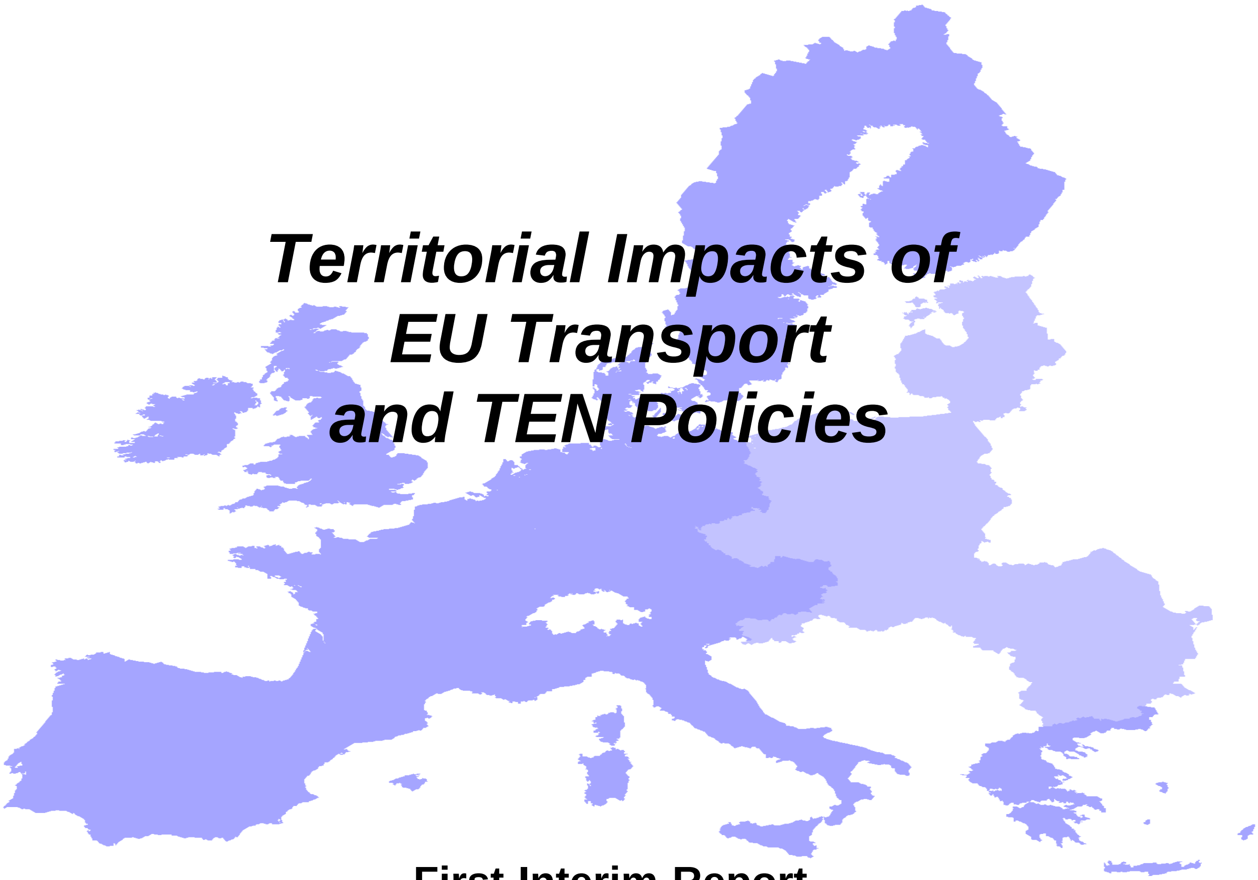
Territorial Impacts of EU Transport and TEN Policies



First Interim Report
for Action 2.1.1 of the
European Spatial Planning Observatory Network
ESPON 2006

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Deliverable 1: First Interim Report

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Contents

1 Introduction

ESPON 2.1.1 concentrates on the evaluation of territorial effects of the trans-European transport and telecommunication networks (TEN). However, as agreed on the briefing in Brussels (August 2002) territorial impacts of energy policies will not be addressed in this project. The major questions under this action is how far the TENs provide the right answers for a territorial development as described in the European Spatial Development Perspective (ESDP). The measures proposed in the White Paper "European Transport Policy for 2010: Time to Decide" (COM 2001/370) provides the framework for the subject investigated under this action. Reference is made to the policy options developed in the cross-sectoral approach of the ESDP. The ESDP stresses the need for an integrated approach for improved transport links, makes reference to the polycentric development model, highlights the efficient and sustainable use of infrastructure and refers to the importance of the diffusion of innovation and knowledge. This integrated approach will be followed in analysing transport and telecommunication networks. Any analysis will take into account the principle of territorial balance, the particular problems of peripheral regions and the improvement of secondary networks.

In this framework the goals of ESPON 2.1.1 are to:

- develop *methods for the assessment of territorial impacts* of EU transport and TEN policies,

- develop *territorial indicators, typologies and concepts*, establish *database and map-making facilities* and conduct *empirical statistical data analyses*,

- analyse *territorial trends, potentials and problems* deriving from EU transport and TEN policies at different scales and in different parts of an enlarged European territory,

- show the *influence of transport and telecommunications policies on spatial development* at relevant scales,

- show the *interplay between EU and sub-EU spatial policies* and best examples for implementation,

- recommend *further policy developments* in support of territorial cohesion and a polycentric and better balanced EU territory,

- find *appropriate instruments to improve the spatial co-ordination of EU and national sector policies and the ESDP*,

- provide *input for the achievement of the horizontal projects* under ESPON Priority 3 (in particular ESPON 3.1).

To meet these objectives the project will make best use of existing research and relevant studies and will build on a strong co-operation with ESPON project 1.2.1. and 1.2.2. concerning infrastructure and telecommunication access, as well as policy impacts addressed under measure 2.1, in order to avoid any overlap. The project will also be conducted in close co-operation with Action 3.1.

The consortium of ESPON 2.1.1 consists of partners from five countries: Spiekermann & Wegener, Urban and Regional Research (D), Free University of Amsterdam (NL), Royal Institute of Technology (S), Federal Office for Building and Regional Planning (D), Politecnico of Milan (I) and University of Kent (UK) under the co-ordination of Christian-Albrechts University of Kiel (D).

Objectives of Work Package 1

The general goal of Work Package 1 is to specify the scope of work in more detail. A description of the methodologies used in ESPON 2.1.1 for the assessment of territorial impacts of EU transport and TEN policies is given and a list of data requirements of the proposed models and methodologies is provided and evaluated with respect to data availability and comparability. Indicators that can be used for measuring and for judging the territorial impacts of transport policies are defined taking into account the results of the Study Programme on European Spatial Planning (SPESP) and the expected results of other ESPON projects, in particular ESPON 3.1. A first analysis of the interactions between EU transport and TEN policies and other spatially relevant Community policies and the institutional context in which such policies are designed and implemented are given.

Future work in ESPON 2.1.1 will build on the frameworks set up in this Work Package. Consequently, Work Package 1 also defines in detail the objectives of each work package, the time schedule for each work package, the responsibilities of each project participants, the interaction between work packages and the internal procedures for project communication. The Work Package provides the contents of the First Interim Report.

Structure of the First Interim Report

According to the objectives of Work Package 1 the First Interim Report, which is Deliverable D1 of ESPON 2.1.1 is as follows:

Chapter 2 describes indicators, which are relevant for the assessment of territorial impacts of EU transport and TEN policies. They are distinguished with respect to the kind of territorial impact they measure, such as the effects on the distribution and location of economic activities, on the distribution of population and migration, on regional labour markets and on the sectoral structure of the regional economy as well as on regional accessibility. Indicators for measuring the spatial impacts of ICTs are also presented. Building on the indicators of territorial impacts, cohesion indicators can be derived. A summary list of the suggested indicators is provided in the last section of the chapter.

Chapter 3 gives a first outline on the methodologies proposed within ESPON 2.1.1 for assessing the territorial impacts of transport policies and investments, moving from methodologies addressing specific issues, such as causality analysis and the territorial impacts of ICTs, to more complex models, i.e. a quasi-production-function approach and a spatial equilibrium model of trade and passenger flows. Furthermore, there will be carried out an analysis of the impacts of transport and TEN policies on the polycentric development and on overloaded transport corridors taking especially into account the spatial objectives given in the ESDP.

Chapter 4 describes the data requirements of the different methodologies in an integrated approach. Data needs are differentiated by the regional scale: European, national and regional. The chapter concludes with an overview on data that have to be collected for ESPON 2.1.1.

Chapter 5 sets out the basic range of policy areas which interact with transport and TEN policies, such as other Community policies and different levels of policy implementation. It also identifies the types of interactions which are likely to be relevant in order to suggest ways in which these might need to be incorporated in the definition of indicators.

Chapter 6 presents the future work plan based on the findings and decisions made during the work of this Work Package.

Chapter 7 concludes the report.

2 Consensus on Indicators

This chapter presents indicators relevant for the assessment of territorial impacts of EU transport and TEN policies. The indicators are distinguished with respect to the kind of territorial impact they measure. Indicators measuring the impacts on economic activities, the sectoral structure of an economy, as well as on population, i.e. migration, the labour market and on accessibility are presented. In addition indicators are described for assessing the role of information and telecommunication technologies on the regional development. Building on these indicators of territorial impacts, cohesion indicators are derived. The proposed indicators are summarised in the last section.

2.1 Economic Indicators

EU transport and TEN policies do have effects on the regional distribution and location of economic activities. This section provides a definition and description of indicators measuring the economic impacts of transport policy changes. The indicators mainly comprise GDP per capita and equivalent income measures of user benefits.

2.1.1 GDP per Capita

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 standard measure of the size and performance of a regional economy and its competitiveness.

Total GDP represents only the supply side of regional socio-economic development. To derive policy-relevant indicators, it has to be related to the demand side, i.e. to population. This is done by calculating total *regional GDP per capita*.

Regional GDP is designed to measure total output in a particular area, including services. However, it is also a measure of income, the main components being wages and salaries, profits and rent, though it excludes transfers of income, from individuals and companies (which might transfer part of their profits elsewhere) as well as from government, in the form, for example, of social benefits. This leads to a problem concerning the use of GDP as a measure of income in some regions, such as some city-regions, where commuting by people resident in other regions adds to the local work force and GDP. Income per head of the people living in the city is, therefore, overstated while that of neighbouring regions is understated.

For the assessment of the economic performance of regions it is important to observe and compare GDP per Capita for certain years as well as the development over time. This is especially important to assess the convergence of regions and will be measured by the *change of regional GDP per capita*.

In order to facilitate international comparisons, the GDP in national currency of each Member State is converted into a common currency (ECU until 1998, Euro from the beginning of 1999) by means of its official exchange rate. The comparison of regional GDP on a Euro-basis reflects economic strength in an absolute dimension.

However GDP measured on Euro-basis does not necessarily reflect the actual purchasing power of each national currency on its economic territory, because the converted GDP is a function not only of the level of goods and services produced on the economic territory, but also of the general price level. Therefore, the simple use of the GDP converted into a common currency does not provide, in most cases, a correct indication of the volume of goods and services.

In order to remove the distortions due to price-level differences, transitive purchasing power parities (PPP) are calculated and used as a factor of conversion (exchange rate from national currency to PPP). These parities are obtained as a weighted average of relative price ratios regarding a homogeneous basket of goods and services, comparable and representative for each Member State. The 'comparable volume' values of GDP obtained in this way are hence expressed in terms of purchasing power standards (PPS), a unit that is independent of any national currency. It makes sense to analyse both indicators in this project (Euro and PPS).

Productivity of Regions can be characterised by the *GDP per employees*.

2.1.2 Equivalent Income Measures of User Benefits

In contrast to other economic indicators, such as changes in GDP per capita or changes in (disposable) income, the equivalent income measures of user benefits measure the welfare change resulting from a policy change, such as changes in transport and infrastructure investments. Considering the household's preference relations in consumption by introducing utility functions, one can investigate the normative side of consumer theory, called welfare analysis. In general, welfare analysis concerns itself with the evaluation of the effects of changes in the consumer's environment, such as policy changes, on his or her well-being. The level of well-being before and after the change only can be evaluated by the preference-based approach to consumer demand.

This microeconomic approach (see for example Varian (1999, 1992)) 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 given 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[1] 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 (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 on benchmark levels), in order to make the household as well-off as under the policy change. Obviously, the

[1] The duality concept is well presented in Deaton and Muellbauer (1980).

EV is an equivalent income measure of user benefits, because it represents the money metric equivalent to the utility change brought about by the policy change. This also illustrates, that 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 e.g. transport infrastructure investments other variables like prices and travel times do change.

Obviously, one will not be able to directly observe equivalent income measures of user benefits in the real world. These indicators only can be derived by setting up models with a consistent microeconomic foundation of preference-based consumer behaviour. Computable General Equilibrium (CGE) models, such as CGEurope (see section 3.4), fulfil these requirements. CGE models inhabit additional attractive features, such as the possibility of introducing different assumptions about market forms, technologies and preferences, of taking into account different financial flows between the representative agents in the economy, or, in case of an open economy model, of considering the interactions between different regions or countries by e.g. trade, passenger travel or financial flows. The EV being the model's output then will measure welfare gains and losses including all effects generated by the specified economic setting, such as market imperfections etc. This shows, that assessing policy changes by the EV is perfectly in line with the theoretical concepts in cost-benefit analysis. The danger of omitting indirect effects as well as the danger of double-counting is avoided.

In order to assess the spatial impacts of policy changes, such as transport and infrastructure investments, by means of an equivalent income measure of user benefits setting up a spatial CGE model (SCGE) is favourable. E.g. by assuming identical preferences of households in one region, the resulting EV will measure the welfare changes in each region and therefore gives information about the spatial distribution of welfare gains and losses of the respective policy change. However, in order to compare the spatial impacts over regions it is useful to express regional *EV as per capita* amounts or as shares in benchmark regional GDP. The latter is also called the *Relative Equivalent Variation* (REV) and is defined as the percentage increase of the benchmark income the region would need, in order to be as well-off as after the policy change (again holding everything else constant on benchmark levels).

2.2 Population Indicators

Regional population indicators are important in ESPON 2.1.1 because they inform about the attractiveness of a region as a place to live and work, which may be influenced by its accessibility, and hence by transport investments. There may be two kinds of population indicators:

2.2.1 Population by Age

Total population as such is not a suitable indicator because it predominantly measures the size of the region. Moreover, in empirical before-and after studies, in which the situation before the implementation of a transport policy is compared with the situation after its implementation, changes in population are not informative because they may be caused by a multitude of other reasons, among them fertility, mortality, which are not likely to be affected by transport policy, or immigration and outmigration for reasons unrelated to the transport measure. Only in model-based studies in which, besides the transport policy of interest, everything else is kept unchanged, the comparison between *total regional population* in a transport scenario in which a transport policy is implemented and a reference or business-as-usual scenario in which the measure is not implemented, is meaningful: If regional population in the policy scenario is different from the business-as-usual scenario, the change is due to the effect of the policy, for instance because an increase in regional accessibility has led to economic growth which in turn has attracted population.

A more appropriate indicator is *population change* because it neutralises the effect of region size. If after the opening of a new transport project the population in a region has increased more (or decreased less) than in the reference scenario, this may be an effect of the increase in accessibility, which may have led to economic growth in the region which in turn may have attracted population, as above.

Another population indicator of interest is related to age. In general, a younger population is associated with a successful, vibrant economy, whereas an ageing population may indicate a declining economy deserted by a large number of young and active people. On the other hand, a high proportion of elderly people may also result from high life expectancy caused by a good health system or from a high proportion of affluent pensioners, as in some Mediterranean regions. However that may be, a population age indicator should be collected.

Two population age indicators are frequently used: *mean age* and the *proportion of people over 60 (or 65).* In the ideal case, an age distribution, classified by gender, would be collected. In the case of a dynamic modelling approach forecasting population, such as the SASI model (see Section 3.3), population by age and gender would be required anyway.

2.2.2 Migration Flows

There is a clear causal link between transport policies and interregional migration. If a region is economically successful and so offers more and better paid job opportunities than other regions, it is likely to attract ceteris paribus job-seeking immigrants from poorer regions with fewer job opportunities. Consequently, if a region benefits economically from a transport infrastructure project, it will attract more immigrants. Regional positive net migration is therefore a good indicator of the socio-economic effect of a transport measure.

However, this applies only where international movements of labour are unrestricted. This, however, is almost nowhere the case. Even within the European Union, international labour migration is far below the level that could be expected given the differences in wages and job opportunities between the Member States. And immigration into the European Union is constrained by increasingly rigorous national immigration laws. It can be expected that after the pending enlargement of the European Union labour mobility will be constrained for several years. It follows that immigration to the more affluent countries will continue to be far lower than the attraction of these countries would suggest and will therefore not reflect the impact of transport policies.

Nevertheless, it will be desirable to consider *regional net migration*, either as total net migration or as net migration as percent of regional population, as regional indicator in ESPON 2.1.1. In a dynamic regional economic model such as the SASI model (see Section 3.3), interregional migration would be forecast anyway.

2.3 Labour Market Indicators

The description of the situation and relevant developments on regional labour markets has to take into account the demand side as well as the supply side of labour markets. That for it is at first necessary to get distinguished information on the regional employment situation, because employment depicts the part of labour markets where supply and demand fit together. Regional employment data show the scope regional population participates on regional wealth due to gainful employment. Indicators describing the structure of regional employment in terms of education, gender as well as labour organisation (part time employment, telecommuting) allow conclusions concerning the competitiveness and the ability of the working people to arrange with alternating needs on the labour market.

Imbalances on labour markets can be directly identified by looking at unemployment indicators. To identify possible reasons for such imbalances it is important to get information about the personal skills and characteristics of the unemployed. Important issues in this context are again educational levels, age and gender of unemployed persons.

To learn more about the causes for labour market imbalances it is important to look at the regional labour force. This indicator reflects individual decisions in respect of engaging in gainful employment or not. Structural changes of the (regional) labour force e.g. caused by changes in the school-system, higher participation rates of women or demographic trends are important to be realised. The empirical observation of labour force developments is important to obtain some hints concerning potential labour market imbalances and possible policy options.

To empirically record these rather complex relations on labour markets it is suggested to survey the following described indicators.

2.3.1 Employment

Employment is one of the main indicators measuring economic wealth and individual participation on economic prosperity. For empirical purposes employment is measured as follows on EU level: “Persons in employment are those who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent. Family workers are also included.” (see Eurostat (1999c)). The employment rate represents persons in employment (working part-time as well as full-time) as a percentage of the population of working age (15-64 years).

The number of part-time employees could be an additional indicator for the character of the regional labour market. It can either be a signal for its flexibility (e.g. under the viewpoint of quick adjustment to the demands of labour) or on the other hand for its weakness (e.g. under the viewpoint under-utilisation). Therefore this indicator should only be looked at in synopsis with other labour-force indicators.

Part-time workers are those who usually work less hours than the full-time employees. This definition comprises all forms of part-time work (i.e. half-day work, work for one, two or three days a week, etc.). The number of employees can be differentiated by the weekly number of hours which they work. The latter number is therefore considered in relation to the number of hours regarded as a standard full-time working week in the examined Member State or region.

Whereas the full-time employee category is relatively homogeneous, the part-time employee category can cover anything between 20% or even less and 80% or more of the standard working hours of the Member State or region. It is difficult to distinguish exactly between part-time and full-time work because of the variation in working practices between Member States and industries.

Part-time employees and intermittent/seasonal employees (who may work full time but for a fixed short period, e.g. temporary workers) should be distinguished from one another (see Eurostat Concepts and Definitions Database (Eurostat 1999c)).

The qualification and education of a country's working population is justly considered as a factor which has not only cultural, but increasingly also economic importance. Education also plays a key role regarding employment prospects at regional level. The group of main relevance in economic respects is the working age population between 15 and 64.

The information on educational qualification is available from the European Union Labour Force Survey (Eurostat). It summarises the main groups of the International Standard Classification of Education in three classes as low, middle or high. The ISCED represents one tool which attempts to make the different national school and education systems comparable through the use of a common screen.

Table 2.1 Levels of Education and Training (ISCED).

Categories	Description	code
Low	less than upper secondary	1, 2
middle	upper secondary	3, 4
High	tertiary	5, 6

The occupational qualification shows the activities performed by the employed. This indicator cannot be determined directly from the available data, but could be calculated by performing a regional breakdown of the countries' employment structure according to the International Standard Classification of Occupations (ISCO). This additional structural indicator does not correspond to the sectoral structure of a national economy. The occupational categories are represented in several economic sectors.

Usable information on occupational qualifications is based on the 1-digit level of ISCO Educational qualification of the population.

Where appropriate special analysis for the Labour Force Survey could be carried out in the context of ESPON.

Table 2.2 International Standard Classification of Occupations.

one-digit code	Description
1	Legislators, senior officials & managers
2	Professionals
3	Technicians & associate professionals
4	Clerks
5	Service workers & shop & market sales workers
6	Skilled agricultural &fishery workers
7	Craft & related trades workers
8	Plant & machine operators &assemblers
9	Elementary occupations
0	Armed forces (excluded)

2.3.2 Labour Force Participation

The *regional labour force* represents the supply side of the regional labour market and is insofar an important input factor for regional economic development.

It comprises persons in employment and unemployed persons. Demographic prospects have implications for the size and age composition of the labour force. These, however, are as much influenced by changes in *participation* as by demographic trends. Such changes are determined, in turn, by a range of factors, such as attitudes towards further education, the age of retirement and women working, as well as the availability of child-care facilities, the nature of pension schemes and the possibility of early retirement and the structure of households. They are also affected by economic factors, especially the ease or difficulty of finding a job, which has a strong effect on people’s motivation to join the labour force. Participation, therefore, tends to increase as net job creation rises and to decline when it falls.

Moreover, demographic trends can potentially influence participation, and vice versa, insofar as, for example, a reduction in working-age population relative to the demand for labour encourages more people to join the labour force or growth of economic activity stimulates an increase in net inward migration. Given the wide range of factors affecting participation and the complex nature of the interrelationships between them, any projections of the labour force in future years are considerably more uncertain than those of population and are surrounded by a very wide margin of error.

The prospective ageing of the work force and the increased number of older workers raises questions about the effect on the ability to adapt to changes in technology and new ways of working. In the past, the steady stream of young, freshly educated people joining the labour market provided employers, in some degree, with up-to-date technical knowledge and recently acquired skills at a relatively low wage. The decline in this stream and the changing circumstances mean that there will be more need to develop other ways to ensure that the skills of the work force are renewed and that firms can respond to advances in technology and new working methods. This implies more importance to life-long learning, to retraining existing members of the work force and to updating the skills of women returning to work after a period of absence for family reasons.

For empirical purposes labour force is measured as follows: The labour force is the sum of those employed and those unemployed. The activity or participation rate is this figure relative to the total population aged 15–64.

The qualification and education of a country's labour force is also considered as a factor of increasing economic importance and can be measured as *percentage regional labour* force differentiated by *educational level*.

2.3.3 Unemployment

Empirical data on unemployment indicate the scale of economic and social problems caused by the labour market. Measuring unemployment in a quite detailed manner is essential for elaborating the regional economic effects of infrastructure policy.

On the EU level unemployment is defined and measured as follows: Unemployed persons are those who, during the reference week

(1) had no employment, and

(2) were available to start work within the next two weeks, and

(3) had actively sought employment at some time during the previous four weeks.

In addition, unemployed persons include those who had no employment and had already found a job to start later. *Unemployment rates* represent unemployed persons as a percentage of the labour force. To measure unemployment and its regional outcome the unemployment rate is defined as the total number unemployed relative to the total number of the labour force.

Unemployment by age groups and qualification is chosen as an indicator because young and highly qualified unemployed persons have distinguishable mobility patterns, e.g. they are more likely to commute over longer distances and to change their place of residence.

The levels of qualification and education of the unemployed is also considered as a factor of economic relevance (for definitions see employment indicators 2.3.1).

2.4 Information on Sectoral Structure

The sectoral structure of regions is characteristic for their level of economic development. Most common indicators divide employment or Gross Domestic Product respectively *Gross Value Added* data on the three or six basic economy sectors such as agriculture, industry and service or agriculture, energy & manufacturing, construction, market services, non-market services and other services. If sectoral information is required on NUTS-3 level it will only be feasible to use the three sectors, since data on a more detailed sectoral level will not be available for all NUTS-3 regions of EU-27.

Where appropriate the indicators listed in the section above should be differentiated by the three or six main economic sectors supplemented by R&D. This is e.g. relevant for the task of estimating and explaining transportation flows and the definition of a typology of regions.

One might compile the share of these sectors on the basis of the employment or GDP data. Particularly in remote regions, the output in terms of value added in the agricultural sector is very low because of low productivity. Although (or perhaps because) a high proportion of employment is found in this sector, it is advisable to use *employment shares* rather than output shares. Low proportions of employment in the agricultural sector indicate an advanced economic structure. In contrast, a high proportion of employment in the service sector is usually considered indicative of an advanced economic structure. This is not true in every case. There are many service sector jobs that do not necessarily point to an advanced economic structure. On the other hand, a highly productive industrial sector does not necessarily indicate a weak economic structure. In addition to these conceptual problems, there are also problems with interpreting the data as companies categorised as industrial may incorporate a high share of service occupations.

The future orientation of industries is another key indicator of economic strength. Future orientation is used as a guide to the innovative capacity of firms. The indicators most commonly used are those such as R&D investment per employee (or as a share of all investments) or the output and the *share of R&D employment from the total employment*. Data availability recommends the employment indicator, which also has fewer problems of definition. To describe the innovative potential of the private sector employment in R&D should be limited to the non-governmental sector.

2.5 Accessibility Indicators

In the context of spatial development, the quality of transport infrastructure in terms of capacity, connectivity, travel speeds etc. determines the quality of locations relative to other locations, i.e. the competitive advantage of locations which is usually measured as accessibility. Investment in transport infrastructure leads to changing locational qualities and may induce changes in spatial development patterns.

There are numerous definitions and concepts of accessibility. A general definition is that "accessibility indicators describe the location of an area with respect to opportunities, activities or assets existing in other areas and in the area itself, where 'area' may be a region, a city or a corridor" (Wegener et al., 2002). Accessibility indicators can differ in complexity.

- Simple accessibility indicators take only transport infrastructure in the area itself into account. This is then measured as the total length of roads, motorways or rail lines, number of railway stations or motorway exits or as travel time to the nearest nodes of high-level networks. These indicators may express important information about the area itself, but they do not reflect the fact that many destinations of interest are outside the area.

- More complex accessibility indicators take account of the connectivity of transport networks by distinguishing between the network itself and the activities or opportunities that can be reached by it. These indicators always include in their formulation a spatial impedance term that describes the ease of reaching other such destinations of interest. Impedance can be measured in terms of travel time, cost or inconvenience.

In the context of territorial impacts of TEN investments, the simple accessibility indicators are of limited value, because they do describe the transport endowment of a region only. And this changes directly according to investments. Useful for territorial impact assessment are the more complex accessibility indicators, because they describe the changing locational advantages and opportunities as consequences of transport infrastructure investments or other transport policies.

Therefore, the more complex accessibility indicators are considered only in which accessibility is a construct of two functions, one representing the activities or opportunities to be reached and one representing the effort, time, distance or cost needed to reach them:

$$A_i = \sum_j g(W_j)\, f\,(c_{ij})$$

where A_i is the accessibility of area i, W_j is the activity W to be reached in area j, and c_{ij} is the generalised cost of reaching area j from area i. The functions $g(W_{ij})$ and $f(c_{ij})$ are called *activity functions* and *impedance functions*, respectively. They are associated multiplicatively, i.e. are weights to each other. That is, both are necessary elements of accessibility. Ai is the total of the activities reachable at j weighted by the ease of getting from i to j.

These more complex accessibility indictors can be classified by their specification of the destination and the impedance functions (Schürmann et al., 1997, Wegener et al, 2002).

- *Travel cost indicators* measure the accumulated or average travel cost to a pre-defined set of destinations, for instance, the average travel time to all cities with more than 500,000 inhabitants.

- *Daily accessibility* is based on the notion of a fixed budget for travel in which a destination has to be reached to be of interest. The indicator is derived from the example of a business traveller who wishes to travel to a certain place in order to conduct business there and who wants to be back home in the evening (Törnqvist, 1970). Maximum travel times of between three and five hours one-way are commonly used for this indicator type.

- *Potential accessibility* is based on the assumption that the attraction of a destination increases with size, and declines with distance, travel time or cost. Destination size is usually represented by population or economic indicators such as GDP or income.

Each of the different accessibility types can be seen to have their own advantages and disadvantages. Travel time indicators and daily accessibility indicators are easy to understand and to communicate though they generally lack a theoretical foundation. Potential accessibility is founded on sound behavioural principles but contain parameters that need to be calibrated and their values cannot be expressed in familiar units.

Modal accessibility indicators are usually presented separately in order to demonstrate differences between modes. Or, they may be integrated into one indicator expressing the combined effect of alternative modes for a location. There are essentially two methods of integration. One is to select the fastest mode to each destination, which in general will be air for distant destinations and road or rail for shorter distances, and to ignore the remaining modes. Another way is to calculate an aggregate accessibility measure combining the information contained in the modal accessibility indicators by a 'composite' generalised travel cost. This is superior to average travel costs across modes because it makes sure that the removal of a mode with higher costs does not result in a – false – reduction in aggregate travel cost.

Out of the large set of possible accessibility indicator, only a small sub-set can be used in ESPON 2.1.1 to assess the impact of transport policies with respect to changing locational qualities. For reasons of theoretical soundness and explanatory power, the SASI model provides and uses potential accessibility indicator (Fürst et al., 2000) which are proposed to serve as indicator for the project as well. The accessibility indicators include modal and multimodal indicators and consist of *accessibility potential by road, accessibility potential by rail, accessibility potential by air, multimodal (road, rail) accessibility potential, multimodal (road, rail, air) accessibility potential.*

2.6 Connectedness Indicators

The indicators proposed here are derived indicators of, and to run methodologies on, ICTs territorial impacts. They build on raw data of infrastructures and services development covering a high spectrum of phenomena, from indicators on the existence, diffusion and development of physical networks to economic indicators on the market of ICTs etc. as presented in chapter 4 of this report. Indicators on ICTs territorial impacts mainly can be subdivided into three kinds of indicator groups:

(1) *Economic and Labour Market Indicators*. Economic performance indicators also provide an important measure for assessing ICTs territorial impacts, since it represents the phenomena under study: economic level and economic development in form of GDP and/or employment. The sectoral dimension of this indicator can provide a useful information on which sectors growth is more decisive. This group of indicators include GDP, GDP per capita (also differentiated by sector), GDP annual growth rate as well as employment, sectoral employment and the annual growth rate of employment. They are already presented in section 2.1, 2.3 and 2.4.

(2) *Industrial territorial concentration activity indicator* provides a measure of the concentration of industrial activities, which is useful to understand where firms (or sectors) have decided to locate. The measure will help to identify the role of ICTs on the relocation of productive and residential activities in favour of more remote and less accessible locations. This impact will be labelled as the spatial relocation impact. The sectoral concentration coefficient represents such an indicator.

(3) *ICTs network diffusion indicator* is an explicative variable of both economic growth and concentration/diffusion phenomena. It is useful to understand whether the economic growth and geographical relocation of activities can be explained by ICTs diffusion. In this case, we have to see whether advanced technologies, intense use, ICTs service qualities etc. play a role. ICTs network diffusion can be measured by basic network endowment, basic service availability (as a weighted sum of existing basic services), basic service availability weighted by quality measures, advanced network endowment, basic network and services availability weighted by intensity of use measures, ICTs revenues (or employment) on GDP (or on total employment) and ICTs investments on GDP.

2.7 Cohesion Indicators

It is the purpose of work package 3 to review the economic approach to the measurement of cohesion between regions and to propose a number of indicators for this cohesion by means of a conclusion of this work. It is therefore impossible at this stage of the project to provide a list of such indicators. Instead, what follows is a description of the methodology that will be used.

The normative literature on welfare measurement at the individual level and the aggregation of individual welfare to that of groups of individuals (e.g. the population of a region) provides a general framework that allows us to study:

a) the possibility of aggregating individual variables (utility, real income, etc) to analogous regional variables, the restrictiveness of the assumptions needed for using only averages and the possibilities to relax these assumptions by using additional information about the distribution of the individual variables;

b) the sensitivity of the outcomes of such aggregation procedures for the way the regions are defined (size of regions, aggregation of basic geographical units to larger regions);

c) the appropriateness of using multidimensional concepts of cohesion (e.g. by using not only the average income level, but also the variation around its mean, unemployment, environmental quality, et cetera) and the alternative that supposes an integration of all dimensions at the individual level by using equivalent income measures for the non-monetary aspects involved;

d) the possibility of decomposing equity concepts (such as inequality measures) at a higher level (such as the European union) to parts corresponding to lower levels (such as the individual countries).

This study will be concluded with a list of proposed indicators of social cohesion and an assessment of the assumptions needed to justify their use and interpretation as welfare measures. In this evaluation attention will also be paid to the intuitive appeal and the practical usefulness of the proposed indicators. In this context also the traditional (aggregate) indicators of cohesion (such as per capita income and accessibility) will be discussed. The ideal outcome of the study would be a set of operational measures that are easy to interpret and have a sound theoretical justification. However, it must be expected that trade-offs between the various desirable aspects cannot be avoided.

In addition, traditional indicators of cohesion with respect to GDP per capita (in PPS) and accessibility, such as the coefficient of variation and the GINI coefficient will be used. Methodological problems of these cohesion indicators, e.g. with respect to the level of spatial aggregation and the choice of indicator (relative v. absolute) detected during the work for SPESP will be examined and suggestions how to overcome them will be made.

It can be anticipated that real income, which can be regarded (if properly adjusted when necessary) as money metric utility will play a basic role as an input in many, if not all, of the proposed indicators. In some cases the output may also be interpreted as a properly adjusted indicator of the average real income, where the adjustment takes into account the (lack of) social cohesion in the form of regional (in)equality.

2.7.1 Individual data

The economic approach to the measurement and evaluation of regional (in)equality will be used as a background to the study of social cohesion in the European Union. A distinguishing feature of this theory is that it is based on *individual* variables, such as income and utilities. All indicators at an aggregate level are functions of these individual variables. In principle, one should therefore construct indicators of social cohesion on the basis of individual information, for instance those collected in the European Community Household Panel (ECHP).

An alternative approach would be to use aggregate information referring to the basic regions of the European Union defined on a *per capita* basis. The economic, population, labour market and sectoral structure indicators referred to in the previous sections (2.1-2.4) can be presented in this way (e.g. per capita regional income, probability that someone living in a particular region is poor or unemployed or if working has a job in a specific sector). On the basis of such information one may construct indicators of interregional cohesion.

This second approach rests on the implicit assumption that these regional indicators can be regarded as referring to a *representative individual*. Although this assumption is convenient because it simplifies matters enormously, it is usually hard to motivate from the basic economic methodology.

It is well known, for instance, that from a welfare economic point of view the appropriate value for regional income is not just the average income of all individuals in the region, but to average income multiplied by a correction term that has a value between zero and one and is related to an indicator of income inequality. This shows that it is helpful when the information about regional averages is supplemented by information about the distribution of these values within the region (i.e. by indicators of intra-regional inequality). In a multidimensional framework, in which one studies for instance labour force participation, income, and the presence of environmental externalities simultaneously, it is helpful to have information about the simultaneous distribution of these indicators over the individuals within the region. (Compare for instance the situation in which environmental externalities are distributed independently from incomes with one in which the externalities are disproportionately experienced by the poor; the former situation is implicitly assumed to be relevant if one uses only averages.)

Ideally we need information about all relevant indicators at the individual level. If this information is unavailable, aggregate (per capita) information has to be used. The implicit assumptions that have to be made to justify this can be relaxed if this information is supplemented by information about intra-regional inequality of these indicators at the individual level and even more if the covariances between the various indicators that are of interest are known.

2.7.2 Which Indicators?

The headings of previous (sub)sections of this chapter mention the indicators listed below. It is assumed that the required information refers to the basic regions to be distinguished within the ESPON project. Desirable additions are indicated.

- *GDP per capita*. Some indicator of the income *distribution* would be very helpful. For instance: Atkinson or Theil measures of inequality. In the EU an indicator of income inequality defined as the share of top 20% in total income divided by the share of the bottom 20% is used (at least at the national scale). Moreover, it is important to concentrate on real (not on nominal) income. For this reason, information on price levels (or the cost of purchasing a given basket of relevant commodities in the various regions of the EU) would be helpful (regional differences are probably not negligible). Special attention should be given to the housing market, since regional differences in house prices (and rents) seem to be substantial.

- *Poverty Rate*. The number of households in a population under the poverty line would be a significant indicator of the economic success of a region. It would provide additional information compared with economic indicators, such as GDP per capita or disposable income, because it would also measure the distribution of income in a region.

  The European Commission proposed a communication on 'structural indicators' (Commission 2000). Among these indicators, six concern social cohesion: (1) distribution of income, (2) poverty rate before and after transfers, (3) persistence poverty (4) jobless households (5) regional cohesion and (6) early school-leavers not in further education or training. The poverty rate is a difficult concept because there exist several ways of calculating poverty. According to United Nations statistics, a poor household is one with an income level that is considered minimumly sufficient to sustain a family in terms of food, housing, clothing, medical needs, and so on. As this is difficult to calculate, in many studies the mean national household income is taken to be the poverty line – a household with an income below this threshold is considered to be poor. This measure raises two problems. First, it implies that even if all households in a country would experience a ten-percent gain in income, the poverty rate would remain the same. Second, to take the national mean income as benchmark may be questionable in a European context. It has therefore been proposed to consider the mean European household income as poverty line or a combination of national and European mean income (Fourage, 2001).

  A further difficulty with the *poverty rate* as an indicator in ESPON 2.1.1 is that in empirical before-and-after studies of transport policies it presents the same problems as other population indicators in that any changes that may be observed cannot be unambiguously identified as effects of the policy because it may be the result of many other influences. This would not apply to modelling studies in which besides the policies of interest everything else is kept equal. However, there is presently no known model in which the effects of transport projects on social cohesion within regions is modelled.

- *Equivalent Income Measures of User Benefits*. E.g. assuming this also refers to the user benefits of investments in transport infrastructure as computed, for instance, with a CGE model, such as CGEurope. Information about the relation between these benefits and income would be helpful.

- *Population age*. From a welfare economic perspective the relation between age and income seems to be especially important. Distribution of age is helpful. Share of the population that is retired or otherwise non-participating on the labour market and the average incomes of these groups is useful as additional information.

- *Migration flows*. From a welfare economic perspective the relation between migration and welfare (e.g. measured as real income) is important. How does the income of the migrants relate to the average in the regions of origin and destination and how does the income of the migrants change because of the migration?

- *Employment*. Also here the relation with income is important. What is average income of unemployed and employed people? The relation with the poverty rate is also of interest (share of the (un)employed that is poor).

- *Labour force participation*. Same remarks as for employment can be applied.

- *Unemployment*. Is complementary to employment, such that the same remarks can be applied. In the EU the following indicators are available at the national level: share of jobless households, variations in unemployment rate across regions (which suggests that unemployment rates are also available at the regional level) and the long term unemployment rate.

- *Sectoral structure*. This seems to be important because of its relation with (risk of) unemployment, low/high income jobs et cetera.

In summary real income can be interpreted as money metric utility and as such it is of primary importance for the measurement of social cohesion from a welfare economic perspective. For this reason the relation of the other indicators to income is of special interest.

Most of the analysis will have a static character in the sense that regional welfare indicators will be compared at one point of time. Convergence issues will be addressed in a comparative static context: policy alternatives will be compared in order to find out whether or not regional differences increase. An option to be explored is whether a link can be established with endogenous growth theories (see also section 3.3). If the models to be used in this project will indeed become dynamic, it makes sense to broaden the analysis of equity issues so that also convergence issues will be taken on board.

Apart from the indicators mentioned in sections 2.1-2.4 there are others that are relevant to social cohesion, such as the share of the people aged 18-24 with only lower education (available at national scale in the EU), life expectancy (or share of the premature deaths (defined as deaths before the age of 65). However, it seems fair to say that the indicators listed above are the most relevant ones for a study concentrating on transport. Additional information on the (equivalent income measures of) transport related external effects such as congestion, noise, traffic accidents, air pollution will however be useful and contribute to the main theme of the ESPON project.

2.7.3 Trade-Off Analysis between Efficiency and Equity

The territorial impacts of EU and transport and TEN policies will be measured by indicators of regional development concerning economy, population and labour markets according to sections 2.1-2.5 above. The disparities between regions in terms of these indicator dimensions will be measured by cohesion indicators. Any given EU transport and TEN policy will result in territorial impacts and cohesion impacts forecast by the assessment tools used in ESPON 2.1.1 (see section 3). The spatial pattern of any territorial indicator, e.g. based on income or employment information, can be presented in maps or diagrams and for each pattern one or more cohesion indicators can be used to measure the disparities (e.g. in GDP per capita among NUTS-3 regions for EU-27). The graphical analysis of the territorial impacts on any specific region can show if a certain policy is favourable e.g. in an economic and/or labour market sense and if similar conclusions are valid for any particular set of regions. It can illustrate the actual trade-off between potentially conflicting indicator dimensions, such as if there are conflicts between ambitions of high income and low unemployment.

Any cohesion indicator corresponding to the territorial indicator measures the disparities between regions and gives information on equity. Hence, the locus of any particular policy can be plotted in an efficiency/equity diagram illustrating the potential conflicts between efficiency and equity ambitions.

The analyses can show how different policy scenarios compare with respect to efficiency (economic development) and equity (cohesion) and the most equitable scenario can be identified for a given set of policies that satisfies a certain minimum level of efficiency. Alternatively, the most efficient policy scenario can be found which satisfies a certain minimum level of cohesion. The trade-off analysis between efficiency and equity may be conducted in terms of income or any other choice of territorial impact indicator that may be viewed as a relevant component of overall efficiency. Regardless the indicator chosen, the analysis can assist in characterising region types and policies and will contribute to the integrated perspectives on both the territorial impact and cohesion indicators.

2.8 Overview of Indicators

This section summarises all indicators proposed for measuring the territorial impacts of transport and TEN policies. So far, suggestions have been made for indicators, which are desirable for assessing infrastructure and telecommunication policy changes. However, some of them are not feasible and will not be calculated and/or forecast in ESPON 2.1.1. Therefore, it is necessary to distinguish the proposed indicators with respect to desirability and feasibility.

Table 2.3 presents all indicators which are calculated and/or forecast by the methodologies used in ESPON Action 2.1.1. The methodologies' output include economic indicators, population indicators, labour market indicators, information on sectoral structure, accessibility indicators, indicators for measuring ICTs territorial impacts and cohesion indicators.

Table 2.3 Indicators forecast in ESPON Action 2.1.1.

Economic Indicators
Regional GDP per capita (in Euro)
Regional GDP per capita (in PPS)
Regional GDP per capita change (% in Euro)
Regional GDP per employee (in Euro)
Equivalent variation
Equivalent variation per capita
Relative equivalent variation
Population Indicators

Total regional population (number) Regional population change (%) Mean age of regional population (years) Percent persons over 60 years (%) Net migration (%)
Labour Market Indicators
Regional employment (number) Regional labour force (number) Regional labour force participation rate (%) Regional labour force (%, 3 educational levels) Regional unemployment rate (%)
Information on Sectoral Structure
Regional GDP by sector Regional employment by sector (%)
Accessibility Indicators
Accessibility potential by road Accessibility potential by rail Accessibility potential by air Multimodal (road, rail) accessibility potential Multimodal (road, rail, air) accessibility potential
Connectedness Indicators
Industrial territorial concentration activity indicator ICTs network diffusion indicator
Cohesion Indicators
GDP per capita (coefficient of variation, GINI coefficient) Variation of unemployment rate across regions (coefficient of variation, GINI coefficient)

Table 2.4 gives a wish list of additional indicators being desirable for evaluating the outcome of the methodologies used in ESPON 2.1.1. These indicators could be used for comparing and connecting the results with the objectives of the ESDP. However, due to rare data availability the calculation of these indicators is often not feasible and needs to be checked in co-operation with other ESPON projects. If it is decided to calculate and/or forecast one of these indicators, however, additional data will be required, which possibly is not already included in the current list of data requirements (see chapter 4).

Table 2.4 Desirable Indicators.

Population Indicators
Regional poverty rate (%)
Indicators for classifying the urban system (highly agglomerated, medium, rural, …)
Labour Market Indicators
Regional employment (excluding agriculture) by gender (%)
Regional telecommuting (%)
Regional employees by qualification (%, 3 educational levels)
Regional employees by profession
Regional unemployment by age groups (number, unemployed under 25 and over 54 years)
Regional unemployment (%, 3 educational levels)
Information on Sectoral Structure
Regional Gross Value Added by sector (%)
Regional employment in R&D (%) excluding governmental employment
Other Cohesion Indicators
Atkinson or Theil measures of inequality
Information on national or regional price levels
Regional house prices
Population age
Share of retired population
Income of retired population
Poverty rate
Persistence of poverty (Percentage of the population consistently below the poverty line for three years)
Average per capita income of poor and non-poor people
Relation of income of migrants to average income of people in region of origin
Change of income of migrants after migration
Average income of employed vs. Unemployed
Labour force participation
Share of jobless households (national, preferably regional level)
Long term unemployment rate
Sectoral structure of unemployment
Share of people aged 18-24 with low education
Life expectancy
Information on external effects: congestion, noise, traffic accidents, air pollution

3 First Outline of Methodologies of Territorial Impact Analysis

This chapter gives a first outline on the methodologies proposed within ESPON 2.1.1 for assessing the territorial impacts of transport policies and investments. The first two sections present methodologies addressing specific issues, such as the Causality Analysis of regional production and accessibility, and the assessment of territorial impacts of ICTs. Section 3.3 and 3.4 describe the more complex models, i.e. the quasi-production-function approach measuring the impact of EU transport and TEN policies by accessibility indicators and a spatial computable general equilibrium model of trade and passenger flows incorporating product diversity and monopolistic competition. Furthermore, there is presented a first outline of a methodology to evaluate the impacts of transport and TEN policies on the polycentric connectedness and on overloaded transport corridors taking especially into account the spatial objectives given in the ESDP.

3.1 Causality Analysis

Regional production is generally influenced by a number of factors, such as capital, human capital, and accessibility. It is the latter that we are interested in here. It is often thought that accessibility will have a positive impact on regional production. However, the converse relation may hold true as well: highly productive regions may want to invest parts of their wealth in infrastructure, hence improving regional accessibility. Thus, there is the problem of *causality*: which factor influences the other to what extent? To what extent is regional production influenced by accessibility, and to what extent is accessibility influenced by regional production? The empirical answer to these questions will, in general, be difficult to obtain. Nevertheless, the availability of adequate data will allow for answering at least a part of these questions. Hence, we propose some approaches addressing the problem of causality.

Let us first give a general specification of the theoretical model. Let production P be a function F of accessibility A and other factors X, and let accessibility be a function G of production P and other factors Y:

$$\begin{aligned} P &= F(A, X) \\ A &= G(P, Y) \end{aligned} \qquad (1)$$

Note that accessibility will often be measured by an indicator function, so that G will map (P,Y) on a scale of 0 to 1.[2]

In practice, there exist a number of ways to proceed with this general model. Ideally, one would want to estimate a *structural model*, which is directly based on (1). Such a specification would take the form

$$\begin{aligned} P &= F(A, X, e_1) \\ A &= G(P, Y, e_2) \end{aligned} \qquad (2)$$

where the random variables e_1 and e_2 are most often assumed to follow a normal distribution. This specification would match the theoretical specification in (1), and, most importantly,

[2] Although it is not necessarily the case that A lies within this range, it will be assumed so for the moment, without loss of generality.

identify all its parameters. However, a practical drawback of this approach is that the actual specification of F and G typically restricts the domain of the model parameters, so that in terms of model flexibility, other approaches are to be preferred.[3] Estimation of the parameters of the system in (2) takes place by *Full Information Maximum Likelihood* (FIML).

A second approach, known as estimation with *Instrumental Variables* (IV), exclusively focuses on the first equation in (1). It proceeds by (i) regressing A on a set of exogenous variables, and (ii) inserting the predicted values $\hat{A}$ from this regression into the production function specification:

$$P = F(\hat{A}, X, e_1) \tag{3}$$

This last specification can then be estimated by Least Squares (if possible) or Maximum Likelihood techniques, both yielding consistent parameter estimates.
A few remarks are in order here. Firstly, A will often be constrained to the domain (0,1), so that the first stage regression will be of the form

$$H^{-1}(A) = Z'g \tag{4}$$

for some probability distribution function H and g representing the parameter vector. For instance, the well-known Probit-specification assumes H to be equal to the standard normal distribution function. The requirement that Z exclusively contains exogenous regressors implies that production cannot be included as an explanatory variable in (4). Thus, this approach will only gauge the causal effect of accessibility on production, and not vice versa. Note that the special case where $Z = X$ is also known as *Two Stage Least Squares* (2SLS).

Secondly, it is important to note that this method is only theoretically consistent if the specification in (3) is of the form

$$F_0(P) = F_1(A) + F_2(X, e_1) \tag{5}$$

and if the predicted values for $F_1(A)$ are inserted into this equation, and *not* $F_1(\hat{A})$. For example, if logarithmic transformations are preferred, then one could estimate the model

$$\text{STEP 1:} \quad a = Z'g + e_2$$
$$\text{STEP 2:} \quad \ln P = b_0 + b_1\hat{a} + X'b_2 + e_1$$

where $a \equiv \ln A$.[4] If the specification is not linear in F_1 and F_2 as in (5), then estimation with IV is still possible, but will require a generalised approach (see e.g. McFadden, 1999). Thirdly, it is noted that one could apply this same approach in order to assess the impact of production on accessibility, simply by "predicting" production first, and substituting the predicted value into the second equation of (2).

Finally, it should be realised that the success of this approach crucially depends on the availability of proper instruments. In practice, this is often a problem. However, if appropriate

[3] See, e.g., MaCurdy et al. (1990), who discuss the estimation of structural models for labour demand.
[4] One could, however, doubt the normality assumption of e_2 here, because a will be strictly negative.

instruments are available, then this method has the advantage over the estimation of a structural model in the fact that it is more flexible.

Examples of instrumental variables to be used here are physical features of regions such as peripherality of location, flatness of surface, presence of natural barriers and other variables such as regional population, population density and labour force. It is clear that the first variables have a clearly exogenous character and are therefore very suitable as instruments. Variables such as labour force may be less suitable as instruments since they may be closely related to regional production.

A third way of dealing with the above-sketched problem is based on the *Granger causality test*.[5] This test first postulates a specification describing one part of the relation between production P and accessibility A, and then performs a statistical test on whether there *is* a causal relation. For instance, the linear specification

$$P_t = a_0 + \sum_{j=1}^{n} a_j P_{t-j} + \sum_{j=1}^{n} b_j A_{t-j} + g' X_t + e_t \qquad (6)$$

leads to a causality test of the form:

$$b_1 = \ldots = b_n = 0.$$

In trying to identify the causal relation between regional production and accessibility one could estimate (6), as well as its counterpart with A on the left hand side, and hence perform the Granger causality test. Note that under the assumption of normal iid error terms, this test is nothing but a standard F-test.

In order to be able to carry out the Causality Analysis the use of panel data is strongly preferred over the use of a pure cross-section over regions. The latter will not allow for purging unobserved regional effects, such as, e.g., the regional institutional settings, and will therefore not be able to separately identify the effects of accessibility on production from institutional effects on production. Conversely, if regional data are recorded during a certain time period, then one is able to filter away such effects, by making use of a "fixed effects" specification. Therefore time-series data is required for analysing the causal direction. Information on regional production by sector could be purchased from Cambridge Econometrics providing time-series data on Gross Value Added and employment by sector on NUTS-2 level. The database builds on the REGIO data provided by Eurostat, however existing data gaps have been filled and the series has been extended to more recent years using national data where available and backwards updates have been carried out.

If time-series data on regional level is not available for all countries considered in ESPON, the Causality Analysis could be conducted for sample countries or by using time-series data on national scale.

3.2 Methodology for the Analysis of ICTs Territorial Impacts

The general aim of this section is to present some suggestions on descriptive and interpretative methodologies of ICTs territorial impact analysis. In particular, we will:

[5] See Granger (1969).

- highlight the major impacts that ICTs can generate at territorial level;
- stress the different descriptive and interpretative methodologies to measure ICTs territorial impacts.

The methodologies that are suggested have two major positive characteristics. Firstly, they can be applied to different transport and telecommunications infrastructures and secondly, they do not require a specific territorial disaggregation level of the data. The first aspect leaves open the possibility to provide a comprehensive impact analysis of both transport and telecommunications technologies, when the data are available at the same territorial disaggregation level. The second aspect allows to test these methodologies at more aggregated territorial levels of analysis, when data at very fine territorial disaggregation level are not available, at least as far as the spatial economic effect is concerned.

3.2.1 ICTs Territorial Impacts

Before presenting ICTs territorial impact methodologies, it is necessary to explain what is referred to when dealing with ICTs territorial impact. The main ICTs territorial impacts, emphasised by the literature, are twofold:

- the role of ICTs on regional employment and income growth, giving rise to two different possible scenarios: *regional (and sub-regional) convergence vs. divergence*. We will refer to this impact as the *spatial economic impact*;
- the role of ICTs on *relocation of productive and residential activities in favour of more remote and less accessible locations*, which we label the *spatial relocation impact*.

The two sources of impact can be interpreted as intertwined: a relocation of productive and residential activities in more remote areas gives them more chances of employment and income growth. In the literature, two opposite views are stressed on these kinds of territorial phenomena, namely:

- a positive view, which stresses the importance of long distance connections and just-in-time information for lagging regions in the era of globalisation;
- a negative view, which interprets new communication technologies as a modern way of exploiting developing regions, since these technologies facilitate the decentralisation of lower phases of the production process in areas with favourable wage differentials.

These two views illustrate that the spatial relocation and the spatial economic impacts are not always directly intertwined: even if a relocation process takes place, its economic impact does not necessarily give rise to a convergence trend, when simple and low value added activities are relocated. Therefore the methodologies we suggest will aim at (i) describing ICTs territorial impact, in terms of both spatial economic and relocation effects; (ii) at analysing the effective role played by ICTs on regional growth and (ii) at interpreting the linkage between the spatial relocation of activities and regional development.

The methodologies will comprise both *descriptive* as well as *interpretative* instruments for ICTs territorial impact analysis and will be based on the composed indicators presented in section 2.6 of this report. The following section will give a first outline of the suggested methodologies to measure both the spatial relocation effect and the spatial economic effect. In addition we will aim at proposing a methodology to find out whether a relationship exists between the two effects.

3.2.2 Methodologies for the Measurement of ICTs Spatial Economic Impact

In order to measure the impact of ICTs on regional development, i.e. on regional divergence or convergence trends, we suggest the following methodologies.

With the use of a *descriptive methodology*, it is intended to provide a typology of regions, each of which witnessing a different degree of economic impact. In particular, by running a statistical cluster analysis based on some of the indicators suggested in section 2.6, we are able to define different groups of regions, with a high homogeneity within each clusters and with high variations among clusters in terms of the indicators used. The expected result from the application of this methodology is the identification of groups of regions which show a similar behaviour in terms of economic performance and ICTs use and adoption. The results can be presented on a map.

The *interpretative* methodology we suggest is a "quasi production function" methodology, which allows, through the estimate of an econometric model, to measure the role that ICTs (adoption and use; advanced or basic networks and services) play on regional or subregional performance. This methodology will be exactly the one used to measure the role of transport networks on territorial performance. If data are available at the same territorial disaggregation level, a unique methodological impact analysis can be run.

3.2.3 Methodologies for the Measurement of ICTs Spatial Relocation Impact

Methodologies are suggested in this part of the report for the measurement of spatial territorial impact. A word of cautiousness is required at this stage. Differently from the methodologies suggested for the spatial economic impact analysis, the spatial relocation impact analysis requires data at a high disaggregated level of analysis. Therefore, the application of the methodologies we suggest here is subject to the existence of data at NUTS-2 or NUTS-3 level.

A *descriptive methodology* of the concentration vs. dispersion of industrial activities and ICTs diffusion is based on the construction of two indicators, one measuring the time changes of concentration of industrial activities and the other measuring the changes in the diffusion trends of networks or services (see section 2.6).

The plot of the two indicators on a graph allows us to identify four main quadrants, each representing a different situation (see figure 3.1):

- in the top right hand side quadrant, territories will be highlighted where higher changes in the concentration of industrial activities is associated with larger ICTs diffusion;

- in the top left hand side quadrant, territories will be shown where changes in the concentration of industrial activities is linked to negative (or low) increases in ICTs networks and services diffusion;

- in the bottom left hand side quadrant territories with negative (or low) changes in concentration of industrial activities are highlighted, which also witness a negative (or low) change in ICTs diffusion process;

- finally, in the bottom right hand side quadrant territories with a high diffusion of ICTs are present, but where the adoption of ICTs has not driven to any high concentration of industrial activities.

Once these territories are envisaged, it is easy to analyse the economic characteristics of these territories, in order to check whether any common economic situation characterise these territories and can be a possible explanation for the different behaviours in terms of ICTs relocation impact. In this way, a possible descriptive relationship can be provided between the spatial relocation impact and the spatial economic impact. The results of this exercise can easily be presented on geographical maps.

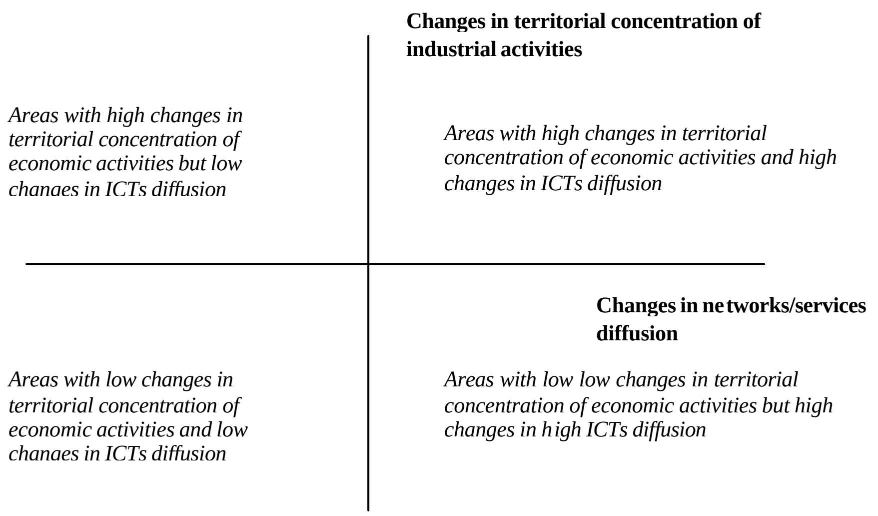

Figure 3.1 Typologies of Territories in Terms of ICTs Spatial Relocation Impact.

The *interpretative methodology* we suggest on the role of ICTs on concentration/diffusion of industrial activities is through econometric analysis which present as a dependent variable the territorial concentration of industrial activity and as explicative variables, among others, ICTs adoption and use. A time series, and cross section analysis is in this case suggested, in order to highlight, through panel methodology, the spatial and temporal components of this role. A more indepth analysis of other explicative variables and of a good index of spatial concentration of economic activity is still required.

3.3 Quasi-Production Function Model with Accessibility

This type of model is based on an extension of the production-function approach in which the classical production factors are complemented by one or more variables representing the locational advantage, or accessibility of a region. As an example of a quasi-production function model, the SASI model developed in the 4th RTD Framework SASI project and updated and extended in the 5th RTD Framework IASON project will be used.

The SASI model is a recursive simulation model of socio-economic development of regions in Europe subject to exogenous assumptions about the economic and demographic development of the European Union as a whole and transport infrastructure investments and transport system improvements, in particular of the trans-European transport networks. For each region the model forecasts the development of accessibility, GDP per capita and unemployment. In addition cohesion indicators expressing the impact of transport infrastructure investments and transport system improvements on the convergence (or divergence) of socio-economic development in the regions of the European Union are calculated.

The main concept of the SASI model is to explain locational structures and locational change in Europe in combined time-series/cross-section regressions, with accessibility indicators being a subset of a range of explanatory variables. Accessibility is measured by spatially disaggregate accessibility indicators which take into account that accessibility within a region is not homogenous but rapidly decreases with increasing distance from the nodes of the networks. The focus of the regression approach is on long-term spatial distributional effects of transport policies. Factors of production including labour, capital and knowledge are considered as mobile in the long run, and the model incorporates determinants of the redistribution of factor stocks and population. The model is therefore suitable to check whether long-run tendencies in spatial development coincide with development objectives discussed above. Its application is restricted, however, in other respects: The model generates distributive, not generative effects of transport cost reductions, and it does not produce regional welfare assessments fitting into the framework of cost-benefit analysis.

The SASI model differs from other approaches to model the impacts of transport on regional development by modelling not only production (the demand side of regional labour markets) but also population (the supply side of regional labour markets), which makes it possible to model regional unemployment. A second distinct feature is its dynamic network database based on a 'strategic' subset of highly detailed pan-European road, rail and air networks including major historical network changes as far back as 1981 and forecasting expected network changes according to the most recent EU documents on the future evolution of the trans-European transport networks.

The SASI model has seven submodels. Figure 3.2 visualises the interactions between these submodels.

- *European Developments.* Here assumptions about European developments are entered that are processed by the subsequent submodels. European developments include assumptions about the future performance of the European economy as a whole and the level of immigration and outmigration across Europe's borders. Another relevant European policy field are transfer payments by the European Union via the Structural Funds or the Common Agricultural Policy or by national governments to assist specific regions, which, because of their concentration on peripheral regions, are responsible for a sizeable part of their economic growth. The last group of assumptions are those about policy decisions on the trans-European networks. A network scenario is a time-sequenced investment programme for addition, upgrading or closure of links of the road, rail or air networks.

- *Regional Accessibility.* This submodel calculates regional accessibility indicators expressing the locational advantage of each region with respect to relevant destinations in the region and in other regions as a function of travel time or travel cost (or both) to reach these destinations by the strategic road, rail and air networks.

- *Regional GDP.* This submodel forecasts gross domestic product (GDP) by industrial sector generated in each region by a quasi-production function incorporating endowment indicators and accessibility. Endowment indicators are indicators measuring the suitability or capacity of the region for economic activity. They include traditional location factors such as availability of skilled labour and business services, capital stock (i.e. production facilities) and intraregional transport infrastructure as well as 'soft' location factors such as indicators describing the spatial organisation of the region, i.e. its settlement structure and internal transport system, or institutions of higher education, cultural facilities, good housing and a pleasant climate and environment.

- *Regional Employment.* Regional employment is derived from regional GDP by exogenous forecasts of regional labour productivity by industrial sector (GDP per worker) modified by effects of changes in regional accessibility.

- *Regional Population.* Regional population changes due to natural change and migration. Births and deaths are modelled by a cohort-survival model subject to exogenous forecasts of regional fertility and mortality rates. Interregional migration within the European Union is modelled in a simplified migration model as annual net migration as a function of regional unemployment and other indicators expressing the attractiveness of the region as a place of employment and a place to live.

- *Regional Labour Force.* Regional labour force is derived from regional GDP and exogenous forecasts of regional labour force participation rates modified by effects of regional unemployment.

- *Socio-economic Indicators.* Total GDP and employment are related to population and labour force by calculating total regional GDP per capita and regional unemployment. Accessibility, besides being a factor determining regional production, is also considered a policy-relevant output of the model. In addition, equity or cohesion indicators describing the distribution of accessibility, GDP per capita and unemployment across regions are calculated.

The *spatial* dimension of the model is established by the subdivision of the European Union and the 12 candidate countries in eastern Europe and Liechtenstein, Norway and Switzerland into 1,291 regions and by connecting these regions by road, rail, air and waterway networks.

The *temporal* dimension of the model is established by dividing time into periods of one year duration. By modelling relatively short time periods both short- and long-term lagged impacts can be taken into account. In each simulation year the seven submodels of the SASI model are processed in a recursive way, i.e. sequentially one after another. This implies that within one simulation period no equilibrium between model variables is established; in other words, all endogenous effects in the model are lagged by one or more years.

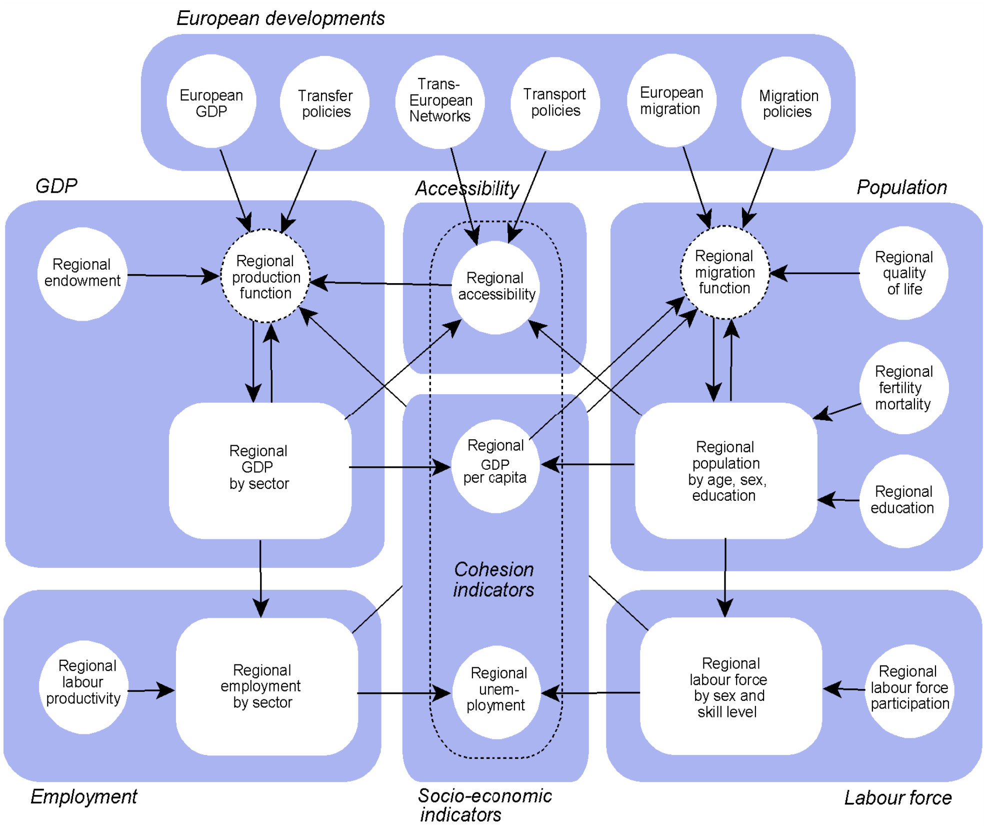

Figure 3.2 The SASI Model

The SASI model developed in the SASI project is presently being updated and extended in the IASON project in several dimensions:

New ideas from growth theory as well as new evidence on firm location are being reviewed and transformed into operational indicators of locational advantage and disadvantage and incorporated into the econometric approach. The following changes are being made:

- *Rates v. levels*. The traditional production function approach relates the *level* of output to the *level* of infrastructure. New growth theory suggests that a link might also exist between the level of infrastructure and the *rate* of growth, because good accessibility means good access to diversity making research and development more productive. It is being examined whether this effect can be incorporated into the model functions by exploring the feasibility of forecasting *rates* of change of regional economic development rather than the *levels* of regional production,

- *Productivity.* The feasibility of forecasting regional sectoral labour productivity endogenously as a function of accessibility and other variables instead of using exogenous productivity forecasts is being explored.

- *Accessibility.* In the accessibility calculations, not only travel time but also transport costs is being considered. The possibility to explicitly consider wage levels and/or production costs of potential suppliers in other regions in the accessibility submodel is being examined. It is expected that this will enhance the contribution of the accessibility indicators to the explanation of regional economic development in the regional production functions.

- *Migration*. Work is underway to forecast migration *flows* as a function of regional employment and/or unemployment and other indicators expressing the attractiveness of the region as a place of employment and a place to live instead of the present *net* migration. It is expected that this will improve the explanatory power of the migration model in the Population submodel.

The model will also be validated by using the econometric results stemming from the Causality Analysis between regional production and accessibility as presented in section 3.1.

The specification of the original SASI model is contained in SASI Deliverable 8 (Wegener and Bökemann, 1998). The implementation of the original SASI model, i.e. the application of empirical data to it and the estimation and calibration of its parameters, was described in EUNET/SASI Deliverable 11 (Fürst et al., 1999). The software system of the original SASI model was described in SASI Deliverable 13 (Wegener et al., 2000). The results of the demonstration scenario simulations with the original SASI model were presented in SASI Deliverable D15 (Fürst et al., 2000). The specification of the extended SASI model is contained in Bröcker et al. (2002).

3.4 Spatial Equilibrium Model of Trade and Passenger Flows

Although extensive research is already under way for assessing the infrastructure needs as well as costs and benefits of individual projects, very little is still known about the spatial distribution of the benefits. Traditional approaches to cost benefit and regional impact analysis are not really capable of taking account of the complex mechanisms by which transport cost changes affect the spatial allocation. This holds true already in a static framework, not to speak about the even more complex channels through which the transport system aspects economic dynamics. The critical issue is to assign the benefits from using the transport links to regions. Assigning costs and benefits from construction and maintenance to regions is less of a problem, and traditional techniques like multiplier analysis are acceptable. Assessing the benefits from newly installed capacities and answering the question where they accrue, however, is much more difficult.

Therefore an additional approach will be applied, largely drawing on the same database as the production function approach. The aim is to set up a multi-regional computable general equilibrium, in which transport costs explicitly appear as firms' expenditures for transport and other kinds of business travel and as households' costs of private passenger travel (for examples see Venables and Gasiorek, 1998, Bröcker, 1998a). This is done in the CGEurope model (see Bröcker, 1998a, 1999, 2000, 2001). The CGEurope model has been developed in an academic environment in a project financed by a national research council and has been extended in the IASON project financed be the European Commission. CGEurope is a multiregional computable general equilibrium model, incorporating innovative features from recent developments in the literature like product diversity and monopolistic competition, explicit modelling of out-of-pocket as well as time costs of business transport as well as private passenger transport.

Transport policies are modelled by changing exogenously transport costs or travel times. As a response, prices as well as quantities react on the changes resulting in changes in income and welfare. The main indicator for the regional consequences one is looking at is the welfare change of regional households as measured by the household's utility functions. Though an ordinal utility index as it stands has no operational meaning, it can be transformed to the so-called Hick's measures of variation, which measures the welfare change in monetary terms (see section 2.1.2).

The focus of the CGEurope model is on evaluating welfare effects in a comparative static equilibrium analysis, that means by comparing cases "with" and "without", leaving everything else unchanged. Hence the approach does not allow for long-term predictions of locational change. It studies welfare gains and losses given the spatial distribution of factors of production. Comparative static simulations will be carried out for a recent benchmark year, based on observed data, as well as for a future year, based on predictions of data.

CGEurope is a multiregional model for a closed system of regions, treating separately each region and linking them through endogenous trade. The world is subdivided into a large number of regions.[6] Each region shelters a set of households owning a bundle of immobile production factors used by regional firms for producing goods. The CGEurope model distinguishes between two different sectors: tradable goods as well as non-tradable (local) goods. Beyond factor services, firms also use local goods and tradables as inputs. The firms in a region buy local goods from each other, while tradables are bought everywhere in the world, including the own region. Produced tradables are sold everywhere in the world, including the own region. Free entry drives profits to zero; hence, the firms' receipts for sold local goods and tradables equal their expenditures for factor services, intermediate local and tradable goods and transport.

Regional final demand, including investment and public sector demand, is modelled as expenditure of utility maximising regional households, who spend their total disposable income in the respective period. Disposable income stems from returns on regional production factors, which, by assumption, are exclusively owned by regional households, and a net transfer payment from the rest of the world. This transfer income can be positive or negative, depending on whether the region has a trade deficit or surplus. Transfers are held constant in our simulations. Introducing fixed interregional income transfers is a simplified way to get rid of a detailed modelling of interregional factor income flows, and of all kinds of interregional flows of private and public funds. Households act as price taking utility maximisers and expend their income for local and tradable goods as well as for travel. The vector of travel demand is differentiated by purpose of travel and destination. Households gain utility from a set of activities connected with travel (like tourism) and suffer from disutility for spending travel time.

The factor supply is always fully employed due to the assumption of perfect price flexibility, which implies the assumption that the rate of unemployment remains unaffected by the exogenous influences under study.

Firms representing production sectors are of two kinds, producers of local goods and producers of tradables. Each local good is a homogeneous good, though one equivalently may regard it as a given set of goods, such that the good's price is to be interpreted as the price of a

[6] In ESPON 2.1.1 the spatial dimension of the model is established by the subdivision of the European Union and the 12 candidate countries in eastern Europe and Liechtenstein, Norway and Switzerland into 1,291 regions and by connecting these regions by road, rail, air and waterway networks.

composite local good. The market for tradables, however, is modelled in a fundamentally different way. Tradables consist of a large number of close but imperfect substitutes. The set of goods is not fixed exogenously, but it is determined in the equilibrium solution and varies with changing exogenous variables. Different goods stem from producers in different regions. Therefore, relative prices of tradables do play a role. Changes of exogenous variables make these relative prices change and induce substitution effects.

Firms maximise profits. Local goods producers take prices for inputs as well as for local goods sold to households and other firms as given. Due to linear homogeneity, the price of local good equals its unit cost obtained from cost minimisation under given input prices. Tradable goods producers take only prices for inputs as given. They produce a raw output by a technology designed in the same way as for local goods producers. Instead of directly selling their output, however, they transform the homogeneous raw output into a final differentiated output. The respective technology is increasing returns, with a decreasing ratio of average to marginal input. Firms are free to compete in the market for a tradable good, which already exists, or to sell a new one not yet in the market. The latter turns out to be always the better choice. Hence, only one firm monopolistically supplies each good, which is aware of the finite price elasticity of demand for the good. The firm therefore sets the price according to the rules of monopolistic mark-up pricing. This choice, of course, is only made if the firm at least breaks even with this strategy. If it comes out with a positive profit, however, new firms are attracted opening new markets, such that demand for each single good declines until profits are driven back to zero.

This is the well-known mechanism of Chamberlinian monopolistic competition determining the number of goods in the market as well as the quantity of each single good (see Krugman, 1991, Fujita et al., 1999, Bröcker, 1998a). Due to free entry, the price of a tradable good just equals its average unit cost. It turns out that under the assumption of a constant price elasticity of demand for each variety of goods, which is valid in our framework, output per variety is also constant, such that output variations come in the form of variations in the number of varieties, and real output is the endogenous measure of variety.

Summarising the basic philosophy of our approach, it obviously strongly relies on neo-classical ideas, even though it departs from the traditional computable general equilibrium approach by allowing for imperfect markets. In other respects, however, the strictness of neo-classical assumptions is retained: firms and households act perfectly rationally, prices are flexible, and markets are cleared, including labour markets. Though these assumptions are often criticised for contrasting with reality, there is no better choice. Even if households don't maximise utility subject to a budget constraint, it is not questioned that they react on prices and that the budget constraint must eventually hold. Neo-classical demand theory is just an easy way to represent these reactions consistently in a formal way. Similar comments apply to modelling reactions of firms.

3.5 Polycentric Connectedness and Overloaded Corridors

The impact analysis described so far is primarily devoted to measuring effects on a regional scale, while – beyond that – the ESDP focuses also on interregional connectedness at different levels. Hence, it is desirable to evaluate the impacts of TEN measures on the quality of connections between a prescribed set of centres within different levels of the hierarchy of central places.

The first part of this analysis deals with *polycentric and balanced development* and urban-rural partnership. It will be operationalized by a systematic and structured selection of abstract links that connect places within the polycentric hierarchical system of centres all over Europe.

These links of different levels of service can be weighted and scaled by two factors: the quality of accessibility today compared to an average standard level and on the other hand the classification of the connected regions in a typology reflecting their economic strength respectively structural problems.

At last the TEN projects are examined regarding their contribution to improve these links. Whenever an improvement of accessibility is significant (by reduced travel times or higher beeline speeds), the weighted value of each improved relevant link directly can be assigned to the causing project.

Regarding sustainable use of infrastructure in urbanised regions a special analysis of *overloaded transport corridors* would be desirable, even though data might not be available. In a first step regions and corridors that are highly overloaded with the burden of transport are identified and classified empirically at regional level. Then TEN projects are examined regarding their expected contribution to unburden the concerned regions and corridors. The relocation or transport streams and possibly expected modal shifts from road to rail or waterways could be used as an additional indicator for the reduction of the transport burden. This can be justified by a more sustainable use of infrastructure and lower external costs for these modes.

This approach is based on concepts developed in Germany by the Federal Office for Building and Regional Planning together with the Federal Ministry of Transport, Building and Housing. It was designed and carried out to complement the cost-benefit analysis methods in the review of the Federal Transport Infrastructure and Investment Plan (BVWP '92). Of course this method has to be adapted and modified to the European scale and the ESDP provided that its approach turns out to be practicable.

Most of the regional and network data required for carrying out this analysis especially for the polycentric development is covered by the other methods of territorial impact analysis. This is the case for road and rail network data, interregional time/cost matrices for different scenarios and typologies of regions. The needs and sources for additional settlement structure data and classifications of the European urban system are still to be evaluated within the ESPON framework (Work Package 2).

The analysis of overloaded transport corridors, however, has to be based on data of provided transport services and flows and on predictions, reassignments of flows resulting from TEN projects. This kind of data can not be calculated from the models used in this consortium. The availability of these transport flow data sets still has to be checked.

4 Data Requirements

The different methodologies of territorial impact analysis described in the previous chapter have specific data needs. This chapter presents the data requirements in an integrated manner across methodologies. It commences with an introduction to the regional and temporal scope of the analysis and continues with a classification of data categories. Then, the required data at European, national and regional scale are described. The chapter concludes with an overview on data that have to be collected for ESPON 2.1.1.

4.1 Regional and Temporal Scope

This section specifies the system of regions and the base year and temporal dimension of the four methodologies.

4.1.1 Regional System

The system of regions to be used is based on Level 3 of the Nomenclature of Territorial Units for Statistics (NUTS) for EU member states (Eurostat, 1999a) and equivalent regions for the candidate countries and Liechtenstein, Norway and Switzerland (Eurostat, 1999b).

The 1,083 NUTS-3 regions defined for the EU member states, the 162 equivalent regions located in candidate accession countries in central, eastern and southern Europe and 46 comparable regions in Liechtenstein, Norway and Switzerland are the 1,291 'internal' regions of the database to be constructed. Altogether, the internal regions comprise a population of 492 million in 1,291 regions with an average regional population of about 381,000. There are 50 additional regions defined for the rest of Europe and one region representing the 'rest of the world'; these are treated as 51 'external' regions of the models. Altogether, the external regions (excluding the region representing the rest of the world) comprise a population of about 299 million in 50 regions with an average population of 598,000. Altogether, 1,342 regions were defined (see Figure 4.1).

The different approaches differ in the way they deal with the regional system:

- The Causality Analysis and the extended SASI model analyse and make forecasts only for the territory covered by the 1,291 internal regions. The external regions (excluding the region representing the rest of the world) are used as locations of activities for the calculation of accessibility indicators. This implies that exogenous assumptions for the development of population and economic activities in the external regions have to be made.

- The new CGEurope model makes no distinction between internal and external regions, i.e. it makes forecasts for the territory covered by all regions of the IASON system of regions (except the region representing the rest of the world).

- The quasi-production function approach for the territorial impacts of ICT will probably use only the NUTS-0 level, due to scarce data availability at lower regional level.

All data have to be collected for the 1,341 region system or aggregates of that (see below) excluding the region representing the rest of the world.

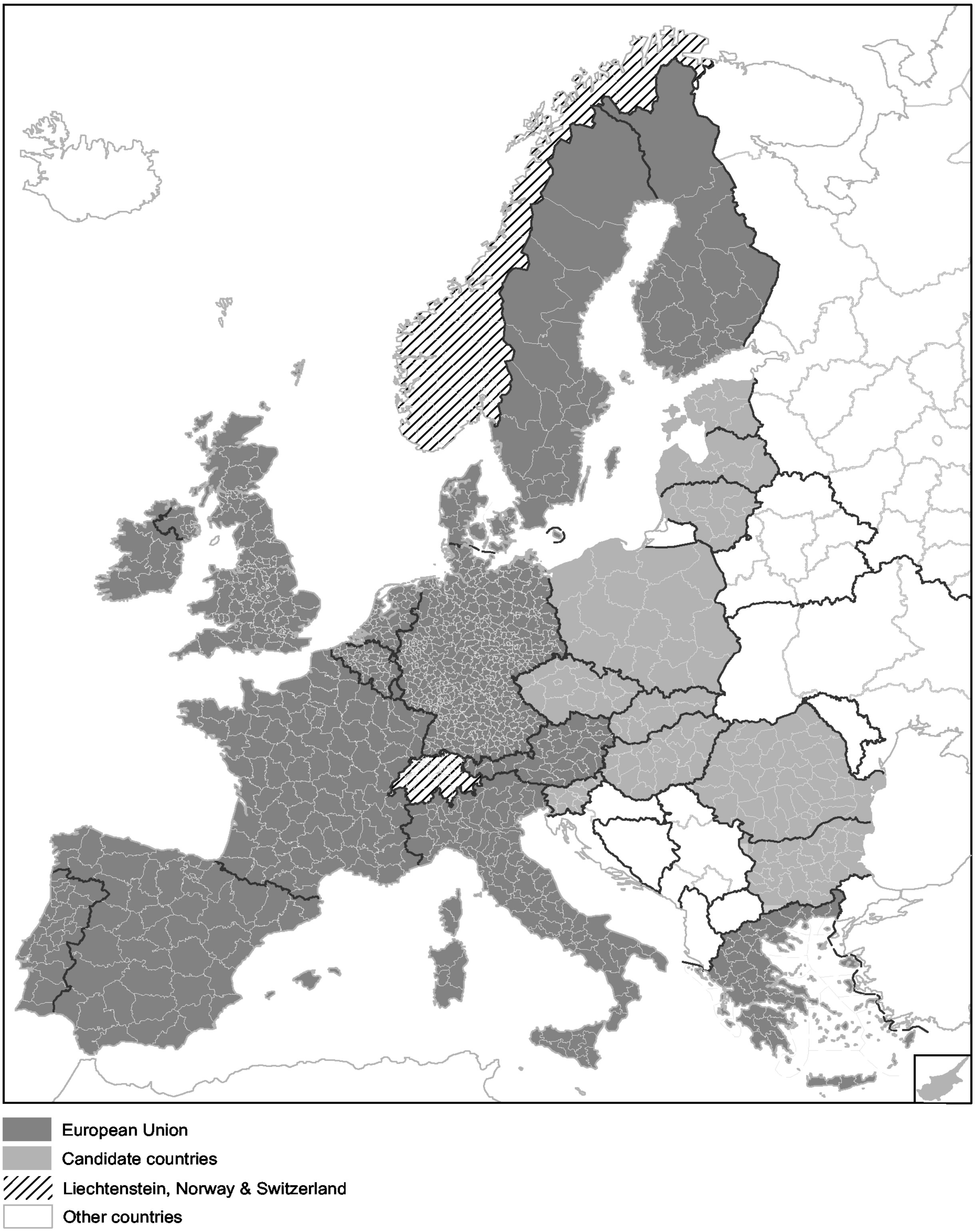

Figure 4.1 The Regional System.

4.1.2 Temporal Dimension

The *common benchmark year* of the methodologies is 1997, the most recent year for which the required economic data are available. The *common target year* for which model results will be compared is 2020.

In addition, the extended SASI model will be run from 1981 (SASI 'historical' base year) to the present to demonstrate that it is able to reproduce the main trends of spatial development in Europe over a significant time period of the past with satisfactory accuracy. The forecasting horizon of the extended SASI model is 2021. This allows twenty years of backcasting and twenty years of forecasting. The simulation period of the extended SASI model is one year. This makes it possible to output results for the *common benchmark year* 1997 and the *common target year* 2020 or to start model runs from the common benchmark year 1997 with data of that year.

4.2 Data Categories

This section introduces the main categories of data used by the methodologies. The first distinction is by the purpose for which the data are necessary. Here data used for the simulation runs and data used for calibration and validation of the models and raw data used to build composite indicators are distinguished. Next the different spatial levels for which data are requested are explained. Third, the main groups of data, such as economic, population and network data, are defined.

4.2.1 Simulation, Calibration/ Validation Data and Raw Data

Three major groups of data are distinguished: data required for running the models (simulation data), data needed for their calibration or validation, and raw data to build composite indicators. In each of the categories, the data can be classified by spatial and temporal reference.

Simulation data are the data required to perform simulation runs. They can be grouped into *base-year* data and *time-series* data.

- *Base-year* data describe the state of the regions and the strategic transport networks in the historical base year 1981 of the extended SASI model or in the common benchmark year 1997.

- *Time-series* data describe exogenous developments or policies defined to control or constrain the simulation. They are either collected or estimated from actual events for the time between the historical base year 1981 and the present (in the case of the extended SASI model) or are assumptions or policies for the future (both models). If possible, time-series data are required in five-year increments, however; if data are not available, other years can be used, since the extended SASI model is able to perform the appropriate interpolations.

Calibration data are data needed for calibrating the functions of the models. Validation data are reference data with which the model results in the period between the base year and the present are compared to assess the validity of the models. Validation is preferable over calibration where processes simulated in the models are unobservable or unobserved because of lack of data. Validation can be used to experimentally adjust model parameters that cannot be calibrated until the model results match available data.

In the thematic field of ICT raw data are required in order to build composite indicators (see Section 2.5), which will be used to run methodologies on ICT's territorial impact.

4.2.2 Spatial Levels

There are three main spatial levels at which data are required: *European data*, *national data* and *regional data*. Regional data are in general required for NUTS-3 regions. However, where data for NUTS-3 regions are not available, data for NUTS-2 or NUTS-1 regions can be collected and disaggregated to NUTS-3 regions. For some data categories, only national data will be available. These include economic data (GDP and international trade), demographic data (fertility, mortality, migration), and in particular data on ICT. These data will not be disaggregated to the regional level but will be assumed to be valid for all regions and used as national controls or for analysis at the national level as in the case of ICT. European data are required as time series projections for future developments in the form of assumptions for future years to be used as control totals to feed scenarios.

4.2.3 Data Groups

At the European level, two main groups of data are required, socio-economic and network data:

- *European socio-economic data* include data on the socio-economic development of the entire study region, i.e. the European Union, the candidate countries and Liechtenstein, Norway and Switzerland, such as data on total European economic development, total immigration to the EU, total EU transfer payments and trans-European transport policies.

- *European network data* include data on the evolution of the trans-European road, rail, air and waterway networks including transport costs, border waiting times and political and cultural barriers, as well as base information needed to specify transport policy scenarios.

At the national level, the main data groups are economic and demographic data, as empirical data for the past and in the form of assumptions for future years, and indicators of physical ICT infrastructure and services:

- *National economic data* for the EU member states, the candidate countries and Liechtenstein, Norway and Switzerland include national accounts, international trade by commodity groups and data on ICT markets.

- *National demographic data* include data on fertility and mortality and on immigration and outmigration and international migration flows.

- *National ICT infrastructure and service data* include information on the diffusion of basic and advanced networks and services, the quality of services and on the use of networks and services.

At the regional level, the main data groups are economic data, population data and data on regional attractiveness:

- *Regional economic data* include gross domestic product, gross value added and employment by sector, unemployment, interregional passenger flows and regional transfers.

- *Regional population data* include population, educational attainment and labour force participation as well as indicators for classifying the urban system.

- *Regional attractiveness data* include indicators of quality of life and indicators of the physical features of a region.

European and national data have to be collected for the years between the SASI historical base year 1981and the present and as assumptions for the time between the present and the forecasting horizon 2021. Regional data have to be collected for the time between the SASI historical base year 1981 and the present.

4.3 European Data

This section deals with data at the European level. There are two kinds of European data, socio-economic and network data. Socio-economic data are about the performance of the European economy, about international migration and about supra-national transfers, such as the Structural Funds. These data provide the framework for the simulations by the two models employed. They are therefore required partly as empirical data (for calibration/validation) or as assumptions about future developments (for forecasts). Network data present the European network database consisting of strategic road, rail, air and waterway networks, including assumptions on transport costs and material and immaterial barriers, as well as assumptions about their future development in various network scenarios.

4.3.1 European Developments

In the extended SASI model, European development data represent the socio-economic development of the study area as a whole between the historical base year 1981 and the present and its expected development until the simulation horizon 2021.

(1) *Assumptions about the performance of the European economy as a whole*. These assumptions are required by the SASI model for each simulation period.

The performance of the European economy is represented by observed (or estimated) values of sectoral GDP for the whole study area, i.e. the European Union plus the 12 candidate countries plus Liechtenstein, Norway and Switzerland for the years between 1981 and the present and forecasts until the year 2021. These assumptions serve as constraints to ensure that the regional forecasts of economic development remain consistent with external developments not modelled.

To keep the total economic development exogenous to the model means that the model is prevented from making forecasts about the general increase in production through transport infrastructure investments, although in principle its parameters are estimated in a way that makes it capable of doing that. Alternatively, it is possible to let the model determine the total level of annual GDP and to use the observed values of the period from 1981 to the present to validate these forecasts.

(2) *Assumptions about immigration and outmigration across Europe's border.* These assumptions are required by the SASI model for each simulation period.

European migration trends are represented by observed annual immigration and outmigration to and from the 15+12+3 countries of the study area for selected years between 1981 and the present and of forecasts for future years up to 2021. The assumptions serve as constraints to ensure that the regional forecasts of population remain consistent with external developments not modelled.

(3) *Assumptions about total transfer payments by the European Union via the Structural Funds and the Common Agricultural Policy*. These assumptions are required by the SASI model in order to run scenarios with global policy changes at the European level which affect transfer payments of a certain kind to all or to a certain kind of regions.

European and national transfer payments are taken into account by annual transfers (in Euro of 1997) during the period between 1981 and the present and forecasts for the period up to 2021.

The data for these three types of assumptions do not need to be provided for each year nor for time intervals of equal length as the SASI model performs the required interpolations for the years in between.

4.3.2 Transport Networks and Policies

Crucial for the tasks of ESPON 2.1.1 is information on the European transport networks and their development over time. Two types of information are required:

(1) *Assumptions about the development of trans-European transport networks (TEN-T and TINA).* For the modelling work, network data on historical development of the European road, rail, waterway and air networks are required for the period between 1981 and the present, based on assumptions on the development of trans-European networks, data on future networks until the year 2021, both in five-year increments.

The spatial dimension of the system of regions is established by their connection via networks. The economic centres of the regions are connected to the network by so-called access links. The 'strategic' road, rail and waterways networks required should comprise the trans-European networks specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996) and specified in the TEN implementation report (European Commission, 1998) and latest revisions of the TEN guidelines provided by the European Commission (1999a; 2002), the TINA networks as identified and further promoted by the TINA Secretariat (1999, 2002), the Helsinki Corridors as well as selected additional links in eastern Europe and other links to guarantee connectivity of NUTS-3 level regions. The strategic air network should be based on the TEN and TINA airports and other important airports in the remaining countries and should contain all flights between these airports.

The networks will be used to calculate travel times and travel costs between regions and regional accessibility. For that the historical and future developments of the networks are required as input information. The development of the networks over time could be reflected in intervals of five years in the database, i.e. the established network database contains information for all modes for the years 1981 (the historical base year for the extended SASI model), 1986, 1991, 1996, 2001, 2006, 2011 and 2016 (as the envisaged completion year of all TEN and TINA projects).

The different networks should contain a number of attributes for each link:

- The *road network database* should contain information on the type of road ('link category'), inclusion in the TEN and TINA programmes, time penalties in agglomeration areas to take account of congestion and slope gradients in hilly areas, car ferry timetable travel times, road tolls, national speed limits and border delays.

- The *rail network* database should contain information on the link category (number of tracks, electrification, suitability for high speed), length, inclusion in the TEN and TINA programmes including priority projects, designation as freight corridors, and travel times from time tables.

- The *air network database* should contain information for each relation on the number of regular flights (per day or per week) and the flight travel time.

- The *waterway network database* should contain information on the type of the waterway (short-sea shipping route, free flowing river, canalised river, canal), and for inland waterways on the inclusion in the TEN and TINA programmes, on the waterway class, and on the lock dimensions (i.e. number and location of lock chambers).

Technically, each transport network will be stored as a separate layer of the geographical information system ArcInfo. For calculating travel time matrices and travel cost matrices for the CGEurope model and accessibility indicators for the Causality Analysis and the SASI model, tools are available to extract the links relevant for a certain policy scenario from the GIS database and to convert them to ASCII text files for further processing in the models.

In order to calculate travel times and travel costs between regions, the following additional data not directly linked to individual network links have to be collected: monetary transport costs, waiting times at road borders and proxies for political and cultural barriers between countries.

(2) *Assumptions about transport policy decisions.* Besides the base or reference (or business-as-usual) scenario so defined, a set of transport policy scenarios to be analysed in terms of their spatial implication has to be developed.

A policy scenario is a time-sequenced programme consisting of a combination of policies in the fields of transport, economy and migration. In technical terms, a scenario is any combination of assumptions about the development of the trans-European network infrastructure, European/national transport policies, total European GDP, European/national transfer policies, total European migration and European/national migration policies.

There are two fundamental groups of scenarios: scenarios based on assumptions about socio-economic macro trends with respect to European GDP, European migration and European trans-national transfer policies, and scenarios based on policies affecting the European transport infrastructure and its use.

In ESPON 2.1.1, only the latter kind of scenario, transport scenarios, will be investigated. There will most likely be one base or reference (or business-as-usual) scenario and a limited number of transport policy scenarios. Transport scenarios can be further subdivided into *pricing scenarios* and *network scenarios*:

- *Pricing scenarios* investigate different ways of levying social marginal costs of road transport from heavy goods vehicles, or alternatively from all modes, by a km-charge, by fuel tax or by a combination of both. Pricing scenarios are entered into the models by changing the monetary travel cost functions.

- *Network scenarios* investigate different time schedules of implementing the trans-European transport (TEN-T) and TINA networks. Network scenarios are entered into the models by changing the underlying network databases. The SASI model has a network scenario generation software tool to accomplish this using ArcGIS software.

4.4 National Data

This section presents national data. National economic data mainly consist of GDP data and information on international trade flows used by the new CGEurope model and ICT market data used for the ICT territorial impact analysis. National demographic data on fertility, mortality and migration are used by the extended SASI model.

4.4.1 Economic Data

Economic data comprise data on GDP and international trade as well as a few further information on the economic structure in the respective countries. Data required for ICTs territorial impacts analysis include ICT market data, such as market revenues and expenses, investments in ICTs and ICT employment.

(1) *GDP, information on economic structure and international trade.* In addition to national GDP, CGEurope also requires some further information on the economic structure in order to parameterise the model. International trade constitutes a further important variable of the CGEurope model. This importance is given by the fact that the proposed analysis will concentrate on the consequences that transport projects and policies have in the region in question as well as how much of these consequences flow outside the region. On account of parsimonious parameterisation in the CGEurope model, data on trade is only required at the international level, while interregional trade flows result from the calibration procedure.

(2) *ICT market data* are required to derive composite indicators in the analysis of territorial impacts of ICT. One way through which one can measure ICTs diffusion is through economic indicators, such as revenues from service provision, as well as ICTs investments and employments. The latter can become a good measure of the impact that ICTs technologies have on regional economy.

There are three groups of economic data to be collected describing different aspects of ICT, each group consisting of a number of specific variables:

- *Market revenues and expenses*. The revenues include revenues of operators, revenues from leased lines, from installation charges from calls (local, national, international), internet access revenues, revenues from mobile telecommunication services, internet access revenues of PTOs and incumbent, revenues from mobile services and revenues from fixed telephone lines. The market expenses include total expenditures for all telecommunications services, internet access costs, monthly internet service providers charge, fixed telephone call charges (local, national, international), mobile call charges and price of leased lines.

- *Investments in ICTs*. The investment data include indicators on telecommunication investments, total, by type of networks, and by geographical area.

- *ICT employment*. The employment data include numbers of total staff in fixed telecommunications provider services, in mobile telecommunications provider services and staff employed by internet service providers.

4.4.2 Demographic Data

Changes of regional population are modelled in the extended SASI model at the regional level. However, only in few countries fertility and mortality data are available for individual regions. Interregional migration data are available for some countries, however, for international migration in general only the country of origin, but not the region of origin is recorded. Therefore, fertility, mortality and migration data can be collected only at the national level.

(1) *Fertility and mortality* rates at national level are used in the population submodel of the SASI model.

Fertility rates by age group of mothers and mortality rates by year of age and gender are readily available for the 15 current EU member states for most years since 1981. For the candidate countries, only crude fertility and mortality rates are available for selected years since 1981. Both data are required also as forecasts until 2021.

(2) *Migration data* are required in the population submodel of the SASI model for calibration and validation.

Although the migration submodel in the extended SASI model models interregional migration flows, its calibration will have to be performed with national migration data for lack of consistent data on interregional migration flows. However, even the analysis of international migration in Europe, and especially migration from outside the European Union, is limited by patchy availability of data and lack of consistent data on the number of foreign population. The main problems of existing data arise from variations in national practices and incompatibility of sources, concepts and definitions.

For these reasons, for the calibration and validation of the migration submodel in the extended SASI model a combination of data on international migration flows, national immigration and outmigration and national net migration for the years between 1981 and the present will be used:

- *Migration flows*. In the absence of consistent data on interregional migration flows, data on international migration flows would be the second best solution for calibrating or validating a migration model. However, even information on migration flows between European countries is far from being complete.

- *Immigration, outmigration and net migration*. Wherever possible, immigration and outmigration will be used for calibrating and validating the migration submodel of the extended SASI model. However, net migration data are more complete than data on immigration and outmigration.

- *Immigration limits*. Because of the strict immigration laws of the EU member states, it will be possible in the SASI model to constrain the immigration to a particular country predicted by the model on the basis of its attractiveness as a place to live and work by an exogenous upper limit representing the effect of restrictive immigration laws.

4.4.3 ICT Infrastructure and Services

Although it is wishful to conduct the analysis of the territorial impacts of ICT at a regional level, it is not feasible because of the rare regional data availability. Given this constraint, the request for data collection dealing with ICT infrastructure and services is at the national level.

(1) *National ICT infrastructure data* are required for building composite indicators in order to run the methodologies on ICT's territorial impacts

The ICT infrastructure data include data on the diffusion of basic and advanced networks and information on the quality of the networks. Two groups of data are distinguished:

- *Telephone network size*. Data on telephone network size provide a measure of the diffusion of the stock of basic telecommunications infrastructures. Switching and transmission equipments are technologically advanced, and in general may transmit voice, data, images and texts. Data in this group include telephone main lines in operation, total capacity of local public switching, main telephone lines connected to digital exchanges, main telephone lines for residential use, main telephone lines for urban areas (to be defined), public pay phones, percentage of capacity used of main telephone lines.

- *Advanced network size*. Data in this group include number of internet hosts, number of internet service providers, number of public internet access points, number of internet access technologies by transmission speed, number of Integrated Broadband Networks (IBN) subscribers, number of packet switching (X25) data network subscribers.

(2) *National ICT service data* are required for building composite indicators in order to run the methodologies on ICT's territorial impacts.

The ICT service data include data on the diffusion of basic and advanced services, the quality of basic services and the use of networks and services:

- *Basic services*. This group of data provides a measure of the services and telecommunication facilities that are offered on the network. Basic services will be described by number of telephone subscribers (home/office subscribers), number of telex subscribers line, number of leased analogue circuits, number of leased digital circuits, number of videotext subscribers.

- *Advanced services*. Specular to the previous one, this group of data gives a measure of the advanced services that are offered on a telecommunications network. Advanced service data comprise the number of internet subscribers (at home/at work/both), number of internet subscribers by technology lines, number of installed PC connected to internet. number of ISDN subscribers, number of videoconference rooms available, number of packet switching (X25) data network subscribers, number of cellular telephone subscribers, number of private and public firms using e-commerce enabling technologies, number of web sites, number of businesses with web sites, internet purchases and sales (e-commerce diffusion), cable TV subscribers.

- *Quality of basic services*. Data on quality of basic services provide a picture of the state of the art of the telecommunications technologies, the quality, and not only the quantity, of services is important. In this respect some measures on the quality of basic infrastructures are required. Although this information is desirable to obtain, however it will probably be impossible to obtain due to competition which inhibits ICTs firms to provide information. Data in this group include waiting list for main lines, percentage of calls which fall during the busy hour, telephone main lines faults, percentage of calls for operator service answered within 15 minutes.

- *Use of networks and services.* The intensity of use of telecommunications technologies is an extremely important information for measuring the impact of telecommunications on regional development. It is in fact through the use rather than through the adoption of telecommunications that one can really understand the impact these technologies have on economic growth. This group is characterised by traffic data such as international telephone traffic, national telephone traffic, local telephone traffic, cellular mobile traffic, average daily time spent on-line, traffic from fixed lines to cellular lines, traffic from mobile telephones to fixed lines.

4.5 Regional Data

This section presents the data to be collected at the regional level, i.e. for NUTS-3 or NUTS-2 regions in the EU Member States or for equivalent regions in the candidate and other countries. The main data categories are economic data, population data and indicators of regional attractiveness.

4.5.1 Economic Data

For the purpose of assessing the economic impacts of transport projects and policies, the proposed methodologies rely on information on the economic situation of each region. Nearly all methodologies require information on the regional location of the sectors, which can be represented by the sectoral gross regional product, gross value added or employment. In addition, the CGEurope requires information on interregional flows of passengers and the SASI model needs data on unemployment and regional transfers.

(1) *Gross regional product, gross value added and employment by sector and region* are required for the calibration and validation of the models to be applied.

The ICT impact analysis require these data for the common benchmark year 1997 only, whereas the Causality Analysis and the extended SASI model require time-series data for GDP and employment since 1981 (the SASI historical base year) until the present. Time-series data is, however, only available for the EU countries, but will be sufficient for model evaluation and validation.

A sectoral classification was designed to provide the different approaches with enough sectoral detail to focus on transport- and/or shipping-intensive industries while taking into consideration general data availability across countries based on recent experience. Sectoral information for each region depends on: (i) whether national statistical offices compile the information by economic activity in the context of regional accounts; (ii) the extent of updating by national statistical offices after the recent widespread revisions of national accounts; (iii) finally, availability of regional socio-economic data at the NUTS-2 and NUTS-3 levels for the considered sectors.

For the methodologies requiring sectoral information it would be desirable to use the following six sectors (see Table 4.1), which are equivalent to the NACE Rev.1 TA6 classification defined by Eurostat. However, data based on this classification might not be available for all NUTS-3 regions of the EU-27 countries. Therefore, if data on NUTS-3 is required it will be more feasible to use only the following three sectors: agriculture, manufacturing and services. In general there will always exist some trade-off between sectoral and regional disaggregation, which needs to be solved.

Table 4.1 Common Economic Sectors.

NACE Rev.1	Codes TA6	Codes TA17	Labels
1	A_B	A	Agriculture, hunting and forestry
		B	Fishing
2	C_E		Industry, including energy
		C	Mining and quarrying
		D	Manufacturing
		E	Electricity, gas and water supply
3	F	F	Construction
4	G_I		Wholesale and retail trade, repair of motor vehicles and household goods, hotels and restaurants; transport and communication
		G	Wholesale and retail trade, repair of motor vehicles and personal household goods
		H	Hotels and restaurants
		I	Transport, storage and communication
5	J_K		Financial, real estate, renting and other business activities
		J	Financial intermediation
		K	Real estate, renting and business activities
6	L_P		Other service activities
		L	Public administration and defence, compulsory social security
		M	Education
		N	Health and social work
		O	Other community, social and personal service activities
		P	Private households with employed persons

The time-series dimension required for the SASI model and the Causality Analysis are additionally demanding for data availability. The database provided by Cambridge Econometrics will be useful with this respect providing data on NUTS-2 level, but would need to be purchased for ESPON 2.1.1.

(2) *Unemployment data* are required for the validation of the SASI model. The SASI model requires regional unemployment data as time series data since 1981 until the present.

(3) *Interregional flow* data are indispensable for the empirical implementation of the enhanced CGEurope model.

In the CGEurope model, not only effects of transport cost changes, but also for private long distance travel, which could also include interregional travel within a country, will be evaluated. Hence data on interregional passenger flows are required, if possible by region of origin and region of destination. Although data on NUTS-3 level would be desirable, data on interregional passenger flows is available from SCENES only on NUTS-2. Data on interregional travel flows are not necessary for the other methodologies.

(4) *Regional transfer data* are required by the SASI model to adjust its GDP forecast.

Data on transfer payments to the region include national transfer payments, European Union Structural Funds and agricultural transfer payments related to the Common Agricultural Policy. Data are required between 1981 and the present and as forecast until 2021.

4.5.2 Population Data

Population data are needed for the extended SASI model as the supply side of regional labour markets. Regional population changes due to natural change (fertility, mortality) and migration.

(1) *Population by age and gender* is required by the SASI model as input for the historical base year and as time-series data for later years until the present for validation.

Required is a consistent database of population by twenty 5-year age groups and gender for all NUTS-3 regions for selected years between the historical base year 1981 and the present.

(2) *Educational attainment* is required by the SASI model as variable in the production function.

Educational attainment of residents in working age will be used as an endowment factor describing human resources and so the availability of skilled labour in the regions in the SASI model. Regional educational attainment data are based on the International Standard Classification of Education (ISCED) and should contain the number of residents in working age for ISCED classes low, medium and high. Educational attainment data are required in five-year- intervals as observed data for the period since 1981 until the present and as external forecast until 2020.

(3) *Labour force participation rates* are required by the SASI model as variable to estimate regional labour force from regional population.

Regional labour force participation rates are required by gender in five-year-intervals since 1981 until the present and as external forecast until 2020.

The approach for analysing the polycentric development and overloaded transport corridors also requires *information for classifying the urban system* (e.g. with respect to highly agglomerated regions, medium agglomerated, rural etc.). However, the exact data needs still need to be specified during the project.

4.5.3 Regional Attractiveness

The extended SASI model considers various measures of attractiveness, partly as additional production factors in the regional production functions, partly as pull and push factors in the migration submodel. Migration to or from a region depends partly on job opportunities and partly on the attractiveness of the region as a place to live (Fürst et al., 1999). Not only highly skilled persons but also pensioners who want to spend their retirement age at the countryside, at the shores or at other attractive places account for a large percentage of European migration flows. These flows are nearly independent of the economic situation of regions.

The SASI model therefore includes a composite regional quality-of-life indicator derived by multi-criteria analysis (Schürmann, 1999). The indicator considers three categories, *climate*, *landscape* and *tourist facilities*. The *climate* category considers the fact that retirement migration prefers regions with warm climate and little rain. The beauty and variety of the *landscape* plays also a prominent role. The number and degree of leisure and *tourist facilities* is also an import point for many people in their decisions regarding migration targets.

For the Causality Analysis further data is desirable on physical features. The first feature concerns the peripherality of the regions measured as the average distance to all other regions. Furthermore, adding physical barriers in the analysis implies that for each region it must be known if it is a mountainous region or bordering to the sea.

4.6 Data Collection Plan

The final section of this chapter summarises the data requirements of ESPON 2.1.1 and gives information which data are already available for the project team from previous projects and which data have to be collected.

In general, the ESPON 2.1.1 project is in a fairly good position with respect to data availability for their methodologies. This is mainly, because data problems have been identified and solved in previous projects in which the SASI and the CGEurope model have been developed to that extent they will be applied in ESPON, in particular the IASON project. A comprehensive documentation of data requirements, data availability and missing data estimation techniques to handle and fill data gaps can be found in Bröcker et al. (2002). However, the database for the SASI and CGEurope models should be improved and cross-checked with other data sources in ESPON.

Current regional data availability is poor with respect to ICT data. At present, no data on ICT are available at NUTS2 and NUTS3 level. An effort in this respect has to be made by international bodies, in order to collect data at a more disaggregate level. ESPON Action 1.2.2

could be a starting point in this respect, providing scientific and operational suggestions to this kind of work.

Table 4.2 summarises the data requirements of the different methodologies, gives information on data availability at the sites of the project partners and lists data to be collected in ESPON.

As has already been mentioned in chapter 2, additional data might be needed, if it is decided to calculate and/or forecast indicators, which so far are not output of the presented methodologies.

Table 4.2 Data Availability and Requests for Data Collection.

Data description	**Data available in project group**		**Request for data collection**	
	Spatial level	**Comment**	**Spatial level**	**Comment**
European developments				
Total European GDP by industrial sector, 1981–2021	Europe (15+12+3)		Europe (15+12+3)	to cross-check the available data
Total European immigration and outmigration, 1981–2021	Europe (15+12+3)		Europe (15+12+3)	to cross-check the available data
Total transfer payments by the EU, 1981–2021	Europe (15+12+3)		Europe (15+12+3)	to cross-check the available data, to update assumptions about future years
Transport networks and policies				
Road network, 1981-2021	Europe (15+12+3 +external)	for attributes see Section 4.3	Europe (15+12+3 +external)	GISCO road network to cross-check the available network data
Rail network, 1981-2021	Europe (15+12+3 +external)	for attributes see Section 4.3	Europe (15+12+3 +external)	GISCO rail network to cross-check the available network data
Air network, 1981-2021	Europe (15+12+3 +external)	for attributes see Section 4.3	Europe (15+12+3 +external)	Update to 2002 necessary
Waterway network, 1981-2021	Europe (15+12+3 +external)	Only inland waterway network available, for attributes see Section 4.3	Europe (15+12+3 +external)	Short Sea Shipping network, GISCO inland waterway network to cross-check
Transport policy decisions, 2002-2021	Europe (15+12+3 +external)	TEN-T and TINA development paths available	Europe (15+12+3 +external)	Transport scenarios to be defined
National Economic Data				
National accounts, 1997	NUTS 0 (15+12+3)	have been harmonised from different sources		
International trade, 1997	NUTS 0 (15+12+3 +external)	have been harmonised from different sources		

ICT market revenues and expenses, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Investments in ICT, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
ICT employment, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
National demographic data				
Fertility rates by age group of mothers, 1981–2021	NUTS 0 (15+12+3)	data gaps in candidate countries	NUTS 0 (15+12+3)	for candidate countries since 1981, all countries for future years to check assumptions
Mortality rates by year of age and gender, 1981–2021	NUTS 0 (15+12+3)	data gaps in candidate countries	NUTS 0 (15+12+3)	for candidate countries since 1981, all countries for future years to check assumptions
Migration flows, 1981-2001	NUTS 0 (15+12+3)	data gaps still existing	NUTS 0 (15+12+3)	to check and fill data gaps
Im-, out-, net migration, 1981–2001	NUTS 0 (15+12+3)	data gaps still existing	NUTS 0 (15+12+3)	to check and fill data gaps
Immigration limits 1997–2021	NUTS 0 (15+12+3)		NUTS 0 (15+12+3)	to check assumptions
National ICT Infrastructure and Services				
Telephone network size, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Advanced network size, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Basic services, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Advanced services, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Quality of basic services, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Use of networks and services, 1997	-		NUTS 0 or below (15+12+3)	for details see Section 4.4 priority list can be provided
Regional economic data				
GDP by sector	NUTS 3 (15+12+3)	missing data, estimation techniques to be applied	NUTS 3 (15+12+3)	to check
GDP by sector, 1981-2001	NUTS 3 (15)	missing data, estimation techniques to be applied	NUTS 3 (15)	could be purchased from Cambridge Econometrics (NUTS 2),
Gross value added by sector, 1997	NUTS 3 (15+12+3)	missing data estimation techniques applied	NUTS 3 (15+12+3)	to check
Employment by sector	NUTS 3 (15+12+3)	missing data, estimation techniques to be applied	NUTS 3 (15+12+3)	to check
Employment by	NUTS 3	missing data, estimation	NUTS 3	could be purchased from

sector, 1981-2001	(15)	techniques to be applied	(15)	Cambridge Econometrics (NUTS 2),
Unemployment, 1981–2001	NUTS 3 (15+12+3)	missing data estimation techniques applied	NUTS 3 (15+12+3)	to check
Interregional passenger flow data, 1997	NUTS 2 (15+12+3)	possible data-source: SCENES		
Regional transfer data, 1981–2021	NUTS 3 (15+12+3)	partly based on spatial disaggregation	NUTS 3 (15+12+3)	to check past data and future assumptions
Regional population data				
Population by age and gender, 1981–2001	NUTS 3 (15+12+3)	missing data estimation techniques applied	NUTS 3 (15+12+3)	update historical data for candidate countries
Educational attainment, 1981–2021	NUTS 2 (15+12+3)	NUTS 2 data used for NUTS 3, partly based on national developments	NUTS 3 (15+12+3)	to check past data and assumptions about future
Labour force participation rates by gender, 1981–2021	NUTS 3 (15+12+3)	missing data estimation techniques applied	NUTS 3 (15+12+3)	to check past data and assumptions about future
Information for classifying the urban system	NUTS 3 (15+12+3)		NUTS 3 (15+12+3)	to check
Regional attractiveness				
Quality of life indicator	NUTS 3 (15+12+3)	Composite indicator		
Accessibility by distance			NUTS 3 (15+12+3)	for details see section 3.1
Mountain region			NUTS 3 (15+12+3)	for details see section 3.1
Sea border region			NUTS 3 (15+12+3)	for details see section 3.1

5 First Description of Relevant Sector Policies

In this section we set out the basic range of policy areas which inter-relate with transport networks and the TENs. The institutional context for policy involves the interaction between EU transport and TEN policies and other Community policies and between the different levels of policy implementation, EU, national, regional and local government. The first of these we term *horizontal co-ordination* between different sectoral policies and the second, *vertical co-ordination* between different policy levels. At this stage we simply set out the relevant EU policy areas which interact with transport and TEN policy and identify the types of interaction which are likely to be relevant in order to suggest ways in which these might need to be incorporated in the definition of indicators. This establishes the framework for the analysis; subsequently we shall carry out a parallel analysis for telecommunications TENs.

5.1 Horizontal Co-ordination

Horizontal co-ordination has two dimensions: the co-ordination of policy measures between different government departments and agencies at any given level of government and the co-ordination of policies implemented by the private sector with those of the public sector. The increasing use of the private sector in the finance and provision of both infrastructure and services in the transport sector implies the need for a careful analysis of the way in which the stated aims of public policy can be realised. However, here we concentrate on public policy areas. The analysis will have three main elements:

- The identification of horizontal spillovers between policy areas by analysis of policy documents

- The analysis of how policy responds to the evidence of horizontal spillovers

- The analysis of the organisational structures put in place to implement policy

A key to understanding horizontal co-ordination is the distinction between identifying spillovers between policy areas or establishing co-ordination between them as an *aim of policy* and the implementation of detailed *policy objectives and measures* to address such matters. Thus there will be a need to examine both the extent to which spillovers are recognised in key policy documents and the way this has shaped the policy design and its implementation. A particular interest is in the ways in which the private sector has been used as a means of implementing policy, through privatisation, public-private partnerships etc. and the institutional arrangements which have been introduced to facilitate this. This leads to an assessment of the relative transactions costs of organising transport investment and provision in different structures. These can range from a highly integrated public sector provision, where transactions costs may be hidden in a structure which is perceived not to be efficient, to a highly disaggregated, though often regulated, private sector provision in which transactions costs are more transparent, allowing for greater efficiency through competition, but may be higher due to the contractual structure which needs to be established.

Given the critical nature of transport in the process of integration, almost all EU policy areas have some relevance to transport and will be affected by transport and TEN policies. The principal policy areas which need to be codified are transport policy itself; regional, structural and cohesion policies; environmental policies; Common Agricultural Policy; internal market, competition and stability and growth policies; and the European Spatial Development Policy.

5.2 Transport Policy

Transport policy in the EU has two main objectives: to ensure efficient operation and development of the transport sector; and to ensure that transport contributes to the completion of the single market. The 2001 White Paper on European Transport Policy recognises the extent to which the period since the previous, 1992, White Paper has seen a considerable opening up of European transport markets, even if these remain more distorted than would be ideal. This has led to unequal growth in the different modes, resulting in excessive congestion and problems of environmental pollution. The 1992 White Paper did, however, tend to focus on infrastructure development as a solution to the problem, a position reaffirmed by the 1993 White Paper on Growth, Competitiveness and Employment which reinforced the role of TENs as a means of securing both increased competitiveness and greater cohesion.

Increasingly during the 1990s it was recognised that, although there were substantial infrastructure needs within the EU, and even more so in the candidate countries, simply building new infrastructure was not practical in many cases and in others may fail to address the real needs and solve the specific problem, be that one of accessibility or of excessive congestion. Thus emphasis shifted towards a parallel policy of ensuring a consistent charging framework for the use of transport infrastructure. The effect of charging would be to ensure a more efficient use of existing infrastructure, and thus potentially to reduce the effective cost to essential users. This has important implications both for the measurement of effective accessibility on the network and thus for interactions with policies dealing with location and regional development.

The 2001 White Paper has three main themes of relevance to an evaluation of the TENs:

(1) Shifting the balance between modes

- road quality, rail integration and modernisation, air traffic growth, waterways integration, intermodalility
- regulation versus competition, increased efficiency may lead to further growth;

(2) Eliminating bottlenecks

- corridor investments, priority links, but problems with finance;

(3) Placing users at the heart of policy

- safety, charging and taxes
- pricing, investment and subsidiarity.

Thus regulation, investment and pricing are all seen as playing a role and hence the impact of each has to be evaluated.

Relevance for indicators: The main relevance for indicators is in terms of identifying the way in which the transport projects in question meets policy needs. In practice this is to identify whether a particular project is primarily addressed toward modal shift, bottleneck elimination or increasing the efficiency of use.

Relevant policy documents which should be taken into account are: *Fair Payment for Infrastructure Use*, COM(1998)466 final; *High Level Group on Transport Infrastructure Charging: Final Report on Options for Charging Users Directly for Transport Infrastructure Operating Costs*, September 1999; *European Transport Policy for 2010, Time to Decide*, 2001.

5.3 Regional and Cohesion Policies

ERDF expenditures were historically heavily directed towards infrastructure and although the proportion of the Structural and Cohesion Funds devoted to infrastructure has fallen, the increase in the size of the Funds still leaves a large volume of expenditure on infrastructure. There is a clear message that transport, and transport infrastructure in particular, is seen as a major contributor to the Commission's cohesion policy. It is important that this link is clearly identified. However, there is also the link in the reverse direction. Structural Fund expenditures which are effective in changing the economic position of regions will have an impact on the demand for transport and hence the use of the transport networks, both in that region and in other regions.

A particularly important distinction is that to be made between expenditure devoted to improving the internal infrastructure of assisted regions and that to inter-regional infrastructure s such as the TENs. The latter requires us to look carefully at the distribution of benefits between regions, including regions geographically remote from the infrastructure. The former is more likely to have a direct positive impact on the productivity of regional enterprises and regional competitiveness. It is important to understand the way that inter-regional and intra-regional networks relate to each other and serve the needs of a region; that development of one may require parallel development of the other and that this relationship will differ according to the economic sectoral and spatial structure of each region.

Current Structural Fund expenditures are heavily weighted towards assistance to Objective 1, lagging regions with GDP/capita below 75% of the EU average, both in terms of the total expenditure and the contribution which can be made towards any particular project. Evidence on the effectiveness of Structural Fund expenditure in raising income levels is mixed This reaffirms the need to examine projects carefully on an individual basis. Whereas it could be argued that the regional implications of transport projects have often not been thoroughly evaluated, it is also clear that a basic assumption has often been made that transport infrastructure investment is good for a region and the wider transport implications have not been thoroughly evaluated. This is a critical link between policy areas.

The future enlargement of the EU poses major questions for the Structural Funds and their operation after 2006. The two main questions of relevance here are the future geographical distribution of funds, and how this relates to the future development of the network, and any changes in the basis for funding which would change the nature of eligible projects.

Relevance for indicators: The primary distinction here is one of identifying whether projects are located in, or directly affect designated assisted regions, and which Structural Fund Objective. Ideally a rather wider definition of the geographical area affected by a project needs to be taken in order to ensure that the genuine net effect is identified.

The following policy documents should be considered: *Sixth Periodic Report on the socio-economic situation and development of the regions of the European Union*, 1999; *Second Report on Economic and Social Cohesion*, 2001; *First progress report on economic and social cohesion*, COM(2002) 46 final.

5.4 Environmental Policy

There is a strong direct relationship between environmental policy and transport policy embodied in the drive towards sustainability in transport policy. Transport has a relationship with all four priority areas in the Sixth Environment Action Programme: climate change, nature and biodiversity, environment and health, natural resources and waste. Developments of the TENs have a direct environmental impact through their impacts on mobility, which affect both climate change and local environmental health. Although this is a largely negative impact, the potential diversion of traffic from modes with greater environmental damage to those which are more environmentally friendly is an important objective of transport policy.

Environmental constraints on industry can also have important transport implications through affecting the location of economic activity and through policies on waste disposal which can be transport creating. New infrastructure has an immediate effect on natural habitats. The Action Programme identifies the need for environmental concerns to be integrated into all EU policies and for existing legislation to be implemented. Information is important in ensuring that individuals, firms and other organisations take consistent decisions with regard to the environment and that appropriate incentive structures exist to encourage this.

Land use and planning decisions are seen as having a key link with environmental policy; both of these interact with transport policy. The key link between policy areas is ensuring both the right information and the appropriate signals and incentives to ensure consistent decision making. Proper environmental evaluation has a direct link with policies on charging for the use of infrastructure; full implementation of the Action Programme has major implications for the effective cost of using infrastructure, on the balance of costs between different modes and on the benefits of greater emphasis on intermodality.

Relevance for indicators: The contribution to environmental policy is a critical aspect of transport network developments. Environmental impact analysis is already a requirement of transport investments, here we need a basic indication of the specific contribution to the goals of the Action Programme (*Sixth Environment Action Programme* (Decision 1600/2002/EC, 22 July 2002)).

5.5 Common Agricultural Policy

As one of the EU's major policy areas, CAP has a major potential impact on transport. CAP support policies maintain agricultural production in regions where they would not survive in a free market and lead to EU domestic production being relatively greater (and imports relatively smaller) than they would be in the absence of support. In the reverse direction, the improvement of transport links to remote regions can change the relative competitiveness of their agricultural production as well as reducing the dependence of these regions on agriculture.

There are modal implications as well: for non-perishable goods the improvement of links such as short sea shipping can have positive benefits for agricultural markets; for perishable goods the improvement of high-speed rail and road networks can led to lower prices and enlarged markets. As well as price support policies, guidance measures under the CAP as part of the Structural Funds have an important impact on the development of rural communities for which accessibility and choice in transport remain major areas of concern. The reform of CAP implies the strengthening of agricultural production in some regions but also the restructuring in others.

The emphasis on increasing market orientation in the farming sector requires that inputs to the sector should also be priced in a way which reflects costs to avoid further distortion, and this includes transport. The benefits from improved transport can be reduced where these can be lost in subsidised transport-using sectors. The extension of the CAP regime to the candidate countries could imply a long-term realignment of markets with important transport consequences.

Relevance for indicators: The importance of CAP as a policy area in the EU requires that regions which have a significant agricultural (or rural) sector need to receive special consideration. This can easily be achieved through an indicator of sectoral structure of each region, although ideally we should define this more precisely according to the nature of the agricultural activity in the region.

Relevant policy documents are : *Mid-Term Review of the Common Agricultural Policy*, COM(2002) 394 final; *Guidelines For The Evaluation Of Leader+ Programmes*, DOCUMENT VI/43503/02-REV.1, January 2002; *Evaluation of rural development programmes 2000-2006*, DOCUMENT VI/8866/99-REV., 1999.

5.6 Internal Market and Competition Policies

It is already clear that the substantial growth in freight tonne-km in the EU over the past decade is related to the process of integration in markets following the completion of the Single Market. Cross-border manufacturing trade continues to grow faster than GDP. The pressure to seek scale economies and thus concentration of activities, the search for new markets and sources of supply, and the move towards integration within sectors all lead to an increased demand for transport. Thus the linkages within and between industries are a significant determinant of industries' transport needs.

At the same time the changing structure of the EU's industrial base, including the increasing emphasis on the tertiary sector, has changed the nature of that demand for transport, largely reducing the overall significance of transport costs in total costs, but increasing the need for faster and, above all, reliable transport. Thus the emphasis has switched from simply providing a given capacity of transport, to ensuring that the quality of the service offered by that capacity meets the increasingly demanding needs of industry and commerce.

The extent of integration which has been achieved within the EU's internal market is a reflection of the integration which has been achieved within the transport sector, but as the recent Transport White Paper identifies, there is still much to be done, not least in removing the many remaining barriers to full integration of the transport sector itself, both within and between modes. The transport sector has an important role to play in the process of reform to ensure a more competitive European economy and promote economic growth.

The Broad Economic Policy Guidelines sit centrally in the economic reform process, providing a key linkage between the core centrally determined policy areas such as monetary policy and the exchange rate and the more decentralised policies on labour market reform, product and capital markets etc. following the Cardiff, Luxembourg and Cologne processes. Essentially this provides a framework for dialogue leading to the setting of strategies. Transport is not specifically mentioned as part of this process, but implicitly is clearly both affected by more efficient labour and product markets which might lead to further integration and has its part to play in securing such greater efficiency. Above all, as a sector in which labour costs are a substantial share of total costs, improvements in labour market flexibility and efficiency will have an impact on the organisation and effectiveness of the transport sector.

The advantage of the procedure established under the Cardiff Process is that it is designed to bring out issues in the development of markets in the member states which can provide the basis for future planning as brought out both by the BEPG and the Economic Policy Committees in their work on individual member states proposals. This transparency will be advantageous in identifying where future transport needs may arise.

Relevance for indicators: It is more difficult to determine a direct link into an easily usable indicator for this area of policy. What we need ideally is a set of indicators which link the transport usage of individual sectors so that the progress of economic integration and reform can be built in. Further work is needed on trying to map the best way of dealing with this important linkage.

Important policy documents are: *Fourth Annual Report on Economic Reform (Cardiff Process)* December 2001; *The Impact and Effectiveness of the Single Market*, Communication from the Commission to the European Parliament and Council 30 October 1996.

5.7 Stability and Growth Policies

As well as the process of economic reform embodied in the Cardiff Process the overall growth of the EU economy is an important driver of transport demand. The efficiency of the transport system contributes to the elimination of bottlenecks which help to improve overall growth potential and reduce differential inflationary pressures. Conversely the need to maintain control of public expenditure in order to meet the limits set by the Stability and Growth Pact limits the rate of improvement of transport infrastructure unless private investment can fill the gap.

Relevance for indicators: Evidence of the position of different member states within the SGP can give an indication of the likelihood of being able to undertake major infrastructure schemes, and in some cases where these may have the effect of removing bottlenecks which could cause problems within the constraints of the SGP.

The most important policy document is *Co-ordination of economic policies in the EU: a presentation of key features of the main procedures*, Euro Papers No 45, July 2002.

5.8 European Spatial Development Perspectives (ESDP)

Cutting across many of the policy areas identified above is the ESDP. The three guidelines of the ESDP are significant in understanding the relationship between transport and other policy areas, calling for: polycentric spatial development and a new urban-rural relationship; parity of access to infrastructure; wise management of the natural and cultural heritage. The core first guideline illustrates the tension between the competitiveness and cohesion objectives of the EU and how this requires a careful balance between policies which strengthen the infrastructure of individual city regions and those which develop the links between them. Furthermore the link between what happens within regions and what happens between them is important in the planning of, and evaluating the contribution of, TENs.

5.9 Vertical Co-ordination

We have discussed above the extent to which there are horizontal links between different EU policy areas. These links are also repeated at the level of each member state, and in some cases at levels below that of the member state, depending on the allocation of competences.

Vertical co-ordination involves the relationships between different levels of government and decision making. This addresses the question as to how higher levels of government establish a policy environment within which lower levels operate. This has three main dimensions:

- The way in which policy is framed to establish the goals which need to be addressed by the lower levels of decision making (top-down policy formation)

- The extent to which the formation of policy by higher level bodies is informed by and takes cognisance of the views and needs of lower level bodies (bottom-up policy formation)

- The way in which high levels of government monitor and police decisions by lower level bodies

It is clear that where there are strong financial/fiscal links between different levels of decision making, both policy formation and monitoring will involve more intense vertical relationships than in cases which just involve exhortation, e.g. the direct provision of transport subsidies will involve a different set of relationships from a general desire to promote sustainable mobility. It will be of particular interest to identify in the case of TENs where the exhortation comes from the European level, but the finance is more likely to come from the national and regional level, how this has affected the shape of the network.

For this part of the research we shall need to look carefully at the ways in which a range of different government levels, national and local, integrate EU policies in their own policy making. It is proposed to examine, for a set of member states, the response to the 2001 EU White Paper on Transport.

6 Detailed Work Plan

The task of this work package was to develop a detailed work plan for all work packages of the project. The work has started from the work programme and specified the scope of work in more detail.

In a Kick-off Meeting the following points were agreed:

- objectives of each work package,
- time schedule for each work package and deliverable,
- responsibilities of each project participants,
- interactions between work packages and other ESPON projects and
- the internal procedures for project communication.

Furthermore a consensus on existing indicators for measuring territorial impacts of EU transport and TEN policies and to outline a methodology for the impact analysis and the analysis of European transport and TEN policy for NUTS-3 regions in EU-27 was reached.

Based on the proposed methodologies data requirements were identified and evaluated with respect to data availability. The outcome of this Work Package is the starting point for the future work in ESPON 2.1.1.

Work Package 2: Indicators, Databases and Mapping

This work package will develop a standard set of indicators of territorial impacts of EU transport and TEN policies and procedures for setting up and maintaining the regional and network databases required for periodically re-calculating and presenting these indicators in diagrams and maps and for integrating or linking these databases and mapping tools with the databases and mapping tools existing at Eurostat.

The work package will start from the preliminary catalogue of indicators and data requirements developed in Work Package 1 and reviews them in the light of the analysis of EU transport and TEN policies and other spatially relevant Community policies.

There will be a close co-operation with ESPON 3.1 in the definition of standards for the formulation of indicators, a common architecture and standards for the collection of data and for the creation of maps with the aim of creating a unified, integrated European spatial monitoring system. Furthermore, in order to avoid duplication of effort, it will be essential that the transport and TEN networks used in ESPON 1.2.1 and ESPON 2.1.1 are the same and that the accessibility indicators calculated in ESPON 1.2.1 are the same as the ones used in the analyses and models of ESPON 2.1.1.

The empirically derived indicators will be analysed with the aim to identify types of regions which are homogenous with respect to the territorial effects of EU transport and TEN policies, i.e. with similar needs of transport and TEN infrastructure development and/or similar expected responses to EU transport and TEN policies. The indicators and typologies will be presented using GIS-based mapping tools taking account of the map design specification to be issued for ESPON. Maps that will be applied include maps of spatial distributions of indicators by NUTS-3 regions, maps of spatial distributions of changes of indicator values over time by NUTS-3 region. In addition, more sophisticated mapping and visualisation techniques, such as time-space maps and 3D surfaces of indicator values cell will be applied and further explored. The results will be passed to Work Package 7: “Recommendations”.

Work Package 3: Cohesion Indicators

This work package reviews existing indicators of cohesion (equity) between regions in Europe and develops a set of robust and policy-relevant cohesion indicators with respect to regional socio-economic development.

Starting point of the overview will be the normative literature on welfare measurement at the individual level and the aggregation to groups of individuals (e.g. the population of a region) by means of a social welfare function. This literature provides a general framework that allows to study the possibility of aggregating individual variables (utility, real income, etc) to analogous regional variables, the sensitivity of the outcomes of such aggregation procedures for the way the regions are defined (size of regions, aggregation of basic geographical units to larger regions), the appropriateness of using multidimensional concepts of cohesion (e.g. by using not only the average income level, but also the variation around its mean, unemployment, environmental quality, et cetera), and the possibility of decomposing equity concepts (such as inequality measures) at a higher level (such as the European union) to parts corresponding to lower levels (such as the individual countries).

The review will also deal with the way traditional (aggregate) indicators of cohesion (such as per capita income and accessibility) can be interpreted in this framework. It will make explicit the assumptions that are needed to establish the appropriateness of these indicators in the welfare economic framework used and possibly suggest alternative indicators. Attention will be paid to theoretical consistency and operationality.

Work Package 4: Forecasting Methods

This work package reviews existing methods of strategic assessment of territorial impacts of transport policies used in EU Member States and at the European level for forecasting the territorial impacts of trans-European transport policies and develops forecasting tools of different complexity for different policy analysis needs. These forecasting tools will contain causality analysis, descriptive and analytical techniques of ICT, a quasi-production function model with accessibility based on the extended SASI model and a spatial-equilibrium model of trade and passenger flows based on the extended CGEurope model. Furthermore, there will be carried out an analysis of the impacts of transport and TEN policies on the polycentric connectedness and on overloaded transport corridors taking especially into account the spatial objectives given in the ESDP.

One approach for analysing and forecasting the contribution of telecommunication infrastructure to regional development is based on a descriptive statistical analysis, such as cluster analysis. These indicators are also calculated in ESPON 1.2.2, from which these data will be supplied. It will be desirable to run the ICTs indicators provided and the territorial indicators in similar equation regressions. In addition the ICTs indicators could also be included in the SASI model. Other interfaces in these respects are the ESPON projects 1.2.1, 2.1.2 and 2.1.3.

In order to analyse the territorial impacts of EU transport and TEN policies, a database of EU transport and TEN policies, the *Policy* database will be established. The Policy database contains the data describing the EU transport and TEN policies to be assessed: investment or subsidy policies affecting the sequence and time schedule of implementation of individual projects of the trans-European transport networks and non-spatial policies, such as regulatory, fiscal or pricing policies affecting the use of the trans-European and other transport networks.

Work Package 5: Forecasting

This work package applies, the forecasting tools developed in Work Package 4. The work will start with the definition of a number of scenarios of EU transport and TEN policies. Particular attention will be given to scenarios including a combination of transport and telecommunications infrastructure policies in the candidate countries. The selected policies will be simulated using the modelling tools developed or adopted in Work Package 4. The validity of the model forecasts can be examined by presenting the spatial patterns predicted by each of them. It will be evaluated how these scenarios differ with respect to efficiency and equity and what types of conflicts emerge between these two indicator dimensions. Finally, recommendations on the improvement of TEN will be concluded and the results will be given to Work Package 7.

Work Package 6: Institutional Issues

This work package analyses the interactions between EU transport and TEN policies and other spatially relevant Community policies and the institutional context in which such policies are designed and implemented. The work package will look into the mechanisms, i.e. communication and co-ordination processes and institutional and legal instruments by which EU transport and TEN policies are brought about and the institutional barriers that delay or inhibit their implementation.

It will address issues of horizontal co-ordination between different sectoral policies, such as regional and cohesion policy, environmental policy, common agriculture policy, research policy, internal market policy, competition policy, and stability and growth policy. It is objective to identify relevant transport links in policies, such as infrastructure development, mobility and transport market organisations and will identify the impacts and policy responses on changes in these links.

Secondly, it will address issues of *vertical co-ordination* between EU-level, national level, regional level, local level and private sector. The use of higher levels of policy making in formulating policy as a constraint on policy formulation and higher levels of policy as an instrument for policy formulation.

The third objective is the development of *a theoretical framework* for analysing the interactions between EU transport and TEN policies and other spatially relevant Community policies. Concepts like horizontal and vertical spillovers , the role of transaction costs and the importance of contracts will be considered. Alternative institutional structures will be taken into account.

A series of case studies of both policy initiatives and projects to examine both horizontal and vertical co-ordination will be conducted. The case studies will examine horizontal co-ordination by exploring horizontal spillover between policy areas (by analysis of policy documents), policy responses to horizontal spillover and the organisational structures put in place to implement policy. The case studies will examine vertical co-ordination by analysing how higher levels of government establish a policy environment within which the lower level operates, the extent to which policy making at higher levels is informed by and takes account of the views and needs of lower levels, and the way in which higher levels of government monitor and policy decisions by lower-level bodies.

It will be established how far policies, and which policies, were invoked and became instrumental in a final decision and how far objective indicators were used as a means of making policy aims more specific and effective.

Work Package 7: Recommendations

This work package makes recommendations for improvements of the methodology to assess the territorial impacts of EU transport and TEN policies and for better horizontal and vertical co-ordination in the design and implementation of such policies. Recommendations will be made for the improvement of the methodology and the presentation of the territorial impacts, from which input of all Work Packages is used. Furthermore these recommendations cover a set of reference indicators of territorial impacts of EU transport and TEN policies, indicators of ICTs territorial impact and a set of cohesion indicators.

One main objective is the advice on procedures for maintaining the databases necessary for calculating these indicators as well as indicators of territorial impacts of EU transport and TEN policies and their periodical re-calculation. A manual for the calculation of indicators of territorial impacts and for the application of the forecasting methodologies, as developed in Work Package 5: “Forecasting”, will be provided.

Finally, using the results of Work Package 6: “Institutional Issues”, it is desired to give recommendations for further research needs in the area of modelling territorial impacts of EU transport and TEN policies and for the improvement of horizontal and vertical co-ordination of EU transport and TEN policies with other spatially relevant Community policies and between spatial planning levels.

Work Package 8: Project Co-ordination

The work package leaders will be responsible for verifying the satisfactory completion of the tasks of their work packages, and the project co-ordinator will review each work package overall to ensure the overall scientific and technical quality of the work packages’ work. Each work package leader will complete a progress report as required. The report will be controlled by the project co-ordinator with respect to progress against work plan and objectives. Furthermore, there will be regular co-ordination meetings to ensure the control of progress in terms of schedule, resources and quality.

The co-ordinator will establish and ensure an efficient communication and information sharing between the work packages, the ESPON Contact Point, the ESPON Co-ordination Unit and ESPON 3.1 as well as with other ESPON projects. Material on ESPON 2.1.1 will be provided for the ESPON homepage, including general information on the project.

Additional to progress meetings, a workshop scheduled for Project Month 19 with invited practitioners will be held to present and discuss the results of the project achieved at that point and, if necessary, adjust the work for the rest of the project.

Interactions with other ESPON Projects

To meet the objectives the project will build on a strong co-operation with other ESPON projects, especially with ESPON Actions 1.2.1 and 1.2.2 concerning infrastructure and telecommunication access, as well as policy impacts addressed under measure 2.1, in order to avoid any overlap. The project will also be conducted in close co-operation with Action 3.1.

There is a strong linkage between ESPON projects 1.2.1 and 2.1.1. Both are dealing with transport aspects of territorial development in Europe. Whereas ESPON project 1.2.1 belongs to the thematic projects of the programme, ESPON project 2.1.1 belongs to the group of projects dealing with policy impacts on territorial development. Consequently, ESPON project 1.2.1 focuses on analytical approaches in the field of transport infrastructure and services and ESPON project 2.1.1 is concerned with forecasting methodologies dealing with spatial impacts of TEN-T developments. In both projects, transport infrastructure endowment indicators and the concept of accessibility play key roles and thus constitute common features.

A close co-operation between the two projects is guaranteed, because S&W is a main partner in both actions. An exchange of ideas, concepts and methodologies between the project partners of both projects will take place at the 1st ESPON Seminar on 21-22 November 2002 in Luxembourg.

Interactions between ESPON Action 2.1.1 and Action 1.2.2, which assesses the spatial effects of networks and telecommunication services, are necessary in order to avoid overlaps. Action 2.1.1 will analyse and forecast the contribution of telecommunication infrastructure to regional development, which is partly based on a descriptive analysis. These indicators are calculated in co-operation with ESPON 1.2.2, which will provide the required data. Also regional data availability is poor with respect to ICT data, demanding a strong co-operation with ESPON Action 1.2.2. Suggestions and new ideas on these issues will be exchanged between the two projects.

The close co-operation between Action 2.1.1 and 3.1 will be guaranteed by the incorporation of the German ESPON Contact Point into the TPG of ESPON 2.1.1.

7 Conclusions

This report completes Work Package 1 of ESPON 2.1.1 by presenting the work and results of the first three project months.

A consensus on indicators for measuring and assessing the territorial impacts of EU transport and TEN policies was found and presented in the report.

Different methodologies of territorial impact analysis were set up ranging from methodologies addressing particularly important issues, such as the causality analysis of regional production and accessibility or the ICTs territorial impact analysis, to two larger models. One of these models is based on an extension of the production-function approach and measures the impact of EU transport and TEN policies by accessibility and socio-economic indicators. The second model to be applied in Action 2.1.1 is a multi-regional computable general equilibrium model of trade and passenger flows incorporating product diversity and monopolistic competition. Furthermore, there was given a first outline for the analysis of the impacts of transport and TEN policies on the polycentric connectedness and on overloaded transport corridors taking especially into account the spatial objectives given in the ESDP.

Starting from the proposed methodologies, data requirements for ESPON 2.1.1 were identified and evaluated with respect to data availability and comparability at Community level, and the appropriate geographical level for data collection was defined. It turned out that the degree of data availability is fairly high due to the work done in previous EU projects. However, regional data availability is poor with respect to ICT data, demanding a strong co-operation with ESPON Action 1.2.2.

The basic range of policy areas interacting with the EU transport and TEN policies was set out including other Community policies and different levels of policy implementation, such as EU, national, regional and local government. Both, horizontal co-ordination between different sectoral policies, such as transport policies, regional and cohesion policies, environmental, agricultural policies and internal market and competition policies, and vertical co-ordination between different policy levels were considered taking into account the relevant policy documents, such as the ESDP.

The methodological and political framework for the assessment of territorial impacts of EU transport and TEN policies set up in Work Package 1 and presented in this report will be the starting point for future work in Action 2.1.1. Data will be collected and existing data gaps will be filled if possible i.e. by estimated proxies using interpolation techniques or disaggregation from higher spatial levels from other regions with similar characters. The defined indicators will be developed and graphically visualized using the established database and map-making facilities, in order to analyse territorial trends, potentials and problems deriving from EU transport and TEN policies at different scales and in different parts of an enlarged European territory. The proposed methodologies will be implemented and used for analysing and diagnosing the territorial impacts of EU transport and TEN policies. The interactions between EU transport and TEN policies and other spatially relevant Community policies and the institutional context in which such policies are designed and implemented will be analysed. Based on the results of the case studies and policy scenarios carried out in ESPON 2.1.1 conclusions and recommendations for policy adjustments and improvements in the EU transport and TEN policies, for further policy developments in support of territorial cohesion and a better balanced EU territory, as well as for improving the spatial co-ordination of EU and national sector policies will be drawn particularly referring to the ESDP.

References

Bröcker, J. (1998a). *Operational spatial computable general equilibrium modelling*. Annals of Regional Science 32, 367-387.

Bröcker, J. (1998b): *Spatial Effects of Transeuropean Networks: Preliminary Results from a Spatial Computable General Equilibrium Analysis*. Diskussionsbeiträge aus dem Institut für Wirtschaft und Verkehr der Technischen Universität Dresden .4/98, Dresden: TU Dresden

Bröcker, J. (1999): *The economic impacts of the TEN projects on the Øresund region: an equilibrium modelling approach*. Paper presented at the International Seminar on Regional Development Impacts of the Øresund Bridge, Copenhagen, November 28, 1999.

Bröcker, J. (2000): *Trans-European effects of "Trans-European Networks": results from a spatial CGE analysis*. In: Bolle, F., Carlberg, M. (eds.): *Advances in Behavioral Economics*. Heidelberg: Physica, 141-159.

Bröcker, J. (2001): *Spatial effects of European transport policy: a CGE approach*. In: Hewings, G. (ed): Title (forthcoming).

Bröcker, J., Kancs, A., Schürmann, C., Wegener, M. (2002). *Methodology for the Assessment of Spatial Economic Impacts of Transport Projects and Policies.* IASON Deliverable 2. Kiel/Dortmund: Christian-Albrechts-Universität Kiel/Institut für Raumplanung, Universität Dortmund. http://irpud.raumplanung.uni-dortmund.de/irpud/pro/iason/ber54.pdf.

Bröcker, J., Kretschmer, U., Schürmann, C., Spiekermann, K., Stelder, D., Wegener, M. (2002): *The IASON Common Spatial Database*. Deliverable D3 of the project IASON (Integrated Appraisal of Spatial Economic and Network Effects of Transport Investments and Policies). Kiel and Dortmund: Institut of Regional Research and Institute of Spatial Planning.

Cambridge Econometrics: *European Regional Prospects*. http://www.camecon.co.uk/whatsnew/releases/uk02.htm.

Co-ordination of economic policies in the EU: a presentation of key features of the main procedures, Euro Papers No 45, July 2002.

Deaton, A., Muellbauer, J. (1980): *Economics and consumer behavior,* Cambridge[u.a.]: Cambridge University Press.

European Commission (1998): *Trans-European Transportation Network. Report on the Implementation of the Guidelines. Basic Data on the Networks*. Report to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions on the implementation of the guidelines for the development of the trans-European transport network (Decision 1692/96/EC).

European Commission (1999a): *14 TEN Priority Projects*. http://europa.eu.int/en/comm/dg07/tentpp9807/index.htm.

European Commission (1999b): Sixth Periodic Report on the Social and Economic Situation and Development of Regions in the European Union, Brussels.

European Commission (2000). Communication from the Commission; Structural Indicators. COM(2000) 594 final.

European Commission (2002): *Revision of the Trans-European Transport Networks "TEN-T". Community Guidelines.* http://europa.eu.int/comm/transport/themes/network/english/ten-t-en.html. 02-04-2002. Brussels: European Commission.

European Communities (1996): Decision No. 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on the Community guidelines for the development of the trans-European transport networks. *Official Journal of the European Communities* 39, L 228, 9 September 1996, 1-104.

European Transport Policy for 2010, Time to Decide, 2001.

Eurostat (1999a): *Regions. Nomenclature of Territorial Units for Statistics - NUTS.* Luxembourg: Office for Official Publications of the European Communities.

Eurostat (1999b): *Statistical Regions in the EFTA Countries and the Central European Countries (CEC).* Luxembourg: Office for Official Publications of the European Communities.

Eurostat (1999c*): Concepts and Definitions Database, Statistics in focus Theme 3 – 11/1999: Labour force survey – Principal results.*

Eurostat: *Regions Statistical Yearbook*, various years, Luxembourg.

Eurostat (2001): *Employment and Labour Market in Central European Countries* (Detailed Tables, THEME 3 Population and social conditions).

Evaluation of rural development programmes 2000-2006, DOCUMENT VI/8866/99-REV., 1999.

Fair Payment for Infrastructure Use, COM(1998)466 final.

Federal Office for Building and Regional Planning (2001): *Criteria for the Spatial Differentiation of the EU-Territory: Economic Strength*, Bonn.

First progress report on economic and social cohesion, COM(2002) 46 final.

Fourage, D. (2001): *Subsidiarity and Poverty in the European Union. Fiscal Competition or Co-ordination?* Working Paper. Tilburg: Tilburg Institute for Social and Socio-Economic Research (TISSER) & Institute for Labour Studies (OSA), Tilburg University.

Fourth Annual Report on Economic Reform (Cardiff Process) December 2001.

Fujita, M., Krugman, P. Venables, A.J. (1999). *The Spatial Economy: Cities, Regions, and International Trade*. Cambridge, MA: MIT Press.

Fürst, F., Hackl, R., Holl, A., Kramar, H., Schürmann, C., Spiekermann, K., Wegener, M. (1999): The *SASI Model. Model Implementation.* SASI Deliverable D11. Dortmund: Institute of Spatial Planning, University of Dortmund.

Fürst, F., Hackl, R., Holl, A., Kramar, H., Schürmann, C., Spiekermann, K., Wegener, M. (1999): The *SASI Model. Model Implementation*. SASI Deliverable D11. Dortmund: Institute of Spatial Planning, University of Dortmund.

Fürst, F., Schürmann, C., Spiekermann, K., Wegener, M. (2000): *The SASI Model. Demonstration Examples.* SASI Deliverable D15. Dortmund: Institute of Spatial Planning, University of Dortmund. http://irpud.raumplanung.uni-dortmund.de/irpud/pro/sasi/ber51.pdf.

Granger, C. (1969), *Investigating Causal Relations by Econometric Methods and Cross-Spectral Methods*, Econometrica 34, 424-438.

Guidelines For The Evaluation Of Leader+ Programmes, DOCUMENT VI/43503/02-REV.1, January 2002.

High Level Group on Transport Infrastructure Charging (1999): Final Report on Options for Charging Users Directly for Transport Infrastructure Operating Costs, September 1999.

Hicks, J.R. (1939): *Value and Capital: An inquiry into some fundamental principles of economic theory,* Oxford: Clarendon Press.

Isard, W., Azis, I., Drennan, M., Miller, R., Saltzman, S.,Thorbecke, E. (1998): *Methods of Interregional and Regional Analysis*. Brookfield, Vermont: Ashgate Publishing Company.

Krugman, P. (1991): *Geography and Trade*. Leuven: Leuven University Press.

MaCurdy, T., Green, D., and Paarsch, H. (1990), *Assessing Empirical Approaches for Analyzing Taxes and Labor Supply*, Journal of Human Resources 25, 415-490.

McFadden, D. (1999), *Course Notes: Generalized Method of Moments (GMM) and Instrumental Variables*, http://emlab.berkeley.edu/users/mcfadden/e240b_f01/ch4.pdf.

Mid-Term Review of the Common Agricultural Policy, COM(2002) 394 final

Schürmann, C., Spiekermann, K., Wegener, M. (1997): *Accessibility Indicators*, Berichte aus dem Institut für Raumplanung 39, Dortmund, IRPUD.

Schürmann, C. (1999): *Quality of Life in European Regions: A Multi-Criteria Analysis*. Arbeitspapier 165. Dortmund: Institute of Spatial Planning.

Second Report on Economic and Social Cohesion, 2001.

Sixth Environment Action Programme (Decision 1600/2002/EC, 22 July 2002).

Sixth Periodic Report on the socio-economic situation and development of the regions of the European Union, 1999.

The Impact and Effectiveness of the Single Market, Communication from the Commission to the European Parliament and Council 30 October 1996.

TINA Secretariat (1999): *TINA Transport Infrastructure Needs Assessment. Identification of the Network Components for a Future Trans-European Transport Network in Bulgaria,* *Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.* Final Report. Vienna: TINA Secretariat.

TINA Secretariat (2002): *Status of the Pan-European Transport Corridors and Transport Areas. Developments and Activities in 2000 and 2001.* Final Report. Vienna: TINA.

Törnqvist, G. (1970): *Contact Systems and Regional Development*, Lund Studies in Geography B 35, Lund, C.W.K. Gleerup.

Varian, H.R. (1992): *Microeconomic analysis*, 3. ed., New York : Norton.

Varian, H.R. (1999): *Intermediate microeconomics : a modern approach*, 5. ed., New York, NY : Norton.

Venables, A.J., Gasiorek, M. (1998): *The Welfare Implications of Transport Improvements in the Presence of Market Failures*. SACTRA Working Paper A, Revised 4/1/98, London: London School of Economics.

Wegener, M., Bökemann, D. (1998): *The SASI Model: Model Structure***.** SASI Deliverable D8. Berichte aus dem Institut für Raumplanung 40. Dortmund: Institut für Raumplanung, Universität Dortmund. http://irpud.raumplanung.uni-dortmund.de/irpud/pro/sasi/ber40.pdf.

Wegener, M., Schürmann, C., Spiekermann, K. (2000)*: The SASI Model: Model Software*. SASI Deliverable D13. Berichte aus dem Institut für Raumplanung 50. Dortmund: Institut für Raumplanung, Universität Dortmund. http://irpud.raumplanung.uni-dortmund.de/irpud/pro/sasi/ber50.pdf.

Wegener, M., Eskelinnen, H., Fürst, F., Schürmann, C., Spiekermann, K. (2002): *Criteria for the Spatial Differentiation of the EU Territory: Geographical Position*. Forschungen 102.2, Bonn, Bundesamt für Bauwesen und Raumordnung.