Contract No. TREN / 06 / FP6SSP / S07.56190 / 022578

# REFIT

Refinement and test of sustainability and tools with regard to European Transport policies

Deliverable 3.1:

## Assessing the economic dimension of sustainable transport policy: an overview

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**Authors:** Ming Chen, Lorí Tavasszy (TNO)
Artem Korzhenevych, Johannes Bröcker (CAU Kiel)
Griet De Ceuster, Olga Ivanova (TML)

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**Project Manager**

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# Executive summary

The objective of the REFIT study is to provide a set of sustainability indicators for assessing the effect of various policy packages of priority interest through state-of-the-art models at European scale.

In this report it will be investigated which elements in economic modelling would need to be improved. The advantage of the CGEurope model is that the outcome of policies can be evaluated on spatial level so that equity aspects can be studied. However the spatial detail has resulted in a more aggregated description of financial flows such as the investment in infrastructure and the revenues from pricing policies. A description will be made how to overcome these gaps in modelling (experience from TRANS-TOOLS will be used).

Work Package 3 aims at quantifying the effects of transport policies on the economic indicators. A first overview of themes that will be addressed are:

- Accessibility and reliability
- Transport operation costs
- Productivity/ efficiency
- Cost to the economy
- Benefits to the economy

Besides linking the existing three models to these themes, the work package will make a step forward in addressing the impacts of transport policy on:

- spatial distribution of economic activity in Europe
- (un)employment
- fair pricing between the modes

This will be accomplished by applying and improving the CGEurope model so that the economic impact of transport projects and modelling of feedback effects on freight and travel demand that occur due to regional growth can be assessed. The CGEurope model is developed to make forecasts for the economic growth at the regional scale with differentiation with respect to the impact on the economic sectors, using the scenario data of socio-economic or transport models, e.g. SASI and SCENES or TRANSTOOLS, as input of the model. One of the main drivers of the to model is to assess the impact of a change in freight

In this report in chapter 2 an overview is provided of the REFIT methodology for assessing Sustainability of Transport policies. This chapter is based on the content of D2.1. In chapter 3 the possibilities and gaps of the existing models being considered in REFIT are analysed. Based on this the solutions for the gaps are formulated in chapter 4. This chapter will guide the activities of the remaining of WP 3. In chapter 5 the connection of the economic dimension studied in this deliverable with the social (WP 4) and environmental (WP 5) dimensions is described. Finally in chapter 6 a first set-up for the handbook to be written at the end of the project is given.

# 1. Introduction

## 1.1 The REFIT project

The objective of the study is to provide a set of sustainability indicators for assessing the effect of various policies/packages of priority interest through state-of-art models at European scale. The objective is therefore to develop, test and validate a "modelling tools-based" methodology that produces data on a set of identified indicators and that enables *ex-ante* evaluation of the European Common Transport Policy considering the economic, environmental and social dimensions of sustainability.

Work Package 1 defined the ideal transport sustainability impact assessment framework and provided a list of transport sustainability indicators encompassing the economic, environmental and social impacts of transport policies. Work Package 2 developed the REFIT assessment framework of indicators and models that addresses sustainable development issues at European scale in their economic, environmental, and social dimensions. The assessment framework is designed to link sustainability objectives and assessment methodologies with practical tools and indicators in the area of transport research.

The aim of the subsequent REFIT work packages is to refine as needed the available indicators and to develop new economic, environmental and social modules fully linked with the existing pan-European transport models TRANS-TOOLS and TREMOVE.

## 1.2 Objectives of WP3

Work package 3 aims at quantifying the effects of transport policies on the economic indicators.
A first overview of themes that will be addressed are:

- Accessibility and reliability
- Transport operation costs
- Productivity/ efficiency
- Cost to the economy
- Benefits to the economy

Besides linking the existing three models to these themes, the work package will make a step forward in addressing the impacts of transport policy on:

- spatial distribution of economic activity in Europe
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This will be accomplished by applying and improving the CGEurope model so that the economic impact of transport projects and modelling of feedback effects on freight and travel demand that occur due to regional growth can be assessed. The CGEurope model is developed to make forecasts for the economic growth at the regional scale with differentiation with respect to the impact on the economic sectors, using the scenario data of socio-economic or transport models, e.g. SASI and SCENES or TRANSTOOLS, as input of the model. One of the main drivers of the to model is to assess the impact of a change in freight transport distances, costs and volumes as well as travel activity at the regional level, but also changes social cohesion between European regions can be analysed.

## 1.3 Objectives of the report and report structure

In this report it will be investigated which elements in economic modelling would need to be improved. The advantage of the CGEurope is that the outcome of policies can be evaluated on spatial level so that equity aspects can be studied. However, the spatial detail has resulted in a more aggregated description of financial flows such as the investment in infrastructure and the revenues from pricing policies. A description will be made how to overcome these gaps in modelling (experience from TRANS-TOOLS will be used).

In this report in chapter 2 an overview is provided of the REFIT methodology for assessing Sustainability of Transport policies. This chapter is based on the content of D2.1. In chapter 3, the possibilities and gaps of the existing models being considered in REFIT are analysed. Based on this the solutions for the gaps are formulated in chapter 4. This chapter will guide the activities of the remaining of WP 3. In chapter 5, the connection of the economic dimension studied in this deliverable with the social (WP 4) and environmental (WP 5) dimensions is described. Finally, in chapter 6, a first set-up for the handbook to be written at the end of the project is given.

# 2. Overview of the REFIT methodology for assessing sustainability of transport policies

## 2.1 Introduction

This chapter is identical in deliverable D4.1 and D5.1 and is based on the deliverable D2.1. This chapter is included so D3.1 can be read independently from the other deliverables. Those familiar with these deliverables mentioned can skip this chapter and continue reading chapter 3.

## 2.2 Conceptual framework for transport sustainability impact assessment

Transport activities contribute to the formation of national income and wealth. They contribute also to the depletion of natural resources, for instance the energy consumed by the different transport modes, the land taken by road, rail, airports and ports infrastructures, etc. Transport emissions are one of the most important contributors to air pollution, particulate matter and $CO_2$ accumulation. Human capital is depleted as a consequence of road and other transport modes accidents, as well as of health damages caused by transport air and noise emissions.

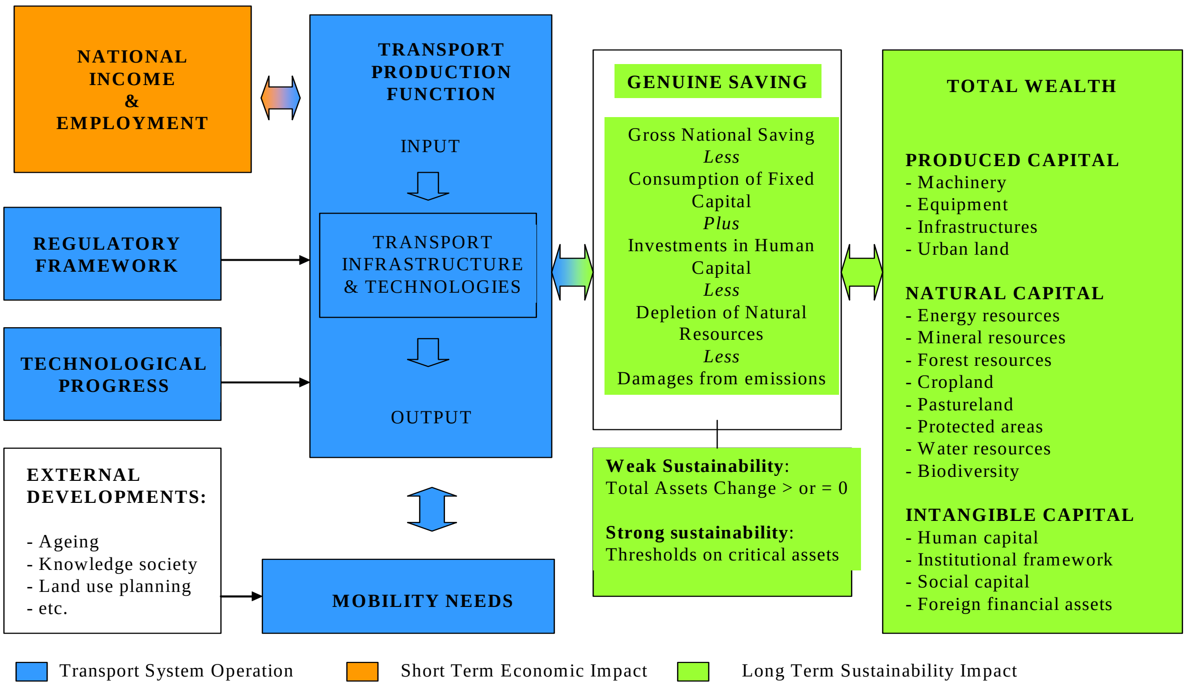
According to the general sustainability assessment framework based on the weak sustainability rule – presented in REFIT Deliverable D1.1 - the transport sustainability impact assessment can be done by identifying the specific **contribution of transport to the process of total wealth formation and the correlated concept of genuine saving**[1]**.** This is indeed the concept of transport sustainability impact assessment presented in the diagram on the following page, reproduced from REFIT D1.1. At the *core* of the diagram, there is the "transport production function" which transforms inputs of resources – capital, labour, land, energy etc. – into outputs –i.e. transport services – in order to satisfy the mobility needs (both passenger and freight). The latter are influenced by external developments – including for instance the ageing of population and the growing knowledge and leisure society - or policy trends as land use planning, integrated mobility demand management etc. The transport production function uses transport infrastructure and technologies that are subject to step changes depending on the flows of investments injected into the system and technological progress. The transport production function is also influenced by the existing regulatory framework. The output of the transport production function is the availability of transport infrastructure and the supply of transport services.

The transport production sectors contribute to the formation of GDP, Gross National income and employment, as any other sector of the economy. Consumption of private and public transport services is also an important component of total consumption, and the deterioration of transport equipment and infrastructure is included in the consumption of fixed capital. Thus, transport contributes firstly to the formation of *gross and net national saving*, the first components of country genuine saving computation.

[1] The process of genuine saving computation is fully described in REFIT D1.1.

Then, continuing in the process of genuine saving calculation, the most relevant contribution of transport to the value of human capital is negative, i.e. the potential years of life lost due to the injuries and fatalities caused by transport accidents. Going downward in the computation process, transport is clearly a key consumer of energy and land resources, and a major source of pollutants and $CO_2$ emissions.
According to the proposed concept, an ideal **transport sustainability impact assessment** would require to consider for each EU country the genuine saving calculation process, and to enucleate the contribution of transport to the various steps, as summarized in the following table adapted from World Bank (2006).

Fig. 2.1 Concept of transport sustainability impact assessment




## 2.3 The operational framework

The REFIT operational framework is aimed at producing a set of forecasting indicators for the assessment of European Transport Policies. The starting point is the definition of the policy packages, intended as an aggregation of individual policy measures, which constitute the input for the modelling tools, under form of assumptions on the value/state of a set of variables (the policy leverages of the models). The modelling tools are formed by the *core* models and the *ad-hoc* models: the *core* models simulate the change induced by a policy package on a wide range of variables and produce a set of data which are either the input of the three *ad-hoc* models, which in turn produce the sustainability indicators respectively for the economic, environmental and social dimension, or are directly used to compute indicators.

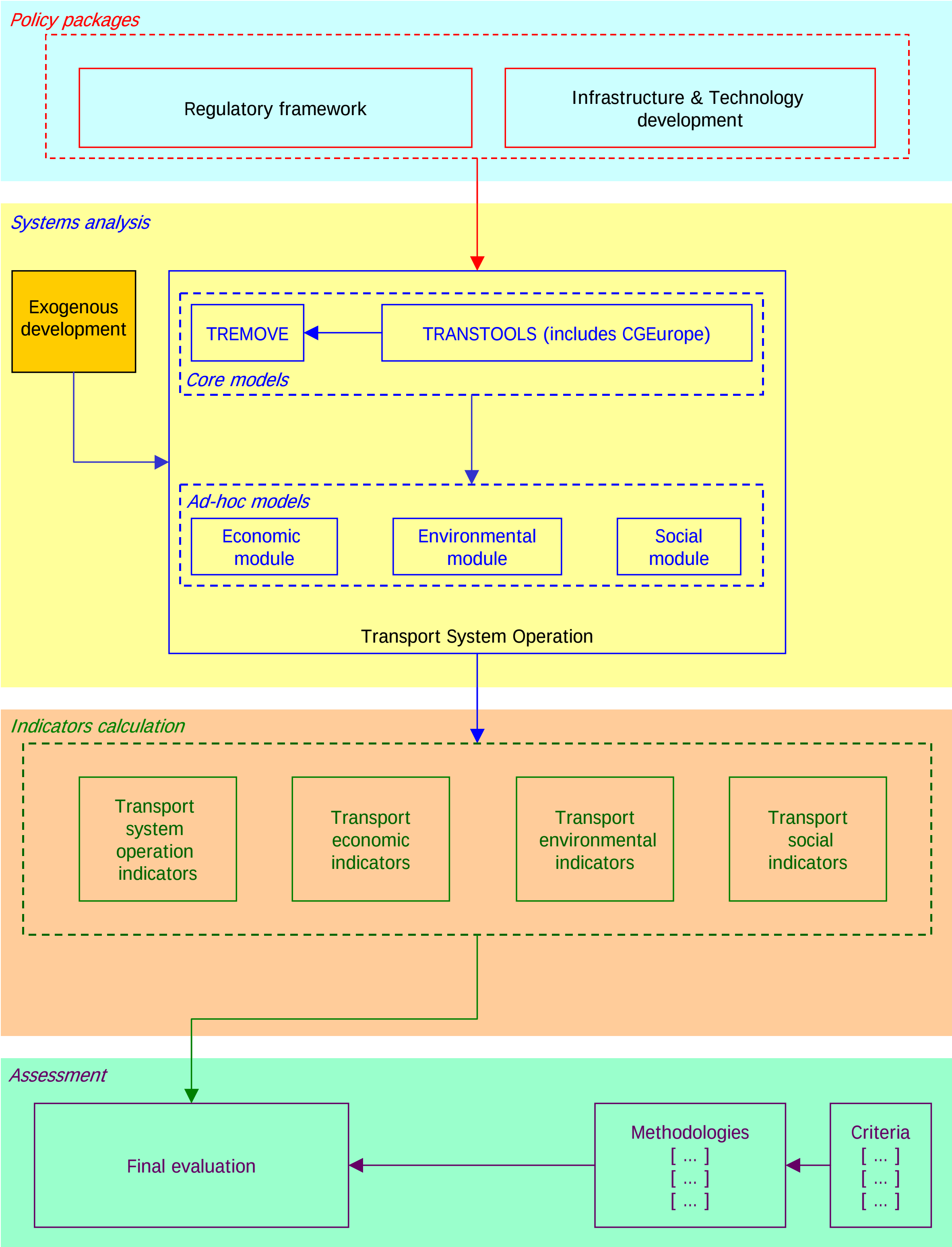
The *core* models are the two European based model TRANS-TOOLS[2] and TREMOVE. *Ad-hoc* models will be developed to analyse specific aspects which are not addressed by the *core* models in sufficient detail; these have the twofold aim of extending the quantification of (indirect) policy effects with reference to specific domains and processing direct outcome of the *core* models to produce indicators. Indicatively:

- the *economic module* will consider the linkages between transport and economy, mainly in terms of the effects of transport policy measures on economic variables like GDP or employment;
- the *environmental module* will be focused on health impacts of air-pollution and traffic noise;
- the *social module* will consider the effects of policies on the social side, addressing aspects like distribution of costs and benefits.

The main role of the modules is to produce sustainability indicators to provide synthetic measures of the effects of transport policy packages on given domains like economy and environment. Indicators will be policy sensitive in the sense that their ingredients will include variables whose value is affected by the implementation of policy packages. The effect of specific measures will be generally reflected by a change of the value or one or more indicators.
Figure 2.2 shows the main components of the operational framework. It includes four main areas which are described in some detail below.

[2] Note that the operational framework is valid also if other transport models are applied instead of TRANSTOOLS. In this case, the economic model of TRANS-TOOLS, CG-Europe, should be considered separately

Fig. 2.2 The REFIT operational framework



### 2.3.1 The "Policy Packages" area

The first area includes the leverages that will be used to design the policy packages. These leverages act on two main domains. On the one side, leverages may modify the regulatory framework of the transport system. The term "regulatory" is used here in a wide sense to include not only elements like market regulation (e.g. open rail market to competition) but also measures which affect directly transport costs like road pricing or environmental taxation, etc. On the other side, policy packages can include measures concerned with the 'hardware' side, that is the improvement of infrastructures (e.g. the implementation of new roads and rails on TEN corridors) as well as the technological development (e.g. reduced emissions of pollutants from transport modes). From a conceptual point of view, having in mind the conceptual framework developed in Work Package 1 and summarised in paragraph 2.1, the definition of a policy package implies a "change of assets" which might be either positive (the creation of new assets, e.g. new transport infrastructures) or negative (resource consumption, which is a reduction of assets). The Policy Package area provides inputs to the *core* and *ad-hoc* models of the "Transport System Operation" box within the System Analysis area.

### 2.3.2 The "Systems Analysis" area

This area is the 'engine' of the operational framework, where the input defined in the Policy Package area are translated into raw output which will serve to compute the indicators. The main element in this area is the "Transport System Operation", which includes:

- the *core* models, TRANS-TOOLS and TREMOVE, and
- the *ad-hoc* models, which produce sustainability indicators respectively for the economic, environmental and social dimension.

The components of the transport system operations are described in chapter 3. Another component of this area is the definition of the "Exogenous development". It includes all those trends which are relevant to define the mobility patterns although these are not part of the transport system (e.g. economic growth, population development, etc.) and also out of control of the European transport policy maker. Assumptions concerning such exogenous elements enter as input in the modelling tools and allow them to provide forecasts about the development of transport demand and its effects.

### 2.3.3 The "Indicators Processing" area

The System Analysis area produces a wide range of quantitative results. Such results are transferred to the Indicator Processing area for the calculation of the sustainability indicators. The indicators are grouped by topic according to the classification given in Work Package 1: transport system operation indicators, transport economic impact indicators, transport environmental indicators and transport social indicators. In some cases, the modelling output will be directly translated into indicators while in other cases additional processing will be needed. Therefore, even if the 'heart' of the quantification of impacts of the policy packages is in the System Analysis area, the Indicator Processing plays a key role as well. The indicators produced will provide the basis for the assessment phase carried out in the last area of the operational framework.

### 2.3.4 The "Assessment" area

The Assessment area is the place where the indicators developed in the previous steps of the operational framework can be used to derive a final response concerning the impacts of the transport policy packages on the sustainability. In REFIT is explicitly recognised that the measurement of the impacts of transport policy requires a multidimensional approach. Therefore different domains (economy, environment, society) are considered and within each domain a wide range of indicators is available. The Assessment area addresses the task of using the whole set of indicators in order to obtain a synthetic measure of sustainability.

However, this issue has not a neutral solution. The objective of REFIT is not to suggest to use one methodology instead of another one, but to provide the elements required for applying alternative methods. The choice of the methodology is left to the applications of the framework. So, in this area the values of the indicators are first collected from the different tools and made available in a coherent form (e.g. in terms of geographical scope and segmentation). Secondly, alternative paths for the overall sustainability assessment are indicated to the user in terms of rules for indicators selection, weighting, aggregation, etc. In doing so, for some methodology it is also indicated which additional information are required (e.g. to perform a Cost-Benefit Analysis, exogenous data about the cost of implementing the measures is needed as well as a full estimation of changes on the travel time side). As a preliminary step for the policy assessment, an operational tool made under the form of excel worksheet has been proposed.

## 2.4 The modelling tools in the REFIT framework

### 2.4.1 The TRANS-TOOLS model

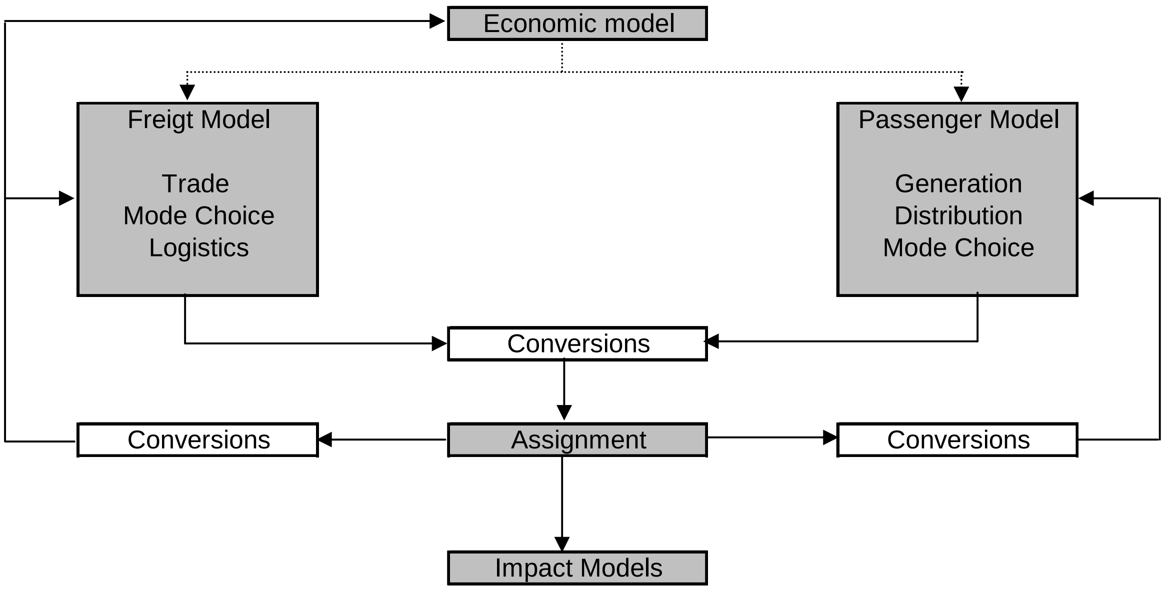
TRANS-TOOLS is a European transport network model covering both passenger and freight, as well as intermodal transport[3]. The TRANS-TOOLS model is made of different modules, which exchange information according to a sequential approach, i.e. the origin/destination matrix produced by the passenger model is transferred to the modal split model, etc.. Feed back effects are taken into account, i.e. transport costs and times produced by the assignment model are fed back to the modal split model. The main sub-models are:

- Freight demand model
- Passenger demand model
- Assignment model

In additions to these main elements of the model system, the TRANS-TOOLS Model also includes a regional economic model based on CGEurope and impact models. The different models are linked applying a number of conversion routines. The principle of the model in overview is illustrated in 2.1. The model framework allows feedbacks between the sub-models to achieve equilibrium between supply and demand.

[3] The project has been developed within the 6th Framework Program RTD for the Directorate General for Transport of the European Commission.

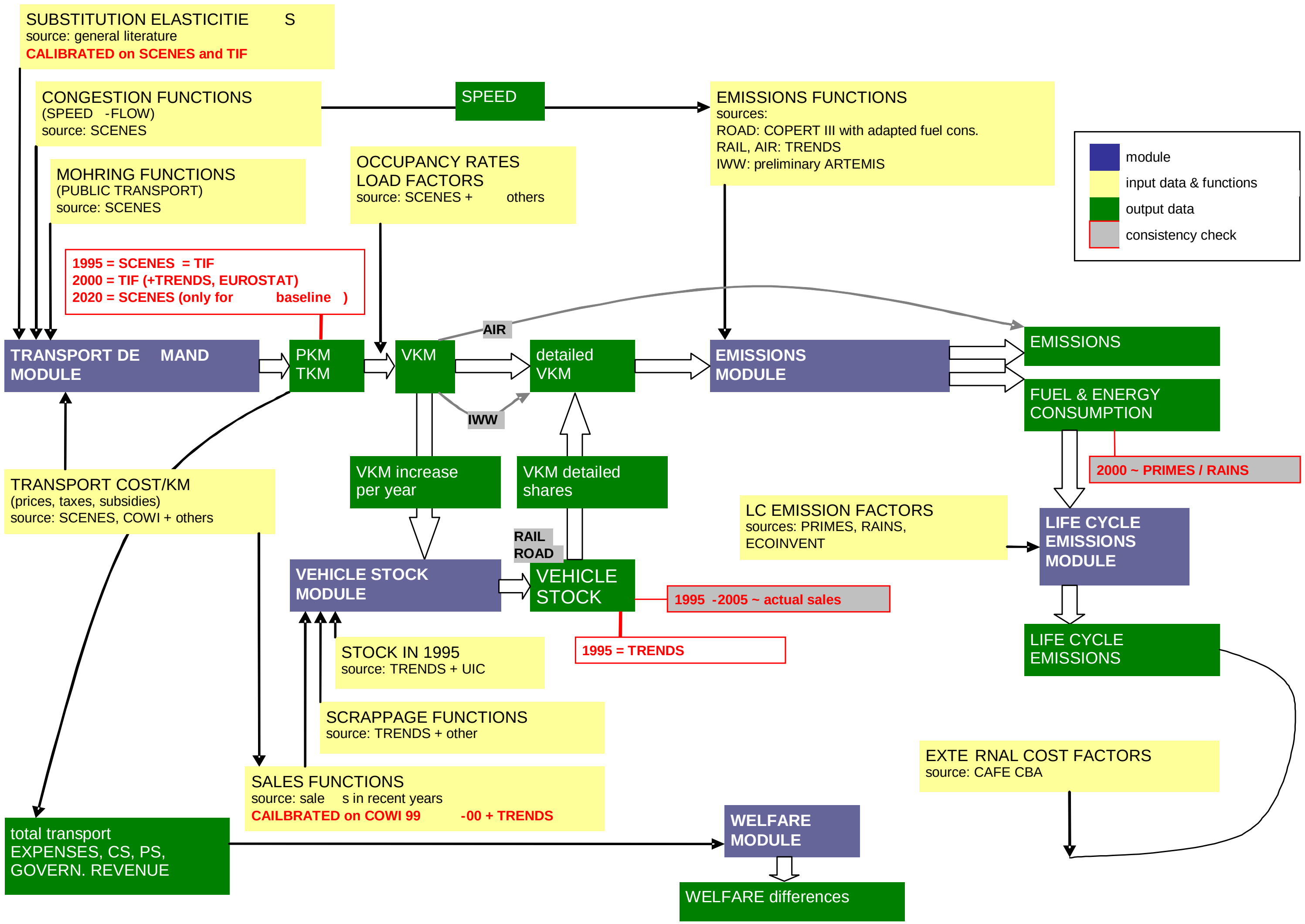
Figure 2.1 Overview of the TRANS-TOOLS model.




#### 2.4.2 The TREMOVE model

TREMOVE is a transport and emissions simulation model developed for the European Commission. It is designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates the transport demand, the modal split, the vehicle fleets, the emissions of air pollutants and the welfare level under different policy scenarios. All relevant transport modes are modelled, including air and maritime transport. The model covers the 1995-2020 period, with yearly intervals.
TREMOVE predicts the overall emissions from the transport sector in different policy scenarios. The strength of the model is that it also enables to assess the effects of environmental policies on future vehicle fleets and on overall transport demand and its modal split. The calculated welfare effect of a policy then is not only determined by technology costs and emission reductions, but also by effects on household mobility, industry logistic processes and government tax income from the transport sector.
TREMOVE consist of 21 parallel country models, and one maritime model. TREMOVE consists of three inter-linked 'core' modules: a transport demand module, a vehicle turnover module and an emission and fuel consumption module, to which we add a welfare cost module and a life cycle emissions module.

An overview map can be found in the next figure.


SUBSTITUTION ELASTICITIE S
source: general literature
CALIBRATED on SCENES and TIF
CONGESTION FUNCTIONS
(SPEED -FLOW)
source: SCENES
SPEED
EMISSIONS FUNCTIONS
sources:
ROAD: COPERT III with adapted fuel cons.
RAIL, AIR: TRENDS
IWW: preliminary ARTEMIS
module
input data & functions
output data
consistency check
MOHRING FUNCTIONS
(PUBLIC TRANSPORT)
source: SCENES
OCCUPANCY RATES
LOAD FACTORS
source: SCENES + others
1995 = SCENES = TIF
2000 = TIF (+TRENDS, EUROSTAT)
2020 = SCENES (only for baseline )
AIR
TRANSPORT DE MAND
MODULE
PKM
TKM
VKM
detailed
VKM
EMISSIONS
MODULE
EMISSIONS
FUEL & ENERGY
CONSUMPTION
IWW
TRANSPORT COST/KM
(prices, taxes, subsidies)
source: SCENES, COWI + others
VKM increase
per year
VKM detailed
shares
2000 ~ PRIMES / RAINS
LC EMISSION FACTORS
sources: PRIMES, RAINS,
ECOINVENT
LIFE CYCLE
EMISSIONS
MODULE
RAIL
ROAD
VEHICLE STOCK
MODULE
VEHICLE
STOCK
1995 -2005 ~ actual sales
LIFE CYCLE
EMISSIONS
STOCK IN 1995
source: TRENDS + UIC
1995 = TRENDS
SCRAPPAGE FUNCTIONS
source: TRENDS + other
EXTE RNAL COST FACTORS
source: CAFE CBA
SALES FUNCTIONS
source: sale s in recent years
CAILBRATED on COWI 99 -00 + TRENDS
WELFARE
MODULE
total transport
EXPENSES, CS, PS,
GOVERN. REVENUE
WELFARE differences

## 2.5 Stepwise procedures for the evaluation of economic dimension using the REFIT framework

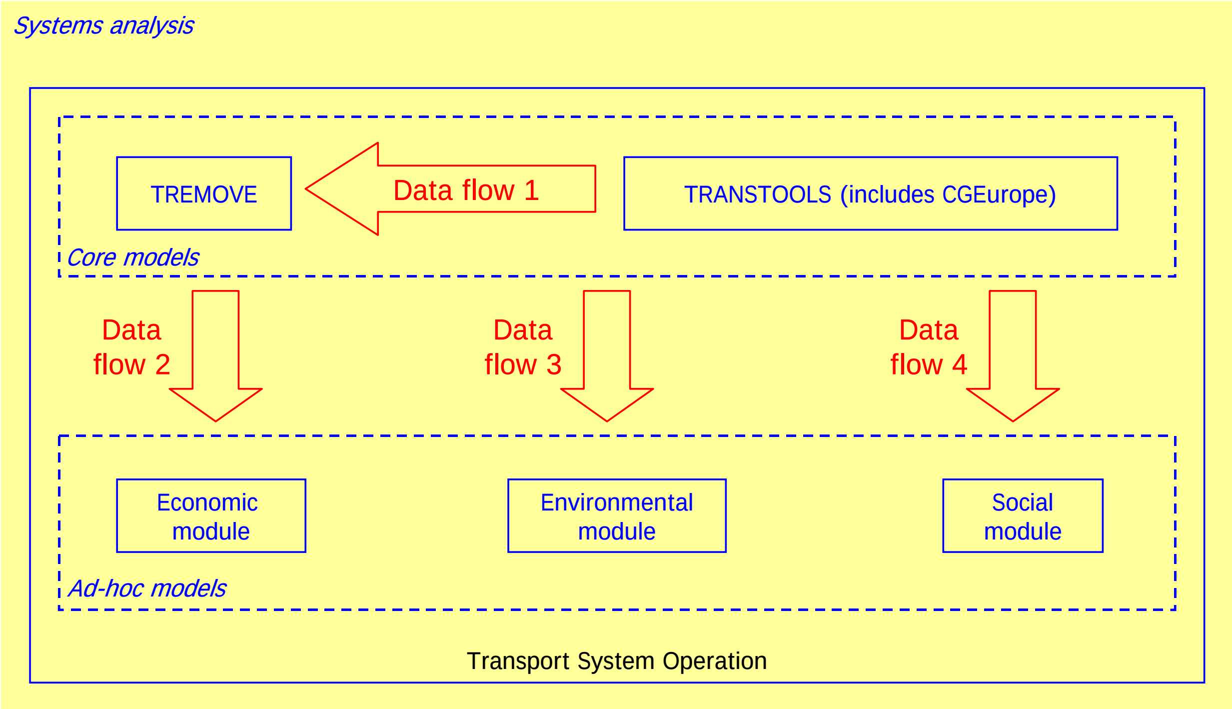
Following a classification developed in the ASSESS project (see Martens *et. al.*, 2005) and adopted also in TRANS-TOOLS (Burgess *et. al.*, 2006), transport policy measures can be classified into three main groups:

1. Measures whose direct impacts can be simulated in the REFIT framework (e.g. infrastructure charging can be directly coded in the TRANS-TOOLS model);
2. Measures whose impacts can be simulated only indirectly in the REFIT framework (e.g. liberalisation is expected to modify transport costs and only such modifications – quantified exogenously – can be coded in the models);
3. Measures whose impacts cannot be simulated by the REFIT framework (e.g. the regulations concerning safety of third countries aircraft is out of the domain of all modelling tools in REFIT).

Thus, a preliminary condition for using the REFIT models to compute indicators is to select the policy measures properly, i.e. those which can be dealt with in modelling terms. The modelling tools within the REFIT framework can be better applied for assessing measure ‘packages’ rather than single measures. Packages consist of more measures considered at the same time so that the input for the models (e.g. variation of costs for a given mode) is the sum of the single measures.

As far as policy packages involve several measures affecting the transport sector, their simulation requires to use all modelling tools in a co-ordinated way. Even if one simple measure is modelled, so that input could change in one model only, all tools are needed in order to compute all indicators required for the assessment. The models are independent tools, but a coherent simulation of policy scenarios requires that inputs are consistent across the models. Figure 2.4  provides a synthetic view of data flows between models.

Figure 2.4 Data flows within the TREMOVE modelling framework




A set of tables presented in deliverable D1.2 identify which modelling variable(s) are chosen to compute each indicators. In most of the cases, the correspondence between the indicator and the modelling variables is straightforward. In some cases, however, the indicator is not a direct output of the models, so further work is required.

In order to use different indicators for the assessment, all of them should be computed with the same geographical detail. The following two levels approach will be followed:

- At the first level all indicators which can be computed from modelling outputs are produced for each country;
- At the second level transport system operation indicators and environmental indicators are produced for the three region types: metropolitan city, other cities, non-urban.

In deliverable D2.1 chapter 4 the above and the way to calculate several important indicators is discussed in more detail.

# 3. Existing models for assessing the economic dimension: possibilities and gaps

## 3.1 Major sustainability indicators of the economic dimension

The following table provides the synthetic picture of the economic indicators covered within the REFIT operational framework. The calculation of these economic indicators and the required work to make this possible is the main topic of this deliverable.

Tab. 3.1 Transport economic indicators

| Code | Indicator | Variable | Linkage to framework models |
|---|---|---|---|
| | **Spatial impact indicators** | | |
| ESPCG | Change of regional GDP due to changes of regional accessibility | % Difference between GDP of reference case and GDP of policy case | Economic ad-hoc |
| ESPAM | Accessibility measures | Accessibility measure | TRANS-TOOLS for transport impedances |
| ESPWM | Welfare measures | Equivalent variation measured compared to reference case | Economic ad-hoc |
| ESPPF | Job-housing proximity and commuting flows | | - |
| ESPTR | Trade | Total value of import + export from each country | Economic ad-hoc |
| ESPAG | Urban access quality | Agglomeration of firms/jobs - City attractiveness | - |
| | **Sectoral impact indicators** | | |
| ESETGVA | Transport sector production: share of GVA generated by the transport sector | % Of GDP from transport sector | Social ad-hoc |
| ESETE | Transport sector employment | Rate of employed | Social ad-hoc |
| ESECO | Total change of industry output and employment due to transport investments and policies | % Change of industry output between reference case and policy case | - |
| ESECE | | % Change of employment rate between reference case and policy case | - |
| | **Transport budget indicators** | | |
| EBHTE | Households transport expenditures | % Households transport exp. on total exp. | Social ad-hoc |
| EBBTE | Business transport expenditures | % Business transport expenditures on total exp. | Social ad-hoc |
| EBGNR | Government net revenues (taxes – subsidies) from transport | Government net revenues (taxes – subsidies) from transport | TREMOVE |

## 3.2 The existing models: possibilities

### 3.2.1 Main outputs of the core models

#### *3.2.1.1 TRANS-TOOLS*

For each of different scenarios the TRANS-TOOLS model can give output. Each scenario can be described in outcome on:

- freight transport (tonnes per commodity, country, mode and logistics activity, and spatial development);
- passenger transport (passengers per motive, country, mode and spatial development);
- economic outcome of feedback processes (GDP change and welfare effect) – *CGEurope;*
- network characteristics (number of freight and passenger vehicles in yearly value, AADT, and peak moments);
- external effects related to network intensities (in terms of emissions and accidents).

#### *3.2.1.2 TREMOVE*

The output of TREMOVE is a database formed by four parts: Demand, Stock, Emissions, and Welfare output[4]. All the data are available for 21 European Countries. The model covers the 1995-2020 period.
The output demand is calculated by vehicle categories (14 types), trip Purpose (6), trip Distance (3), Region (3), network (6), peak and off-peak period.
The output emission considers the elements listed in the table 3.1 and it is calculated by vehicle categories (14), fuel type (8), vehicle type (25), technology (54), region (3), network (6), peak and off-peak period. The three types of regions considered in the model run are metropolitan city, other cities, non-urban.
The output stock is referred to 10 vehicle categories, fuel type (8), vehicle type (25), technology and vehicle age (60).
The welfare model calculates the differences in Consumer Surplus, Producer Surplus, effect on government budget and differences in external costs. It refers to Region (3), country (21) and year (1995…2020).

[4] Detailed output schemes are provided in the annex of this deliverable.

Table. 3.1 Level of detail of TREMOVE and TRANS-TOOLS models

| Variable | TREMOVE requirements | TRANS-TOOLS segmentation |
|---|---|---|
| Country | EU25 + Switzerland and Norway | EU25 + Switzerland and Norway and for freight all other European countries and other parts of the world as partner relations |
| Region | Metropolitan city<br>Other cities<br>Non-urban | NUTS 3 regions for passenger demand and NUTS 2 regions for freight demand |
| Trip distance | Urban,<br>Short distance,<br>Long distance | Network distance from origin region to destination region |
| Passenger transport mode | Slow<br>Car<br>Motorcycle<br>Bus/Coach<br>Metro/Tram<br>Passenger train<br>Plane | Car<br>Railway<br>Air |
| Freight transport mode | Road freight vehicles<br>Freight train<br>Inland shipping | Road freight vehicles<br>Freight train<br>Inland shipping<br>Maritime transport |
| Road passenger vehicle category | Small car<br>Medium/big car<br>Moped<br>Motorcycle<br>Bus<br>Coach | Road passenger modes are not segmented into vehicle types |
| Road freight vehicle category | Light duty vehicle<br>Heavy duty vehicle | Road freight mode is not segmented into vehicle types |
| Road network | Urban road<br>Non-urban road<br>Motorway | Several different link types |
| Time period | Peak hours<br>Off-peak hours | Whole day |
| Passenger trip purpose | Commuting<br>Business<br>Non-working | Business<br>Private<br>Tourism |
| Freight commodity groups | Bulk<br>Bulk/general cargo<br>General Cargo<br>Unitised | Eleven commodity groups based on NST-R chapters (10) + crude oil taken separately. |

Source: TRT based on ASSESS data and Chen, T.M., *et al*. (2005)[5].

For some indicators that can be computed in different models it will be necessary to choose the reference model, in order to avoid duplications.

5 Chen, T.M., *et al*. (2005). Deliverable 3: Report on model specification and calibration results TRANS-TOOLS (TOOLS for TRansport forecasting ANd Scenario testing) Deliverable3. Funded by 6th Framework RTD Programme. TNO Inro, Delft, Netherlands

The choice of the reference model needs to be validated on the basis of quantitative computations that will be performed in the models later on in the project. As a general approach, a criterion to make a choice could emerge considering that the procedure for the simulation of policy packages can be interpreted as a flow of data through the various modelling tools, starting from TRANS-TOOLS and finishing to the *ad-hoc* models. Each tool adds to the simulation its specific capability and so as the data flow proceeds, more impacts can be modelled. Therefore, as far as possible, modelling outputs will be extracted at the end of the data flow. For instance, despite TRANS-TOOLS is the transport model within the REFIT framework, some policy measures will require TREMOVE for being simulated. Therefore most of transport operation indicators will be extracted from TREMOVE and not from TRANS-TOOLS, because only from TREMOVE the full impact of measures on transport demand can be captured. However, there well might be policies which can be dealt with using TRANS-TOOLS only. In such cases, this criterion would not be of practical use.

### 3.2.2 Indicators that can be computed with the available REFIT tools

In the following it will be discussed by indicator selected in WP 2 which input can be extracted from the core models and which should be calculated by ad-hoc models. The indicators are described in more detail in the indicator sheets in the annex.

#### 3.2.2.1 Trade

Within REFIT, the indicator ‘trade’ is calculated in the following way. Basically, for each country matrices of trade by mode of transport can be defined (e.g. value of goods exported to and imported from other countries by truck), but such a matrix cannot be regarded as a synthetic indicator. A measure of the size of trade or of its composition could be used as indicator. Indeed, the composition of trade can be changed e.g. in terms of a different ranking of commercial partners for a given country, however the transport policy does not play a major role in this type of change. Instead, transport policy measures can affect the usage of modes, but an indicator like e.g. the mode share of rail on international freight traffic belongs more to the transport operation domain than to the economic domain. In the end, the **total value of import plus export from each country** could be used as indicator. **The total value of import plus export from each country can be drawn directly from the TRANS-TOOLS model**.

#### 3.2.2.2 Government net revenues (taxes – subsidies) from transport

Provided that the relevant data on revenues from transport related taxes and charges and on transport earmarked subsidies and final expenditures are available from the official national, regional and local budget accounts, the computation of the indicator is straightforward.
When the revenues are more than the amount needed to finance transport subsidies and expenditures, the surplus is financing the general budget of the level of government concerned. The contrary happens when revenues are less than the required transport subsidies and expenditures, in which case the deficit is financed by the general budget. **The welfare module of TREMOVE calculates the policy effects on government budget.** Thus, it can provide the data of net government revenues. More detail would be an improvement as described in the following section.

#### 3.2.2.3 Welfare measures: equivalent variation (EV)

Calling the situation before the policy change the benchmark, the EV of a policy change can be defined as the amount of money that must be added to the household's benchmark income (everything else held constant at benchmark levels), in order to bring the household the same utility as under the policy change. **The relative equivalent variation can be computed by economic module of TRANS-TOOLS by region and scenario year.**

#### 3.2.2.4 Change of regional GDP due to changes in regional accessibility

The Gross Domestic Product (GDP) per capita and the real GDP growth rate are the most common measures of the standard of living, wealth and economic growth. The GDP is a measure of the size and performance of a regional economy and its competitiveness. **The change of GDP between a with-policy situation and a without-policy situation can be extracted from the TRANS-TOOLS model.** However, the time path of GDP is not the output of TRANS-TOOLS and should become output of the economic ad hoc model. This economic ad hoc model should compute the time paths of real GDP by region and scenario.

## 3.3 The existing models: gaps

### 3.3.1 Indicators that can not be computed with the available REFIT tools

In the following it will be discussed by indicator selected in WP 2 which input can **not** be extracted from the core models and which should be calculated by ad-hoc models. The indicators are described in more detail in the indicator sheets in the annex.

#### 3.3.1.1 Accessibility

As described in the relating indicator sheet, several measures of accessibility are available from theory. As far as the usage of the modelling tools within the REFIT framework is concerned, a gravity type measure might be the most appropriate. In fact, on the one side measures based on distance and topological measures are essentially dependent on the 'supply side' only so that bottlenecks phenomena can be hardly recognised. At the same time, space-time measures are based on the concept of activity, which is more appropriate in an urban context than at the European level.

Therefore, assuming to use potential (gravity type) accessibility measures of the type:

$$A_i = \sum_{j=1}^{n} f\left(C_{ij}\right)\frac{P_j}{\partial_j}$$

where:

$A_i$ is accessibility of zone *i*;

$f\left(C_{ij}\right)$ is a cost function describing 'impendence' between zone *i* and zone *j*;

$P_j$ is a measure of the opportunities in zone *j*;

$\partial_j$ is a measure of demand potential;

The models in the REFIT framework in combination with additional data sources can provide the information required to compute the indicators, e.g.:

- $C_{ij}$ can be measured in terms of generalised cost for O/D pairs from TRANS-TOOLS;
- Demand potential of zones can be measured in terms of population from EUROSTAT and scenario input TRANS-TOOLS. Population growth is needed to calculate after-shock GDP per capita.
- Attractiveness (opportunity) of zones can be measured in terms of GDP from EUROSTAT and scenario input TRANS-TOOLS. **The effects of transport policy on GDP however is not available in the core models and should be calculated in the ad-hoc model**

#### 3.3.1.2 'Job housing proximity and commuting flows' and 'Urban access quality'

As described in the table A5 and A7 in the annex several calculation methods are possible for this indicator. All have in common that they require quite detailed information especially geographically. European models can generally work only at a more aggregate level mainly due to data (non-) availability reasons.

**It therefore should be concluded that models in the REFIT framework' scale of analysis is too coarse for such indicators.**

#### 3.3.1.3 Transport sector production: share of GVA generated by the transport sector

Gross Value Added of the transport sector is given by the difference between output and intermediate consumption for the transport sector. It contains the difference between the value of goods and services produced and the cost of raw materials and other outputs, which are used in production. TSI is a combined, multimodal, seasonally adjusted economic measure of transport measured on a monthly basis. For the purposes of the TSI, the output of the transport sector is equal to the economic value added of transport carriers, that is, the difference between their revenues and the costs of their inputs. In the case of urban public transport, total payroll is used as a proxy for economic value added.

Base year data is collected annually by EUROSTAT**. The GVA of the transport sector cannot be calculated by the REFIT core models. The ad-hoc REFIT models should be able to calculate this information.** Input to these models can be matrices of freight and business passenger costs is produced by TRANS-TOOLS.

#### 3.3.1.4 Transport sector employment

Employed persons are all persons aged 15 years and more (16 years and over in ES, UK and SE (1995-2000), 15 to 74 years in DK, EE, HU, LV, FI, SE (from 2001), 16-74 in IS and NO) and who did any work for pay or profit during the reference week. The employment rate of persons is the share of employed persons in the total population of the same age group.

**The rate of unemployed in the transport sector is not calculated in REFIT core models. The REFIT ad hoc models should be able to calculate these indicators at NUTS2/country level.**

#### 3.3.1.5 Total change of industry output and employment due to transport investments and policies

As CGeurope does not have any industry structure except for tradables and non-tradables, the total output change indicator is well represented by the regional GDP change. In addition, total regional employment response is an output of the envisioned extension to CGEurope

**It therefore should be concluded that models in the REFIT framework' scale of analysis is too coarse for such indicators.**

#### 3.3.1.6 Household transport expenditures

Household final expenditure have been annually collected and adjusted by EUROSTAT. Annual National accounts breakdowns have been compiled in accordance with the European System of Accounts - ESA 1995; figures are collected from National Statistical Institutes' Accounts Departments. Member States report annually information to EUROSTAT on household consumption expenditure based on harmonised grouping. Household consumption expenditure has been built following COICOP procedure: Classification of individual consumption by purpose – 1998. The complete classification is available at EUROSTAT's RAMON classification database or at the United Nations classification registry.

**The households' consumption by household in transport sector is a measure that should be calculated by the ad-hoc model**. Such an indicator might be expressed as the share of the transport expenditure over the total of households' expenditures. The data output should be available at NUTS2/country level.

#### 3.3.1.7 Business transport expenditures

The System of National Accounts (SNA) has been prepared under the joint responsibility of the United Nations, the International Monetary Fund, the Commission of the European Communities, the OECD and the World Bank. It consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules (SNA 1.1) and it can be implemented at different levels of aggregation (individual economic agents or institutional units).
The System is formed by a series of interconnected flows accounts related to different types of economic activity (production or distribution and use of income, accumulation) taking place within a given period of time, together with balance sheets that record the values of the stocks of assets and liabilities held by institutional units or sectors at the beginning and end of the period. The TSA approach introduces a system of satellite accounts in which own-account transport is accounted for separately and the production boundary of the System is extended to include the households transport activity for work purposes

**The business transport expenditure is an output indicator that can realistically be provided by the ad hoc model**. Such an indicator might be expressed as the share of the business transport expenditure over the total of expenditures. The data output should be available at NUTS2/country level.

#### 3.3.1.8 Government net revenues (taxes – subsidies) from transport

As described in section 3.2.2.2 the welfare module of TREMOVE calculates the policy effects on government budget and can provide the data of net government revenues. More detail would be better on this indicator. **The ad hoc model should be able to compute the policy effects on governmental taxes and subsidies by type**.

#### 3.3.1.9 Time paths of the effects

CGEurope is a static model. It calculates the impact of transport cost changes by comparing two static equilibria, representing the reference situation and a counterfactual, respectively. For the counterfactual it is assumed that certain infrastructure components are in place that are not yet existing in the reference situation.

Both, the reference situation and the counterfactual, refer to a certain year, either a historical one or a predictive one. Adjustment to the new infrastructure is assumed to take place instantaneously: after the new infrastructure is in place, the counterfactual world is realized immediately, and assumed to last forever. GDP and welfare effects are per annum level effects, and they are assumed to last forever as well. As these are annual permanent flows, one can transform them into rates of return on investment by dividing them through the installation cost of the respective infrastructure.

This approach allows for a good approximation of the welfare gain that in the real world would be obtained in the course of time. But it has shortcomings. First, policymakers might be interested in the **time paths** of the effects as well. Second, handling of incomplete factor mobility is not really possible in a comparative static framework. Either one assumes factors to be completely immobile (as it was assumed in the CGEurope version incorporated in the TRANS-TOOLS model), or one assumes it to be perfectly mobile. As labour mobility is still low in Europe, the first assumption may be acceptable with respect to labour, but with respect to capital both assumptions are unrealistic extreme cases. If factor returns change, capital will respond, though not by equalizing rates of return instantaneously. Capital already nailed to the ground will not move, but investments shift to places with higher returns and lead to higher capital stocks in these places after some time of capital accumulation. Obviously, this can not be dealt with in other than a **dynamic framework**, making the time path of capital accumulation explicit. **This is the framework to be implemented in the economic ad-hoc model during the REFIT project.**

#### 3.3.1.10 Unemployment rate response

It is a well-known fact that inside the expanding European Union some people live in areas of high unemployment, while others are surrounded by little joblessness. One of the biggest political concerns about complex effects generated by implementing certain measures in transport is whether these measures can improve welfare and stimulate employment. In fact, as unemployment rates vary strongly across regions in Europe, the regional (un)employment impacts can be considerable and in some cases undesirable. That is why an extension of the CGEurope model aims at estimating regional (un)employment effects resulting from policy scenarios in transport development. **This is to be the output of the REFIT economic ad-hoc model.**

### 3.3.2 Which essential model outputs are missing?

#### 3.3.2.1 Missing outputs

Summarising from the previous discussion on the (non) possibility to compute the indicators we find the following gaps that should be computed by the ad hoc models:

1 Time paths of regional GDP and welfare effects
2 Regional labour market response to transport policies
3 The GVA of the transport sector
4 The rate of unemployment in the transport sector
5 The households' consumption by household in transport sector, expressed as the share of the transport expenditure over the total of households' expenditures.
6 The business transport expenditure expressed as the share of the business transport expenditure over the total of expenditures
7 The policy effects on governmental taxes and subsidies by type

#### 3.3.2.2 The geographical detail in TREMOVE and TRANS-TOOLS

The assessment of the policy packages should make reference to a given geographical scope where the policy measures are applied. In order to use different indicators for the assessment, all of them should be computed with the same geographical detail. The REFIT framework deals with the European transport policy, whose measures are mainly related to the European Union level and the member states level.

Therefore, it seems reasonable that the indicators are computed for each EU country. Actually, given the features of the modelling tools, several indicators can be computed also for a sub-national level. However, there are some indicators which are only available for the countries and not for their regions. Furthermore, in most of the cases TREMOVE is the reference model for extracting the indicators and such a model does not provide regional data. The conclusion is that in order to have a complete set of results for the assessment, the reference geographical detail is the country. Calculations can take place on the network level by using input of TREMOVE on the TRANS-TOOLS network. These network results can be aggregated to regional and country levels.

At the same time, several TREMOVE outputs are available for three region types (metropolitan city, other cities, non-urban). It is therefore reasonable that at least transport system operation indicators and environmental indicators are produced also for such a three region types.

In summary, a two levels approach could be followed:

- At the first level all indicators which can be computed from modelling outputs are produced for each country;
- At the second level transport system operation indicators and environmental indicators are produced for the three region types: metropolitan city, other cities, non-urban.

However, for some indicators such as e.g. the population exposure to noise, a different scale of detail could be expected. Therefore, the geographical detail of the REFIT application of some indicators will depend for a large part on the specific requirements of the indicators. In general it can be stated however that a NUTS II regional level of detail is preferred above the national level.

# 4. Solutions for the gaps identified

## 4.1 New modelling tools relevant for the economic indicators

The two models that are most suitable for calculating the gaps indicated in section 3.3.2 are the CGEurope-R and EDIP models. These models will be developed during REFIT project. Gaps 1 – 2 will be computed by CGEurope-R and gaps 3 – 7 by EDIP. The further discussion will therefore focus mainly on these two models.

### 4.1.1 CGEurope-R

The REFIT *ad-hoc* economic model is an extension of CGEurope in which dynamic framework with imperfect labor market is considered.
CGEurope-R is a dynamic spatial general equilibrium model for a closed system of regions covering the whole world. All regions are treated separately and are linked through endogenous trade.
In each region there is assumed to dwell a set of households, owning a bundle of production factors, which is used by regional firms for production of goods. We distinguish between two types of goods, local and tradable. Local goods can only be sold within the region of production, while tradables are sold everywhere in the world, including the own region. Given the main task of assessing regional welfare and employment response to transport policy measures, introduction of more sectoral detail would lead to excessive difficulties.
Local goods are produced by perfect competitive firms. Tradable goods are produced under monopolistic competition and are modelled as being close but imperfect substitutes, following the Dixit-Stiglitz (1977) approach. Due to free market entry, however, profits are driven to zero, as they are in the market for locals. Households are assumed to act as utility maximizers, taking all prices as given. Utility emerges from consumption (in fixed income shares) of local goods and a CES-composite of tradables, consisting of all, regionally produced and imported variants.

Stock of effective labor is assumed to grow according to an exogenously determined time path. Equilibrium in the labor market allows for unemployment. For this purpose, a vertical labor supply curve from the previous version of *CGEurope* is replaced by a region-specific wage curve, introduced by Blanchflower and Oswald (1994). It is a formalization of negative dependence between wages and unemployment, suggested by the efficiency wage theory.
The fundamental dynamic relation is the equation relating $\dot{K}_r$, the increase of capital per unit of time, to investment:
$$\dot{K}_r = I_r - \delta K_r,$$
where $I_r$ is gross investment and $\delta$ is the rate of depreciation. $I_r$ is now a component of final demand, and households' demand is no longer equal to income, but equal to income minus saving. For the sake of simplicity, we assume investments to be composed of local and tradable goods just in the same way as consumption.

Through CGEurope-R it will be possible to predict the time path of GDP. CGEurope-R will compute also the welfare changes of the households by using the concept of money metric indirect utility function[6] and equivalent variation (EV).

All CGEurope results will be provided at the NUTS II level of detail.

#### 4.1.2 EDIP

The EDIP model includes the representation of the micro-economic behaviour of the following economic agents: several types of households differentiated by 5 income quintiles, 3 degrees of urbanization and 6 family types; production sectors differentiated by 23 NACE classification categories; investment agent; federal government and external trade sector.
The EDIP model has a single structure for all EU countries. It is one model with 27 different versions, which are estimated using the country-specific social accounting matrices for the EU27. The structure of the SAM does not differ between the countries and it corresponds to the structure of the EDIP model.
The social model called the European Model for the Assessment of Income Distribution and Inequality Effects of Economic Policies (EDIP) is constructed using the Computable General Equilibrium (CGE) framework. The EDIP model is a dynamic, recursive over time, model, involving dynamics of capital accumulation and technology progress, stock and flow relationships and backward looking expectations.

Main outputs of the EDIP model include the relative changes in:
- a set of social inequality indicators including the inequality of income distribution Gini coefficient, at-risk-of-poverty rate after social transfers, by household type, relative at-risk-of-poverty gap, long-term unemployment rate;
- real and nominal GDP;
- consumer price index by household type;
- unemployment level by household type;
- change in household’s welfare (equivalent variation) by household type;
- domestic outputs by sector and commodity type;
- labour, capital and intermediate goods inputs by sector type;
- households’ consumption by household and commodity type;
- households’ consumption of leisure by household type;
- savings by economic agent;
- investments by sector and capital commodity type;
- emissions levels related to production and to transport activity by main emissions types;
- demand for transport services by households and production sectors by distance class and vehicle type;
- households’ car stock by household type;
- governmental tax revenues by type of tax;
- governmental subsidies by type of subsidy;
- exports and imports by commodity type;
- terms of trade with the rest of the world;
- number of operating firms by sector type;

[6] The money metric indirect utility function expresses the welfare change induced by a policy change in monetary units (Euro).

- producer prices by sector and commodity type;
- consumer prices by commodity type.

Within REFIT EDIP will be developed at the national level. A further development on the NUTS II or even NUTS III level could be possible but would require more time and budget than available in this project still leaving a large uncertainty on whether a proper result will be achieved. It therefore has been chosen to focus here on the national level and guarantee a certain outcome. If and where possible in this REFIT project some first steps for a further extension to the NUTS II level will be analysed.

*GVA of the transport sector*
EDIP model includes a detailed description of the production technology of the transport sector. The transportation sector in EDIP consists of the four sub-sectors: road, rail, air and maritime/waterways. Each of the sectors produce specific type of the transportation service bought by the households and firms by using labour, capital and intermediate inputs. The optimal combination of the production inputs per unit of output is determined by the cost-minimization problem. This allows one to calculate the GVA of the transportation sector using EDIP per each of the sub-sectors corresponding to the main transport modes.

*The rate of employed in the transport sector*
EDIP model incorporates the representation of the production activities of different economic sectors including the representation of the transportation sector split into the four sub-sectors: road, rail, air and maritime/waterways. The sectors use labour, capital and intermediate goods for production. Given that EDIP calculates the level of employment in each sector of the economy, it is possible to use this information in order to calculate the ratio of employed in the transportation to the overall level of employment in the economy.

*The households' consumption by household in transport sector, expressed as the share of the transport expenditure over the total of households' expenditures.*
EDIP incorporates the representation of consumption activities of several major socio-economic groups, where each of these groups is represented by one household in the model. Households use their consumption budget on buying different goods and services (including the transportation) such as to maximize their aggregate utility measure. Each household consumes transportation by road, rail, air and sea/waterways. Hence, the share of the households' budget used to buy transportation services in the total consumption budget can be easily calculated using the outputs of the EDIP model.

*The business transport expenditure expressed as the share of the business transport expenditure over the total of expenditures*
EDIP incorporates the representation of consumption activities of several major socio-economic groups, where each of these groups is represented by one household in the model. Households use their consumption budget on buying different goods and services (including the transportation) such as to maximize their aggregate utility measure. Each household consumes transportation by road, rail, air and sea/waterways. Hence, the share of the households' budget used to buy transportation services in the total consumption budget can be easily calculated using the outputs of the EDIP model.

*The policy effects on governmental taxes and subsidies by type*

EDIP includes the full representation of the governmental sector, which collects taxes, pays subsidies, makes transfers to different domestic and foreign economic agents and buys services and goods. The models includes all major types of personal and business taxes and subsides and can calculate the tax revenues/costs associated with them. Thos allows EDIP to capture the effects of particular policy measures upon the overall taxes/subsidies by type.

## 4.2 Actions during REFIT

In this section it will be described in main lines what will be done in REFIT. This section gives more direction to the project and will be refined in the following tasks of WP 3.

**Data collection and statistical analysis – CGEurope**

To specify the dynamic model, exogenous growth rates for the effective labour stock have to be defined. Two sources of such data are in place: the rich literature studying convergence with estimates for separate regions or countries, and the official predictions of GDP per capita and population growth rates from the European Commission (e.g. the growth rates used in the project ASSESS).

For specifying the dynamic equations, the data on capital stock per country will also be taken from the GTAP database. The data on transport costs and revenue is expected to come from the TRANS-TOOLS model, once it will be run for the scenarios to be analysed in REFIT project.

The country-level values of unemployment elasticity of pay (needed for the construction of the wage curves) are taken from the rich wage curve literature.

**Improvement of the existing models – CGEurope**

*Unemployment*

In the basic CGEurope model labour effort is a part of regional composite factor service and so is assumed to be fully-employed, labour market being cleared by a flexible wage. Of course, this is an extremely unrealistic representation of European regions. A more realistic approach is to introduce imperfect factor markets to reflect stylised facts in most industrialised countries. In order to allow for a gap between supply and demand on the labour market, we need to relax a corresponding assumption of the neoclassical Walrasian model. We have to assume that adjustments are constrained by a certain degree of wage rigidity.

A possible measure of wage stickiness was proposed by Blanchflower and Oswald (1994). In their study the empirical responsiveness of workers' remuneration to the state of the labour market is captured by the coefficient on log unemployment rate in an equation for log real earnings. A way to provide an intellectual rationale for the wage curve is by appealing to efficiency wage theory. The well-known characteristic of efficiency wage analysis is that firms set pay in an environment where the wage influences productivity. Shapiro and Stiglitz (1984) is an archetypal case. In equilibrium, firms try to maximize profits and workers choose how hard to work. If the costs of shirking at work are low, employees put in little effort. The outside rate of unemployment plays a role, because it determines the ease with which a fired worker can get another job. In a highly depressed labour market, employees are frightened of losing their jobs, and so put in high effort even if pay is comparatively low. Put differently, a marginal rise in unemployment leads to a corresponding marginal fall in the level of wages. The reason is that firms can reduce pay slightly while maintaining a motivated workforce. Unemployment is a discipline device: when it is high the generosity of workers remuneration can be low. Hence there is an efficiency wage interpretation of a negative dependence between wages and unemployment.

Thus, the implementation of the regional wage curves in CGEurope will allow to assess the impact of policy scenarios on the *rate of unemployment*.

*Dynamics*
There are two approaches to implement the dynamics of capital accumulation: the recursive, and the forward-looking. The former is known to work and has been applied in well-known current models such as GTAP or MONASH, but it is not fully consistent with modern neoclassical investment theory. The forward looking approach, on the other hand, is theoretically consistent, but it is technically very demanding, and models that large as ours are not known to have worked with forward looking approach by now. The difference between two approaches can be seen in the specification of investment equation, which in the forward looking case includes Tobin's q, the market price of current capital stock. The fact that this price changes over time creates difficulties in finding the stable solution of the system.
In the course of the project the main effort will be made to create a working version of a forward-looking model. If this will not be possible to solve, the recursive model will be used to approximate the effects of policy actions.

**Data collection - EDIP**

Various national and European statistical sources are used for the construction of the database, used for the calibration and estimation of the coefficients of the social module. EuroStat is the main source of the statistical data for the model. The database for the social module is constructed for the year 2004.
Major elements of the social module database include the national accounts, supply and use tables, results of the national households' survey and the transport-related data from TREMOVE model. The national accounts, supply and use tables in NACE95 classification are available from EuroStat for all the EU25 countries. Similar data for the rest of the European countries has been requested from the national statistical offices. The delivered data was usually of a good quality but was not always had been consistent with the NACE95 classification. Thus we needed to make the respective changes to the structure of the data.
The results of the households' budget survey were available from EuroStat only for the EU15 countries. For the rest of the countries in the social module we have requested the data from the national statistical officers and are waiting to receive it.
The collected socio-economic data for the European countries is used to construct the Social Accounting Matrices (SAM) for all the EU27 countries. These data matrices are the basis for the construction of the socio-economic general equilibrium models for the countries.
The data on the economic transactions between different economic agents summarized in the form of the SAM is combined with the data on transport flow, transportation costs (time and monetary) and with the data from the households' budget survey for the construction of the EDIP model for each of the EU29 countries.

**Model building - EDIP**

The social model called the European Model for the Assessment of Income Distribution and Inequality Effects of Economic Policies (EDIP) is constructed using the Computable General Equilibrium (CGE) framework, which takes as a basis the notion of the Walrasian equilibrium. Walrasian equilibrium is one of the foundations of the modern micro economics theory.
CGE models are a class of economic model that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. A model consists

of (a) equations describing model variables and (b) a database (usually very detailed) consistent with the model equations.

The model equations tend to be neo-classical in spirit, assuming cost-minimizing behavior by producers, average-cost pricing, and household demands based on optimizing behavior. A CGE model database consists of tables of transaction values and elasticities: dimensionless parameters that capture behavioral response. The database is presented as a social accounting matrix (SAM). It covers the whole economy of a country, and distinguishes a number of sectors, commodities, primary factors and types of households.

The EDIP model has a single structure for all EU countries. It is one model with 27 different versions, which are estimated using the country-specific social accounting matrices for the EU27. The structure of the SAM does not differ between the countries and it corresponds to the structure of the EDIP model.

CGE models utilize the notion of the aggregate economic agent. They represent the behavior of the whole population group or of the whole industrial sector as the behavior of one single aggregate agent. It is further assumed that the behavior of each such aggregate agent is driven by certain optimization criteria such as maximization of utility or minimization of costs.

The EDIP model includes the representation of the micro-economic behavior of the following economic agents: several types of households differentiated by 5 income quintiles, 3 degrees of urbanization and 6 family types; production sectors differentiated by 23 NACE classification categories; investment agent; federal government and external trade sector.

The EDIP model is a dynamic, recursive over time, model, involving dynamics of capital accumulation and technology progress, stock and flow relationships and backward looking expectations. A recursive dynamic structure composed of a sequence of several temporary equilibriums. The first equilibrium in the sequence is given by the benchmark year. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibriums are connected to each other through capital accumulation. Thus, the endogenous determination of investment behavior is essential for the dynamic part of the model. Investment and capital accumulation in year t depend on expected rates of return for year t+1, which are determined by actual returns on capital in year t.

Behavior of the households is based on the utility-maximization principle. Household’s utility is associated with the level and structure of its consumption. Each household spends its consumption budget on services and goods in order to maximize its satisfaction from the chosen consumption bundle. Utility of the household is maximized under the budget constraint, where the household’s consumption spending is equal to its income minus income tax and the household’s savings. Households in the EDIP model receive their income in the form of wages, capital rent and transfers from the federal government. The governmental transfers consist of the unemployment benefits and other transfers.

The level of the unemployment benefits, received by the household, depends upon the level of unemployment associated with this particular household type. The unemployment in the economy is modeled according to the Phillips curve, which links the level of the real wage in the economy to the unemployment level. According to the Phillips curve the higher is the real wage, the lower is the unemployment level.

Behavior of the sectors is based on the minimization of the production costs for a given output level under the sector’s technological constraint. Production costs of each sector in the EDIP model include labor costs, capital costs and the costs of intermediate inputs. The sector’s technological constraint describes the production technology of each sector. It provides information on how many of different units of labor, capital and of the 23 commodities, traded in the economy, are necessary for the production of one unit of the composite sectoral output. Each

sector in the economy may produce more then one type of commodity and the combination of these different commodities corresponds to the sectoral composite output.
The EDIP model adopts the assumption of the average costs pricing in combination with the assumption of the Dixit-Stiglitz monopolistic competition between the firms inside each sector. Under the Dixit-Stiglitz monopolistic competition framework, it is assumed that each sector consists of a number of the identical firms, each producing a unique specification of a particular commodity. The same type of the commodity, produced by an individual firm, is slightly different from the same type of commodity, produced by other firms inside the sector.
These differences in the commodity specification give individual firms a certain monopolistic power over the consumers. Certain consumers prefer certain specification of the commodity and, hence, they are prepared to pay a bit more for it. The monopolistic power of the individual firms results in the deviation from the marginal costs pricing rule of perfect competition. The producer prices are now equal to the sector's average production costs and depend upon the number of the individual firms, which operate on the market.
Under the assumption of the imperfect competition (monopolistic competition in case of the EDIP model) the total sectoral production costs consist of the variable costs and of the fixed costs. The sectoral variable costs are equal to the marginal output costs multiplied by the sectoral output level. The sectoral fixed costs depend upon the number of the individual operating firms and are equal to the number of firms inside a sector multiplied by the fixed costs per firm.
Zero profit condition should hold for each of the 23 NACE sectors and it states that the variable production costs plus the fixed production costs are equal to the total revenues of the sector. The zero profit condition defines the equilibrium number of the individual operating firms in each sector. The number of firms is such that any new firm entering the market causes negative profits for all the firms in the sector. Increase in the number of the firms operating in a particular industrial or service sector is beneficial for the consumers since it provides them with the better choice opportunities.
The outputs of the domestic sectors are either consumed inside the country or exported abroad. Each of the 23 domestic sectors chooses how much of its output to sell inside the country, how much to export to the EU25 and how much to export to the rest of the world. The proportions, in which the total output of each sector is split between these three possibilities, depend upon the relative prices of the commodities inside the country and on the world market.
An Armington assumption on international trade is adopted in the model. According to this assumption the commodities produced by the domestic sectors for the consumption inside the country and for the consumption outside of it have different specifications. In order for the sector to be able to switch its technological process between producing these two different specifications of commodities, it has to overcome some adjustments. The degree of difficulty and feasibility of such adjustment is represented by the constant elasticity of transformation (CET) elasticity of substitution between producing commodity for the domestic use, for export to the EU25 and for the export to the rest of the world. The higher is this elasticity of substitution the more feasibly and easy the adjustment technological process described above. Than the proportions, in which the total output of each sector is split between the three possibilities, depend not only upon the relative prices of the commodities inside the country and on the world market but also upon the CET elasticity of substitution.
Domestic sales of each of the 23 types of commodities composed of the commodities produced by the domestic sectors, those imported from the EU25 and those imported from the rest of the world. According to the Armington assumption, the same type of commodity produced by the domestic sectors, imported from the EU25 or imported from the rest of the world has different specifications and, hence, cannot be treated as a homogenous good. Domestic consumers have

different preferences for these three specifications and can substitute between them in case the relative prices of the specifications change. The substitution possibilities between these three commodity specifications are represented by the Armington elasticity of substitution and vary between the types of commodities. The shares in which commodity is bought from the domestic producers, from the EU25 and from the rest of the world are determine by the relative producer prices of the commodity inside the country, in EU25 and in the rest of the world as well as by the Armington elasticity of substitution.

The equilibrium prices of all commodities and capital are defined by the market equilibrium conditions. Under the market equilibrium the sum of demands for a particular commodity is equal to the sum of its supplies. Due to the existence of unemployment the labor market is assumed to be in disequilibrium such that the equilibrium labor prices is determined by the equality between the sum of the sectoral labor demands and the total labor endowment in the economy minus the unemployment.

The model incorporates the representation of investment and savings decisions of the economic agents. Savings in the economy are made by households, government and the rest of the world. The total savings accumulated at each period of time are invested into accumulation of the sector-specific physical capital, which is not mobile between the sectors. The stock of this capital at each period of time is equal to the last period stock minus depreciation plus the new capital accumulated during the previous period of time.

The total investment into the sector-specific capital stock is spent on buying different types of capital goods such as machinery, equipment and buildings. The concrete mixture of different capital goods used for physical investments is determined by the maximization of the utility of the investment agent. This is an artificial national economic agent responsible for buying capital goods for physical investments in all the domestic sectors.

The EDIP model incorporates the representation of the federal government. The governmental sector collects taxes, pays subsidies and makes transfers to households, production sectors and to the rest of the world. The federal government consumes a number of commodities, where the optimal governmental demand is determined according to the maximization of the governmental consumption utility function. The model incorporates the governmental budget constraint. According to this constraint the total governmental tax revenues are spend on subsidies, transfers, governmental savings and consumption.

Finally, the model includes the trade balance constraint, according to which the value of the country's exports plus the governmental transfers to the rest of the world are equal to the value of the country's imports.

Households and domestic sectors use transport services in their consumption and production activities. The transport services represented in the EDIP model are differentiated by the three distance classes (long, short and urban) and 14 main vehicle type categories. The vehicle categories include both freight and passenger vehicles, which operate on road, rail, inland waterways and air. Each type of transport service is associated with the particular after tax price, which includes VAT taxes and other taxes. Public transport and freight transport services are produced by several national transport sectors, namely road, rail, inland waterways and air sectors. These sectors use labor, capital and commodities, for example fuels and vehicles, as inputs to their production. Passenger transportation by car is produced by the households themselves using fuel and car vehicles. In order to own a passenger car vehicle a household has to pay the car ownership costs, which include different types of taxes, such as registration taxes, for example.

The EDIP model employs the concept of a variable expenditure function with quasi-fixed durable goods (car vehicles) as arguments in order to derive a demand system for nondurable

goods (fuels) in prices of the nondurables, in the stocks of durables and in variables expenditure. Investment demand for durables and their desired stocks (car stocks) are determined inside the model. The desired stock of cars in the EDIP model depends upon the development of the demand for transportation and the car ownership costs.
All production activities and in particular the transportation activity is associated with emissions and environmental damage. Environmental quality is one of the main factors of the households' utility function. Changes in the levels of emissions have a direct impact upon the utilities of the households.
Detailed emissions can be calculated for transportation using the TREMOVE emission module. As mentioned earlier, the TREMOVE emission module is very detailed and considers various transportation modes, technologies, fuel types, road types etc. The link between the demand module and emission module ensure that policy measures influence the overall emission factor.
For the emissions of other sectors, another, more simplified approach is suggested. Still, instead of using a general fixed emission factor, it is the objective to add some other factors to make influence by policy measures possible.
The welfare of each household type (population group) in the EDIP model is calculated as the equivalent variation measure and depends upon consumption of commodities, consumption of leisure and the level of environmental quality.

## 4.3 Actions to be taken up later

In this section action are listed that will not be done in REFIT but would be an improvement if they are done after REFIT.

For some indicators it has been concluded that they can not be calculated with the core models and it is not seen feasible to calculate them with the ad hoc models as being developed in this project:

- Total change of industry output and employment due to transport investments and policies
- Job housing proximity and commuting flows
- Urban access quality

The main reason for this is the poor data availability at a European scale for the variables that are relevant for the calculation of these indicators.

- Total change of industry output and employment due to transport investments and policies

In order to model industry output response to transport policies, one has to introduce industry-commodity framework into CGEurope. A necessary additional piece of information is then the disaggregation of baseyear transport flows and costs between regions into different commodity groups (using e.g. NSTR nomenclature). A correspondence must then be created between these commodity groups and the industries as defined in country-level input-output tables. An example of such industry classification would be NACE or ISIC nomenclature. As was clarified during the work in the TRANS-TOOLS project, creating such a correspondence is not particularly straightforward, and, more importantly, the final usefulness of this exercise relies fully on the existence of high-quality disaggregated flows and costs data mentioned before. Because the main source of European transport data, the ETIS-BASE, suffers from certain problems, described in the TRANS-TOOLS early deliverables (D3), the work on modelling industry output response was postponed. This work could of course be continued once e.g. the ETIS-BASE is updated and the mentioned problems are removed.
Modelling the response of employment by industry is a much more demanding exercise, and is probably not feasible to make for the project mainly focusing on European transport sector.

- Job housing proximity and commuting flows

In order to be able to access the changes in the commuting flows and in the home-job locations pair of the households', a very detailed geographical representation is necessary. The most disaggregate regional level at which the REFIT models operate is the NUTS3 level. Even this detailed regional level is not enough for the reliable and full representation of the commuting and location behaviour of the households. This means that within the present set of the REFIT models one cannot calculate this sustainability indicator. Constructing a much more detailed regional model incorporating commuting and location of different household type is the subject of the future research.

- Urban access quality

The quality of the urban access depends upon the quality of the infrastructure of a particular city as well as upon the density of public and private transport in the city. This indicator can be assessed only with the transportation model describing the city network and the transportation flows on it. None of the REFIT models include the representation of such urban transport network and hence they are not able to calculate the value of this sustainability indicator. However, the indicator can be calculated using the existing transportation network models for the major European cities.

- Refining the geographical details of the ad-hoc social model EDIP

Under the REFIT project we will develop the ad-hoc social model, used for the calculation of the sustainability indicators of the social dimension, for the EU29 at the national level. This means that the model allows for calculating each of the social indicators per European country. Given the good data availability at the REGIO EuroStat statistical database, it is in principle possible to refine the geographical dimension of the ad-hoc social model to NUTS2 or even NUTS3 geographical level.  Disaggregation of the social model to NUTS2 or NUTS3 level requires large amount of data work involving the construction of the interregional trade flows, regional economic accounts of households and firms etc. and cannot be done within the budget and time schedule of REFIT.

# 5. Connection of the economic dimension with social and environmental ones

The economic, social and environmental dimensions are not completely independent from each other; they are interrelated on several aspects. These interrelationships are described in the following sections focusing on the interrelationships with the economic dimension.

It should be noted that because of the interrelationships it is not possible to just add up effects since this will lead to double counts. This aspect will be further analysed and demonstrated in the following steps of the REFIT project.

## 5.1 Links between economic and social dimensions

There exist several major channels through which social and economic dimensions of transport sustainability is interrelated:

- Consumption of transport services by socio-economic groups
- Productivity of labour
- Location decisions of the households and firms
- Availability of labour resources.

Each socio-economic group is associated with the specific **consumption pattern and preferences with respect to the transportation services**. Poor households, in general, consume more public transport services, whereas reach households use more private cars. Rural households leave in the areas with lower density of public transport network and, hence, need to use more private car for their trips. Households leaving in the densely populated areas, such as major European cities, have better possibilities for using the public transport and less dependent upon the use of private cars. Large families prefer using a private car for their travel trips, since it gives them more flexibility and comfort.
The distribution of income between different socio-economic groups influences the economic performance of transport sector via the diversity of their consumption preferences associated with the consumption of transportation services. Redistribution of the income from reach households to poor ones via the income tax results in a certain increase in the consumption of the public transport services. This is explained firstly by the fact that poor households prefer use of public transport to the use of private car. Secondly, it is explained by the fact that poor households mostly live in the densely populated areas with the good level of the provision of the public transport services. In case a subsidy is given to the rural households, it results in the increase in the use of the private car, which is the predominant type of transportation for this type of households.
Changes in the consumption levels of the different types of transportation services, resulting from the changes in income distribution between the socio-economic groups, lead to the respective changes in the demands for the particular transportation services. These demand changes influence the performance of the transportation sector and in particular its production, consumption of intermediate inputs and its value added.

Changes in the economic conditions influence the performance of the transportation sector and the price levels of different services it produces. Given that diverse socio-economic groups buy different amount and types of the transportation services, they will be influenced in a totally different way by the changes in their price levels. An increase in the governmental subsidies to the public transport sector will bring the most benefits to the urban households and the poor households, which consumer most of the public transport services. Changes in the prices of the private cars coursed by for example changes in the import taxes will have the most influence upon the rural households, large families and the reach households, whereas other socio-economic groups will stay uninfluenced.

**The productivity of labour** is directly influenced by the economic conditions in which different socio-economic groups live, their ability to receive health services, buy quality food, exercise and have enough rest. The quality of labour, in particular its health, is directly influenced by the performance of the transport sector via the noise and accidents. It is well-known that labour productivity is the major factor of an efficient production of any sector in the economy and in particular of the transportation sector. The link between the social and economic factors related to labour productivity is not that strong as in case of the households' consumption activities but it is relevant for the comprehensive analysis of the sustainability issue.

Any economic activity happens in space and, hence, depends upon the **availability of the input factors such as labour**, intermediate goods and capital at the particular geographic location. Quality and availability of the transportation services has a major influence upon the **location and commuting decisions** of the different socio-economic groups. These decisions are in their turn closely linked with the availability of labour at a particular production location. The absence of sufficient labour supply leads to diminishing production activities and has an influence upon the gross domestic product and value added.

Decisions of the firms to locate themselves in space are also influenced by the availability and quality of the transportation services at different geographical locations. This leads to the situation of high unemployment in the remote areas and negatively influences the socio-economic groups leaving in there.

Accidents associated with the transportation activity lead to deaths or the lost of full physical health for a lot of people each year.  It is true that different socio-economic groups are under a different level of the risk of transportation accidents. The risk of accidents depends upon the residential location of the socio-economic groups and their preferences for various types of transportation services. Accidents lead to a significant loss of labour resources in Europe and hence negatively influence the economy.

## 5.2 Links between economic and environmental dimensions

There exist several major channels through which the economic and environmental dimensions of transport sustainability are interrelated:

- Movements of traded goods generate emissions
- Economic activity generate emissions due to commuting
- Welfare increase generates more transport emissions
- Environmental tax earned by the government
- Environmental measures generate need for new (environmental friendly) products
- Internalisation of external costs

Physical goods that are traded have to be transported from the place of production to the place of consumption. This can be done in steps including for instance wholesale and shops. An increase of trade/sale of physical goods will generate an increase of transport movements which will result in an absolute increase in emissions (due to change of organisation of transport/distribution the emission per product could also be lower).

Economic activities also generate movements of people between their home and work. More economic activity therefore generates more commuting which also will generate an absolute increase of emissions.

Economic services generate movements of people that want to consume the service or it generates movements of service providers that deliver the service at home. An increase of the economic services therefore generates transport movements that result in an increase in emissions with the exception of electronic services (such as teleconferences).

Welfare increase in itself generates the possibility to consume more either physical goods or services. Increase of welfare could therefore possibly generate more transport movements resulting in more emissions.

Environmental damage is something that is presently unwanted in most developed societies (in line with the Maslov pyramid theory). Governments therefore raise tax on activities and/or goods that cause environmental damage especially when this concerns external effects (external in the sense of not priced). Transport is one of these activities (the more km produced the higher the tax) but also the vehicles used for transportation can be subject to tax rules; i.e. the higher the weight or this could also become the more damaging the vehicle per km the higher the tax in various forms. Economical increase therefore also generates a higher government income. This higher government income can be used to stimulate the production of environmental friendly goods (including vehicles and energy sources).

Environmental measures make that it is more attractive to produce and market environmental friendly products, also it will cause faster replacements of products. This includes the replacement of vehicles. It can also happen that technological breakthroughs happen and that completely new alternatives come available that will better fulfil the needs of the consumers. In these ways environmental measures stimulate economic activity.

Finally external costs can be internalised. External costs can be expressed in monetary terms and in this way be made an economic aspect. In this study this is not considered under the economic dimensions but will be applied at a later stage in the demonstration of assessment methods.

# ANNEX

Tab. A.1 Transport economic indicators

| | Indicator | Variable | Unit | Linkage to framework models | Spatial detail |
|---|---|---|---|---|---|
| Spatial impact indicators | Change of regional GDP due to changes of regional accessibility | % difference between GDP of reference case and GDP of policy case | % | CG-Europe-R | Region |
| | Accessibility measures | accessibility measure | AD | TRANS-TOOLS for transport impedances | Region |
| | Welfare measures | Equivalent variation measured compared to reference case | 1000€ /year | CGEurope-R | Region |
| | Trade | Total value of import + export from each country | M€ | CG-Europe-R | Region |
| Sectoral impact indicators | Transport sector production: share of GVA generated by the transport sector | % of GDP from transport sector | M€/inh | EDIP | Country |
| | Transport sector employment | Rate of employed | % | EDIP | Country |
| Transport Budget Indicators | Households transport expenditures | % households transport exp. on total exp. | % | EDIP | Country |
| | Business transport expenditures | % Business transport expenditures on total exp. | % | EDIP | Country |
| | Government net revenues (taxes – subsidies) from transport | Government net revenues (taxes – subsidies) from transport | M€/year | TREMOVE | Country |

## Tab. A.2 Change of regional GDP due to changes of regional accessibility

| Code | Change of regional GDP due to changes of regional accessibility |
|---|---|
| ESPGDP | Regional GDP trends and forecasts<br>Changes of regional GDP forecasts induced by transport policies |

**Description**

The Gross Domestic Product (GDP) per capita and the real GDP growth rate are the most common measures of the standard of living, wealth and economic growth. The GDP is a measure of the size and performance of a regional economy and its competitiveness. GDP levels and growth are correlated with the access to European markets (i.e. to population, job opportunities, etc.), which varies significantly among the EU regions and is highest in north-western Europe. This is mainly due to high infrastructure densities in that region. Studies on the link between the transport infrastructure and services and regional development are inconclusive as regards the extent to which transport infrastructure actually leads to growth in economic welfare and to strengthened cohesion among regions.

Journey time savings and increased reliability for business travel contribute to GDP. Faster and more reliable journeys in the course of work, in fact, represent a productivity gain. Moreover there are effects in the labour market that may mean further effects of transport on GDP if transport directly or indirectly causes an increase in labour supply. In this case GDP rises because time savings have an impact on the labour supply decision of a few individuals (see “Transport, Wider Economic Benefits and Impacts on GDP”, Department of Transport – UK).

**Calculation method**

The effects of policies on the spatial distribution of GDP have been studied in the IASON project with the help of the SASI model, providing insights into the effects of TEN investments or SCMP policy on regional GDP, unemployment and accessibility of regions. The welfare generation effects are modelled instead by the CGEurope model, answering to questions such as what is the impact on income and consumption of households in different regions. Both models use the same system of regions, the same network data and a common database of regional socio-economic data to examine the above policy scenarios. Both models forecast changes in regional GDP per capita in 2020 induced by the policies, computing differences in regional GDP per capita between the policy scenarios and the reference scenario in 2020.

**Data availability and territorial level**

Regional GDP forecasts for European NUTS2 regions are available at www at Eurostat - Gross domestic product (GDP) at current market prices at NUTS level 2.
The IASON Final Report includes several maps which show the changes in GDP per capita caused by TEN and SCMP policies analysed with regard to accessibility. These results demonstrate that regions that gain in accessibility also gain in GDP per capita. Similar observations, but with opposite sign, can be made with respect to the impact of transport pricing: the peripheral regions, which lose most in accessibility, also lose most in GDP per capita.

**Calculation in the REFIT framework**

CGEurope is able to compute the changes of real GDP by region and scenario year with respect to the reference scenario. The refined version of CGEurope, which considers dynamic framework with imperfect labour market, can predict the time path of GDP as well. The data can be provided at NUTS2 detail level.

**Classification of the indicators according to the REFIT framework**

*a. Indicators that can be addressed by the REFIT ad hoc models*
Regional GDP trends and forecasts: CGEurope-R
Changes of regional GDP forecasts induced by transport policies CGEurope-R

**Policy sensitiveness**

*TRANSPORT POLICIES*
**Transport European Network**: TEN projects aim to eliminate bottlenecks on the main international routes by promoting corridors with priority for freight, rapid passenger network and traffic management plans for main roads, motorways of the seas. Large infrastructure investments have a direct positive impact on the GDP of the regions concerned. The improved accessibility will have an indirect effect on GDP growth of core and peripheral regions in Europe.
*OTHER EU POLICIES*
**Regional policy**: The main goal of the EU regional policy is to reduce regional disparities and future imbalances. To this end one of the main tasks of the European Regional Development Found (ERDF) is to provide financial contribution for the transport infrastructure projects, in particular TEN networks in order to reach regional cohesion for what concerns growth and jobs.

**Agriculture and rural development**: As far as the TEN projects will improve the accessibility of outlying regions, they will be complementary to rural development policies.
**Enterprise and industry**: Opening and competitiveness of European markets together with TEN projects will be underlying driving forces for enterprise and industry promotion.

## Tab. A.3 Accessibility measures

| Code | Accessibility measures |
|---|---|
| ESPAM | Distance measures<br>Topological accessibility indexes<br>Space-time accessibility measures<br>Potential accessibility (gravity type) measures |

**Description**

According to a wider definition, we may consider “accessibility” to be the ease for people to participate in activities from specific locations to a destination using a mode of transport at a specific time. The ease of participation in activities refers to any benefits or costs associated with travel. Such benefits and costs may encompass money, time, convenience and comfort to name a few. The above definition of accessibility acknowledges that:

- Individuals have varied socio-economic characteristics, behaviour and needs which influence their choices that in turn impact their accessibility;
- Accessibility is different for all activity types because of their location, importance, availability and their nature;
- Location characteristics of destinations vary by their spatial separation from the location of individuals and by the characteristics of the destination itself;
- Each transport mode varies in relation to costs, benefits, characteristics and user perceptions;
- Time influence accessibility through the variation in the availability of activities, the attractiveness of areas and the state of the transport system throughout different times of the day and between different days of the week.

In summary, accessibility is more than just overcoming spatial separation between locations. It also acknowledges the differences between the people for whom the measure is calculated, the activities to which people need access, the property of activity locations, the modes of travel that overcome the spatial separation between people and activities, and the influence of time on accessibility.

Accessibility measures can be divided in “process” and “outcome” measures. Outcome measures are based on the actual use and level of satisfaction obtained from taking part in a given activity or service. This type of measures implies that accessibility should be gauged from the travel patterns of people, not just the presence of the facilities. In contrast, process accessibility measures are based upon the supply characteristics of an urban system and the characteristics of the population, implying that accessibility is the opportunity or potential to travel to selected activities and is independent of actual trip making.

**Calculation method**

**Distance measures** view accessibility as exclusively a function of a spatial separation between two places. Although Euclidean distance is the simplest measure, other distance metrics and network-based shortest path lengths and travel times are possible and appropriate depending on the context.

**Topological measures** examine the degree and pattern of connectivity of nodes within a network. Topological accessibility is traditionally the number of links connecting one vertex to another in a connected graph. Based on deriving shortest path matrices representing the connectivity between pair of vertices within a network, a range of topological measures exist that either indicate accessibility between any two locations or provide an overall measures of accessibility for the entire network.

**Space-time measures** are based on the concept of “time geography” first developed by Hagerstrand (1970), which introduces the constraint of time with space to determine the behavioural possibilities of an individual. Space-time prisms are three-dimensional objects with an x-y plane representing space and a z-coordinate representing time. The space-time framework assumes that events undertaken by an individual have a spatial and temporal component and that an individual can only participate in activities at a single location and point in time. The space-time path traces the individual’s physical movement in space with respect to time. One problem is the assumption of a uniform travel velocity over space and time. This is highly unrealistic: most physical movement is constrained into corridors by the built environment, as well as the modes used to traverse these corridors. In addition, the increasingly saturated nature of many transportation networks means that travel times within these conduits can be highly variable over time due to congestion.

**Potential (gravity type) accessibility measures** postulate a tradeoff between the utility of a destination and its required travel cost relative to a given origin. These types of measures have their foundation in spatial interaction and spatial choice theories. Spatial interaction theory addresses aggregate flows of people, material or information between origins and destinations based on their characteristics and the degree of spatial separation between origin-destination pairs. Spatial choice theory addresses individual-level preferences and choices among locations using utility functions that often incorporate destination attractiveness and disutility associated to the spatial separation between and origin and destination (both theories are consistent: one can derive the spatial interaction model from a spatial choice foundation). Weibull (1976) formulated a measure of accessibility by first specifying the desirable properties for the measure and then deriving the measure from these properties. The mathematical form derived and used to represent accessibility to jobs in Stockholm was:

$$A_i = \sum_{j=1}^{n} f\left(C_{ij}\right)\frac{O_j}{\partial_j}$$

where $A_i$ is accessibility, $f\left(C_{ij}\right)$ is the cost function, $O_j$ is the opportunities in zone j and $\partial_j$ is the demand potential formulated (in the travel to work case by two possible modes of transport, but the formula can be generalised to any number of modes) as:

$$\partial_j = \sum_{k=1}^{n}\left[P^1\left(C_{kj}^1\right)h_k^1 + P^2\left(C_{kj}^2\right)h_k^2\right]$$

where $P^m\left(C_{kj}^m\right)$ is a non-increasing function in the range [0,1] for mode *m* where $P^m(0)$ equals one and approaches zero as the cost approaches infinity, and $h_k^m$ is the number of individuals that live in zone *k* choosing mode *m*. Without the cost function and the demand potential $\partial_j$ this measure is referred to as the "cumulative opportunities" measure and with the cost (impedance) function referred to as a "cumulative opportunity weighted by impedance" or more commonly as the "gravity-based measure".

**Data availability and territorial level**

Data to build accessibility measures are usually available for individual urban areas. They include data related to the urban transport system providing information on the transport infrastructure, traffic characteristics and modal systems. In addition, locally available information on land use provides an indication of what and how much is offered for activities at various locations. Densities of opportunities offered in zones are calculated for land-use types that include population, employment, education enrolment places, retail, social and recreational facilities. Finally, revealed preference data are often collected from household travel and time use surveys, which provide information on the socio-economic and travel patterns of the population in various areas of the urban space.
At the interurban level regional accessibility indexes have been computed for NUTS2 regions in Europe. The IASON final report show four types of accessibility indicators calculated in the SASI model and used as explanatory variables in the regional production functions (Cfr IASON, Final Publishable Report, pages 55-57):
Accessibility rail/road (passenger travel)
Accessibility rail/road/air (passenger travel)
Accessibility road (freight)
Accessibility rail/road (freight).

**Calculation in the REFIT framework**

The potential (gravity type) accessibility measures can be calculated through the REFIT models as Cij (transport cost between zone i and zone j) can be measured in terms of generalised cost for O/D pairs from TRANS-TOOLS. Attractiveness (opportunity) of zones can be measured in terms of GDP from CGEurope-R. Demand potential of zones can be measured in terms of population from CGEurope-R. The data output are available at NUTS2/country level.

**Classification of the indicators according to the REFIT framework**

*a. Indicators that can be addressed by the REFIT core models:*
The accessibility measures: TRANSTOOLS
*b. Indicators that can be addressed by the REFIT ad hoc models*
The attractiveness measures: CGEurope-R

**Policy sensitiveness**

*TRANSPORT POLICIES*
**Urban transport**: The main goal of these measures is to reduce congestion and improve accessibility in European cities. Best transport practices are promoted in order to increase the quality of urban transport either by modernizing public transport or enabling more rationale use of private cars. Accessibility measures can help to measure urban transport policies achievements.
**Transport European Network**: TENs aim to improve the connections between EU regions in particular with the peripheral areas and islands, and this should be reflected by accessibility indicators computed at the regional level.
*OTHER EU POLICIES*
**Enterprise and industry**: Improved accessibility, as measured by regional indicators, can support regional industry competitiveness and growth, avoiding transport efficiency bottlenecks.
**Regional policy**: EU regional policy aims to reduce regional disparities and future imbalances also by supporting

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| financially transport infrastructure projects, in particular TEN investments which aim to improve the accessibility to global markets. |

## Tab. A.4 Welfare measures

| Code | Welfare measures |
|---|---|
| ESPWM | Behavioural utility measure (logsum)<br>Consumer surplus measures |

**Description**

**Behavioural utility** is based on the assumption that individuals are rational entities and will make choices to maximise their own satisfaction or in case of choice modelling, maximise utility. The utility of an alternative is derived from the observable attributes (weighted by their contribution to influence a decision) and unobserved attributes, which are considered as random variables estimated from a distribution representing the sampled population. If we assume that the unobserved utilities have identical but independent distributions and scale the observed utilities appropriately, we can derive the expected maximum utility measure from the nested logit choice model:

$$A_i = \ln \sum_{j \in K_i} \exp(u_{ij})$$

where $u_{ij}$ is the observed utility of destination *j* for person *i*, and $K_i$ is the choice set for person *i*. Although this does not appear to be a place-based measure, in practice the person *i* is linked to a location and the utilities $\{u_{ij}\}$ typically include origin-destination travel costs measures as disutilities. This measure of accessibility is also called the *inclusive value* or *logsum*, representing in a single value the benefit an individual obtains from a set of alternatives.
There is a close correspondence between the expected maximum utility of a choice situation and the concept of **consumer surplus** in microeconomic theory. Consumer surplus measures the benefits to an individual from the prevailing price in the market. It can also be referred as a measure of the willingness to pay for a commodity as it is the difference between what a person is willing to pay for a commodity and what they actually pay. Consumer's surplus is the extra value an individual receives above the purchase price (it can be negative as well). There are two major consumer surplus measures, namely *Marshallian surplus* which represents an individual's willingness to pay above the prevailing market price and the *compensating variation*, which represents the income transfer required to maintain the same utility level given a small change in market price.

**Calculation method**

The logsum measure has been the most frequent application of accessibility used in integrated land use-transport models. The utility of a particular choice can be derived in a number of ways. Generally speaking, it can be partitioned into two sub-functions: one depends on measures of accessibility that can be directly observed, such as the physical attributes of the land use-transport system (available modes at the origin and destination, travel speed etc.); another sub-function depends on aspects of utility less easily observed, including the preferences or tastes that households embody with respect to the overall feel of the neighbourhood in which they live or how they travel. The first sub-function determines in practice the choice set of feasible travel alternatives, while the second sub-function determines the relative attractiveness of the feasible travel alternatives.
A synthetic indicator is the **change in consumer surplus per person per trip**, which can show the time and money saved for each trip made by each resident with the introduction of the new policy as compared to a reference scenario without intervention. This shows the true benefit derived from the policy on a per capita basis without the influence of other factors such as the population size.
The normative side of the consumer theory, called welfare analysis, states that households gain benefits from the allocation of their income between consumption and savings. Consequently, how well off a policy change actually makes a household, depends on the effects of the policy change on prices, output, trade flows, income and how the household evaluates the benefits of these changes. This is assessed by the assumed utility function representing the consumer's preferences. By comparing the utility level before and after the policy change the *welfare effects* induced by the policy change can be measured. However, since utility levels only measure ordinal scales, they have to be translated into money metric terms. This can be done by applying the microeconomic concept of duality (see Deaton and Muellbauer, 1980) leading to a function, which gives the wealth (in monetary terms) required to reach a given level of utility when prices are constant. Using this (the so-called money metric indirect utility) function, one can measure the welfare change expressed in monetary units (Euro) induced by a policy change.
One of the well-known measures of welfare change based on this function and originating in Hicks (1939) is the **Equivalent Variation (EV)**. Calling the situation before the policy change the benchmark, the EV of a policy change can be defined as the amount of money that must be added to the household's benchmark income (everything else held constant at benchmark levels), in order to bring the household the same utility as under the policy change. Obviously,

| |
|---|
| the EV is not the same as the income increase generated by the policy change. This would be so only if no variable influencing utility but income changed. However, as a consequence of transport cost changes other variables like prices and product varieties also change.<br>In the **REFIT** framework the welfare indicator can be expressed by the welfare changes of the households.<br>The welfare changes of the households are computable through REFIT models by using the concept of money metric indirect utility function and equivalent variation (EV).<br>The economic model CgEurope-R and EDIP ad hoc social model are able to compute the relative equivalent variation by region and scenario year. The data are available at NUTS2/country level. |
| **Data availability and territorial level** |
| The behavioural utility and consumer surplus measures incorporate the preferences and needs of individuals elicited from their revealed travel patterns. The main sources of data are therefore households travel behaviour surveys. |
| **Linkage with models** |
| *a. Indicators that can be addressed by the REFIT ad hoc models:*<br>Welfare measures: CGEurope-R and EDIP |
| **Policy sensitiveness** |
| *TRANSPORT POLICIES*<br>Transport pricing and taxation: these policies are clearly expected to cause changes in consumer surplus per person per trip where they are implemented, changing the distribution of households welfare. |

## Tab. A.5 Trade flows

| Code | Trade flows |
|---|---|
| ESPTR | Import/Export flows |

**Description**

External trade statistics provide the level of exports and imports of goods by the main transport mode (air, pipelines, rail, road and sea). "Goods" means all movable property including electric current; in consequence trade in services is exempted. External trade statistics are expressed in million of euro.
Data record the trade between Member States in terms of arrivals and dispatches of goods as well as in terms of imports and exports between Member States and non member countries. Exports include goods which leave the statistical territory of the Member State vice versa imports mean all inward flows. Extra-EU trade imports are recorded at the frontier country where the goods are placed under the customs procedures. Extra-EU trade statistics do not record exchanges involving goods in transit, placed in a customs warehouse or given temporary admission.
EU-trade statistics have been categorized into large economic classes of commodities following both the Standard International Trade Classification (SITC Rev. 3) and the Broad Economic Categories (BEC) provided by the UNSD-International Trade Statistics Branch in order to promote international comparability of trade statistics.
Nomenclatures and correspondence tables are available at the Eurostat’s classification server RAMON.
The following items represent the main groups of products, further disaggregated in sub-classes:

- Food and live animals
- Beverages and tobacco
- Crude materials, inedible, except fuels
- Mineral fuels, lubricants and related materials
- Animal and vegetable oils, fats and waxes
- Chemicals and related products, n.e.s.
- Manufactured goods classified chiefly by material
- Machinery and transport equipment
- Miscellaneous manufactured articles
- Commodities and transactions not classified elsewhere in the SITC
- Gold, monetary
- Gold

Nowadays, for a country trade represents one of the main determinant of its economic and social performance and potentials: country’s growth is strictly linked to its trade. It is important to highlight that country’s export competitiveness is determined by its productive volume but it is also influenced by its skill to move goods to foreign markets at the lowest possible cost and under conditions required by importers and consumers. The latter factors constitute major elements of supply capacity and are largely determined by the availability, quality and cost of transport and logistics services.
During the last two decades, world trade has grown more than twice as fast as world GDP. In the 1990s, growth in expenditure on international transport was even faster than trade growth: in fact, while exports increased by about 75%, real expenditure on international transport more than doubled. The primary reason for this is greater demand for just-in-time (JIT) deliveries, which has increased the share of air transportation, as well as more frequent, more secure and more reliable multimodal door-to-door transport services as reported by UNCTAD (United Nations Conference on Trade and Development) and WTO (World Trade Organization) analyses.

**Calculation method**

The Member States collect, compile and transmit the external trade statistics to Eurostat according to specific Council regulations. The information providers are generally enterprises with a trade above the thresholds system. External trade statistics collect exhaustive data above the thresholds exempting the information providers (companies) from statistical formalities.

- Extra-EU trade statistics are collected, by using the statistical copy of the customs declaration, on the basis of the statistical part of the single administrative document (SAD) provided by the Customs authorities when transactions are above the extra-EU transaction threshold (1000 EUR or 1000 kg in net mass).
- Intra-EU trade statistics are collected, directly from trade operators as a consequence of the abolishment of customs control at the borders between the Member States, on the basis of the Intrastat declarations provided by the trade operators not exempted from the statistical obligation, (i.e. legal or natural VAT registered persons in the reporting Member State who have carried out an annual intra-Community trade above the Intrastat exemption threshold during the previous year or reached the threshold during the current year).

In addition to the data collected from SAD and Intrastat declarations, Member States compile and provide Eurostat with adjustments in order to compensate the impact of the trade not collected due to the threshold system. Therefore, the trade coverage should be close to 100%.

**Data availability and territorial level**

The statistical information is mainly provided by the traders on the basis of Customs (extra-EU) and Intrastat (intra-EU) declarations. Data are collected by the competent national authorities of the Member States and compiled according to a harmonised methodology established by EU regulations before transmission to Eurostat. External trade statistics cover both extra- and intra-EU trade: Extra-EU trade statistics cover the trading of goods between a Member State and a non-member country. Intra-EU trade statistics cover the trading of goods between Member States. The trade value and the quantity are the basic indicators available for all products of the Combined Nomenclature.
Geographical coverage: External trade Euro-Indicators are published for the Euro-zone, the European Union (EU-25 and EU-15) and for each Member State separately.
Temporal coverage: Since January 1989.
Last update: 2004/2006
Other sources:
Freight transport: EU: Energy & Transport in figures - 2005
Paved roads: IRF – International Road Federation, World road statistics 2004.
Air transport, freight: ICAO – International Civil Aviation Organization, Civil Aviation statistics of the world

**Calculation in the REFIT framework**

Within REFIT, the indicator ‘trade’ is calculated in the following way. Basically, for each country matrices of trade by mode of transport can be defined (e.g. value of goods exported to and imported from other countries by truck), but such a matrix cannot be regarded as a synthetic indicator. A measure of the size of trade or of its composition could be used as indicator. Indeed, the composition of trade can be changed e.g. in terms of a different ranking of commercial partners for a given country, however the transport policy does not play a major role in this type of change. Instead, transport policy measures can affect the usage of modes, but an indicator like e.g. the mode share of rail on international freight traffic belongs more to the transport operation domain than to the economic domain. In the end, the **total value of import plus export from each country** could be used as indicator. The total value of import plus export from each country can be drawn from the TRANS-TOOLS model.

**Classification of the indicators according to the REFIT framework**

*a. Indicators that can be addressed by the REFIT core models:*
Total value of import plus export from each country TRANSTOOLS;

**Policy sensitiveness**

*TRANSPORT POLICIES*

**TEN infrastructure investments** will improve/create new freight corridors fastening the movements of goods within Europe and in particular towards the peripheral and island regions. Intermodal transport measures (e.g. standardization of loading units, development of the profession of freight integrator etc.) will clearly affect the trade flows within Europe and with the other continents. Moreover, railways’ reorganisation by opening up national (cabotage) and international good transport as well as building of motorways of the seas can provide a competitive alternative to road. On the other side, measures set in road transport sector will allow to improve quality of freight services. All these measure together will support in the future new trade patterns that can be measured as changes in the major trade flows by country and transport mode.

*OTHER EU POLICIES*

**Internal market and services**: Further expansion of trade flows in particular those related to the NMS is expected, hence transport freight volumes will likely increase.
**Taxation and customs union:** EU Tax Policy mainly aims to overcome all potential tax obstacles to cross border activities. Concerning the transport sector, actions on VAT and excise duties are of particular relevance for trade flows at European level.
**Agriculture and rural development:** Currently CAP inhibits transport creating several barriers to trade. New measures (e.g. abolishment of Direct Payments) are expected to decrease export figures on one side and increase imports from third countries on the other side.

## Tab. A.6 Transport sector production

| Code | Transport sector production |
|---|---|
| ESETGVA | Share of Gross Value Added generated by transport<br>Transport service output index (TSI) |
| **Description** | |
| The share of GVA generated by transport indicates the direct contribution of the transport sector to national economy (SUMMA Final Report – EC51 indicator). The role of transport has kept growing in production as in everyday life. Growing affluence (one of the causes of which is mobility) and improvements in transport technology have led transport to become a major component of national output and a major user of resources. Transport includes all activities related directly and indirectly to the use of vehicles, vessels and aircraft and of related infrastructures (highways, inland waterways, railways, pipelines, port facilities, airports, warehouses etc.) for the movement of goods and passengers.<br>The TSI is a monthly measure of the volume of services performed by the for-hire transportation sector. The index covers the activities of for-hire[7] freight carriers, for-hire passenger carriers, and a combination of the two. The TSI is still under development and is therefore experimental. It is being examined for refinements in data sources, methodologies, and interpretations. The TSI tells us how the output of transportation services has increased or decreased from month to month. The movement of the index over time can be compared with other economic measures to understand the relationship of transportation to long-term changes in the economy. | |
| **Calculation method** | |
| Gross Value Added of the transport sector is given by the difference between output and intermediate consumption for the transport sector. It contains the difference between the value of goods and services produced and the cost of raw materials and other outputs, which are used in production. TSI is a combined, multimodal, seasonally adjusted economic measure of transport measured on a monthly basis. For the purposes of the TSI, the output of the transport sector is equal to the economic value added of transport carriers, that is, the difference between their revenues and the costs of their inputs. In the case of urban public transport, total payroll is used as a proxy for economic value added. | |
| **Data availability and territorial level** | |
| Data are collected yearly by Eurostat and are also available in the EU energy and transport in figures - Statistical pocketbook 2005.<br>Geographical coverage: EU-25.<br>Last update: 2005.<br>As it concerns the TSI, since 2002 the US Bureau of Transportation Statistics (BTS) staff gathered monthly data for each mode of transportation from a range of U.S. government and private sources. | |
| **Calculation in the REFIT framework** | |
| Within REFIT, the GVA of the transport sector can be processed by the ad hoc social model EDIP.<br>The ad-hoc REFIT models require as input the cost of freight and business passenger transport between the modelled regions. More specifically, a matrices of freight and business passenger costs is produced by TRANS-TOOLS. | |
| **Classification of the indicators according to the REFIT framework** | |
| *b. Indicators that can be addressed by the REFIT ad core models:*<br>Share of Gross Value Added generated by transport: EDIP | |
| **Policy sensitiveness**<br>*TRANSPORT POLICIES*<br>Expansion of several transport related activities can contribute in generating further value added. Indeed, actions like liberalisation of the **rail market** (both passenger and freight) by separating management infrastructure and service operation can encourage the access of new rail operators that stimulates the market. The growth of **water transport** implies as well an increase of business in ports and terminals offering a high level of service to short-sea customers, while **airport capacity expansion** and improvements in **road transport sector** will probably contribute to the growth of those transport market segments. | |

[7] Refers to a vehicle operated on behalf of or by a company that provides transport services to external customers for a fee. It is distinguished from private transportation services, in which a firm transports its own freight and does not offer its transportation services to other shippers.

*OTHER EU POLICIES*
**Internal market and services**: the creation of a European internal market, the stimuli to economic development and increasing product differentiations are all issues that affect transport volume and transport sector production.

## Tab. A.7 Employment in the transport sector

| Code | Employment in the transport sector |
|---|---|
| ESETEM | |
| **Description** | |
| The transport services sector employed about 7.5 million persons in the EU-25 (see Energy&Transport in Figures 2005). 61% of them worked in land transport (road, rail, inland waterways), 2% in sea transport, 5% in air transport and around one third (32%) in supporting and auxiliary transport activities (such as cargo handling, storage and warehousing, travel and transport agencies, tour operators). | |
| **Calculation method** | |
| Employed persons are all persons aged 15 years and more (16 years and over in ES, UK and SE (1995-2000), 15 to 74 years in DK, EE, HU, LV, FI, SE (from 2001), 16-74 in IS and NO) and who did any work for pay or profit during the reference week.<br>The employment rate of persons aged 15-64 (16-64 in ES, SE(1995-2000), UK, IS and NO) (respectively 55-64) is the share of employed persons aged 15-64 or 16-64 in mentioned cases (respectively 55-64) in the total population of the same age. (see labour market: Employment and Unemployment). | |
| **Data availability and territorial level** | |
| Data are collected by Eurostat and explicitly the annual data is derived from the quarterly European Union labour Force Survey and reported in the "Energy & Transport in figures 2005" report edited by the EC Directorate-General for Energy and Transport.<br>Geographical coverage: EU-25, EEA, EFTA and European Union Candidate Countries.<br>Last update: 2003. | |
| **Calculation in the REFIT framework** | |
| The rate of unemployed in the transport sector is calculated in REFIT applying the EDIP social model. Such an indicator is provided applying the efficiency wage theory in which wages and unemployment are negative correlated. The data are available at NUTS2/country level. | |
| **Classification of the indicators according to the REFIT framework** | |
| *b. Indicators that can be addressed by the REFIT ad core models:*<br>Employment in the transport sector: EDIP | |
| **Policy sensitiveness** | |
| <u>*TRANSPORT POLICIES*</u><br>It is worthwhile noting that even if implementation of transport measures can affect positively the economic growth, the impacts on employment are expected to be quite small. However, policies to strengthen **intermodality** and to restructure the **rail transport sector** will likely have positive indirect effects on the transport employment. Indeed, the access of new rail operators due to the liberalization of the rail market can stimulate the labour market by creating new employment. In addition, both harmonisations of working conditions and development of new professions like freight integrators will provide improvements in the quality of work and also a potential increase of jobs. In this context, actions concerning **road transport sector** and in particular **TENs** will not only have significant impacts on social conditions, but also impact on employment in quantitative terms.<br><u>*OTHER EU POLICIES*</u><br>**Competition policy**: the measures taken in this area may have important consequences on the transport sector in particular for what concerns maritime, air and rail transport. Actions like liberalization and merges will have direct impact on the level of employment. | |

## Tab. A.8 Households transport expenditure

| Code | Households transport expenditure |
|---|---|
| EBHTE | |

**Description**

Eurostat provides a detail breakdown of final consumption expenditure of households by consumption purpose, among which transport. Data are recorded at current prices (Millions of euro), constant prices (Millions of euro at 1995 prices and exchange rates) and included the corresponding price indices (1995=100). It reflects the structure of consumption expenditure and in this context particular attention it is given to transport-related expenditures.
Final consumption expenditure covers the purchase of all goods and services that are used for the direct satisfaction of the individual needs or wants or the collective needs of members of the community. Final consumption expenditure may take place on the domestic territory or abroad.
Total final consumption expenditure (ESA 1995, 3.75 – 3.80, and SNA 1993, 9.93 – 9.99) is the sum of final consumption expenditure by all residential institutional units: households, non profit institutions serving household (NPISH), general government. Household final consumption expenditure mainly represents traditional consumer spending and it includes the following transport related items:

- purchase of cars, other motor vehicles and bicycles (COICOP 07.1.1 - COICOP 07.1.3)
- petrol and engine oil (COICOP 07.2.2)
- insurance (COICOP 12.5.4)
- spares parts and accessories (COICOP 07.2.1)
- maintenance and repair (COICOP 07.2.3)
- public transport (tram, buses and taxi) (COICOP 07.3.2)
- other transport means (COICOP 07.3.1, COICOP 07.3.3 and COICOP 07.3.4)
- other services: i.e. tolls and parking meters (COICOP 07.2.4)

Consumer expenditures per capita has increased in Europe by 46% since 1980 to 1997, shifting gradually from basic needs as food and housing towards less basic needs as transport, fuel, and recreation (TERM 2001 – fact sheet). Whilst in the latest years the share of transport expenditure of household has remained more or less constant over time but varying between countries (from almost 15% in France to less than 8% in Estonia). The biggest increase in this share has been in the Member States with the lowest GDP per capita for example, in Lithuania and Latvia (Eurostat, 2005). In 2003, private households in the EU25 spent roughly 13.3% of their total consumption on transport. About one sixth of this expenses was used to purchase passenger transport services, the remainder for private transport mainly cars (Energy & Transport in figures - Statistical pocketbook 2005).
This aggregate gives an indication of the relative share of personal travel in the total consumption. Nowadays, mobility has a certain importance in our society and it represents a fundamental aspect of citizens life: people travel more often than the past and for longer distances, as a consequence of urban sprawl, employment dynamics and increasing car ownership. In the new Member States the growth in passenger cars per 1 000 inhabitants in 1990-2001 was 74%. Moreover, the relative relevance of the several purposes of travel is changing: people travel not only for work and school but also often for other non-systematic purposes like shopping and pleasure.

**Calculation method**

Household final expenditure have been annually collected and adjusted by Eurostat. Annual National accounts breakdowns have been compiled in accordance with the European System of Accounts - ESA 1995; figures are collected from National Statistical Institutes' Accounts Departments. Member States report annually information to Eurostat on household consumption expenditure based on harmonised grouping. Household consumption expenditure has been built following COICOP procedure: Classification of individual consumption by purpose – 1998. The complete classification is available at Eurostat's RAMON classification database or at the United Nations classification registry.

**Data availability and territorial level**

The basic statistics of the National Accounts, and therefore including those related to households, come from many sources, i.e.: administrative data from government, censuses, and surveys of businesses and households. Sources vary from country to country and may cover a large set of economic, social, financial and environmental items, which need not always be strictly related to National Accounts. In any case, there is no single one survey source for National Accounts.
Geographical coverage: European Union (EU-25), Euro-zone, EU Member States, Candidate Countries, Norway, Iceland, Switzerland.
Temporal coverage: Full coverage is given for EU25 and euro-zone aggregates since 1995 (for many countries longer

series are available). The coverage for national data varies according to availability of the data for the different countries and can, in some cases, start substantially earlier than the EU25 totals.
Last update: 2004.

**Calculation in the REFIT framework**

The households' consumption by household in transport sector is a measure that can be provided by the EDIP model Such an indicator might be expressed as the share of the transport expenditure over the total of households' expenditures. The data output are available at NUTS2/country level.

**Classification of the indicators according to the REFIT framework**

*b. Indicators that can be addressed by the REFIT ad core models:*
Households transport expenditure: EDIP

**Policy sensitiveness**

*TRANSPORT POLICIES*

**Transport pricing and taxation:** Both harmonization of pricing regulations and introduction of taxes on energy products and passenger cars will affect cost structure. As a consequence, household expenditure will undergo changes due to different households' behaviour (acquisition of new green cars, fuel prices).

*OTHER EU POLICIES*

**Taxation and customs union**: Currently European scenario is quite uneven since there is a very low harmonisation among Member States about taxes relevant for passenger transport (energy taxes, VAT, car taxes). Harmonisation of the tax system, especially with regard to the car registration taxes, may influence the households purchases.

## Tab. A.9 Business transport expenditure

| Code | Business transport expenditure |
|---|---|
| EBBTE | |
| **Description** | |
| The current System of National Accounts (SNA) central framework do not provide a full account of transport activities in the national economy, because business own-account transport is not separately recorded and households transport for work purposes - a form of household own-account production – is not included in the production boundary. Indeed, focusing on business transport activities, the SNA central framework just covers transport services rendered to third parties, while own-account transport is treated as an ancillary activity: its inputs are unidentified components of the costs of the producing units it serves. While accounting for principal and secondary activities is quite straightforward, ancillary activities require additional data to be estimated, as data on fuel consumption and vehicles costs, drivers wages, etc.<br>New more comprehensive systems have been studied based on the Transport Satellite Account (TSA) approach, in order to add an explicit account of the various forms of own-account transport to the standards commercial transport production statistics. An example is represented by integrated system of National Accounting including Transport and Externalities Accounts (NATEA). | |
| **Calculation method** | |
| The System of National Accounts (SNA) has been prepared under the joint responsibility of the United Nations, the International Monetary Fund, the Commission of the European Communities, the OECD and the World Bank. It consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules (SNA 1.1) and it can be implemented at different levels of aggregation (individual economic agents or institutional units).<br>The System is formed by a series of interconnected *flows accounts* related to different types of economic activity (production or distribution and use of income, accumulation) taking place within a given period of time, together with *balance sheets* that record the values of the stocks of assets and liabilities held by institutional units or sectors at the beginning and end of the period. The TSA approach introduces a system of satellite accounts in which own-account transport is accounted for separately and the production boundary of the System is extended to include the households transport activity for work purposes. | |
| **Data availability and territorial level** | |
| The basic statistics of the National Accounts, and therefore including those related to households, come from many sources, i.e.: administrative data from government, censuses, and surveys of businesses and households. Sources vary from country to country and may cover a large set of economic, social, financial and environmental items, which need not always be strictly related to National Accounts. In any case, there is no single one survey source for National Accounts.<br>Geographical coverage: European Union (EU-25), Euro-zone, EU Member States, Candidate Countries, Norway, Iceland, Switzerland.<br>Temporal coverage: Full coverage is given for EU25 and euro-zone aggregates since 1995 (for many countries longer series are available). The coverage for national data varies according to availability of the data for the different countries and can, in some cases, start substantially earlier than the EU25 totals.<br>Last update: 2004. | |
| **Calculation in the REFIT framework** | |
| The business transport expenditure is an output indicator that can be provided by the EDIP model. Such an indicator might be expressed as the share of the business transport expenditure over the total of expenditures. The data output are available at NUTS2/country level. | |
| **Classification of the indicators according to the REFIT framework** | |
| *b. Indicators that can be addressed by the REFIT ad core models:*<br>Business transport expenditure: EDIP | |
| **Policy sensitiveness** | |
| <u>*TRANSPORT POLICIES*</u><br>**Transport pricing and taxation**: Infrastructure charges, taxes on energy products and vehicles, as well harmonisation of taxation will affect the business expenditures related to the purchase and use of vehicles. A potential result can be a modal shift to other cleaner modes of transport. | |

## Tab. A.10 Government net revenues from transport

| Code | Government net revenues from transport |
|---|---|
| EBGNR | Government net revenues from transport related taxes and charges net of transport related subsidies and final expenditure |

**Description**

The government revenue collection and allocation mechanisms related to transport activities are a component of the whole public finance mechanism. In broad terms, the main fiscal flows are taxes paid by the taxpayers to the different levels of government: local, regional, national. In addition to taxes, users may pay directly to the government charges for transport infrastructure use (e.g. road or parking charges), when the infrastructure is not managed by a private infrastructure manager (as it is usually the case for urban roads).

Depending on EU member states fiscal laws, taxes and charges are paid by the households and business sectors (taxes) and by the users of the public services (charges) respectively to the local, regional and national governments. In principle, revenues are pooled at municipal, regional and national levels in order to finance government activities and public investments which cannot be realised by single individuals or private companies on the market (as it is the case for pure public goods), and which is more efficient to realise by pooling public revenues at the appropriate spatial scale.

Revenues which are pooled at the higher levels of government – e.g. the national State – can be then partially transferred to lower levels of government – e.g. from the State to the regional and/or municipal government. This is mainly due to the fact that tax bases at the lower levels of government may be too narrow or unevenly distributed to allow an efficient and equitable collection of the revenues: in this case the solution is provided by an higher level taxing a wider base and then redistributing a part of the revenues (net of the quota needed to finance the expenditure of the higher level of government) to the authorities at the lower levels, based on some allocation criteria.

As final outcome of the public finance process, there is a different distribution of final expenditures as compared to the distribution of revenues initially allocated to the different tiers of governments.

Coming now to the specific funding of public transport infrastructures and services, the indicator "**government net revenues from transport**" accounts therefore for the difference between the revenue received from transport related taxes and charges by each tier of government and the outlays of the same tiers, taking the form of subsidies to lower level of governments or transport operators (e.g. urban public transport operators) or final expenditures for transport infrastructure and services (e.g. urban road maintenance).

**Calculation method**

Provided that the relevant data on revenues from transport related taxes and charges and on transport earmarked subsidies and final expenditures are available from the official national, regional and local budget accounts, the computation of the indicator is straightforward.

When the revenues are more than the amount needed to finance transport subsidies and expenditures, the surplus is financing the general budget of the level of government concerned. The contrary happens when revenues are less than the required transport subsidies and expenditures, in which case the deficit is financed by the general budget.

**Data availability and territorial level**

Data on revenues and expenditures of national, regional and local governments can be gathered from their official budgets, although it is not always easy to extract all the revenues and expenses earmarked specifically for transport, in which case some assumptions may be necessary to allocate general budget items.

**Calculation in the REFIT framework**

The welfare module of TREMOVE calculates the policy effects on government budget. Thus, it can provide the data of net government revenues. EDIP model can compute governmental taxes and subsidies by type.

**Classification of the indicators according to the REFIT framework**

*a. Indicators that can be addressed by the REFIT core models:*

Government net revenues from transport: TREMOVE

**Policy sensitiveness**

*TRANSPORT POLICIES*

**Transport pricing and taxation**: measures establishing infrastructure charging and pricing system may provide significant benefits for the public budget, with additional sources of revenue which can be used to finance investment funds earmarked to improve the transport sector.

*OTHER EU POLICIES*

**Economic and financial affairs**: transport taxes – e.g. fuel taxes – may heavily contribute to the EU Member States public budgets. Any major change of national or regional taxes can therefore affect national economic and financial affairs.