share of passenger trips (% trips) , by transport flow, 1995 EU and CEEC8



SHORT: 1. C&B, all / 0 car, 2. C&B, all / part car, 3. C&B, all / full car, 4. Shop/ pb / educ / vis / dt, children / all car groups, 5. Shop / pb / educ / vis / dt, all >15 / 0 car, 6. Shop / pb / educ / vis / dt, all >15 / part car, 7. Shop / pb / educ / vis / dt, all >15 / full car. **LONG**: 8. Vfr / dt / oth, all / 0 car, 9. Vfr / dt / oth, all / part & full car, 10. C&B, all, 11. Int busi (1+ night), all, 12. Int hol, all / 0 car, 13. Int hol, all / part & full car, 14. Dom hol, all / 0 car, 15. Dom hol, all / part & full car

Moving from mode share by number of trips to modal share by person kilometres travelled changes the picture to a significant degree. Figure 3.8 below shows a pie chart similar to Figure 3.6, this time showing modal share by person kilometre travelled. Trips to and from the four distant external zones (representing the Americas, Asia, Middle East and Africa are excluded from this figure, as the long distances involved have a disproportionate effect on the person kilometres measure, given the small number of trips.

Figure 3.8: Overall modal share (% person kilometres), 1995 EU and CEEC8[1]

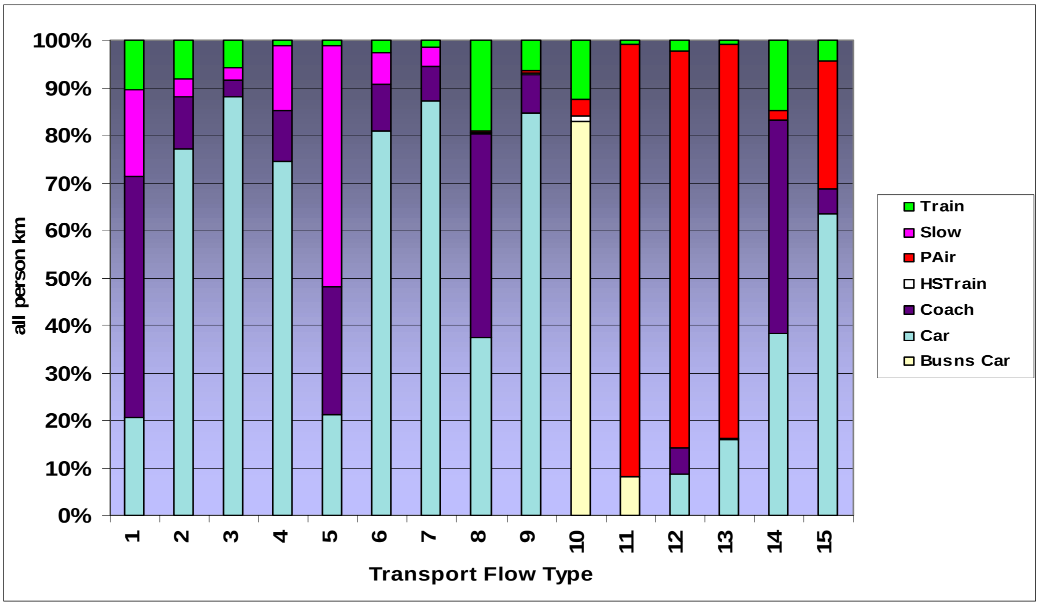


[1] Excluding travel to and from the distant external zones

The proportion of slow mode travel when viewed in this way reduces to 4%. The 0.1% of trips travelled by air represents 5.9% of person kilometres travelled. The dominance of car is also demonstrated, accounting for nearly 65% of all person kilometre movements.

Figure 3.9, below shows the proportions of modal travel by person kilometres, disaggregated again by Transport Flow. The trips to and from distant externals are included here, hence the very large proportion of air for the international Transport Flows (Flows 11, 12 and 13). In general the modal proportions travelled by car, air and rail increase when viewed in this way, the slow proportion drops and the bus / coach proportion changes the least.

Figure 3.9: Modal share of passenger trips (% person-km) , by transport flow, 1995 EU and CEEC8



SHORT: 1. C&B, all / 0 car, 2. C&B, all / part car, 3. C&B, all / full car, 4. Shop/ pb / educ / vis / dt, children / all car groups, 5. Shop / pb / educ / vis / dt, all >15 / 0 car, 6. Shop / pb / educ / vis / dt, all >15 / part car, 7. Shop / pb / educ / vis / dt, all >15 / full car. **LONG**: 8. Vfr / dt / oth, all / 0 car, 9. Vfr / dt / oth, all / part & full car, 10. C&B, all, 11. Int busi (1+ night), all, 12. Int hol, all / 0 car, 13. Int hol, all / part & full car, 14. Dom hol, all / 0 car, 15. Dom hol, all / part & full car

3.2.3 Trip Purpose by Distance

This section looks at trip purpose, considered by trips of different distances. It is essential that the proportions of trips by broad purpose is sensible over different distance ranges to correctly represent the whole scope of travel behaviour.

Figure 3.10 below shows the proportion of trips of each Transport Flow, over a range of distances. This figure includes all of the flow types in the model, i.e., both the long and the short trip purposes. This demonstrates how the nature of trip making changes over distance. Over the shortest distances, the dominant transport flow is 'pbe, s, pc', that is shopping, personal business, education and visits, short distance, part car availability. For example, this trip purpose accounts for around 45% of trips between 20km and 50km in the model. At the other end of the distance scale, around ¾ of trips over 1200km are international holiday trips made by those with part and full car availability.

For increased clarity, this chart is also shown in terms of the long and the short distance Transport Flows respectively in Figures 3.11 and 3.12 respectively. The 'short' Transport Flows are shown against a much finer range of distances. These 'short' Flows represent the intra-zonal aspect of the model to a large extent.

In Figures 3.11 and 3.12, there are various aggregates shown, the most significant being the business / non-business aggregations. This shows how the key business / non-business proportions changes over the distance ranges.

Figure 3.10: Trip purpose by distance (% trips), All Transport Flows, 1995 EU and CEEC8

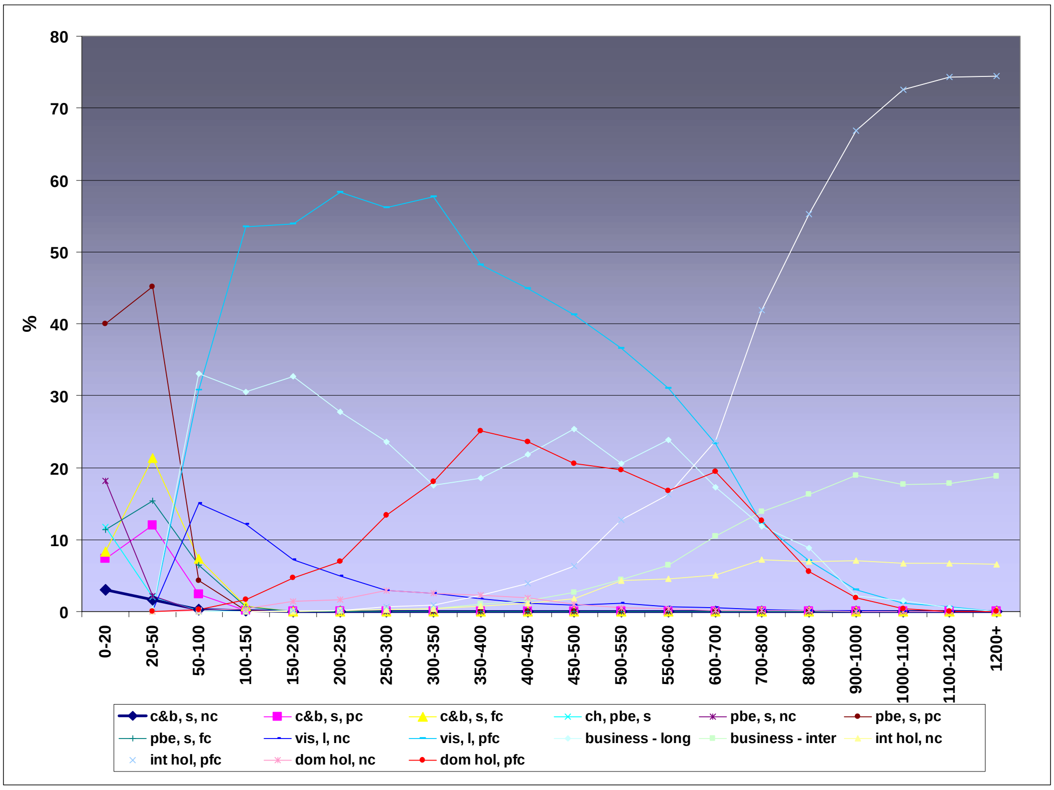


Figure 3.11: Trip purpose by distance (% trips), 'Short' Transport Flows, 1995 EU and CEEC8

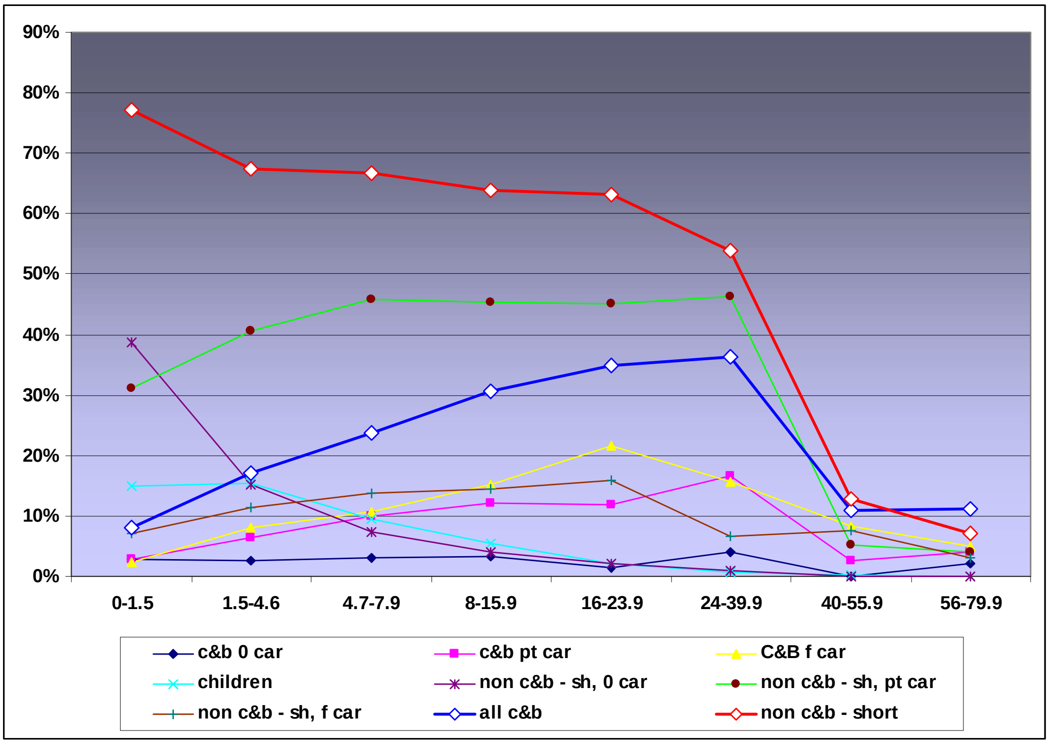
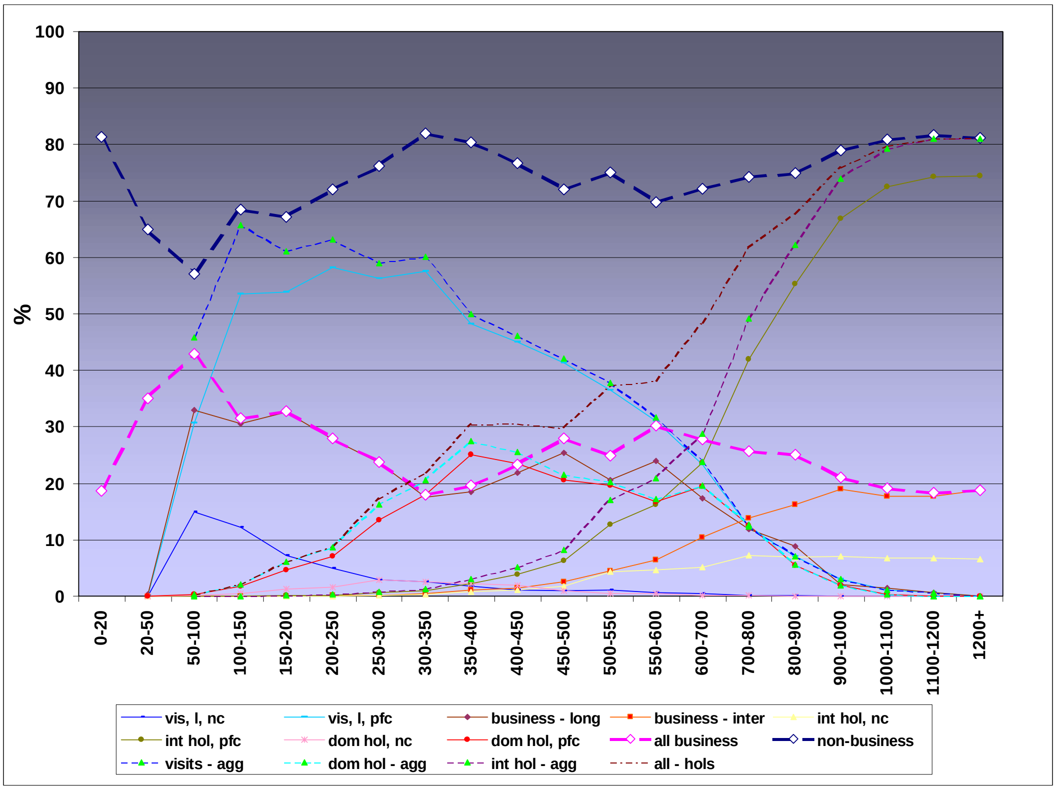
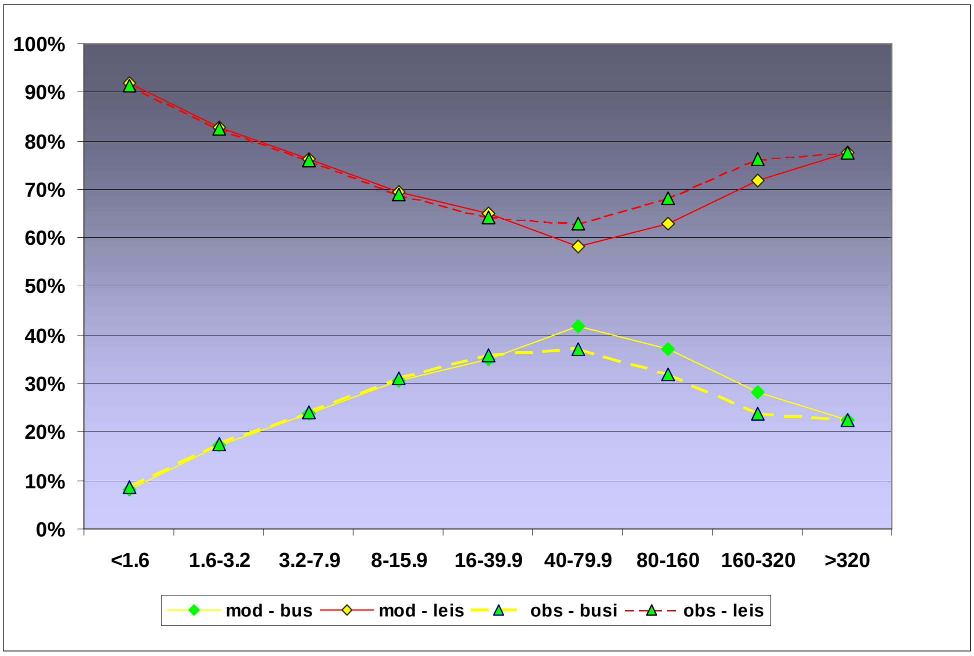


Figure 3.12: Trip purpose by distance (% trips), 'Long' Transport Flows, 1995 EU and CEEC8



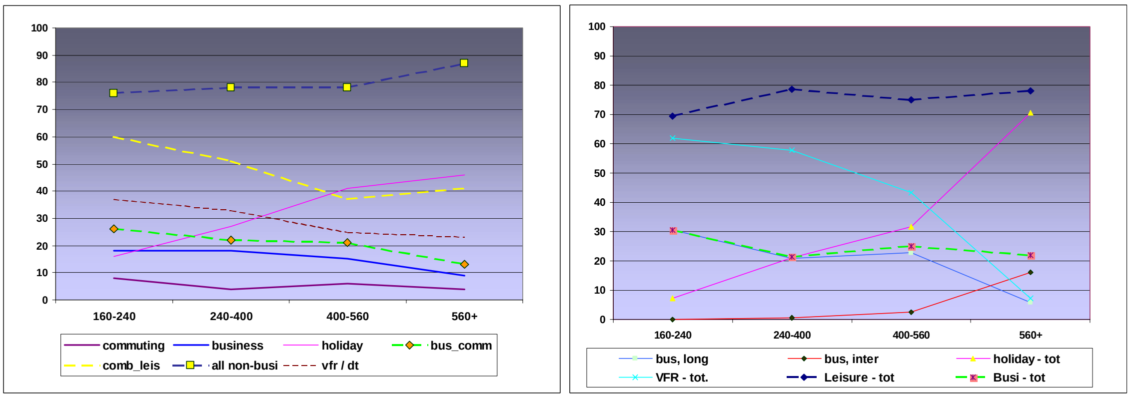
Once again, there is very limited 'observed' data to validate this type of highly detailed trip purpose data. However, Figure 3.13 below shows a comparison with detailed UK NTS data, for the business / leisure split at different trip distances up to a grouping of >320km. This shows a very close match and gives some confidence that the broad parameters of the base year model are correct in this respect.

Figure 3.13: Modelled 1995 and UK NTS trip purpose (% trips) by distance band



This broad business / non-business can be looked at in a bit more detail in Figure 3.14 below. Here, UK NTS data and modelled data can be compared for longer travel distance ranges, and for a greater range of purposes. It can be seen that the business / non-business split compares well over these longer distanes. Over 660km, the proportion of modelled holiday trips is higher than the NTS. This is in part due to definitional differances

Figure 3.14: UK NTS and modelled trip purpose by distance



UK NTS Modelled

A further comparison can be made with the ‘Long Distance Passenger Travel’ Statistics in Focus publication, produced by Eurostat. Here, the purposes of ‘long’ trips are reported for 7 European countries. The results are shown in Table 3.2 below, together with the figures from the model.

Table 3.2: ‘Long distance travel’, Eurostat ‘observed’ data, by purpose

	Denmark	**Spain**	**France**	**Italy**	**Austria**[1]	**Portugal**	**Sweden**
% comm. & business	39.7	33.3	17.5	25.3	48	36.7	24.2
% leisure	60.3	66.7	82.5[2]	74.7	52	63.3	75.8

[1] trips > 75km
[2] includes ‘trips home’

The corresponding modelled figures are 28.7% business and 71.3% leisure, this being the average for all countries. It can be seen that this average figure seems plausible in the context of these Observed figures in the table.

3.2.4 Modal Split by Distance

The next important aspect of personal travel behaviour which must be well represented by the model is modal split by distance. This can be considered for all trips, as well as individual Transport Flows. Again, it is important to look in detail over the shortest distances, broadening the ranges out as the distance increases.

Figure 3.15 shows overall modal split by distance, and Figure 3.16 shows the UK NTS data for the same set of distance ranges (‘air’ is excluded from this data – it essentially only contains domestic travel). The dotted orange line in Figure 3.15 shows the proportion of the total trips which occur in each distance band shown here, to illustrate the general distribution of trips over distance.

Figure 3.15: Overall modal split (% trips) by short distance band, 1995 EU and CEEC8

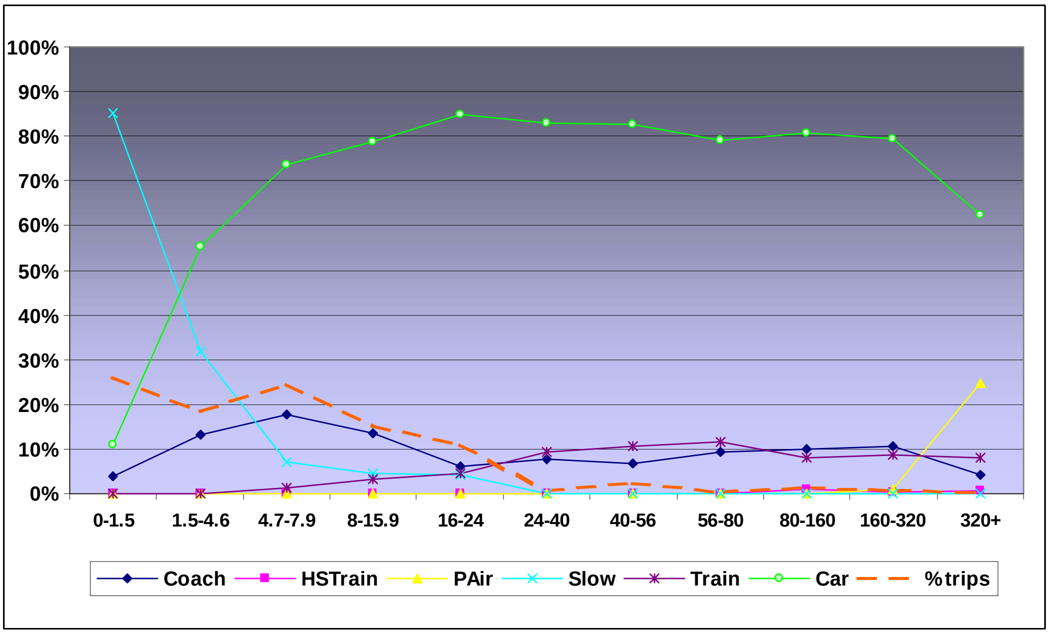
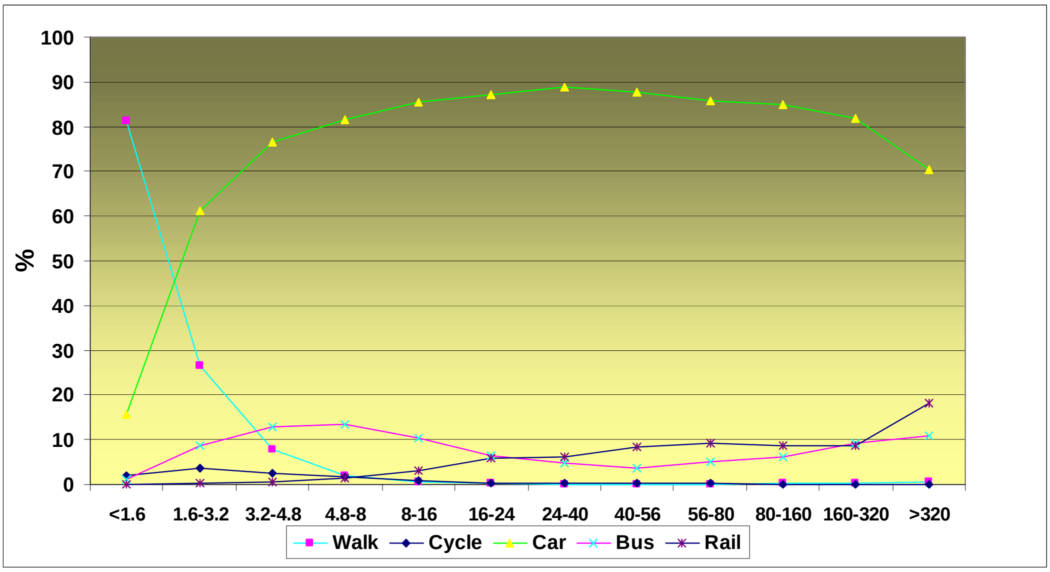


Figure 3.16: Overall UK NTS modal split (% trips) by distance band, 1995

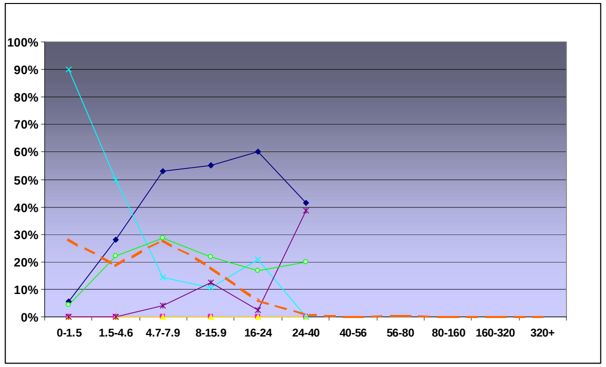


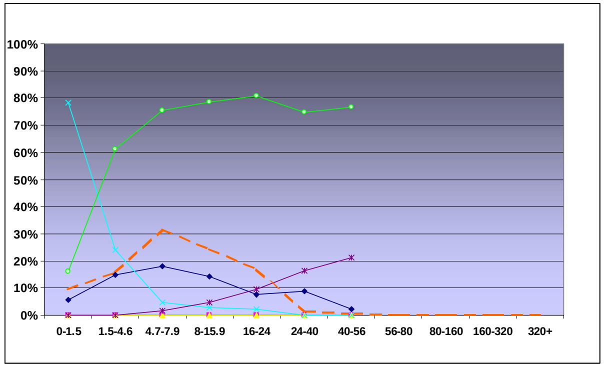
There is a good degree of similarity between this UK NTS data (Fig.3.16) and the model output (Fig.3.15). Again, this gives a good indication that the model is representing the basic characteristics of passenger travel well.

The above charts show the results in the aggregate only. To ensure that the model behaves sensibly, it is necessary to look at the behaviour of each of the Tansport Fows in the model. These are shown in Figure 3.17a-c, below, for each of the 'short' Tansport Flows in the model. This figure shows the mode split at quite a disaggregated level – the greater car use associated with greater car availability is clearly seen here.

The legends are not shown in this figure for space reasons - the colour coding is the same as as in Figure 3.15, above: lime green – car, dark blue – coach, yellow – air, high speed train – pink, slow modes – light blue, train – brown. The dotted red line again shows the proportion of the trips within the transport flow which occur in each of the distance bands.

Figure 3.17a: Mode split by distance – short flows, EU and CEEC8, 1995, Flows 1, 2 ,3 [commuting and business 0 car / part car / full car]





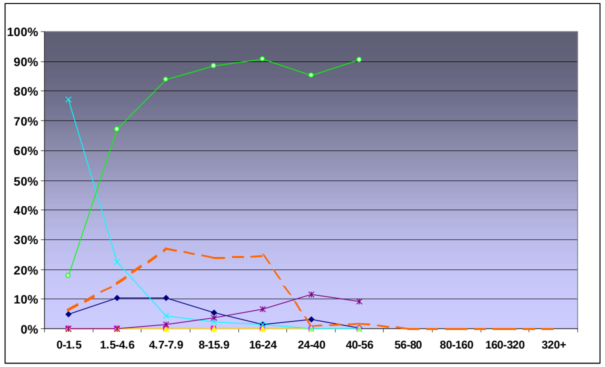
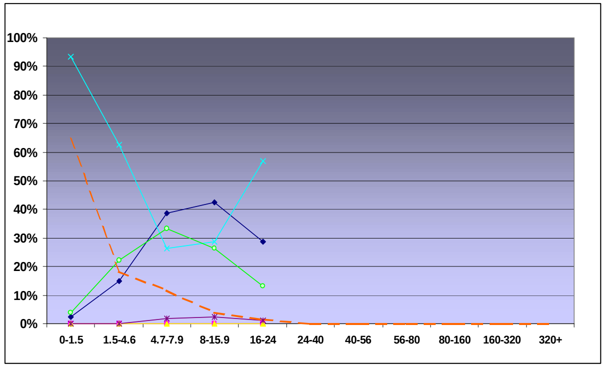
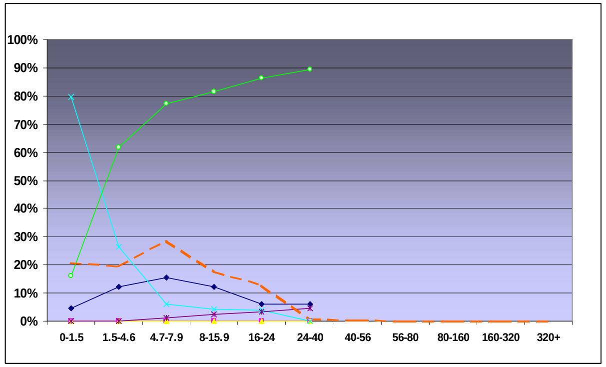


Figure 3.17b: Mode split by distance – short flows, EU and CEEC8, 1995, Flows 5, 6, 7 [other short, 0 car / other short, part car / other short, full car]





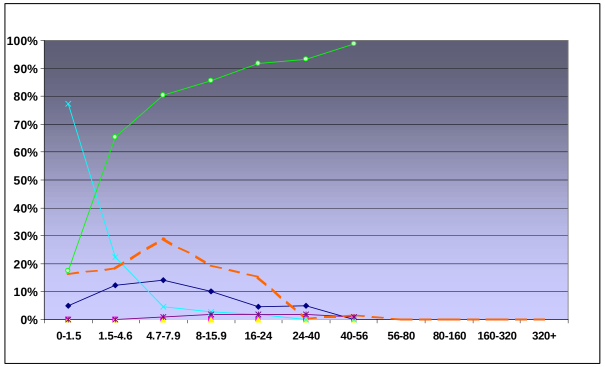
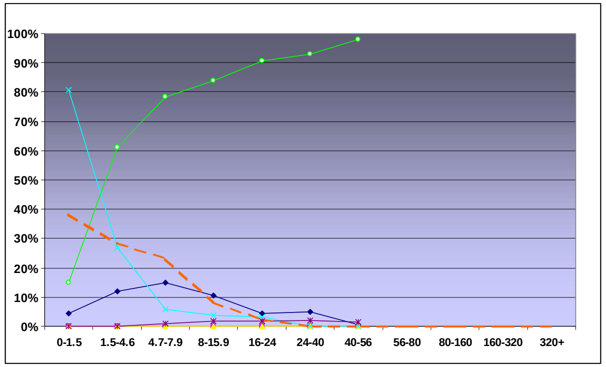


Figure 3.17c: Mode split by distance – short flows, EU and CEEC8, 1995, Flow 4 [all children]



The 'long' trip purposes are now reported below. Firstly, using a more deatiled set of long distance distance bands, Figure 3.18 shows the modal split by distance band up to 1200km and above – this figure includes all trips, including short.

Figure 3.18: Overall modal split (% trips) by long distance band, 1995 EU and CEEC8

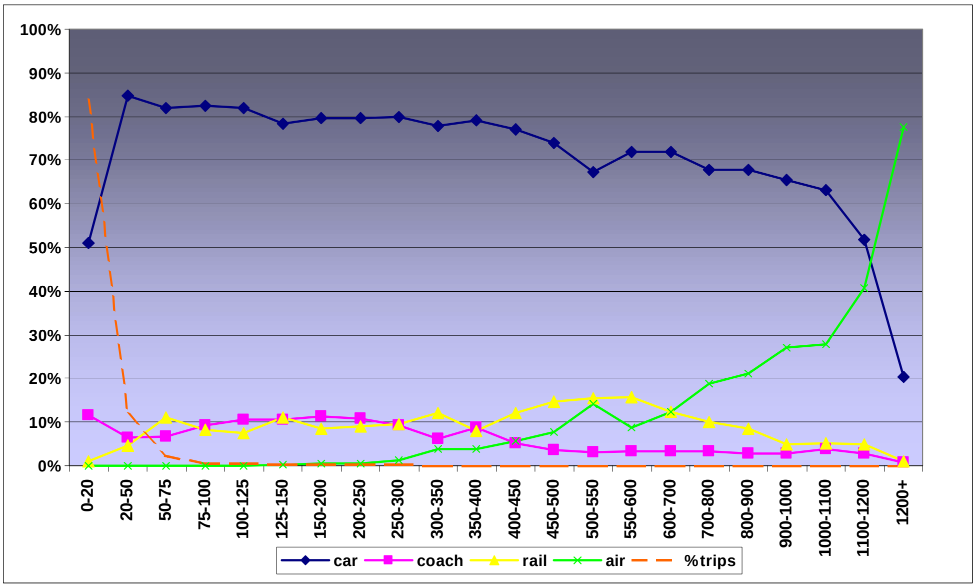
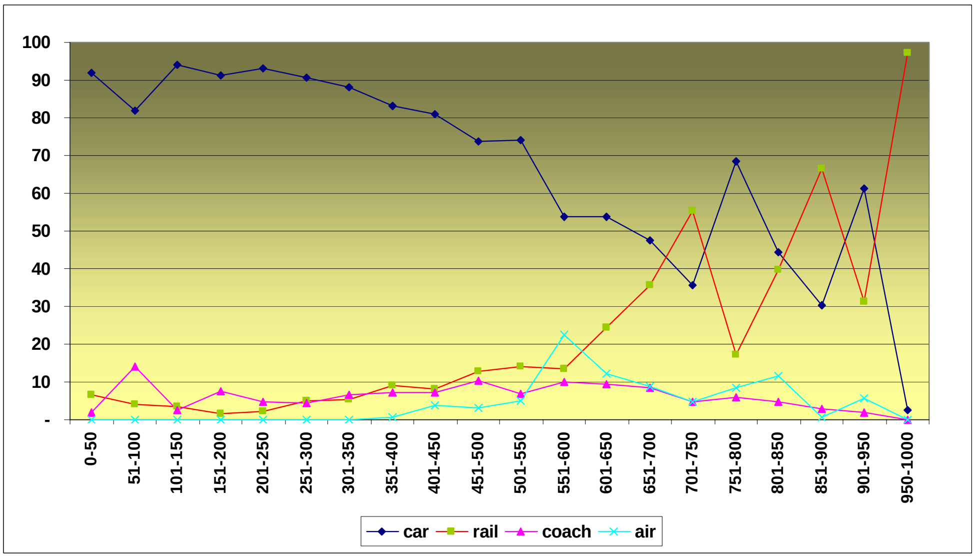


Figure 3.19 below shows 'observed' modal spit data derived from the German official travel matrix from 1991. The comparison with SCENES modelled data is limited as the German data contains only domestic trips - but it does provide some context for the model results. Both show coach and rail with around 10% of the modal share until around 400-500km. After this the comparison is more difficult, given the differences in scope – nevertheless this derived observed data demonstrates that the model output does seem sensible and plausible.

Figure 3.19: 'Observed' German modal split by distance, 1991 (domestic trips only)



Figures 3.20a-c overleaf show the mode split by distance for each of the 'long' Transport Flows in the model. Entries against the distance bands on these charts are only shown where there are 1% or more of the total trips for the transport flow – this stops very small numbers of trips having a distorting and mis-leading effect on the results.

Figure 3.20a: Mode split by distance – Long flows, EU and CEEC8, 1995, Flows 8, 9, 10 [vfr / day trip /other long, 0 car, p&f car, c&b long]

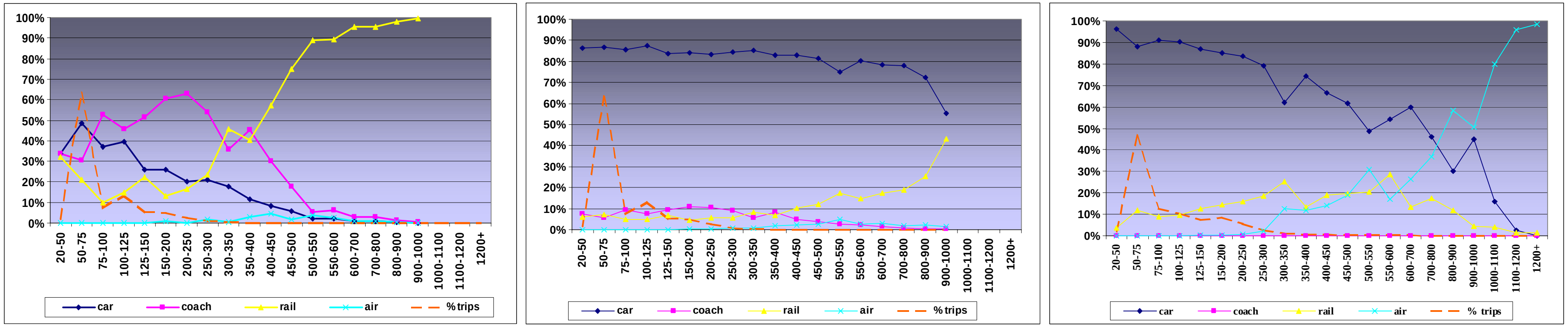


Figure 3.20b: Mode split by distance – Long flows, EU and CEEC8, 1995, Flows 11, 12, 13 [int. business, int. hol, 0 car, int. hol p&f car]

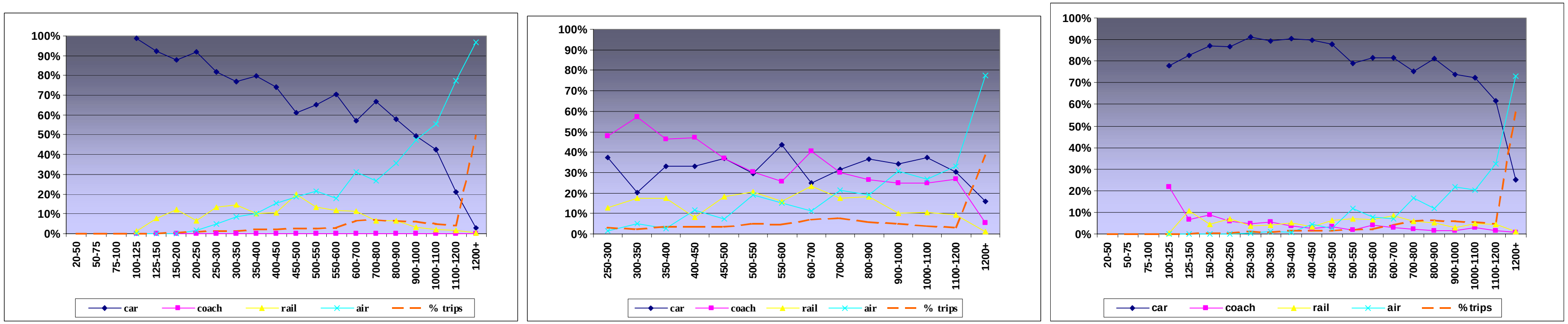
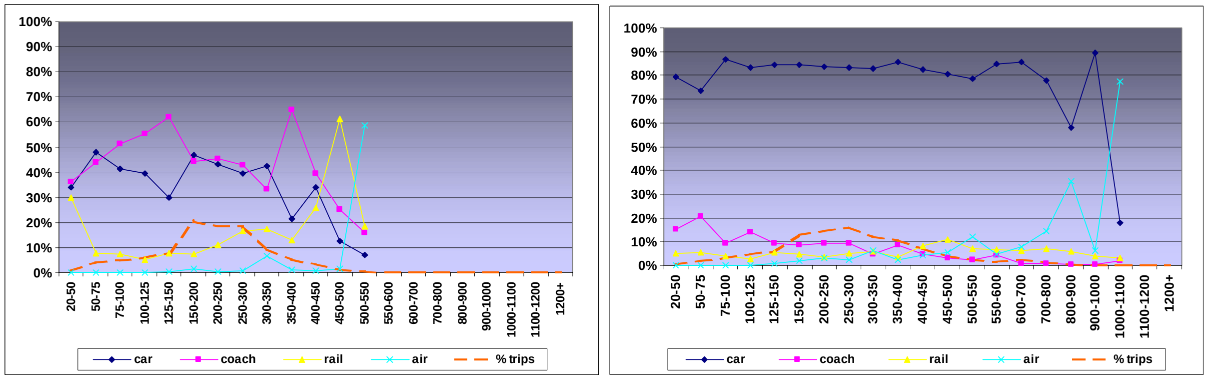
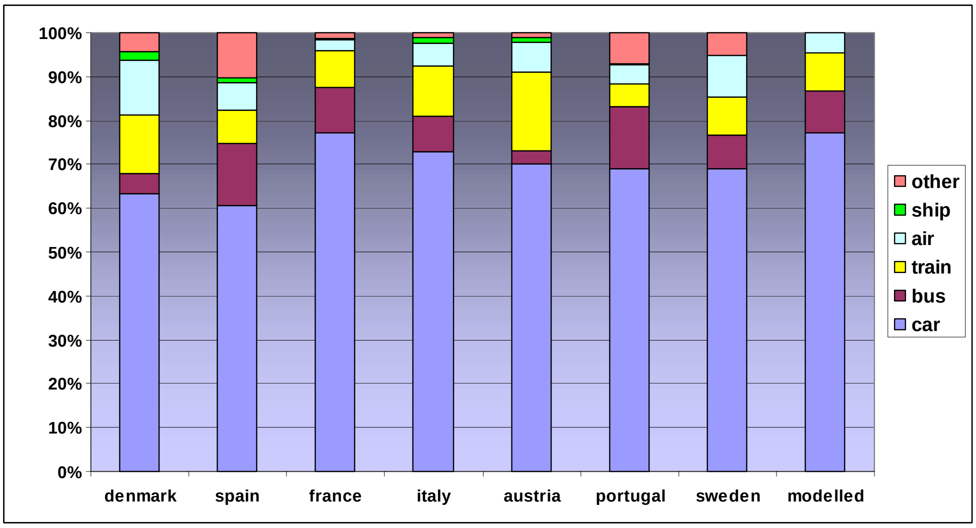


Figure 3.20c: Mode split by distance – Long flows, EU and CEEC8, 1995, Flows 14 and 15 [domestic holidays, 0 car, p&f car]



Finally, the Eurostat 'Long Distance Passenger Travel' publication also reports figures for modal split for trips greater then 100km. These are shown in Figure 3.21 below, together with the figures produced for all trips greater than 100km in the 1995 model. The 'long distance' threshold for Austria is 75km. Also note that the mode 'ship' in the observed data would be regarded as a 'ferry' trip in the model. The bulk of these would be reported as car trips in the model.

Figure 3.21: 'Observed' and modelled long distance modal split (>100km)



Although comparisons of this nature are always difficult due to the lack of a common definitional approach, it is clear that the average model results here are broadly in line with the 'observed' data shown here.

3.3 1995 Model Validation Results

This section considers the 1995 calibrated model results at the country level and above, and compares the results with estimates of passenger travel by mode – these are generally produced by individual countries, and collated by Eurostat and other international organisations. The objective of the model calibration was to represent in the model what is known about individuals' travel behaviour and characteristics from National Travel Survey, then reconcile this with the national aggregates to validate the model.

A variety of sources have been used to establish the 'observed' base year aggregates by country and mode. These are Eurostat's Transport in Figures (various editions), ECMT (various publications) and publications from the Auto-Oil programme. These sources often give different figures for the same mode / country / year. Therefore a view was taken as to which figure seemed most appropriate based on factors such as model output, other countries' figures, and the implications of the observed data for the average trip length and / or trip rate by country etc.

A further issue relating to the 'observed' data set is the extent to which it comprises wholly domestic travel, or includes international travel, excluding or including travel by foreigners in any country. Correspondence with the produces of TiF suggested that this issue was treated inconsistently between countries and that definitions are unclear. The approach taken was to aim the modelled domestic person-km to be between 90% and 100% of the published 'observed' figure. This allows some international travel to make up the difference. Given the margin for error associated with the 'observed' data, it was felt that this degree of accuracy was sufficient.

In this section the results for the EU countries and the CEEC8 are reported.

The final base year aggregate results by mode for the EU countries are shown below in Table 3.3. The travel volumes here are for domestic travel only, i.e., wholly within each member state.

Table 3.3: Modelled Passenger Travel – 1995 EU Domestic (billion pkm / annum)

	Car	Coach	Train	Slow	Air	Total
Austria	65.8	12.4	8.9	3.1	0.02	**90.1**
Belgium	85.0	12.5	5.8	4.2	0.00	**107.5**
Denmark	52.5	10.9	4.6	4.9	0.00	**72.8**
Finland	49.4	8.1	3.2	2.2	1.49	**64.3**
France	642.8	47.5	58.7	34.3	8.20	**791.5**
Germany	900.8	80.9	64.3	46.7	6.34	**1,099.1**
Greece	52.6	9.7	1.4	3.5	1.32	**68.6**
Ireland	27.5	5.3	1.2	2.0	0.00	**36.0**
Italy	591.0	91.5	52.4	37.9	5.16	**778.1**
Luxembourg	4.2	0.4	0.0	0.2	0.00	**4.8**
Netherlands	142.6	16.3	13.8	14.3	0.00	**187.0**
Portugal	64.9	12.8	4.8	3.8	0.08	**86.3**
Spain	300.3	42.0	16.3	11.8	4.91	**375.4**
Sweden	83.0	9.5	6.1	6.3	1.97	**106.8**
UK	606.3	46.0	31.3	34.6	4.80	**723.0**
TOTAL EU15	**3,668.9**	**405.8**	**272.8**	**209.7**	**34.3**	**4,591.4**

Of this 4,591 billion passenger km, some 3,034 billion are treated as intra-zonal in the SCENES model, that is two thirds of EU domestic person km. In terms of countries, this figure ranges from 100% (Luxembourg, 1 zone) down to 52% for the UK, where the zones are relatively large.

Table 3.4 shows these EU modelled volumes for car, coach and train as a proportion of the final 'Observed' figures for each country. In virtually all cases, these proportions lie between 0.9 and 1.0. This was one of the main model validation indicators.

Table 3.4: 1995 EU Domestic Modelled / 'Observed' passenger km values

	Car	Coach	Train		Car	Coach	Train
Austria	0.94	0.95	0.90	**Italy**	0.96	0.99	1.00
Belgium	0.92	0.94	0.86	**Luxembourg**	0.90	0.98	-
Denmark	0.95	1.03	0.91	**Netherlands**	0.95	1.03	0.99
Finland	0.97	0.96	0.99	**Portugal**	0.98	0.94	0.99
France	0.95	0.95	1.00	**Spain**	0.92	0.96	1.02
Germany	0.94	0.94	0.93	**Sweden**	0.94	0.93	0.98
Greece	0.92	0.96	0.91	**UK**	0.99	0.90	1.04
Ireland	0.94	1.01	0.94				

Table 3.5 below now shows the aggregate domestic travel volumes by mode for the CEEC8 countries. Table 3.6 then also gives a similar comparison between these values and the published data for these countries. Unfortunately there are no published estimates for car travel in any of the Baltic States, or Slovenia.

Table 3.5: Modelled Passenger Travel – 1995 CEEC8 Domestic (billion pkm / annum)

	Car	Coach	Train	Slow	Air	Total
Czech	50.8	17.4	8.1	4.4	0.00	80.7
Estonia	4.2	2.1	0.5	0.7	0.00	7.5
Hungary	42.4	15.7	7.8	4.3	0.00	70.2
Lithuania	11.9	3.4	1.1	1.9	0.00	18.3
Latvia	6.5	1.9	1.3	1.1	0.00	10.9
Poland	179.4	39.8	24.1	17.2	0.00	260.6
Slovenia	7.6	2.2	0.5	0.9	0.00	11.2
Slovakia	14.9	10.2	3.3	2.6	0.02	31.1
TOTAL CEEC8	**317.9**	**92.8**	**46.8**	**32.9**	**0.02**	**490.5**

Table 3.6: 1995 CEEC Domestic Modelled / 'Observed' passenger km values

	Car	Coach	Train
Czech	0.93	0.88	1.01
Estonia	NA	0.85	1.08
Hungary	0.96	0.96	0.94
Lithuania	NA	1.02	0.94
Latvia	NA	1.04	0.98
Poland	0.92	0.91	0.91
Slovenia	NA	0.87	0.90
Slovakia	1.00	0.91	0.79

Again the 1995 modelled values are generally in line with the published data for the CEEC8. The match is not quite as good as in the EU countries, but the quality of the observed data for the CEEC8 is likely to be poor in comparison to some of the EU countries. Nevertheless, the model does represent the base year passenger travel situation in the CEEC8 to a good level, considering the limited data available.

The domestic person kilometres can also be viewed by mode as a proportion of the total person kilometres for that country. Table 3.7 overleaf shows the modelled figures - this data is interpreted as e.g., Austria, 73% of all domestic person kilometres travelled are done so using the car – note for example the higher than average proportion of slow modes in the Netherlands.

It is also clear that the proportion of car travel is, as one would expect, very much smaller in the CEEC8 countries, with coach, train, and slow modes all taking a larger proportion of travel here than in the EU. The EU total is also given – these figures match closely with the 'observed' data.

The country level results are presented graphically below in Figures 3.22 and 3.23 overleaf. Here, the results are translated into trips per person per annum, by mode (Fig 3.22) and person kilometres travelled per person per annum, by mode (Fig 3.23). The results from the CEEC8 countries are also included here, so the number of trips and person kilometres in both these charts includes all travel within this whole 'internal' modelled area, but not travel to 'external' countries.

Table 3.7: Modelled domestic person-km by country and mode, proportion of the total, 1995 (%)

	Car	Coach	Train	Slow
Austria	73.0	13.7	9.8	3.4
Belgium	79.1	11.6	5.4	3.9
Denmark	72.1	15.0	6.2	6.7
Finland	76.9	12.5	4.9	3.4
France	81.2	6.0	7.4	4.3
Germany	82.0	7.4	5.8	4.3
Greece	76.7	14.2	2.1	5.1
Ireland	76.5	14.6	3.4	5.5
Italy	76.0	11.8	6.7	4.9
Luxembourg	87.7	8.1	0.0	4.2
Netherlands	76.2	8.7	7.4	7.6
Portugal	75.2	14.8	5.5	4.4
Spain	80.0	11.2	4.4	3.2
Sweden	77.7	8.9	5.7	5.9
UK	83.9	6.4	4.3	4.8
EU TOTAL	**79.9**	**8.8**	**5.9**	**4.6**
EU 'Observed'	**80.8**	**8.9**	**5.9**	**4.4**
Czech	62.9	21.6	10.0	5.5
Estonia	56.5	28.5	6.0	9.0
Hungary	60.4	22.4	11.1	6.1
Lithuania	65.3	18.7	5.8	10.2
Latvia	59.7	17.5	12.3	10.5
Poland	68.9	15.3	9.3	6.6
Slovenia	68.1	19.5	4.8	7.6
Slovakia	48.0	32.9	10.7	8.3

Figure 3.22: EU and CEEC8, person trips / person / year, by mode, 1995

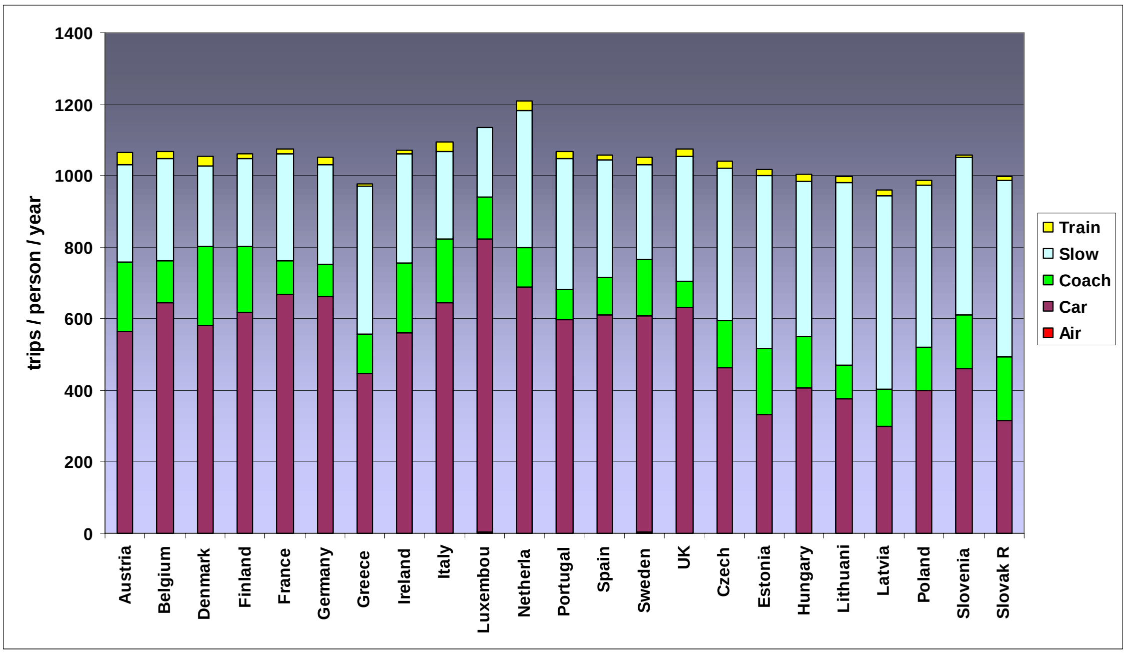
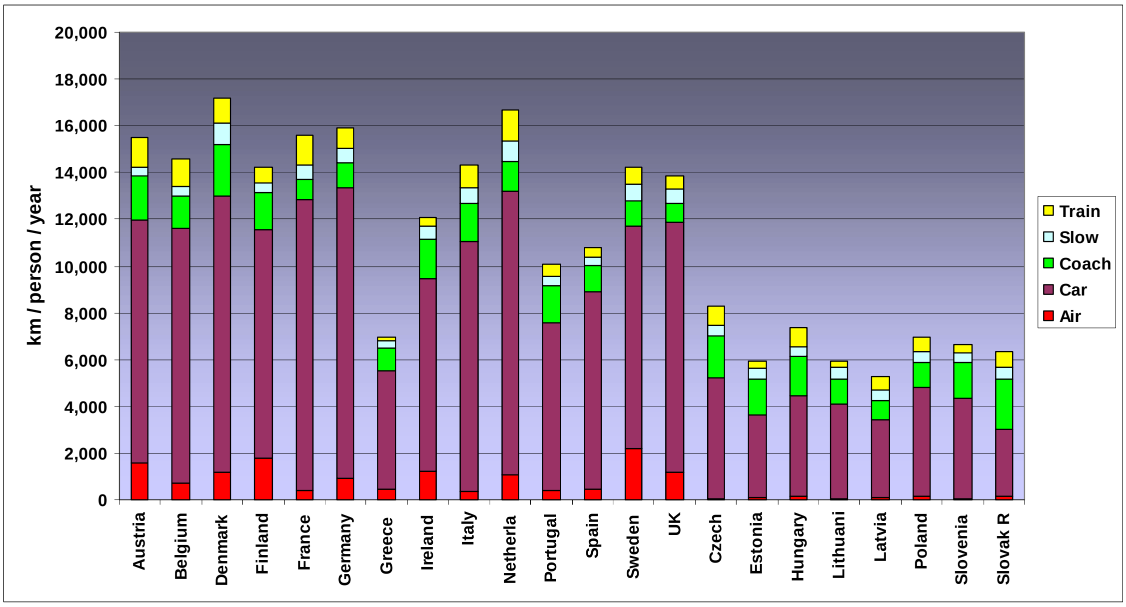


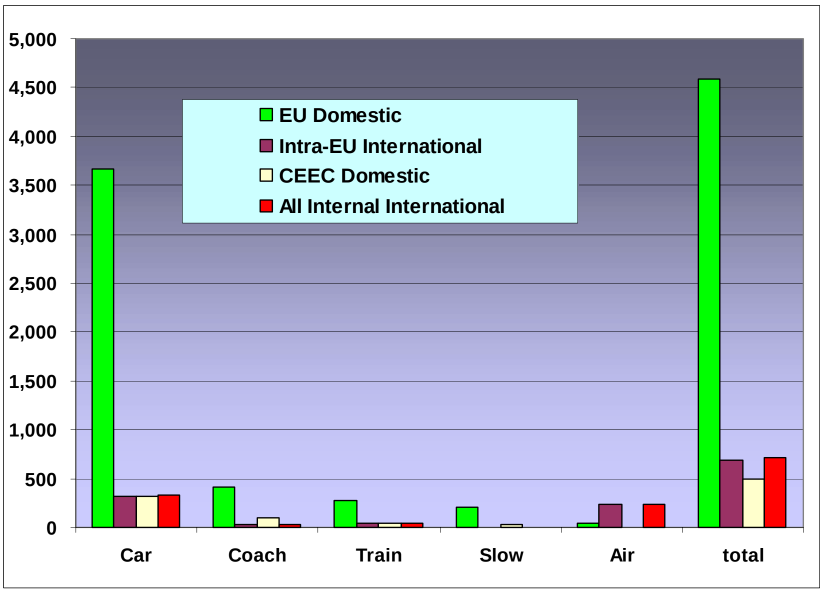
Figure 3.23: EU and CEEC8, person km / person / year, by mode, 1995



It can be seen that although the number of trips made per person in the CEEC8 are not much below EU levels, the volume of travel in terms of person-km per annum is much less. This therefore simply reflects a lower average trip distance in these countries. Greece, Portugal, Spain and Ireland have the smallest amounts of travel per person amongst the EU countries. This reflects the lower car ownership rates in these countries. Note also how small a proportion of all person-km travelled the slow modes comprise.

The various elements of the total passenger travel (person kilometres) in the model are shown graphically in Figure 3.24, below. The overwhelming dominance of EU domestic travel is clear in this representation (shown in light green). The ‘internal’ international here refers to all international travel within and between the EU and CEEC8. International travel within the CEEC8 is not specifically shown here as it is very small in volume.

Figure 3.24: Modelled 1995 domestic and international travel (10^9 person km per annum)



The results for the EU as a whole are now summarised in Table 3.8 below.

Table 3.8: EU Summary results, 1995 (10^9 pkm/annum)

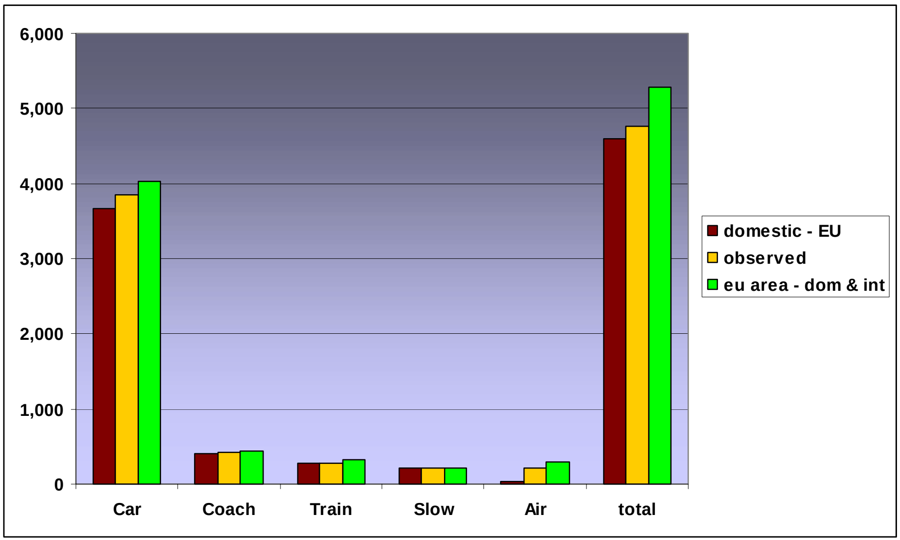
	Car pkm	Bus / Coach pkm	Train pkm	Slow pkm	Air pkm	Total
EU Domestic	3,668.9	405.8	272.8	209.7	34.3	4,591.4
EU Dom.+ Int.[1]	3,986.8	430.6	317.8	209.7	276.5	5,221.4
'Observed'	3,855.5	424.3	279.3	208.8	209.0[2]	4,976.9

[1] This figure refers to domestic and intra-EU international travel with origins and destinations within the EU only.

[2] This figure was revised downwards from 274,000 (01/00 TiF) to 209,000 (08/00 TiF).

The approach taken to calibration is clear from Table 3.8 and there is a good comparison between the modelled and observed figures. For each mode the 'observed' figure lies between the modelled 'domestic' and the modelled 'domestic plus international'. This is illustrated graphically in Figure 3.25 below.

Figure 3.25: EU summary results, modelled and observed, 1995, (10^9 pkm/annum)



Note that the passenger-km for the Air mode above was set up in the context of the original 'observed' figure, seen in Table 3.8. However, Air travel in the base year can also be viewed from the perspective of the number and pattern of trips. Tables 3.9 and 3.10 overleaf show the modelled and observed Air trips, for both domestic and EU international trips.

Given that this observed pattern of trips appears unchanged in both the Tifs of 01/00 and 08/00, there must be some doubts about the person-km total for air in the two publications. The model matches the pattern of international air travel fairly well, and has approximately the correct number of domestic flights in each of the countries where this is a significant factor. The overall number of air trips in the model matches the published data well.

The behavioural characteristics of passenger travel in the model have been demonstrated in this Chapter, together the results showing that the national aggregate totals produced by the model match the published data well. This base year model therefore provides a good foundation for the making the 2020 Scenario forecasts. Chapter 4 now describes the calibration and validation of the SCENES freight model.

Table 3.9: 1995 Observed Air trips (10^6 trips / annum)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Lux.	Neth.	Portugal	Spain	Sweden	UK	Grand Total
Austria	**0.69**															
Belgium	0.28	-														
Denmark	0.21	0.44	-													
Finland	0.05	0.16	0.40	**2.27**												
France	0.59	1.26	0.63	0.21	**23.81**											
Germany	2.02	1.36	1.28	0.58	4.49	**17.75**										
Greece	0.88	0.46	0.43	0.28	0.98	4.48	**3.66**									
Ireland	0.03	0.17	0.14	0.01	0.60	0.46	0.06	-								
Italy	0.52	1.50	0.55	0.13	4.11	4.18	1.14	0.20	**15.23**							
Luxembourg	0.01	0.06	0.05	0.00	0.10	0.20	0.04	0.00	0.07	-						
Netherlands	0.42	0.29	0.44	0.21	1.58	2.07	1.00	0.28	1.19	0.06	-					
Portugal	0.09	0.41	0.15	0.07	1.30	1.76	0.02	0.12	0.41	0.09	0.62	**1.23**				
Spain	0.80	2.28	0.67	0.69	3.83	14.88	0.19	0.75	3.05	0.25	2.40	0.97	**17.52**			
Sweden	0.18	0.39	2.30	1.17	0.50	0.74	0.90	0.03	0.26	0.00	0.64	0.09	1.37	**7.21**		
UK	1.72	2.22	1.50	0.49	6.59	7.05	3.78	7.60	4.95	0.19	5.82	3.22	19.49	1.58	**14.54**	
Observed International	**7.80**	**11.00**	**8.54**	**3.84**	**24.08**	**35.82**	**7.13**	**8.98**	**9.93**	**0.59**	**9.48**	**4.28**	**20.86**	**1.58**		**153.91**
Observed Domestic																**103.90**
Observed Total																**257.81**

Sources: International: Eurostat Transport in Figures, 2000, Table 5.16, and Domestic: IATA, European Air Transport Forecast, 1980-2010 (1995-96 edition)

Table 3.10: 1995 Modelled Air trips (10^6 trips / annum)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Lux.	Neth.	Portugal	Spain	Sweden	UK	Grand Total
Austria	**0.06**															
Belgium	0.07	**0.00**														
Denmark	0.08	0.09	**0.00**													
Finland	0.10	0.14	0.15	**4.08**												
France	2.43	2.56	0.65	0.47	**22.47**											
Germany	0.71	0.22	0.74	1.16	7.55	**17.38**										
Greece	1.05	0.69	0.56	0.35	1.65	4.94	**3.61**									
Ireland	0.24	0.18	0.05	0.06	1.07	0.72	0.16	**0.00**								
Italy	1.12	0.97	0.49	0.56	2.70	6.79	1.09	0.38	**14.14**							
Luxembourg	0.00	0.00	0.00	0.01	0.18	0.00	0.05	0.02	0.03	**0.00**						
Netherlands	0.39	0.01	0.23	0.19	2.77	0.81	1.24	0.26	1.77	0.00	**0.00**					
Portugal	0.78	0.59	0.25	0.16	1.02	2.16	0.12	0.20	1.06	0.09	0.96	**0.21**				
Spain	1.56	1.51	0.26	0.19	3.11	19.32	0.47	0.29	4.35	0.81	4.08	0.13	**13.45**			
Sweden	0.33	0.19	0.49	1.31	2.26	2.36	0.88	0.05	0.84	0.03	0.53	0.17	0.58	**5.41**		
UK	1.90	0.42	0.74	0.48	7.20	5.81	4.83	5.26	4.67	0.09	2.20	2.59	18.32	1.25	**13.15**	
Observed International	**10.76**	**7.58**	**4.60**	**4.93**	**29.48**	**42.90**	**8.83**	**6.46**	**12.72**	**1.01**	**7.76**	**2.89**	**18.90**	**1.25**		**160.08**
Observed Domestic																**93.98**
Observed Total																**254.06**

4. Freight model validation and calibration

4.1 Freight Model Structure

The basic structure of the SCENES freight model is recapped here. More details can be found in SCENES Deliverable 4. The freight model comprises three main parts, a Regional Economic Model which establishes the trade matrix, an Interface module which translates this monetary trade into transport volumes, and a Transport model, which assigns these flows to transport networks and undertakes the modal split. There is then a feedback of transport costs and times in the form of disutilities from the transport model back to the Regional Economic Model.

4.1.1 SCENES Regional Economic Model

The Regional Economic Model (REM) is a spatial adaptation of an Input-Output (IO) model. It is driven by final demand for a given year and it estimates the demand for industry outputs by sector. It calculates the demand for each industry in each zone, using the national average IO coefficients applicable to that zone. This demand is then met by suppliers from the home zone as well as other zones, based on generalised cost of transport, factory gate production cost at the supply zone, and a residual attractiveness of the supply zone estimated for the base year. The REM outputs matrices of trade flows between zones, for the freight transport model to assign to the networks.

The base data are the EUROSTAT 1995 IO tables for each EU15 country. The data required some modification to generate the input for the SCENES model. This included modification of the IO tables to the 24 branches of industries used in SCENES, and the allocation of national totals to individual zones based on the Gross Value Added (GVA) and other socio-economic data per zone. To achieve the required zonal disaggregation two sources of information were used. These were, first, an intra-EU freight matrices derived from the trade data, and, second, a set of GVA and socio-economic data by zone. This gives a full disaggregation of country level production data to the level of SCENES zones for the base year 1995.

The EUROSTAT IO tables came at the level of 25 branches. For SCENES, they were modified to 24 different branches for the purpose of freight demand modelling. Table 4.1 shows the correspondence of the SCENES and EUROSTAT categories.

Table 4.1: Correspondence between Eurostat 25 and 24-sector I/O aggregations

	24-sector aggregation (used in SCENES REM)		**25-sector aggregation (contained in EUROSTAT IOTs)**
1	Agriculture, forestry and fishery products	**1**	Agriculture, forestry and fishery products
2, 3, 4, 5	Coal, coke and lignite, Extraction of crude petroleum and gas, Manufactured fuel, Other fuels	**2**	Fuel and power products
6, 7	Ferrous and non-ferrous ores, Metals	**3**	Ferrous and non-ferrous ores and metals
8, 9, 10	Cement and building materials, Glass and ceramic materials, Other non-metallic mineral products	**4**	Non-Metallic mineral products
11, 12	Basic chemicals, Fertilisers and chemical products	**5**	Chemical products
13	Metal products except machinery	**6**	Metal products except machinery
14	Agricultural and industrial machinery	**7**	Agricultural and industrial machinery
15	Electrical products	**8, 9**	Office and data processing machines, Electrical goods
16	Transport equipment	**10**	Transport equipment
17, 18	Food, beverages and tobacco – consumer, Food, beverages and tobacco – conditioned	**11**	Food, beverages and tobacco
19	Textiles, clothing, leather and footwear	**12**	Textiles, clothing, leather and footwear
20, 21	Paper pulp, Printing products	**13**	Paper and printing products
22	Other manufactured products	**15**	Other manufactured products
23	Other chemical products	**14**	Rubber and plastic products
24	Services	**16, 17, 18, 19, 20, 21, 22, 23, 24, 25**	Building and construction, Recovery, repair services, wholesale and retail, Lodging and catering services, Inland transport services, Maritime and air transport services, Auxiliary transport services, Communication services, Services of credit and insurance institutions, Other market services, Non-Market services

For the countries Denmark, Germany, Spain, France and Italy, the 59-sector national tables were used directly to modify the IO tables as shown above. For the countries Belgium, the Netherlands, Luxembourg, Austria, Sweden, Finland, Greece and Portugal, the same basic procedure was used though with the 59-sector table from one of the five preceding countries being used. Table 4.2 shows the 'donor' country tables that were used in each case. Finally, for the UK and Ireland, the expansion was based on the 1990 UK 123 sector IOT. The correspondence between the 59 branch and the SCENES categories are shown in Table 4.3.

Table 4.2: 'Donor' countries for modification of other countries' IOT

'Donor' country	**Country**
Denmark (59 sector, 1985 IOT)	Netherlands / Belgium / Luxembourg / Finland / Sweden
Germany (59 sector, 1985 IOT)	Austria
Spain (59 sector, 1985 IOT)	Greece / Portugal
France (59 sector, 1985 IOT)	-
Italy (59 sector, 1985 IOT)	-
United Kingdom (123 sector, 1990 IOT)	Ireland

Table 4.3: Correspondence between 59 branches and 24 SCENES categories

	59-sector aggregation (contained in EUROSTAT 1985 IOTs)		**24-sector aggregation (used in SCENES REM)**
1	Agriculture, forestry and fishery products	**1**	Agriculture, forestry and fishery products
2, 3, 4	Coal and coke briquettes, Lignite and lignite briquettes, Products of coking	**2**	Coal, coke and lignite
5	Crude petroleum	**3**	Extraction of crude petroleum and gas (1)
6	Refined petroleum products	**4**	Manufactured fuel (1)
7	Natural gas	**3**	Extraction of crude petroleum and gas (2)
8 **9**	Water (collection, purification, distribution) Electric power	**5** **5**	Other fuels (1) Other fuels (2)
10	Manufactured gases	**4**	Manufactured fuel (2)
11	Steam, hot water, compressed air	**5**	Other fuels (3)
12	Nuclear fuels	**4**	Manufactured fuel (3)
13	Iron ore and ECSC iron and steel products	**6**	Ferrous and non-ferrous ores
14, 15	Non-ECSC iron and steel products, Non-Ferrous metal ores; Non-Ferrous metals	**7**	Metals
16	Cement, lime and plaster	**8**	Cement and building materials
17 **18**	Glass Earthenware and ceramic products	**9**	Glass and ceramic materials
19	Other minerals and derived products (non-metal)	**10**	Other non-metallic mineral products
20	Chemical products	**11, 12**	Basic chemicals, Fertilisers and chemical products
21	Metal products	**13**	Metal products except machinery
22	Agricultural and industrial machinery	**14**	Agricultural and industrial machinery
23, 24	Office machines, etc.Electrical goods	**15**	Electrical products
25, 26	Motor vehicles and engines, Other transport equipment	**16**	Transport equipment
27, 28	Meat and meat products, Milk and dairy products	**18**	Food, beverages and tobacco – conditioned
29,30,31	Other food products, Beverages, Tobacco products	**17**	Food, beverages and tobacco – consumer
32,33	Textiles and clothing, Leathers, leather and skin goods, footwear	**19**	Textiles, clothing, leather and footwear
34	Timber and wooden furniture	**22**	Other manufactured products (1)
35	Pulp, paper, board	**20**	Paper pulp
36	Paper goods, products of printing	**21**	Printing products
37	Rubber and plastic products	**23**	Other chemical products
38	Other manufacturing products	**22**	Other manufactured products (2)
39,40,41, 42,43,44, 45,46,47, 48,49,50, 51,52,53, 54,55,56, 57,58,59	Building and civil engineering works, Recovery and repair services, Wholesale and retail trade, Lodging and catering services, Railway transport services, Road transport services, Inland waterways services, Maritime and coastal transport services, Air transport services, Auxiliary transport services, Communications, Credit and insurance, Business services provided to enterprises, Renting of immovable goods, Market services of education and research, Market services of health, Market services n.e.c, General public services, Non-Market services of education and research, Non-Market services of health, Non-Market services n.e.c	**24**	Services

The main inputs to the model files for the Regional Economic Model are:

- inter-industry technical coefficients by country and industry,
- total domestic production by zone by industry,
- public consumption, investment and change in stocks by zone by industry,
- private consumption per capita by country and industry,
- imports from third countries, by third country and industry, and
- exports from third countries, by third country and industry.

The output is a matrix of trade by the 24 sectors in Table 4.1 at the zonal level for 1995.

4.1.2 Linking Regional Economic Model with Freight Transport Model

The linkages are two way:

- The regional economic model produces the matrices of trade, which are converted by an interface program to tonnes of freight to input to the transport model
- The transport model produces monetary and generalised transport costs (the latter including a valuation of time and other non-monetary costs of transport) for the regional economic model. The regional economic model may then use the monetary costs for cost accounting, and generalised costs for modelling the spatial distribution of trades.

Table 4.4 shows how the trades generated in the REM are related to the transport flows.

Table 4.4: Correspondence between Industries and Freight Flows

	Factors		**Transport flow**
1	Agriculture, forestry and fishery products	1	Agricultural products
2	Coal, coke and lignite	4	Solid fuels and ores
3	Extraction of crude petroleum and gas	-	-
4	Manufactured fuel	5	Petroleum products
5	Other fuels	-	-
6	Ferrous and non-ferrous ores	4	Solid fuels and ores
7	Metals	6	Metal products
8	Cement and building materials	7	Manufactured building materials
9	Glass and ceramic materials	13	Miscellaneous articles
10	Other non-metallic mineral products	8	Crude building materials
11	Basic chemicals	9	Basic chemicals
12	Fertilisers and chemical products	10	Fertilisers, plastics and other chemicals
13	Metal products except machinery	13	Miscellaneous articles
14	Agricultural and industrial machinery	11	Large machinery
15	Electrical products	12	Small machinery
16	Transport equipment	11	Large machinery
17	Food, beverages and tobacco – consumer	2	Consumer food
18	Food, beverages and tobacco – conditioned	3	Conditioned food
19	Textiles, clothing, leather and footwear	13	Miscellaneous articles
20	Paper pulp	10	Fertilisers, plastics and other chemicals
21	Printing products	13	Miscellaneous articles
22	Other manufactured products	13	Miscellaneous articles
23	Other chemical products	10	Fertilisers, plastics and other chemicals

Note that services (Factor 24) do not directly generate any tonnes in the system.

4.1.3 Freight transport model

The SCENES freight transport model takes the trade matrices from the REM and performs modal split and network assignment. Some key elements of the freight transport model are outlined in this Section.

<u>Freight flows</u>

For the SCENES freight model, thirteen 'Transport Flows' are defined, as shown above in Table 4.4. The specification of these Transport Flows is based on the following:

- transport requirements are different among different commodities - the more detailed the classification is, the more appropriate can be the description of the model parameters;
- enhanced computing power allows the management of a larger number of flows; and,
- the logistic module appended to freight model (with the aim of taking into account the logistics chains), requires a configuration of the freight flows into logistics families. It demands however a suitable definition of the flows according to their handling requirements in terms of logistics families.

At the same time, the definition of Transport Flows must take into account the following main constraints:

- Availability of detailed data: Apart from TREX, other data sources generally provide data at the NST/R chapter (1-digit) level or even more coarsely. The EUROSTAT Carriage of Goods database, which is the main reference for the national flows, provides data according to a different grouping of the NST/R 2-digit named Group of Goods. Therefore, defining a highly detailed set of flows in the model might be useless as a number of assumptions would require to be formulated to estimate observed data by flow, starting from aggregated figures;
- Flows are linked in the model with the trades of the REM, which are defined from the NACE-CLIO 59 branches;
- The number of flows affects the computational resources needed to run the model.

On the basis of these considerations, the 13 Transport Flows defined for the model are shown below in Table 4.5 together with their relationship with standard freight classifications.

Table 4.5: SCENES freight flows compared with standard freight classifications

Flow	**NST/R group**	**Group of Goods**	**Handling category**
1- Cereals and agricult. Products	00 01 04 05 06 09 17 18	1 3 4 5 part of 6 7	General cargo
2 – Consumer food	02 11 12 13 16	Part of 2 Part of 6	Unitised
3 – Conditioned food	03 14	Part of 2 Part of 6	Unitised
4 – Solid fuels and ores	21 22 23 41 45 46	8 11 12	Solid Bulk
5 – Petroleum products	32 33 34	10	Liquid Bulk
6 – Metal products	51 52 53 54 55 56	13	General Cargo
7 – Cement and manuf. Build mat.	64 69	14	Unitised
8 – Crude building materials	61 62 63 65	15	Solid Bulk
9 – Basic chemicals	81 83	17 part of 18	Solid Bulk
10 – Fertil,, plastic and oth. Chem.	71 72 82 84 89	16 part of 18 19	General Cargo
11 – Large Machinery	91 92 939	part of 20	General Cargo
12 – Small Machinery	931	part of 20	Unitised
13 – Miscell. Manufact. Articles	94 95 96 97 99	21 22 23 24	Unitised

Freight transport modes

Ten main modes (or user modes) of transport are implemented in the model (Heavy Goods Vehicle (HGV), Light Goods Vehicle (LGV), bulk rail, bulk ship, bulk waterway, product pipelines, air freight, container rail, container ship, container waterway, and shuttle rail). In addition, there are nine intra-zonal modes (representing trips of different length and by different mode), therefore a total of nineteen modes are included in the model. HGV represents articulated trucks used on the longer distances whilst LGV represents rigid trucks with a lower average distance. Lighter vehicles used for local distribution are modelled by intra-zonal modes. Each mode is available to a set of Flows, according to its specific features with respect to the nature of the flows, which are grouped into four handling categories with similar requirements:

- Solid bulk (B)
- Liquid bulk (L)
- General Cargo (G)
- Unitised freight (U)

Modal split is performed using a multinomial nested logit model.

Key parameter inputs

This section describes the main parameters used in the SCENES freight model, namely: load factors, cost functions, and, values of time.

For the **Load Factors** in the model, the assignment unit is tonne for each mode except for road transport. For road, the number of truck units correspondent to a certain level of road traffic (expressed in tons) is obtained by means of suitable load factors. Different road modes are present in the model: HGV, LGV and road intrazonal modes. Such modes are different in terms of dimensions and typical range of operating distance, so different load factors have been implemented. These are shown in Table 4.6 below.

Table 4.6: Load factors for Heavy Goods Vehicles including empty trips (Tonnes/vehicle)

Flow	**HGV**	**LGV**	**Intra-zonal road freight**				
			<10 km	10-25 km	25-50 km	50–100 km	100–200 km
Agricultural products	10.7	3.2	3.2	3.2	3.2	5.1	6.9
Consumer food	10.8	3.2	3.2	3.2	3.2	5.1	6.9
Conditioned food	9.8	3.0	3.0	3.0	3.0	4.7	6.4
Solid fuels and ores	10.8	3.3	3.3	3.3	3.3	5.2	7.1
Petroleum products	11.9	3.6	3.6	3.6	3.6	5.7	7.8
Metal products	11.6	3.5	3.5	3.5	3.5	5.6	7.6
Manufact. Building Materials	11.3	3.4	3.4	3.4	3.4	5.4	7.3
Crude Building Materials	10.7	3.2	3.2	3.2	3.2	5.1	6.9
Basic Chemicals	10.9	3.3	3.3	3.3	3.3	5.2	7.1
Fertil., Plastic and other Chem.	11.7	3.5	3.5	3.5	3.5	5.6	7.6
Large machinery	8.3	2.5	2.5	2.5	2.5	3.9	5.4
Small machinery	7.4	2.3	2.3	2.3	2.3	3.6	4.9
Miscellaneous articles	7.4	2.3	2.3	2.3	2.3	3.6	4.9

Sources: TRT estimates on: *GS EVED/Dienst fur Gesamtverkehrsfragen* data (Alps Crossing database), UK CSRGT data and CONFETRA data

For road transport, different **Cost Functions** were estimated for HGV used on longer distances, LGV used on shorter distances, and an intra-zonal road mode which represent vehicles used for local distribution. The haulage costs are a function of travel distance and time. Motorway tolls, ferries tariffs and terminal costs are included as separate elements in the cost functions.

There are three different rail modes: conventional rail, unitised rail and shuttle services. Separate cost functions are developed for each. Loading/unloading and freight terminal access costs are included in rail costs as per transport stages on each OD pair. Shipping and port costs were estimated based on sample surveys from a study of transport cost by TRT. Different sources were considered to estimate the transport costs for inland navigation. The NEA report ‘Market Observation System Inland Navigation’, provides detailed figures about costs and prices of inland waterways also by groups of commodities (solid and liquid cargoes). The EUFRANET deliverable quoted above also includes an average cost per tonne-km for inland navigation and port operations costs. A further document regarding transport of containers by inland waterways was obtained, where a cost function and terminal costs are reported. The air freight cost function estimated for STREAMS came from the official tariffs reported by TACT (The Air Cargo Tariff). The same functions updated to 1995 have been considered for SCENES with a 20% discount, which is believed to be a representative level of actual rates.

Values of time represent the users’ valuation of time savings, and thus the trade off between transport cost and transport time. Freight consignments have very different valuations of time savings because of the characteristics of the goods carried (e.g., value, weight, volume, timeliness, safety, reliability, etc.). These time values were estimated based on a number of freight user surveys and through the calibration of the logit modal split model.

4.2 Approaches to freight model calibration

In this section the steps followed for the calibration of the SCENES freight model are described. The process included essentially three steps:

- calibration of paths;
- general calibration of modal shares;
- calibration of modal shares by country and by flow.

4.2.1 Calibration of paths

The first stage of the calibration was the check of path choice. This point required to verify the consistency of various component of the model: cost functions, resting times at customs, ferry tariffs and so on. This part of work led to some changes to such components, mainly to some ferry tariffs (and travel times) which was the component estimated on a limited base of observed data.

Time at customs were also changed during this step. The starting point for setting times at customs was the IRU web site, where they are monitored according to the declarations of truck drives for a number of customs between EU and Eastern Europe countries (the intra-EU customs are not associated to a significant resting time). However, the variability among drivers declarations were very relevant, so only estimation of the size could be drawn from this source and a calibration was required.

4.2.2 General calibration of modal shares

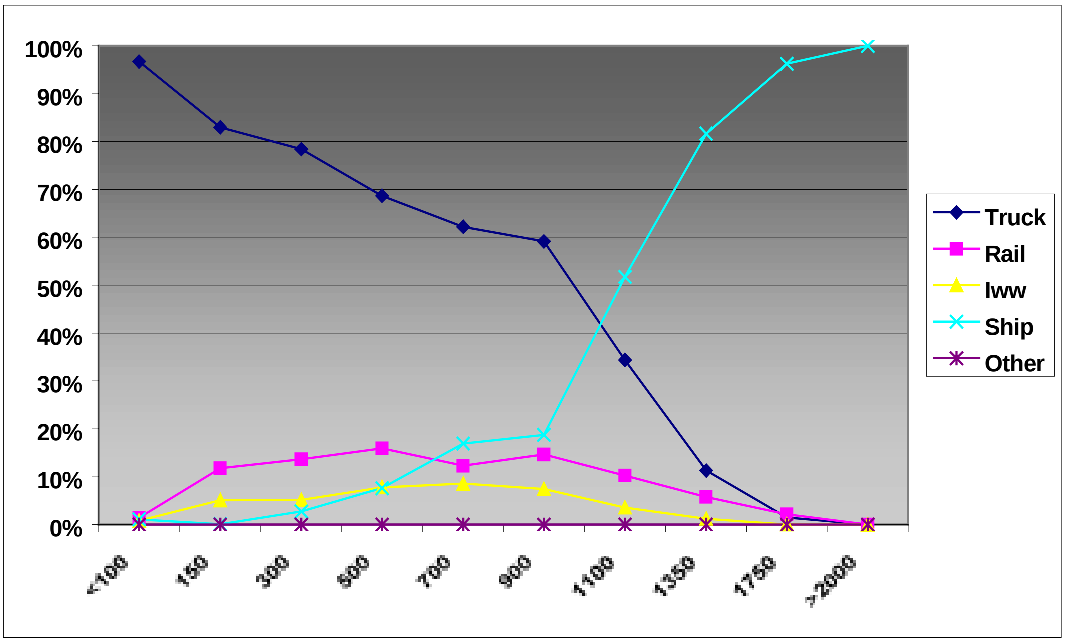
The second step of the calibration process was the set-up of modal shares at a general level, i.e., on the overall traffic simulated by the model. The scope of this step was to have a model whose modes worked correctly in broad terms, before dealing with the specific conditions in each country.

The first process in this phase was to check the behaviour of the modes at different distances. Assuming a matrix with correct average distances, if the competitiveness of various modes at difference distances is sensible, the model is in good position for representing the observed modal shares.

The observed data of tonnes and tonnes-km resulted from an intensive work of corrections on original figures published by different sources (see SCENES Deliverable 4 for details). Data by distance band was only available as figures published by a single source (EUROSTAT - NEWCRONOS database) and limited to land modes (road, rail and Inland navigation). Therefore, data by distance band were not always fully consistent to the overall traffic figures used as reference for the calibration. This made the check of the performance of modes by distance bands based on judgement as well as on the comparison of modelled and published figures.

This part of work lead to some changes to the structure of the model. For instance, in some cases a distance-related disutility term was included in the mode choice function for road, rail and inland navigation. This additional term was required since the trip time by sea shipping was very long in comparison to other modes. Therefore, especially for flows with a higher value of time, sea shipping was hardly competitive to other modes. Modal shares by distance are reported in the following Figure 4.1.

Figure 4.1: Freight modal share by distance – all flows (% tonnes)



At the same time modal shares by flow regarding the whole traffic were compared to the observed ones, in order to verify that the adjustment of modal shares on different distances produces correct results also in terms of overall modal shares. The two elements were linked also because elements used to calibrate the competitiveness of modes at different distances were the modal constants, which are the main elements controlling the modal shares.

Another task performed during this phase was the check of the elasticity of the models. Road and rail elasticities with respect to cost and time were estimated by means of tests on the model. The analysis was carried out on different distance bands because the different competitiveness of modes affects the elasticities. For instance, modal shift is almost impossible for flows moving under 50 km.

The relative weight of modal constant on the disutility function ruling modal split as well as the parameters of the Logit model which performs the modal split itself were the elements calibrated in this phase. The elasticities obtained in the model are summarised in tables below. Elasticities under 50 km are null, so they are not reported.

Table 4.7: Elasticity of road freight with respect to cost

	Modelled elasticity			
Flow	**50-150km**	**150-500km**	**>500km**	**Published road elasticity***
1 - Cereals and agricult. Products	-0.31	-0.26	-0.78	min -0.14 ; max -1.55
2 - Consumer food	-0.12	-0.07	-0.41	min -0.52 ; max -1.54
3 - Conditioned food	-0.18	-0.05	-0.17	min -0.52 ; max -1.54
4 - Solid fuels and ores	-0.61	-0.26	-1.00	n.a.
5 - Petroleum products	-0.26	-0.49	-0.51	min -0.52 ; max -0.66
6 - Metal products	-0.67	-1.81	-3.34	min -0.18 ; max -1.36
7 - Cement, Manuf. Build. mat.	-0.14	-0.11	-0.35	min -1.03 ; max -2.04
8 - Crude building materials	-0.48	-0.81	-1.34	min -1.03 ; max -2.04
9 - Basic chemicals	-0.50	-1.11	-1.30	min -0.98 ; max -2.31
10 - Fertil., plastic and oth. Chem.	-0.15	-0.36	-0.98	min -0.29 ; max -1.05
11 - Large Machinery	-0.11	-0.17	-0.71	min -0.78 ; max -1.23
12 - Small Machinery	-0.11	-0.11	-0.75	min -0.78 ; max -1.23
13 – Miscell. Manufact. articles	-0.13	-0.14	-0.45	min -0.52 ; max -2.96

Tae Hoon Oum, W.G. Waters II, Jong-Say Yong - Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates - Journal of Transport Economics and Policy, May 1992

Table 4.8: Elasticity of rail freight with respect to cost

	Modelled elasticity			
Flow	**50-150km**	**150-500km**	**>500km**	**Published road elasticity***
1 - Cereals and agricult. Products	-1.29	-1.68	-2.18	min -0.05 ; max -1.97
2 – Consumer food	-0.07	-0.82	-1.35	min -0.02 ; max -2.58
3 – Conditioned food	-0.03	-0.74	-1.07	min -0.02 ; max -2.58
4 - Solid fuels and ores	-0.23	-0.41	-1.30	n.a.
5 – Petroleum products	-0.64	-1.03	-2.24	min -0.53 ; max -0.99
6 - Metal products	-0.87	-1.66	-3.55	min -1.57 ; max -2.16
7 - Cement, Manuf. Build. mat.	-0.50	-0.61	-0.54	min -0.69 ; max -1.68
8 - Crude building materials	-1.97	-2.45	-3.78	min -0.69 ; max -1.68
9 - Basic chemicals	-1.13	-1.72	-2.92	min -0.66 ; max -2.25
10 - Fertil., plastic and oth. Chem.	-1.18	-1.62	-3.10	min -0.66 ; max -2.25
11 - Large Machinery	-1.97	-2.61	-2.56	min -0.16 ; max -3.5
12 - Small Machinery	-0.11	-0.72	-1.06	min -0.16 ; max -3.5
13 – Miscell. Manufact. Articles	-0.16	-0.74	-0.69	min -0.56 ; max -2.68

* Tae Hoon Oum, W.G. Waters II, Jong-Say Yong - Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates - Journal of Transport Economics and Policy, May 1992

Table 4.9: Elasticity of road and rail freight with respect to time

	Road			Rail		
Flow	**50-150km**	**150-500km**	**>500km**	**50-150km**	**150-500km**	**>500km**
1 - Cereals and agricult. Products	-0.01	-0.09	-0.40	-0.19	-0.53	-1.00
2 – Consumer food	0.00	-0.02	-0.23	-0.01	-0.30	-0.94
3 – Conditioned food	-0.01	-0.02	-0.16	0.00	-0.50	-1.06
4 - Solid fuels and ores	-0.06	-0.07	-0.48	-0.02	-0.06	-0.28
5 – Petroleum products	-0.02	-0.11	-0.40	-0.09	-0.19	-0.62
6 - Metal products	-0.04	-0.24	-0.76	-0.02	-0.18	-0.57
7 - Cement, Manuf. Build. mat.	0.00	-0.04	-0.19	-0.06	-0.16	-0.26
8 - Crude building materials	-0.03	-0.15	-0.51	-0.06	-0.16	-0.47
9 - Basic chemicals	-0.06	-0.26	-0.46	-0.09	-0.22	-0.55
10 - Fertil., plastic and oth. Chem.	-0.01	-0.11	-0.44	-0.09	-0.28	-0.99
11 - Large Machinery	0.01	-0.06	-0.55	0.55	-1.26	-2.15
12 – Small Machinery	0.00	-0.06	-0.61	-0.03	-0.53	-1.06
13 – Miscell. Manufact. articles	0.00	-0.08	-0.38	-0.05	-0.51	-0.76

4.2.3 Calibration of modal shares by country

After the general calibration was ended, the modal shares by flow measured on the overall traffic were broadly corrected, the shares on different distances were reasonable and the elasticities of the model were within a correct range. The final stage of the calibration was dedicated to the assessment of modal shares by country and flow, for domestic traffic as well as for international traffic and for tonnes as well as for tonnes-km.

The first operation was about domestic traffic. This is the most important component of the traffic simulated by the model and it was important that the model could match the observed figures in a satisfying way. Although the modal shares by flow were broadly corrected, significant differences were present when single countries were considered. This was not surprising as the observed shares were generally different from country to country.

The calibration was carried out using the new modelling feature which allows one to set up specific parameters by groups of zones. The fourteen EU countries (Luxembourg was associated to Belgium as usual) were defined as different zone sets and for each one a specific set of parameters were calibrated.

This calibration involved mainly modal constants, while most of other parameters proved to be general enough to be adapted to each country. In some countries specific cost functions for rail were calibrated (see above). For some other countries, the distance parameter included in the disutility function to make sea shipping competitive was changed. Interventions on cost functions and distance parameters were used mainly with the scope of reproducing correctly the modal shares in terms of tonnes-km. For the same reason also the modal constants of intra-zonal modes were calibrated by country. During this phase of the work, some further change on the general parameters (i.e., not country-specific) was included in the model.

The result of this part of the work was a satisfying matching of modelled and observed data in terms of modal shares by country and flow.

The following step was dedicated to international modal shares. A detailed analysis of modal shares on country by country pairs was carried out and modelled results compared to observed ones drawn from EUROSTAT TREX database. Where a significant difference were detected both in absolute terms and in relative terms (i.e., a relevant volume of traffic with a very different modal split) specific interventions were implemented in terms of additional disutilities by mode. This process involved both intra-EU traffic and traffic to and from other countries.

4.3 1995 Model validation

This Section introduces the comparison between the observed traffic and the results of the SCENES freight model in terms of modal shares. All results concern EU15 countries only.

Different observed and modelled data have been compared for validation purposes. The large majority of figures compare well both in terms of total traffic and in terms of traffic by country or by flow. Where discrepancies are larger, reasonable explanations can be found in all cases.

4.3.1 Total traffic (tonnes)

Total traffic in the model is currently traffic to, from and within EU15 countries, including domestic traffic. Tables 4.4 and 4.5 below show the comparison between observed and modelled total traffic by country and by flow respectively. The total traffic referred to here for each country comprises domestic tonnes, all exports, plus non-EU imports.

The model reproduces modal shares of total traffic in a satisfactory way. Road traffic is slightly overestimated (85% instead of 83%) but the difference is small. Sea shipping is the underestimated mode (6% instead of 8%) but the underestimation can be explained partly by domestic traffic (see below) and partly by overseas traffic which is relevant for this mode, but in the model is represented in a less sophisticated way.

Both the comparison by country and the comparison by flow are good. For 13 countries out of 14[2], the maximum difference between modelled and observed modal shares is 5% when road is involved and 3% when modes with a lower share are involved. The comparison for Greece is slightly less good, because modelled sea shipping share is 12% while the observed one is 19%. This is almost entirely explained by domestic traffic (see below) and due to the particular context of Greece.

In terms of Flows, the comparison is very good as well, with 11 flows out of 13 showing very small discrepancies. For Flows 4 and 5 (‘Solid fuels and ores’ and ‘Petroleum Products’) the differences are larger though the hierarchy by modes and the size of the shares are correctly represented.

[2] Luxembourg is associated to Belgium in the statistics, and thus the comparisons here.

Table 4.10: Total national & international freight traffic by Country (Tonnes*1000/year)

		Observed data		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**
AUT	Road	242 061	87%	238 946	86%
	Rail	33 206	12%	29 029	10%
	IWW	3 115	1%	6 520	2%
	Sea	397	0%	1 554	1%
	Other	262	0%	1 982	1%
	Total	279 041	100%	278 031	100%
B-LUX	Road	415 982	73%	413 221	73%
	Rail	38 894	7%	51 589	9%
	IWW	50 361	9%	52 307	9%
	Sea	58 413	10%	44 843	8%
	Other	5 201	1%	6 189	1%
	Total	568 851	100%	568 149	100%
DEN	Road	175 611	78%	180 168	80%
	Rail	3 418	2%	3 020	1%
	IWW	-	0%	227	0%
	Sea	47 216	21%	42 762	19%
	Other	93	0%	0	0%
	Total	226 338	100%	226 176	100%
FIN	Road	340 038	84%	345 909	85%
	Rail	32 142	8%	21 400	5%
	IWW	197	0%	-	0%
	Sea	34 077	8%	40 236	10%
	Other	51	0%	0	0%
	Total	406 505	100%	407 545	100%
FRA	Road	1 383 026	85%	1 399 350	86%
	Rail	97 068	6%	92 862	6%
	IWW	27 569	2%	35 469	2%
	Sea	100 684	6%	84 305	5%
	Other	16 392	1%	13 395	1%
	Total	1 624 739	100%	1 625 379	100%
GER	Road	3 178 100	85%	3 245 355	87%
	Rail	282 726	8%	267 420	7%
	IWW	134 502	4%	118 823	3%
	Sea	112 760	3%	92 062	2%
	Other	40 792	1%	22 705	1%
	Total	3 748 880	100%	3 746 358	100%
GRE	Road	169 097	80%	174 993	87%
	Rail	1 631	1%	3 196	2%
	IWW	0	0%	11	0%
	Sea	39 363	19%	23 873	12%
	Other	157	0%	0	0%
	Total	210 249	100%	202 073	100%
IRE	Road	66 178	81%	66 720	82%
	Rail	3 049	4%	2 323	3%
	IWW	-	0%	-	0%
	Sea	12 674	15%	12 175	15%
	Other	66	0%	0	0%
	Total	81 968	100%	81 218	100%

		Observed data		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**
ITA	Road	1 241 481	85%	1 261 867	87%
	Rail	52 134	4%	51 443	4%
	IWW	81	0%	6 677	0%
	Sea	164 191	11%	119 437	8%
	Other	886	0%	14 577	1%
	Total	1 458 773	100%	1 454 001	100%
NED	Road	446 902	70%	459 821	73%
	Rail	8 135	1%	11 587	2%
	IWW	112 596	18%	104 569	17%
	Sea	63 635	10%	50 502	8%
	Other	7 415	1%	2 454	0%
	Total	638 684	100%	628 933	100%
POR	Road	265 088	88%	274 640	91%
	Rail	7 837	3%	7 587	3%
	IWW	0	0%	-	0%
	Sea	28 590	9%	18 509	6%
	Other	94	0%	-	0%
	Total	301 609	100%	300 736	100%
SPA	Road	591 015	82%	605 476	86%
	Rail	23 327	3%	25 954	4%
	IWW	0	0%	0	0%
	Sea	105 129	15%	66 383	9%
	Other	952	0%	9 629	1%
	Total	720 423	100%	707 442	100%
SWE	Road	327 080	85%	371 590	84%
	Rail	6 035	2%	18 094	4%
	IWW	0	0%	-	0%
	Sea	53 007	14%	53 944	12%
	Other	156	0%	0	0%
	Total	386 278	100%	443 629	100%
UK	Road	1 589 148	85%	1 625 505	88%
	Rail	119 622	6%	118 257	6%
	IWW	-	0%	-	0%
	Sea	153 373	8%	113 019	6%
	Other	1 170	0%	1	0%
	Total	1 863 312	100%	1 856 781	100%
TOT	*Road*	*10 430 807*	*83%*	*10 663 561*	*85%*
	Rail	*709 224*	*6%*	*703 760*	*6%*
	IWW	*328 423*	*3%*	*324 603*	*3%*
	Sea	*973 511*	*8%*	*763 603*	*6%*
	Other	*73 686*	*1%*	*70 933*	*1%*
	Total	*12 515 651*	*100%*	*12 526 449*	*100%*

Table 4.11: Total national & international freight traffic by Flow (Tonnes*1000/year)

		Observed data		Modelled data				Observed data		Modelled data	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
1	Road	1 030 759	85%	1 041 287	86%	8	Road	3 883 488	94%	3 925 858	95%
	Rail	50 590	4%	42 142	3%		Rail	77 711	2%	67 248	2%
	IWW	26 878	2%	28 079	2%		IWW	123 556	3%	105 591	3%
	Sea	99 183	8%	97 586	8%		Sea	63 809	2%	50 470	1%
	Other	251	0%	-	0%		Other	46	0%	-	0%
	Total	1 207 661	100%	1 209 093	100%		Total	4 148 609	100%	4 149 162	100%
2	Road	581 953	92%	591 644	95%	9	Road	220 370	75%	218 060	77%
	Rail	9 387	1%	9 029	1%		Rail	17 262	6%	16 204	6%
	IWW	7 061	1%	7 946	1%		IWW	10 844	4%	12 277	4%
	Sea	31 108	5%	15 918	3%		Sea	45 797	16%	38 465	13%
	Other	115	0%	-	0%		Other	122	0%	-	0%
	Total	629 625	100%	624 536	100%		Total	294 396	100%	285 005	100%
3	Road	519 341	96%	523 771	97%	10	Road	406 180	81%	401 489	80%
	Rail	5 356	1%	4 459	1%		Rail	36 017	7%	37 166	7%
	IWW	3 631	1%	5 535	1%		IWW	18 355	4%	21 065	4%
	Sea	14 987	3%	8 508	2%		Sea	38 566	8%	41 545	8%
	Other	363	0%	-	0%		Other	395	0%	-	0%
	Total	543 677	100%	542 272	100%		Total	499 512	100%	501 264	100%
4	Road	302 410	38%	364 465	44%	11	Road	195 114	88%	192 318	87%
	Rail	244 907	31%	245 593	30%		Rail	13 167	6%	12 281	6%
	IWW	56 720	7%	53 250	6%		IWW	639	0%	2 798	1%
	Sea	198 528	25%	162 555	20%		Sea	11 402	5%	13 937	6%
	Other	46	0%	-	0%		Other	1 168	1%	-	0%
	Total	802 610	100%	825 861	100%		Total	221 490	100%	221 334	100%
5	Road	377 143	43%	449 452	52%	12	Road	48 840	85%	50 388	88%
	Rail	50 247	6%	52 197	6%		Rail	3 544	6%	4 337	8%
	IWW	56 320	6%	51 666	6%		IWW	143	0%	201	0%
	Sea	315 985	36%	236 332	27%		Sea	4 089	7%	1 976	3%
	Other	68 995	8%	70 871	8%		Other	540	1%	62	0%
	Total	868 689	100%	860 519	100%		Total	57 156	100%	56 964	100%
6	Road	314 443	66%	316 254	66%	13	Road	1 471 971	91%	1 492 663	91%
	Rail	108 286	23%	108 111	22%		Rail	68 865	4%	83 261	5%
	IWW	11 387	2%	15 914	3%		IWW	7 089	0%	11 803	1%
	Sea	42 863	9%	40 535	8%		Sea	69 419	4%	44 717	3%
	Other	110	0%	-	0%		Other	1 487	0%	-	0%
	Total	477 089	100%	480 813	100%		Total	1 618 830	100%	1 632 443	100%
7	Road	1 078 796	94%	1 095 913	96%	TOT	Road	*10 430 807*	*83%*	*10 663 561*	*85%*
	Rail	23 885	2%	21 731	2%		Rail	*709 224*	*6%*	*703 760*	*6%*
	IWW	5 802	1%	8 479	1%		IWW	*328 423*	*3%*	*324 603*	*3%*
	Sea	37 773	3%	11 060	1%		Sea	*973 511*	*8%*	*763 603*	*6%*
	Other	49	0%	-	0%		Other	*73 686*	*1%*	*70 933*	*1%*
	Total	1 146 305	100%	1 137 182	100%		Total	*12 515 651*	*100%*	*12 526 449*	*100%*

Key:
1: Cereals and agricultural products
2: Consumer food
3: Conditioned food
4: Solid fuels and ores
5: Petroleum products
6: Metal products
7: Cement and manufact. Build. mat.
8: Crude building materials
9: Basic chemicals
10: Fertilisers, plastic and other chem.
11: Large Machinery
12: Small Machinery
13: Miscell. manufact. articl.

Overseas, or External traffic is the major reason for the larger differences for the Transport Flows, while domestic and Intra-Europe traffic compare better (see below).

It should be considered that overseas traffic is modelled by means of direct links from four external zones to main ports in Europe available for deep-sea vessels. Since this is the only mode available for overseas traffic a mode choice could not be performed by the model. For this reason, in the model deep-sea ships are considered just as feeder for land modes or for coastal shipping in Europe. In other terms, only the European part of the shipment is represented in detailed way and the modal split of overseas traffic is that of this part. This is justified because traffic in Europe is the real object of the model, however the simple way of modelling flows to and from overseas and the relatively limited number of ports modelled makes difficult to reproduce precisely the modal shares. This is true for all flows, but as Solid Fuels and Ores and Petroleum Products are largely the most important flows from overseas, the effect on modal shares is particularly visible for them.

4.3.2 Domestic traffic (tonnes)

Domestic traffic is the largest part of the matrix (about 85% of flows modelled are domestic flows). The comparisons show that the model simulates very well the modal shares of domestic traffic. Sea shipping is the only mode with a modelled traffic not very close to the observed one. This can be explained by two main reasons.

First, the structure of the sea network in the model is simplified in comparison to rail or road network. Although the SCENES model has significantly increased the number of ports represented with respect to the STREAMS model, in many countries a number of minor port exist which are used for local traffic also on shorter distances. This is particularly true for Greece, but also for Italy, Spain, UK among others. The model is not detailed enough to reproduce such local sea traffic. On the other hand, domestic statistics of sea shipping are drawn from local sources and not from EUROSTAT databases. So, the method of collection could not be always consistent to the structure of the model. Namely, some of domestic traffic reported under sea shipping could be unaccompanied Ro-Ro could, especially for higher value goods. Unaccompanied Ro-Ro is road traffic in the model and not sea shipping and this also may cause problems when observed and modelled data are compared. Anyway, it should be noticed that domestic sea traffic is a very small amount of total freight flows (2% as a overall share).

In terms of countries, those where sea shipping has a significant role show sometimes some larger differences between modelled and observed modal shares (e.g. Denmark, Greece, Spain) whereas for the others the model performs very well.

In terms of flows, comparisons are all satisfying. Bulk goods, like Petroleum products (flow 5) or crude building materials show the larger discrepancies regarding sea shipping share (and this could accounted to traffic of minor ports) together with Miscellaneous manufactured articles and Cement and manufactured building materials (flow 13 and 7); for such two flows the difference could be due to unaccompanied traffic on ferries.

Table 4.12: Domestic freight traffic by country (Tonnes*1000/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
AUT	Road	219 522	93%	215 624	92%	*ITA*	Road	1 142 492	93%	1 142 005	93%
	Rail	15 892	7%	14 877	6%		Rail	26 673	2%	35 828	3%
	IWW	521	0%	3 349	1%		IWW	-	0%	6 307	1%
	Sea	-	0%	-	0%		Sea	60 855	5%	32 609	3%
	Other	-	0%	1 687	1%		Other	-	0%	12 237	1%
	Total	235 935	100%	235 537	100%		Total	1 230 021	100%	1 228 988	100%
B-LUX	Road	336 609	89%	327 801	87%	*NED*	Road	354 270	82%	363 371	85%
	Rail	25 691	7%	30 199	8%		Rail	4 012	1%	4 344	1%
	IWW	15 260	4%	16 402	4%		IWW	71 280	17%	58 440	14%
	Sea	-	0%	138	0%		Sea	-	0%	383	0%
	Other	-	0%	2 346	1%		Other	-	0%	203	0%
	Total	377 560	100%	376 886	100%		Total	429 562	100%	426 741	100%
DEN	Road	158 231	89%	171 989	97%	*POR*	Road	250 615	94%	258 256	97%
	Rail	1 062	1%	1 099	1%		Rail	7 054	3%	7 079	3%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Sea	17 619	10%	3 582	2%		Sea	10 000	4%	2 189	1%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	176 912	100%	176 670	100%		Total	267 669	100%	267 523	100%
FIN	Road	332 332	92%	340 082	94%	*SPA*	Road	528 486	91%	538 901	93%
	Rail	21 236	6%	18 122	5%		Rail	19 688	3%	23 538	4%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Sea	7 952	2%	2 687	1%		Sea	32 302	6%	7 595	1%
	Other	-	0%	-	0%		Other	-	0%	9 629	2%
	Total	361 521	100%	360 892	100%		Total	580 476	100%	579 663	100%
FRA	Road	1 257 778	92%	1 256 399	92%	*SWE*	Road	313 357	96%	355 797	93%
	Rail	78 665	6%	69 345	5%		Rail	n.a.	0%	14 994	4%
	IWW	17 107	1%	23 654	2%		IWW	-	0%	-	0%
	Sea	12 730	1%	4 147	0%		Sea	12 746	4%	10 497	3%
	Other	-	0%	11 405	1%		Other	-	0%	-	0%
	Total	1 366 280	100%	1 364 950	100%		Total	326 103	100%	381 288	100%
GER	Road	3 008 853	90%	3 030 704	91%	*UK*	Road	1 544 171	91%	1 565 313	92%
	Rail	226 940	7%	213 713	6%		Rail	109 923	6%	94 146	6%
	IWW	71 414	2%	73 560	2%		IWW	-	0%	-	0%
	Sea	18 585	1%	1 604	0%		Sea	41 285	2%	32 792	2%
	Other	-	0%	2 541	0%		Other	-	0%	0	0%
	Total	3 325 792	100%	3 322 116	100%		Total	1 695 379	100%	1 692 249	100%
GRE	Road	158 230	89%	167 454	95%	*TOT*	*Road*	*9 666 749*	*91%*	*9 797 006*	*92%*
	Rail	556	0%	2 523	1%		*Rail*	*540 258*	*5%*	*532 047*	*5%*
	IWW	-	0%	-	0%		*IWW*	*175 582*	*2%*	*181 712*	*2%*
	Sea	18 902	11%	6 771	4%		*Sea*	*233 976*	*2%*	*105 046*	*1%*
	Other	-	0%	-	0%		*Other*	*-*	*0%*	*40 050*	*0%*
	Total	177 688	100%	176 748	100%		*Total*	*10 616 564*	*100%*	*10 655 851*	*100%*
IRE	Road	61 802	94%	63 308	97%						
	Rail	2 865	4%	2 241	3%						
	IWW	-	0%	-	0%						
	Sea	1 000	2%	52	0%						
	Other	-	0%	-	0%						
	Total	65 667	100%	65 601	100%						

Table 4.13: Domestic freight traffic by flow (Tonnes*1000/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
1	Road	929 060	95%	930 706	95%	8	Road	3 828 114	96%	3 865 326	97%
	Rail	30 673	3%	29 732	3%		Rail	67 854	2%	56 711	1%
	IWW	9 599	1%	11 755	1%		IWW	77 000	2%	62 938	2%
	Sea	11 938	1%	11 642	1%		Sea	11 250	0%	1 783	0%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	981 270	100%	983 836	100%		Total	3 984 217	100%	3 986 753	100%
2	Road	522 134	98%	523 733	98%	9	Road	183 650	88%	183 407	87%
	Rail	5 995	1%	4 276	1%		Rail	10 713	5%	11 429	5%
	IWW	3 975	1%	5 295	1%		IWW	3 722	2%	5 764	3%
	Sea	2 539	0%	1 396	0%		Sea	11 101	5%	9 371	4%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	534 643	100%	534 700	100%		Total	209 185	100%	209 970	100%
3	Road	473 667	98%	475 754	99%	10	Road	312 811	89%	317 332	90%
	Rail	4 379	1%	2 490	1%		Rail	26 551	8%	26 871	8%
	IWW	3 258	1%	3 711	1%		IWW	8 764	2%	8 891	3%
	Sea	635	0%	49	0%		Sea	3 700	1%	1 039	0%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	481 938	100%	482 004	100%		Total	351 826	100%	354 132	100%
4	Road	196 351	44%	222 320	48%	11	Road	157 843	94%	157 540	95%
	Rail	194 097	43%	198 484	43%		Rail	7 804	5%	6 048	4%
	IWW	27 405	6%	28 522	6%		IWW	384	0%	1 510	1%
	Sea	28 595	6%	14 611	3%		Sea	2 610	2%	700	0%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	446 447	100%	463 935	100%		Total	168 641	100%	165 797	100%
5	Road	366 736	67%	376 178	68%	12	Road	39 548	93%	40 839	96%
	Rail	41 197	8%	44 794	8%		Rail	1 953	5%	1 498	4%
	IWW	29 578	5%	32 768	6%		IWW	96	0%	108	0%
	Sea	111 065	20%	58 427	11%		Sea	783	2%	1	0%
	Other	-	0%	40 050	7%		Other	-	0%	0	0%
	Total	548 576	100%	552 215	100%		Total	42 380	100%	42 447	100%
6	Road	251 578	73%	261 568	74%	13	Road	1 366 318	94%	1 383 648	95%
	Rail	79 597	23%	78 173	22%		Rail	52 697	4%	58 498	4%
	IWW	3 358	1%	6 491	2%		IWW	4 836	0%	7 276	1%
	Sea	8 495	2%	4 995	1%		Sea	22 707	2%	1 030	0%
	Other	-	0%	-	0%		Other	-	0%	-	0%
	Total	343 027	100%	351 227	100%		Total	1 446 558	100%	1 450 451	100%
7	Road	1 038 942	96%	1 058 654	98%	TOT	Road	*9 666 749*	*91%*	*9 797 006*	*92%*
	Rail	16 748	2%	13 043	1%		Rail	*540 258*	*5%*	*532 047*	*5%*
	IWW	3 606	0%	6 684	1%		IWW	*175 582*	*2%*	*181 712*	*2%*
	Sea	18 559	2%	3	0%		Sea	*233 976*	*2%*	*105 046*	*1%*
	Other	-	0%	-	0%		Other	-	*0%*	*40 050*	*0%*
	Total	1 077 855	100%	1 078 383	100%		Total	*10 616 564*	*100%*	*10 655 851*	*100%*

Key: 1: Cereals and agricultural products 6: Metal products 11: Large Machinery
2: Consumer food 7: Cement and manufact. Build. mat. 12: Small Machinery
3: Conditioned food 8: Crude building materials 13: Miscell. manufact. articl. 4:
Solid fuels and ores 9: Basic chemicals
5: Petroleum products 10: Fertilisers, plastic and other chem.

4.3.3 Intra-EU15 traffic (tonnes)

The modal shares of traffic within the EU15 countries are simulated correctly by the model. If all countries and flows are considered together, modelled tonnes by mode are very close to the observed data.

At the country level, the comparisons are also satisfying. The modelled modal shares are generally very close to the observed ones and where differences are larger the relative importance of the modes is well reproduced. Greece and UK show some less good results because of their special condition, i.e., the role of sea shipping and ferries. Again, there could be some inconsistencies regarding the classification of modes in observed data and in the model.

At the flow level the differences between the observed figures and the model results are generally low. Flow 5 (petroleum products) presents the worst fit, but in this case is important the role of the ‘other modes’ (pipelines). The pipeline network modelled in the SCENES model is only that strictly dedicated to petroleum products. This is mainly internal to some countries (Italy, Spain, France) and only some links connect different countries. Furthermore, part of the pipeline traffic is distribution of oil product flows to or from ports and therefore the model classifies it under shipping and not pipelines.

The ‘by country’ tables which follow are in terms of country of off-loading.

Table 4.14: IntraEU15 freight traffic by country (Tonnes*1000/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
AUT	Road	14 897	74%	14 193	71%	*ITA*	Road	38 086	51%	41 864	57%
	Rail	4 589	23%	3 575	18%		Rail	17 331	23%	9 532	13%
	IWW	540	3%	1 323	7%		IWW	80	0%	310	0%
	Sea	1	0%	914	5%		Sea	18 855	25%	22 079	30%
	Other	198	1%	1	0%		Other	59	0%	1	0%
	Total	20 224	100%	20 005	100%		Total	74 412	100%	73 786	100%
B-LUX	Road	44 381	44%	46 172	45%	*NED*	Road	52 090	48%	46 343	44%
	Rail	7 691	8%	10 670	10%		Rail	3 282	3%	4 570	4%
	IWW	26 869	27%	27 805	27%		IWW	34 839	32%	36 407	35%
	Sea	19 388	19%	15 053	15%		Sea	17 655	16%	17 210	16%
	Other	2 954	3%	2 367	2%		Other	1 315	1%	65	0%
	Total	101 283	100%	102 067	100%		Total	109 181	100%	104 595	100%
DEN	Road	7 286	40%	6 365	35%	*POR*	Road	6 749	45%	6 894	45%
	Rail	1 984	11%	1 292	7%		Rail	721	5%	345	2%
	IWW	-	0%	195	1%		IWW	-	0%	-	0%
	Sea	9 071	49%	10 192	56%		Sea	7 466	50%	7 955	52%
	Other	23	0%	-	0%		Other	20	0%	-	0%
	Total	18 364	100%	18 043	100%		Total	14 956	100%	15 194	100%
FIN	Road	292	2%	685	6%	*SPA*	Road	23 484	57%	20 905	51%
	Rail	87	1%	158	1%		Rail	2 281	6%	2 153	5%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Sea	11 337	97%	10 490	93%		Sea	15 517	38%	17 859	44%
	Other	14	0%	0	0%		Other	34	0%	0	0%
	Total	11 729	100%	11 333	100%		Total	41 315	100%	40 917	100%
FRA	Road	56 556	57%	56 904	54%	*SWE*	Road	1 844	8%	3 564	14%
	Rail	12 723	13%	15 203	14%		Rail	521	2%	1 219	5%
	IWW	6 107	6%	8 063	8%		IWW	-	0%	-	0%
	Sea	24 233	24%	25 435	24%		Sea	21 534	90%	20 884	81%
	Other	158	0%	169	0%		Other	28	0%	0	0%
	Total	99 777	100%	105 774	100%		Total	23 927	100%	25 667	100%
GER	Road	79 705	50%	87 650	54%	*UK*	Road	10 900	17%	16 488	26%
	Rail	18 499	12%	18 562	12%		Rail	185	0%	17	0%
	IWW	30 739	19%	21 829	14%		IWW	-	0%	-	0%
	Sea	24 311	15%	30 263	19%		Sea	54 487	83%	46 347	74%
	Other	5 764	4%	2 537	2%		Other	60	0%	1	0%
	Total	159 018	100%	160 840	100%		Total	65 632	100%	62 853	100%
GRE	Road	2 768	25%	1 712	14%	*TOT*	*Road*	*342 351*	*45%*	*352 532*	*46%*
	Rail	701	6%	187	2%		*Rail*	*70 779*	*9%*	*67 485*	*9%*
	IWW	-	0%	11	0%		*IWW*	*99 174*	*13%*	*95 942*	*13%*
	Sea	7 465	67%	10 229	84%		*Sea*	*241 530*	*32%*	*245 891*	*32%*
	Other	126	1%	-	0%		*Other*	*10 800*	*1%*	*5 141*	*1%*
	Total	11 060	100%	12 140	100%		*Total*	*764 633*	*100%*	*766 991*	*100%*
IRE	Road	3 313	24%	2 795	20%						
	Rail	183	1%	1	0%						
	IWW	-	0%	-	0%						
	Sea	10 212	74%	10 982	80%						
	Other	46	0%	0	0%						
	Total	13 755	100%	13 777	100%						

Table 4.15: IntraEU15 freight traffic by flow (Tonnes*1000/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
1	Road	42 507	49%	46 703	53%	8	Road	31 444	31%	32 141	31%
	Rail	7 173	8%	4 948	6%		Rail	4 478	4%	4 886	5%
	IWW	10 785	12%	9 953	11%		IWW	40 400	39%	39 002	38%
	Sea	26 878	31%	26 705	30%		Sea	26 559	26%	27 319	26%
	Other	25	0%	-	0%		Other	12	0%	-	0%
	Total	87 369	100%	88 308	100%		Total	102 893	100%	103 347	100%
2	Road	30 348	72%	30 747	75%	9	Road	22 714	47%	17 783	47%
	Rail	894	2%	1 040	3%		Rail	3 225	7%	2 737	7%
	IWW	1 933	5%	1 424	3%		IWW	5 082	11%	4 437	12%
	Sea	9 221	22%	7 854	19%		Sea	17 194	36%	13 184	35%
	Other	30	0%	-	0%		Other	36	0%	-	0%
	Total	42 427	100%	41 065	100%		Total	48 251	100%	38 141	100%
3	Road	28 337	80%	28 710	81%	10	Road	40 422	55%	39 914	54%
	Rail	636	2%	336	1%		Rail	6 062	8%	6 274	9%
	IWW	262	1%	856	2%		IWW	5 511	8%	5 779	8%
	Sea	5 973	17%	5 501	16%		Sea	21 200	29%	21 393	29%
	Other	11	0%	-	0%		Other	49	0%	-	0%
	Total	35 220	100%	35 403	100%		Total	73 244	100%	73 359	100%
4	Road	7 050	18%	8 948	20%	11	Road	14 762	57%	16 104	56%
	Rail	8 074	20%	6 555	14%		Rail	3 787	15%	4 145	14%
	IWW	9 317	23%	10 221	22%		IWW	1	0%	5	0%
	Sea	15 702	39%	19 790	43%		Sea	7 018	27%	8 483	30%
	Other	1	0%	-	0%		Other	225	1%	-	0%
	Total	40 144	100%	45 514	100%		Total	25 793	100%	28 738	100%
5	Road	6 561	7%	13 012	13%	12	Road	5 162	64%	4 819	62%
	Rail	3 550	4%	3 560	4%		Rail	1 362	17%	1 318	17%
	IWW	20 380	21%	18 039	18%		IWW	0	0%	9	0%
	Sea	57 314	58%	58 039	59%		Sea	1 509	19%	1 592	20%
	Other	10 200	10%	5 080	5%		Other	35	0%	62	1%
	Total	98 005	100%	97 729	100%		Total	8 068	100%	7 800	100%
6	Road	32 757	46%	32 267	45%	13	Road	60 634	59%	62 804	58%
	Rail	17 799	25%	17 533	24%		Rail	12 497	12%	12 444	12%
	IWW	2 393	3%	3 284	5%		IWW	1 763	2%	1 984	2%
	Sea	18 893	26%	18 741	26%		Sea	28 513	28%	30 952	29%
	Other	16	0%	-	0%		Other	141	0%	-	0%
	Total	71 857	100%	71 825	100%		Total	103 547	100%	108 185	100%
7	Road	19 653	71%	18 581	67%	*TOT*	*Road*	*342 351*	*45%*	*352 532*	*46%*
	Rail	1 242	4%	1 709	6%		*Rail*	*70 779*	*9%*	*67 485*	*9%*
	IWW	1 347	5%	950	3%		*IWW*	*99 174*	*13%*	*95 942*	*13%*
	Sea	5 554	20%	6 338	23%		*Sea*	*241 530*	*32%*	*245 891*	*32%*
	Other	19	0%	-	0%		*Other*	*10 800*	*1%*	*5 141*	*1%*
	Total	27 815	100%	27 577	100%		*Total*	*764 633*	*100%*	*766 991*	*100%*

Key: 1: Cereals and agricultural products 6: Metal products 11: Large Machinery
2: Consumer food 7: Cement and manufact. Build. mat. 12: Small Machinery
3: Conditioned food 8: Crude building materials 13: Miscell. manufact. articl. 4: Solid fuels and ores 9: Basic chemicals
5: Petroleum products 10: Fertilisers, plastic and other chem.

4.3.4 Domestic tonnes per km

The modal shares of domestic tonnes*km are not as well reproduced as tonnes, but the comparisons are generally satisfying, with limited differences between modelled and observed data.

On the overall domestic traffic, modelled modal shares are very close to observed ones. Rail and inland waterway shares are slightly overestimated whereas sea shipping is a bit underestimated. This is consistent with the difficulty of reproducing the entire amount of domestic sea traffic (see above). Part of traffic that the model is not able to assign to sea shipping is assigned to rail and inland waterway instead. As rail and Inland Waterway are more competitive on longer distances, the amount of tonnes*km by such modes results overestimated. However, differences are little.

Looking at country by country data, most of the results compare well to the published figures although some discrepancies are present. The problem of reproducing sea tonnes*km as explained above is particularly apparent in Greece, UK and Spain. In such three countries, road and rail capture part of the tonnes*km which should performed by sea shipping. Spain presents the worst results because modelled rail tonnes*km are higher than sea shipping tonnes*km, while in the observed data the reverse applies and there is a clear different of size. In UK sea shipping is the second mode also in terms of modelled result even though the difference with respect to rail is too low if compared to observed statistics.

On the flow side, flow 4 (Solid fuels and ores) shows a significant underestimation of road tonnes*km and a correspondent overestimation of rail tonnes*km. This could be due to the use of rail on very short distances (even for intra-zonal trips) in some countries for such a flow. The treatment of intra-zonal trips has been enhanced in the SCENES model with respect to STREAMS and the benefit on the control of tonnes*km is apparent, but rail as important intra-zonal mode is an ‘extreme’ case that the model does not deal with perfectly. Also flow 7 (Cement and manufactured building materials) and flow 13 (Miscellaneous manufactured articles) show some significant discrepancies. Such flows are those for which part of traffic registered as shipping is actually Ro-Ro traffic which the model treats as road traffic. For other flows discrepancies are sometimes significant, but they do not alter the correct representation of the hierarchy among modes.

Table 4.16: Domestic freight traffic by country (Million Tonnes*km/year)

		Observed data		Modelled data				Observed data		Modelled data	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
AUT	Road	11 300	79%	10 185	71%	*ITA*	Road	162 400	78%	146 054	72%
	Rail	2 977	21%	3 663	25%		Rail	10 601	5%	16 164	8%
	IWW	83	1%	586	4%		IWW	-	0%	904	0%
	Sea	-	0%	-	0%		Sea	35 300	17%	39 583	20%
	Total	14 360	100%	14 627	100%		Total	208 301	100%	205 232	100%
B-LUX	Road	19 500	84%	18 576	70%	*NED*	Road	27 000	81%	23 234	73%
	Rail	2 320	10%	4 701	18%		Rail	690	2%	881	3%
	IWW	1 456	6%	3 248	12%		IWW	5 707	17%	7 449	23%
	Sea	-	0%	35	0%		Sea	-	0%	178	1%
	Total	23 276	100%	26 782	100%		Total	33 397	100%	31 768	100%
DEN	Road	9 300	77%	8 358	75%	*POR*	Road	11 100	79%	11 160	79%
	Rail	529	4%	474	4%		Rail	1 607	11%	2 053	14%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Sea	2 300	19%	2 381	21%		Sea	1 400	10%	973	7%
	Total	12 129	100%	11 214	100%		Total	14 107	100%	14 186	100%
FIN	Road	21 300	71%	19 045	66%	*SPA*	Road	78 700	64%	84 632	79%
	Rail	5 929	20%	7 463	26%		Rail	7 962	6%	12 014	11%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Sea	2 600	9%	2 516	9%		Sea	37 200	30%	10 534	10%
	Total	29 829	100%	29 024	100%		Total	123 862	100%	111 186	100%
FRA	Road	135 300	78%	123 360	75%	*SWE*	Road	27 800	78%	33 756	59%
	Rail	29 644	17%	28 858	18%		Rail	n.a.	n.a.	7 101	12%
	IWW	2 258	1%	5 241	3%		IWW	-	0%	-	0%
	Sea	6 200	4%	6 436	4%		Sea	7 900	22%	16 496	29%
	Total	173 402	100%	168 412	100%		Total	35 700	100%	57 353	100%
GER	Road	201 300	79%	182 120	74%	*UK*	Road	143 700	68%	151 225	76%
	Rail	35 562	14%	41 066	17%		Rail	14 071	7%	22 428	11%
	IWW	17 148	7%	22 995	9%		IWW	-	0%	-	0%
	Sea	800	0%	1 530	1%		Sea	52 500	25%	25 634	13%
	Total	254 810	100%	247 938	100%		Total	210 271	100%	199 287	100%
GRE	Road	12 400	63%	14 251	73%	*TOT*	*Road*	*865 600*	*75%*	*829 673*	*73%*
	Rail	152	1%	759	4%		*Rail*	*112 565*	*10%*	*148 350*	*13%*
	IWW	-	0%	-	0%		*IWW*	*26 652*	*2%*	*40 423*	*4%*
	Sea	7 100	36%	4 590	23%		*Sea*	*153 600*	*13%*	*110 917*	*10%*
	Total	19 652	100%	19 600	100%		*Total*	*1 158 417*	*100%*	*1 141 081*	*100%*
IRE	Road	4 500	85%	3 715	83%						
	Rail	521	10%	724	16%						
	IWW	-	0%	-	0%						
	Sea	300	6%	31	1%						
	Total	5 321	100%	4 471	100%						

Table 4.17: Domestic freight traffic by flow (Million Tonnes*km/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
1	Road	117 828	86%	117 639	78%	8	Road	114 381	83%	112 926	84%
	Rail	9 601	7%	13 086	9%		Rail	10 758	8%	11 625	9%
	IWW	1 839	1%	3 051	2%		IWW	8 221	6%	9 232	7%
	Sea	7 986	6%	16 722	11%		Sea	4 816	3%	1 363	1%
	Total	137 253	100%	150 498	100%		Total	138 175	100%	135 145	100%
2	Road	79 712	95%	76 243	94%	9	Road	23 676	67%	15 133	52%
	Rail	2 535	3%	2 076	3%		Rail	3 253	9%	3 441	12%
	IWW	510	1%	1 597	2%		IWW	528	1%	1 134	4%
	Sea	1 387	2%	1 360	2%		Sea	7 763	22%	9 369	32%
	Total	84 144	100%	81 275	100%		Total	35 220	100%	29 077	100%
3	Road	75 236	97%	72 314	97%	10	Road	45 460	78%	44 901	79%
	Rail	1 874	2%	1 009	1%		Rail	8 210	14%	8 418	15%
	IWW	411	1%	1 186	2%		IWW	1 779	3%	2 627	5%
	Sea	347	0%	32	0%		Sea	2 588	4%	1 236	2%
	Total	77 867	100%	74 541	100%		Total	58 036	100%	57 182	100%
4	Road	19 302	30%	11 462	16%	11	Road	28 232	84%	27 916	87%
	Rail	22 720	35%	35 243	48%		Rail	3 614	11%	2 938	9%
	IWW	7 040	11%	8 022	11%		IWW	52	0%	198	1%
	Sea	15 482	24%	18 223	25%		Sea	1 732	5%	1 029	3%
	Total	64 544	100%	72 950	100%		Total	33 630	100%	32 081	100%
5	Road	38 919	30%	38 232	34%	12	Road	7 058	83%	7 107	89%
	Rail	10 029	8%	12 542	11%		Rail	904	11%	836	10%
	IWW	4 336	3%	7 764	7%		IWW	13	0%	35	0%
	Sea	77 611	59%	53 799	48%		Sea	520	6%	1	0%
	Total	130 894	100%	124 056	100%		Total	8 494	100%	7 978	100%
6	Road	50 847	71%	44 399	59%	13	Road	196 075	84%	187 412	85%
	Rail	13 840	19%	21 653	29%		Rail	22 201	9%	31 064	14%
	IWW	939	1%	1 748	2%		IWW	453	0%	2 404	1%
	Sea	5 795	8%	7 051	9%		Sea	15 071	6%	730	0%
	Total	71 422	100%	74 852	100%		Total	233 801	100%	221 609	100%
7	Road	68 875	81%	73 988	93%	TOT	Road	*865 600*	*75%*	*829 673*	*73%*
	Rail	3 027	4%	4 421	6%		Rail	*112 565*	*10%*	*148 350*	*13%*
	IWW	532	1%	1 425	2%		IWW	*26 652*	*2%*	*40 423*	*4%*
	Sea	12 502	15%	2	0%		Sea	*153 600*	*13%*	*110 917*	*10%*
	Total	84 937	100%	79 836	100%		Total	*1 158 417*	*100%*	*1 141 081*	*100%*

Key: 1: Cereals and agricultural products 6: Metal products 11: Large Machinery
2: Consumer food 7: Cement and manufact. Build. mat. 12: Small Machinery
3: Conditioned food 8: Crude building materials 13: Miscell. manufact. articl. 4: Solid fuels and ores 9: Basic chemicals
5: Petroleum products 10: Fertilisers, plastic and other chem.

4.3.5 Total tonne - kilometres

Total tonnes-km are those registered on the national territory, as opposed to domestic, which is the tonne-km arising only from domestic movements. Observed data is drawn from EUROSTAT publication *Transport in figures 1999*. It is available only at the country level for road, rail and inland navigation; figures by flow are not reported. Details about the method used for estimation are not reported. The total tonnes-km produced by the model are slightly more than the total tonnes-km published by EUROSTAT. However the overestimation is not so high: about 11%. So the two figures are similar and differences could be attached to different methods used for the estimation. The modal shares are very close to each other.

Table 4.18: Total freight traffic on national territory by country (Million Tonnes-km/year)

		Observed data		**Modelled data**				**Observed data**		**Modelled data**	
		Volumes	**% share**	**Volumes**	**% share**			**Volumes**	**% share**	**Volumes**	**% share**
AUT	Road	14 900	50%	26 891	62%	*ITA*	Road	194 800	90%	189 470	86%
	Rail	13 200	44%	14 417	33%		Rail	21 700	10%	32 067	14%
	IWW	2 000	7%	2 075	5%		IWW	-	0%	13	0%
	Total	30 100	100%	43 383	100%		Total	216 500	100%	221 550	100%
B-LUX	Road	38 500	73%	56 481	74%	*NED*	Road	42 200	52%	48 625	58%
	Rail	8 200	16%	13 000	17%		Rail	3 100	4%	4 070	5%
	IWW	6 100	12%	7 154	9%		IWW	35 500	44%	31 110	37%
	Total	52 800	100%	76 635	100%		Total	80 800	100%	83 805	100%
DEN	Road	14 700	88%	9 383	89%	*POR*	Road	13 000	58%	14 361	80%
	Rail	2 000	12%	1 183	11%		Rail	9 600	42%	3 496	20%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Total	16 700	100%	10 566	100%		Total	22 600	100%	17 858	100%
FIN	Road	23 200	71%	23 012	63%	*SPA*	Road	94 600	90%	115 864	88%
	Rail	9 600	29%	13 725	37%		Rail	10 400	10%	16 150	12%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Total	32 800	100%	36 737	100%		Total	105 000	100%	132 014	100%
FRA	Road	232 800	81%	227 683	78%	*SWE*	Road	29 300	60%	41 524	70%
	Rail	48 100	17%	53 754	18%		Rail	19 400	40%	17 966	30%
	IWW	5 900	2%	10 494	4%		IWW	-	0%	-	0%
	Total	286 800	100%	291 931	100%		Total	48 700	100%	59 491	100%
GER	Road	279 700	68%	295 814	66%	*UK*	Road	146 700	92%	175 355	87%
	Rail	68 800	17%	83 955	19%		Rail	13 300	8%	25 782	13%
	IWW	64 000	16%	66 379	15%		IWW	-	0%	-	0%
	Total	412 500	100%	446 148	100%		Total	160 000	100%	201 137	100%
GRE	Road	14 800	98%	17 138	90%	*TOT*	*Road*	*1 144 600*	*77%*	*1 248 099*	*76%*
	Rail	300	2%	1 976	10%		*Rail*	*228 300*	*15%*	*283 532*	*17%*
	IWW	-	0%	-	0%		*IWW*	*113 500*	*8%*	*117 225*	*7%*
	Total	15 100	100%	19 114	100%		*Total*	*1 486 400*	*100%*	*1 648 856*	*100%*
IRE	Road	5 400	90%	6 498	77%						
	Rail	600	10%	1 989	23%						
	IWW	-	0%	-	0%						
	Total	6 000	100%	8 487	100%						

Also data by country compare well in general, especially for larger countries like Germany, France, and Italy. The model produces larger figures for Austria, Belgium, Greece, Ireland, Spain and UK. For Austria the difference is entirely due to road and could be explained by transit traffic which is subjected to restrictions which cannot be represented in the model. For other countries seaborne traffic could play a role to explain the overestimation of the model either in terms of excess of tonnes passing through ports (e.g., in Belgium) or in terms of higher distances required in the model to reach the limited number of ports represented in the network. In Denmark and Portugal the model underestimates the tonnes*km on the national territory although the magnitude is correct.

This Chapter has described the setting up and the validation of the base year freight model. Chapter 5 now reports the traffic levels on the road networks associated with the combined passenger and freight 1995 calibrated model.

5. Base Year Network Flows

The SCENES model uses a detailed representation of the transport network for all modes in the EU and the CEEC8. These networks are specified to contain all of the most significant links in terms of medium and long distance travel between the NUTS2 zones. The links are given their real attributes by length, type and speed etc. They are therefore ‘real’ and not ‘corridor’ representations. The road networks features speed / flow relationships based on 24-hour flow profiles for different types of road – these were firstly developed in the STREAMS project.

The presence in the model of these detailed transport networks inevitably raises expectations of an accurate portrayal of road traffic in particular at the link level. However, it should be noted that the primary purpose of having detailed networks is to build up an accurate representation of the costs and times associated with travelling within and between zones in the model. This allows modal split calculations to be made on as ‘real world’ a basis as possible.

Given that there are no observed NUTS2 travel matrices to build the model on, the distribution of travel is based on theoretical expectations and knowledge of the general distribution of trips by distance, rather than hard data (i.e., synthetic). With this in mind, it should not be expected that a model of this nature can produce an exact match to traffic flows on the European transport networks. However, significant efforts were made to reduce the problems of gross road network overloading that were seen to occur in places during applications of the predecessor STREAMS model.

With this in mind a large number of new road links were added to the networks in the evolution of the model from STREAMS into SCENES. To illustrate the progress which has been made, the STREAMS 1994 Base Year summary network results are reproduced below, as reported in STREAMS D8/D10, together with an equivalent table for the SCENES 1995 Base Year.

Table 5.1: STREAMS 1994 / SCENES 1995 EU road network km by flow / capacity ratio

Test / Road Type	**Flow / Capacity Ratio**					
%km	**<.25**	**.25 - .50**	**.50 - .75**	**.75 - 1.00**	**1+**	**Length (km)**
STREAMS 1994 Base						
Toll Motorway	42.2	37.4	15.5	3.7	1.2	**29,590**
Motorway	12.7	24.4	32.2	19.9	10.8	**47,342**
Dual Carriageway	56.3	29.6	9.2	2.8	2.0	**30,125**
Other Road	57.1	21.7	10.8	5.0	5.4	**78,951**
Total	**52.0**	**26.7**	**12.3**	**4.9**	**4.1**	**186,009**
SCENES 1995 Base						
Toll Motorway	86.7	11.7	1.5	0.1	0.0	**29,432**
Motorway	50.9	32.9	11.8	3.4	1.0	**50,119**
Dual Carriageway	81.6	13.1	3.4	1.4	0.6	**36,541**
Other Road	61.7	19.5	10.0	4.8	3.9	**154,786**
Total	**65.1**	**20.3**	**8.5**	**3.6**	**2.5**	**270,876**

The straight flow / capacity ratios output by the model (based on 24-hour single direction flows and capacities) were adjusted to a more meaningful indicator as follows. The capacity coded on to the road networks represents a 24-hour capacity. This was necessary since the capacity restraint functions were formulated from 24-hour capacity figures, where the functions were adjusted in line with the hourly profile of traffic throughout the day. Analysis of traffic data indicated that approximately 90% of traffic flow occurs within the period 0600 – 2200 hours. The 24-hour link flow and capacity data were therefore adjusted accordingly and new flow / capacity ratios determined. It is these ‘adjusted’ figures which appear in Table 5.1 above.

The extent of the additional network can be seen in the Table. As the previous STREAMS networks contained virtually all of the EU toll motorway, motorway and dual carriageways, it is the ‘other’ links which have increased significantly. The objective of the exercise was to add this secondary network, across zone boundaries in particular, to provide the alternative routes to the motorway and dual carriageway routes, since clearly this secondary network plays a significant role in reality.

The effect of adding this network has been to significantly reduce the kilometres of toll motorway, motorway and dual carriageway road network in the model where the adjusted flow / capacity ratio was in the higher groups, e.g., greater then 0.5.

In the reporting of network flows that follows in this Deliverable, this method of presentation is abandoned and replaced by a measure of the percentage of network kilometres by road type and country that have different levels of transport flow, in terms of ‘passenger car units’[3] (pcus) per day. These figures now refer to the 2-way combined all-day flow on the links. Table 5.2 below shows the SCENES 1995 model results using this new measure, for the EU as a whole, by road type.

Table 5.2: Percent of EU road network km by road traffic flow (2-way) and road type

	‘000 pcu / day							
% km	**<10**	**10-20**	**20-30**	**30-50**	**50-70**	**70-100**	**100+**	**Network km**
Toll-M-way	21.8	29.4	18.1	19.3	6.7	2.3	2.4	**14,716**
M-way	9.7	10.8	12.6	22.3	15.0	16.6	13.0	**25,201**
Dual carr.	30.6	27.4	17.0	13.9	5.3	2.9	2.9	**18,270**
Other	52.2	22.8	11.1	11.1	2.0	0.6	0.3	**77,393**
TOTAL	**38.1**	**21.9**	**12.9**	**14.5**	**5.4**	**4.1**	**3.2**	**135,580**
TOTAL UN / CEC	**35.6**	**26.4**	**12.1**	**12.6**	**7.4**	**3.9**	**2.0**	**73,812**

Table 5.2 therefore says, e.g., 52.2% of EU ‘other’ road-km experiences traffic flows of less than 10,000 pcu per day (AADT – Annual Average Daily Traffic, i.e., Annual traffic / 365). At the other end of the scale, 13.0% of motorway kilometres have traffic loads of greater than 100,000 pcu / day.

It is possible to make a rough comparison between these results and real data, using the UN / CEC road traffic census. The traffic counts included in this traffic census are incorporated into the SCENES model files, the flows representing traffic at zone boundaries as far as possible. Processing this observed data in the same way as the modelled above, gives the results shown in the bottom row of the above table. As can be seen from this total network kilometres, the coverage of the UN / CEC is slightly over half that of the modelled network. The proportions of modelled and observed road-km in each of the flow categories do however match well. In the aggregate, the model therefore does clearly produce a volume and pattern of traffic which is not markedly out of step with the observed situation.

Table 5.3 overleaf shows the results in the same format, but aggregated across road types, and shown for each individual country. The countries with the most heavily trafficked roads in the model are Germany, Belgium, UK and the Netherlands. This would be in line with most expectations regarding road traffic in the EU. Sweden, Ireland, Greece and Finland have the most lightly trafficked road networks, again in line with expectation.

[3] Passenger car units measure cars as ‘1’ and trucks as ‘2.5’ etc.

Table 5.3: Percent of EU road network km by road traffic flow (2-way) and EU country

% km	**'000 pcu / day**							
	<10	**10-20**	**20-30**	**30-50**	**50-70**	**70-100**	**100+**	**network-km**
Austria	37.0	24.9	19.0	11.7	3.6	2.9	1.0	4,498
Belgium	29.6	14.5	13.1	16.0	11.0	7.7	8.2	3,855
Germany	26.0	19.6	11.6	18.6	8.1	9.8	6.2	28,710
Denmark	65.5	21.9	0.4	12.2	0.0	0.0	0.0	1,382
Spain	48.5	28.6	13.2	8.0	0.6	0.0	1.2	13,907
Finland	86.1	7.9	2.6	3.4	0.0	0.0	0.0	5,644
France	25.2	31.8	16.9	17.4	5.2	1.9	1.7	25,017
Greece	75.8	11.6	0.0	12.0	0.6	0.0	0.0	4,024
Ireland	75.6	14.5	5.9	3.9	0.0	0.0	0.0	2,263
Italy	31.1	24.8	17.5	18.2	4.9	1.9	1.6	15,867
Luxembourg	11.1	28.8	29.8	19.3	4.9	6.1	0.0	285
Netherlands	17.2	16.8	16.4	21.5	11.6	8.8	7.7	3,830
Portugal	65.3	19.7	12.4	2.3	0.4	0.0	0.0	3,643
Sweden	70.7	15.9	7.6	3.4	1.4	0.0	0.9	7,104
UK	30.3	15.5	13.0	17.0	10.1	7.3	6.7	15,552

Chapter 9 of this Deliverable contains the road network flows associated with each of the Scenario tests for 2020. The flows are compared to the 1995 levels. For 1995 though, the levels of traffic on the road networks appears more realistic than was the case with the STREAMS model. Chapter 6 now describes the basis for the 2020 Forecast Scenarios implemented within SCENES.

6. Scenarios Specification for 2020

The SCENES Scenarios for 2020 comprise two main elements – an External Scenario and a range of Transport Scenarios. The External Scenario is common to both the passenger and freight model, and comprises assumptions regarding the following:

- Population by group (young / old / employed pt / employed ft / not in employment), by zone, derived from country total projections
- Car ownership rates by country / zone
- Income growth by country – inferred from GDP
- Improvements to the transport infrastructure networks
- Trends in vehicle occupancy
- Trends in international trip rates, and other trip rates

These assumptions are based on forecasts made within and outwith the SCENES project. Once established, these are treated as fixed – it follows that there is only one external scenario. The Transport Scenarios are based in the main on differing assumptions regarding the future evolution of transport costs, and how these changes in costs might differ between modes. By definition, these Transport Scenarios must be developed separately for the passenger and freight models. The main inputs to the External Scenario and Transport Scenarios are now presented in this section.

6.1 External Scenario

The zonal estimates of the five population groups are based on NUTS2 forecasts of population and employment, which were produced as part of the SCENES project and reported in Deliverable D3. The final national total produced for each country is then compared to the Eurostat Baseline 2020 forecast – an overall adjustment is made to all the population groups in the relevant country to bring the SCENES forecast into line with Eurostat national totals.

Table 6.1 shows the forecast 2020 population levels at the country level, together with the levels of forecast employment used as input to determining the population groups.

Table 6.1: SCENES 2020 External Scenario – Population and Employment

	Population[1]	**Employment [2]**		**Population[2]**	**Employment[2]**
Austria	8,443	3,991	**Czech Rep.**	9,743	4,611
Belgium	10,658	4,296	**Estonia**	1,170	589
Germany	84,670	37,856	**Hungary**	9,167	4,003
Denmark	5,526	3,118	**Lithuania**	3,465	1,673
Spain	38,668	12,640	**Latvia**	1,999	985
Finland	5,350	2,066	**Poland**	39,318	17,250
France	62,831	25,353	**Slovenia**	1,871	867
Greece	11,269	3,748	**Slovak Rep.**	5,446	2,496
Ireland	3,909	1,461			
Italy	56,543	21,313			
Luxembourg	501	264			
Netherlands	17,204	7,459			
Portugal	9,959	4,132			
Sweden	9,470	4,327			
UK	61,038	25,921			
EU Total	**386,039**	**157,945**	**CEEC Total**	**74,199**	**32,474**

1 Source – Eurostat 'Baseline' 2020 Forecast
2 Source – SCENES Project Deliverable 3a and 3b, 'Drivers of Transport Demand'

It should be noted that the population forecasts for 2020 imply a reduction in the population levels for all the CEE Countries with the exception of Poland and the Slovak Republic. Within the EU countries, only Italy is forecast to see a reduction in population levels.

Forecasts of zonal car stock are also required for 2020. A similar approach to that above was taken, in that the SCENES zonal growth forecasts in motorisation were used in the first instance. An overall adjustment was then made based on the forecasts used in the DGTREN PRIMES study. This is principally to ensure a level of consistency between DGTREN projects. Separate SCENES produced forecasts were used for the CEEC8. Table 6.2 presents these forecasts in the form of cars / 1000 persons, at the country level.

Table 6.2: SCENES 2020 External Scenario – Car Ownership levels

	Cars / 1000[1]		**Cars / 1000**[2]
Austria	639	**Czech Rep.**	462
Belgium	721	**Estonia**	469
Germany	742	**Hungary**	412
Denmark	411	**Lithuania**	403
Spain	580	**Latvia**	327
Finland	537	**Poland**	390
France	636	**Slovenia**	510
Greece	354	**Slovak Rep.**	370
Ireland	445		
Italy	865		
Luxembourg			
Netherlands	573		
Portugal	610		
Sweden	576		
UK	519		

1 Source – DGTREN PRIMES Study
2 Source – SCENES Project Deliverable 3b, 'Drivers of Transport Demand'

The final socio-economic component of the External Scenario is the GDP forecast data. This is shown in Table 6.3 below, and again uses PRIMES and SCENES data sources.

Table 6.3: SCENES 2020 External Scenario – GDP (% pa growth)

	1995-2010[1]	**2010-2020**[1]	**1995-2020**		**1995-2010**[2]	**2010-2020**[2]	**1995-2020**
Austria	2.31	1.66	2.05	**Czech Rep.**	3.9	4.3	4.06
Belgium	2.37	1.75	2.12	**Estonia**	4.8	5.1	4.92
Germany	2.36	1.73	2.11	**Hungary**	5.0	4.5	4.80
Denmark	2.35	1.52	2.02	**Lithuania**	5.1	5.8	5.38
Spain	3.03	2.29	2.73	**Latvia**	4.0	5.0	4.40
Finland	2.99	1.73	2.48	**Poland**	5.9	5.1	5.58
France	2.37	1.76	2.13	**Slovenia**	4.6	3.9	4.32
Greece	3.55	2.95	3.31	**Slovak Rep.**	5.2	4.5	4.92
Ireland	5.11	2.08	3.89				
Italy	2.12	1.71	1.96				
Luxembourg			4.40				
Netherlands	2.82	1.99	2.49				
Portugal	3.72	2.97	3.42				
Sweden	2.15	1.47	1.88				
UK	2.51	1.84	2.24				

1 Source – DGTREN PRIMES Study
2 Source – SCENES Project Deliverable 3a and 3b, 'Drivers of Transport Demand'

The significance of the GDP forecasts in the passenger model is that they are used as a proxy for income growth. For the EU countries, average income value of time elasticities are used. These have been shown to be necessary to prevents the full impact of income growth being reflected in the values of time used in the model. The income elasticities used are :

- Business, 0.45
- Commuting, 0.65
- Other, 0.5 (published as 0.35)

The source for these values is a 1993 Hague Consulting Group, Value of Time Study.

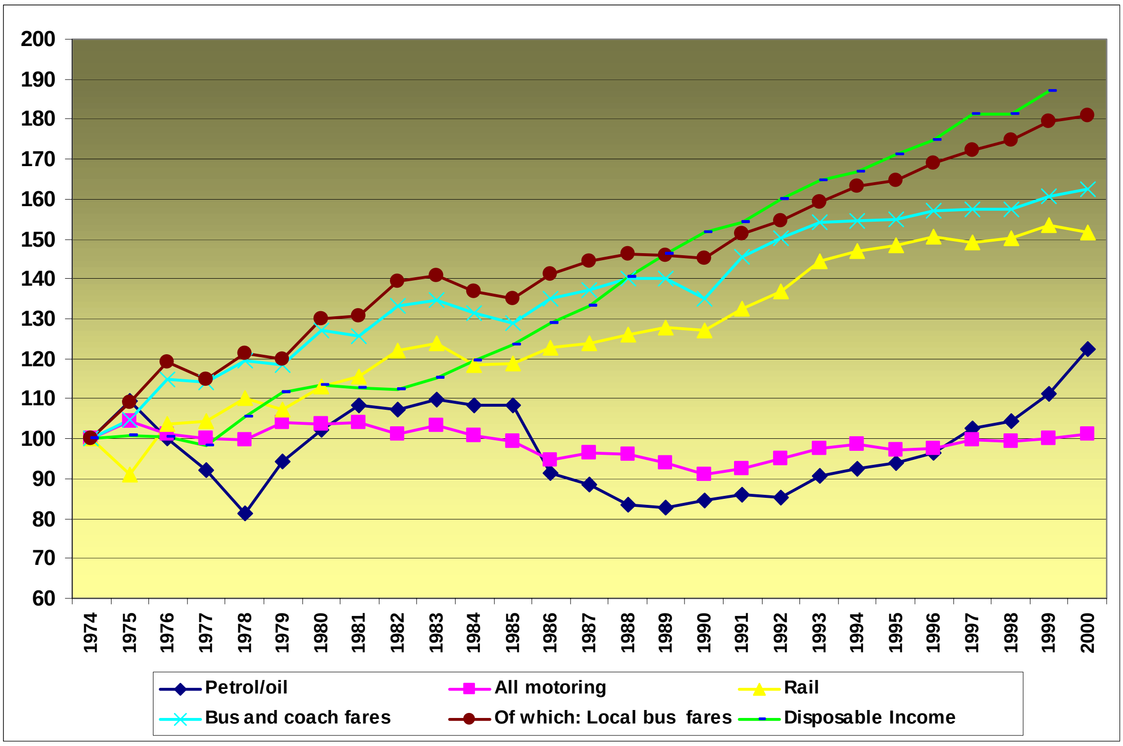
The Transport Networks used in 2020 are also common to all tests. These networks include planned national and international transport infrastructure developments. One of the main data sources used to specify these networks was the Commission's 'TENs Implementation Report', which assesses the planned Trans-European Transport Networks for their progress and likely date of implementation, or completion.

6.2 Passenger Transport Scenarios

A number of Transport Scenarios are then developed. These are based on the previous work undertaken in the STREAMS and Pilot SEA projects, as well as the 2010 Common Transport Policy model runs undertaken in the Autumn of 2000.

The specification of the transport scenarios is based on a number of hypotheses as to how transport costs by mode will change in the future, in real terms (i.e., after inflation is taken into account). Clearly, the specification of these hypotheses would be greatly helped if the past trends in transport costs in European countries were known with some certainty. The only data source of this nature which has been found to date relates to the UK. Figure 6.1 below shows real terms changes in the cost of transport in the UK from 1974-2000, together with disposable income over this period.

Figure 6.1: Real changes in transport costs, UK 1974-2000 (1974=100)



Source – Transport Trends, 2001 Edition, UKDETR

A clear pattern emerges when historical transport costs are considered over this long time period. Basically the real cost of motoring, when all costs are considered has remained remarkably unchanged over 26 years, and has often been below the level of 1974. Fuel prices in isolation appear rather more cyclical. The other modes over the period have seen significant and more steady rises in costs, although still less than the change in disposable income. So overall, the real costs of transport relative to income have reduced across all modes over a long period. This is one of the key reasons for the increase in transport which have occurred.

Some of these changes can be illustrated by looking at the cost changes during different elements of the overall time period shown above. Table 6.4 below shows the growth rates for the 1974-2000 period by real terms percentage per annum changes. Motoring costs are split between petrol / oil and all motoring costs. The latter will include maintenance, purchase, depreciation and insurance etc. The rates are also shown for 5-year periods within this overall period.

Table 6.4: Percent per annum real cost changes in UK transport costs

	Petrol / oil	**All motoring**	**Rail**	**Bus and coach fares**	**Of which: Local bus fares**	**Disposable Income**
1974-00	0.78	0.04	1.61	1.88	2.30	2.54
1974-94	-0.39	-0.07	1.95	2.20	2.48	2.59
1975-80	-1.37	-0.10	4.43	3.91	3.61	2.40
1980-85	1.20	-0.86	0.98	0.30	0.74	1.72
1985-90	-4.85	-1.77	1.34	0.94	1.50	4.21
1990-95	2.11	1.30	3.19	2.79	2.54	2.42
1995-00	5.43	0.81	0.40	0.93	1.88	2.26

Source – Transport Trends, 2001 Edition, UKDETR

The overall trend between 1974 and 2000 shows all motoring costs rising at only .04% above inflation. During this period rail travel has increased in cost by 1.61% per annum, and bus travel has gone up by between 1.9% and 2.3% per annum. The effect of the 'fuel price escalator' policy which was recently used by UK Governments can be seen in the 5.43% per annum real growth in petrol / oil prices between 1995-2000, and the 2.11% figure for 1990-95 (the policy was introduced during this period). The stated objective of this policy was to assist in meeting emissions Kyoto agreements by bringing UK fuel prices (then amongst the cheaper in Europe) into line with other comparable countries. This escalator policy has now ceased, partly due to increasingly stiff public opposition.

The period 1974-94 is also included in the above table – this represents the pre-escalator situation with transport cost changes in the UK.

Lessons can be drawn from these figures for the generation of Transport scenarios for SCENES 2020. The PRIMES GDP 2020 forecasts are being used as proxy for the 'disposable income' column of Table 6.4, so are in line with broad past trends for most of the major European countries at least (the GDP rates are typically in the range of 2-3% per annum). The splitting of car costs into 'all motoring' and 'petrol / oil' allows differential growth rates to be applied in the model. Business car travel in the model is based on 'all motoring' costs, whilst leisure comprises only 'out of pocket' expenses, which in this case is 'petrol / oil'. For leisure, the other costs are regarded as essentially sunk costs – they are implied in the car ownership forecasts, and once a car is bought, the 'out of pocket' expenses are what typically governs mode choice etc.

The key issue in any Transport Cost scenario is the extent to which transport costs rise in relation to the growth in incomes. The previous SCENES 2010 CTP Transport Scenarios, which generally reflected the previous Pilot SEA Transport Scenarios are reproduced below in Table 6.5. Also shown is the UK 1974-94 (i.e., pre escalator) trend for comparison:

Table 6.5: Transport cost Scenarios for CTP SCENES runs (% per annum, 1995-2010)

Transport Mode	**Reference Scenario / Scenario Tendanciel**	**Scenario 'Radical'**	**Scenario 'Voluntariste'**	**UK 1974-94**
Car	+1.0%	+2.5%	+1.5%	-.39%[1] -.07%[2]
Local bus	+1.0%	-0.5%	-1.0%	+2.48%
Long distance coach	-1.0%	-0.5%	-0.5%	+2.20%
Rail – conventional	+1.0%	+0.5%	+0.75%	+1.95%
Rail – high speed	+1.0%	-0.5%	-0.75%	NA
Air	-0.5%	+0.5%	+0%	NA

[1] – Petrol and oil only
[2] – All motoring costs

These CTP Scenarios show a major shift in favour of the public transport modes compared to the UK 20 year trend discussed above. Unfortunately we do not have comparable data for other countries at this stage – in particular it is likely that some other countries, with a stronger tradition of public subsidy, have maybe not seen such high growth in public transport charges. Although the UK also saw fares increasing in the pre-Thatcher era. There is however, no real reason to believe that most other countries have not seem similar patterns of car costs over this period.

A further issue is the political acceptability of fuel prices increasing at above inflation rates over a sustained period. The wave of demonstrations seen in many European countries in the Autumn of 2000 against the level of fuel tax was significant, regardless of the motivation. It also initially had a high level of public support. For example, an increase of 2.5% per year (as suggested in the Scenario Radical above), for 25 years would see 1995 fuel prices increase by 85% over and above inflation. This sort of increase would also out-strip the growth in disposable income in some countries.

The Transport Scenarios tested and reported here are as follows:

- Constant Cost Scenario. This test involves keeping transport costs for all modes constant in real terms.
- Income Tracking Scenario. Here, transport costs for all modes will rise in line with average EU incomes over the 1995-2020 period.
- Long Term Trend Scenario. This scenario uses the UK trend by mode between 1974 and 1994, i.e., before the fuel price escalator was introduced. This can be viewed as a 'free-market' scenario.
- Radical Scenario. This test repeats the CTP Radical cost regime for the period up to 2020, and implies intervention in balancing the costs between modes.

These scenarios are selected to represent the range of possibilities and eventualities for the countries of the EU. Clearly, in reality different countries will be likely to, in essence, adopt different scenarios. Results from all these tests are reported here at the country level, so it is possible to 'mix and match' results to some extent if required, given the domestic nature of the vast majority of travel.

For the CEE Countries, one alternative Transport Scenario is defined. This Illustrative Scenario is based on (i) decreasing car costs, following Western European precedents in the early stages of expansion of car ownership, and (ii) increasing public transport costs – as state subsidy decreases and privatisation occurs, public transport prices will approach their 'market' value. The purpose of this Scenario is again to demonstrate the SCENES model's approach to forecasting in the CEEC context. The values used are:

- Car and Air: -.05% per annum
- Bus / Coach, & Train: +4% per annum

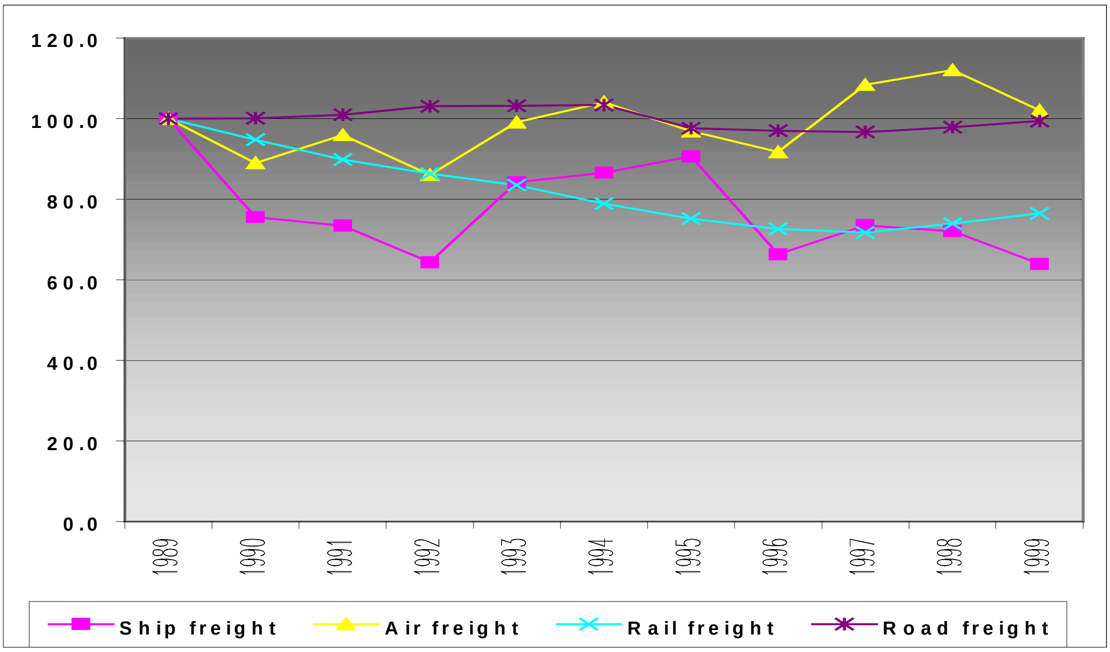
6.3 Freight Transport Scenarios

The freight transport costs scenarios are defined on the basis both of the observed past trend of freight rates and of assumptions already made in previous projects - STREAMS and Pilot SEA.

It is difficult to identify the historical trend of freight rates in EU countries given that even data calculation for a single year requires a substantial amount of work. This is because rates are often considered as reserved data and official figures are often unreliable. In the course of a work carried out in Italy about the cost of international transport (on behalf of the Italian Exchange Office) in order to estimate the Balance of Payment for transport services, a historical series of rates was estimated on the basis of survey among carries and forwarders. The estimation concerns only Italian transport to / from abroad, but there are not reasons to believe that the other countries experienced a very different path, with the exception of rail transport as explained below.

The following Figure 6.2 shows the trend of the rates in the period 1989-1999, while Table 6.6 summarises the yearly percentage changes.

Figure 6.2: Index of freight rates 1989-1999 (International traffic to/from Italy; 1989=100)



Source: TRT elaboration on data reported in UIC, *Indagine campionaria su trasporto internazionale merci e passeggeri* (A sample survey on international transport of goods and passengers), Roma, 2000.

Table 6.6: Percent per annum real cost changes in Italian international freight transport by mode

Period	Road Freight	Rail Freight	Air freight	Ship freight
1989-99	-0.06	-2.64	+0.2	-4.37
1997-99		+3.25		

From the graph it is apparent that rates of Road and Air freight (but the latter plays a negligible role in freight transport) have remained substantially unchanged during the period 1989-1999. Shipping rates has decreased by over 4% per year from 1989, but this average rate is misleading on the light of the significant oscillations observed during the period - indeed, shipping rates changes very frequently according to market conditions. Furthermore, the shipping rates trend observed in Figure 6.2 can also be partially explained by Lira / US$ exchange rate which also has shown relevant changes in the period observed.

For Rail freight the average change of –2.6% per year is strongly conditioned by the particular conditions of Italian railways, which has been (and still are) abundantly subsidised. Only in recent years a more market-oriented policy was assumed and the effects on rates can be appreciated if the period 1997-99 is considered, with an increment of 3.25% per annum. Summing up, the observed past trends say that road freight rates are unchanged, ship rates show an overall decreasing tendency but with several oscillations and rail freight fares are probably increasing under the balance requirements following liberalisation of services.

The second element for the definition of freight transport scenarios is represented by the assumptions made in previous projects STREAMS and Pilot SEA. Such assumptions are summarised in Table 6.7.

Table 6.7: Comparisons of past trend and previous projects assumptions (% change per year)

Mode of transport	Italian International traffic Past trend (1989-1999)	STREAMS assumptions	Pilot SEA assumptions
Heavy Goods Vehicles	-0.06	-2	-1
Light Goods Vehicles		0	+0.5
Rail bulk	–2.6 1	0	+2
Rail unitised	+3.25 2	0	+1.5
Ship	-4.37	-0.5	-1
Inland navigation	NA	-0.5	+1

1 1989-1999, 2 1997-1999

In general terms, the assumptions made in previous projects were consistent to the past trend in terms of direction whereas the size of changes is generally different. However, the observed trend is calculated on ten years only and we stressed that the percentage change of ship rates could be overestimated, as well as the rail rates could be considered as peculiar of the Italian case. For Inland navigation a comparison is not possible. From the analysis above, in the same manner as for passengers, four alternative freight transport scenarios are defined as follows:

- Constant Cost Scenario. This test involves keeping transport costs for all modes constant in real terms.
- Basic Scenario. The Pilot-SEA assumptions are retained over the 1995-2020 period.
- Observed Trend Scenario. This scenario adopts the observed change rates for Italian international traffic with the exception of ship where just half of the observed variation is used and rail where the rate is half of the trend of the last three years.
- Intervention Scenario. This Scenario assumes interventions on different modes with the aim of reduce road share for environmental reasons, etc.

The Scenarios are summarised in Table 6.8 below. As for the passenger model, results from all these tests are reported here at the country level.

Table 6.8: Freight Transport Scenarios (% per annum transport cost change, 1995-2020)

Mode of transport	Constant Scenario	Base Scenario	Trend Scenario	Intervention Scenario
Heavy Goods Vehicles	0	-1	0	+1.5
Light Goods Vehicles	0	+0.5	0	+1
Rail bulk	0	+2	+1.5	0
Rail unitised	0	+1.5	+1.5	0
Ship	0	-1	-2	-2
Inland navigation	0	+1	+1	0

7. Passenger model 2020 Scenario results

The four forecast scenarios for 2020 described in Chapter 6 generate a very large amount of model output, which could potentially be reported in enormous detail. The main model output file is a matrix text file, which contains flows, times and costs for all zones, modes, and transport flows in the model (some 190mbytes). This file can therefore be aggregated in many different ways. The other output files are network based, i.e., times, flows, etc. on the individual transport links themselves.

The first section of this Chapter considers the forecasts aggregated, firstly for the EU as a whole, then across all modes for individual countries. Section 7.2 looks at the results aggregated for the CEE countries. Finally in this Chapter, Section 7.3 looks at some of the detailed changes in trip making behaviour between 1995 and 2020 which underlie these aggregate changes.

7.1 Aggregate EU Transport Results

The results in this section are aggregate results. They give the model forecasts for the four 2020 Scenarios, in terms of person-km per annum, by mode, for the EU as a whole, then aggregated across modes for each of the EU countries. Both types of results are considered from the point of view of domestic travel only, then domestic plus intra-EU international.

Firstly, Table 7.1 shows the results for the EU when only domestic trips are included, that is trips within the national boundaries of individual nation states. The annual totals and percentage changes per annum from the 1995 Base Year model are shown – the latter are also illustrated diagrammatically in Figure 7.1.

Table 7.1: EU Domestic passengers, 2020 10^9 person-km / annum

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised*
Cons. Cost	5,175.2	481.5	496.5	184.3	105.1	**6,442.6**	**6,153.20**
Inc. Track	4,600.9	337.0	176.7	203.5	22.1	**5,340.4**	**5,114.60**
Long-term trend	5,485.9	302.2	200.4	191.9	110.7	**6,291.0**	**5,988.50**
Radical	4,296.4	604.2	466.7	194.9	79.1	**5,641.3**	**5,367.30**
1995 Base	3,668.9	405.8	272.8	209.7	36.7	**4,593.7**	**4,347.50**
CC % pa	*1.39*	*0.69*	*2.42*	*-0.52*	*4.30*	***1.36***	***1.40***
IT % pa	*0.91*	*-0.74*	*-1.72*	*-0.12*	*-2.01*	***0.60***	***0.65***
LTT % pa	*1.62*	*-1.17*	*-1.23*	*-0.35*	*4.52*	***1.27***	***1.29***
Rad. % pa	*0.63*	*1.60*	*2.17*	*-0.29*	*3.12*	***0.83***	***0.85***

* Comprises Car, Bus / Coach, Train

The rates of transport growth for EU domestic traffic are seen to differ markedly between these Scenarios. The Scenarios were set up in this way to encompass the broad range of possible future trends. The ‘Income Tracking’ Scenario sees the least amount of overall growth. In this Scenario, transport costs keep pace with income growth, thus a key source of previous growth in transport, where incomes rise faster than transport costs, is not present. The increase seen here will be mostly due to the growth in car ownership. Conversely, the highest growth is seen in the ‘Constant Cost’ Scenario. In this case, transport costs for all modes remain the same in real terms in 2020 (i.e., accounting for inflation) as they are in 1995, and incomes are rising at approximately 2.5% per annum, again in real terms. Thus there is a big differential between transport costs and income growth and transport becomes very much cheaper, relative to incomes.

The ‘Long Term Trend’ Scenario encounters only slightly less growth than ‘Constant Cost’, but the distribution of this growth between modes is very different. The ‘Long Term Trend’ Scenario sees car costs reducing slightly over time, while costs for other modes keep a much closer pace with income. Thus the growth in car person-km is greatest for this Scenario. The Rail and Bus-Coach modes see a decline in use, as has been the case in some EU countries in the last 25 years.

The 'Radical' Scenario cost regime penalises Car at the expense of the other modes. Hence the overall growth is the second lowest of the four Scenarios, but the growth in Car person-km is the least of the four tests.

If the 'mechanised only' modes are considered, the overall rates of growth in travel are slightly higher, since the slow mode trips (which are excluded) decline in each case. However, this definition excludes Air traffic, which often grows at a faster rate than other modes. To aid interpretation, Figure 7.1 shows the percentage per annum changes for each mode and Scenario.

Figure 7.1: Passenger Scenarios, 1995-2020 % per annum change by mode, EU domestic

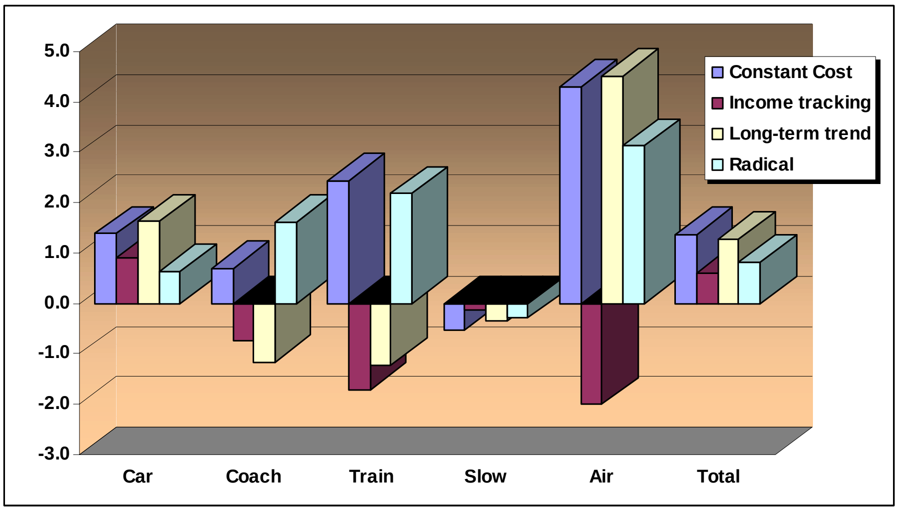


Table 7.2 shows the results in the same format, except this time, the figures also include the EU-international trips. Again, the per-annum changes in person-km are shown, overleaf in Figure 7.2.

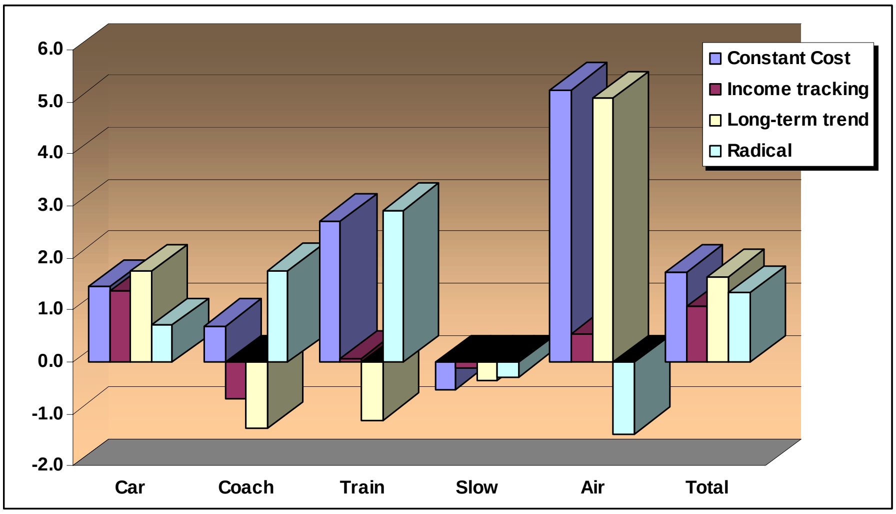
Table 7.2: EU Domestic plus intra-EU international passengers, 2020 10^9 person-km / annum

Scenario	Car	Coach	Train	Slow	Air	Total	Total mechanised*
Constant Cost	5,713.4	511.8	619.5	184.3	992.1	**8,021.1**	**6,844.70**
Income tracking	5,598.0	361.3	323.5	203.5	316.7	**6,802.9**	**6,282.80**
Long-term trend	6,140.6	312.3	240.4	191.9	953.9	**7,839.1**	**6,693.30**
Radical	4,755.8	667.5	652.7	194.9	194.9	**7,268.3**	**6,076.00**
1995 Base	3,986.8	430.6	317.8	209.7	276.5	**5,221.4**	**4,735.20**
CC % pa	*1.45*	*0.69*	*2.71*	*-0.52*	*5.24*	***1.73***	***1.48***
IT % pa	*1.37*	*-0.70*	*0.07*	*-0.12*	*0.54*	***1.06***	***1.14***
LTT % pa	*1.74*	*-1.28*	*-1.11*	*-0.35*	*5.08*	***1.64***	***1.39***
Rad. % pa	*0.71*	*1.77*	*2.92*	*-0.29*	*-1.39*	***1.33***	***1.00***

* Comprises Car, Bus/Coach, Train

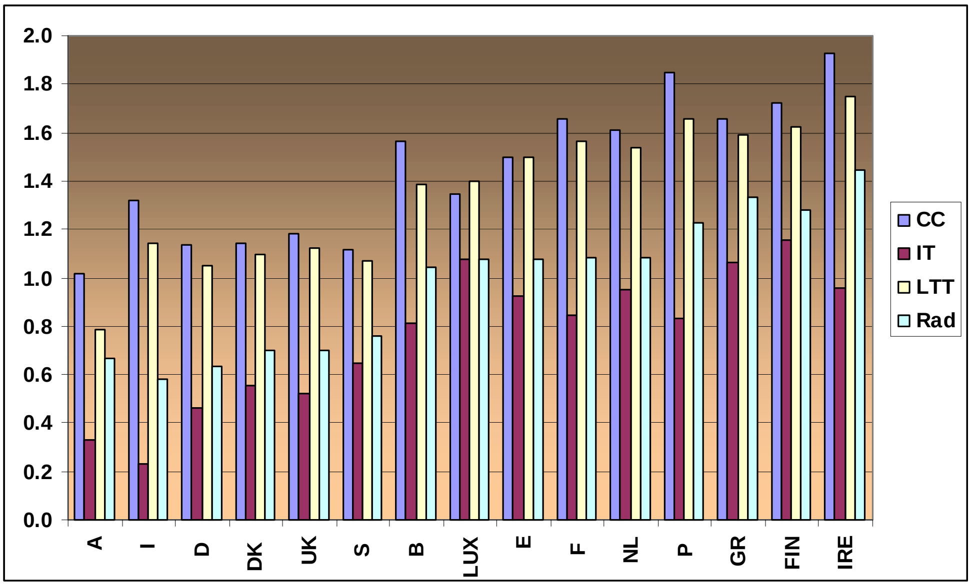
The main outcome here is that the overall growth rates for all 4 tests are higher than when only domestic travel was considered. This is because international travel is increasing at a greater rate than domestic: in the main, this has happened as incomes have increased and the cost of travel and holidays has decreased. The sequence of tests in terms of overall rates of growth are the same as was the case for the domestic travel only.

Figure 7.2: Passenger Scenarios, 1995-2020 % per annum change by mode, EU domestic, plus intra-EU international



The following figures contain the rates of transport growth for each of the EU countries for each of the four Scenarios. As above, Figure 7.3 firstly contains only the domestic part of travel. The countries have been ordered by the average growth across the four scenarios (not shown), to aid interpretation.

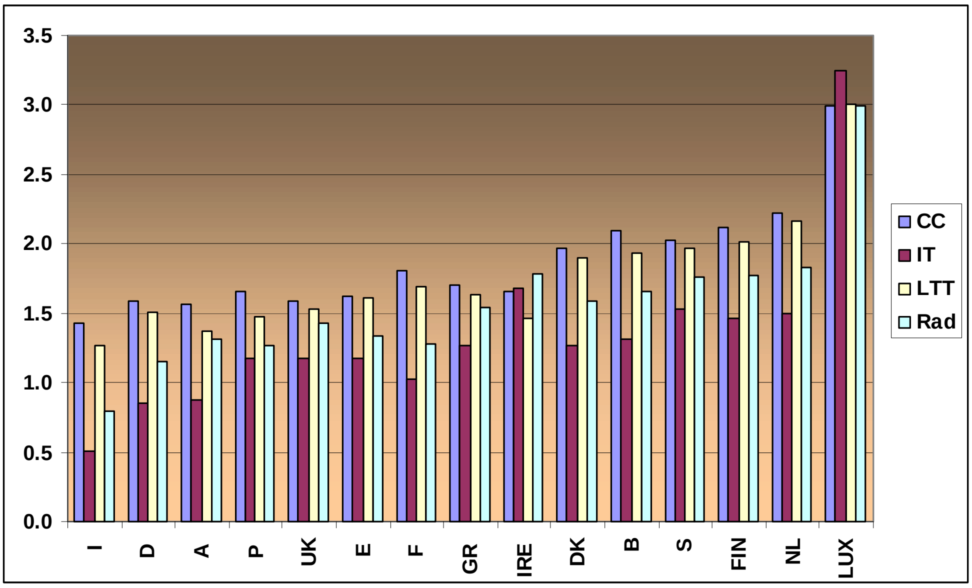
Figure 7.3: Passenger Scenarios, 1995-2020 % per annum growth by country, EU domestic, all modes



Looking at the country results for domestic travel, Austria, Italy and Germany genarally have the lowest levels of growth. Portugal, Greece, Ireland and surprisingly Finland comprise the countries with higher growth rates. Much of this differential growth can be attributed to differential growth in car ownership. Countries such as Germany and Austria, with high car ownership in 1995, see less growth than those countries such as Greece and Portugal who are 'catching up' to some extent.

Figure 7.4 shows the data in the same format, but including intra-EU international travel.

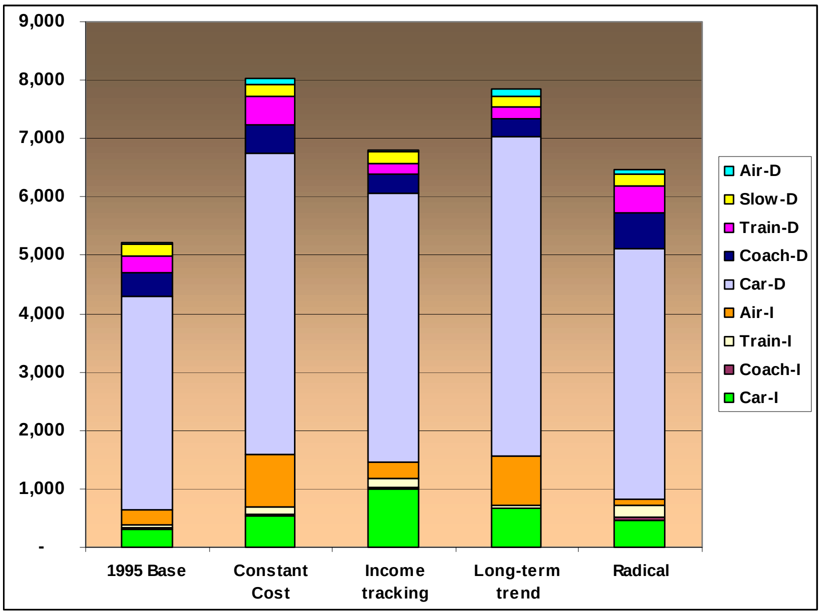
Figure 7.4: Passenger Scenarios, 1995-2020 % per annum growth by country, EU domestic & intra-EU international, all modes



The generally higher growth rates of travel once international travel is included can clearly be seen. The countries also appear in a very different order, although Italy, Germany and Austria are still the bottom three countries.

Figure 7.5 now shows the total travel with origins and destinations within the EU for the Base Year and the four 2020 Scenarios. Here, the domestic and international modal elements are separated out to illustrate the relative contribution of each to the total.

Figure 7.5: Passenger Scenarios, 1995 - 2020, 10^9 domestic & intra-EU international person-km, by mode



The purpose of this chart is to illustrate the very significant rises which are forecast for international travel in particular. Overall though the dominance of domestic car travel, constituting the largest proportion of all travel remains the case.

7.2 Aggregate CEEC Transport Results

This section reports the model forecasts for the illustrative 2020 External and Transport Scenario which has been applied in the CEE countries. In general, its to be expected that the growth in transport will of course be greater in the CEE countries, than will be the case with the EU countries, as these countries are, to some extent, 'catching up' with trends in Western Europe. This general pattern is seen in the model results.

Looking initially at the growth in CEEC domestic travel, Table 7.3 Below shows the results aggregated across the eight CEE countries contained in the model.

Table 7.3: CEEC Domestic passenger travel, 2020 10^9 person-km / annum

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised*
2020 CEEC	700.3	102.8	52.5	19.3	.8	875.7	855.6
1995 Base	317.8	92.8	46.8	32.9	.02	**490.7**	**457.50**
% pa	*3.21*	*0.41*	*0.46*	*-2.12*	*15*	***2.35***	***2.54***

* Comprises Car, Bus/Coach, Train

Although at first sight, these growth rates may seem below expectation, a comparison can be made between domestic kilometres travelled per person per day for the EU countries and the CEE countries in both years. In the 1995 model, the figure for the EU is 34.0 km per person per day – for the CEEC, the equivalent figure is 18.2. By 2020, the modelled figure for the CEEC is 33.2km, whilst the EU figures range from 37.9km to 45.7km, depending on the Scenario.

So in 1995 the CEEC volume of travel was only 53% of the EU value, whilst in 2020, this proportion ranges from 73% to 88%, again depending on the Scenario. By 2020, the CEEC volume of travel is therefore very much closer to that of the EU than is the case for 1995, although it has not quite 'caught up'. The growth rates in terms of person kilometres travelled per year are shown at the CEE country level in Table 7.4 below.

Table 7.4: CEEC Growth in Domestic passenger travel by country, person km % pa, 1995-2020

	Car	Coach	Train	Slow	Total	Total – mechanised*
Czech	2.13	-0.39	-1.29	-1.61	1.27	1.38
Estonia	1.08	0.35	-0.86	-2.59	0.54	0.75
Hungary	3.26	0.11	-0.60	-2.63	2.16	2.34
Lithuania	3.11	0.27	-0.17	-2.64	2.17	2.49
Latvia	2.74	0.31	-1.26	-3.47	1.62	1.95
Poland	3.66	0.83	1.32	-2.24	2.91	3.11
Slovenia	2.21	0.34	0.75	-2.18	1.61	1.81
Slovakia	1.59	0.42	0.06	-0.70	0.94	1.04

* Comprises Car, Bus/Coach, Train

The largest growth in car use for the Illustrative Scenario is therefore seen in Poland, Hungary, and Lithuania. Growth in the other modes is much more modest, or indeed negative. All countries see a significant decline in the slow modes. The significantly declining population in many of these countries must also be taken into account when considering the expectations for transport growth.

7.3 Underlying changes in the characteristics of Transport

Having reported the aggregate results in Section 7.1 and 7.2, this section looks at the changes in travel behaviour which underlie the aggregate figures. Firstly the basic components of transport demand are reported – namely changes in the number of trips and average trip distances.

7.3.1 Number of Trips

As there is only one External Scenario, the actual number of trips in the 2020 modelling system is common to all four of the Scenario tests. Also the only trip rates which are changed in moving from 1995-2020 are the international tourism trips (holidays and business). Here, there is clear evidence, and existing forecasts, that the number of trips made will continue to rise. For the other types of travel, the evidence is that trip rates stay relatively stable through time, if the analysis is conducted with an appropriate degree of segmentation of the population.

Applying the new car ownership levels and employment / demographic changes for the 2020 External Scenario gives rise to a new set of implied trip rates for each country. Table 7.5 below shows these rates in full, together with the percentage increase in trip rates between 1995 and 2020.

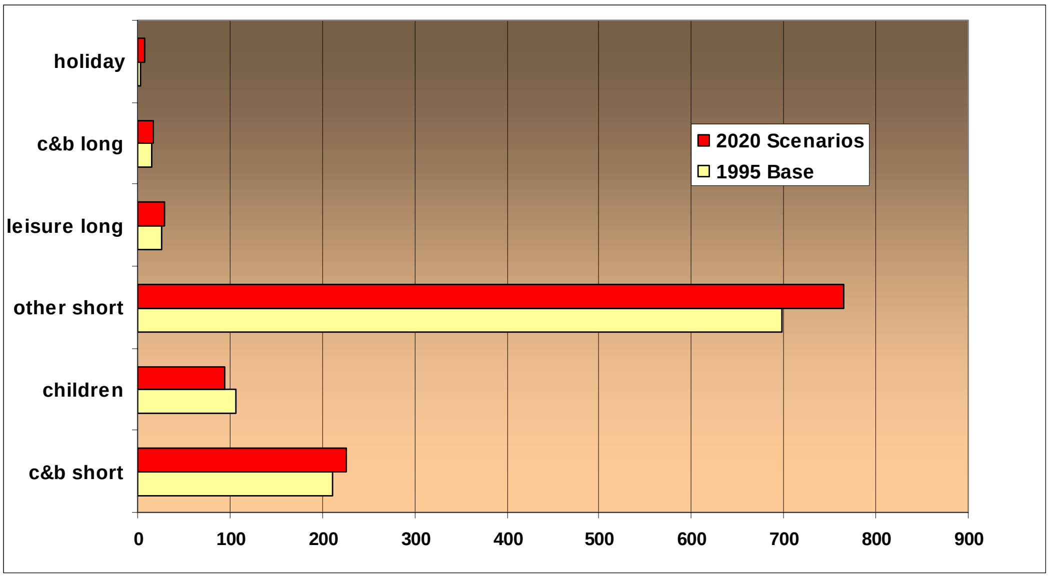
Table 7.5: Country level trip rates, 1995 and 2020 trips / person / year

Country	**1995 Trips / person / annum**	**2020 Trips / person / annum**	***% increase***
Austria	1063.5	1107.1	*4.1*
Belgium	1068.8	1178.1	*10.2*
Denmark	1055.3	1101.0	*4.3*
Finland	1060.3	1111.8	*4.9*
France	1073.3	1147.3	*6.9*
Germany	1050.7	1130.8	*7.6*
Greece	977.3	1021.4	*4.5*
Ireland	1072.4	1102.1	*2.8*
Italy	1094.9	1231.2	*12.4*
Luxembourg	1136.3	1185.7	*4.3*
Netherlands	1207.6	1316.4	*9.0*
Portugal	1066.8	1133.2	*6.2*
Spain	1056.7	1106.6	*4.7*
Sweden	1050.7	1083.6	*3.1*
UK	1075.4	1110.2	*3.2*
Czech	1039.6	1100.3	*5.8*
Estonia	1015.7	1112.5	*9.5*
Hungary	1004.9	1090.9	*8.5*
Lithuania	995.8	1087.6	*9.2*
Latvia	961.1	1058.4	*10.1*
Poland	987.9	1078.6	*9.2*
Slovenia	1058.9	1130.7	*6.8*
Slovakia	997.9	1073.7	*7.6*
Total	**1059.89**	**1136.6**	***7.2***

Overall, the changes in car ownership and demographics have increased the trip rates by around 7%. This is seen to vary quite widely by country, with Italy seeing the largest rise. This is in the main due to the high car ownership levels forecast for Italy.

Figure 7.6 shows the change in overall trip rates by broad purpose between 1995 and 2020. The ‘other short’ category sees the biggest rise – these trip rates are most affected by increased car availability. The number of commuting & business trips are clearly less affected by car availability and are determined by employment levels. The trip rate for children has declined as the number of children as a proportion of the population declines between 1995 and 2020.

Figure 7.6: Passenger trips / person per annum, by purpose, 1995 & 2020, EU & CEEC8



7.3.2 Average Trip Distance

If an increase in the number of trips is one source of growth in transport, increases in the average trip distance has also been a significant component of the growth in transport. The SCENES model incorporates incomes in the utility functions. As incomes rise, the amount of ‘disutility’ incurred for a particular cost declines – this reduction in disutility leads systematically to a lengthening of trips in the model. Table 7.6 below shows average trip distances considered for all modes added together and domestic trips only.

Table 7.6: Country level Domestic Average Trips Distances, 1995 and 2020 Scenarios (km / trip)

Country	1995 Base	CC 2020	IT 2020	LTT 2020	Radical 2020
Austria	10.63	12.58	10.60	11.87	11.52
Belgium	10.06	12.85	10.65	12.30	11.28
Denmark	13.29	16.27	14.04	16.07	14.56
Finland	11.87	16.56	14.41	16.17	14.85
France	12.80	16.69	13.64	16.31	14.48
Germany	12.89	15.33	12.96	15.01	13.53
Greece	6.71	8.97	7.75	8.82	8.28
Ireland	9.36	13.51	10.64	12.93	12.01
Italy	12.44	15.56	11.89	14.92	12.98
Luxembourg	11.09	12.34	11.51	12.50	11.53
Netherlands	10.04	12.53	10.63	12.29	10.99
Portugal	8.60	12.10	9.40	11.53	10.37
Spain	9.46	12.77	11.06	12.77	11.51
Sweden	11.58	13.89	12.36	13.72	12.72
UK	11.52	14.36	12.19	14.14	12.74
Czech	7.54	10.38	10.49	10.37	10.54
Estonia	5.06	6.60	6.60	6.60	6.61
Hungary	7.00	11.94	11.97	11.97	11.97
Lithuania	4.95	8.29	8.30	8.29	8.30
Latvia	4.57	7.73	7.73	7.72	7.73
Poland	6.83	12.71	12.88	12.67	12.85
Slovenia	5.34	7.95	7.97	7.95	7.97
Slovakia	5.82	6.72	6.89	6.71	6.88
Total	**10.85**	**14.14**	**12.02**	**13.84**	**12.61**

The relative increases between 1995 and the four 2020 Scenarios follow the same pattern as the aggregate results. Even the test with the slowest growth (IT – Income Tracking) sees a 10% increase in average domestic trip distance. On the other hand, the Constant Costs Scenario sees an increase of over 30%. It is therefore clear that increases in the average trip distance is a more significant factor than the increase in the number of trips, in accounting for the growth in transport in these tests. The figures are presented for domestic travel only, as they become less meaningful when international travel is included and the average can be distorted by the presence of very long trips.

7.3.3 Modal Split

As in Chapter 5, modal split is considered both in terms of number of trips, and person-kilometres travelled. Given that there are four Scenarios being tested, five basic modes, and 23 countries, a lot of information is produced from the model output. Firstly Table 7.7 gives the basic modal split for each of the Scenarios, in terms of the ***number of trips***.

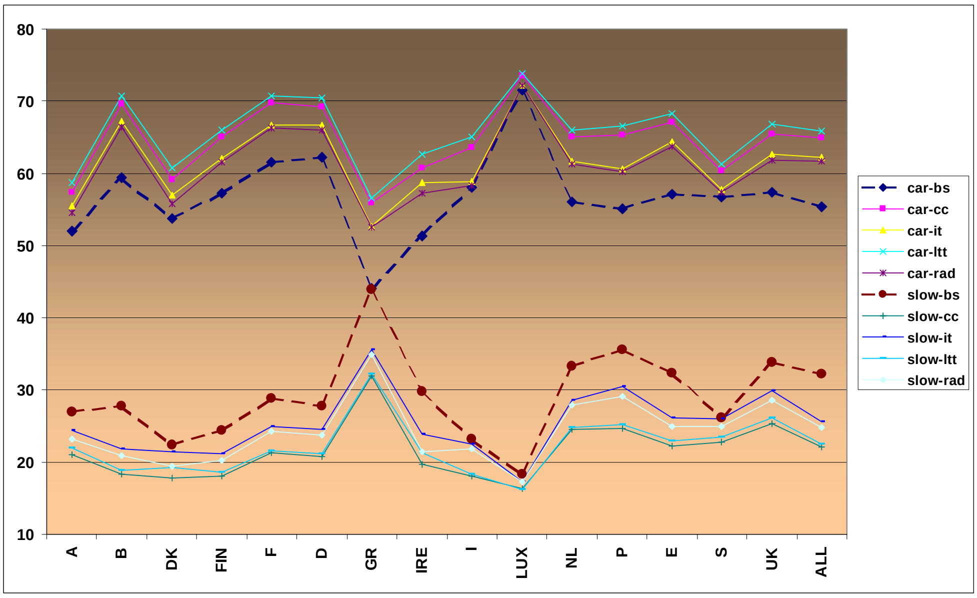
Table 7.7: Basic Modal Split, 1995 and 2020 Scenarios (% all trips), EU & CEEC

	Car – Business	**Car**	**Coach**	**HST**	**Air**	**Slow**	**Rail**
1995 Base	1.27	55.07	10.88	0.02	0.12	30.84	1.79
2020 CC	1.25	64.21	10.68	0.08	0.29	21.12	2.37
2020 IT	1.35	62.07	10.81	0.02	0.10	24.35	1.30
2020 LTT	1.32	65.45	9.97	0.03	0.29	21.51	1.43
2020 Rad	1.24	61.09	11.63	0.09	0.25	23.58	2.13

The main modal shift in all cases is away from the slow modes to the private car. The rise in the proportion of car trips varies between 6 percentage points in the Scenario Radical and 10 percentage points for the Long-Term-Trend Scenario. High speed rail has a large growth in the proportion of trips made in both the Constant Cost and Radical Scenarios. The other two scenarios see the proportion remaining stable.

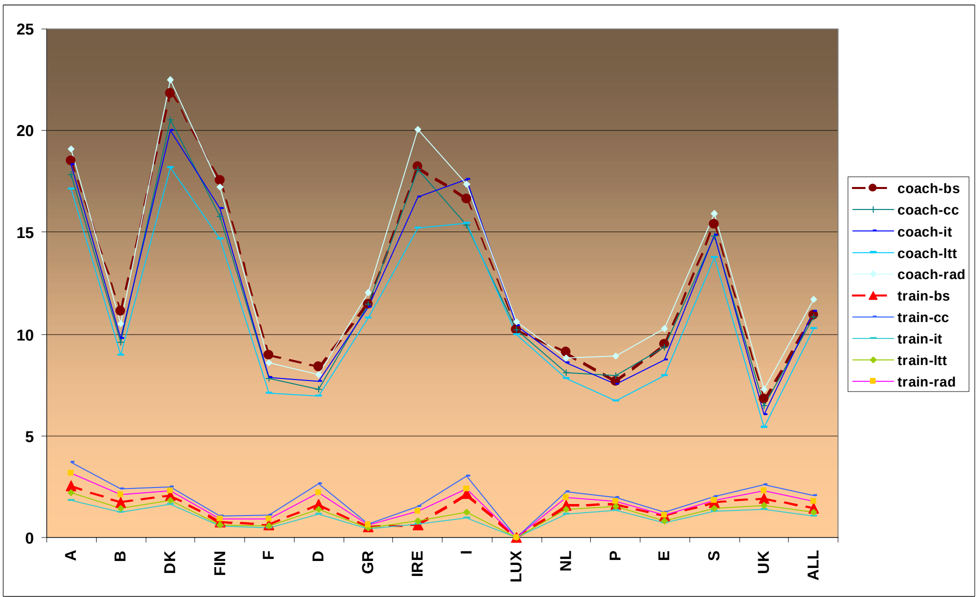
The modal split is more usefully viewed at the national level. The figures below have split the trips into the short / long denominations used before (< and > approximately 40km) for the EU15 countries and the four 2020 Scenarios. Figures 7.7 And 7.8 give the proportions of short trips by mode and country for the 1995 base year and the 2020 Scenarios. For clarity of presentation, the modes have been split into two charts with car and slow modes in Figure 7.7 And bus / coach and train in Figure 7.8.

Figure 7.7: Modal Split (% trips) short trips, 1995 & 2020, EU & CEEC8, car and slow modes



The general shift in modal share from slow modes to car is clear from Figure 7.7, although the extent of the shift does vary from country to country. Greece sees the largest shift and Denmark and Sweden see much smaller shifts. The lowest car share is generally seen with the Radical Scenario, with the Long-term-trend scenario showing the highest proportion of short car trips.

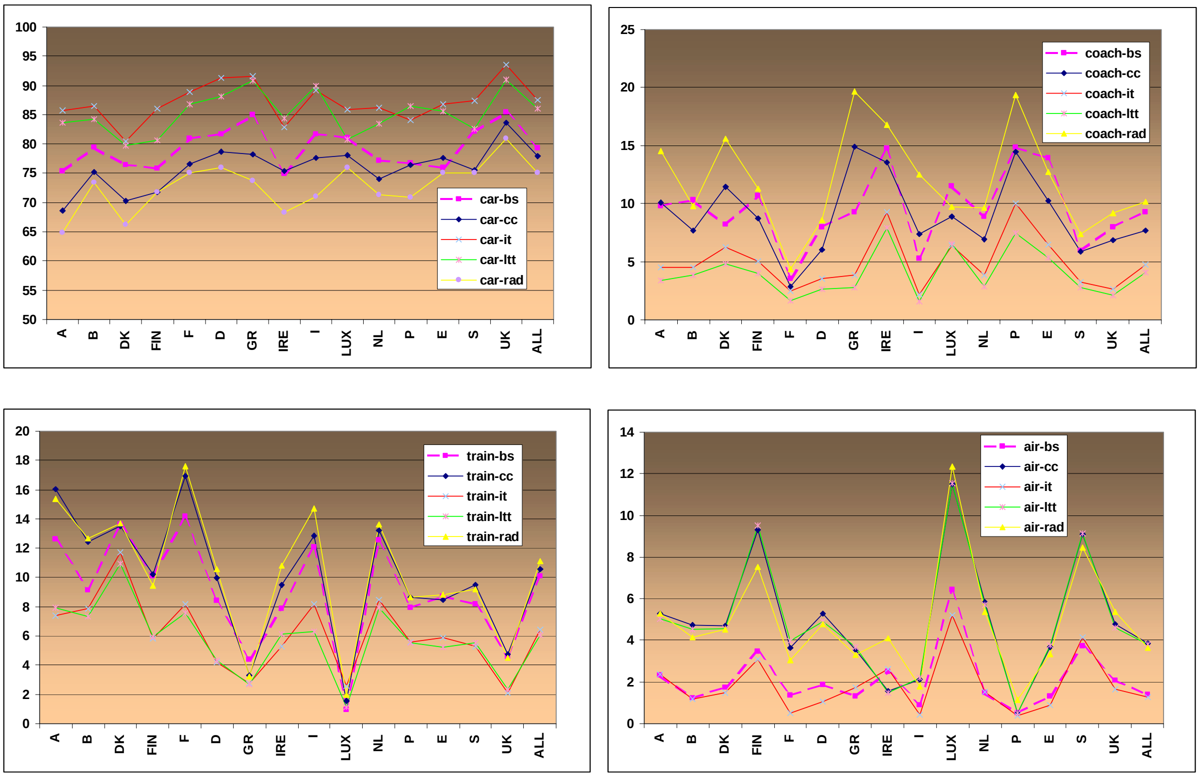
Figure 7.8: Modal Split (% trips) short trips, 1995 & 2020, EU & CEEC8, bus and train modes



There is less dramatic movement when looking at the changes in the bus and train proportions for short trips. The Scenario Radical generally has a higher coach share for most countries, and Income Tracking and Constant Cost see reductions in the proportion of rail trips for virtually all countries.

Figure 7.9a-d below shows the results in the same format for the long trips. Here, each mode, car, coach, train and air are shown in their own chart. The modal proportion for each mode for each Scenario and country can be seen in these figures.

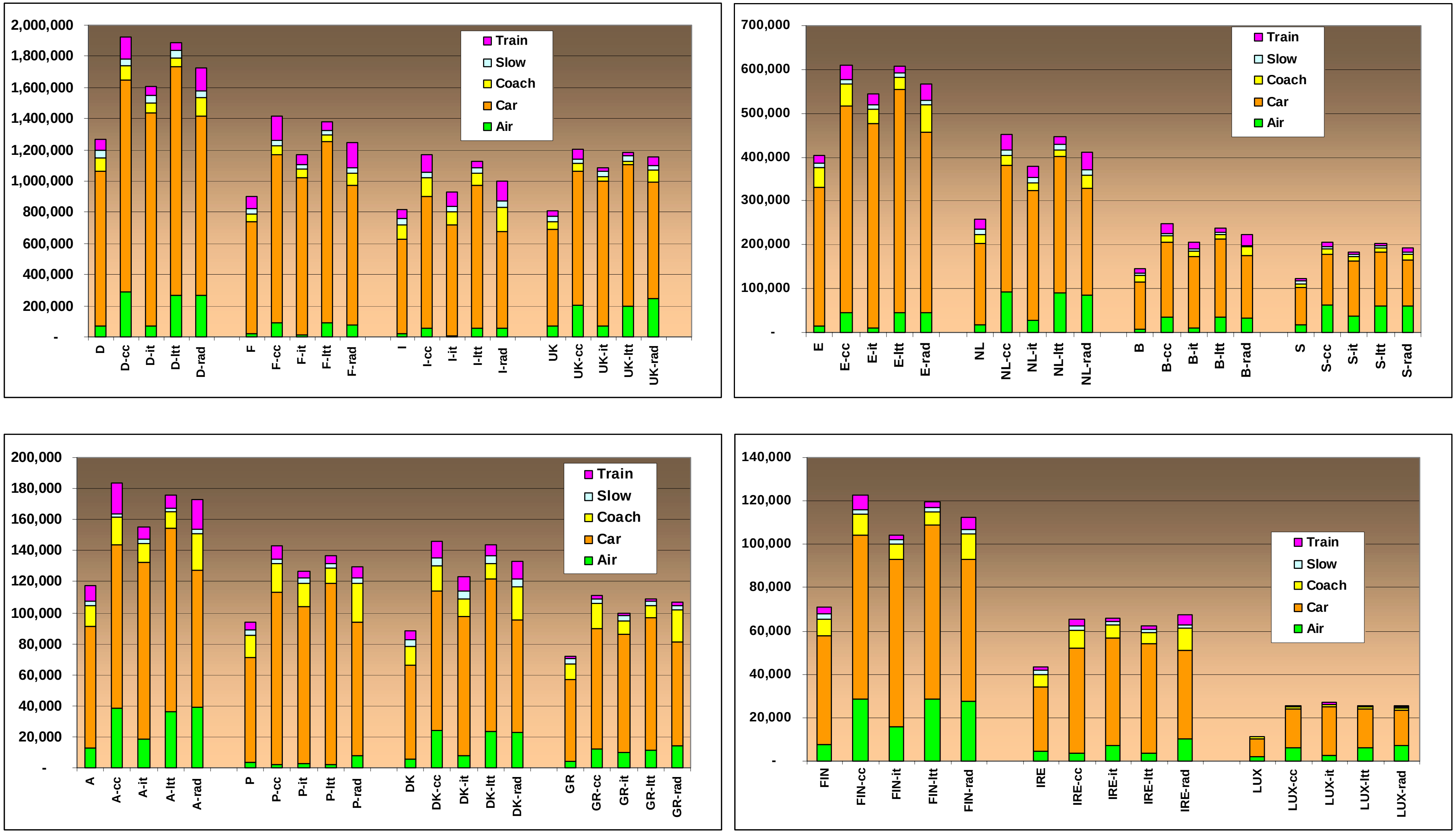
Figure 7.9a-d: Modal Split (% trips) long trips, 1995&2020, EU&CEEC8, car, coach, train, air, modes



There are more significant modal shifts apparent when looking at the ‘long’ transport flows in the model. In the above figures, the 1995 Base year modal proportions are shown in the heavy, dotted pink line. For all countries the Scenario Radical sees significant reductions in the car’s modal share, whilst Long-term-trend and Income Tracking see the modal share of car increase significantly. It is clear from these figures that the model does produce results which do differ substantially between countries.

Figure 7.10, overleaf, shows the ***person kilometres*** travelled for each EU country and mode, for the base year and each of the four Scenarios being tested. In each case, the base year person-kilometre figure is also shown for comparison (shown against the country code only). The order in which the countries appear has been changed to reflect the overall level of travel – this makes the presentation and scaling more clear. The inclusion of intra-EU international trips here makes the air mode much more significant than when domestic travel only is included.

Figure 7.10: EU domestic and EU intra-EU international, pkm*10^6 / annum by mode, 1995 and 2020 Scenarios

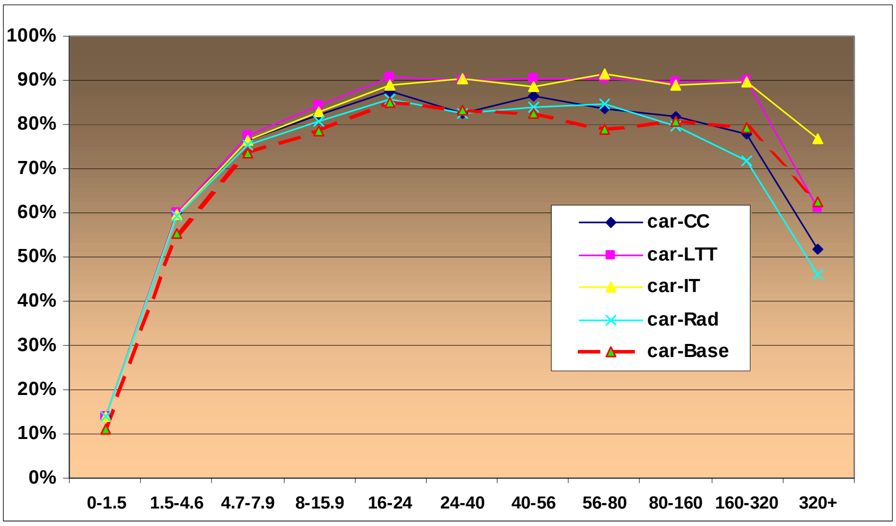


Note: ‘CC’ – Constant cost scenario, ‘IT’ – Income tracking scenario, ‘LTT’ – Long term trend scenario, ‘rad’ – Radical scenario

7.3.4 Mode Split by Distance

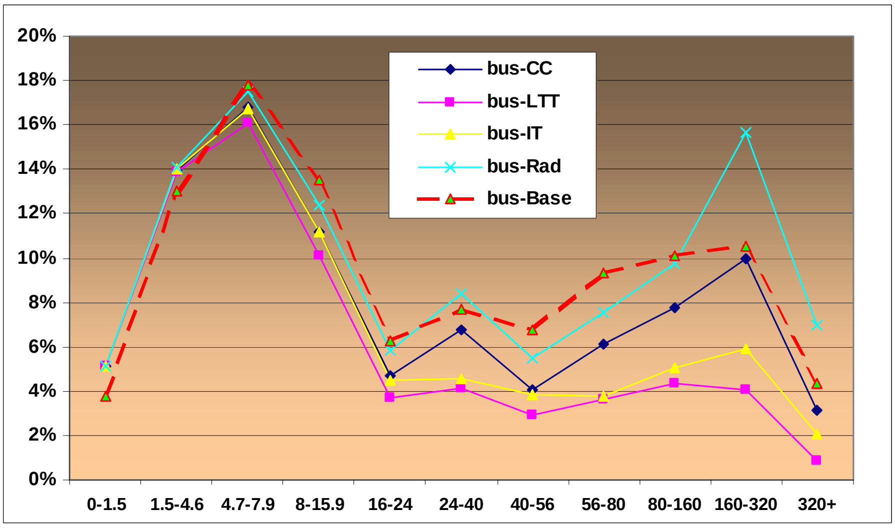
Having looked at the modal split in terms of number of trips and person kilometres travelled, this section demonstrates the changes in modal split by different distance bands. All trips are considered together here – i.e., the results are not country or flow specific. This means that EU and CEEC figures are included in these charts. The CEEC figures of course do not change between the tests and in any case represent a small proportion of the trips under consideration. Firstly, the results are reported for the short and medium range distance bands. In the figures that follow, the 1995 Base Year pattern is shown in a heavy red dotted line. Figures 7.11 To 7.13 show the proportions of car, bus / coach and train modes for these distance ranges respectively.

Figure 7.11**:** Mode split by distance, Car, short ranges, (% trips), 1995&2020 Scenarios



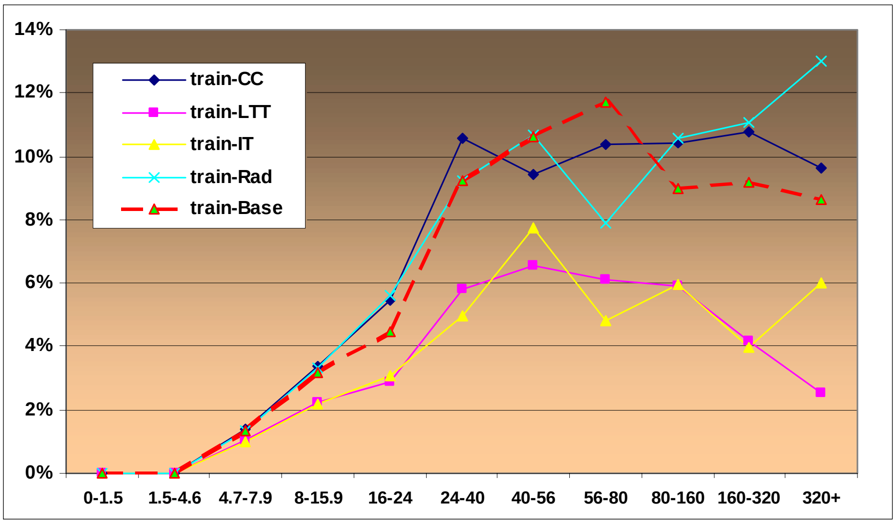
Looking at the changes in modal share for car, below and including the 16-24km range, the share of car increases for all tests. This can be explained by the increased car availability. Beyond this distance, the differential cost changes become more significant, with Scenario IT and Scenario LTT increasing their modal share by up to 10 percentage points. The Scenario Radical, where car costs increase much faster than those of other modes, comes closest to retaining the Base Year modal share of car over the shorter distances. The longer-distance ranges are shown in more detail in Figure 7.14 below.

Figure 7.12**:** Mode split by distance, Bus / Coach, short ranges, (% trips), 1995&2020 Scenarios



Over the shortest distance, bus actually gains slightly in terms of modal share. This will be due to increased incomes encouraging people to switch frm the slow modes within the model. Beyond this, modal share is generally lost. Only in the Scenario Radical does bus gain modal share, and that is only in the 24-40km range.

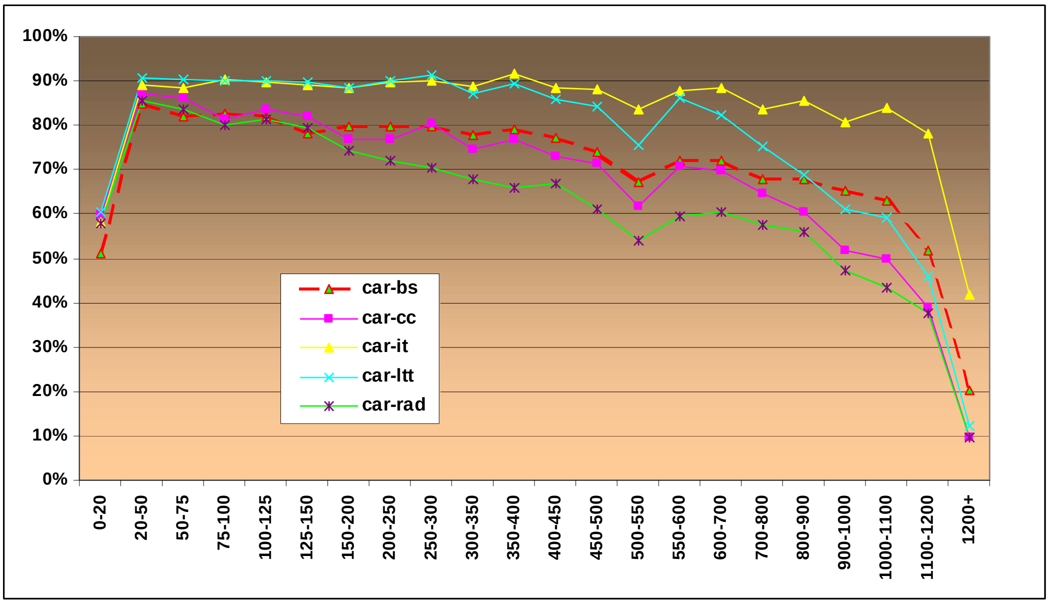
Figure 7.13**:** Mode split by distance, Train, short ranges, (% trips), 1995&2020 Scenarios



The pattern for rail splits clearly between the LTT / IT Scenarios and the CC / Radical Scenarios. The latter two Scenarios see rail largely maintain then increase its modal share with distance, whilst the other two see the modal share of rail decline throughout, due to a combination of increased car availability and unfavourable costs for rail.

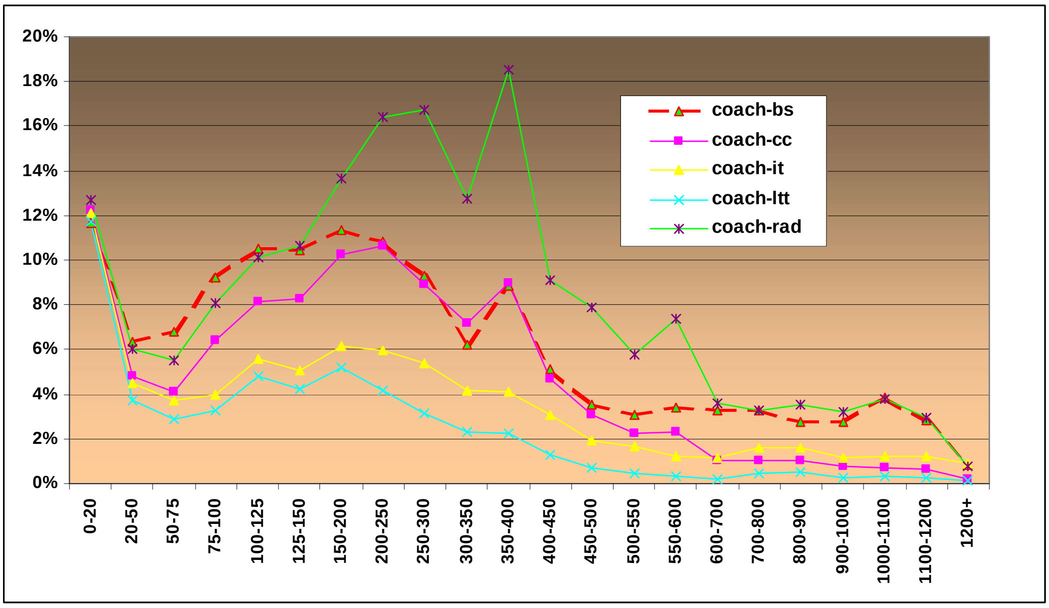
Mode split by distance is now shown for car, bus/coach, rail and air over much longer distances. Firstly, Figure 7.14 shows the model results for car.

Figure 7.14: Mode split by distance, Car, long distance ranges, (% trips), 1995&2020 Scenarios



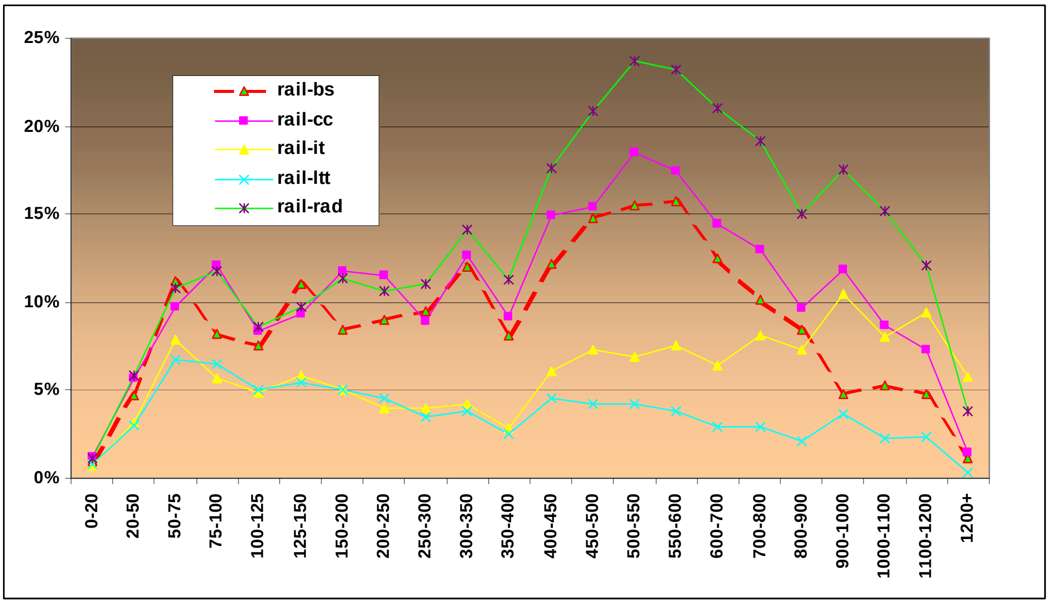
Again, it is the Scenario Radical which has the greatest effect on the modal share of Car when viewed over these longer distance ranges. Perhaps surprisingly, the Income Tracking Scenario sees the largest Car modal share, as the other modes are disproportionately affected by the large cost increases applied in this test. It should be remembered that this is a higher modal share of a smaller overall volume of travel however, as the cost changes in this Scenario do have a major effect in limiting the growth of travel. The LTT Scenario also sees significant increases in the modal share of car, except over the very longest distances. Figure 7.15 Now shows the same type of model results for Bus / Coach.

Figure 7.15**:** Mode split by distance, Coach/Bus, long distance ranges, (% trips), 1995&2020 Scenarios



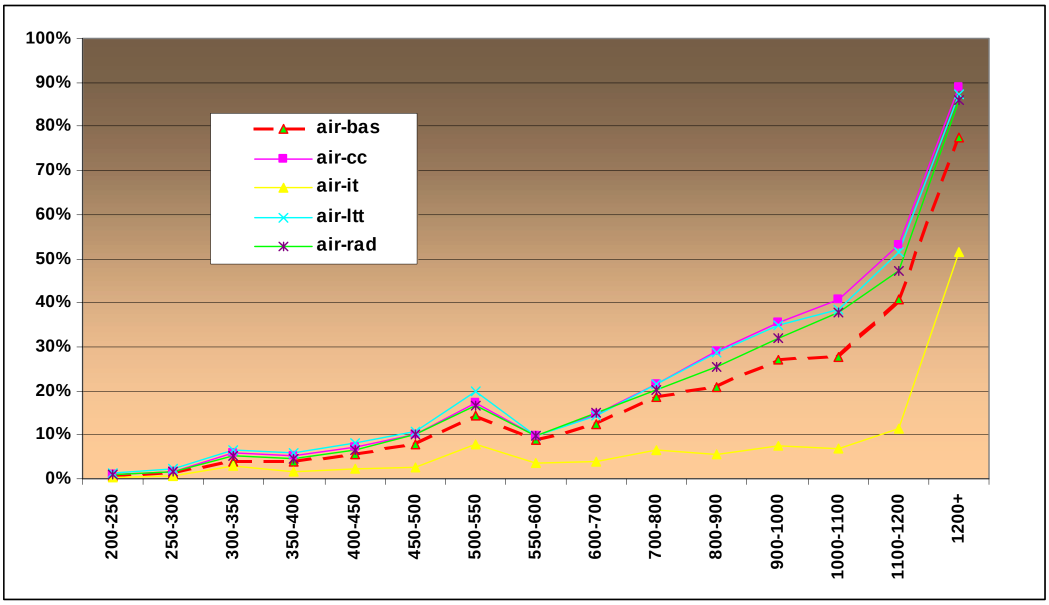
The Scenario Radical is seen to have a major effect on Coach modal share between 150 and 700km. All the other Scenarios see a reduction in the modal share of Coach, most significantly in the case of the LTT Scenario. Figure 7.16 Now shows the same type of model results for Rail.

Figure 7.16**:** Mode split by distance, Rail, long distance ranges, (% trips), 1995&2020 Scenarios



Very large variations are seen in the modal share of rail (including high-speed train) between the four Scenarios and the Base Year. The LTT Scenario, where Rail costs increase significantly whilst Car costs remain stable, results in a very significant loss in Rail's modal share over all distances. On the other hand, the Scenario Radical, which is almost the reverse of LTT, results in large gains in the modal share of Rail. The CC Scenario also sees some gains for rail over the medium and longer distances. In this case, all other things being equal, increases in incomes lead to more people choosing the faster modes – this may explain this tendency here. Figure 7.17 shows the same type of model results for Air.

Figure 7.17**:** Mode split by distance, Air, long distance ranges, (% trips), 1995&2020 Scenarios

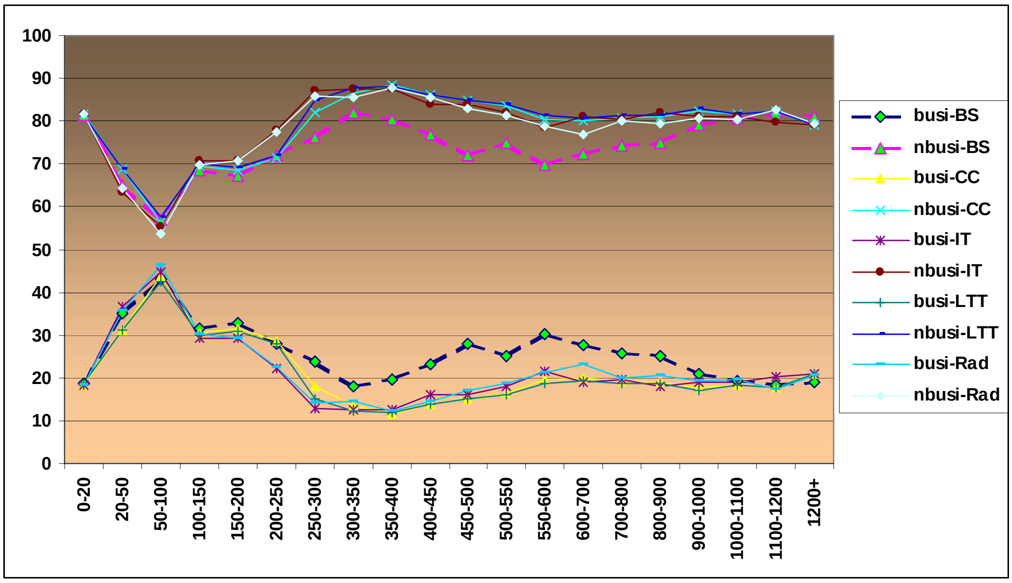


The modal share changes for Air are perhaps less than for the other modes. The exception is rhe IT Scenario. Here, across the board transport costs increases affect the most expensive mode significantly, leading to a dramatic loss in modal share for the Air mode.

7.3.5 Trip purpose by Distance

This section briefly looks at the changes in trip purpose over different distance bands forecast for 2020. Figure 7.18 shows the proportions of all trips made over different distances, split by the aggregated business / non-business travel purposes, for each of the four Scenarios and the base year.

Figure 7.18: Broad trip purpose by distance, (% trips), 1995&2020 Scenarios



A clear pattern emerges when the trips are considered in this way. Firstly, there are not great differences between each of the four 2020 Scenarios in this regard. However between the 1995 base year and the 2020 Scenarios, there is a higher proportion of leisure trips over the middle distance ranges. This difference disappears over the very longest distances. This is because these trip will largely comprise the international ‘tourism’ trips – these are both business and holiday trips which include at least one overnight stay. The same growth rate was applied to both these trip rates in the model, in line with World Tourism Organisation forecasts.

For the other trips, the increased car availability in 2020 leads to a higher growth in leisure trips than business and commuting trips. This explains the increase in the proportion of leisure trips over the short and medium distance ranges.

This Chapter has reported the results of the 2020 forecast Scenarios in some detail, both in terms of aggregate person-km travelled, and the behavioural characteristics of the trips which make up these aggregates. Chapter 8 now reports the results of the 2020 forecasts for the freight model.

8. Freight model 2020 scenario results

This Chapter presents the results of the four freight Transport Scenario forecasts outlined in Chapter 6. As was the case with the passenger Scenarios, it is possible to present the freight Scenario results in many different and detailed ways, using for example, combinations of the 13 Transport Flows, several main modes, and the 206 internal EU zones. The main outputs presented here are tonnes lifted and tonne-km moved by mode, and by Transport Flow – these are looked at from different geographical aspects. Clearly for freight movements, the international movements are of particular significance, so the imports / exports are looked at in more detail than was the case for the passenger forecasts.

There are three Sections in this Chapter which deal in turn with:

- the total freight tonnages in the modelled system,
- the freight tonnes lifted by each main mode, by country and Transport Flow for each 2020 Scenario, and
- the freight tonne-km by mode resulting from these freight movements, overall and by country, for each 2020 Scenario.

8.1 Total Freight tonnages – 2020 Scenarios

As outlined in Chapter 6, there is one 'External' Scenario which is used for the 2020 tests. In the freight model, this External Scenario is applied to the Regional Economic Model and it is this which determines the tonnes in the modelled system for 2020. The influence of the different transport cost regimes between the Scenarios determines the length of haul and hence the tonne-km moved, but does not affect the actual tonnages lifted (in the same way that transport disutilities do not affect the number of trips made in the passenger model, but do affect the person-km travelled). This section, which considers only the tonnages, does not therefore differentiate between the Scenarios, as the tonnages are effectively common to all.

Looking at the total amount of tonnes in the modelled system, Table 8.1 shows the main aggregate 2020 Scenario results. The 'intra-EU15 total' figure is the combination of the 'EU National' and 'Intra-EU15 international' tonnages.

Table 8.1: Total freight tonnages by movement, 1995 & 2020 ('000 / annum)

	TREX 'observed'	**1995 Modelled**	**2020 Modelled**	***1995-2020 Pa growth***
Intra-EU15 total	11,418,021	11,424,424	14,604,528	*0.99*
EU15 national	10,653,388	10,638,725	13,116,210	*0.84*
Intra-EU15 international	764,633	785,699	1,488,318	*2.59*
CEEC – EU15	98,227	103,376	245,022	*3.51*
EU15 – CEEC	25,588	26,105	60,270	*3.40*
Rest Europe - EU15	191,426	190,953	453,161	*3.52*
EU15 – rest Europe	79,891	74,711	163,471	*3.18*
Rest World – EU15	544,016	542,551	1,171,908	*3.13*
EU15 – rest World	179,210	182,732	427,821	*3.46*

Table 8.1 therefore shows the modelled and 'observed' values for 1995, together with the 2020 forecast, and the percentage per annum growth rates in each case. The main trend is that international tonnages are growing at a much faster rate than national tonnages. In addition the tonnages imported and exported to / from the EU are growing at a slightly faster rate than international tonnages within the EU. The dominance of the national markets in terms of tonnes is still clear from these figures in 2020, accounting for more than three quarters of the tonnes lifted here.

Table 8.2 goes on to show these increases in tonnages disaggregated to the 13 Transport Flows used in the freight model. Also shown in this table is the freight handling category. This helps to illustrate how the highest growth rates are seen away from the Solid Bulk flows.

Table 8.2: Growth in freight tonnes lifted by Transport Flow: 1995-2020 % per annum

	Transport Flow (% pa growth, tonnes)												
	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***
Handling Category	***GC***	***U***	***U***	***SB***	***LB***	***GC***	***U***	***SB***	***SB***	***GC***	***GC***	***U***	***U***
Intra-EU15 total	***.40***	***1.0***	***.90***	***.84***	***.83***	***1.6***	***.86***	***.84***	***1.1***	***1.4***	***2.4***	***2.7***	***1.3***
EU15 national	*.15*	*.92*	*.81*	*1.0*	*.46*	*1.3*	*.82*	*.85*	*.80*	*1.0*	*1.8*	*1.9*	*1.0*
Intra-EU15 International	*2.5*	*2.2*	*1.9*	*-1.1*	*2.5*	*2.9*	*2.1*	*.44*	*2.3*	*3.0*	*4.8*	*5.3*	*4.2*
CEEC – EU15	*3.0*	*5.0*	*3.6*	*3.2*	*2.9*	*3.9*	*3.2*	*3.2*	*3.2*	*3.6*	*5.2*	*5.2*	*4.5*
EU15 – CEEC	*2.7*	*3.5*	*3.7*	*2.0*	*2.3*	*3.9*	*.46*	*3.9*	*3.2*	*3.6*	*5.0*	*5.0*	*4.0*
Rest Europe – EU15	*3.7*	*5.0*	*4.6*	*3.6*	*2.7*	*4.1*	*3.1*	*3.4*	*3.4*	*3.9*	*5.6*	*6.8*	*5.6*
EU15 – rest Europe	*2.9*	*4.9*	*3.9*	*1.5*	*1.8*	*3.9*	*-2.2*	*3.2*	*3.4*	*3.4*	*4.9*	*4.8*	*4.0*
Rest World – EU15	*2.8*	*3.5*	*3.6*	*3.1*	*2.9*	*3.5*	*3.0*	*3.3*	*3.2*	*3.0*	*4.5*	*4.5*	*3.9*
EU15 – rest World	*2.9*	*6.4*	*3.9*	*3.0*	*1.9*	*3.9*	*-.46*	*3.3*	*3.5*	*3.0*	*4.9*	*5.1*	*4.2*

Transport Flows: 1 - Agricultural products, 2 - Consumer food, 3 - Conditioned food, 4 - Solid fuels and ores, 5 - Petroleum products, 6 - Metal products, 7 - Manufactured building materials, 8 - Crude building materials, 9 - Basic chemicals, 10 - Fertilisers, plastics and other chemicals, 11 - Large machinery, 12 - Small machinery, 13 - Miscellaneous articles
Handling Category: GC – General Cargo, U – Unitised, SB – Solid Bulk, LB – Liquid bulk

The Transport Flows which generally see the highest rates of growth are Flows 11 and 12 – these are Large and Small Machinery flows respectively. This represents the higher value products which are forecast to grow at a faster rate than the bulk products, e.g., Flows 4 and 8 (solid fuels and ores, and crude building materials) see much smaller rates of growth within the EU, at less than 1% per annum. The agriculture and food related flows (Flows 1, 2 and 3) also see smaller rates of volume growth.

Section 8.2 now looks at the modal share for the transportation of these tonnes, for each of the 2020 Scenarios.

8.2 Freight tonnes by main mode – 2020 Scenarios

This section considers the freight Scenario results in terms of tonnes lifted by main mode. The first part looks at modal split overall and by country, and the second considers the modal share by individual Transport Flow.

8.2.1 Tonnages by mode, EU and country level

This section looks at the modal share by 'main' mode, for 1995 and the four 2020 Scenarios. 'Main' mode means the mode attributed in the model to a consignment (or part consignment) between any origin – destination (OD) pair. This is based on a modal hierarchy as follows:

- Truck (LGV, HGV) – Level 1

- Railway (bulk, container, shuttle services) – Level 2
- Inland waterway (bulk and container) – Level 3
- Shipping (bulk and container) – Level 4
- Air Freight – Level 5
- Pipeline – Level 5

The mode attributed to a consignment in the matrix is the mode which is highest in this hierarchy for any given OD pair, so for example, where the mode 'Shipping' is attributed, this could be a combination of Truck and / or Rail and / or Inland Waterway and Shipping.

As explained above the absolute amount of tonnes in the system does not change significantly between the different 2020 Scenarios. In this section, the modal shares are presented, firstly for national tonnes, then for intra-EU international tonnes.

Table 8.3 shows the modal shares by main mode for all EU national tonnes lifted, for each of the four Scenarios and the base year (BF – Base Forecast Scenario, CC – Constant Cost Scenario, Int – Intervention Scenario, Tr – Trend Scenario).

Table 8.3: Modal share of EU national tonnes lifted (% tonnes), 1995 and 2020 Scenarios

Test	Truck	Rail	Shipping	IWW	Other
1995 Base	92.4	4.3	1.1	1.8	0.3
2020 BF	94.1	2.2	0.9	2.4	0.3
2020 CC	91.8	4.9	0.8	2.1	0.3
2020 Tr	93.0	2.8	1.0	2.8	0.3
2020 Int	88.6	6.8	1.2	3.1	0.3

There are significant differences in the modal share of national tonnages between the Scenarios. As might be expected the Constant Cost Scenario sees the smallest change from 1995, and the Intervention Scenario sees the greatest change. Indeed the Intervention Scenario sees a significant reduction in the share of Truck, down by over 4 percentage points from 1995. The modal share of Rail declines in both the Base Forecast and Trend Scenarios.

These changes are seen to a greater extent when the modal share of intra-EU international tonnes is considered, shown in Table 8.4.

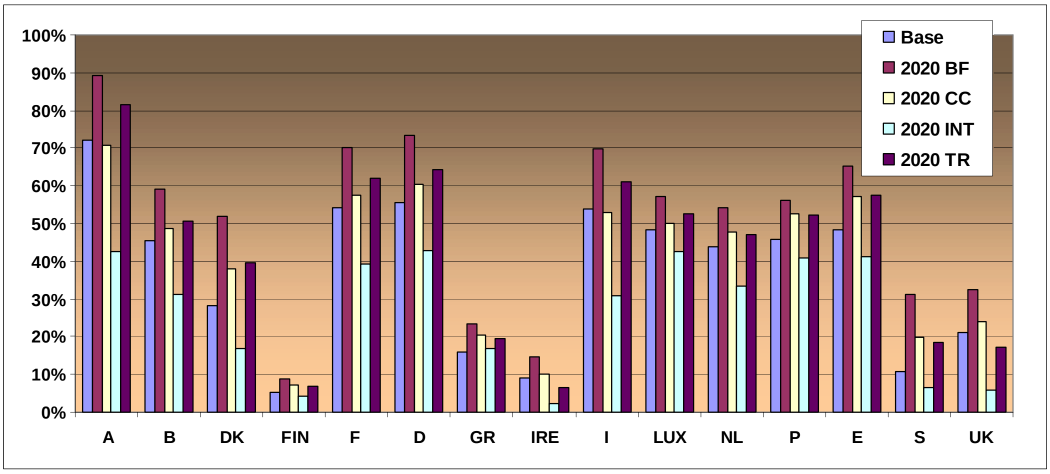
Table 8.4: Modal share of intra-EU international tonnes lifted (% tonnes), 1995 and 2020 Scenarios

Test	Truck	Rail	Shipping	IWW	Other
1995 Base	45.0	9.0	33.1	12.9	0.0
2020 BF	59.0	2.6	29.3	9.1	0.0
2020 CC	48.3	11.6	30.3	9.8	0.0
2020 Tr	50.2	4.4	34.2	11.2	0.0
2020 Int	31.5	18.7	36.4	13.5	0.0

The larger distances involved in the international tonnages exacerbates the effects of the different transport cost regimes of the Scenarios. The modal share of Truck is drastically reduced in the Intervention Scenario when the results are viewed in this form. Otherwise Truck's modal share increases in all cases between 1995 and 2020, with Rail seeing a large drop in both the Base Forecast and the Trend Scenarios.

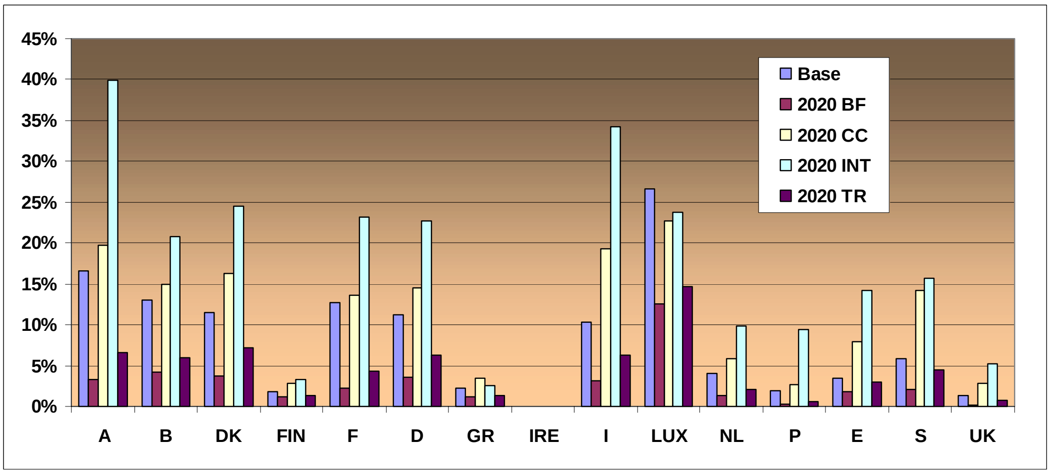
The intra-EU international modal tonnages are shown at the country level in the following figures. Figures 8.1 to 8.4 shows the percentage modal share of Truck, Train, Inland Waterway and Shipping respectively for tonnes lifted (by country of receipt). The results are shown for the base year and the four scenario tests. Note that in these definitions, a truck which travels by ferry is still regarded as a Truck trip.

Figure 8.1: Intra-EU international tonnages by country - % Truck



Geography dictates to a large degree some of the international modal share characteristics. For example, for EU trade with Finland, road transport is not an attractive option. Similarly for Greece, Ireland and Sweden. By contrast, more landlocked countries such as Austria, have a very high proportion of Truck use. This chart allows a comparison of the modal share of Truck for each of the 2020 Scenarios with each other and the base year. For example, in the Intervention Scenario, the modal share of Truck declines substantially relative to the 1995 figure. On the whole though, the proportion of Truck tonnes increases significantly for all other Scenarios and countries, with the odd exception.

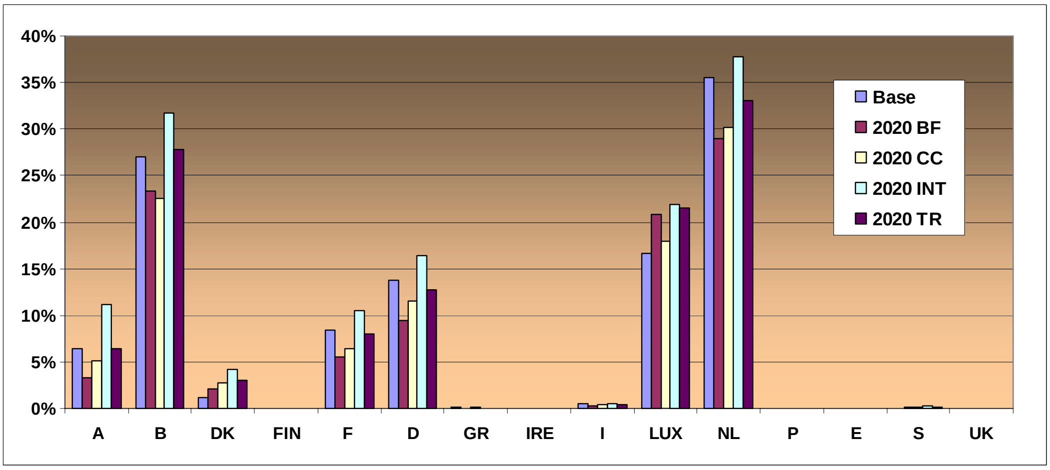
Figure 8.2: Intra-EU international tonnages by country - % Train



Looking at the modal share of international Rail, there is again a wide range of results for the different countries. Of the major countries, Austria has the highest share of Rail tonnes in the base year – this figure grows to nearly 50% in the Intervention Scenario. The effect of the Base Forecats Scenario in sharply reducing the share of international rail tonnes is clearly seen in all countries.

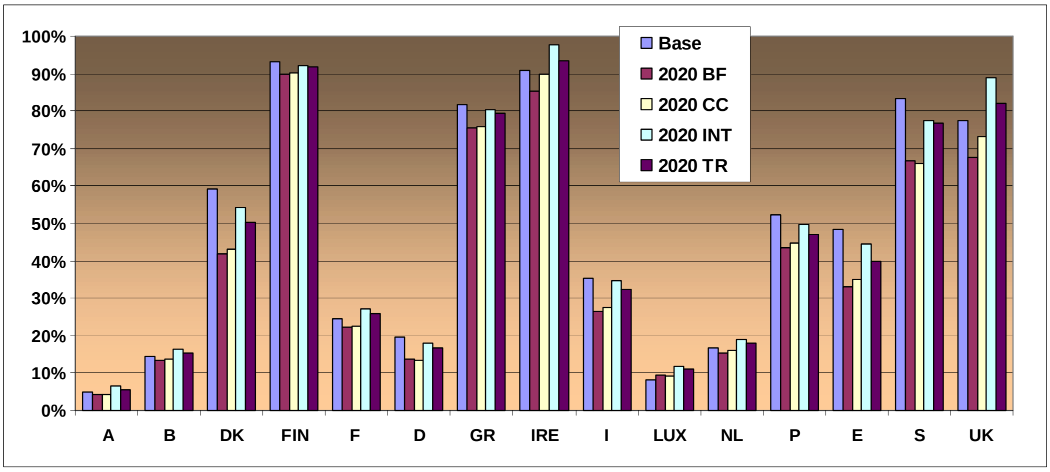
Figure 8.3 below now shows the modal share of Inland Waterway by country for EU international tonnages.

Figure 8.3: Intra-EU international tonnages by country - % Inland Waterway



Belgium and the Netherlands are clearly the most significant countries for Inland Waterway tonnages although Germany and Luxembourg also have a large volume of tonnes. In most countries, the only test which increases the proportion of IWW international tonnages is the Intervention Scenario, whilst the other scenarios see a reduction in modal share. Figure 8.4 now shows the same for of data for Coastal Shipping.

Figure 8.4: Intra-EU international tonnages by country - % Coastal Shipping

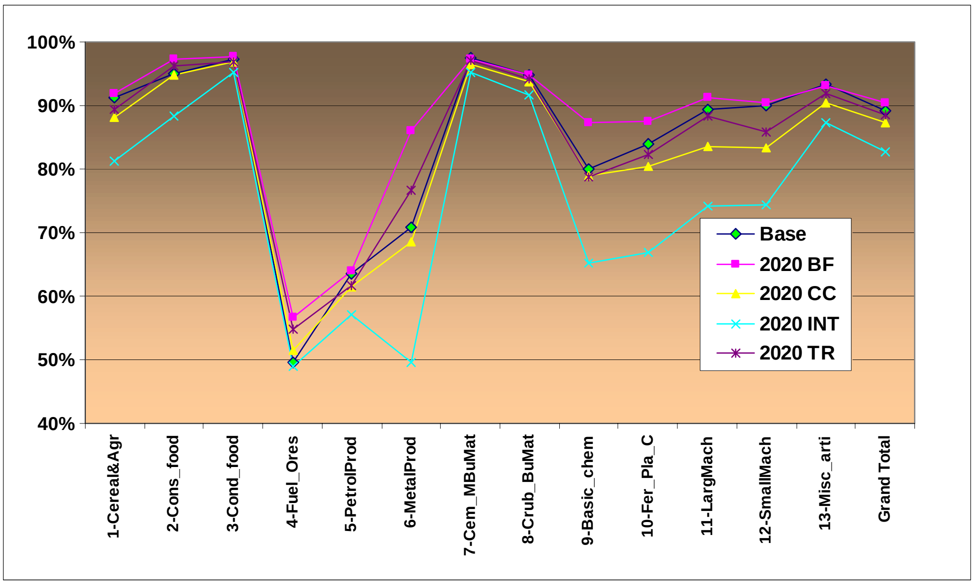


Coastal shipping clearly plays a very significant role in EU international freight, particularly so for Finland, Greece, Ireland, Sweden and the UK. The picture for the Scenarios is mixed, although most countries see a decline from the 1995 position in modal share in all Scenarios, even in some cases for the Intervention Scenario, such as Finland, Portugal, and Spain.

8.2.2 Tonnages by mode, by Transport Flow

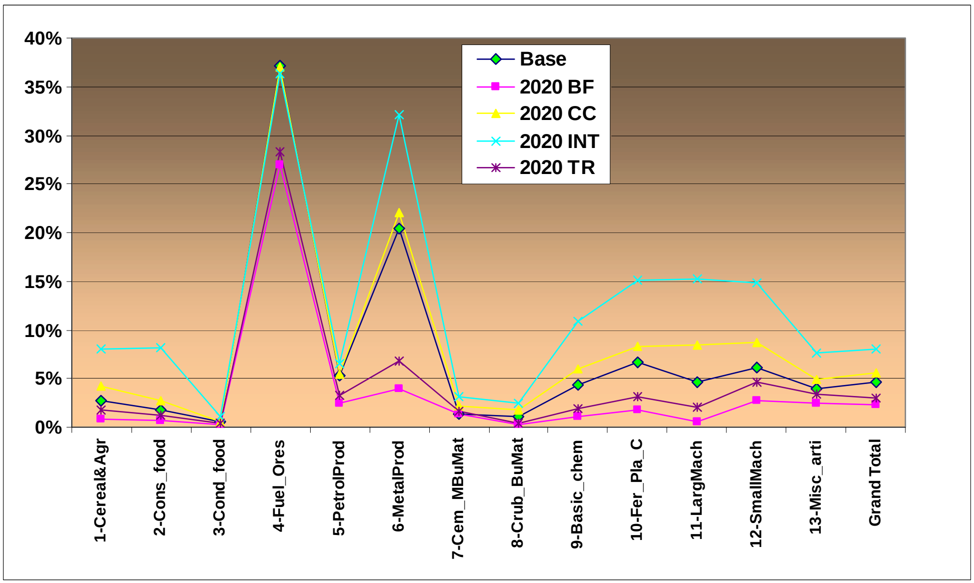
This Section reports the modal share of tonnages lifted by the 13 Transport Flows in the freight transport model. The Transport Flows were given in full with Table 8.2 above. It uses the same modal hierarchy as defined above to attribute a mode to an OD consignment. Figure 8.5 shows the proportion of Truck tonnes for each of the Transport Flows for the 1995 base and the four 2020 Scenarios. The freight movements included here are all national tonnes plus intra-EU international tonnes. Including the externals here would have distorting effect on the production of meaningful results.

Figure 8.5: Intra-EU international and National tonnages by Transport Flow - % Truck



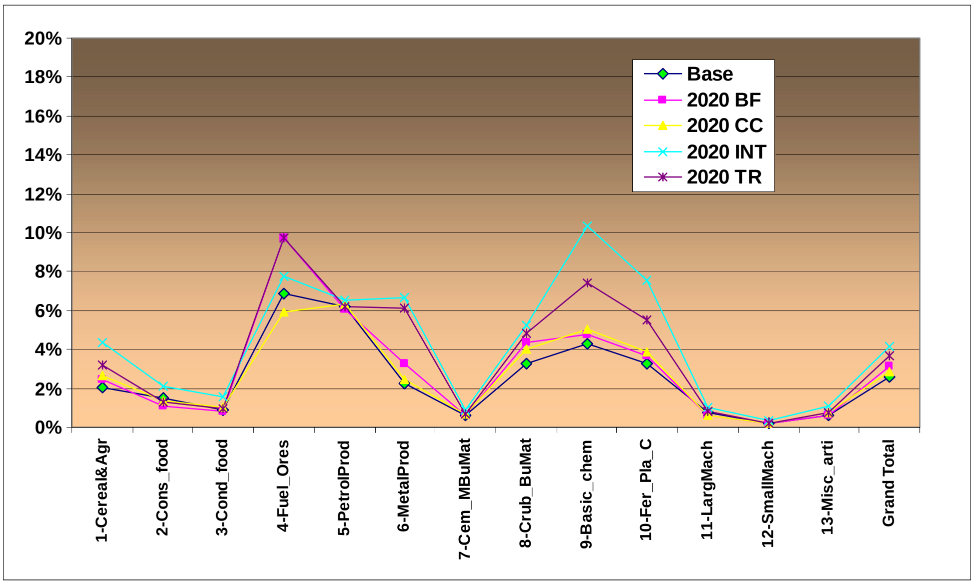
This figure partly shows that some Transport Flows are more sensitive to the 2020 cost Scenarios than others. For example, Flow 1 'Cereals and Agricultural Products' appears more sensitive to the cost changes than Flow 3 'Conditioned Food'. Some of the bulk flows also appear less sensitive, but this is in part to the shorter distances typically moved with these flows. Flows 6, 9, and 10 appear to have the the greatest range of Truck proportions. Figure 8.6 below shows the same type of data for Train.

Figure 8.6: Intra-EU international and National tonnages by Transport Flow - % Train



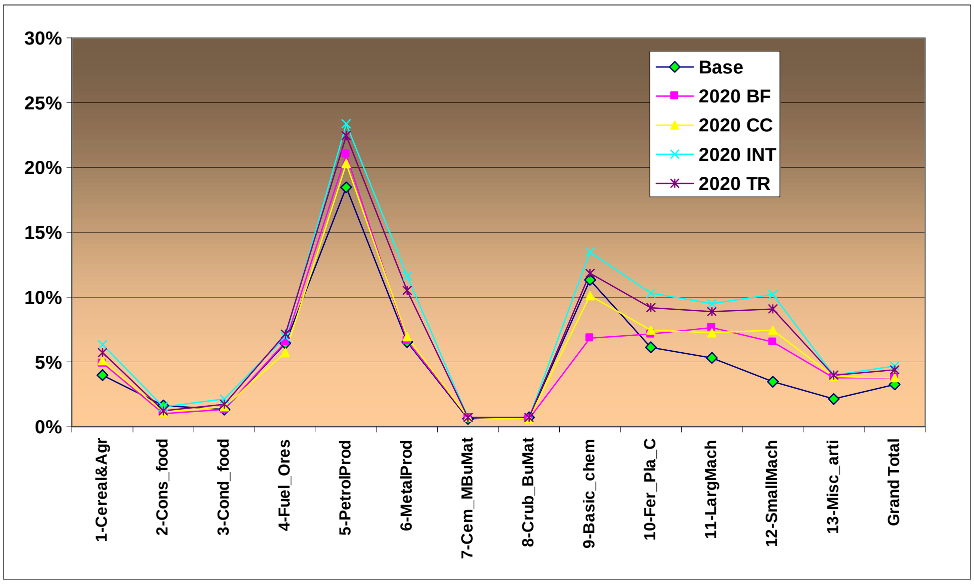
Compared to the 1995 base year results, the increase in the modal share of rail associated with the Intervention and Constant Cost Scenarios are particularly pronounced for Flows 1, 2, 6, 10, 11 and 12. These flows see particularly large positive changes in rail modal share compared to 1995. Other flows such as Flows 3, 5, 7 and 8 continue to have a low rail modal share in all the Scenarios. Figure 8.7 now shows the modal proportions by Transport Flow for Inland Waterway.

Figure 8.7: Intra-EU international and National tonnages by Transport Flow - % Inland Waterway



Inland Waterway plays a much smaller role than the other modes, but is still significant for some Flows and in some countries in particular. The most significant flows are Fuel Ores, Petroleum Products and Basic Chemicals, and the changes in these associated with the 2020 Scenarios can be seen above. Finally, Figure 8.8 shows the same sort of data for Coastal Shipping.

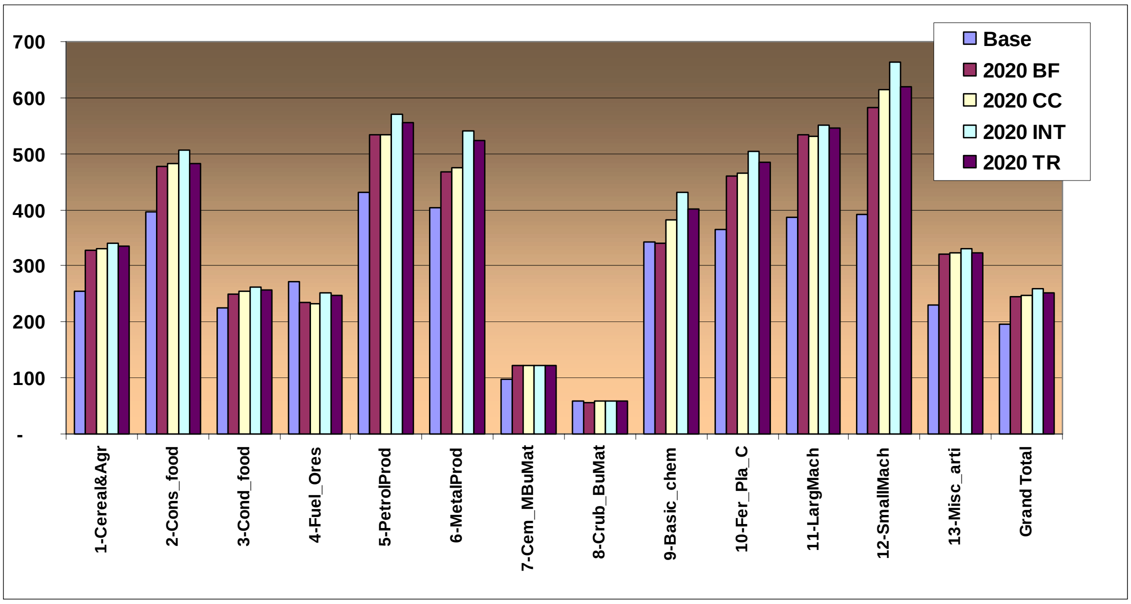
Figure 8.8: Intra-EU international and National tonnages by Transport Flow - % Coastal Shipping



The proportion of Coastal Shipping is generally low in this figure, since the figure includes national transport, where the Shipping proportions are much smaller than for international tonnages. This is reflected in the very low proportions for Flows 7 and 8 – these Flows are almost entirely national. Flows 1 to 4 see little change between the Scenarios, Flows 9 to 12 see more significant changes.

Finally in this Section, Figure 8.9 shows the average length of haul (simply tonne-km divided by tonnes) associated with each Transport Flow for this EU national and intra-EU international traffic.

Figure 8.9: Intra-EU international and National freight by Transport Flow – Average Distance (km)



The increases in average distance vary widely between the 13 Transport Flows. Flows 11 and 12 in particular see large increases, whilst the bulk Flows 7 and 8 see much smaller increases. The 'Total' figure above has increased from around 200 km in 1995 to approximately 250 km in 2020. This increase, together with the increase in tonnes in the modelled system gives rise to the changes in tonne-km which are reported in the next Section, 8.3.

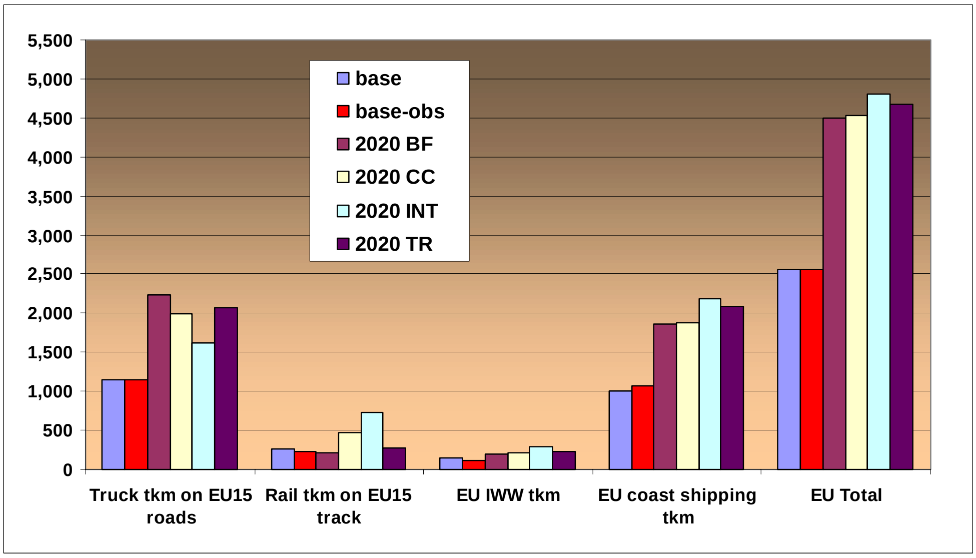
8.3 Freight tonne-km by mode – 2020 Scenarios

This Section reports the freight Scenarios in terms of tonne-km moved on the transport networks. This can be considered by mode and country. Results by mode for each of the Transport Flows are not reported, as modes are attributed based on the modal hierarchy described above. This leads to the potential for mis-interpretation, e.g., a journey from Austria to the UK which uses Truck and Shipping would attribute the full distance between Austria and the UK to Shipping, rather than just the Shipping element. The tonne-km results are therefore extracted from network based rather than matrix based results, and these cannot easily distinguish between individual Transport Flows.

Figure 8.10 below shows the main results, i.e., the total tonne-km by mode travelled on EU territory for the 1995 base year and the four 2020 Scenarios. These figures include the tonne-km travelled on EU territory by import and export traffic from and to outside the EU.

Also shown in Figure 8.10 are the equivalent estimates of 'Observed' figures for 1995, obtained from the Eurostat 'Transport in Figures' (2000) publication.

Figure 8.10: Tonne-km travelled on EU territory, 1995 & 2020, by mode (tonne-km *10^9 / annum)



This figure shows the very considerble increase which is forecast for tonne-km travelled on EU transport networks in each of the four 2020 Scenarios. Overall, the total tonne-km travelled nearly doubles between 1995 and 2020. It is initially surprising that the Scenario which sees the greatest overall volume of tonne-km is the Intervention Scenario. Detailed analysis of the results shows that with Truck being heavily penalised in this Scenario, much of the volume is diverted onto cheaper, but less direct modes such as Train and Shipping in particular. This results in a net increase in EU tonne-km for this test.

The large increase in Shipping tonne-km for all Scenarios can be attributed to the growth in international freight movements, relative to national freight which (as as shown above) is forecast to grow much more slowly. The comparison between the 1995 modelled and observed figures shows that the model reproduces the base year situation well.

There are also major modal differences between the four 2020 Scenarios, reflecting the cost regimes in each case. The Base Forecast Scenario sees the largest increase in Truck tonne-km and a reduction in Train tonne-km relative to the 1995 Base Year position.

The changes from 1995-2020 are shown below in Figure 8.11 overleaf as percent per annum changes in tonne-km by mode.

This figure clearly shows the very high growth rate of Train tonne-km resulting from the Intervention Scenario of over 4% per year, although even in this Scenario, Truck tonne-km still grows at more than 1% per annum. For the other tests, the growth rate for Truck tonne-km is more than 2% per annum and more than 2.5% for the Base Forecasts Scenario. The overall growth in tonne-km for each of the four Scenarios lies between 2.28% per annum and 2.56% per annum.

Figure 8.11: Change in Tonne-km on EU territory, 1995-2020, by mode (% per annum)

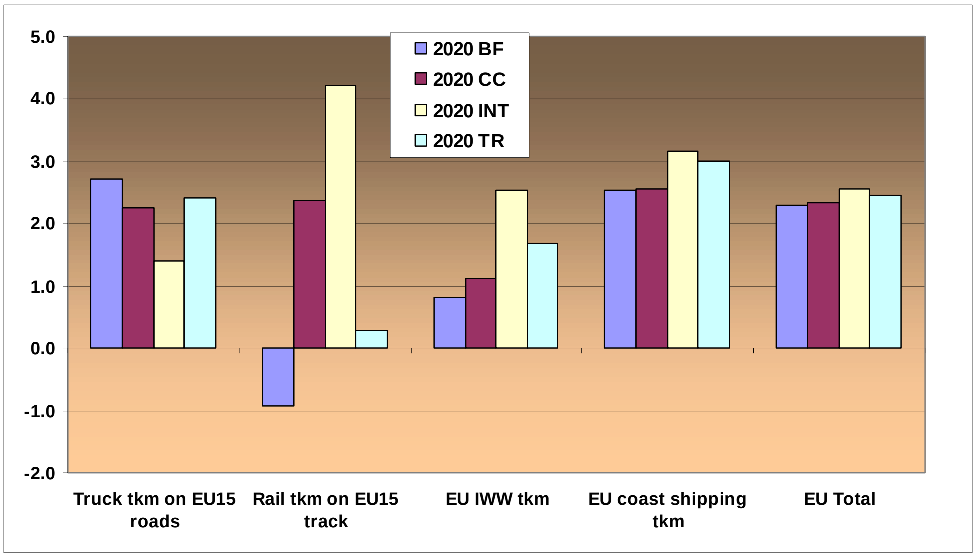
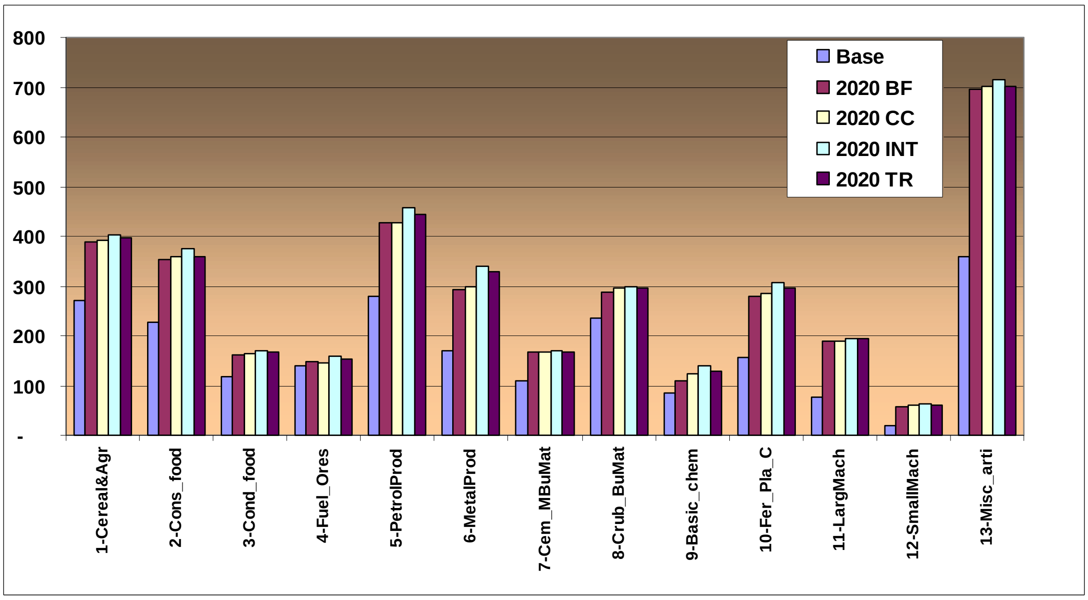


Figure 8.12 below now shows the tonne-km moved for each of the Transport Flows (for all modes), incorporating intra-EU international and EU national flows (i.e., excluding the externals). The purpose of this chart is to show the relativities of the Transport Flows in terms of the total tonne-km in the system.

Figure 8.12: Total intra-EU international and national tkm by Transport Flow (tkm * 10^9 / annum)



By 2020, Flow 13 (Miscellaneous Articles) has become much the dominant Transport Flow in terms of absolute tonne-km, although some of the less significant flows such as Flow 12 and Flow 11 have seen greater rates of growth in the 1995-2020 period. The bulk flows such as Flows 4, 8 and 9 see less significant increases in tonne-km moved.

Returning now to the forecasts by mode, the forecasts of tonne-km moved by Truck are firstly shown in absolute terms for the national territory level in Figure 8.13, below.

Figure 8.13: Tonne-km travelled within EU countries, Truck (tonne-km $*10^9$ / annum)

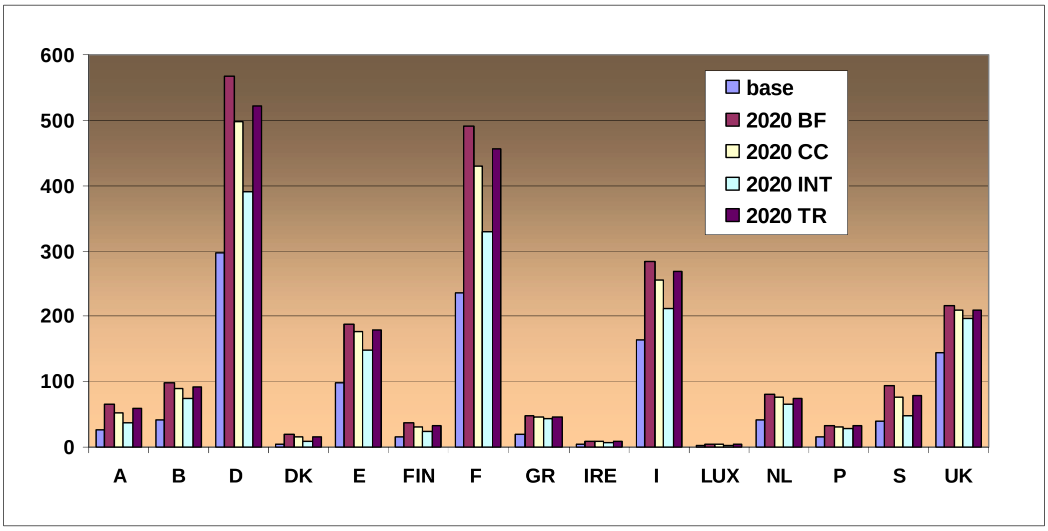
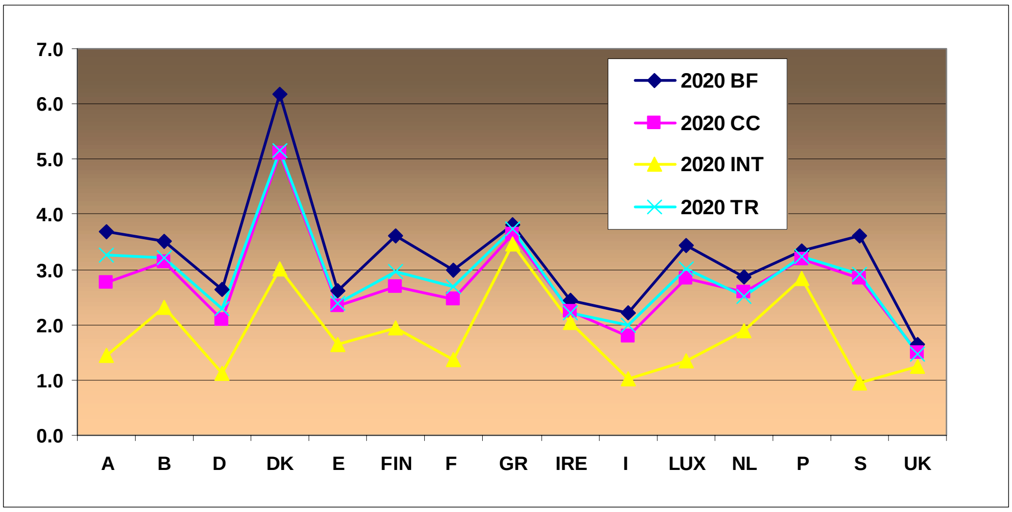


Figure 8.13 clearly shows how Germany, France, Italy and the UK dominate in terms of the absolute volumes of tonne-km moved by truck on EU road networks in 1995. The growing internationalisation of freight traffic in 2020 means that Germany, France and Italy outstrip the UK for Truck tonne-km in 2020. Almost without exception, all countries encounter increases in Truck tonne-km in all the 2020 Scenarios.

The changes between 1995 and 2020 are more clearly demonstrated for each of the four Scenarios in Figure 8.14, below where the percent per annum changes are shown.

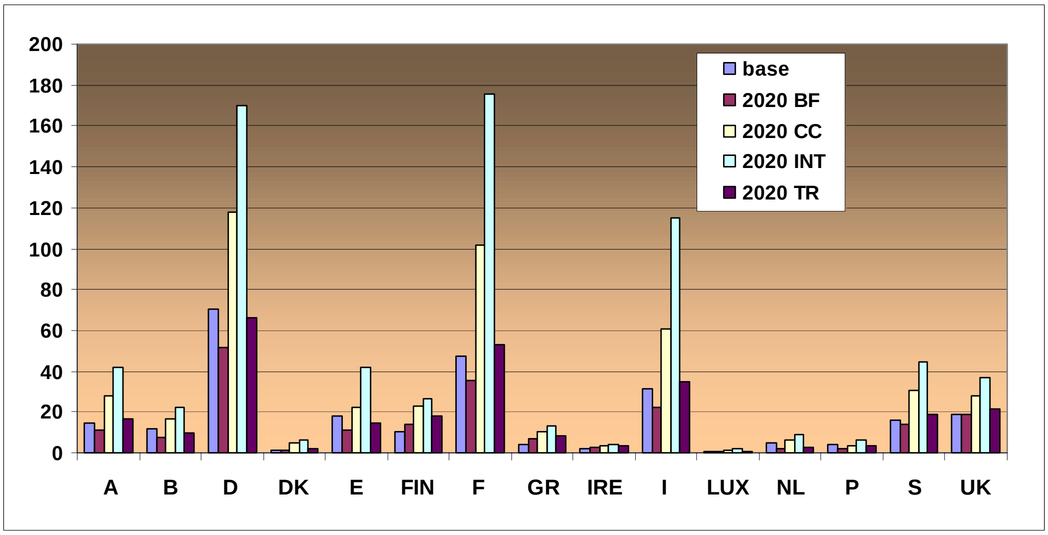
Figure 8.14: Change in Tonne-km on EU territory by country, Truck, 1995-2020 (% per annum)



The general trend is seen in most countries, the Base Forecast has the highest growth in Truck tonne-km, and the Intervention Scenario has the least. In between, the Constant Cost and Trend Scenarios see more similar growth rates. There is however a wide range of growth rates between countries, with the UK in general seeing the smallest growth, and Denmark, Belgium and Portugal seeing the largest growth rates.

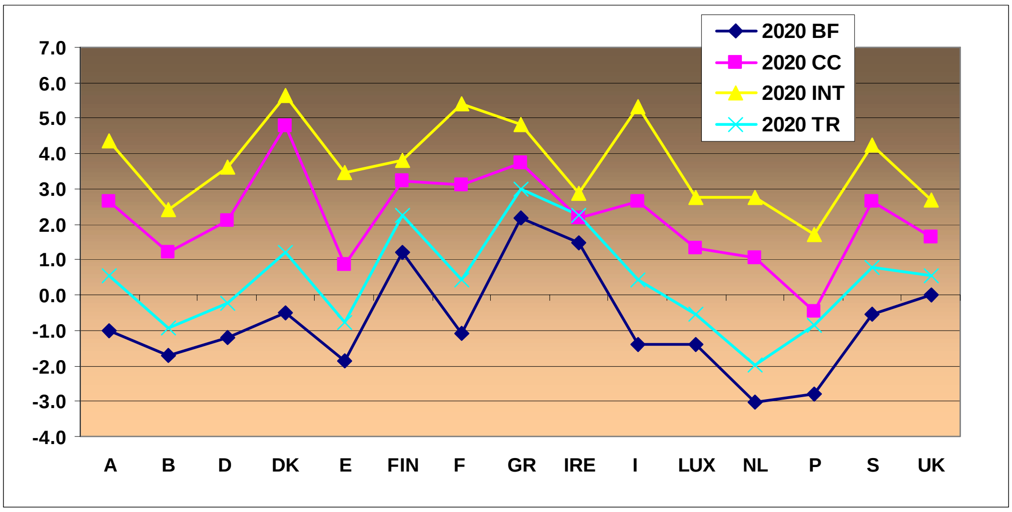
The absolute figures for forecasts of Train tonne-km by country are now shown in Figure 8.15, below.

Figure 8.15: Tonne-km travelled within EU countries, Train (tonne-km $*10^9$ / annum)



The country level figures show that Germany, France and Italy have by far the largest amounts of tonne-km within their borders for the Intervention and Constant Cost Scenarios. The Intervention Scenario in particular produces very large volumes of rail tonne-km in France. The caveat here is that there are no rail capacity restrictions represented on the networks, so this result is pure demand. Aside from this combination of two Scenarios and three countries, the volumes of tonne-km are much more modest. Figure 8.16 shows the equivalent growth rates in rail tonne-km at the national level.

Figure 8.16: Change in Tonne-km on EU territory by country, Train, 1995-2020 (% per annum)



There is a very regular pattern here, with the growth in rail tonne-km increasing in virtually all countries as the tests go from Base Forecasts to Trend to Constant Cost and finally Intervention. The Base Forecast Scenario sees a decline in rail freight in all countries except Finlnd, Ireland and the UK whilst the Trend Scenario has a more even spread between countries increasing and decreasing rail tonne-km. The Intervention Scenario sees very high growth rates forecast of over 5% in Denmark, France and Italy, and genarally above 2% per annum in other countries.

This Chapter has shown the results of the 2020 Scenarios which have been developed for the freight model. The next Chapter reports the levels of road transport on the networks when the passenger and freight components are combined.

9. Combined 2020 model network flows

The 1995 modelled road network flows were presented in Chapter 5, at the EU and country level. Here, the Passenger and Freight 2020 Scenarios are combined and presented together with the 1995 results. In this way, an indication of the likely future traffic levels on the European road network can be established.

The Scenarios are combined as follows:

- Passenger ‘Constant Cost’ and Freight ‘Constant Cost’ [CC],
- Passenger ‘Radical’ and Freight ‘Intervention’ [Rad-Int],
- Passenger ‘Long Term Trend’ and Freight ‘Trend’ [TR], and
- Passenger ‘Income Tracking’ with Freight ‘Base Forecast’ [IT-BF].

The last combination of Scenarios is clearly the least satisfactory of the four, the first three being more internally consistent, but is included in any case for illustrative purposes. The aggregate results are shown in Table 9.1 below. This table shows the percentage of road network kilometres in the EU which carry each range of traffic, e.g., in the Constant Cost combined Scenario (CC), 14.5% of the road network carries between 20,000 and 30,000 pcu / day. Note that the intrazonal links are not included in these calculations.

Table 9.1: Proportion of network km by transport flow, combined 2-way flow, 1995 and 2020

	‘000 pcu / day							
	<10	**10-20**	**20-30**	**30-50**	**50-70**	**70-100**	**100+**	**Grand Total**
Base	38.1	21.9	12.9	14.5	5.4	4.1	3.2	135,580.5
CC	27.5	18.0	14.5	16.9	9.0	6.7	7.3	142,134.9
TR	25.8	16.9	13.7	18.1	10.2	6.9	8.4	142,134.9
Rad-Int	31.9	19.8	12.6	16.6	8.2	5.0	5.9	142,134.9
IT_BF	24.2	16.9	14.2	18.9	10.9	7.0	7.9	142,134.9

This Table illustrates the very significant increase in road traffic associated with the growth in travel forecast in all of the Forecast Scenarios. It also shows the increase in the network from 1995 to 2020 associated with new road construction. Looking at the flows, from the 30,000 to 50,000 pcu / day range onwards, all Scenarios see an increase in the percentage of network-km found in these traffic volume ranges. The combined ‘Trend’ Scenario leads to the largest kilometerage of road with flows of greater than 70,000 pcu / day. Conversely, the combined ‘Radical-Intervention’ Scenario sees the fewest network kilometres experiencing this level of traffic – but even in this Scenario, there is a significant increase from the base year.

Figure 9.1 overleaf shows the EU figures as in Table 9.1 above, but differentiated for each of the four road types: toll motorway, motorway, dual carriageway and other road.

Tables 9.2 to 9.6 then show country level results in the same format for the 1995 Base Year and the four 2020 combined Scenarios.

Figure 9.1: Percentage of EU road network km by traffic volume, 1995 and 2020, by Road Type

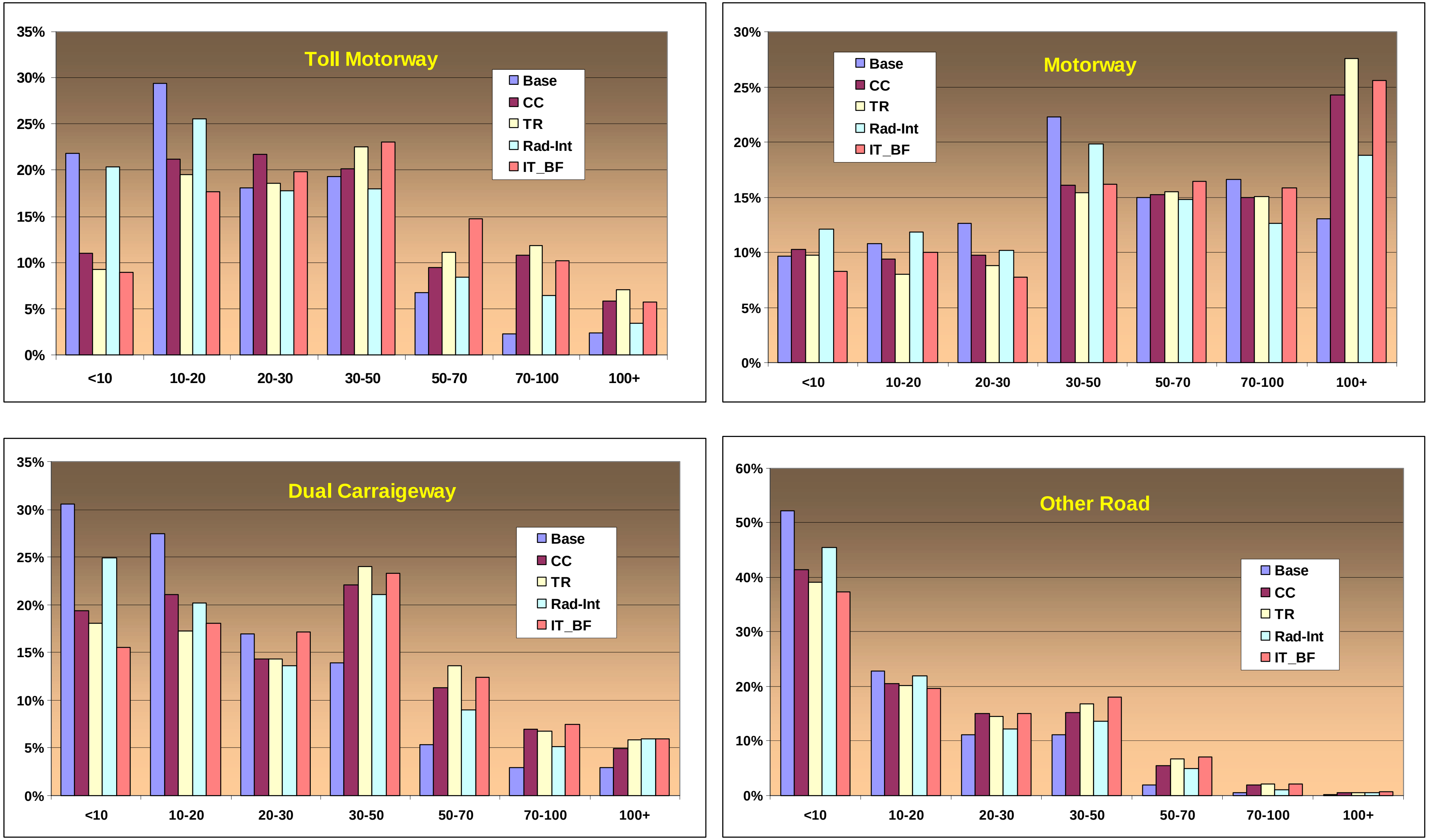


Table 9.2: Country level road traffic flows by road type (% kms), by traffic flow (pcu), 1995 Base Year

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Austria								
t-mway	53.8	21.5	0.0	24.7	0.0	0.0	0.0	96
Mway	3.7	13.1	41.8	18.6	11.1	8.5	3.1	1,434
Dual	12.7	62.8	17.3	6.8	0.0	0.4	0.0	368
Other	58.1	26.1	7.3	8.1	0.1	0.3	0.0	2,600
Belgium								
t-mway	-	-	-	-	-	-	-	
Mway	3.6	5.1	11.4	21.1	22.2	16.6	19.9	1,546
Dual	41.6	24.4	14.7	14.5	2.5	1.8	0.5	913
Other	50.6	18.3	13.9	11.2	4.1	1.7	0.2	1,397
Germany								
t-mway	-	-	-	-	-	-	-	
Mway	5.9	6.6	9.9	23.2	15.5	23.6	15.4	11,140
Dual	19.1	22.9	16.0	23.6	9.6	6.7	2.1	1,597
Other	40.8	28.4	12.4	14.8	2.8	0.5	0.2	15,973
Denmark								
t-mway	-	-	-	-	-	-	-	
Mway	33.1	42.5	0.7	23.7	0.0	0.0	0.0	713
Dual	100.0	0.0	0.0	0.0	0.0	0.0	0.0	15
Other	100.0	0.0	0.0	0.0	0.0	0.0	0.0	654
Spain								
t-mway	34.7	32.5	24.0	8.8	0.0	0.0	0.0	1,912
Mway	15.2	30.6	35.4	18.4	0.4	0.0	0.0	503
Dual	42.5	31.2	13.5	7.4	1.8	0.0	3.5	4,366
Other	58.3	25.8	8.5	7.4	0.0	0.0	0.1	7,126
Finland								
t-mway	-	-	-	-	-	-	-	-
Mway	47.7	9.3	13.1	29.9	0.0	0.0	0.0	396
Dual	-	-	-	-	-	-	-	-
Other	89.0	7.8	1.8	1.4	0.0	0.0	0.0	5,247
France								
t-mway	21.9	30.0	20.3	14.4	9.4	2.1	1.9	6,064
Mway	14.8	15.7	14.3	33.5	7.6	7.9	6.2	2,181
Dual	22.4	33.4	19.3	14.1	4.1	2.9	3.8	3,888
Other	29.4	34.8	15.0	17.0	3.2	0.4	0.2	12,883
Greece								
t-mway	30.4	26.3	0.0	40.7	2.6	0.0	0.0	753
Mway	-	-	-	-	-	-	-	-
Dual	53.7	29.4	0.0	14.7	2.1	0.0	0.0	183
Other	88.2	6.9	0.0	4.9	0.0	0.0	0.0	3,088

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Ireland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.7	33.8	33.6	10.9	0.0	0.0	0.0	51
Dual	63.5	1.1	27.8	7.5	0.0	0.0	0.0	109
Other	77.6	14.7	4.1	3.6	0.0	0.0	0.0	2,103
Italy								
t-mway	16.7	26.5	15.6	25.7	7.3	3.7	4.4	5,488
Mway	35.0	18.7	9.3	16.2	19.7	0.5	0.6	860
Dual	34.0	33.6	20.4	8.8	2.4	0.2	0.5	2,024
Other	40.4	21.8	18.9	15.4	2.2	1.2	0.0	7,495
Luxembourg								
t-mway	-	-	-	-	-	-	-	-
Mway	0.0	7.1	12.4	40.2	17.9	22.4	0.0	77
Dual	0.0	0.0	100.0	0.0	0.0	0.0	0.0	5
Other	15.6	37.7	34.8	11.9	0.0	0.0	0.0	203
Netherlands								
t-mway	-	-	-	-	-	-	-	-
Mway	3.5	11.4	11.7	26.2	18.8	14.6	13.9	2,092
Dual	34.1	15.9	20.8	21.3	2.6	2.9	2.2	234
Other	33.7	24.4	22.4	15.0	2.9	1.6	0.0	1,504
Portugal								
t-mway	3.3	53.6	28.0	15.1	0.0	0.0	0.0	404
Mway	6.5	37.0	41.5	0.9	14.1	0.0	0.0	91
Dual	63.3	5.9	22.5	7.6	0.7	0.0	0.0	273
Other	76.0	15.6	8.3	0.0	0.0	0.0	0.0	2,875
Sweden								
t-mway	-	-	-	-	-	-	-	-
Mway	24.1	31.8	22.9	14.4	0.6	0.0	6.2	942
Dual	29.5	30.0	27.6	6.8	6.1	0.0	0.0	475
Other	81.9	12.0	3.4	1.4	1.2	0.1	0.1	5,687
UK								
t-mway	-	-	-	-	-	-	-	-
Mway	7.3	4.2	4.8	14.8	24.5	21.4	23.0	3,175
Dual	22.5	15.5	16.2	21.3	12.2	7.6	4.8	3,820
Other	42.4	19.7	14.6	16.0	3.9	1.9	1.6	8,557

Table 9.3: Country level road traffic flows by road type (% kms), by traffic flow (pcu), 2020 combined Constant Cost Scenario

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Austria								
t-mway	8.3	0.0	45.4	21.5	0.0	24.7	0.0	96
Mway	2.6	4.8	11.9	40.5	19.5	7.6	13.2	1,556
Dual	7.3	30.9	25.6	30.0	5.8	0.0	0.4	368
Other	42.7	23.4	15.5	15.7	1.7	0.1	1.0	2,600
Belgium								
t-mway	-	-	-	-	-	-	-	
Mway	3.6	5.0	12.1	5.7	14.2	19.8	39.7	1,799
Dual	31.7	26.7	13.7	16.9	5.4	2.4	3.1	808
Other	39.9	23.1	13.0	10.5	7.1	4.7	1.6	1,367
Germany								
t-mway	-	-	-	-	-	-	-	
Mway	5.2	2.7	8.1	15.1	17.6	17.7	33.5	12,822
Dual	17.9	17.7	15.7	20.5	13.5	11.8	2.7	1,604
Other	34.2	26.5	15.8	17.1	4.8	1.3	0.2	15,824
Denmark								
t-mway	-	-	-	-	-	-	-	
Mway	30.3	13.4	10.2	3.0	0.6	37.2	5.4	940
Dual	0.0	100.0	0.0	0.0	0.0	0.0	0.0	7
Other	66.4	14.5	13.4	4.7	0.0	0.0	1.0	464
Spain								
t-mway	19.0	19.2	31.0	22.3	8.4	0.2	0.0	1,912
Mway	29.3	29.8	17.6	15.2	7.0	1.0	0.1	3,048
Dual	16.8	29.6	13.8	24.3	8.3	2.6	4.5	3,539
Other	36.8	28.7	19.3	10.4	4.8	0.0	0.1	5,612
Finland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.1	21.7	18.5	5.2	9.4	24.1	0.0	719
Dual	-	-	-	-	-	-	-	-
Other	79.8	13.5	3.1	3.3	0.0	0.3	0.0	4,910
France								
t-mway	7.5	25.7	23.5	21.5	9.9	8.4	3.5	7,799
Mway	7.4	21.5	10.3	22.7	18.1	11.0	9.0	3,398
Dual	10.3	15.5	22.5	21.9	14.8	9.7	5.2	3,886
Other	22.2	20.9	23.9	19.9	10.2	2.4	0.4	12,585
Greece								
t-mway	38.9	16.5	21.3	5.9	8.6	7.6	1.3	1,872
Mway	-	-	-	-	-	-	-	-
Dual	91.6	1.6	0.0	2.1	3.0	1.7	0.0	182
Other	78.8	11.0	5.3	2.4	2.4	0.1	0.0	2,177

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Ireland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.7	0.0	0.0	33.8	44.5	0.0	0.0	51
Dual	69.7	6.0	0.0	2.1	22.1	0.0	0.0	215
Other	71.4	5.6	4.5	11.5	6.6	0.4	0.0	1,996
Italy								
t-mway	5.2	18.6	17.6	19.4	8.8	18.6	11.9	5,922
Mway	27.4	14.2	6.1	18.5	12.9	19.9	1.0	905
Dual	21.0	34.0	13.9	21.6	6.0	1.3	2.1	2,093
Other	26.1	22.3	16.9	22.6	5.7	6.1	0.5	7,495
Luxembourg								
t-mway	-	-	-	-	-	-	-	-
Mway	0.0	19.2	5.8	42.4	0.0	32.6	0.0	95
Dual	0.0	0.0	100.0	0.0	0.0	0.0	0.0	5
Other	15.6	7.8	41.2	25.9	9.5	0.0	0.0	203
Netherlands								
t-mway	-	-	-	-	-	-	-	-
Mway	1.4	4.7	4.2	20.5	15.8	20.9	32.6	2,175
Dual	14.7	15.6	9.4	27.9	6.1	10.6	15.8	316
Other	21.0	27.1	19.8	25.0	4.4	2.5	0.3	1,405
Portugal								
t-mway	0.0	11.7	1.0	54.4	19.4	3.8	9.6	453
Mway	36.3	25.5	26.5	6.8	3.5	0.0	1.4	989
Dual	58.5	12.1	1.9	21.1	0.0	0.6	5.8	355
Other	67.4	15.4	8.8	8.4	0.0	0.0	0.0	2,856
Sweden								
t-mway	-	-	-	-	-	-	-	-
Mway	15.7	5.8	11.7	25.6	26.6	9.5	5.0	1,495
Dual	34.1	5.5	13.3	23.5	18.3	5.3	0.0	467
Other	79.3	8.2	8.0	3.8	0.6	0.1	0.1	5,094
UK								
t-mway	-	-	-	-	-	-	-	-
Mway	5.6	3.6	3.0	8.1	13.4	15.4	50.9	3,372
Dual	17.9	16.0	8.4	22.9	14.5	11.9	8.3	3,909
Other	32.4	18.6	13.0	20.8	9.7	3.6	2.0	8,356

Table 9.4: Country level road traffic flows by road type (% kms), by traffic flow (pcu), 2020 combined Trend Scenario

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Austria								
t-mway	0.0	8.3	45.4	10.6	10.9	24.7	0.0	96
Mway	2.6	4.2	3.5	38.0	24.2	10.7	16.8	1,556
Dual	7.3	30.9	22.4	30.8	8.2	0.0	0.4	368
Other	40.1	21.2	16.4	18.5	3.4	0.1	0.3	2,600
Belgium								
t-mway	-	-	-	-	-	-	-	
Mway	3.6	3.9	7.4	11.2	11.2	18.0	44.7	1,799
Dual	30.1	20.4	14.2	25.7	4.1	2.9	2.6	808
Other	33.6	25.7	15.6	11.5	7.1	4.7	1.9	1,367
Germany								
t-mway	-	-	-	-	-	-	-	
Mway	5.2	2.1	6.9	13.7	16.3	17.3	38.5	12,822
Dual	16.9	13.9	15.3	20.8	15.4	14.9	2.8	1,604
Other	31.9	25.5	15.2	19.7	5.8	1.4	0.5	15,824
Denmark								
t-mway	-	-	-	-	-	-	-	
Mway	27.9	15.2	5.5	8.2	0.6	34.8	7.8	940
Dual	0.0	100.0	0.0	0.0	0.0	0.0	0.0	7
Other	66.4	0.0	27.9	4.7	0.0	0.0	1.0	464
Spain								
t-mway	8.1	27.7	23.6	20.3	16.1	4.2	0.0	1,912
Mway	29.3	24.7	20.8	14.9	5.9	4.3	0.1	3,048
Dual	15.0	18.3	24.1	24.9	9.1	4.0	4.6	3,539
Other	31.6	30.0	21.9	12.3	3.8	0.2	0.1	5,612
Finland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.1	21.7	18.5	1.9	12.7	24.1	0.0	719
Dual	-	-	-	-	-	-	-	-
Other	79.5	13.7	3.1	2.1	1.2	0.3	0.0	4,910
France								
t-mway	5.8	23.0	18.9	26.5	11.7	7.8	6.3	7,799
Mway	5.9	14.1	14.4	20.7	22.2	11.9	10.8	3,398
Dual	8.9	11.2	17.9	27.3	19.6	8.9	6.3	3,886
Other	19.7	19.0	22.3	22.9	13.0	2.3	0.7	12,585
Greece								
t-mway	38.9	16.5	20.4	4.5	10.8	7.6	1.3	1,872
Mway	-	-	-	-	-	-	-	-
Dual	91.6	1.6	0.0	0.0	5.1	1.7	0.0	182
Other	75.4	14.4	5.3	2.4	2.4	0.1	0.0	2,177

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Ireland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.7	0.0	0.0	33.8	44.5	0.0	0.0	51
Dual	69.7	6.0	0.0	2.3	21.9	0.0	0.0	215
Other	71.4	5.6	4.5	11.5	6.6	0.4	0.0	1,996
Italy								
t-mway	5.5	14.1	17.0	21.5	8.3	21.5	12.1	5,922
Mway	27.4	11.3	5.9	12.3	15.8	25.9	1.5	905
Dual	19.4	33.0	12.7	22.4	9.2	1.0	2.3	2,093
Other	21.2	25.1	13.2	24.7	8.5	6.9	0.3	7,495
Luxembourg								
t-mway	-	-	-	-	-	-	-	-
Mway	0.0	0.0	23.5	14.6	29.2	14.5	18.1	95
Dual	0.0	0.0	100.0	0.0	0.0	0.0	0.0	5
Other	21.3	6.8	34.6	33.9	3.3	0.0	0.0	203
Netherlands								
t-mway	-	-	-	-	-	-	-	-
Mway	1.2	3.4	3.7	17.9	17.9	20.6	35.3	2,175
Dual	12.4	17.8	4.7	28.8	9.9	10.6	15.8	316
Other	21.0	22.5	24.8	24.1	4.7	2.3	0.7	1,405
Portugal								
t-mway	0.0	11.7	1.0	54.4	19.4	3.8	9.6	453
Mway	29.1	33.3	25.8	6.8	3.5	0.0	1.4	989
Dual	55.1	15.5	1.9	21.1	0.0	0.6	5.8	355
Other	66.4	18.3	6.9	8.4	0.0	0.0	0.0	2,856
Sweden								
t-mway	-	-	-	-	-	-	-	-
Mway	13.1	8.4	3.8	33.5	26.6	5.1	9.4	1,495
Dual	29.5	10.1	9.7	27.1	18.3	0.0	5.3	467
Other	78.4	9.1	6.0	5.7	0.6	0.1	0.1	5,094
UK								
t-mway	-	-	-	-	-	-	-	-
Mway	5.6	3.0	2.5	6.8	13.9	15.0	53.3	3,372
Dual	17.8	15.4	5.7	23.4	16.9	9.9	11.0	3,909
Other	31.3	17.5	13.7	20.7	10.8	3.9	2.1	8,356

Table 9.5: Country level road traffic flows by road type (% kms), by traffic flow (pcu), 2020 combined Radical-Intervention Scenario

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Austria								
t-mway	8.3	45.4	0.0	21.5	24.7	0.0	0.0	96
Mway	5.2	9.7	10.2	38.1	15.3	15.2	6.4	1,556
Dual	8.5	30.0	43.2	12.0	5.8	0.3	0.1	368
Other	46.6	24.2	15.5	12.2	1.2	0.2	0.1	2,600
Belgium								
t-mway	-	-	-	-	-	-	-	
Mway	4.6	8.3	7.3	12.6	17.6	16.5	33.2	1,799
Dual	35.6	20.7	19.4	16.1	4.1	2.1	2.1	808
Other	37.2	25.0	12.3	17.7	2.3	4.1	1.4	1,367
Germany								
t-mway	-	-	-	-	-	-	-	
Mway	5.4	5.2	9.0	22.0	17.9	16.0	24.4	12,822
Dual	17.9	15.6	16.9	21.2	15.1	10.7	2.5	1,604
Other	36.5	25.2	16.3	15.8	4.6	1.0	0.5	15,824
Denmark								
t-mway	-	-	-	-	-	-	-	
Mway	30.3	12.8	13.8	8.9	28.9	2.8	2.5	940
Dual	0.0	100.0	0.0	0.0	0.0	0.0	0.0	7
Other	66.4	0.0	27.9	4.7	0.0	0.0	1.0	464
Spain								
t-mway	19.0	24.1	28.0	23.5	5.4	0.0	0.0	1,912
Mway	31.7	37.4	10.0	10.9	8.9	1.1	0.1	3,048
Dual	24.2	28.9	14.9	19.4	5.0	3.1	4.5	3,539
Other	40.1	33.7	11.2	11.8	3.1	0.0	0.1	5,612
Finland								
t-mway	-	-	-	-	-	-	-	-
Mway	19.6	25.1	17.0	14.2	1.0	23.0	0.0	719
Dual	-	-	-	-	-	-	-	-
Other	82.0	11.6	2.7	2.2	1.2	0.2	0.1	4,910
France								
t-mway	19.1	30.2	17.6	19.5	3.5	8.8	1.4	7,799
Mway	12.7	24.3	13.0	27.0	10.8	6.1	6.1	3,398
Dual	18.0	18.7	14.7	27.6	7.4	3.0	10.6	3,886
Other	28.6	31.9	11.1	20.6	6.3	1.0	0.4	12,585
Greece								
t-mway	49.2	6.3	21.3	3.7	10.8	7.6	1.3	1,872
Mway	-	-	-	-	-	-	-	-
Dual	91.6	1.6	0.0	2.1	3.0	1.7	0.0	182
Other	75.4	14.4	5.3	2.4	2.4	0.1	0.0	2,177

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Ireland								
t-mway	-	-	-	-	-	-	-	-
Mway	21.7	0.0	0.0	33.8	44.5	0.0	0.0	51
Dual	69.7	6.0	0.0	2.3	21.9	0.0	0.0	215
Other	71.4	5.6	4.5	11.5	6.6	0.4	0.0	1,996
Italy								
t-mway	15.0	26.8	12.9	17.8	14.7	5.4	7.4	5,922
Mway	35.5	12.2	8.9	23.6	19.2	0.0	0.6	905
Dual	37.7	27.2	14.8	12.5	5.0	2.0	0.8	2,093
Other	38.0	19.0	18.3	14.2	8.1	2.4	0.0	7,495
Luxembourg								
t-mway	-	-	-	-	-	-	-	-
Mway	0.0	19.2	8.3	39.9	0.0	14.5	18.1	95
Dual	0.0	0.0	100.0	0.0	0.0	0.0	0.0	5
Other	15.6	14.6	48.3	18.2	3.3	0.0	0.0	203
Netherlands								
t-mway	-	-	-	-	-	-	-	-
Mway	1.9	5.0	5.6	23.2	16.6	21.7	26.0	2,175
Dual	14.7	17.8	7.2	23.0	18.4	9.3	9.7	316
Other	21.4	28.4	18.9	24.3	4.3	2.4	0.1	1,405
Portugal								
t-mway	0.9	10.8	31.2	30.7	12.9	3.8	9.6	453
Mway	50.6	27.2	10.6	6.8	3.5	1.3	0.1	989
Dual	58.5	12.1	1.9	21.1	0.0	0.6	5.8	355
Other	70.8	14.4	6.4	8.4	0.0	0.0	0.0	2,856
Sweden								
t-mway	-	-	-	-	-	-	-	-
Mway	18.7	3.9	34.8	23.3	8.6	5.7	5.0	1,495
Dual	35.0	12.5	12.6	22.2	12.3	5.3	0.0	467
Other	83.9	9.3	3.2	3.1	0.3	0.1	0.1	5,094
UK								
t-mway	-	-	-	-	-	-	-	-
Mway	5.7	3.8	3.0	10.3	13.3	17.9	46.0	3,372
Dual	18.8	14.4	8.6	24.2	14.4	10.3	9.4	3,909
Other	35.4	17.3	14.2	17.0	11.4	2.5	2.2	8,356

Table 9.6: Country level road traffic flows by road type (% kms), by traffic flow (pcu), 2020 combined Income Tracking – Base Forecast

	<10	10-20	20-30	30-50	50-70	70-100	100+	total kms		<10	10-20	20-30	30-50	50-70	70-100	100+	total kms
Austria									**Ireland**								
t-mway	0.0	8.3	45.4	10.6	10.9	24.7	0.0	96	t-mway	-	-	-	-	-	-	-	-
Mway	0.4	4.8	11.3	21.5	30.0	12.9	19.1	1,556	Mway	21.7	0.0	0.0	33.8	44.5	0.0	0.0	51
Dual	8.4	3.6	50.1	30.1	7.4	0.0	0.4	368	Dual	63.5	12.2	0.0	6.6	17.6	0.0	0.0	215
Other	39.2	14.2	21.7	21.1	3.5	0.1	0.3	2,600	Other	70.1	3.6	7.6	13.1	5.1	0.2	0.2	1,996
Belgium									**Italy**								
t-mway	-	-	-	-	-	-	-		t-mway	4.3	17.8	19.1	26.1	15.1	9.3	8.3	5,922
Mway	2.9	4.1	5.1	12.4	11.8	24.9	38.7	1,799	Mway	27.4	18.2	8.3	18.3	21.1	6.1	0.6	905
Dual	21.0	20.1	20.0	21.8	13.0	1.5	2.6	808	Dual	18.9	40.9	17.3	17.2	2.9	0.7	2.1	2,093
Other	27.7	25.7	14.1	18.4	8.0	4.5	1.6	1,367	Other	25.2	25.4	17.4	18.0	10.8	3.1	0.1	7,495
Germany									**Luxembourg**								
t-mway	-	-	-	-	-	-	-		t-mway	-	-	-	-	-	-	-	-
Mway	4.9	4.5	5.8	15.6	16.7	16.9	35.7	12,822	Mway	0.0	0.0	19.2	11.5	36.7	14.5	18.1	95
Dual	16.1	10.0	14.7	24.8	16.8	8.3	9.3	1,604	Dual	0.0	0.0	0.0	100.0	0.0	0.0	0.0	5
Other	29.2	25.9	14.9	20.4	6.7	2.0	1.0	15,824	Other	9.0	6.6	9.8	53.1	19.8	1.6	0.0	203
Denmark									**Netherlands**								
t-mway	-	-	-	-	-	-	-		t-mway	-	-	-	-	-	-	-	-
Mway	27.8	15.3	5.0	8.8	9.0	26.4	7.8	940	Mway	1.4	3.7	7.6	19.2	16.6	20.4	31.1	2,175
Dual	0.0	100.0	0.0	0.0	0.0	0.0	0.0	7	Dual	13.9	16.6	8.3	28.6	15.6	7.1	9.7	316
Other	57.2	9.2	13.4	14.7	4.4	0.0	1.0	464	Other	22.9	26.1	16.6	25.7	6.0	1.9	0.7	1,405
Spain									**Portugal**								
t-mway	5.4	20.7	31.1	16.7	16.8	9.2	0.1	1,912	t-mway	0.0	11.7	21.1	34.8	18.9	13.2	0.3	453
Mway	25.6	23.7	13.4	29.2	5.5	2.5	0.1	3,048	Mway	24.3	49.6	21.2	0.0	3.5	1.3	0.1	989
Dual	15.0	17.3	25.0	23.3	10.9	4.0	4.5	3,539	Dual	56.2	15.5	2.2	19.6	0.6	5.8	0.0	355
Other	31.8	27.4	21.6	14.5	4.5	0.0	0.1	5,612	Other	62.9	21.9	6.8	8.4	0.0	0.0	0.0	2,856
Finland									**Sweden**								
t-mway	-	-	-	-	-	-	-	-	t-mway	-	-	-	-	-	-	-	-
Mway	13.9	30.9	5.4	12.1	15.1	22.6	0.0	719	Mway	11.6	9.1	3.2	26.8	32.6	7.3	9.5	1,495
Dual	-	-	-	-	-	-	-	-	Dual	21.5	16.0	10.9	26.9	19.5	5.3	0.0	467
Other	75.5	14.3	1.6	8.2	0.1	0.3	0.0	4,910	Other	76.4	9.2	7.7	5.9	0.7	0.1	0.1	5,094
France									**UK**								
t-mway	6.3	18.3	17.9	24.3	15.3	11.3	6.6	7,799	t-mway	-	-	-	-	-	-	-	-
Mway	2.2	15.9	13.2	14.7	20.5	19.3	14.2	3,398	Mway	4.7	3.2	3.4	7.7	14.2	20.1	46.7	3,372
Dual	5.7	14.9	15.8	26.8	16.3	13.1	7.4	3,886	Dual	12.6	15.6	13.4	23.3	14.1	11.4	9.6	3,909
Other	15.6	16.9	22.0	27.5	12.4	4.7	0.9	12,585	Other	30.3	16.6	16.4	20.6	10.6	3.2	2.2	8,356
Greece																	
t-mway	40.4	13.1	16.9	12.2	8.6	7.6	1.3	1,872									
Mway	-	-	-	-	-	-	-	-									
Dual	91.6	1.6	0.0	5.1	0.0	1.7	0.0	182									
Other	78.8	11.0	5.3	2.4	2.4	0.1	0.0	2,177									

10. Summary and Conclusions

This Deliverable 7 of the SCENES project has had three main objectives:

(i) to outline the basic structure and philosophy of the SCENES European Transport Forecasting model,

(ii) to demonstrate the model's capability to match the known 1995 situation for passenger and freight transport in the European Union, and

(iii) to develop and report on four widely varying forecast Scenarios for European transport in 2020.

The basic structure of the various modules which make up the whole model was developed with a view to incorporating as many of the causal mechanisms, which are understood to underlie the observed historical growth in both passenger and freight transport, as possible. To achieve this, a highly disaggregated approach was developed with regard to both the passenger and freight demand modules, and also the representation of transport supply, through the use of a highly multi-modal set of transport networks.

The other design principle for the model was that the disaggregated structure should allow the model to be seen as an overall Framework for modelling European freight transport and passenger travel. Within this Framework, there is a highly disaggregated base year input data set, a significant amount of which has been estimated or derived indirectly from other sources. Other input data was specifically produced within the SCENES project, in WA10.

This disaggregated model structure would therefore allow new, more detailed data to be incorporated within the structure, as it becomes available. The quality of potential input data is improving all the time, be it either in terms of better data being collected by national governments, or indeed from the outputs of other EC funded research projects.

The structure developed for the SCENES model was calibrated to reproduce a known base year situation for both passengers and freight. This process built upon the development work completed during the preceding STREAMS project. During the STREAMS project, and in the early specification stages of the SCENES project, potential improvements to the STREAMS model were suggested. The vast majority of these have been implemented within SCENES. This has allowed a more detailed calibration to take place with the SCENES model. In particular, the implementation of country specific costs for travel and values of time made possible a far better country-level calibration of the volumes of passenger travel. This validation of the model was extensively reported in Chapters 3 and 4.

A further development between the two models was the addition of a significant amount of road network. This was implemented to alleviate the network overloading which had been experienced in STREAMS. The use of large zones, and the inclusion of all traffic meant that the road network simply carried too much traffic in STREAMS. In SCENES, the overall levels of traffic on the road networks has been seen to be much more representative of reality, when the whole network is viewed together.

The final element of this Deliverable 7 described the input Scenarios for 2020, and the resulting transport volumes for passenger and freight transport in each case. The objective here was to illustrate how the model can be used to represent the effects of different transport cost regimes, specified in the Transport Scenarios. These Transport Scenarios span a range of notional policies, from interventionist strategies, to more trend based Scenarios. The objective here was not to produce a semi-definitive set of European transport forecasts.

Other Scenarios could be developed based on different assumptions regarding the development of for example, GDP or car ownership. One approach would perhaps be to implement high, mid, and low growth Scenarios for car ownership, employment, and / or GDP. Different assumptions could also be made about the sectoral development of trade through time.

The wider question concerns how the modelling capability developed within SCENES and other comparable project is taken forward. The most logical next step for a model such as the SCENES model would be to develop the model further to provide a robust and agreed European 'Framework' model. In the base year, this would require:

- an increase the detail at which model validation takes place, e.g., looking in detail at the pattern of traffic within countries, and
- more detailed base year input data regarding e.g., transport costs, demographics, values of time.

For the forecast years, a model 'Reference Scenario' could be developed. In consultation with Member States, the forecasts produced by the model would be reconciled with national forecasts, or projections (where they exist). Thus the model would become a true 'umbrella' model, containing agreed forecasts for all European countries. This EU 'Projection' would indeed be a robust datum for transport policy analysis at the European level.