COMPETITIVE AND SUSTAINABLE GROWTH PROGRAMME

IASON

Integrated Appraisal of
Spatial economic and
Network effects
of transport investments and policies

Deliverable 6:

Modelling the Socio-economic and Spatial Impacts of EU Transport Policy

Version 1
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Contents

Executive Summary

The goal of the IASON project was to improve the understanding of the impact of transportation policies on short- and long-term spatial development in the EU by developing a *unified assessment framework* for transport project and transport policies at the European level integrating network, regional economic and macro-economic impacts.

One of the main issues of the project was to quantify the spatial impact of transport initiatives taking both direct and indirect effects into account. A transport initiative as any kind of public action having an impact on the monetary cost, time cost, efficiency and comfort of transportation of goods and people, in particular transport infrastructure investments and pricing policies. All such initiatives are subject to cost benefit analyses (CBA) at the national and EU level to figure out whether the present value of total net benefits including environmental impacts exceeds the cost. This is a well established practice.

However, several important policy issues remain unresolved in standard evaluation procedures. One issue is whether the so-called direct measurement of user benefit, which consists in quantifying changes in surplus of the users of the transport system, captures all welfare generated in the economy. Another issue is how the gains (or possibly losses) of a transport initiative are distributed among individuals, social strata or regions. All three distributional dimensions are important, but the third dimension, distributional implications in the spatial dimension, is the main issue of this report.

In the research presented in this report, two socio-economic models grounded in theories of spatial economics were used to forecast how regions in Europe are likely to be affected by transport initiatives representing policy options in Europe in the years to come. In co-operation with the European Commission and partners of the IASON and TIPMAC projects, a series of scenarios of infrastructure investments, pricing policies and combinations of both were defined. These were translated into estimates of changes in mode-specific transport cost and used as input into the two models. The two models used were the SASI model and the CGEurope model:

- The SASI model was developed in an earlier EU project in a simpler form and was extended and calibrated in IASON with new data and for a much larger system of regions. SASI is a dynamic model of the spatial European economy, the kernel of which is a so-called quasi-production function quantifying the relation between accessibility and output by region and sector. Transport initiatives lead to changing transport costs and hence to changing spatial patterns of accessibility. This influences output via the econometrically estimated quasi-production function. The production part of the model is connected to a migration model such that a fairly comprehensive picture of the impact of transport initiatives on the spatial economic system emerges.

- CGEurope is a computable general equilibrium (CGE) model of a multiregional economy. Models in this family are routed in modern neoclassical economic theory assuming that the behaviour of firms and households is the outcome of rational choice under technological and financial constraints. Firms choose supply and demand such that profits are maximised, households choose consumption of goods, services and travel such that they attain a maximal utility. In a multiregional setting all these choices are affected by transport cost including time costs. Therefore changes of these costs, as represented by the scenarios,

change all endogenous variables in the system such as prices, outputs, trade and travel flows, and – most importantly – utility. Utility is the ultimate variable of interest in CGEurope. As utility has meaning only in an ordinal sense of 'more' or 'less', it is translated to a monetary equivalent for project evaluation. An early version of CGEurope was developed in an academic research project financed by the German Research Fund (DFG). It was extended and calibrated with a new database for the larger IASON system of regions. Furthermore, a second new multisectoral version of CGEurope was developed in IASON which, however, is applied at a more aggregate spatial level. Both versions of the model are presented in this report.

This summary is organised as follows: Section 2 defines the scenarios to be modelled by the two approaches. Section 3 documents the design, database, calibration and results of the SASI model, Section 4 the design, database, calibration and results of CGEurope. Both models, SASI and CGEurope lead to results, that are similar with regard to the spatial distribution of effects, but the range between low and high within each scenario turns out to be much larger in SASI than in CGEurope. To put it differently, SASI predicts a more pronounced relocation effect of transport initiatives than CGEurope does. Section 5 discusses the similarities and differences between the two models from a theoretical as well as from an empirical point of view. Section 6 draws conclusions concerning transport policy and the methodology of project evaluation.

Scenarios

The policies to be examined in IASON are defined as *policy scenarios*, i.e. as time-sequenced programmes of implementation of network improvements and extension and other transport policies. In addition to the policy scenarios, a *reference scenario* is defined as benchmark for comparisons between the results of the policy scenarios. All scenarios are equal for both SASI and CGEurope. They can be classified into six categories:

- *Reference Scenario*. Scenario 000 is the base or reference scenario serving as the benchmark for the comparisons between the results of the policy scenarios.
- *Network scenarios*. Scenarios A1 to A62 implement different assumptions on the further development of the European transport networks, i.e. they vary in the number, selection and timing of implementation of network links.
- *Pricing scenarios*. Scenarios B1 and B2 examine different schemes of social marginal cost (SMC) pricing. They differ in the kind of pricing regime. These scenarios do not implement any network development, i.e. the pricing scenarios are applied to the networks of the reference scenario.
- *Combination scenario*. Scenario C1 is a combination of network scenario A1 and pricing scenario B2.
- *Rail freight scenario*. Scenario D1 assumes the development of a dedicated rail freight network in Europe.
- *TIPMAC scenarios*. Scenarios E1 and E2 represent combinations of network and pricing scenarios corresponding to the assumptions made in the TIPMAC project.

Table 1 presents a list of all scenarios, subdivided into these six categories:

Table 1. IASON scenarios

Scenario	Code
000 Reference scenario	
Reference scenario	000
A Network scenarios	
Implementation of all TEN priority projects (Essen list)	A1
Implementation of all high-speed rail priority projects (Essen list)	A21
Implementation of all conventional rail priority projects (Essen list)	A22
Implementation of all road priority projects (Essen list)	A23
Implementation of all rail priority projects (Essen list)	A24
Implementation of all TEN and TINA projects	A3
Implementation of all TEN projects	A4
Implementation of new priority projects	A51
Implementation of new priority rail projects	A52
Implementation of new priority road projects	A53
Scenario A3 plus implementation of additional projects in candidate countries	A61
Scenario A3 plus implementation of maximum projects in candidate countries	A62
B Pricing scenarios	
SMC pricing applied to road freight	B1
SMC pricing applied to all modes (travel and freight)	B2
C Combination scenario	
Scenario A1 plus Scenario B2	C1
D Rail freight scenario	
Dedicated rail freight network	D1
E TIPMAC scenarios	
TIPMAC business-as-usual scenario	E1
TIPMAC fast implementation scenario	E2

All scenarios rely on the European transport network database developed by the Institute of Spatial Planning of the University of Dortmund (IRPUD, 2001). The *strategic* road and rail networks used in IASON are subsets of this database, comprising the trans-European networks specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996), further specified in the *TEN Implementation Report* (European Commission, 1998) and latest revisions of the TEN guidelines by the European Commission (1999; 2002a), information on priority projects (European Commission, 1995), latest revisions of the priority projects (European Commission, 2002b; 2003; HLG, 2003, see Figure 1) and on the TINA networks as identified and further promoted by the TINA Secretariat (1999, 2002, see Figure 2) and 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 is based on the TEN and TINA airports and other important airports in the remaining countries and contains all flights between these airports (Bröcker *et al.*, 2002).

Figure 1. New priority projects

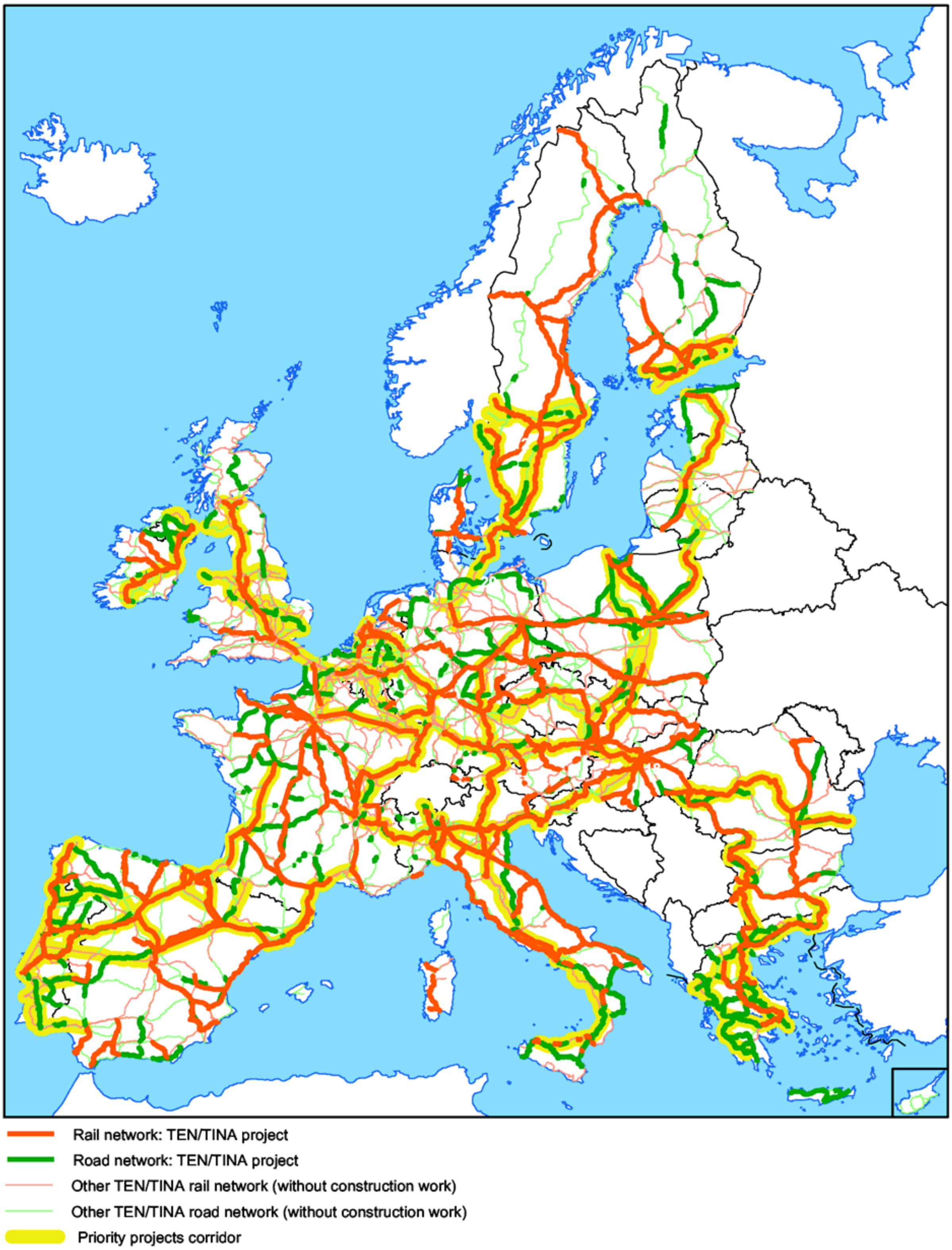


Figure 2. TEN and TINA rail and road projects

The network information is used to calculate travel times and travel costs between regions and regional accessibility for each year of the simulation. For that the historical and future development of the networks is required as input. The development of the networks over time is recorded in the database in five-year time steps, i.e. the network database contains information for the years 1981 (the historical base year of the SASI model), 1986, 1991, 1996, 2001, 2006, 2011, 2016 and 2021 (the envisaged completion year of all TEN and TINA projects). For the past, i.e. until 2001, the same network is used for all scenarios. The network scenarios differ in their assumptions about future network development, i.e. different network data for the years 2006, 2011, 2016 and 2021 are used for the different scenarios. The 2006 network data include all network changes supposed to be finished until the end of 2006, the 2011 network data all network changes supposed to be finished until the end of 2011, and so on. For the years between the five-year time steps, travel times and costs and accessibility indices are interpolated.

The type and expected year of completion of the projects were mainly taken from the *TEN Implementation Report* (European Commission, 1998) and the *TINA Status Report* (TINA Secretariat, 2002). Where no information was available in these two sources, supplementary information from national ministries or other national agencies was used. Most of the projects are composed of different sections with individual project types and completion years. The GIS network database reflects this by representing all projects by their individual sections, with specification of type of work and year of completion. Only in cases where such detailed information was not available, a common completion year for all sections of a project was assigned.

The reference scenario is the benchmark for comparing the results of the policy scenarios. For the period between 1981 and 2001, the reference scenario represents the actual development of the road, rail and air networks in Europe. For all future years the reference scenario preserves the state of the networks in the year 2001, i.e. no further network development after 2001 is foreseen. Thus, the reference scenario is not a realistic scenario but is used only as a benchmark for all other scenarios. All TEN or TINA projects that were already implemented by the end of 2001 are taken into account in this scenario, all other TEN or TINA projects are not considered.

The SASI Model

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 (TEN-T).

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. 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 the spatial development objectives of the European Union. Its application is restricted, however, in other respects: The model generates many distributive and only to a limited extent generative effects of transport cost reductions, and it does not produce regional welfare assessments fitting into the framework of cost-benefit analysis.

SASI model design

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 six forecasting submodels: *European Developments*, *Regional Accessibility*, *Regional GDP*, *Regional Employment*, *Regional Population* and *Regional Labour Force*. A seventh submodel calculates *Socio-Economic Indicators* with respect to efficiency and equity. Figure 3.1 visualises the interactions between these submodels.

The *spatial* dimension of the model is established by the subdivision of the European Union and the 12 candidate countries in eastern Europe in 1,321 regions and by connecting these by road, rail and air networks. For each region the model forecasts the development of accessibility and GDP per capita. 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 *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.

SASI scenarios

With the extended and re-calibrated SASI model, all 18 policy scenarios described in Section 2 were simulated. In addition, the do-nothing or base scenario 000 was simulated as reference or benchmark for comparing the policy scenarios. The reference scenario in SASI is defined as a fictitious development in which no transport infrastructure projects or other transport policies are implemented after 2001. All assumptions for the policy scenarios (e.g. with respect to fertility, mortality, migration, productivity and labour force participation) are identical to those for the reference scenario except the policies under investigation, so that all differences between the policy scenarios and the reference scenario can be attributed to the policies examined. All simulations start in the year 1981 and proceed in one-year time steps until the year 2021. All policy scenarios are equal to the reference scenario until the year 2001.

SASI results: accessibility

Accessibility is a core concept of the SASI model. The maps in Figures 3 and 4 show multimodal accessibility based on generalized costs for passengers and freight, respectively, used as explanatory variables in the regional production functions: the familiar pattern of the highly accessible European core with its peak in the Benelux countries, west and south-west Germany, Switzerland and northern Italy emerges, leaving the Nordic countries, northern England, Scotland and Ireland, Portugal and Spain, southern Italy and Greece as clearly peripheral in the present European Union. Of the accession countries in eastern Europe, the Czech Republic, Slovakia, Hungary and parts of Poland belong to the European core, whereas the Baltic states and Romania and Bulgaria (and of course the two island states Cyprus and Malta) remain peripheral.

Figures 5 to 8 show the changes in accessibility caused by the policies in selected policy scenarios (or more precisely, the difference between the accessibility in the policy scenario and the accessibility in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the accessibility in the policy scenario is higher), whereas blue indicates negative differences.

As to be expected, the network scenarios A1 and A3 improve accessibility everywhere but to a different degree and not equally in all parts of Europe. The 'classical' TEN priority projects of the Essen list (Scenario A1) aimed primarily at improving the accessibility of the peripheral regions in the Mediterranean and the Nordic countries (see Figure 5). Today, with the enlargement of the European Union, the task of better linking the accession countries in central and eastern Europe to the European core has become more important. If all network links designated as TEN and TINA (Scenario A3) are assumed to be implemented as in Scenario A3, the gains in accessibility are much larger and more evenly distributed over the European territory (see Figure 6).

Conversely, all pricing policy scenarios reduce accessibility because per-km costs are included in the generalised-cost function. It is important to note that in all pricing scenarios marginal social cost pricing is applied only to transport links in the present European Union. In the comprehensive pricing scenario B2, in which all modes and both travel and freight are subject to pricing, the effects are concentrated in the central regions which depend on business and leisure travel, whereas the candidate countries in eastern Europe are only little affected (see Figure 7). Figure 8 shows the combined effects of network scenario A1 and pricing scenario B2 (Scenario C1) on multimodal travel accessibility. Now the increased costs due to transport pricing are partly offset by the positive effects of the network improvements, for some Spanish regions the balance is positive. However, because more network improvements in Scenario A1 are located in peripheral regions, the core of Europe with the highest accessibility (see Figures 3 and 4) is now losing more in accessibility than many peripheral regions.

Table 2 shows for each policy scenario the percentage difference in accessibility between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). As accessibility indicator here the sum of two of the four accessibility indicators used in SASI was applied: accessibility rail/road/air (travel) and accessibility rail/road (freight).

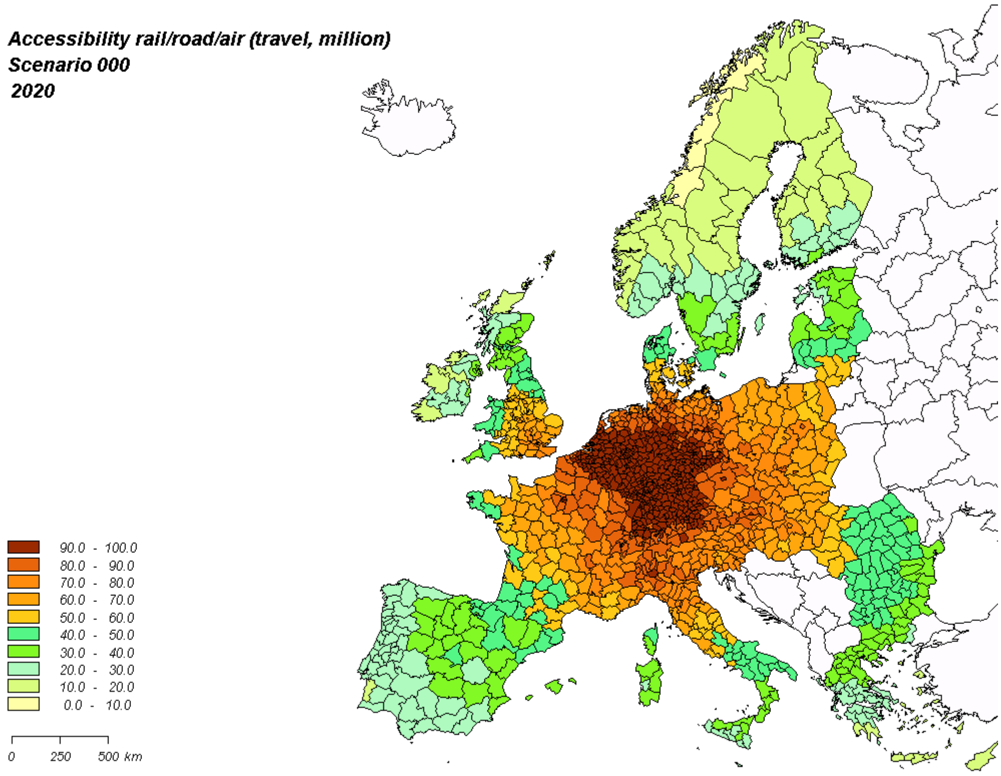


Figure 3. SASI results: reference scenario 000: accessibility rail/road/air (travel, million) in 2020

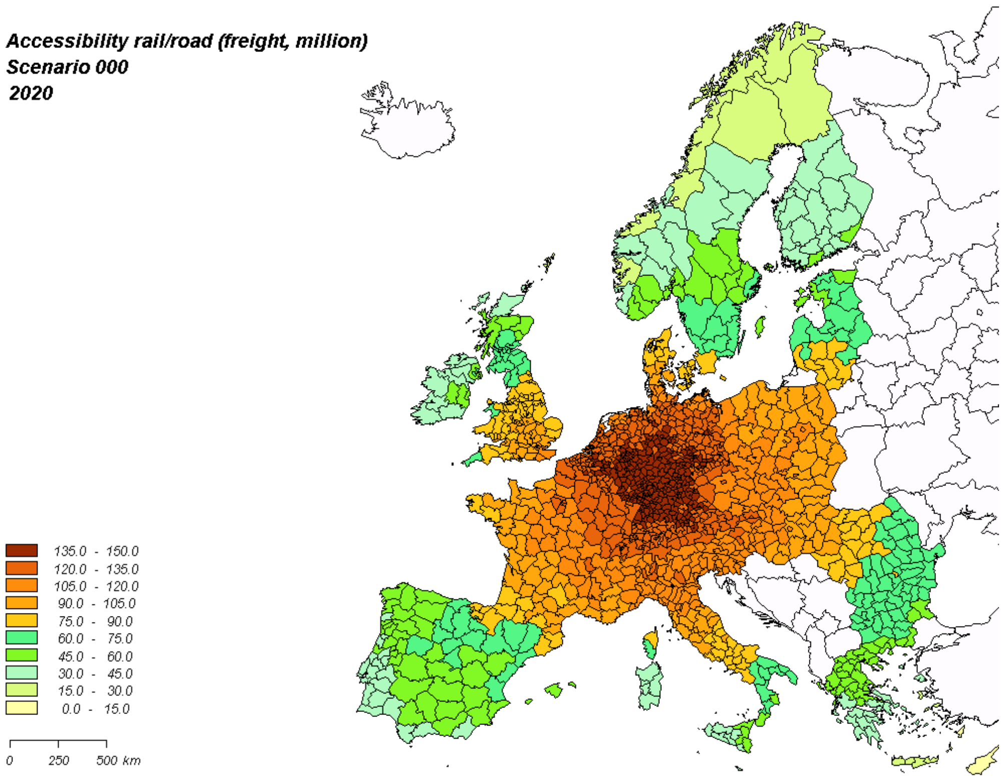


Figure 4. SASI results: reference scenario 000: accessibility rail/road (freight, million) in 2020

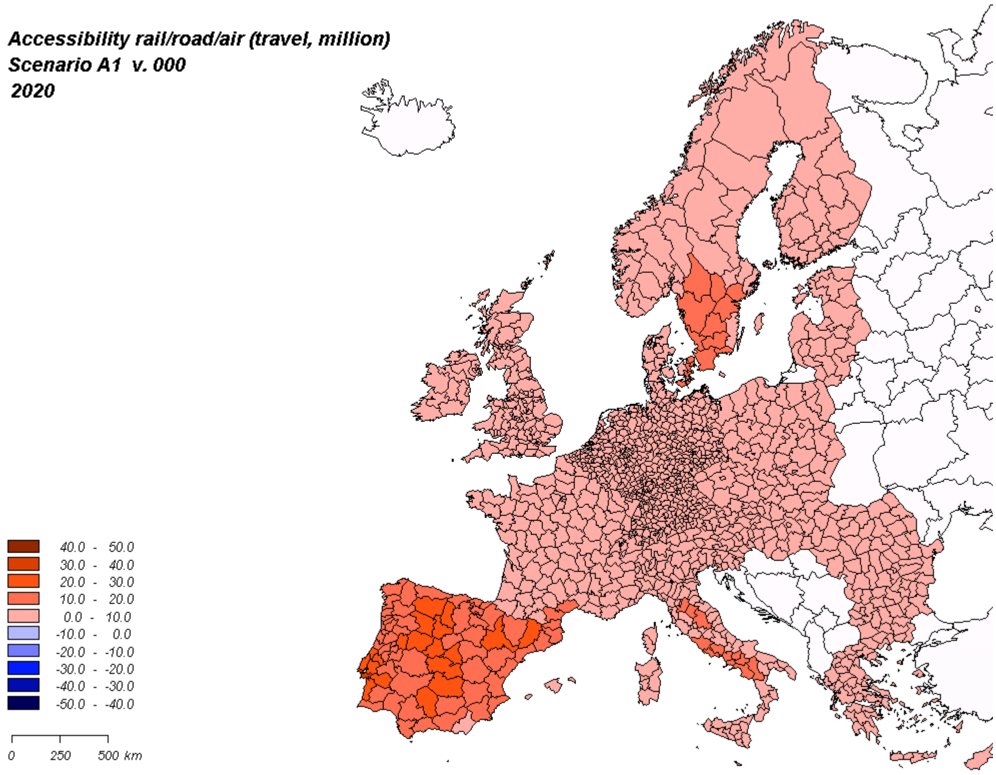


Figure 5. SASI results: percent change in accessibility rail/road/air (travel) by the original priority projects of the Essen list (Scenario A1)

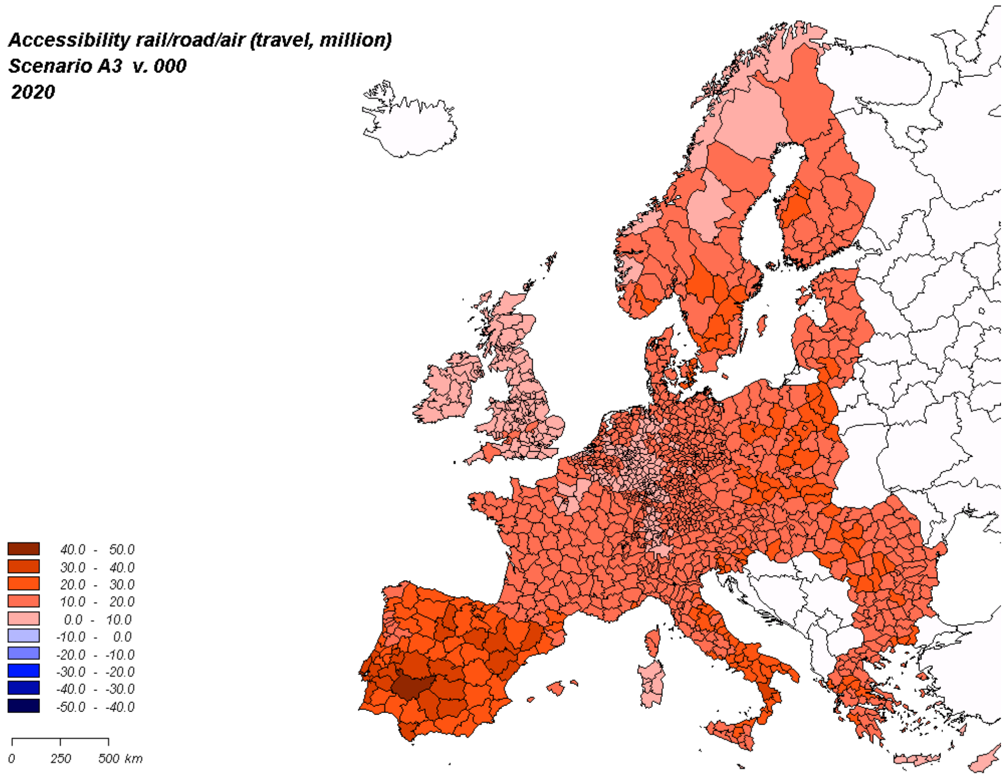


Figure 6. SASI results: percent change in accessibility rail/road/air (travel) by all TEN/TINA projects (Scenario A3)

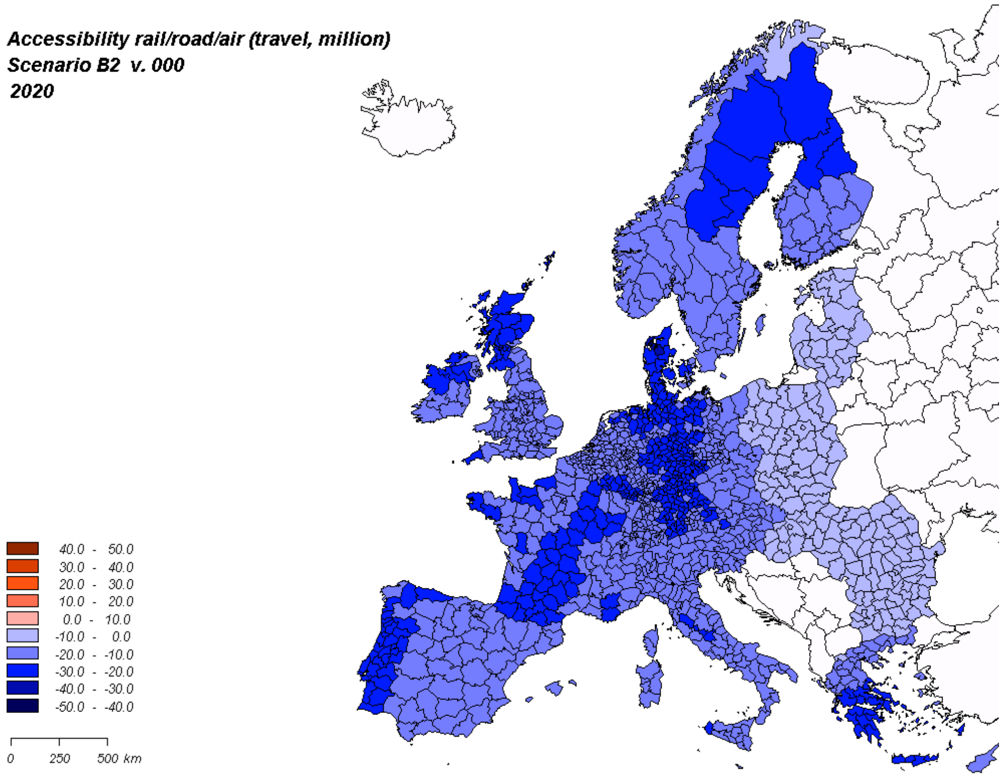


Figure 7. SASI results: percent change in accessibility rail/road/air (travel) by pricing of all modes (Scenario B2)

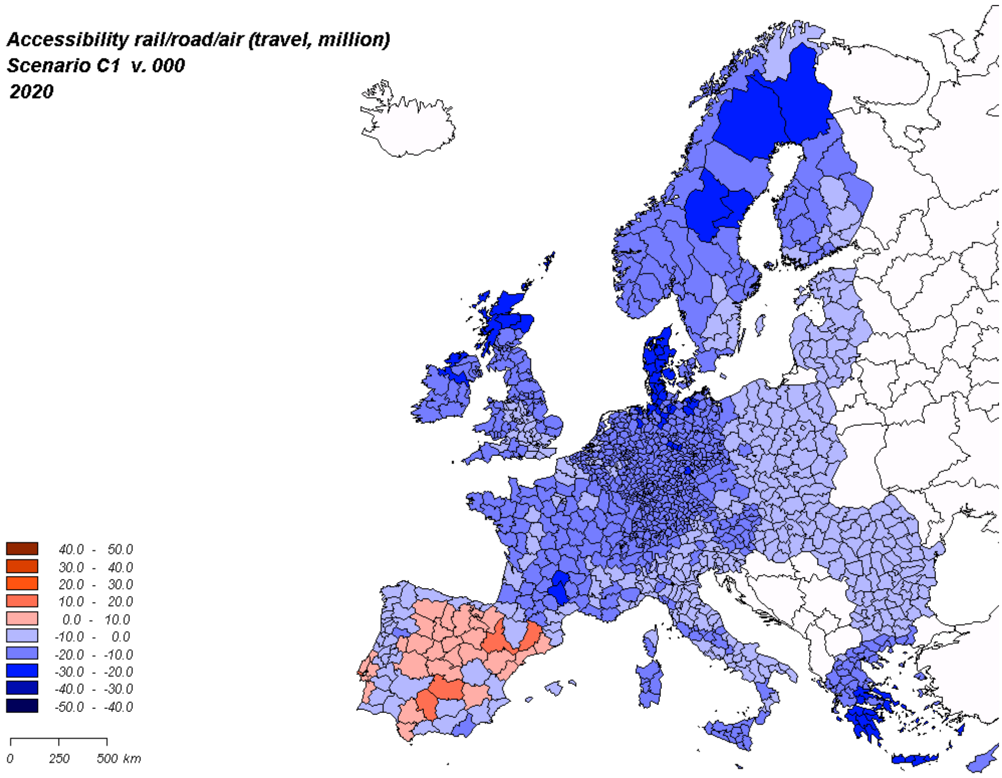


Figure 8. SASI results: percent change in accessibility rail/road/air (travel) by combination of Scenario A1 and B2 (Scenario C1)

Table 2. SASI results: accessibility

	Scenario	Accessibility difference between policy scenario and reference scenario in 2020 (%)			
		EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+6.42	+4.72	+2.48	+5.68
A21	High-speed rail priority projects	+5.50	+3.28	+2.20	+4.86
A22	Conventional rail priority projects	+0.82	+0.90	+0.18	+0.71
A23	Road priority projects	+0.32	+0.81	+0.15	+0.30
A24	Rail priority projects	+6.16	+4.05	+2.35	+5.43
A3	All TEN/TINA projects	+12.74	+11.09	+14.40	+12.99
A4	All TEN projects	+11.06	+9.61	+5.07	+9.96
A51	New priority projects	+8.20	+7.06	+5.78	+7.74
A52	New priority rail projects	+7.84	+6.37	+4.96	+7.29
A53	New priority road projects	+0.48	+0.92	+1.01	+0.59
A61	A3 + additional projects in CC12	+13.74	+11.80	+17.18	+14.30
A62	A3 + maximum projects in CC12	+14.93	+12.73	+22.96	+16.30
B1	SMC pricing road freight	–4.44	–4.90	–5.65	–4.67
B2	SMC pricing all modes travel/freight	–13.37	–13.01	–9.46	–12.67
C1	A1+B2	–6.55	–8.24	–6.68	–6.61
D1	Dedicated rail freight network	+18.78	+17.95	+12.42	+17.63
E1	TIPMAC business-as-usual scenario	+12.55	+10.56	+14.32	+12.82
E2	TIPMAC fast TEN + SMC	+4.75	+1.59	+11.58	+5.89

As it was already observed, all network scenarios have a positive effect on accessibility. The degree of improvement, obviously, is a function of the number of projects and the volume of investment. The high-speed rail priority projects are much more effective than the conventional rail projects, and the rail projects are much more effective than the road improvement projects, but this may be caused by the greater number of high-speed rail and rail projects in the two priority lists. Not surprisingly, if all TEN and TINA projects are implemented, the effects are more substantial, and if even more projects are implemented as in Scenarios 61 and 62, the effects are even larger. Remarkably, the largest accessibility effect is achieved by the dedicated rail freight network of Scenario D1, presumably because of the general technical improvement of the rail network assumed in Scenario D1.

Transport pricing policies, on the other hand, reduce accessibility. Again not surprisingly, the more profound effect occurs if all modes and both travel and goods transport are subjected to pricing as in Scenario B2. If both network and pricing scenarios are combined as in Scenario C1, the outcome depends on the pricing level – in Scenario C1 the negative impacts of the pricing outweigh the positive impacts of the network improvements.

The accessibility of the candidate countries as a whole is not much less than in the present European Union as a whole. However, there remain large differences in accessibility both in the European Union and among the candidate countries. The effects of the network scenarios are stronger in the candidate countries, whereas the pricing scenarios more strongly affect the member states of the present European Union. This effect will be discussed again in the section on cohesion effects.

SASI results: GDP per capita

The major policy-relevant output of the SASI model is regional GDP per capita, i.e. GDP totalled over all six sectors used in SASI divided by population.

Figures 9 to 12 show the changes in GDP per capita caused by the policies in the same set of policies as shown in Figures 4-7 (or more precisely, the difference between GDP per capita in the policy scenario and GDP per capita in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the GDP per capita in the policy scenario is higher), whereas blue indicates negative differences. However, in contrast to the accessibility maps, now the regional GDP per capita are standardised as percent of the EU27+2 average, so that the generative effects of the GDP forecasts are neutralised and only the distributional effects are shown. This serves to demonstrate that even if the model predicts that all regions gain in GDP per capita, there are relative winners and losers.

Figures 9 and 10 demonstrate that regions that gain in accessibility also gain in GDP per capita. A comparison of Figure 9 with Figure 5 shows that if the 'classical' TEN priority projects of the Essen list are implemented as in Scenario A1, the network improvements in the cohesion countries Portugal, Spain and Italy are successful in promoting economic development in these countries as intended. Figure 10 shows that, as in Figure 6, the implementation of all TEN and TINA projects would spread the impacts over a wider area including the candidate countries in eastern Europe.

Similar observations, but with the opposite sign, can be made with respect to the impacts of transport pricing policies. Figure 11 shows the effects of pricing of all modes for both travel and goods transport (Scenario B2). In the more comprehensive pricing scheme of Scenario B2 the peripheral regions seem to be the (relative) winners, because the central regions suffer more under the high charges on travel. If network scenario A1 and pricing scenario B2 are combined as in Scenario C1, the results is, as to be expected, a superposition of the effects of both policies (see Figure 12). A comparison with the accessibility map of Scenario C1 (Figure 8) shows that regions with high losses in accessibility also lose GDP per capita and that regions with gains or only slight losses in accessibility perform well economically.

Table 3 summarises the GDP per capita effects of all simulated policy scenarios. It shows for each policy scenario the percentage difference in GDP per capita between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). GDP per capita shown is the total of GDP of the six sectors used in SASI divided by population, unstandardised. In this unstandardised form, all network scenarios have a positive effect on GDP per capita. As with accessibility, the largest effects are associated with the more comprehensive investment programmes: all TEN projects (Scenario A1), all TEN and TINA projects (Scenario A3) and the larger version of the additional projects in CC12 (Scenario A62). Also in economic terms, high-speed rail is more effective than conventional rail, and rail is more effective than road – but again with the caveat that this result may be due to the larger proportion of rail, and in particular high-speed rail, projects among the projects of the two priority lists. In economic terms, the dedicated rail network is not so successful as its accessibility effect might suggest.

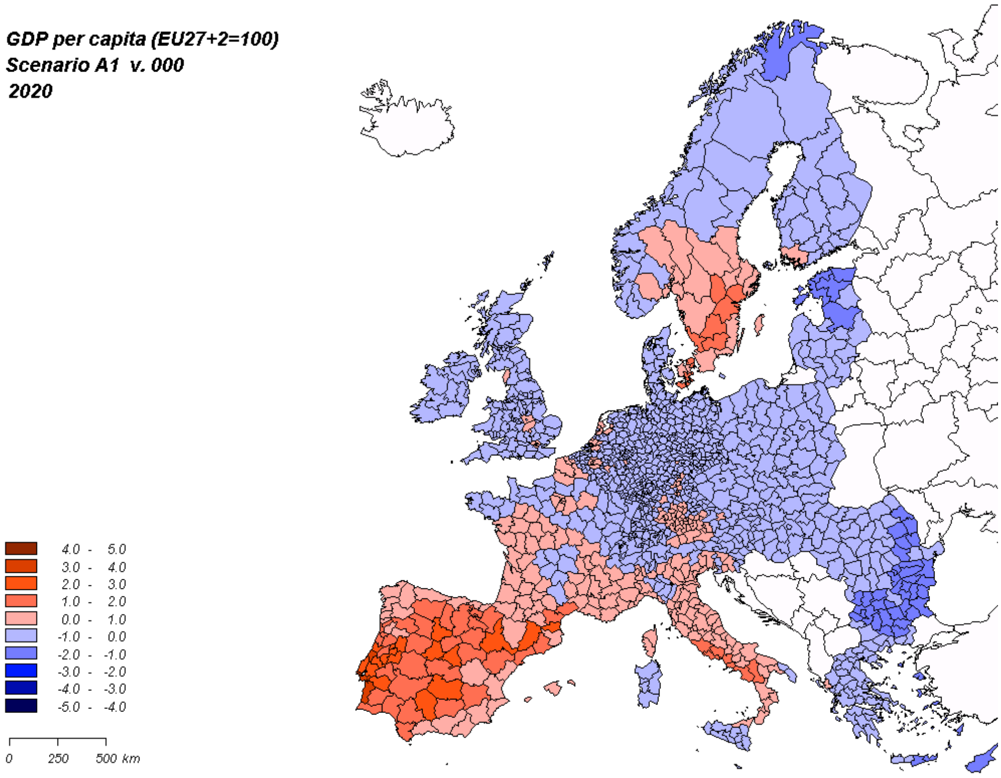


Figure 9. SASI results: percent change in GDP per capita (E27+2=100) by TEN priority projects (Scenario A1)

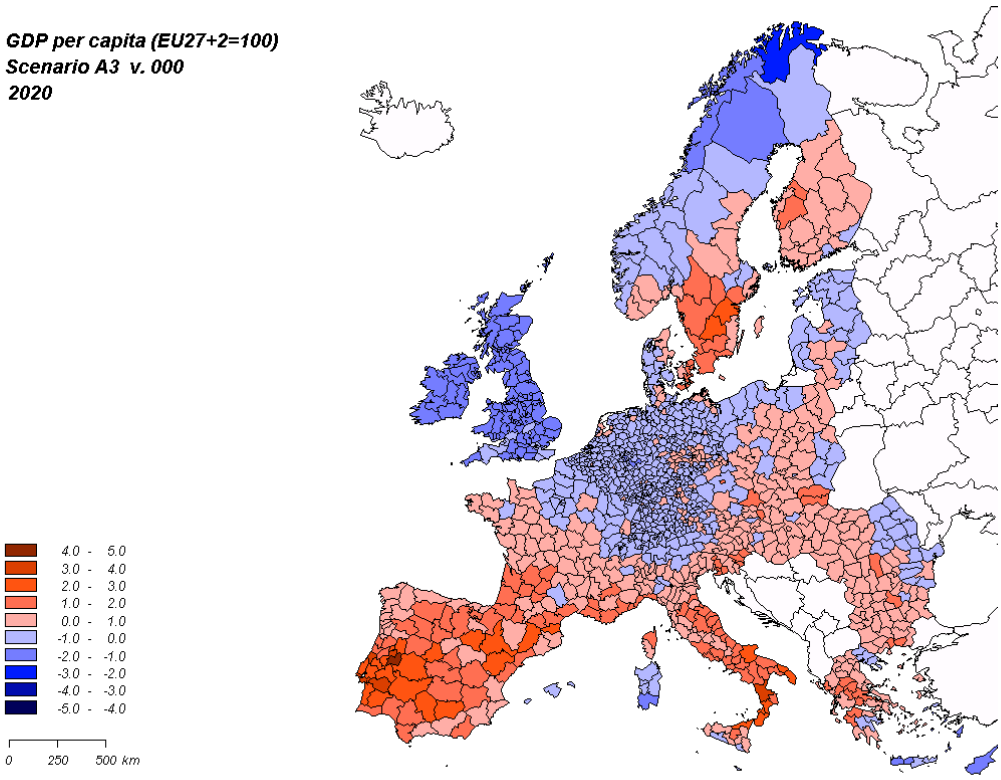


Figure 10. SASI results: percent change in GDP per capita (E27+2=100) by all TEN/TINA projects (Scenario A3)

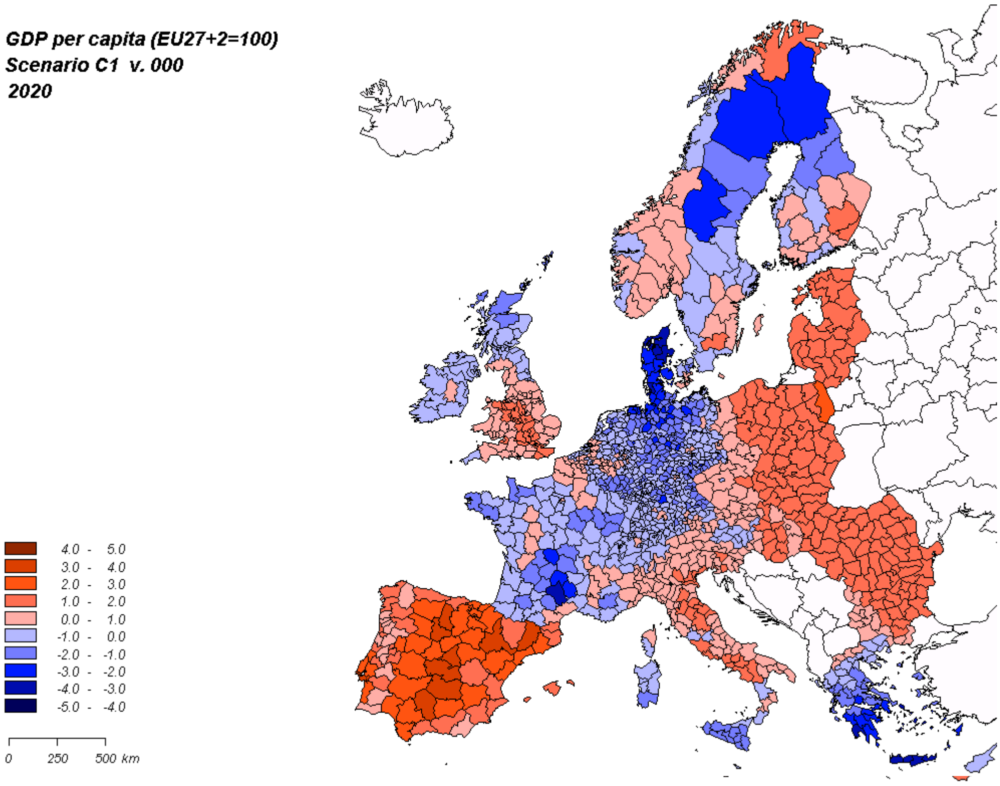
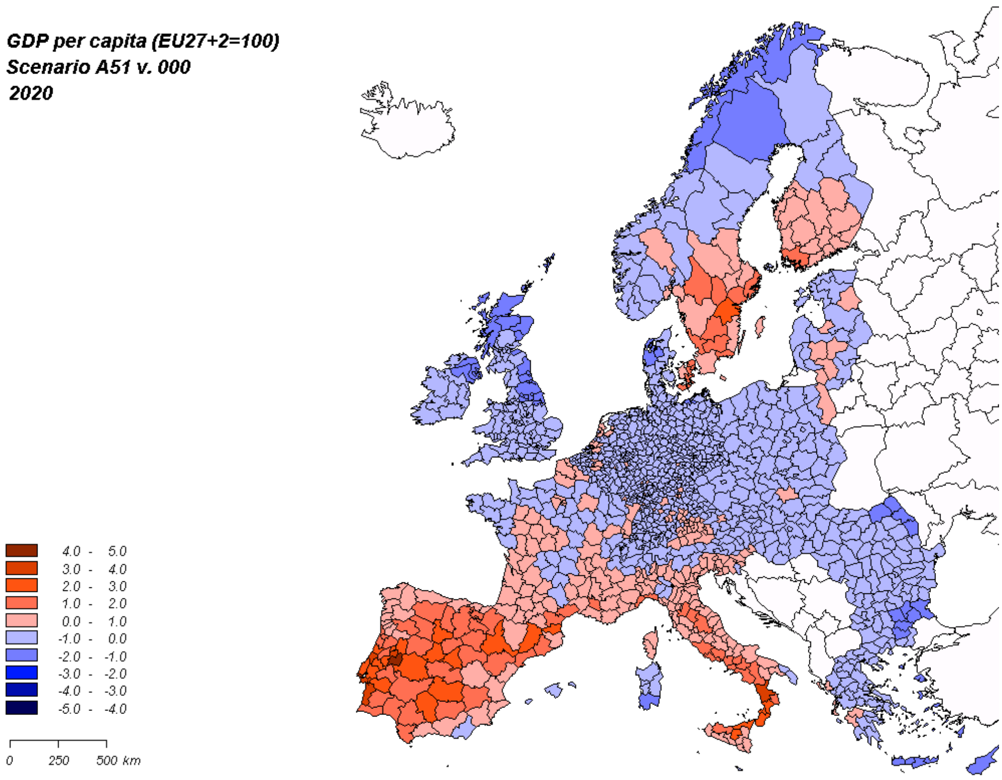


Figure 11. SASI results: percent change in GDP per capita (E27+2=100)



by pricing of all modes (Scenario B2)

Figure 12. SASI: percent change in GDP per capita (E27+2=100) by combination of scenarios A1+B2 (Scenario C1)

Table 3. SASI results: GDP per capita

Scenario		GDP per capita difference between policy scenario and reference scenario in 2020 (%)			
		EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+1.25	+0.88	+0.32	+1.19
A21	High-speed rail priority projects	+1.07	+0.55	+0.28	+1.01
A22	Other rail priority projects	+0.14	+0.20	+0.01	+0.13
A23	Road priority projects	+0.09	+0.18	+0.03	+0.09
A24	Rail priority projects	+1.17	+0.74	+0.30	+1.11
A3	All TEN/TINA projects	+2.59	+2.14	+2.90	+2.58
A4	All TEN projects	+2.19	+1.84	+0.78	+2.11
A51	New priority projects	+1.62	+1.31	+1.02	+1.58
A52	New priority rail projects	+1.54	+1.17	+0.86	+1.49
A53	New priority road projects	+0.12	+0.20	+0.21	+0.13
A61	A3 + additional projects in CC12	+2.84	+2.30	+3.70	+2.85
A62	A3 + maximum projects in CC12	+3.10	+2.48	+5.16	+3.16
B1	SMC pricing road freight	–0.10	–0.16	–0.19	–0.11
B2	SMC pricing all modes travel/freight	–3.84	–3.38	–1.62	–3.72
C1	A1+B2	–2.38	–2.47	–1.23	–2.33
D1	Dedicated rail freight network	+1.71	+1.61	+1.06	+1.68
E1	TIPMAC business-as-usual scenario	+2.54	+2.03	+2.89	+2.52
E2	TIPMAC fast TEN + SMC	+0.33	–0.84	+2.20	+0.35

Transport pricing policies reduce not only accessibility but also GDP per capita. Remarkably, pricing of only freight transport on roads (Scenario B1), has only little economic effect despite its significant negative effect on accessibility (see Table 3). However, if all modes and both travel and goods transport are subjected to pricing as in Scenario B2, the negative effect is very strong and is in fact the strongest effect of all scenarios whether positive or negative. If both network and pricing scenarios are combined as in Scenario C1, the negative effect of pricing by far outweighs the positive impact of the network improvements.

SASI results: cohesion

Strengthening cohesion between the regions in the European Union and reducing the economic and social disparities between them is one of the main goals of the European Union. Transport policy is one of the major policy instruments of the European Union to serve this goal in conjunction with the goal to increase the economic competitiveness of regions. With the enlargement of the European Union and the accession of ten of the twelve candidate countries, cohesion issues become of growing importance.

There are many possible ways to measure the cohesion effects of transport policy measures. Five indicators of territorial cohesion were applied to the results of the scenario simulations. The five indicators are:

- *Coefficient of variation*. This indicator is the standard deviation of regional indicator values expressed in percent of their European average. The coefficient of variation ranges between zero (no variation) and one (extreme polarisation).

- *Gini coefficient*. The Gini coefficient measures the area between the accumulated distribution of sorted indicator values and the straight line representing an equal distribution. Like the coefficient of variation, the Gini coefficient ranges between zero (equal distribution) and one (extreme polarisation).

- *Geometric/arithmetic mean*. This indicator compares two methods of averaging among observations: geometric (multiplicative) and arithmetic (additive) averaging. If all observations are equal, the geometric and arithmetic mean are identical, i.e. their ratio is one. If the observations are very heterogeneous, the geometric mean and hence the ratio between the geometric and the arithmetic mean go towards zero.

- *Correlation between relative change and level*. This indicator examines the relationship between the percentage change of an indicator and its magnitude by calculating the correlation coefficient between them. If for instance the correlation between the changes in GDP per capita of the region and the levels of GDP per capita in the regions is positive, the more affluent regions gain more than the poorer regions and disparities in income are increased. If the correlation is negative, the poorer regions gain more than the rich regions and disparities decrease.

- *Correlation between absolute change and level*. This indicator is constructed as the previous one except that absolute changes are considered.

Tables 4 and 5 summarise the information gained from the five cohesion indicators for accessibility and GDP per capita. The two tables show that with respect to accessibility, almost all policy examined contribute to cohesion, except the two pricing scenarios B1 and B2 – if one applies one of the first four indicators, coefficient of variation, Gini coefficient, geometric/arithmetic mean or relative correlation. However, if one consults also the fifth indicator, absolute correlation, the picture is more complex as more often than not the sign of the indicator is reversed. In terms of GDP per capita, the choice of indicator is even more critical as now even the relative correlation indicator signals polarisation where the coefficient of variation and the Gini coefficient signal cohesion.

It is therefore not easy to assess whether a transport policy supports economic cohesion. Of the policy scenarios examined here, most network scenarios are pro-cohesion except the two road-only scenarios. The scenario assuming road pricing for lorries (Scenario B1) is clearly anti-cohesion, whereas the comprehensive transport pricing scenario B2 is strongly pro-cohesion. However, it is not clear whether these effects are caused by the fact that the two pricing schemes were only applied to the present European Union.

The lesson to be learned from this exercise is that the choice of cohesion indicator is critical in assessing the socio-economic impacts of transport policies and that classifications relying on only one indicator should be avoided.

Table 4. SASI results: accessibility cohesion effects

	Scenario	Accessibility cohesion effects (+/–)				
		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	+	++	+	–
A21	High-speed rail priority projects	+	+	+	+	–
A22	Conventional rail priority projects	+	+	+	+	+
A23	Road priority projects	+	+	+	+	+
A24	Rail priority projects	+	+	+	+	–
A3	All TEN/TINA projects	++	++	++	++	–
A4	All TEN projects	+	+	++	++	–
A51	New priority projects	+	+	++	++	–
A52	New priority rail projects	+	+	++	+	–
A53	New priority road projects	+	+	+	+	+
A61	A3 + additional projects in CC12	++	++	++	++	–
A62	A3 + additional projects in CC12	++	++	++	++	–
B1	SMC pricing road freight	–	–	–	—	++
B2	SMC pricing all modes travel/freight	–	–	–	–	++
C1	A1+B2	+	+	+	+	++
D1	Dedicated rail freight network	++	++	++	++	–
E1	TIPMAC business-as-usual scenario	++	++	++	++	—
E2	TIPMAC fast TEN + SMC	+	++	++	+	+

Table 5. SASI results: GDP per capita cohesion effects

	Scenario	GDP per capita cohesion effects (+/–)				
		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	+	·	–	—
A21	High-speed rail priority projects	+	+	·	–	—
A22	Conventional rail priority projects	+	+	·	–	–
A23	Road priority projects	–	–	·	–	–
A24	Rail priority projects	+	+	·	–	—
A3	All TEN/TINA projects	+	+	·	+	—
A4	All TEN projects	+	+	–	–	—
A51	New priority projects	+	+	·	–	—
A52	New priority rail projects	+	+	·	–	—
A53	New TEN priority road projects	–	–	·	+	–
A61	A3 + additional projects in CC12	+	+	+	+	—
A62	A3 + additional projects in CC12	+	+	+	+	—
B1	SMC pricing road freight	–	–	·	—	++
B2	SMC pricing all modes travel/freight	+	+	+	++	++
C1	A1+B2	+	+	+	+	++
D1	Dedicated rail freight network	+	+	·	–	—
E1	TIPMAC business-as-usual scenario	+	+	·	+	—
E2	TIPMAC fast TEN + SMC	+	+	+	++	+

+/++	Weak/strong cohesion effect: disparities reduced	CoV	Coefficient of variation (%)
–/—	Weak/strong anti-cohesion effect: disparities increased	Gini	Gini coefficient (%)
·	Little or no cohesion effect	G/A	Geometric/arithmetic mean
		RC	Correlation relative change v. level
		AC	Correlation absolute change v. level

The CGEurope Model

CGEurope comes in two versions, one with a single aggregated sector for tradable goods (plus a non-tradable sector), and another with sectoral disaggregation. The first is called CGEuropeI, the second CGEuropeII. CGEuropeI was developed already before the IASON project. It was extended in IASON to deal with multimodal transport and cost of business travel beyond cost of freight, adapted to a more detailed system of regions and calibrated with new data. CGEuropeII was newly developed in IASON. It is multisectoral with an arbitrary number of sectors. Data availability, knowledge about non-calibrated parameters (elasticities) and computational capacity restrict the sectoral detail that can be handled in practice if the number of regions is large as in IASON. The cost data used were produced by the SASI model based on the multimodal transport networks and cost parameters of SCENES

The strength of the multisector version is to generate more detailed results. In particular, the impact of transport initiatives on the sectoral structure of regions can be quantified by the multisectoral version. Another strength is that the multisectoral model takes into account that regions may be affected differently by a transport initiative not only because of their respective locations, but also because of different sectoral structures. These advantages are not without a cost, however. For calibrating the model, much more information is needed. For the IASON study area it was impossible to calibrate the model at the NUTS-3 level. Only NUTS-2 and a high sectoral aggregation level (3 sectors) is available by now.

CGEuropeI model design

CGEuropeI is a static general equilibrium model for a closed system of regions covering the whole world, consisting of the IASON regions plus one region representing the rest of world. In each region reside identical immobile households owning the regional stock of production factors that are immobile as well. Their incomes stem from regional factor returns as well as from an interregional income transfer that can have a positive or negative sign. Income transfers are exogenous (in real terms) and add up to zero for the entire world. They are negligible with regard to quantitative results, but needed for keeping budget constraints closed. Households spend their income for buying goods and services partly produced in their own regions and partly produced in other regions. Households' demand represents total final demand, i.e. private as well as public consumption and investment. There is no separate public sector in the model; that is households have to be regarded as an aggregate of private and public households, their budget constraint is the consolidated budget constraint of private and public households in the region.

Households are price takers on all markets. They maximise a Cobb-Douglas utility depending on the quantity of local goods and the quantity of an index of diversified tradable goods. Hence, they spend fixed shares of their income for local and tradable goods, respectively. Utility changes of households, measured in monetary terms by Hicks' equivalent variation concept, are our measure of regional welfare effects of transport initiatives.

The production sector is represented by firms, whose technologies are identical up to a region-specific productivity scaler. There are two types of firms: firms producing local goods and firms producing tradable product varieties. There is no further sectoral differentiation. Local goods are produced under constant returns to scale and, as the name says, can only be used within the region itself. Tradable goods, however, are produced by a 'Dixit-Stiglitz-Industry' under monopolistic competition and increasing returns to scale.

Analogous to household consumption, firms use tradable goods as a composite index that is composed of all variants produced anywhere in the world. The same index is used for final demand as for intermediate inputs. As usual, varieties are composed by a symmetrical CES-index, with elasticity of substitution between varieties greater than one.

The decisive assumption for the issue under study in this project is that there are transaction costs for goods delivered between regions. Transaction costs have two components, one depending on costs of transportation and business travel, and another representing the extra cost of international trade.

The latter cost component is not measured directly, but drops out from the calibration procedure. One cost component per pair of countries is calibrated such that international trade flows generated in the models' equilibrium are equal to observed trade flows for each pair of countries. It is well documented in the literature that cross-border transactions are much smaller than transactions within a country, everything else being equal. This is due to a wide range of barriers to interaction ranging from institutional differences, different languages and cultural barriers to obvious costs like time costs for border controls outside the Schengen area or tariffs, quotas et cetera outside the EU. Omitting this cost component would lead to a severe overestimation of cross border flows and hence to a bias in project evaluation in favour of cross border links.

Introducing this international impediment is also essential for the calibration of the model for 2020. The situation in 2020 is supposed to differ from the benchmark year 1997 in four respects: (1) the infrastructure will be extended and improved, as described by the infrastructure scenarios; (2) GDP per capita will be larger everywhere due to a general growth trend; (3) there will be a catch-up of EU countries – in particular present candidate countries – that are now poor in comparison to the EU average; (4) integration will be deepened. In particular the present candidates will enjoy a level of integration with the other members comparable to the present degree of integration within the EU. The latter development will be simulated in our predictions by reducing the estimated impediments among candidate countries as well as those between candidate countries and the present EU down to the level now prevailing among present EU members.

The other component of transaction costs depending on costs for freight and business travel represents the channel through which transport initiatives lead to a change of prices and quantities in the economy. Eventually, these changes affect the households' utilities, which – translated into monetary equivalents – are our ultimate welfare measure.

CGEuropeII model design

CGEuropeII has the basic features in common with CGEuropeI: it is a multiregional computable general equilibrium model with households in each region representing final demand and firms representing the production sector. There is a fixed amount of a single primary factor of production in each region, owned by the households of the respective region. There is no public sector, and no monetary system. What distinguishes the two versions is that in CGEuropeII the simplifying distinction between tradables and locals is abandoned. Instead, the model allows for subdividing the economy into an arbitrary number of sectors, each of which may have its own characteristics with regard to its respective degree of localness or of tradability of its output. The current data set allows for a subdivision into six sectors, but with restrictions regarding regional subdivision. Results presented in this report are for a three sectors subdivision. There would be little extra insight by going from three to six sectors, because the disaggregation would be in the service sector; anyway there is little information about trade in this sector and parameterisation of the model for a disaggregated service sector introduces a lot of arbitrariness.

CGEuropeI allows only for two polar cases regarding market structure: the tradables sector is characterized by monopolistic competition à la Dixit-Stiglitz, while the local sector is perfectly competitive with constant returns to scale. As we remove the polarity of the two extreme cases, tradables and non-tradables, in favour of sectors that can have varying degrees of tradability, it is also desirable to remove the polarity of two market forms, Dixit-Stiglitz competition and perfect competition. Instead we admit sector specific degrees of perfect versus monopolistic competition. An extra sector specific parameter varying between zero and one controls the position of the market between the two extremes. This larger flexibility of the model design has its cost, however; we must introduce so-called Armington preferences for obtaining a realistic picture, as to how prices, production and trade flows respond to changing transportation cost. Armington preferences mean that customers of goods have preferences, distinguishing goods with regard to regions of origin. In particular, it is allowed that customers prefer locally produced goods to imported ones, or domestic to foreign suppliers to a certain degree.

Beyond the multisectoral design, another distinctive feature of CGEuropeII is the incorporation of private passenger travel in final demand. Like demand for goods, demand for travel is derived from utility maximization, taking out-of-pocket costs for travel as well a disutility due to time spent for travel into account. A technically detailed description of CGEuropeII is given in Deliverable 2, pp. 36-41. As the design has been slightly modified during implementation, and also to make this report self-contained, we briefly present the formal structure of the model in chapter 4.3.2.

CGEurope results

Table 6 shows aggregate welfare effects for 1997 for EU15, EU27 and the accession countries (CC12), i.e. the change in welfare for the respective group of countries in monetary terms as a percentage of GDP. The results for 2020 are very similar.

Table 6. CGEuropeI model results for 1997, welfare effects in percent of GDP

	A1	A21	A22	A23	A24	A3
EU27	0.109	0.068	0.015	0.029	0.082	0.251
EU15	0.111	0.070	0.015	0.030	0.084	0.242
CC12	0.047	0.030	0.003	0.014	0.034	0.456

	A4	A51	A52	A53	A61	A62
EU27	0.222	0.143	0.108	0.041	0.258	0.273
EU15	0.227	0.143	0.110	0.039	0.253	0.261
CC12	0.109	0.147	0.073	0.081	0.385	0.550

	B1	B2	C	D	E1	E2
EU27	-0.275	-1.069	-0.902	0.248	0.233	-0.223
EU15	-0.275	-1.094	-0.923	0.251	0.224	-0.246
CC12	-0.280	-0.502	-0.430	0.182	0.445	0.307

The aggregate welfare effects given in this table are just the sum of regional welfare effects, so that there is no inequality correction. This means that one € counts one €, irrespective of whether it is gained in a rich or in a poor region. Another question is therefore, to which extent welfare measures of traditional CBA have to be corrected when spatial distribution is taken into account. We introduce an aggregated welfare measure correcting for the spatial distribution effect. If the welfare gain is less (bigger) *without* than *with* an equality correction, then the respective initiative is equality enhancing (reducing). It turns out, however, that the quantitative impact of the initiatives on spatial distribution is in almost any case of minor importance, as compared to the level effect when measured without inequality correction. In fact, correcting the aggregated monetary welfare measure for equality gains (increasing welfare) or equality losses (reducing welfare) modifies the quantitative results only slightly, even if a strong inequality aversion is assumed. This shows that the traditional CBA approach to aggregate surpluses without taking distributional aspects into account, is well justified, as long as inequalities in the benchmark situation are not extremly strong.

The question whether a scenario leads to convergence or divergence between rich and poor regions may depend on the specific inequality indicator used. Indicators that measure relative differences between regions (like the Gini coefficient) classify a policy as pro-cohesion if less developed regions grow faster in *relative* terms than more affluent regions. Measured in *absolute* terms, however, such a policy may still widen the gap between rich and poor regions. Table 7 and 8 give an overview about the cohesion effects of the actual scenarios, according to different equality indicators.

Table 7. CGEurope Model: Welfare Cohesion Effects for 1997

		Welfare cohesion effects (+/–)				
Scenario		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	-	-	-	–
A21	High-speed rail priority projects	+	-	-	-	–
A22	Conventional rail priority projects	+	·	-	-	-
A23	Road priority projects	+	-	+	+	-
A24	Rail priority projects	+	-	-	-	–
A3	All TEN/TINA projects	+	+	++	++	–
A4	All TEN projects	+	+	+	+	–
A51	New priority projects	+	+	+	++	–
A52	New priority rail projects	+	-	+	+	–
A53	New priority road projects	+	+	+	+	-
A61	A3 + additional projects in CC12	+	+	++	++	–
A62	A3 + additional projects in CC12	+	+	++	++	–
B1	SMC pricing road freight	-	-	–	—	++
B2	SMC pricing all modes travel/freight	-	-	+	+	++
C1	A1+B2	-	-	+	+	++
D1	Dedicated rail freight network	+	·	-	-	–
E1	TIPMAC business-as-usual scenario	+	+	++	++	–
E2	TIPMAC fast TEN + SMC	+	+	++	++	++

Table 8. CGEurope Model: Welfare Cohesion Effects for 2020

		welfare cohesion effects (+/–)				
Scenario		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	-	·	+	–
A21	High-speed rail priority projects	+	-	·	+	–
A22	Conventional rail priority projects	+	·	·	+	–
A23	Road priority projects	+	+	·	–	–
A24	Rail priority projects	+	-	·	+	–
A3	All TEN/TINA projects	+	+	+	++	–
A4	All TEN projects	+	+	+	+	–
A51	New priority projects	+	+	+	+	–
A52	New priority rail projects	+	+	+	+	–
A53	New TEN priority road projects	+	+	+	+	–
A61	A3 + additional projects in CC12	+	+	+	+	–
A62	A3 + additional projects in CC12	+	+	+	+	–
B1	SMC pricing road freight	-	-	-	+	++
B2	SMC pricing all modes travel/freight	-	-	+	++	++
C1	A1+B2	-	-	+	+	++
D1	Dedicated rail freight network	+	+	+	+	–
E1	TIPMAC business-as-usual scenario	+	+	+	+	–
E2	TIPMAC fast TEN + SMC	+	+	+	++	++

+/++	Weak/strong cohesion effect: disparities reduced	CoV	Coefficient of variation (%)
–/—	Weak/strong anti-cohesion effect: disparities increased	Gini	Gini coefficient (%)
·	Little or no cohesion effect	G/A	Geometric/arithmetic mean
		RC	Correlation relative change v. level
		AC	Correlation absolute change v. level

Figure 13 shows aggregate welfare effects of CGEuropeI for Scenario A1. This scenario covers the projects of the Essen list, which are all located in the EU15 area; hence the impact is mainly visible in EU15 countries, even though there are also some smaller gains in the accession countries due to their interaction with E15 countries. The welfare gain amounts to around one tenth of one percent of GDP per annum. Taking the EU15 impact only, this amounts to about 9.3 billion Euro for the year 2000. Given the estimated investment cost of 235 billion Euro, the rate of return would be roughly 4 %. Note that this is exclusive of private passenger travel. A look at the map shows the shadows of individual projects. Some of them have a strong impact such as the Nordic triangle plus the Øresund and Fehmarnbelt fixed links, the projects on the Iberian peninsula, the Irish road and rail projects, the road link and West cost main line in Britain and the Greek motorways. In some cases gains generated by a certain link spread over a large area in the prolongation of the respective link. Cases in point are the Italian West coast south of Naples plus Sicily participating in the gains from the North-South high-speed train, the French West coast participating in the gains from the multimodal link Portugal-Spain-Central Europe or north-east Germany and north-west Poland participating from the gains at the Northern end of the North-South high speed train.

Figure 14 shows the effects of Scenario A3, the scenario containing projects that cover more or less the whole area of EU27 except Switzerland. Most regions are positively affected. Only a few gain almost nothing like Paris, East-England and some central regions in Germany and agglomerations in Italy. Accession countries gain almost the double of what EU15 countries gain, in relative terms. Note, however, that in per capita terms gains are still smaller in accession countries because of the lower level of per capita GDP.

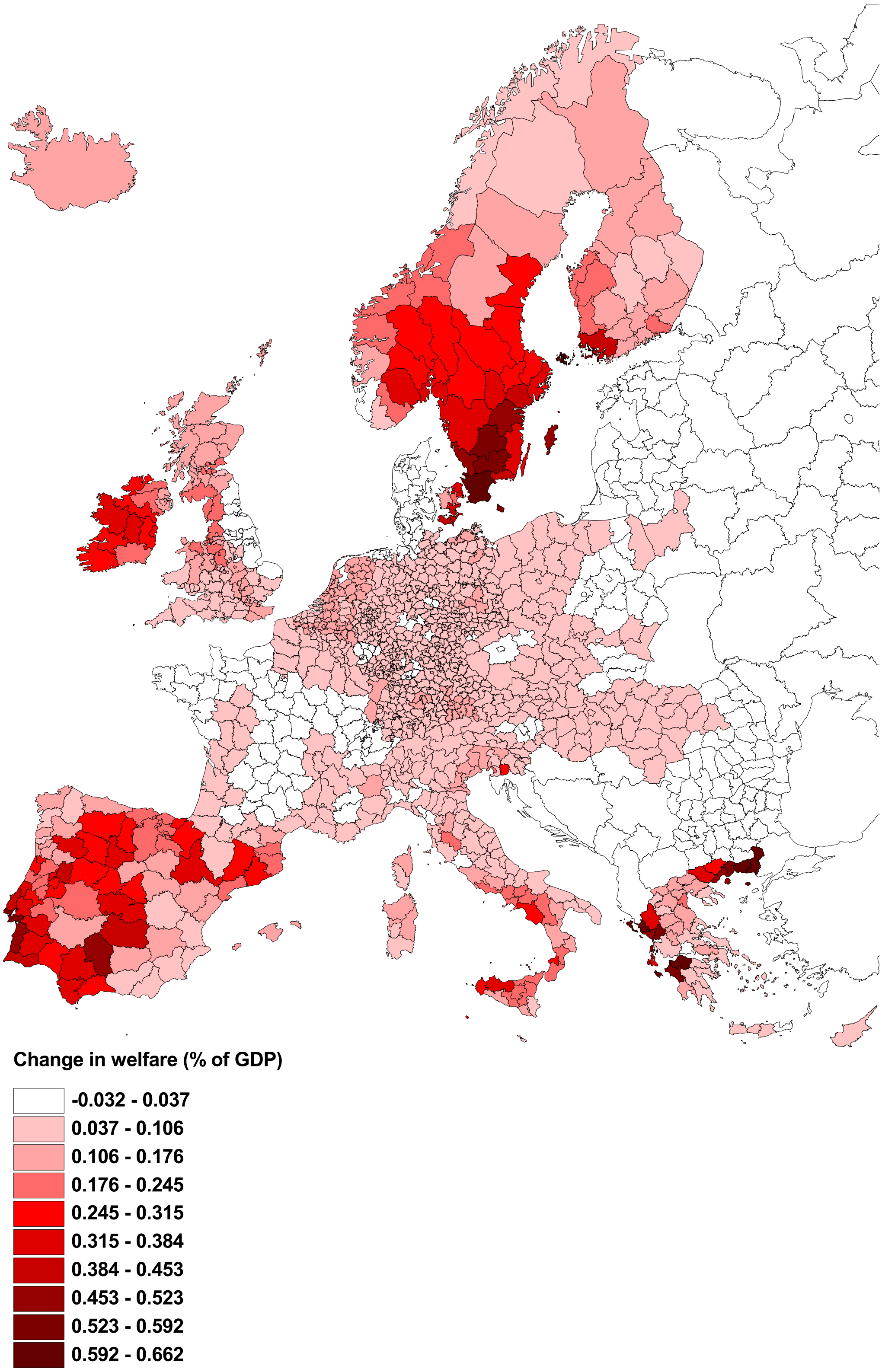


Figure 13. CGEuropeI results: implementation of all TEN priority projects (Scenario A1)

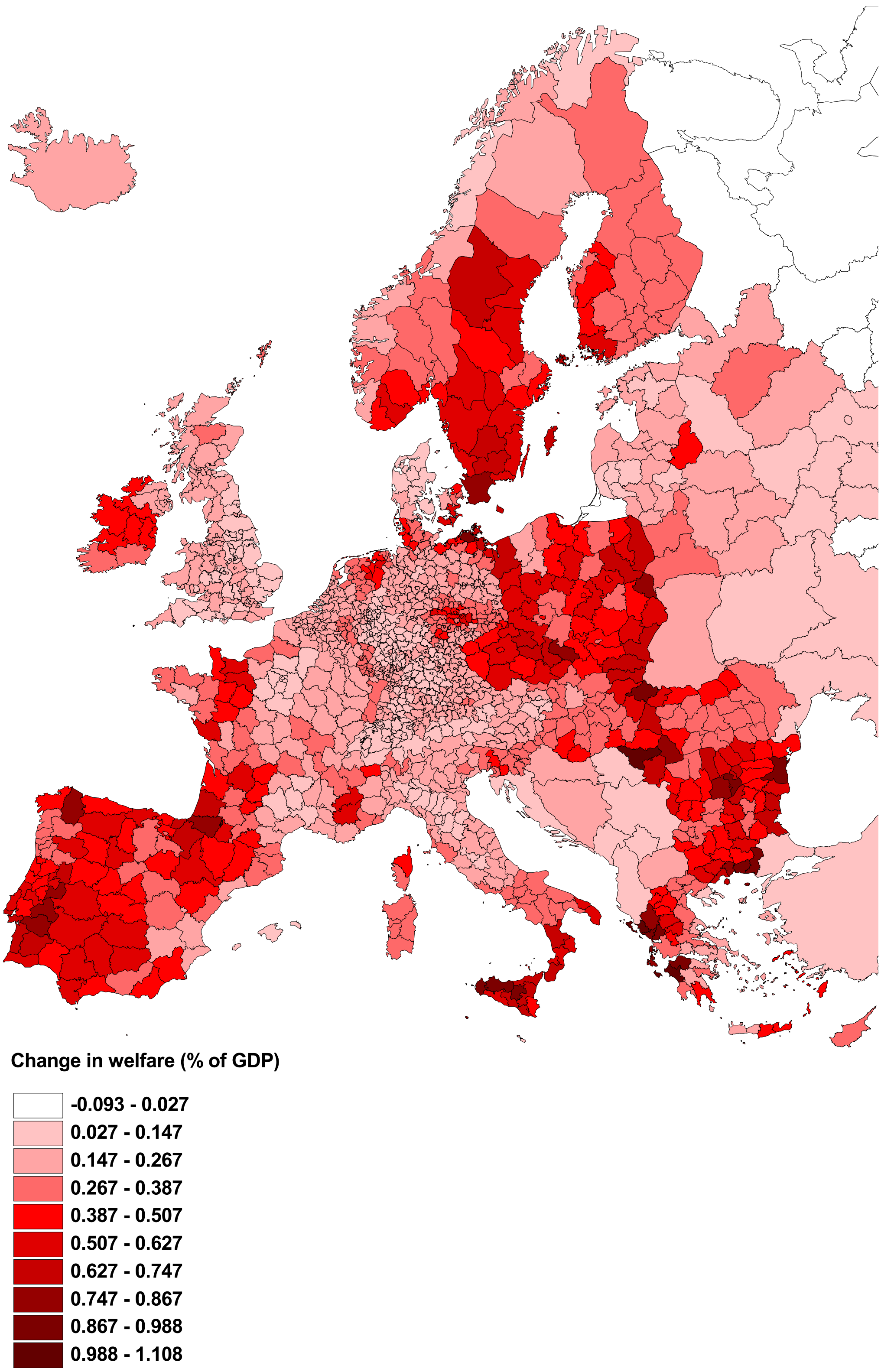


Figure 14. CGEuropeI results: implementation of all TEN and TINA projects (Scenario A3)

Figure15 shows the effects of Scenario B2. An interesting spatial pattern emerges from SMCP pricing that leads to a general increase in travel cost and transportation cost. Note that, in order to isolate the spatial effect of the pricing itself, no redistribution of revenues is assumed. Revenues are “burned”. Exactly the same spatial pattern would emerge, if a lump-sum redistribution proportional to GDP instead of burning was assumed. Only the level would be different, the weighted average of effects would be close to zero. In fact it would be slightly negative, because the welfare loss slightly exceeds the revenue. Note, however, that this is only the case because the intended welfare gain resulting from internalisation of externalities is not included in the model. Neither do travel times react on a reduction of travel flows induced by higher out-of-pocket costs, nor is an improved environment felt by the households as a utility gain in the model. This is explained in order to emphasise that the overall negative welfare impact of the pricing scenarios must not be misinterpreted as a statement against efficiency gains from SMCP. The scenario simulation just isolates the effects form the cost side.

The spatial pattern in Scenario B2 is an overlay of two centre-periphery patterns, a national and a European one. Within each country, regions with a high market potential suffer from the smallest losses, those in the national periphery lose most. This is most clearly observable in large countries like the UK, France, Germany, Spain, Italy and Poland, but even in smaller countries such as Greece (see the light colour around Athens on the map or Denmark). These national patterns are overlaid by a similar, though less pronounced pattern on a European scale, so that regions suffer most that are far from national as well as from European markets, such as Portugal, Scotland, Southern Italy or Northern Norway and Finland.

Figure 16 shows the effects of combination scenario C1. Scenario C is a combination of scenarios A1 and B2. Hence, because of additivity holding also in this case, the spatial pattern is approximately the sum of those generated by these two scenarios and needs not extra discussion.

An important conclusion that can be drawn from the results concerns the relationship between the single sector and the multisector version of CGEurope. It turns out that there is a close similarity between CGEuropeI and CGEuropeII, both with respect to the pattern and the order of magnitude of the effects. This is an argument that counts in favour of the simpler model with just a single tradables sector instead of the multisector version. Only if we are interested in structural effects on a regional level, or if we have good input information on transport costs differing by industry it seems worthwhile to set up a multisectoral framework.

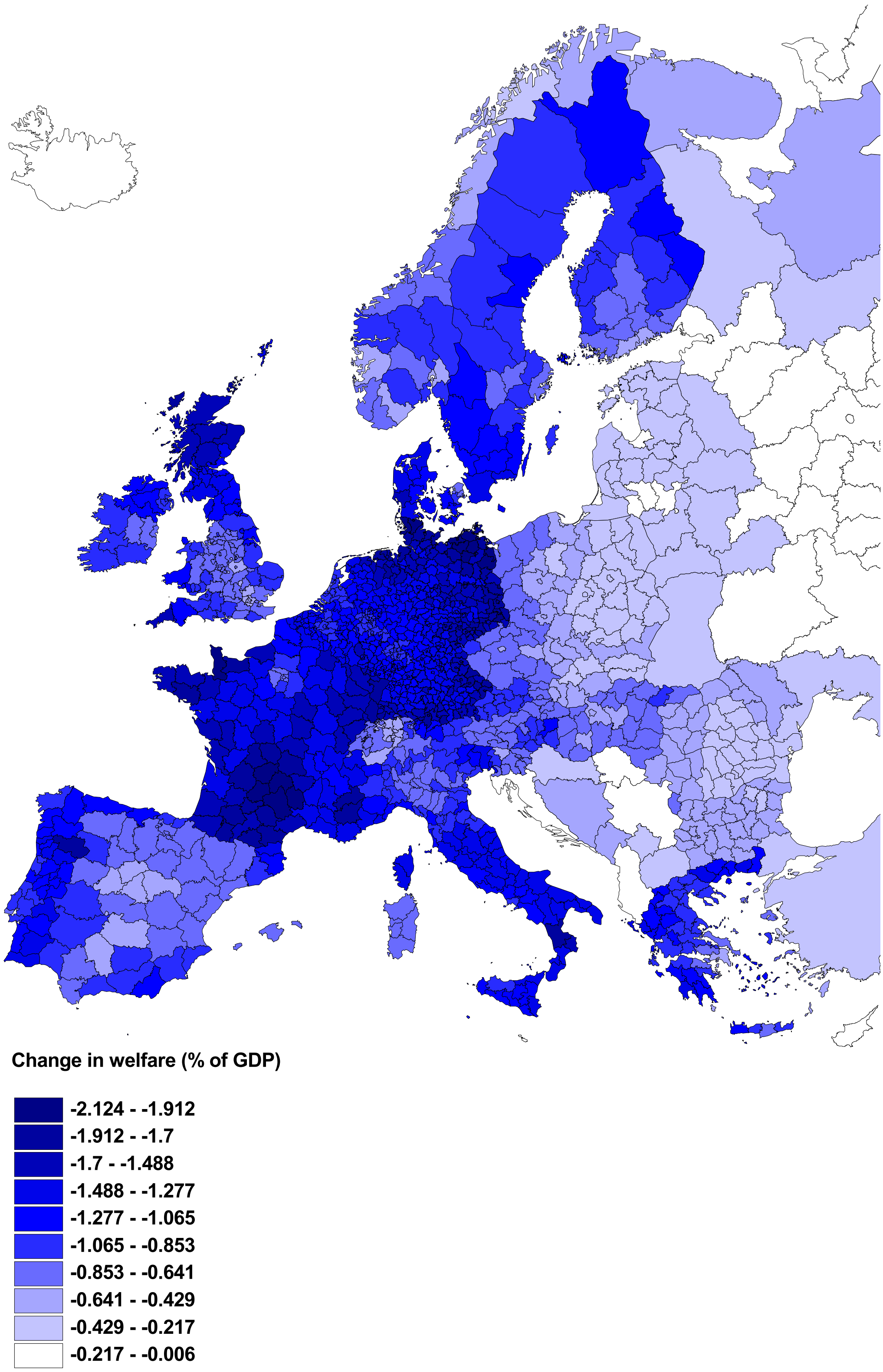


Figure 15. CGEuropeI results: SMCP applied to all modes (Scenario B2)

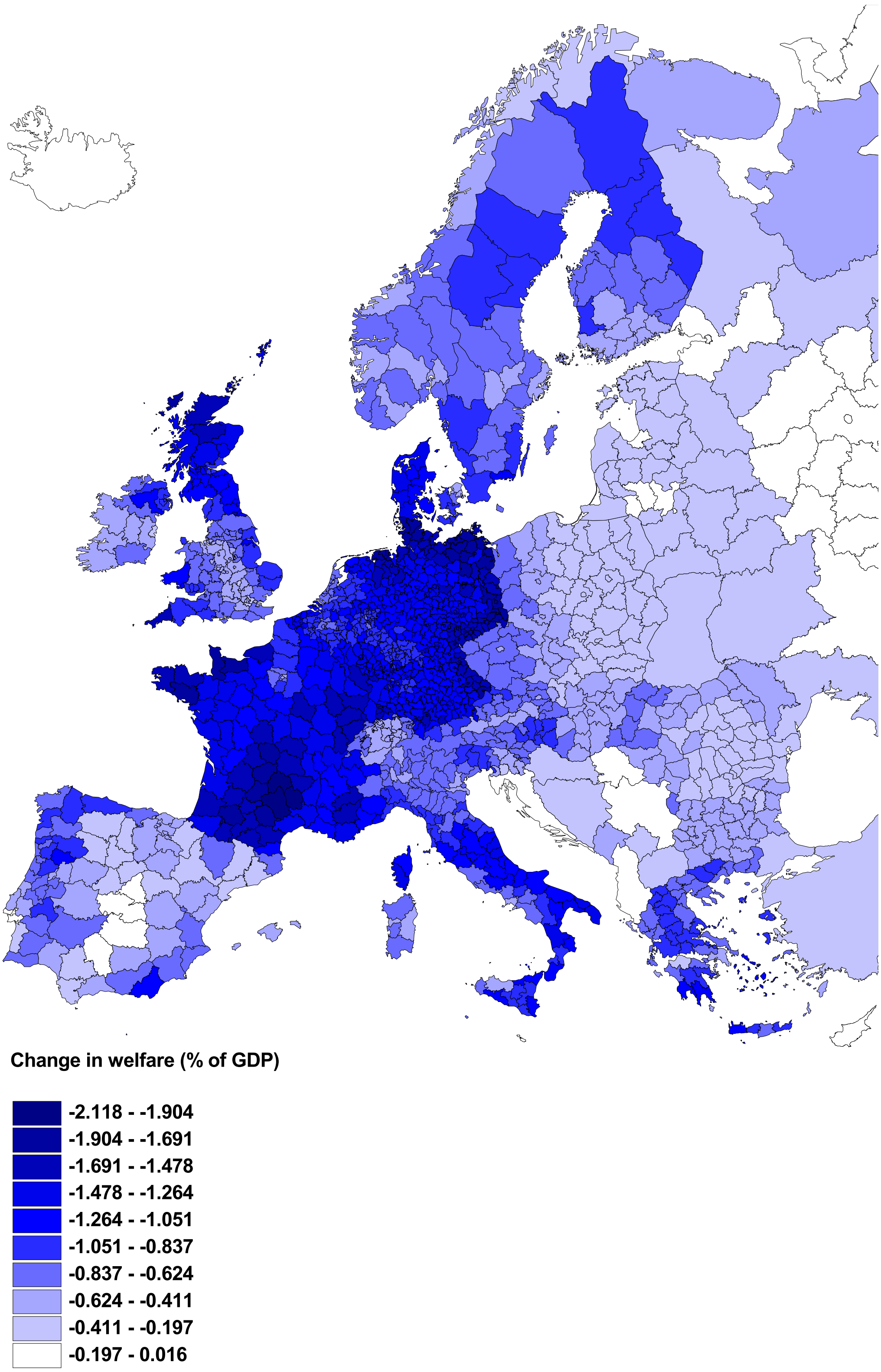


Figure 16. CGEuropeI results: combination of Scenarios A1 and B2 (Scenario C1)

The CGEurope models have also been applied to quantify direct and indirect effects, which is a central issue dealt with in the whole IASON project. Two main observations can be made in this respect:

(1) The spatial distribution of the overall welfare effect does not deviate much from the spatial distribution of the direct cost saving. Direct cost savings of a region can be measured either by cost savings for all flows originating in the region or for all flows with destination in the region. The above statement holds for both indicators.

(2) The so-called total benefit multiplier (TBM) is moderate, in the order of 1.2. The TBM is the ratio of total welfare gain to direct cost saving. To put it differently, there is an extra gain of roughly 20% beyond and above the direct cost saving. This low multiplier is due to the fact, that a moderate degree of monopoly power is the only market imperfection in the model.

SASI and CGEurope: a Comparison

The two models, SASI and CGEurope, are based on completely different philosophies. It would therefore be surprising if they delivered identical or very similar results.

SASI results are based on econometric evidence about the relation between accessibility and output observed in the past. Regional variations of output are a function of accessibility and other factors parameterised such that the evidence is reproduced by this function. CGEurope, however, is calibrated but not tested against time-series data from the past. The model is rather assumed to be correct. The model, however, has not the black-box character of the production function in the SASI model, but explicitly describes how changes in transport cost affect endogenous variables in a general-equilibrium framework. If, despite of the completely different methodology, predictions of both models are close to one another, one may take this as a support for both. CGEurope could be regarded as a theoretical underpinning of SASI, and SASI as an empirical test of CGEurope. This section shows that there are similarities as well as differences between the results of both models. Correlations show that the spatial patterns of effects generated by the two models are similar, but the range is different.

Table 9 shows coefficients obtained by regressing relative GDP effects of the scenarios, predicted by the SASI model, against relative equivalent variation and relative GDP effects predicted by CGEuropeI.

Table 9. Regression results, percent GDP effects SASI against CGEurope

Scenario	SASI change of GDP per capita versus			
	CGEurope relative equivalent variation		CGEurope change of GDP per capita	
	Correlation coefficient	Regression coefficient	Correlation coefficient	Regression Coefficient
A1	0.56	7.05	0.47	5.05
A21	0.77	11.76	0.70	9.10
A22	0.73	6.64	0.68	4.64
A23	0.82	2.49	0.80	1.76
A24	0.71	10.75	0.62	8.17
A3	0.56	7.40	0.50	5.62
A4	0.63	6.93	0.56	5.10
B1	0.28	0.42	0.08	0.30
B2	0.74	3.19	0.73	2.36
C1	0.71	2.55	0.69	1.87
D1	0.54	5.10	0.46	3.64
E1	0.57	7.59	0.52	5.80
E2	0.71	1.25	0.70	0.89

For almost identical results both, the correlation and regression coefficients in the table should be close to one. Obviously, the positive correlations show similarities between the spatial patterns of results. This is due to a similar distance decay function used in both models. On the other hand, the regression coefficients reveal a much larger range of SASI results as compared to CGEurope results. This may be explained by a different treatment of factor mobility in both models. SASI estimates include effects due to attracting mobile factors, that prevail in the long run after returns to mobile factors are equalised through interregional factor flows. CGEurope, however, measures a smaller impact, assuming a fixed factor stock in each region.

Summary and Conclusions

The general goal of the research presented in this report was to perform a systematic and quantitative analysis of the socio-economic and spatial impacts of transport investments and other transport policies by refining existing EU-level models and carrying out scenario simulations in order to improve the understanding of the impact of transportation policies on short- and long-term spatial development in Europe. This part of IASON was unique in that it provided a framework in which two existing forecasting models of socio-economic and spatial impacts of transport policies with different modelling philosophies, theoretical foundations and modelling techniques, the SASI model and the CGEurope model, examined an identical set of transport policy scenarios using a common system of regions, the same network data and a common database of regional socio-economic data.

Results

Both models, the SASI model and the CGEurope model, were applied to examine the same set of 18 transport policy scenarios. The scenarios could be classified into six groups:

Network scenarios:	A1-A62
Pricing scenarios:	B1-B2
Combination scenario:	C1
Rail freight scenario:	D1
TIPMAC scenarios:	E1-E2

In addition, the do-nothing or base scenario 000 was simulated as reference or benchmark for comparing the policy scenarios

Both models used the same system of regions, the same network data and a common database of regional socio-economic data to examine the above policy scenarios. Both models forecast changes in regional GDP per capita in 2020 induced by the policies, or more precisely, differences in regional GDP per capita between the policy scenarios and the reference scenario in 2020. The results of the two models can therefore be compared.

The comparison shows that there are similarities as well as differences between the results of the two models. In general, the models agree with respect to the direction and spatial distribution of the effects of the policies and whether they contribute to greater economic cohesion or greater polarisation between the regions in Europe. The differences lie in the predicted magnitude of the effects, with the SASI model in general forecasting larger positive or negative impacts. Possible reasons for these differences in magnitude are discussed in Chapter 5. The summary here concentrates on the aspects in which the two models agree.

The main general result from the scenario simulations is that the overall effects of transport infrastructure investments and other transport policies are small compared with those of socio-economic and technical macro trends, such as globalisation, increasing competition between cities and regions, ageing of the population, shifting labour force participation and increases in labour productivity.

The second main result is that even large increases in regional accessibility translate into only very small increases in regional economic activity. However, this statement needs to be qualified, as the magnitude of the effect seems to depend strongly on the already existing level of accessibility. For regions in the European core with all the benefits of a central geographical location *plus* an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines may well bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions.

If the different types of policies are compared, high-speed rail projects seem to be more effective in terms of promoting regional economic activity than conventional rail projects, and rail projects seem to be more effective than road projects. All transport pricing scenarios have negative economic effects, because the effects stemming from revenues are disregarded (revenues are "burned"). These negative effects can be mitigated by their combination with network scenarios with positive economic effects, although the net effect depends on the magnitude of the two components. Not surprisingly, large comprehensive programmes have more substantial effects than isolated projects.

As regards the cohesion goal, the situation is very complex. There are several methods and indicators to measure the contribution of a policy or policy combination to the cohesion objective: the coefficient of variation, the Gini coefficient, the ratio between the geometric and arithmetic mean and the correlation coefficients between relative and absolute change and level of the variable of interest.

However, these methods and indicators give partly contradictory results. In particular the most frequently applied indicator of cohesion, the coefficient of variation, tends to signal convergence where in many cases in fact divergence occurs. The coefficient of variation, the Gini coefficient and the ratio between geometric and arithmetic mean measure *relative* differences between regions and classify a policy as pro-cohesion if economically lagging regions grow faster (in relative terms) than economically more advanced, i.e. more affluent regions. So even if poorer regions grow faster than rich regions (in relative terms), in most cases the income gap between rich and poor regions (in absolute terms) is widening. Which concept of cohesion (or convergence or divergence) is used, is a matter of definition. It is therefore of great importance to clearly state which type of cohesion indicator is used or should be used.

Beyond these methodological difficulties, a few general observations about the cohesion effects of the examined policies can be made. In general, network policies, i.e. transport infrastructure improvements, coincide with the cohesion objective, i.e. have a tendency to favour poorer peripheral regions – in relative terms. However, in absolute terms usually the richer and more central regions gain more. The opposite holds true for the pricing scenarios. The characteristic spatial pattern of the pricing scenarios is to disfavour geographically peripheral regions, both peripheral with regard to their respective national markets as well as peripheral with respect to Europe as a whole. As peripheral regions tend to be poorer than central regions, pricing disfavours poorer regions more than richer ones. However, here the two models differ: SASI predicts a pro-cohesion effect of the comprehensive pricing scenario B2 because it is only applied to the present European Union, whereas CGEurope classifies it as anti-cohesion. In absolute terms, all pricing scenarios are pro-cohesion because the rich central regions lose more in both accessibility and GDP. A caveat for these results is that both models only consider the cost side of the pricing scenarios and disregard the revenue side and where the revenues go in the spatial economy.

In summary it can be concluded that many transport policies of the past have been anti-cohesion, i.e. have contributed to widening the spatial disparities between central and peripheral regions in Europe. This is even true for the 'old' list of TEN priority projects. The 'new' list of priority projects is a clear advance in this respect. However, there is room for improvement, as some of the scenarios have shown. The simulations have demonstrated that rapid upgrading and extending of the rail and road infrastructure in eastern Europe would contribute to the economic and social integration of the accession countries after the enlargement of the European Union.

Methodological conclusions and further work

The application of the two models has demonstrated that both models are operational, that their data requirements – beyond the network database – can be largely met by existing statistical data sources and that they are capable of providing policy-relevant results. At the same time the work has given valuable insights into the potential and problems of modelling socio-economic and spatial impacts of transport policies. These insights lead to conclusions for further work.

For the SASI model, the extension of the study area to EU27+2 and the increase of the spatial resolution of the model from NUTS-2 to NUTS-3 regions and the associated refinement of the network database have greatly enhanced the applicability of the model for issues of enlargement of the European Union and the analysis of regional issues or individual projects. The substitution of travel time by generalised cost in the accessibility submodel was an important improvement of the model. The disaggregation of the model to six economic sectors was less successful because it greatly aggravated the data collection problems and has led to innumerable problems of small-scale inconsistencies without improving the predictive performance of the model. The former three economic sectors (agriculture, manufacturing, services) might have been sufficient. The replacement of GDP as the dependent variable of the regional production functions by GDP per capita was a necessary step but may prove problematic in the future when demand and supply on the regional labour market are to be modelled.

Future work for SASI will aim at completing the model enhancements begun in IASON, the endogenous modelling of regional labour productivity and the conversion of the migration submodel from net migration to migration flows. It is also planned to investigate whether the responses of the model to changes in accessibility may be too strong. To better control the magnitude of the response, a suggestion by Bröcker to explicitly model mobility of capital, just as in the migration model mobility of labour is modelled, will be followed.

For the CGEurope model, the conclusion drawn from the observation that all spatial distribution effects are very moderate is that traditional cost-benefit analysis, which disregards distributional issues, is acceptable. In fact, correcting the aggregated monetary welfare measure for equality gains (increasing welfare) or equality losses (reducing welfare) modifies the quantitative results only slightly, even if a strong inequality aversion is assumed. Of course, this conclusion implies a value judgement hidden in the welfare indicator and holds only if the regions affected by a policy do not differ too much in GDP per capita. Correcting for the distribution impact can have a considerable impact and even reverse the sign of welfare change if a policy affects accession countries positively and countries in the present European Union negatively or vice versa.

It could also be shown that indicators of direct cost savings approximate quite well the true regional welfare gain calculated by the model. Indirect effects not showing up in direct cost savings are moderate.

1 Introduction

One of the main issues of the IASON project is to quantify the spatial impact of transport initiatives taking both, direct and indirect effects into account. A transport initiative as any kind of public action having an impact on the monetary cost, time cost, efficiency and comfort of transportation of goods and people. Among them are in particular transport infrastructure investments and pricing policies. All such initiatives are subject to standard cost benefit analyses (CBA) on the national and also on the EU level, in order to figure out whether the present value of total net benefits including environmental impacts exceeds the cost. This is a well established practice.

Several important policy issues remain unresolved in standard evaluation procedures, however. One is whether the so-called direct measurement of user benefit, which consists in quantifying surplus changes of the users of the transportation system, catches all what is generated in the entire economy in terms of welfare. Another issue is how the gains (or possibly losses) of a transport initiative are distributed among individuals, social strata or regions. All these distributional dimensions are important, but the first two are difficult to figure out, and except of transport pricing in urban areas, transport initiatives are likely not to have strong distributional effects with regard to social strata. Transport initiatives do have strong distributional implications in the spatial dimension, however. These are the main issue of this report.

Applying models well grounded on theories of spatial economics, we try to quantify how different regions in Europe are affected by a series of bundles of transport initiatives representing likely policy options in Europe in the years to come. In co-operation with the European Commission and with partners of the IASON and TIPMAC projects, a series of scenarios have been defined representing infrastructure investments, pricing policies or combinations of both. These scenarios are translated into estimates of mode-specific transport cost changes, which are taken as inputs to spatial economic models that serve to quantify the impact of the respective policies on the spatial economic development in Europe.

There are two models used for these exercises, the SASI model and the CGEurope model. The latter comes actually in two versions. SASI has been developed in an earlier EU-financed project in a simpler form and is extended and calibrated with new data and for a much larger system of regions within the IASON project. An early version of CGEurope has been developed in an academic research project financed by the German Research Fund (DFG). It is as well extended and calibrated with a new database for the larger IASON system of regions. Furthermore, a second completely new multisectoral version of CGEurope has been developed within the IASON project. It is however only applicable on a more aggregated spatial level. Interestingly, it delivers largely similar results as the simpler one-sector version of CGEurope. Hence, both versions of the model are applied in this report.

SASI is a dynamic model of the spatial European economy, the kernel of which is a so-called quasi-production function quantifying the relation between accessibility and output by region and sector. Transport initiatives lead to changing transport costs and hence to changing spatial patterns of accessibilities. This influences output via the econometrically estimated quasi-production function. The production kernel of the model is connected to a migration model such that a fairly comprehensive picture of the impact of transport initiatives on the spatial economic system emerges.

CGEurope is, as the acronym says, a computable general equilibrium (CGE) model of a multiregional economy. Models in this family are routed in modern neoclassical economic theory assuming that the behaviour of firms and households is the outcome of rational choice under technological and financial constraints. Firms choose supply and demand such that profits are maximised, households choose consumption of goods, services and travel such that they attain a maximal utility. In a multiregional setting all these choices are affected by transport cost including time costs. Therefore changes of these costs, as represented by the scenarios, change all endogenous variables in the system such as prices, outputs, trade and travel flows, and – most importantly – utility. Utility is the ultimate variable of interest in our context. As Utility itself is something that has a meaning only in an ordinal sense of "more" or "less", it is translated to a monetary equivalent for project evaluation. Monetary welfare indicators for regions as well as for higher aggregates (EU) are extensively documented in this report.

The report is organised as follows: Chapter 2 defines the scenarios to be modelled by the two approaches. Chapter 3 documents the design, database, calibration and results of the SASI model; Chapter 4 documents the design, database, calibration and results of CGEurope. Both chapters are brief with regard to data, as these are extensively described in Deliverable 3. The essentials are summarised here, to make the report self-contained. Both models, SASI and CGEurope lead to results, that are similar with regard to the spatial distribution of effects, but the range between low and high within each scenario turns out to be much larger in SASI than in CGEurope. To put it differently, SASI predicts a more pronounced relocation effect of transport initiatives than CGEurope does. Chapter 5 is devoted to similarities and differences between these two approaches, shedding light on them from a theoretical as well as from an empirical point of view.

Chapter 6 draws some important conclusions of two kinds, conclusions concerning transport policy and conclusions concerning the methodology of project evaluation.

Acknowledgements go to Jan Kiel, who proposed the idea to run scenarios for the evaluation of the new list of priority transport projects. Further acknowledgements go to Tomasz Komornicki and Piotr Korcelli of the Stanislaw Leszczycki Institute of Geography and Spatial Organization of the Polish Academy of Sciences, who helped developing the A61 and A62 scenarios. Dieter Bökemann of the Institute of Urban and Regional Research of the Technical University of Vienna provided valuable advice on the further development of the SASI model. Even though it was not possible to implement all of his suggestions during the IASON project, they will serve as important guidance for the future development of the model.

2 Scenarios

2.1 Introduction

The policies to be examined in IASON are defined as *policy scenarios*, i.e. as time-sequenced programmes of implementation of network improvements and extension and other transport policies. In addition to the policy scenarios, a *reference scenario* is defined as benchmark for comparisons between the results of the policy scenarios.

All scenarios are equal for both the SASI and CGEurope models. Therefore they will be presented in this chapter, before in the following chapters the two models and their results will be presented.

2.2 Overview of Scenarios

The scenarios simulated with the SASI and CGEurope models can be classified into six categories:

- *Reference Scenario*. Scenario 000 is the base or reference scenario serving as the benchmark for the comparisons between the results of the policy scenarios.

- *Network scenarios*. Scenarios A1 to A62 implement different assumptions on the further development of the European transport networks, i.e. they vary in the number, selection and timing of implementation of network links.

- *Pricing scenarios*. Scenarios B1 and B2 examine different schemes of social marginal cost (SMC) pricing. They differ in the kind of pricing regime. These scenarios do not implement any network development, i.e. the pricing scenarios are applied to the networks of the reference scenario.

- *Combination scenario*. Scenario C1 is a combination of network scenario A1 and pricing scenario B2.

- *Rail freight scenario*. Scenario D1 assumes the development of a dedicated rail freight network in Europe.

- *TIPMAC scenarios*. Scenarios E1 and E2 represent combinations of network and pricing scenarios corresponding to the assumptions made in the TIPMAC project.

Table 2.1 presents a list of all scenarios, subdivided into these six categories with a brief description of their main features.

All scenarios rely on the trans-European transport network GIS database developed by the Institute of Spatial Planning of the University of Dortmund (IRPUD, 2001). The *strategic* road, rail and inland waterways networks used in IASON are subsets of this database, comprising the trans-European networks specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996), further specified in the *TEN Implementation Report* (European Commission, 1998) and latest revisions of the TEN guidelines provided by the European Commission (1999; 2002a), information on priority projects (European Commission, 1995), latest publications on the priority projects (European Commission, 2002b; 2003; HLG, 2003), on 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 is based on the TEN and TINA airports and other important airports in the remaining countries and contains all flights between these airports (Bröcker *et al.*, 2002).

Table 2.1. IASON scenarios

Scenario	Code
000 Reference scenario	
Reference scenario	000
A Network scenarios	
Implementation of all TEN priority projects (Essen list)	A1
Implementation of all high-speed rail priority projects (Essen list)	A21
Implementation of all conventional rail priority projects (Essen list)	A22
Implementation of all road priority projects (Essen list)	A23
Implementation of all rail priority projects (Essen list)	A24
Implementation of all TEN and TINA projects	A3
Implementation of all TEN projects	A4
Implementation of new priority projects	A51
Implementation of new priority rail projects	A52
Implementation of new priority road projects	A53
Scenario A3 plus implementation of additional projects in candidate countries	A61
Scenario A3 plus implementation of maximum projects in candidate countries	A62
B Pricing scenarios	
SMC pricing applied to road freight	B1
SMC pricing applied to all modes (travel and freight)	B2
C Combination scenario	
Scenario A1 plus Scenario B2	C1
D Rail freight scenario	
Dedicated rail freight network	D1
E TIPMAC scenarios	
TIPMAC business-as-usual scenario	E1
TIPMAC fast implementation scenario	E2

The network information is used to calculate travel times and travel costs between regions and regional accessibility for each year of the simulation. For that the historical and future development of the networks is required as input. The development of the networks over time is recorded in the database in five-year time steps, i.e. the network database contains information for the years 1981 (the historical base year of the SASI model), 1986, 1991, 1996, 2001, 2006, 2011, 2016 and 2021 (the envisaged completion year of all TEN and TINA projects). For the past, i.e. until 2001, the same network is used for all scenarios. The network scenarios differ in their assumptions about future network development, i.e. different network data for the years 2006, 2011, 2016 and 2021 are used for the different scenarios. The 2006 network data include all network changes supposed to be finished until the end of 2006, the 2011 network data all network changes supposed to be finished until the end of 2011, and so on. For the years between the five-year time steps, travel times and costs and accessibility indices are interpolated.

The type and expected year of completion of the projects were mainly taken from the *TEN Implementation Report* (European Commission, 1998) and the *TINA Status Report* (TINA Secretariat, 2002). Where no information was available in these two sources, supplementary information from national ministries or other national agencies was used. Most of the projects are composed of different sections with individual project types and completion years. The GIS network database reflects this by representing all projects by their individual sections, with specification of type of work and year of completion. Only in cases where such detailed information was not available, a common completion year for all sections of a project was assigned.

2.3 Scenario Specification

In this section the specification of the reference scenario and the 18 policy scenarios is presented in more detail.

2.3.1 The Reference Scenario

The reference scenario is the benchmark for comparing the results of the policy scenarios. For the period between 1981 and 2001, the reference scenario represents the actual development of the road, rail and air networks in Europe. For all future years the reference scenario preserves the state of the networks in the year 2001, i.e. no further network development after 2001 is foreseen. Thus, the reference scenario is not a realistic scenario but is used only as a benchmark for all other scenarios. All TEN or TINA projects that were already implemented by the end of 2001 are taken into account in this scenario, all other TEN or TINA projects are not considered.

2.3.2 Network Scenarios

These scenarios implement different assumptions about the further development of the European transport networks. The scenarios vary by different selection and timing of TEN and TINA projects. There are twelve network scenarios, which can be further subdivided into four groups:

- TEN priority scenarios: A1, A21, A22, A23, A24
- Full TEN/TINA scenarios: A3, A4
- New priority projects scenarios: A51, A52, A53
- Alternative TINA scenarios: A61, A62

TEN priority scenarios

There are five scenarios analysing different options for the implementation of the TEN priority projects. In these five scenarios the priority projects adopted in 1996 and in 2002 in the Essen list are taken into consideration (European Communities, 1996; European Commission, 2002b). These scenarios are

A1 Implementation of all TEN priority projects
A21 Implementation of all high-speed rail priority projects
A22 Implementation of all conventional rail priority projects
A23 Implementation of all road priority projects
A24 Implementation of all rail priority projects

All other TEN not in the Essen priority list are not taken into account in this set of scenarios, nor are the TINA projects, unless they were already implemented until the end of 2001.

Table 2.2 and Figure 2.1 give an overview of all priority projects included in the network scenarios. Table 1 also indicates the official priority project number, the countries covered by the projects and the scenario in which the project is considered.

Table 2.2. Priority projects of the Essen list

Priority project		Countries covered	Scenarios
Rail network			
1	High speed train combined transport North-South	DE, AT, IT	A1, A21, A24
2	High speed rail Paris-Cologne-Amsterdam-London	FR, BE, NL, DE, UK	A1, A21, A24
3	High speed rail south: Madrid-Barcelona-Montpellier/Madrid-Dax	ES, FR	A1, A21, A24
4	High speed rail Paris-Karlsruhe/Luxembourg/Saarbrücken	FR, LU, DE	A1, A21, A24
5	Betuwe line Rotterdam-Rhein/Ruhr	NL, DE	A1, A22, A24
6	High-speed rail Lyon-Venice-Trieste	FR, IT	A1, A21, A24
8	Multimodal link Portugal-Spain-Central Europe	PT, ES, FR	A1 A22, A24
9	Rail Cork-Dublin-Belfast-Larne-Stranraer	IE, UK	A1 A22, A24
11	Øresund rail/road link	DK, SE	A1 A22, A24
12	Nordic triangle	SE, FI	A1 A22, A24
14	West coast main line	UK	A1 A22, A24
16	High capacity rail across the Pyrenees	ES, FR	A1 A22, A24
17	High speed train, combined transport East-West	FR, DE, AT	A1, A21, A24
20	Fixed link Fehmarn Belt	DE, DK	A1, A22, A24
Road network			
7	Greek motorways (Via Egnatia, Pathe)	GR	A1, A23
8	Motorway Lisboa-Valladolid	PT, ES	A1, A23
11	Øresund rail/road link	DK, SE	A1, A23
12	Nordic triangle	SE, FI	A1, A23
13	Ireland / UK / Benelux road link	IE, UK, BE	A1, A23
20	Fixed link Fehmarn Belt	DE, DK	A1, A23

Four of the priority projects have not been implemented in all scenarios: the high-speed rail interoperability project on the Iberian Peninsula (Project 19), Malpensa Airport (Project 10), the Danube river improvement between Vilshofen and Straubing (Project 18) and the global navigation and positioning satellite system Galileo (Project 15).

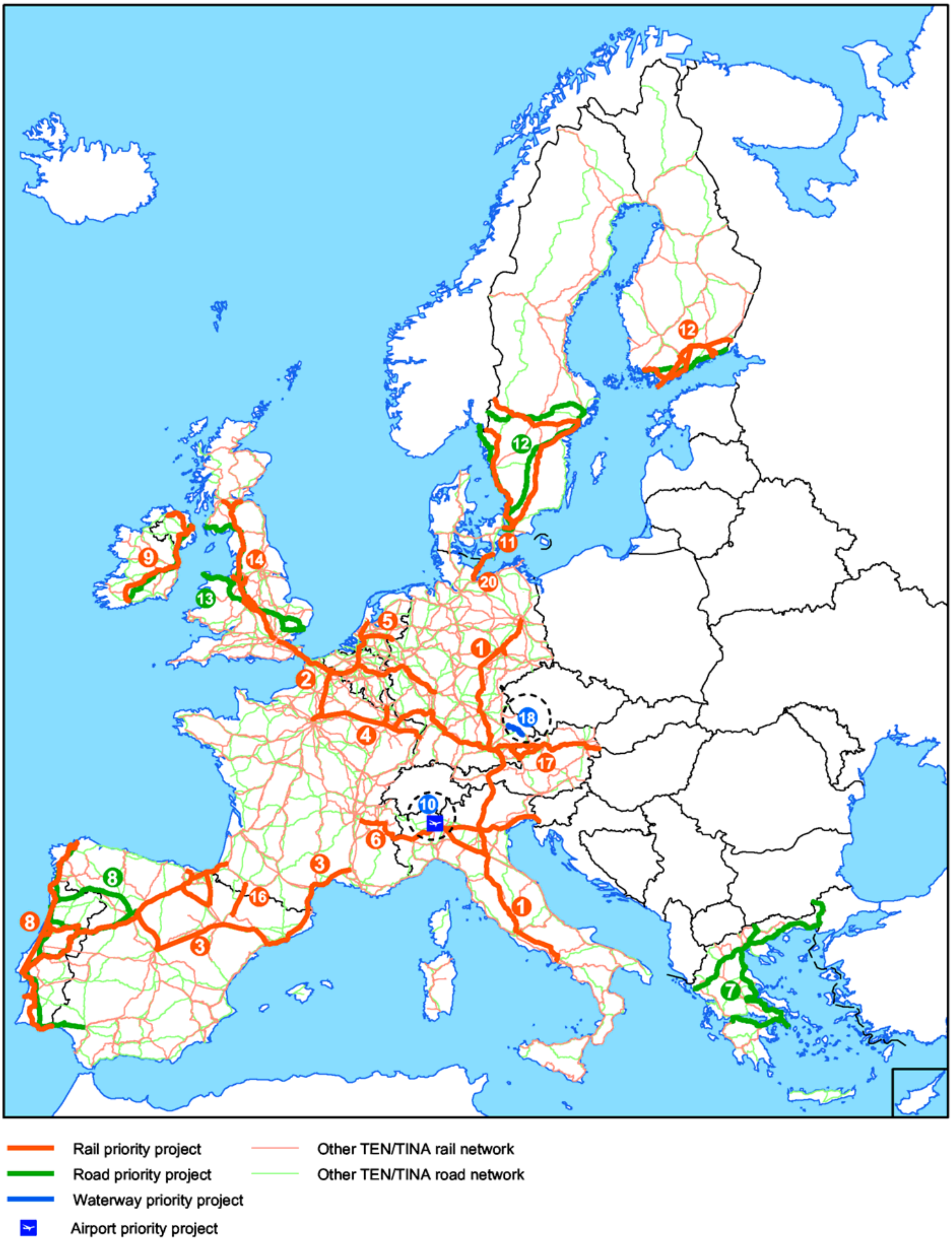


Figure 2.1. Priority projects of the Essen list

Full TEN/TINA scenarios

There are two scenarios examining the impacts of the full implementation of the TEN and TINA networks:

A3 Implementation of all TEN and TINA projects
A4 Implementation of all TEN projects

Scenario A3 considers all projects included in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996) and reported in the *TEN Implementation Report* (European Commission, 1998) as well as all projects reported in the *TINA Final Report* and *TINA Status Report* (TINA Secretariat, 1999; 2002). Scenario A3 features all envisaged projects of the TEN and TINA networks. Scenario A4, however, considers only the projects of the TEN Implementation Report, i.e. does not assume any network development in the accession countries. Compared to the priority project scenarios, the two scenarios include many more projects because the priority projects are only a subset of all TEN projects.

As noted, information on the type of project (e.g. upgrading, new motorway, new conventional rail line etc.), the status of the project (e.g. planning phase, partly or fully completed etc.) and on the estimated year of completion were taken from the TEN Implementation Report and the TINA Status Report. Where this information was not available there, supplementary sources from national ministries and national agencies were used.

Altogether there are some 600 projects comprising some 2,400 individual sections implemented in Scenario A3. Figure 2.2 shows the all TEN and TINA projects considered. Table A.1 in Annex A lists the road and rail projects extracted from the *TEN Implementation Report* on a country-by-country basis.

New priority projects scenarios

Three scenarios assume the implementation of the most recent proposal for the further development of the priority projects. The proposals date back to the high-level group on trans-European transport networks, the so-called Van Miert group (HLG 2003) and were subsequently revised by the European Commission (European Commission, 2003). The three scenarios are:

A51 Implementation of the new priority projects
A52 Implementation of the new priority rail projects
A53 Implementation of the new priority road projects

The revised list of priority projects includes the priority projects of the Essen list plus the additions recommended by the European Commission (see Figure 2.3). The additional projects mainly cover projects in the accession countries or new corridors towards the accession countries as extensions of old priority projects. The spatial coverage of the new list of priority projects is therefore no longer limited to the member states of the present European Union but covers also the accession countries. Table 2.3 lists the projects of the new priority list.

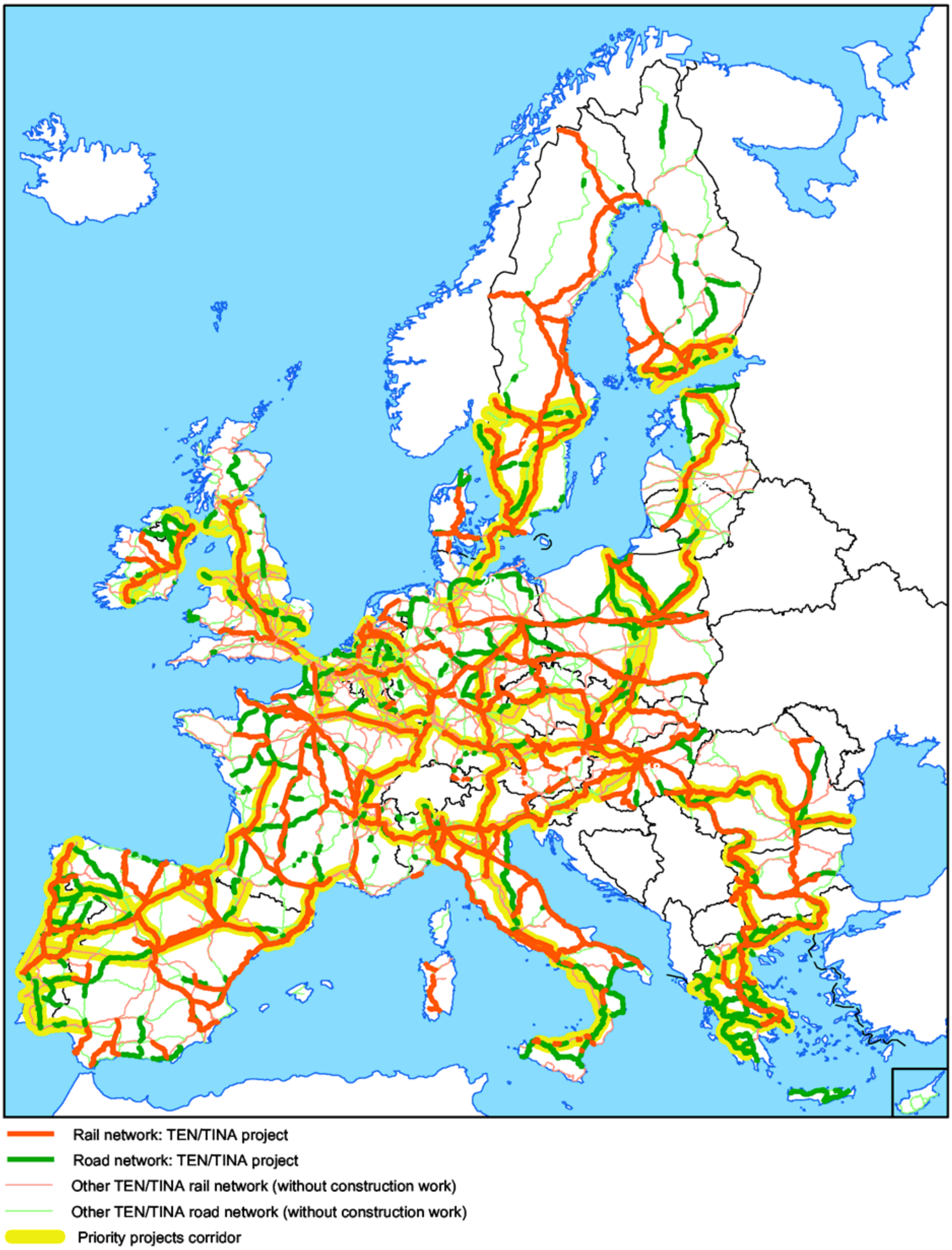


Figure 2.2. TEN and TINA rail and road projects

Table 2.3. New list of priority projects

	Priority project	Countries covered	Scenarios
	Rail network		
1	High speed train combined transport North-South, w. Messina bridge	DE, AT, IT	A51, A52
2	High speed rail Paris-Cologne-Amsterdam-London	FR, BE, NL, DE, UK	A51, A52
3	High speed rail south: Madrid-Barcelon-Montpellier/Madrid-Dax	ES, FR	A51, A52
4	High speed rail Paris-Karlsruhe/Luxembourg/Saarbruecken	FR, LU, DE	A51, A52
5	Betuwe line Rotterdam-Rhein/ruhr	NL, DE	A51, A52
6	High-speed rail Lyon-Venice-Trieste/Koper-Ljubljana-Budapest	FR, IT, SI, HU	A51, A52
8	Multimodal link Portugal-Spain-Central Europe	PT, ES, FR	A51, A52
9	Rail Cork-Dublin-Belfast-Larne-Stranraer	IE, UK	A51, A52
11	Øresund rail/road link	DK, SE	A51, A52
12	Nordic triangle	SE, FI	A51, A52
14	West coast main line	UK	A51, A52
16	High capacity rail across the Pyrenees, freight line Sines-Badajoz	ES, FR, PT	A51, A52
17	High speed train, combined transport East-West	FR, DE, AT, SK	A51, A52
20	Fixed link Fehmarn Belt	DE, DK	A51, A52
22	Rail Athina-Kulata-Sofia-Budapest-Vienna-Praha-Nuernberg	GR,BG,HU,AT,CZ,DE	A51, A52
23	Rail Gdansk-Warsaw-Katowice-Brno/Zilinia	PL. CZ, SK	A51, A52
24	Rail Lyon/Geneva-Basel-Duisburg-Rotterdam-Antwerp	FR, DE, NL, BE	A51, A52
26	Multi-modal link Ireland/UK/continental Europe	IE, UK, BE, FR	A51, A52
27	Rail Baltica	EE, LT, LV, PL	A51, A52
28	Eurocaprail Brussels-Luxembourg-Strasbourg	BE, LU, FR	A51, A52
29	Intermodal corridor Ioannian Sea/Adria	GR	A51, A52
	Road network		
1	Fixed link road/rail Messina bridge	IT	A51, A53
7	Greek motorways (Via Egnatia, Pathe), motorways in BG / RO	GR, BG, RO	A51, A53
8	Motorway Lisboa-Valladolid	PT, ES	A51, A53
11	Øresund rail/road link	DK, SE	A51, A53
12	Nordic triangle	SE, FI	A51, A53
13	Ireland / UK / Benelux road link	IE, UK, BE	A51, A53
20	Fixed link Fehmarn Belt	DE, DK	A51, A53
25	Motorway Gdansk-Katowice-Brno-Vienna	PL, CZ, SK, AT	A51, A53
26	Multi-modal link Ireland/UK/continental Europe	IE, UK, BE, FR	A51, A53

It is worth mentioning that although the numbering scheme of the new list of priority projects remains the same as for the old list, some of the old projects have been extended to cover also accession countries (for example Project 7 now extends into Bulgaria and Romania). As already mentioned, Project 10 (Malpensa), Project 15 (Galileo), Project 18 (Rhine/Meuse-Main-Danube inland waterway axis) and Project 19 (high speed rail interoperability on the Iberian Peninsula) have not been implemented. Furthermore, the motorways of the sea (Project 21) have not been implemented.

Apart from this list of projects, no other network development is assumed in this type of scenarios.

For the old priority projects, information on the type of project and estimated completion year were based on the TEN Implementation Report, information on type of the project and estimated completion year of the new projects (or new parts of old projects) were taken from the TINA Status Report or from the final report of the Van Miert high-level group.

Figure 2.3. New priority projects

Alternative TINA scenarios

As the last group of network scenarios, two variants of the TINA outline plans for the candidate countries in eastern Europe were suggested by Tomasz Komornicki and Piotr Korcelli of the Stanisław Leszczycki Institute of Geography and Spatial Organization of the Polish Academy of Sciences (Komornicki and Korcelli, 2003). The two scenarios are modifications of Scenario A3, in which all TEN and TINA projects are implemented:

A61 A3 plus implementation of additional projects in candidate countries
A62 A3 plus implementation of maximum projects in candidate countries

Both scenarios assume the same network development as in Scenario A3 in the countries of the present European Union, i.e. the full implementation of the all TEN projects. With respect to the accession countries, both scenarios are modifications of the TINA network (TINA Secretariat, 1999; 2002). Scenario A61 represents a more realistic ('minimum') scenario, which compared to the full TINA outline plan reduces the number of transport projects implemented. Scenario A62 represents a maximum development scenario featuring more transport projects than Scenario A61 but still less than in the full TINA outline plan, in particular with respect to rail. However, both scenarios are more optimistic with respect to the general upgrading of the transport networks in the accession countries. They assume that almost all main railway lines are upgraded to high-speed rail and most major roads to motorways or dual-carriageway roads. They assume high-speed lines between Berlin and Warsaw and Vienna and Budapest that were not included in the TINA outline plans and expect that the single-track railway line Riga-Tallinn becomes a high-speed line. Whereas the TINA outline plan mainly removes existing bottlenecks, Scenario A61 improves the access of capital cities and Scenario A62 network connectivity between all regional cities (defined as cities with a population of more than 300,000). Figure 2.4 shows all projects in the accession countries included in the two scenarios in colour, whereas the parts of the network that remain unchanged are shown in black.

2.3.3 Pricing Scenarios

The pricing scenarios examine the effects of social marginal cost (SMC) pricing regimes applied to different parts of the networks and different types of vehicles:

B1 SMC pricing applied to road freight
B2 SMC pricing applied to all modes (travel and freight)

These scenarios do not assume further network development, i.e. the pricing schemes are applied to the networks of the reference scenario. The detailed specification of the pricing schemes are based on Tavasszy et al. (2003). Only transport links in the member states of the current European Union are subject to pricing measures.

It is important to note that in both the SASI model and the CGEurope model only the cost effects of the pricing schemes are taken into account, i.e. it is not considered how the revenues of the toll collection are reallocated into the economy.

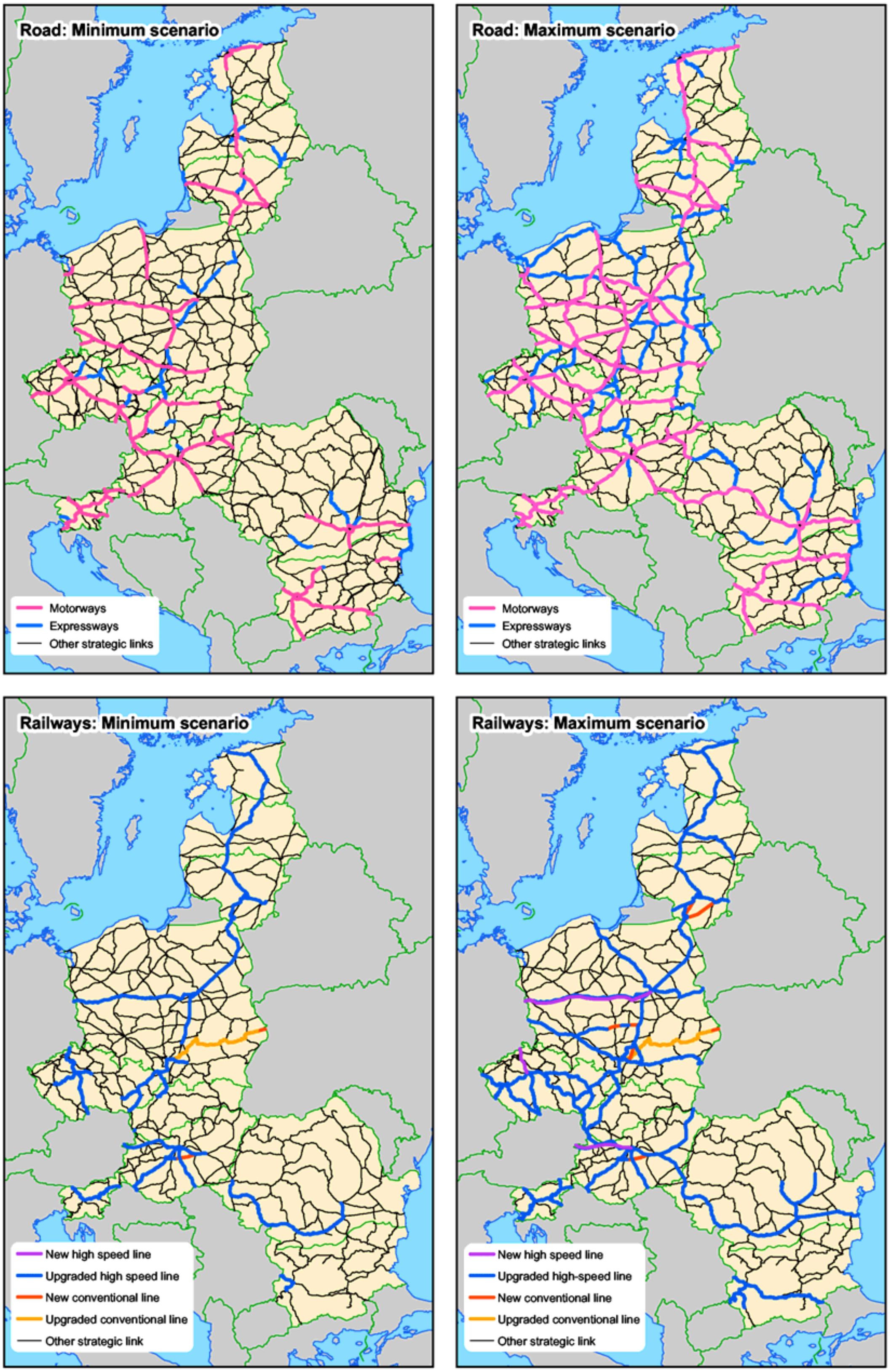


Figure 2.4. Alternative TINA scenarios A61 (left) and A62 (right): road (top) and rail (bottom)

2.3.4 Combination Scenario

This scenario is a combination of Scenario A1 (implementation of all TEN priority projects) and Scenario B2 (SMC pricing applied to all modes and to travel and freight):

C1 Scenario A1 and Scenario B2

2.3.5 Rail Freight Scenario

This scenario is a special kind of network scenario focussing on the development of the dedicated rail freight network proposed in the Eufranet project (Eufranet, 2001):

D1 Dedicated rail freight network

The dedicated rail freight network consists of corridors exclusively dedicated to rail freight transport differentiated into core and intermediate networks (see Figure 2.5). For the purpose of IASON it is assumed that all TEN and TINA projects located in or extending into these corridors are implemented, while projects outside these corridors are not implemented. Beyond this, it is assumed that travel speeds also on those sections of the core and intermediate networks that were not covered by TEN or TINA projects will increase due to improvements in signalling techniques.

As this scenario focuses on rail transport, no further network development for other modes is assumed, i.e. the road network corresponds to the road network of the reference scenario.

2.3.6 TIPMAC Scenarios

These scenarios represent certain combinations of network scenarios and SMC pricing scenarios. The assumptions about network development (type and number of projects, expected year of completion) are the assumptions made in the TIPMAC project (Borgnolo, 2002). Two TIPMAC scenarios were implemented:

E1 TIPMAC business-as-usual scenario
E2 TIPMAC fast implementation scenario

Both scenarios assume full implementation of all TEN and TINA projects and networks, similar to Scenario A3. These two scenarios differ from Scenario A3 in that they assume different years of completion not based on the TEN Implementation Report and TINA Status Report but on information compiled in TIPMAC (Borgnolo, 2002).

The two scenarios differ in their assumption on the year of completion of projects. Scenario E1 represents a rather slow implementation, which is considered as the 'business-as-usual' case, whereas Scenario E2 assumes that all projects are completed as scheduled, i.e. it more or less replicates the assumptions of Scenario A3. It is assumed that in general there is a time lag of about five years between Scenario E1 and Scenario E2 unless otherwise specified.

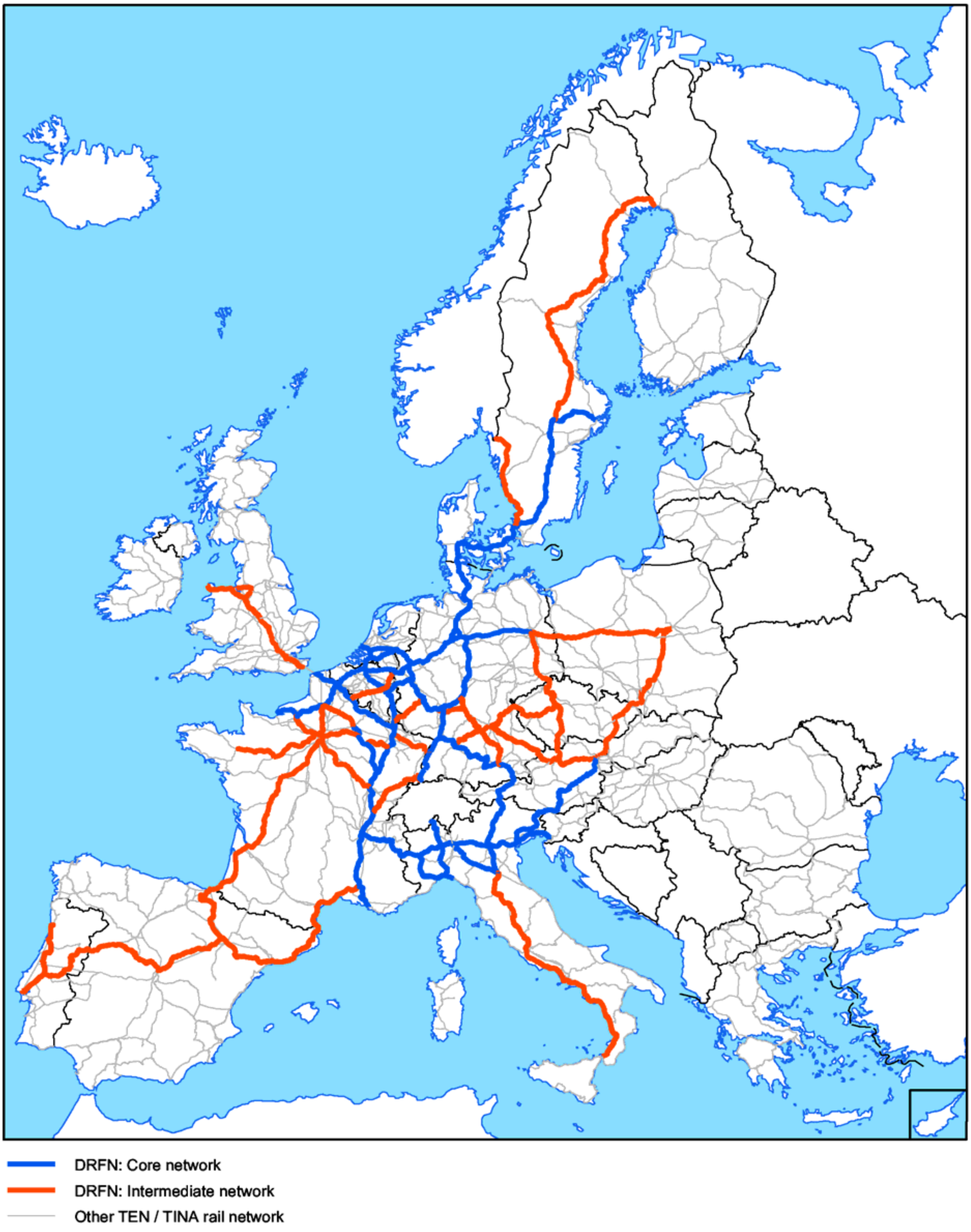


Figure 2.5. The Dedicated Rail Freight Network

3 The Extended SASI Model

3.1 Introduction

The important role of transport infrastructure for regional development is one of the fundamental principles of regional economics. In its most simplified form it implies that regions with better access to the locations of input materials and markets will, *ceteris paribus*, be more productive, more competitive and hence more successful than more remote and isolated regions (Jochimsen, 1966). However, the relationship between transport infrastructure and economic development seems to be more complex than this simple model. There are successful regions in the European core confirming the theoretical expectation that location matters. However, there are also centrally located regions suffering from industrial decline and high unemployment. On the other side of the spectrum the poorest regions, as theory would predict, are at the periphery, but there are also prosperous peripheral regions such as the Scandinavian countries. To make things even more difficult, some of the economically fastest growing regions are among the most peripheral ones.

So it is not surprising that it has been difficult to empirically verify the impact of transport infrastructure on regional development. There seems to be a clear positive correlation between transport infrastructure endowment or the location in interregional networks and the *levels* of economic indicators such as GDP per capita (e.g. Biehl, 1986; 1991; Keeble et al., 1982; 1988). However, this correlation may merely reflect historical agglomeration processes rather than causal relationships still effective today (cf. Bröcker and Peschel, 1988). Attempts to explain *changes* in economic indicators, i.e. economic growth and decline, by transport investment have been much less successful. The reason for this failure may be that in countries with an already highly developed transport infrastructure further transport network improvements bring only marginal benefits. The conclusion is that transport improvements have strong impacts on regional development only where they result in removing a *bottleneck* (Blum, 1982; Biehl, 1986; 1991).

There exists a broad spectrum of theoretical approaches to explain the impacts of transport infrastructure investments on regional socio-economic development. Originating from different scientific disciplines and intellectual traditions, these approaches presently coexist, even though they are partially in contradiction (cf. Linnecker, 1997):

- *National growth approaches model* multiplier effects of public investment in which public investment has either positive or negative (crowding-out) influence on private investment, here the effects of transport infrastructure investment on private investment and productivity. In general only national economies are studied and regional effects are ignored. Pioneered by Aschauer (1989; 1993) such studies use time-series analyses and growth model structures to link public infrastructure expenditures to movements in private sector productivity. An increase in public investment raises the marginal product of private capital and provides an incentive for a higher rate of private capital accumulation and labour productivity growth. Critics of these approaches argue that there may be better infrastructure strategies than new construction and that policy measures aimed at increasing private investment directly rather than via public investment will have greater impact on national competitiveness.

- *Regional growth approaches* rest on the neo-classical growth model which states that regional growth in GDP per capita is a function of regional endowment factors including public capital such as transport infrastructure, and that, based on the assumption of diminishing returns to capital, regions with similar factors should experience converging per-capita incomes over time. The suggestion is that, as long as transport infrastructure is unevenly distributed among regions, transport infrastructure investments in regions with poor infrastructure endowment will accelerate the convergence process, whereas once the level of infrastructure provision becomes uniform across regions, they cease to be important. Critics of regional growth models built on the central assumption of diminishing returns to capital argue that they cannot distinguish between this and other possible mechanisms generating convergence such as migration of labour from poor to rich regions or technological flows from rich to poor regions.

- *Production function approaches* model economic activity in a region as a function of production factors. The classical production factors are capital, labour and land. In modern production function approaches infrastructure is added as a public input used by firms within the region (Jochimsen, 1966; Buhr, 1975). The assumption behind this expanded production function is that regions with higher levels of infrastructure provision will have higher output levels and that in regions with cheap and abundant transport infrastructure more transport-intensive goods will be produced. The main problem of regional production functions is that their econometric estimation tends to confound rather than clarify the complex causal relationships and substitution effects between production factors. This holds equally for production function approaches including measures of regional transport infrastructure endowment. In addition the latter suffer from the fact that they disregard the network quality of transport infrastructure, i.e. treat a kilometre of motorway or railway the same everywhere, irrespective of where they lead to.

- *Accessibility approaches* attempt to respond to the latter criticism by substituting more complex accessibility indicators for the simple infrastructure endowment in the regional production function. Accessibility indicators can be any of the indicators discussed in Schürmann et al. (1997), but in most cases are some form of population or economic potential. In that respect they are the operationalisation of the concept of 'economic potential' which is based on the assumption that regions with better access to markets have a higher probability of being economically successful. Pioneering examples of empirical potential studies for Europe are Keeble et al. (1982; 1988). Today approaches relying only on accessibility or potential measures have been replaced by the hybrid approaches were accessibility is but one of several explanatory factors of regional economic growth. Also the accessibility indicators used have become much more diversified by type, industry and mode (see Schürmann et al., 1997). The SASI model is a model of this type incorporating accessibility as one explanatory variable among other explanatory factors.

- *Regional input-output* approaches model interregional and inter-industry linkages using the Leontief (1966) multiregional input-output framework. These models estimate inter-industry/interregional trade flows as a function of transport cost and a fixed matrix of technical inter-industry input-output coefficients. Final demand in each region is exogenous. Regional supply, however, is elastic, so the models can be used to forecast regional economic development. One recent example of an operational multiregional input-output model is the MEPLAN model (Marcial Echenique & Partners Ltd., 1998).

- *Trade integration approaches* model interregional trade flows as a function of interregional transport and regional product prices. Peschel (1981) and Bröcker and Peschel (1988) estimated a trade model for several European countries as a doubly-constrained spatial interaction model with fixed supply and demand in each region to assess the impact of reduced tariff barriers and border delays between European countries through European integration. Their model could have been used to forecast the impacts of transport infrastructure improvements on interregional trade flows. If the origin constraint of fixed regional supply were relaxed, the model could have been used also for predicting regional economic development. Krugman (1991), Krugman and Venables (1995) and Fujita at al. (1999) extended this simple model of trade flows by the introduction of economies of scale and labour mobility. The CGEurope presented in Chapter 4 of this report is a model of this type.

In this chapter, the extended SASI model used in IASON will be presented.

3.2 Model Design

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 (TEN-T).

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. 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 the spatial development objectives of the European Union. Its application is restricted, however, in other respects: The model generates many distributive and only to a limited extent 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 six forecasting submodels: *European Developments*, *Regional Accessibility*, *Regional GDP*, *Regional Employment*, *Regional Population* and *Regional Labour Force*. A seventh submodel calculates *Socio-Economic Indicators* with respect to efficiency and equity. Figure 3.1 visualises the interactions between these submodels.

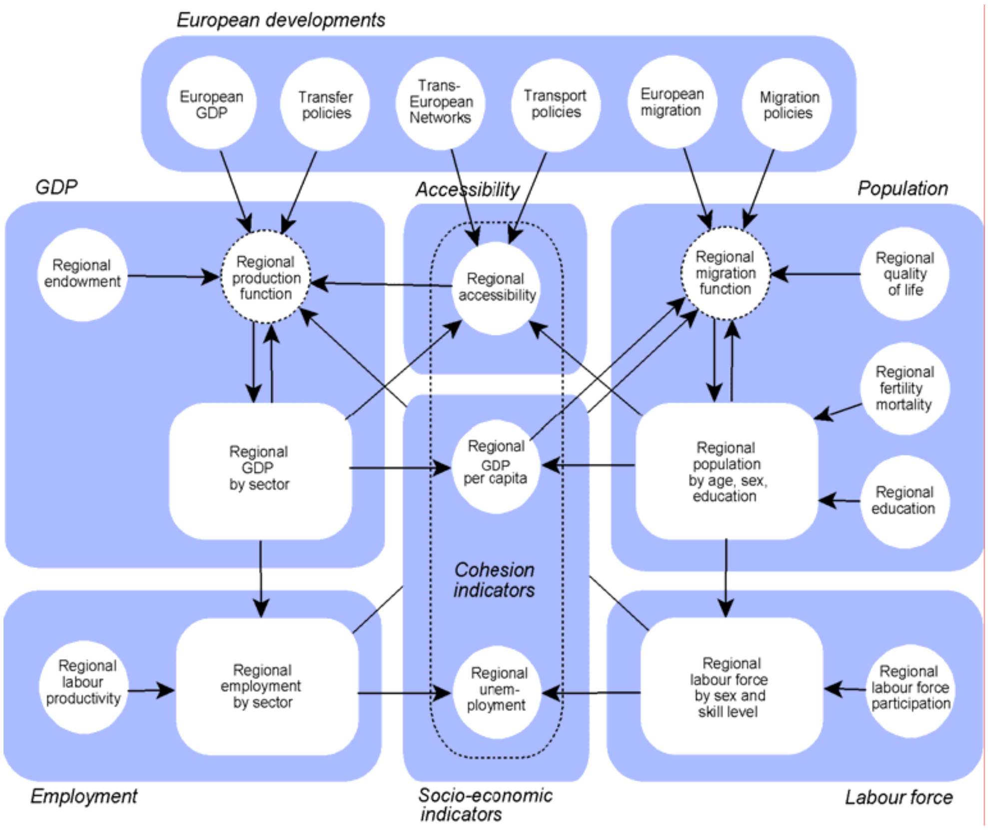


Figure 3.1. The SASI model

The *spatial* dimension of the model is established by the subdivision of the European Union and the 12 candidate countries in eastern Europe in 1,321 regions and by connecting these by road, rail and air networks. For each region the model forecasts the development of accessibility and GDP per capita. 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 *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.

3.2.1 Submodels

In this section the specification of model variables and parameters of the seven submodels of the SASI model is presented in detail based on IASON Deliverable D2 (Bröcker et al., 2002a). Unlike D2, in which the differences between the IASON implementation of the SASI model and the original SASI model (Wegener and Bökemann, 1998; Fürst et al., 1999) were pointed out, here only the IASON implementation of the model is presented.
European Developments

The *European Developments* submodel is not a 'submodel' in the narrow sense because it simply prepares exogenous assumptions about the wider economic and policy framework of the simulations and makes sure that external developments and trends are considered.

For each simulation period the simulation model requires the following assumptions about European developments:

(1) *Assumptions about the performance of the European economy as a whole*. The performance of the European economy is represented by observed values of sectoral GDP for the study area as a whole for the years 1981 to 1997 and forecasts for the years 1998 to 2016. All GDP values are entered in Euro in prices of 1998.

(2) *Assumptions about net migration across Europe's borders*. European migration trends are represented by observed annual net migration of the study area as a whole for the years 1981 to 1997 and of forecasts for the years 1998 to 2016.

These two groups of assumptions serve as constraints to ensure that the regional forecasts of economic development and population remain consistent with external developments not modelled. To keep the total economic development exogenous means that the model is prevented from making forecasts about the general increase in production through transport infrastructure investments (generative effects). However, its parameters are estimated in a way that makes it capable of doing that. Therefore the constraints are only applied to the reference scenario (see Chapter 2); by applying the adjustment factors of the reference scenario also to the policy scenarios, only the *changes* in generative effects induced by the policies are forecast (see below).

(3) *Assumptions about transfer payments by the European Union via the Structural Funds and the Common Agricultural Policy or by national governments to support specific regions*. European and national transfer payments are taken into account by annual transfers (in Euro of 1998) received by the regions in the European Union during the period 1981 to 1996 and forecasts for the period 1996 to 2016.

(4) *Assumptions about European integration*. The accessibility measures used in the SASI model take account of existing barriers between countries, such as border waiting times and political, cultural and language barriers. These barriers are estimated for the period 1981 to 1996 and forecast for the period 1996 to 2016 taking into account the expected effects of the enlargement of the European Union and further integration.

(5) *Assumptions about the development of trans-European transport networks (TEN-T).* The European road, rail and air networks are backcast for the period between 1981 and 2001 in five-year increments. A *policy scenario* is a time-sequenced programme for addition or upgrading of links of the trans-European road, rail and air networks or other transport policies, such as different regimes of social marginal cost pricing (see Chapter 2).

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

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 the generalised travel cost needed to reach these destinations by the strategic road, rail and air networks.

For the selection of accessibility indicators to be used in the model three, possibly conflicting, objectives were considered to be relevant: First, the accessibility indicators should contribute as much as possible to explaining regional economic development. Second, the accessibility indicators should be meaningful by itself as indicators of regional quality of life. Third, the accessibility indicators should be consistent with theories and empirical knowledge about human spatial perception and behaviour.

In the light of these objectives potential accessibility, i.e. the total of destination activities, here population, $W_s(t)$, in 1,321 internal and 51 external destination regions s in year t weighted by a negative exponential function of generalised transport cost $c_{rsm}(t)$ between origin region r and destination region s by mode m in year t was adopted (see Schürmann et al., 1997):

$$A_{rm}(t) = \sum_{s} W_s(t) \exp[-\beta\, c_{rsm}(t)] \tag{3.1}$$

where $A_{rm}(t)$ is the accessibility of region r by mode m in year t.

Modal generalised transport cost $c_{rsm}(t)$ consist of vehicle operating costs or ticket costs based on cost functions of the SCENES project and costs reflecting value of time. For the latter rail timetable travel times and road travel times calculated from road-type specific travel speeds are used and converted to cost by assumptions about the value of time of travellers and drivers. Only one common value of time was assumed for the whole study area, i.e. no distinction was made between the different wage levels and purchasing powers of countries. The border waiting times mentioned above were converted to monetary cost equivalents. In addition, following Bröcker (1984; 1996), political, cultural and language barriers were taken into account of as cost penalties added to the transport costs:

$$c_{rsm} \;=\; c'_{rsm}(t) + e_{r's'}(t) + s_{r's'} + \ell_{r's'} \quad \text{with } r \in \boldsymbol{R}_{r'} \tag{3.2}$$

in which $c'_{rsm}(t)$ is the travel cost between region r and region s in year t and $e_{r's'}(t)$, $s_{r's'}$ and $\ell_{r's'}$ are exogenous time penalties for political, cultural and language diversity in year t between the countries $\boldsymbol{R}_{r'}$ to which regions r and s belong:

- $e_{r's'}(t)$ is a *European integration factor* reflecting in which supranational structures the two countries are, i.e. which political and economic relationship existed between them in year t,

- $s_{k'j'}$ is a *cultural similarity factor* reflecting how similar are cultural and historical experience of the two countries.

- $\ell_{r's'}$ is a *language factor* describing the grade of similarity of the mother language(s) spoken in the two countries

While the latter two factors were kept constant over the whole simulation, $e_{k'j'}(t)$ was reduced from year to year to account for the effect of European integration. For the specification of the three factors, see Fürst et al. (1999). The accessibility indicators used in the model were not standardised to the European average to show increases in accessibility over time.

Modal accessibility indicators were aggregated to one multimodal accessibility indicator expressing the combined effect of alternative modes by replacing the impedance term $c_{rsm}(t)$ by the composite or *logsum* impedance (Williams, 1977):

$$c_{rs}(t) = -\frac{1}{\lambda} \ \ln \sum_{m \in \mathbf{M}_{rs}} \exp[-\lambda \, c_{rsm}(t)] \tag{3.3}$$

where $\boldsymbol{M}_{rs}$ is the set of modes available between regions r and s. Four composite accessibility indicators are used: accessibility by rail and road for travel, accessibility by rail, road and air for travel, accessibility by road for freight and accessibility by rail and road for freight.

Regional GDP

The GDP submodel is based on a quasi-production function incorporating accessibility as additional production factor. The economic output of a region is forecast separately for the six economic sectors used in SASI: agriculture, manufacturing, construction, trade/transport/tourism, financial services and other services (see IASON Deliverable D3, Bröcker et al., 2002b) in order to take different requirements for production by each sector into account. The regional production function predicts annual regional GDP per capita:

$$q_{ir}(t) = \mathrm{f}\,[\mathbf{C}_{ir}(t), \mathbf{L}_{ir}(t), \mathbf{A}_{ir}(t), \mathbf{X}_{ir}(t), \mathbf{S}_{r}(t), R_{ir}(t)] \tag{3.4}$$

where q_{ir}(t) is annual GDP per capita of industrial sector i in region r in year t, $\boldsymbol{C}_{ir}(t)$ *is* a vector of capital factors relevant for industrial sector i in region r in year t, $\mathbf{L}_{ir}(t)$ is a vector of indicators of labour availability relevant for industrial sector i in region r in year t, $\mathbf{A}_{ir}$ is a vector of accessibility indicators relevant for industrial sector i in region r in year t, $\mathbf{X}_{ir}(t)$ is a vector of endowment factors relevant for industrial sector i in region r in year t, $\mathbf{S}_{r}(t)$ are annual transfers received by the region r in year t and R_{ir}(t) is a region-specific residual taking account of factors not modelled (see below). Note that, even though annual GDP is in fact a flow variable relating to a particular year, it is modelled like a stock variable.

Assuming that the different production factors can be substituted by each other only to a certain degree, a multiplicative function which reflects a limitational relation between the factors was chosen. Since this kind of function introduces the coefficients as exponents of the explaining variables it is possible to interpret the coefficients as elasticities of production reflecting the importance of the different production factors for economic growth in a sector. The operational specification of the regional production functions used in the SASI model is:

$$q_{ir}(t) = C_{ir}(t-5)^{\alpha} \, L_{ir}(t-1)^{\beta} \, A_{ir}(t-1)^{\gamma} \ldots X_{ir}(t-1)^{\delta} \ldots S_{r}(t-1)^{\varepsilon} \ \exp(\rho) \ R_{ir}(t) \tag{3.5}$$

where $q_{ir}(t)$ is GDP per capita of sector i in region r in year t, $C_{ir}(t–5)$ is the economic structure (share of regional GDP of sector i) in region r in year t–5, $L_{ir}(t–1)$ is a labour market potential indicating the availability of qualified labour in region r and adjacent regions, $A_{ir}(t–1)$ is accessibility of region r relevant for sector i in year t–1, $X_{ir}(t–1)$ is an endowment factor relevant for sector i in region r in year t–1, $S_r(t–1)$ are transfer payments received by region r in year t–1, $R_{ir}(t)$ is the regression residual of the estimated GDP values of sector i in region r in year t and α, β, χ, δ, ε and ρ are regression coefficients.

The ... indicate that depending on the regression results multiple accessibility indicators and endowment indicators can be included in the equation. The economic structure variable is used as an explanatory variable because the conditions for production in a certain sector depend on the given sectoral structure, which reflects historic developments and path dependencies not covered by other indicators in the equation. The economic structure variables is delayed by five years as structural change is a slow process. Endowment factors are indicators measuring the suitability of the region for economic activity. They include traditional location factors such as capital stock (i.e. production facilities) and intraregional transport infrastructure as well as 'soft' quality-of-life 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 (for the specification of the composite quality-of-life indicator, see Schürmann, 1999). In addition, monetary transfers to regions by the European Union such as assistance by the Structural Funds or the Common Agricultural Policy or by national governments are considered, as these may account for a sizeable portion of the economic development of peripheral regions. Regional transfers per capita $S_r(t)$ are provided by the *European Developments* submodel (see above).

To take account of 'soft' factors not captured by the endowment and accessibility indicators of the model, all GDP per capita forecasts are multiplied by a region- and sector-specific residual constant R_{ir}. In the period 1981 to 1996, R_{ir} is the ratio between observed and predicted GDP per capita of sector i in region r in each year; hence in this period observed sectoral regional GDP is exactly reproduced by the model. In the period 1997 to 2021, the last residuals calculated for the year 1996 are applied.

In addition, the results of the regional GDP per capita forecasts are adjusted such that the total of all regional GDP meets the exogenous forecast of economic development (GDP) of the study area as a whole by the *European Developments* submodel (see above). However, these constraints are applied only to the reference scenario; in the policy scenarios the adjustment factors calculated for the reference scenario in each forecasting year are applied. In this way, the *changes* in generative effects induced by the policies are forecast.

The results of the calibration of the regional production functions will be presented in Section 3.3 below.

Regional GDP by industrial sector $Q_{ir}(t)$ is then

$$Q_{ir}(t) = q_{ir}(t)\ P_r(t) \tag{3.6}$$

where $P_r(t)$ is regional population (see below).

Regional Employment

Regional employment by industrial sector is derived from regional GDP by industrial sector and regional labour productivity.

Regional labour productivity is forecast in the SASI model exogenously based on exogenous forecasts of labour productivity in each country:

$$p_{ir}(t) = p_{ir}(t-1)\,\frac{p_{ir'}(t)}{p_{ir'}(t-1)} \qquad \text{with } r \in \boldsymbol{R}_{r'} \tag{3.7}$$

where $p_{ir}(t)$ is labour productivity, i.e. annual GDP per worker, of industrial sector i in region r in year t, $p_{ir'}(t)$ is average labour productivity in sector i in year t in country or group of regions $\boldsymbol{R}_{r'}$ to which region r belongs. The rationale behind this specification is the assumption that labour productivity by economic sector in a region is predominantly determined by historical conditions in the region, i.e. by its composition of industries and products, technologies and education and skill of labour and that it grows by an average sector-specific growth rate.

Regional employment by industrial sector is then

$$E_{ir}(t) = Q_{ir}(t)\,/\,p_{ir}(t) \tag{3.8}$$

where $E_{ir}(t)$ is employment in industrial sector i in region r in year t, $Q_{ir}(t)$ is the GDP of industrial sector i in region r in year t and $p_{ir}(t)$ is the annual GDP per worker of industrial sector i in region r in year t.

Regional Population

The *Regional Population* submodel forecasts regional population by five-year age groups and sex through natural change (fertility, mortality) and migration. Population forecasts are needed to represent the demand side of regional labour markets.

Changes of population due to births and deaths are modelled by a cohort-survival model subject to exogenous forecasts of regional fertility and mortality rates. To reduce data requirements, a simplified version of the cohort-survival population projection model with five-year age groups is applied. The method starts by calculating survivors for each age group and sex:

$$P'_{asr}(t) = P_{asr}(t-1)\;[1 - d_{asr'}(t-1,t)] \qquad \text{with } r \in \boldsymbol{R}_{r'} \tag{3.9}$$

where $P'_{asr}(t)$ are surviving persons of age group a and sex s in region r in year t, $P_{asr}(t-1)$ is population of age group a and sex s in year $t-1$ and $d_{asr'}(t-1,t)$ is the average annual death rate of age group a and sex s between years $t-1$ and t in country or group of regions $\mathbf{R}_{r'}$ to which region r belongs.

Next it is calculated how many persons change from one age group to the next through ageing employing a smoothing algorithm:

$$g_{asr}(t-1,t) = 0.12\,P'_{asr}(t) + 0.08\,P'_{a+1sr}(t) \qquad \text{for } a = 1,19 \tag{3.10}$$

where $g_{asr}(t-1,t)$ is the number of persons of sex s changing from age group a to age group $a+1$ in region r. Surviving persons in year t are then

$$P_{asr}(t) = P'_{asr}(t) + g_{a-1sr}(t-1,t) - g_{asr}(t-1,t) \qquad \text{for } a = 2,19 \tag{3.11}$$

with special cases

$$P_{20sr}(t) = P'_{20sr}(t) + g_{19sr}(t-1,t) \tag{3.12}$$

$$P_{1sr}(t) = P'_{1sr}(t) + B_{sr}(t-1,t) - g_{1sr}(t-1,t) \tag{3.13}$$

where $B_{sr}(t-1,t)$ are births of sex s in region r between years $t-1$ and t:

$$B_{sr}(t-1,t) = \sum_{a=4}^{10} 0.5\,[P'_{a2r}(t) + P_{a2r}(t)]\;\; b_{asr'}(t-1,t)\;\; [1 - d_{0sr'}(t-1,t)] \;\; \text{with } r \in \mathbf{R}_{r'} \tag{3.14}$$

where $b_{asr'}(t-1,t)$ are average number of births of sex s by women of child-bearing five-year age groups a, $a = 4,10$ (15 to 49 years of age) in country or group of regions $\boldsymbol{R}_{r'}$ to which region r belongs between years $t-1$ and t, and $d_{0sr'}(t-1,t)$ is the death rate during the first year of life of infants of sex s in country or group of regions $\boldsymbol{R}_{r'}$ to which region r belongs. The exogenous forecasts of death and birth rates in the above equations are national rates.

Migration within the European Union and immigration from non-EU countries is modelled in a simplified migration model as annual regional net migration as a function of regional indicators expressing the attractiveness of a region as a place of employment and a place to live to take into account both job-oriented migration and retirement migration:

$$m_r(t) = \alpha \left(\frac{q_r(t-3)}{\overline{q}(t-3)} - 1.5 \right) + \beta \left(\frac{v_r(t-3)}{\overline{v}(t-3)} - 1.5 \right) \tag{3.15}$$

The attractiveness of a region as a place of employment is expressed as the ratio of regional GDP per capita $q_r(t-3)$ and average European GDP per capita $\overline{q}_r(t-3)$. The attractiveness of a region as a place to live is expressed as the ratio of the regional quality of life $v_r(t-3)$ and average European quality of life $\overline{v}(t-3)$. For the specification of the composite quality-of-life indicator, see Schürmann (1999). Both indicators are lagged by three years to take account of delays in perception.

The forecasts of regional net migration are adjusted to comply with total European net migration forecast by the *European Developments* submodel.

Regional educational attainment, i.e. the proportion of residents with higher education in region r, is forecast exogenously assuming that it grows as in the country or group of regions to which region r belongs:

$$h_r(t) = h_r(t-1)\; h_{r'}(t) / h_{r'}(t-1) \qquad \text{with } r \in \boldsymbol{R}_{r'} \tag{3.16}$$

where $h_r(t)$ is the proportion of residents with higher education in region r in year t, and $h_{r'}(t)$ is the average proportion of residents with higher education in country or group of regions $\boldsymbol{R}_{r'}$ to which region r belongs.

Regional Labour Force

Regional labour force is derived from regional population and regional labour force participation.

Regional labour force participation by sex is partly forecast exogenously and partly affected endogenously by changes in job availability or unemployment. It is assumed that labour force participation in a region is predominantly determined by historical conditions in the region, i.e. by cultural and religious traditions and education and that it grows by an average country-specific growth rate. However, it is also assumed that it is positively affected by availability of jobs (or negatively by unemployment):

$$\ell_{sr}(t) = \ell_{sr}(t-1)\, \ell_{sr'}(t) / \ell_{sr'}(t-1) - \varphi_s\, u_r(t-1) \qquad \text{with } r \in \boldsymbol{R}_{r'} \tag{3.17}$$

where $\ell_{sr}(t)$ is labour force participation, i.e. the proportion of economically active persons of sex s of regional population of sex s 15 years of age and older, in region r in year t, $\ell_{sr'}(t)$ is average labour participation of sex s in year t in country or group of regions $\boldsymbol{R}_{r'}$ to which region r belongs, $u_r(t–1)$ is unemployment in region r in the previous year t–1 (see below), and φ_s is a linear elasticity indicating how much the growth in labour productivity is accelerated or slowed down by regional unemployment. Because at the time of execution of the *Regional Labour Force* submodel regional unemployment in year t is not yet known, unemployment in the previous year t–1 is used. Regional labour force by sex s in region r, $L_{sr}(t)$, is then

$$L_{sr}(t) = P_{sr}(t)\, \ell_{sr}(t) \tag{3.18}$$

where $P_{sr}(t)$ is population of sex s 15 years of age and older in region r at time t and $\ell_{sr}(t)$ is the labour force participation rate of sex s in region r in year t.

Regional labour force is disaggregated by skill in proportion to educational attainment in the region calculated in the *Population* submodel (see above):

$$L_{sr1}(t) = h_r(t)\, L_{sr}(t) \tag{3.19}$$

with $L_{sr1}(t)$ being skilled labour and the remainder unskilled labour:

$$L_{sr2}(t) = L_{sr}(t) - L_{sr1}(t) \tag{3.20}$$

Cohesion Indicators

From regional accessibility and GDP per capita forecast by the model equity or cohesion indicators describing their distribution across regions are calculated. Cohesion indicators are macroanalytical indicators combining the indicators of individual regions into one measure of their spatial concentration. Changes in the cohesion indicators predicted by the model for future transport policies reveal whether these policies are likely to reduce or increase existing disparities in accessibility and GDP per capita between the regions. In the IASON application of the SASI model five cohesion indicators are calculated:

- *Coefficient of variation*. The coefficient of variation is the standard deviation of region indicator values expressed in percent of their European average. The coefficient of variation informs about the degree of homogeneity or polarisation of a spatial distribution. A coefficient of variation of zero indicates that all areas have the same indicator values. The different size of regions is accounted for by treating each area as a collection of individuals having the same indicator value. The coefficient of variation can be used to compare two scenarios with respect to cohesion or equity or two points in time of one scenario with respect to whether convergence or divergence occurs.

- *Gini coefficient*. The Lorenz curve compares a rank-ordered cumulative distribution of indicator values of areas with a distribution in which all areas have the same indicator value. This is done graphically by sorting areas by increasing indicator value and drawing their cumulative distribution against a cumulative equal distribution (an upward sloping straight line). The surface between the two cumulative distributions indicates the degree of polarisation of the distribution of indicator values. The Gini coefficient calculates the ratio between the area of that surface and the area of the triangle under the upward sloping line of the equal distribution. A Gini coefficient of zero indicates that the distribution is equal-valued, i.e. that all areas have the same indicator value. A Gini coefficient close to one indicates that the distribution of indicator values is highly polarised, i.e. few areas have very high indicator values and all other areas very low values. The different size of areas can be accounted for by treating each area as a collection of individuals having the same indicator value.

- *Geometric/arithmetic mean*. This indicator compares two methods of averaging among observations: geometric (multiplicative) and arithmetic (additive) averaging. If all observations are equal, the geometric and arithmetic mean are identical, i.e. their ratio is one. If the observations are very heterogeneous, the geometric mean and hence the ratio between the geometric and the arithmetic mean go towards zero.

- *Correlation between relative change and level*. This indicator proposed by Bröcker examines the relationship between the percentage change of an indicator and its magnitude by calculating the correlation coefficient between them. If for instance the correlation between the changes in GDP per capita of the region and the levels of GDP per capita in the regions is positive, the more affluent regions gain more than the poorer regions and that disparities in income are increased. If the correlation is negative, the poorer regions gain more than the rich regions and disparities decrease.

- *Correlation between absolute change and level*. This indicator also proposed by Bröcker is constructed as the previous one except that absolute changes are considered.

3.2.2 Model Output

The main output of the SASI model are accessibility and GDP per capita for each region for each year of the simulation. However, a great number of other regional indicators are generated during the simulation. These indicators can be examined during the simulation by observing time-series diagrams, choropleth maps or 3D representations of variables of interest on the computer display. The user may interactively change the selection of variables to be displayed during processing. The following options can be selected:

Population indicators
- Population (1981=100)
- Percent population 0-5 years
- Percent population 6-14 years
- Percent population 15-29 years
- Percent population 30-59 years

- Percent population 60+ years
- Labour force (1981=100)
- Labour force participation rate (%)
- Percent lower education
- Percent medium education
- Percent higher education
- Net migration per year (%)
- Net commuting (% of labour force)

Economic indicators
- GDP (1981=100)
- Percent non-service GDP
- Percent service GDP
- GDP per capita (in 1,000 Euro of 1998)
- GDP per capita (EU15=100)
- GDP per worker (in 1,000 Euro of 1998)
- Employment (1981=100)
- Percent non-service employment
- Percent service employment
- Unemployment (%)
- Agricultural subsidies (% of GDP)
- European subsidies (% of GDP)
- National subsidies (% of GDP)

Attractiveness indicators
- Accessibility rail/road (travel, million)
- Accessibility rail/road/air (travel, million)
- Accessibility road (freight, million)
- Accessibility rail/road (freight, million)
- Soil quality (yield of cereals in t/ha)
- Developable land (%)
- R&D investment (% of GDP)
- Quality of life (0-100)

The same selection of variables can be analysed and post-processed after the simulation. If several scenarios have been simulated, the user can compare the results using a special comparison software. In addition to the regional indicators, travel cost matrices containing travel costs between 1,372 European regions are calculated for the CGEurope model (see Chapter 4) for the benchmark year 1997 and the future year 2020.

3.3 The Common Spatial Data Base

The common spatial database collected for the SASI and CGEurope models and the data sources used are documented in IASON Deliverable D3 (Bröcker et al., 2002b). Therefore here only the main data categories used for calibration, validation and simulation of the SASI model are summarised.

3.3.1 Calibration/Validation Data

The regional production function in the *Regional GDP* submodel and the migration function in the *Regional Population* submodel are the only model functions *calibrated* using statistical estimation techniques. All other model functions are *validated* by comparing the output of the whole model with observed values for the period between the base year and the present.

Calibration data are data used for calibrating the regional production functions in the *Regional GDP* submodel and the migration function in the *Regional Population* submodel. The four years 1981, 1986, 1991 and 1996 are used to gain insights into changes in parameter values over time; however, only the parameter estimates for 1996 are used in the simulation. The calibration data of 1981 are identical with the simulation data for the same year.

- Regional data (1,321 regions)
  - Regional GDP per capita by industrial sector in 1981, 1986, 1991, 1996
  - Regional labour productivity by industrial sector in 1981, 1986, 1991, 1996
  - Regional endowment factors in 1981, 1986, 1991, 1996
  - Regional labour force in 1981, 1986, 1991, 1996
  - Regional transfers in 1981, 1986, 1991, 1996
- Network data
  - Node and link data of strategic road network in 1981, 1986, 1991, 1996
  - Node and link data of strategic rail network in 1981, 1986, 1991, 1996
  - Node and link data of air network in 1981, 1986, 1991, 1996

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 model:

- Regional data (1,321 regions)
  - Regional population (by age and sex) in 1981, 1986, 1991, 1996, 2001
  - Regional GDP (by industrial sector) in 1981, 1986, 1991, 1996, 2001
  - Regional labour force (by sex) in 1981, 1986, 1991, 1996, 2001
  - Regional employment (by industrial sector) in 1981, 1986, 1991, 1996, 2001

3.3.2 Simulation Data

Simulation data are the data required to perform a typical simulation. 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 base year and so are either regional or network data. Regional base-year data provide base values for the *Regional GDP* submodel and the *Regional Population* submodel as well as base values for exogenous forecasts of changes in regional educational attainment and regional labour force participation. Network base-year data specify the road, rail and air networks used for accessibility calculations in the base year.

- Regional data (1,321 regions)
  - Regional GDP per capita by industrial sector in 1981
  - Regional labour productivity (GDP per worker) by industrial sector in 1981
  - Regional population by five-year age group and sex in 1981
  - Regional educational attainment in 1981

Regional labour force participation rate by sex in 1981
Regional quality-of-life indicators in 1981

Network data
Node and link data of strategic road network in 1981
Node and link data of strategic rail network in 1981
Node and link data of air network in 1981

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 base year and the present or are assumptions or policies for the future. Time-series are defined for each simulation period. All GDP data are converted to Euro of 1998.

European data (29 countries))
Total European GDP by industrial sector, 1981-2021
Total European net migration, 1981-2021

National data (29 countries)
National GDP per worker by industrial sector, 1981-2021
National fertility rates by five-year age group and sex, 1981-2021
National mortality rates by five-year age group and sex, 1981-2021
National educational attainment, 1981-2021
National labour force participation by sex, 1981-2021

Regional data (1,321 regions)
Regional endowment factors, 1981-2021
Regional transfers, 1981-2021

Network data
Changes of node and link data of strategic road network, 1981-2021
Changes of node and link data of strategic rail network, 1981-2021
Changes of node and link data of air network, 1981-2021

3.4 Model Calibration

The regional production functions were estimated by linear regression of the logarithmically transformed Equation 3.5 for the 1,321 internal regions and the six industrial sectors used in IASON for the years 1981, 1986, 1991 and 1996.

The dependent variable is regional GDP per capita in 1,000 Euro of 1998. Because of numerous gaps and inconsistencies in the data, extensive research was necessary to substitute missing or inconsistent data by estimation or by analogy with similar regions. In particular for the candidate countries, which underwent the transition from planned economies to market economies, information on regional GDP was inconsistent or completely missing. It was therefore decided to substitute regional GDP data for the years 1981 to 1991 for all regions by backcasts from 1996 regional GDP by sector based on overall sectoral GDP growth between 1981 and 1996, thus creating a fictitious past with only 1996 regional GDP as real data.

The independent variables of the regressions were a large set of regional indicators of potential explanatory value from which the following list was selected:

sgdpn	Share of GDP of sector *n* (%)
gdpwn	GDP per worker in sector *n* (1,000 Euro of 1998)
acct	Accessibility rail/road/air travel

acctf	Accessibility rail/road/air travel and rail/road freight
rlmp	Regional labour market potential (accessibility to labour)
soilq	Soil quality (yield of cereals in t/ha)
pdens	Population density (pop/ha)
rdinv	R&D investment (% of GDP)
eduhi	Share of population with higher education (%)
quali	Quality of life indicator (0-100)

Data on European or national subsidies originally included in the set of explanatory variables (see Equation 3.5) were eventually excluded because of the multiplicative nature of the regional production functions – they had the effect that estimated GDP per capita in regions without subsidies went to zero. To take account of the slow process of economic structural change, independent variables *sgdpn* and *gdpwn* are lagged by five years; all other independent variables are lagged by one year, i.e. the most recent available value is taken. Because no data are available for years before 1981, no lags are applied for 1981.

Table 3.1 shows the regression coefficients for the selected variables for 1981, 1986, 1991 and 1996. The regression coefficients for all years are equal in sign, similar in magnitude and show a consistent development – although this is likely to be due to the idealised nature of the backcasts from 1996. Figures 3.2 and 3.3 compare observed and predicted GDP per capita in manufacturing and services for the 1,321 regions in 1996. Given the large number of regions and the exclusion of region size by the choice of GDP per capita as dependent variable, the results are very satisfactory. In Figure 3.2 GDP per capita in manufacturing is underpredicted for Ludwigshafen (DEB34) with its large chemical industry and Wolfsburg (DE913) with the Volkswagen plant. In Figure 3.3 GDP per capita in services is underpredicted in industrial cities with universities in Germany, Darmstadt (DE711) and Erlangen (DE252), and the core cities of two large metropolitan areas, Berlin (DE301) and München (DE21H).

Table 3.1 SASI regional production functions: regression results

Sector	Variable	Coefficients			
		1981	1986	1991	1996
1 Agriculture	*sgdp1*	0.670716	0.678486	0.612673	0.593078
	gdpw1	0.580953	0.577406	0.530446	0.534609
	acct	0.077317	0.080556	0.072068	0.059524
	soilq			0.027763	0.029439
	pdens	-0.082487	-0.077390	-0.105002	-0.096862
	constant	-0.710301	-0.551925	-0.256585	-0.162314
	r^2	0.598	0.598	0.599	0.610
2 Manufacturing	*sgdp2*	1.024299	1.028343	0.980890	0.945329
	gdpw2	0.773159	0.761865	0.772353	0.767691
	acctf	0.030257	0.036640	0.059341	0.089031
	rlmp	0.011374	0.010963	0.011548	0.009814
	rdinv	0.149411	0.131605	0.124624	0.118710
	eduhi		0.031781	0.037639	0.042143
	constant	-0.608046	-0.284274	-0.354710	-0.495868
	r^2	0.616	0.621	0.616	0.616
3 Construction	*sgdp3*	0.815283	0.829773	0.835755	0.854567
	gdpw3	0.811540	0.804045	0.814147	0.813972
	acctf	0.199749	0.186223	0.189871	0.200961
	pdens	-0.009355			
	constant	-2.167798	-1.824628	-1.714334	-1.673584
	r^2	0.488	0.513	0.539	0.561
4 Trade, transport, tourism	*sgdp4*	0.993294	0.990967	0.990998	0.988154
	gdpw4	0.827398	0.817955	0.821806	0.817103
	acct	0.092635	0.091252	0.075505	0.079135
	pdens			0.013932	0.017962
	quali	0.422418	0.395414	0.403866	0.389184
	constant	-0.654739	-0.247650	-0.118879	-0.107157
	r^2	0.632	0.645	0.645	0.643
5 Financial services	*sgdp5*	1.366385	1.357455	1.368147	1.352444
	gdpw5	0.263919	0.260719	0.271784	0.277778
	acct	0.325536	0.320795	0.332337	0.351658
	constant	-0.423602	0.072828	0.081188	0.006541
	r^2	0.630	0.639	0.625	0.613
6 Other services	*sgdp6*	0.743147	0.755620	0.811446	0.856616
	gdpw6	0.886186	0.874925	0.882275	0.873002
	acct	0.176436	0.174010	0.176057	0.186729
	eduhi	0.106504	0.113897	0.091919	0.097539
	quali	0.078842	0.055886		
	constant	-1.815009	-1.242453	-1.195974	-1.129410
	r^2	0.694	0.723	0.734	0.741

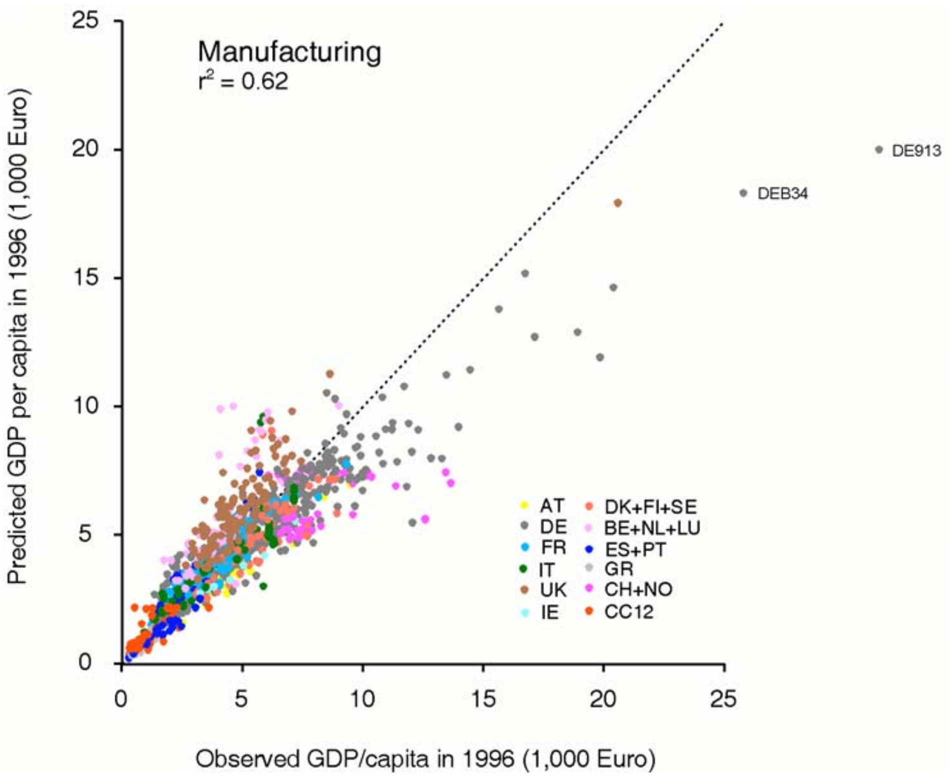


Figure 3.2 Observed and predicted GDP per capita in 1996, manufacturing

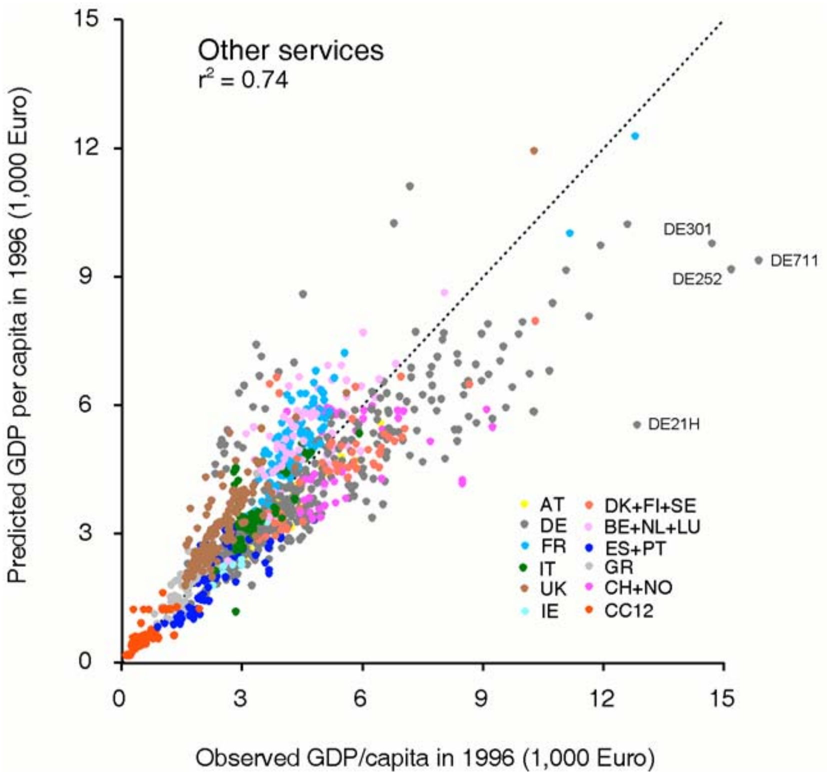


Figure 3.3 Observed and predicted GDP per capita in 1996, other services

3.5 SASI Results

With the extended and re-calibrated SASI model, the following 18 policy scenarios as described in Chapter 2 were simulated:

Network scenarios:	A1	TEN priority projects
	A21	High-speed rail priority projects
	A22	Conventional rail priority projects
	A23	Road priority projects
	A24	Rail priority projects
	A3	All TEN/TINA projects
	A4	All TEN projects
	A51	New priority projects
	A52	New priority rail projects
	A53	New priority road projects
	A61	A3 + additional projects in CC12
	A62	A3 + maximum projects in CC12
Pricing scenarios:	B1	SMC pricing road freight
	B2	SMC pricing all modes travel/freight
Combination scenario:	C1	A1+B2
Rail freight scenario:	D1	Dedicated rail freight network
TIPMAC scenarios:	E1	TIPMAC business-as-usual scenario
	E2	TIPMAC fast TEN + SMC

In addition, the do-nothing or base scenario 000 was simulated as reference or benchmark for comparing the policy scenarios. As also described in Chapter 2, the reference scenario is defined as a fictitious development in which no transport infrastructure projects or other transport policies are implemented after 2001. All assumptions for the policy scenarios (e.g. with respect to fertility, mortality, migration, productivity and labour force participation) are identical to those for the reference scenario except the policies under investigation themselves, so that all differences between the policy scenarios and the reference scenario can be unequivocally attributed to the policies examined.

All simulations start in the year 1981 and proceed in one-year time steps until the year 2021. Figure 3.4 shows as an example population development aggregated by country. Because of the one-year simulation period, the common IASON base year 1997 and target year 2020 are part of the simulation. The left half of Figure 3.4 represents the known past and calibration/validation period of the model. The yellow-shaded right half of the figure is the forecasting period of the model. All policy scenarios are identical and equal to the reference scenario until the year 2001.

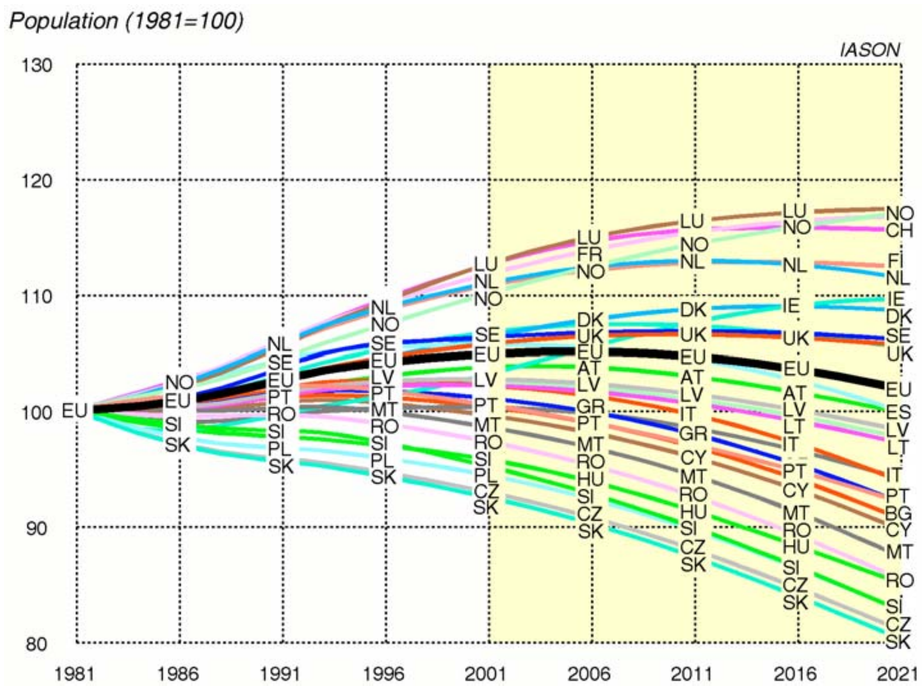


Figure 3.4. Calibration/validation period and forecasting period of the SASI model

3.5.1 Accessibility

Accessibility is a core concept of the SASI model (see Section 3.2). The maps in Figures 3.5 to 3.8 show the four types of accessibility indicator calculated in SASI and used as explanatory variables in the regional production functions:

- accessibility rail/road (travel)
- accessibility rail/road/air (travel)
- accessibility road (freight)
- accessibility rail/road (freight)

The familiar pattern of the highly accessible European core with its peak in the Benelux countries, west and south-west Germany, Switzerland and northern Italy emerges, leaving the Nordic countries, northern England, Scotland and Ireland, Portugal and Spain, southern Italy and Greece as clearly peripheral in the present European Union. Of the accession countries in eastern Europe, the Czech Republic, Slovakia, Hungary and parts of Poland belong to the European core, whereas the Baltic states and Romania and Bulgaria (and of course the two island states Cyprus and Malta) remain peripheral.

Figures 3.9 to 3.13 show the changes in accessibility caused by the policies in selected policy scenarios (or more precisely, the difference between the accessibility in the policy scenario and the accessibility in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the accessibility in the policy scenario is higher), whereas blue indicates negative differences.

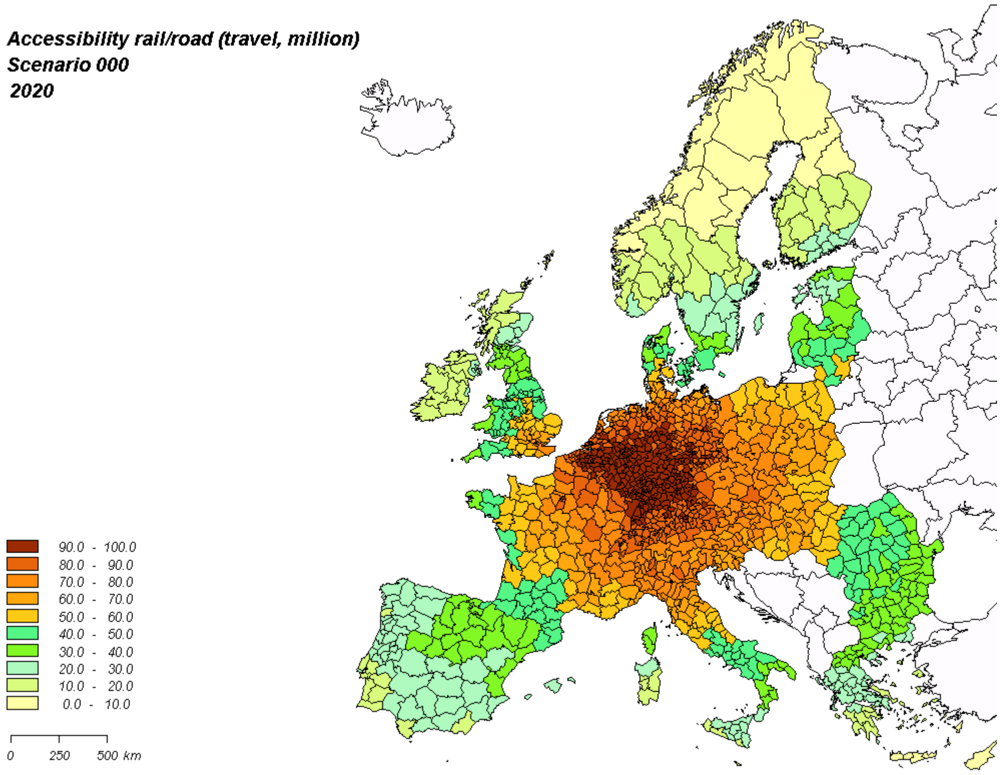


Figure 3.5. Reference scenario 000: Accessibility rail/road (travel, million) in 2020

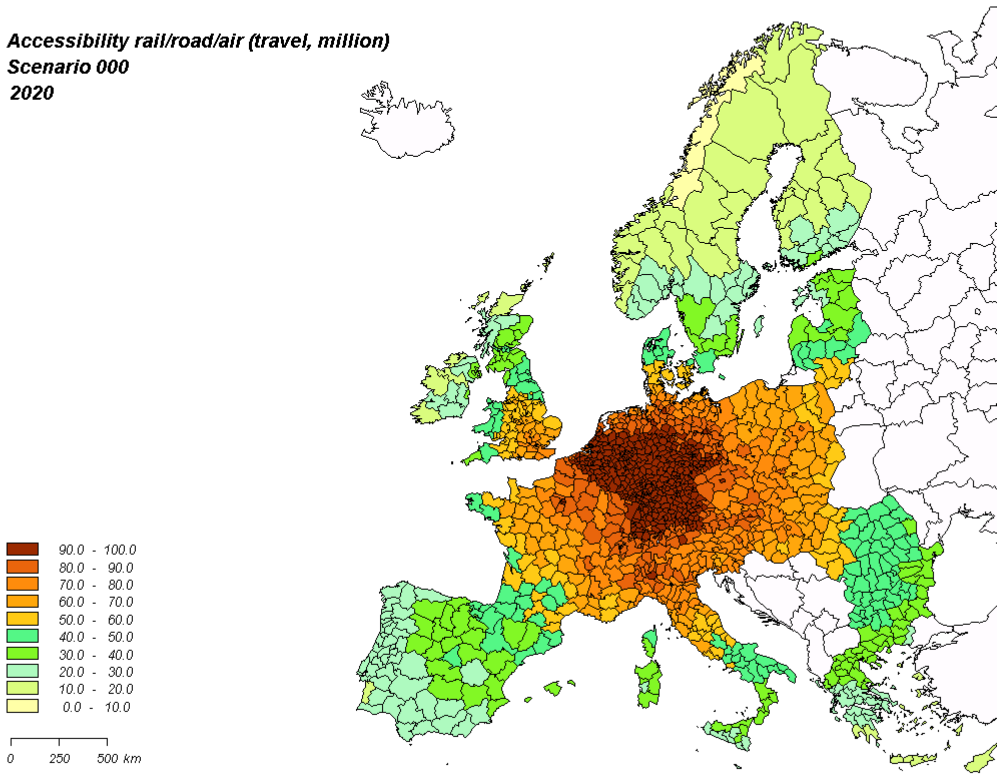


Figure 3.6. Reference scenario 000: Accessibility rail/road/air (travel, million) in 2020

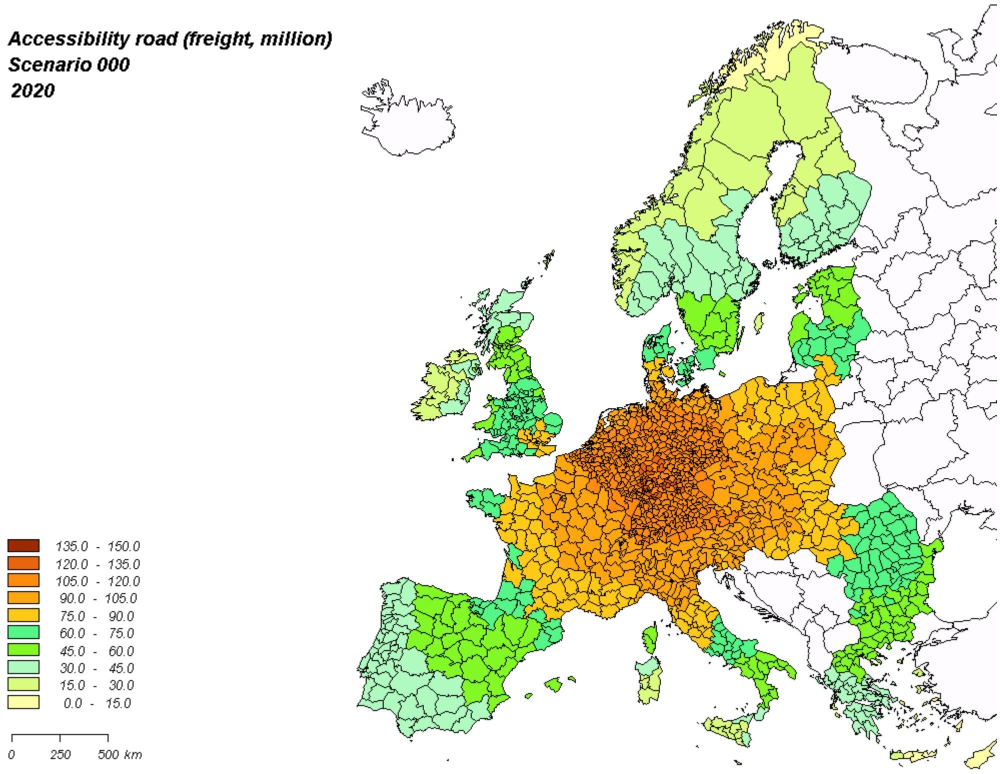


Figure 3.7. Reference scenario 000: Accessibility road (freight, million) in 2020

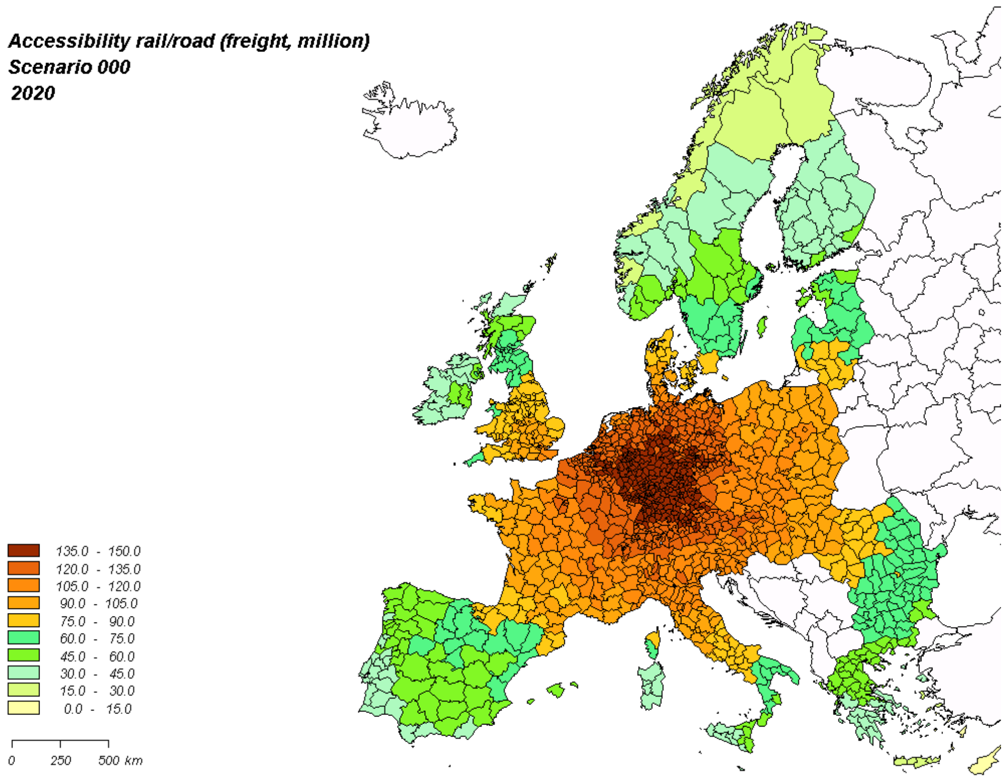


Figure 3.8. Reference scenario 000: Accessibility rail/road (freight, million) in 2020

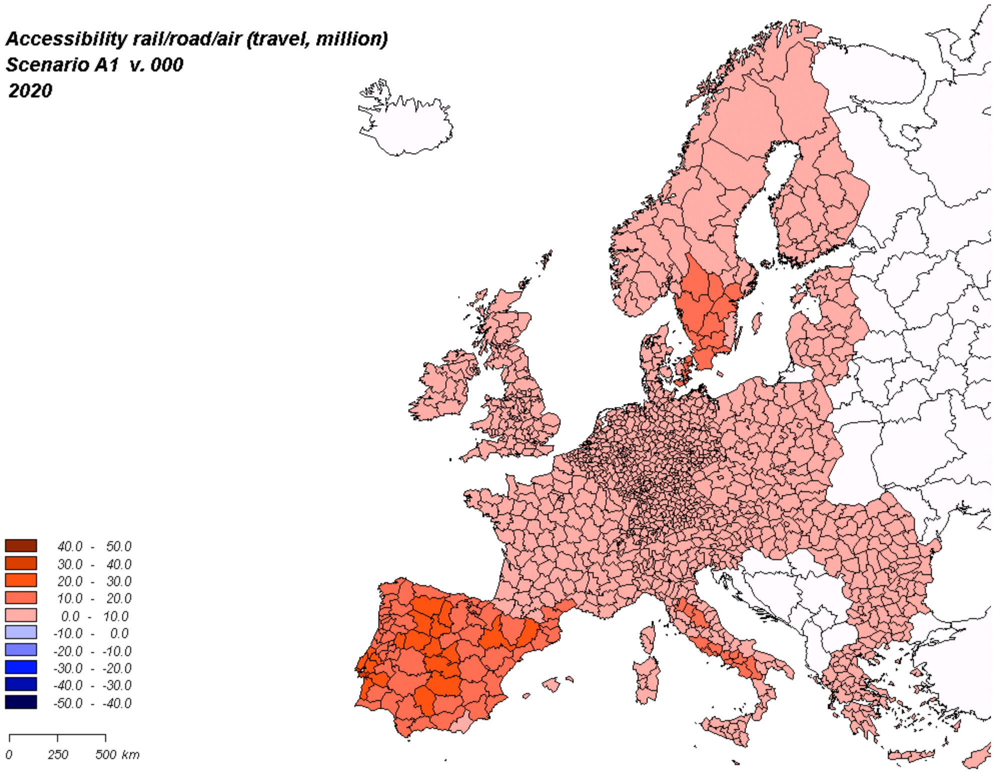


Figure 3.9. Percent change in accessibility rail/road/air (travel) by TEN priority projects (Scenario A1)

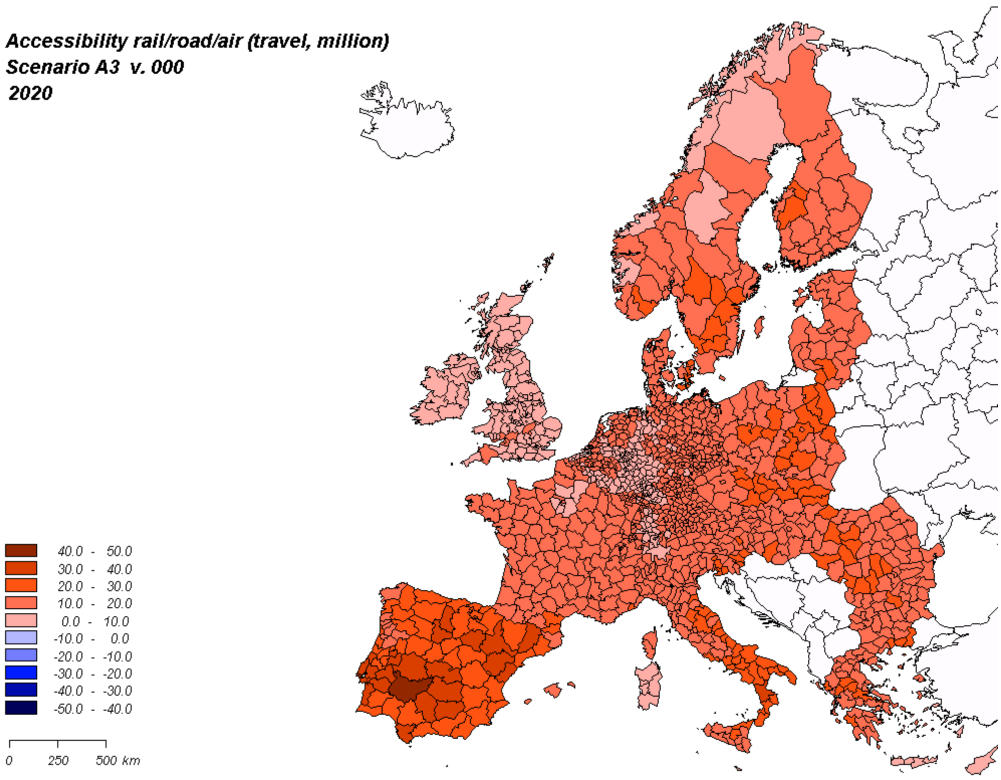


Figure 3.10. Percent change in accessibility rail/road/air (travel) by all TEN/TINA projects (Scenario A3)

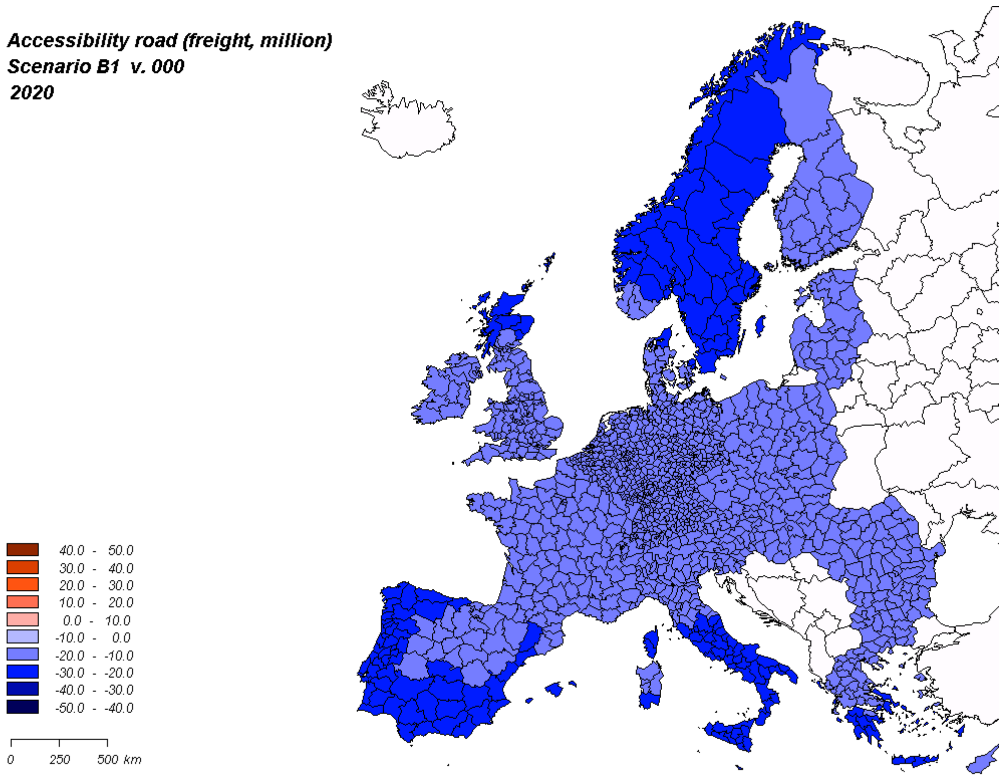


Figure 3.11. Percent change in accessibility road (freight) by freight road pricing (Scenario B1)

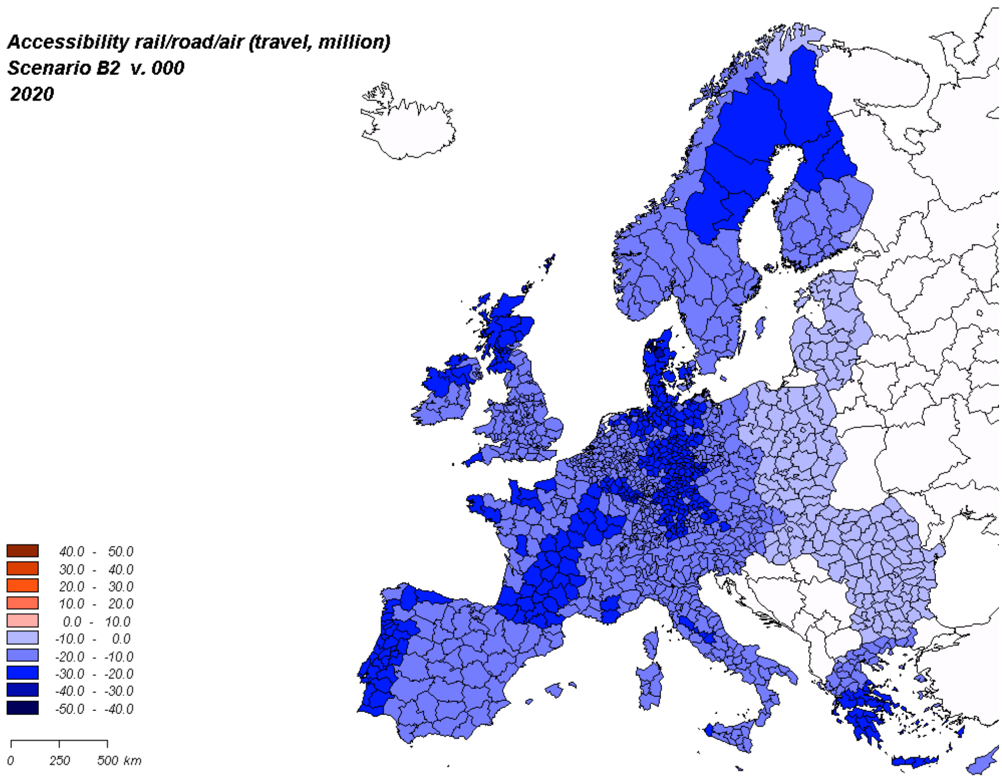


Figure 3.12. Percent change in accessibility rail/road/air (travel) by pricing of all modes (Scenario B2)

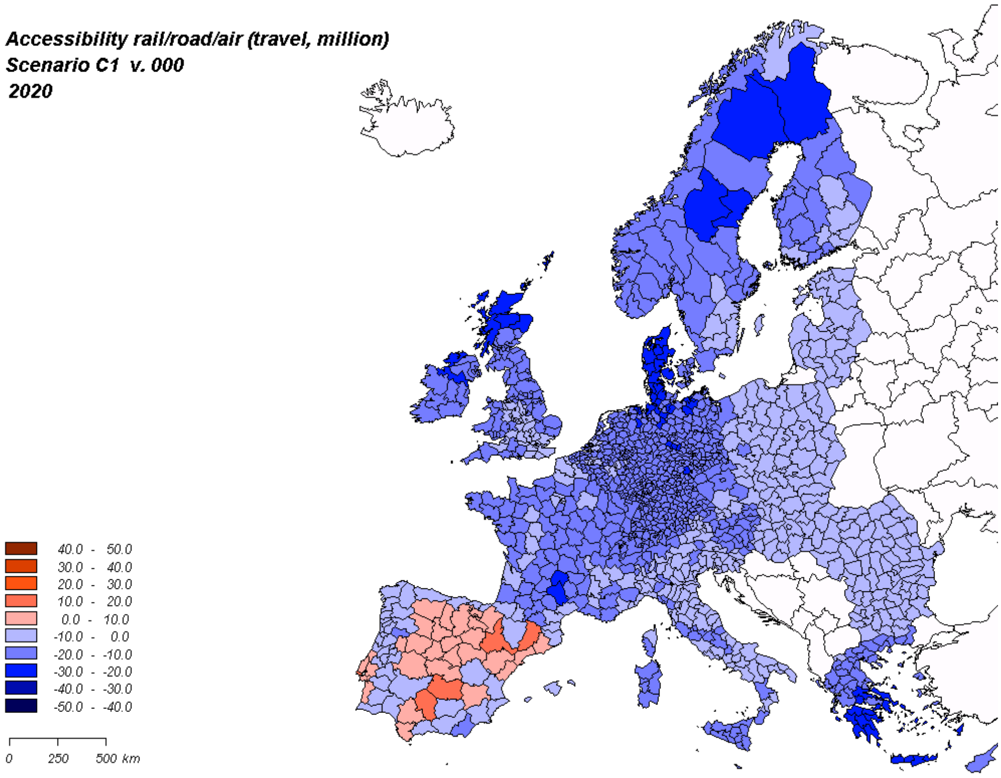


Figure 3.13. Percent change in accessibility rail/road/air (travel by combination of scenarios A1+B2 (Scenario C1)

As to be expected, the network scenarios A1, A3, A51 and A62 improve accessibility everywhere but to a different degree and not equally in all parts of Europe.

The 'classical' TEN priority projects of the Essen list (Scenario A1) aimed primarily at improving the accessibility of the peripheral regions in the Mediterranean and the Nordic countries (see Figure 3.9). Today, with the enlargement of the European Union, the task of better linking the accession countries in central and eastern Europe to the European core has become more important. If all network links designated as TEN and TINA (see Chapter 2) are assumed to be implemented as in Scenario A3, the gains in accessibility are much larger and more evenly distributed over the European territory (see Figure 3.10).

Conversely, all pricing policy scenarios reduce accessibility because per-km costs are included in the generalised-cost function. It is important to note that in all pricing scenarios marginal social cost pricing is applied only to transport links in the present European Union. If only freight transport on roads is priced, as in Scenario B1, the regions most affected are therefore peripheral regions in the present EU member states which depend on long-distance connections to markets – road accessibility by lorry goes down by more than twenty percent in parts of Portugal, Spain, southern Italy and Greece, and in the North in Scotland and Sweden, with Norway also affected (see Figure 3.11). In the more comprehensive pricing scenario B2, in which all modes and both travel and freight are subject to pricing, the effects are concentrated in the central regions which depend on business and leisure travel, whereas the candidate countries in eastern Europe are only little affected (see Figure 3.12).

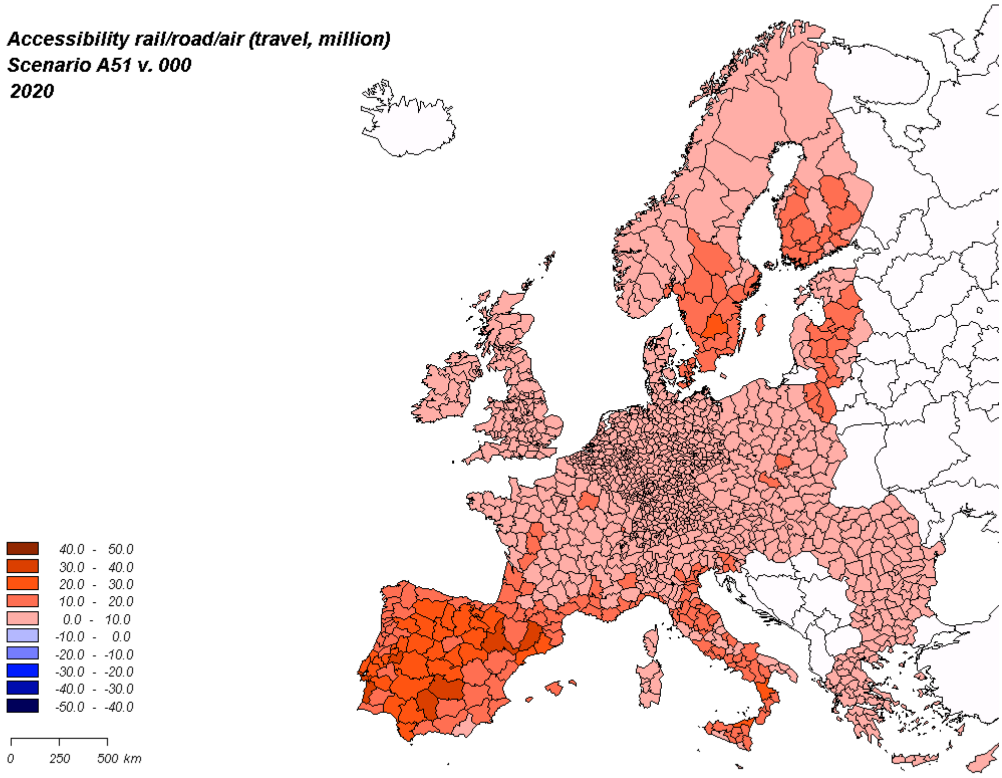


Figure 3.14. Percent change in accessibility rail/road/air (travel) by new priority projects (Scenario A51)

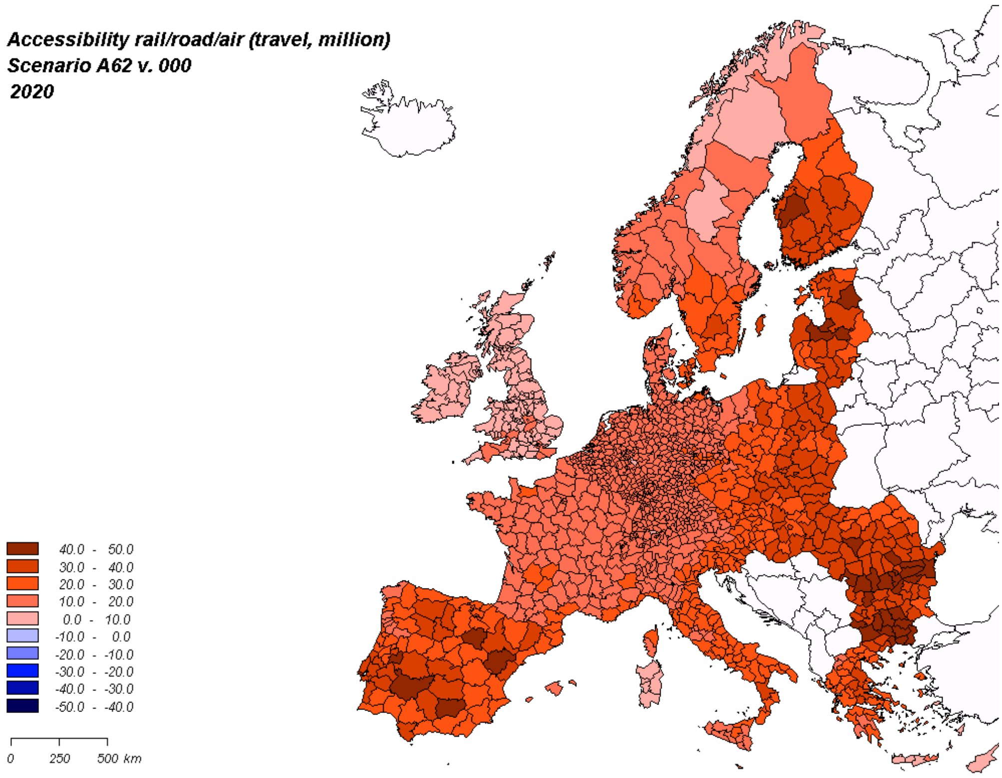


Figure 3.15. Percent change in accessibility rail/road/air (travel) by A3 + maximum projects in eastern Europe (Scenario A62)

Figure 3.13 shows the combined effects of network scenario A1 and pricing scenario B2 (Scenario C1) on multimodal travel accessibility. Now the increased costs due to transport pricing are partly offset by the positive effects of the network improvements, for some Spanish regions the balance is positive. However, because more network improvements in Scenario A1 are located in peripheral regions, the core of Europe with the highest accessibility (see Figures 3.5 to 3.8) is now losing more in accessibility than many peripheral regions.

Figures 3.14 and 3.15 present the effects of the additional network scenarios on accessibility. If one compares the accessibility effects of the new list of priority projects of Scenario A51 (see Figure 3.14) with those of the Essen list of Scenario A1 (see Figure 3.9), the differences seem not very great. However, the new projects in Poland and the Baltic states, which also improve accessibility in Finland, can be clearly identified. Figure 3.15 showing the effects of the most optimistic interpretation of the TINA outline plan in Scenario A62 should be compared with Figure 3.10, in which only the minimum implementation scheme of TINA projects in Scenario A3 is assumed. The results are quite spectacular with accessibility increases in Poland, Slovakia, Romania and Bulgaria and the Baltic states between 40 and 50 percent. Again, Finland participates in these gains, but also central Europe gains because of the improved access to eastern markets.

Table 3.2 and Figures 3.16 and 3.17 summarise the accessibility effects of all simulated policy scenarios.

Table 3.2. SASI model results: accessibility

		Accessibility difference between policy scenario and reference scenario in 2020 (%)			
	Scenario	EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+6.42	+4.72	+2.48	+5.68
A21	High-speed rail priority projects	+5.50	+3.28	+2.20	+4.86
A22	Conventional rail priority projects	+0.82	+0.90	+0.18	+0.71
A23	Road priority projects	+0.32	+0.81	+0.15	+0.30
A24	Rail priority projects	+6.16	+4.05	+2.35	+5.43
A3	All TEN/TINA projects	+12.74	+11.09	+14.40	+12.99
A4	All TEN projects	+11.06	+9.61	+5.07	+9.96
A51	New priority projects	+8.20	+7.06	+5.78	+7.74
A52	New priority rail projects	+7.84	+6.37	+4.96	+7.29
A53	New priority road projects	+0.48	+0.92	+1.01	+0.59
A61	A3 + additional projects in CC12	+13.74	+11.80	+17.18	+14.30
A62	A3 + maximum projects in CC12	+14.93	+12.73	+22.96	+16.30
B1	SMC pricing road freight	–4.44	–4.90	–5.65	–4.67
B2	SMC pricing all modes travel/freight	–13.37	–13.01	–9.46	–12.67
C1	A1+B2	–6.55	–8.24	–6.68	–6.61
D1	Dedicated rail freight network	+18.78	+17.95	+12.42	+17.63
E1	TIPMAC business-as-usual scenario	+12.55	+10.56	+14.32	+12.82
E2	TIPMAC fast TEN + SMC	+4.75	+1.59	+11.58	+5.89

Table 3.2 shows for each policy scenario the percentage difference in accessibility between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). As accessibility indicator here the sum of two of the four accessibility indicators used in SASI was applied: accessibility rail/road/air (travel) and accessibility rail/road (freight). The same type of results for all 29 countries in the study area can be found in Tables B.1 to B.3 of Annex B.

As it was already observed, all network scenarios have a positive effect on accessibility. The degree of improvement, obviously, is a function of the number of projects and the volume of investment. The high-speed rail priority projects are much more effective than the conventional rail projects, and the rail projects are much more effective than the road improvement projects, but this may be caused by the greater number of high-speed rail and rail projects in the two priority lists. Not surprisingly, if all TEN and TINA projects are implemented, the effects are more substantial, and if even more projects are implemented as in Scenarios 61 and 62, the effects are even larger. Remarkably, the largest accessibility effect is achieved by the dedicated rail freight network of Scenario D1, presumably because of the general technical improvement of the rail network assumed in Scenario D1 (see Chapter 2).

Transport pricing policies, on the other hand, reduce accessibility. Again not surprisingly, the more profound effect occurs if all modes and both travel and goods transport are subjected to pricing as in Scenario B2. If both network and pricing scenarios are combined as in Scenario C1, the outcome depends on the pricing level – in Scenario C1 the negative impacts of the pricing outweigh the positive impacts of the network improvements.

Figures 3.16 and 3.17 present the same information in graphical form. Figure 3.1.6 shows the development of accessibility (as defined above) between 1981 and 2021 in the present European Union (EU15) and Figure 3.17 the same for the twelve candidate countries (CC12). Each line in the diagram represents the development of accessibility in one scenario, the heavy black line the reference scenario. As noted before, all scenarios are identical until the year 2001. The lines are colour-coded to indicate the scenario groups.

In the reference scenario accessibility increases after 2001, although in it no network improvements are assumed after 2001. These increases are due to the reduction of waiting times at borders and political, cultural and language barriers through the enlargement of the European Union and further integration assumed for all scenarios. It is obvious that these effects are much stronger for the accession countries than for the member states of the present European Union. The accessibility of the candidate countries as a whole is not much less than in the present European Union as a whole. However, there remain large differences in accessibility both in the European Union and among the candidate countries (see Tables B.1 to B.3 in Annex B). It can be seen that the network scenarios tend to be implemented incrementally and so slowly build up their impact over time, whereas the pricing scenarios work like a shock and then follow the general trend of the reference scenario.

The comparison of the two diagrams seems to indicate that the effects of the network scenarios are stronger in the candidate countries, whereas the pricing scenarios more strongly affect the member states of the present European Union. This effect will be discussed again in the section on cohesion effects.

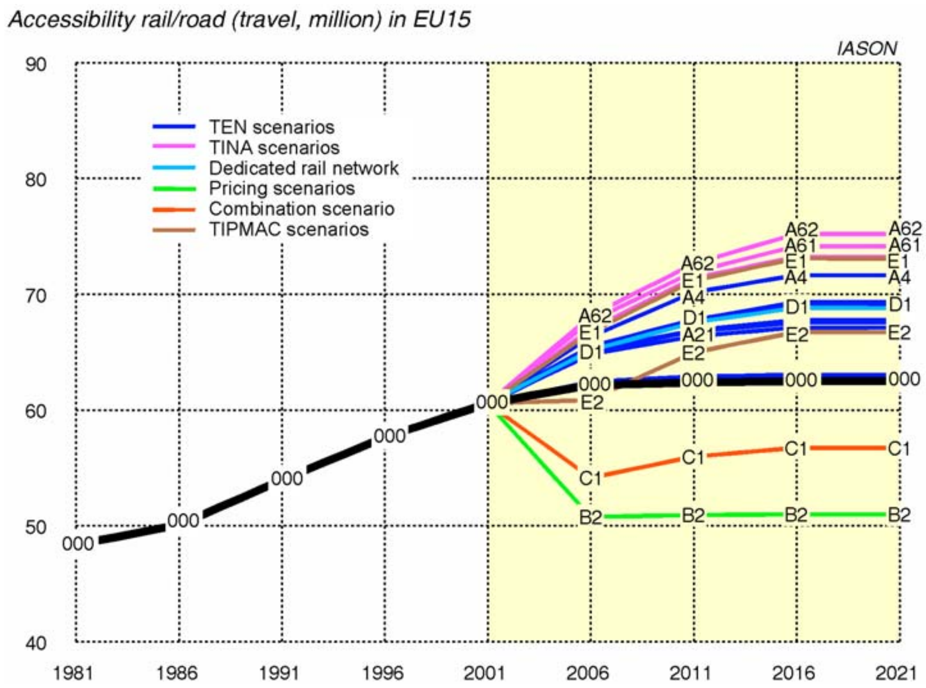


Figure 3.16. Accessibility rail/road (travel, million) in the European Union

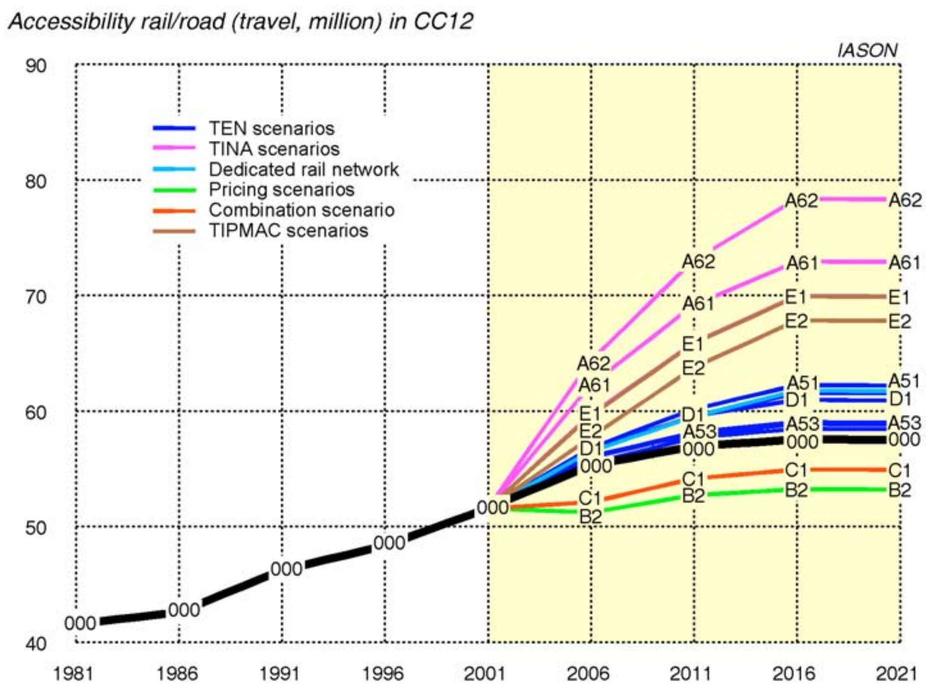


Figure 3.17. Accessibility rail/road (travel, million) in the candidate countries

3.5.2 GDP per Capita

The major policy-relevant output of the SASI model is regional GDP per capita, i.e. GDP totalled over all six sectors used in SASI divided by population.

Figures 3.18 to 3.24 show the changes in GDP per capita caused by the policies in the same set of policies as shown in Figures 3.9 to 3.13 (or more precisely, the difference between GDP per capita in the policy scenario and GDP per capita in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the GDP per capita in the policy scenario is higher), whereas blue indicates negative differences. However, in contrast to the accessibility maps, now the regional GDP per capita are standardised as percent of the EU27+2 average, so that the generative effects of the forecast GDP forecasts are neutralised and only the distributional effects are shown (see Table B.5 in Annex B). This serves to demonstrate that even if the model predicts that all regions gain in GDP per capita, there are relative winners and losers.

Figures 3.18 and 3.19 demonstrate that regions that gain in accessibility also gain in GDP per capita. A comparison of Figure 3.18 with Figure 3.9 shows that if the 'classical' TEN priority projects of the Essen list are implemented as in Scenario A1, the network improvements in the cohesion countries Portugal, Spain and Italy are successful in promoting economic development in these countries as intended. Figure 3.19 shows that, as in Figure 3.10, the implementation of all TEN and TINA projects would spread the impacts over a wider area including the candidate countries in eastern Europe.

Similar observations, but with the opposite sign, can be made with respect to the impacts of transport pricing policies. Figures 3.20 and 3.21 show the effects of road pricing for lorries (Scenario B1) and pricing of all modes for both travel and goods transport (Scenario B2), respectively. Figure 3.20 (Scenario B1) conforms to expectation: the peripheral regions, which lose most in accessibility (see Figure 3.11), also lose most in GDP per capita. The reverse occurs in the case of the more comprehensive pricing scheme of Scenario B2 (Figure 3.21). Now the peripheral regions seem to be the (relative) winners, because the central regions suffer more under the high charges on travel.

If network scenario A1 and pricing scenario B2 are combined as in Scenario C1, the results is, as to be expected, a superposition of the effects of both policies (see Figure 3.22). A comparison with the accessibility map of Scenario C1 (Figure 3.13) shows that regions with high losses in accessibility also lose GDP per capita and that regions with gains or only slight losses in accessibility perform well economically.

The same relationship between accessibility and GDP per capita holds true for the two remaining scenario examples. The changes in GDP per capita resulting from the new priority projects in Scenario 51 (Figure 3.23) correspond well with the changes in accessibility in that scenario in Figure 3.9. A comparison with the GDP per capita in Scenario A1, in which the 'old' priority projects are implemented (see Figure 3.18) , shows that the economic effects of the two priority lists are very similar, except that the new priority projects redress some of the disadvantages of the peripheral regions in eastern Europe. Not surprisingly, the massive network policies in eastern Europe in Scenario A62 lead to significant additional economic growth in the candidate countries (see Figure 3.24).

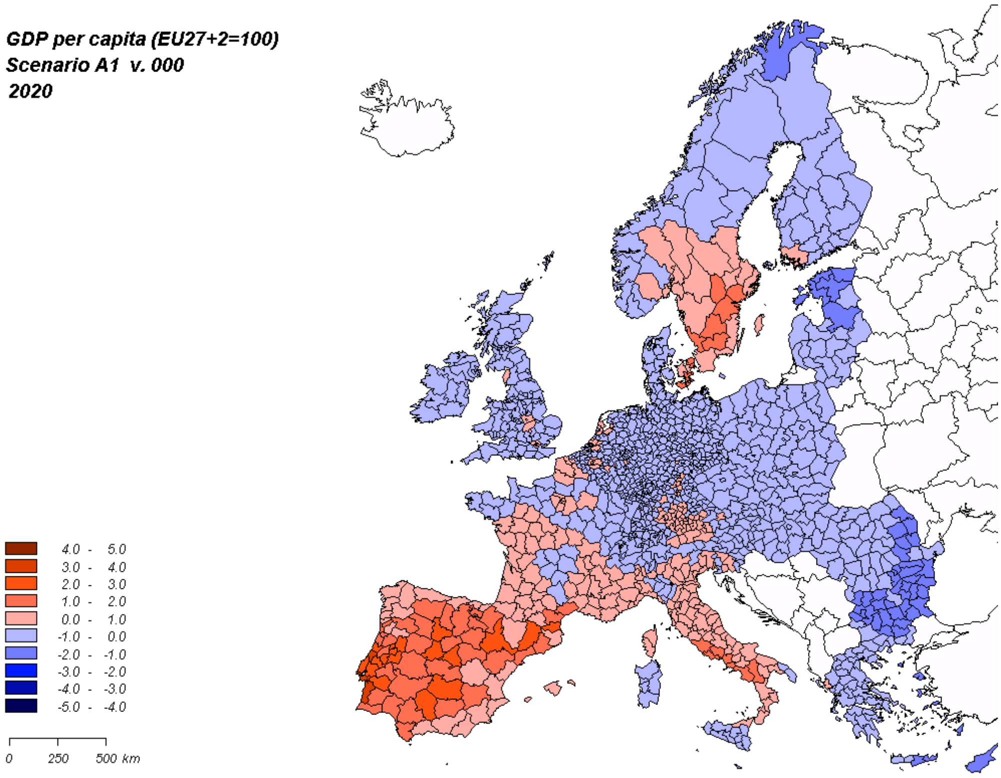


Figure 3.18. Percent change in GDP per capita (E27+2=100) by TEN priority projects (Scenario A1)

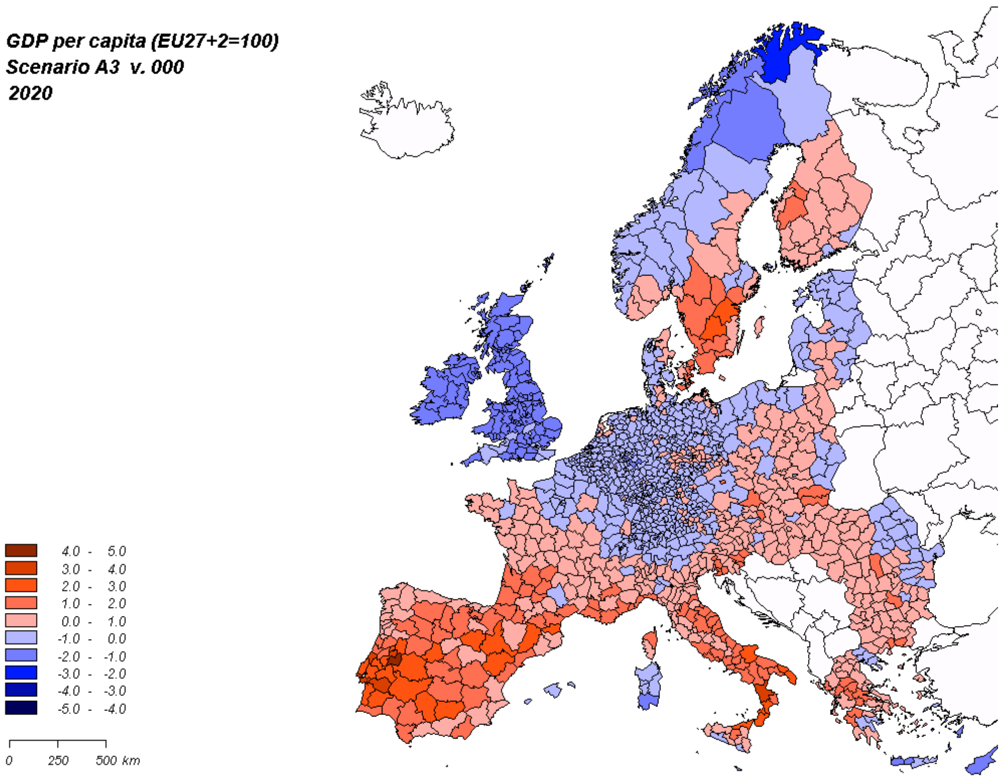


Figure 3.19. Percent change in GDP per capita (E27+2=100) by all TEN/TINA projects (Scenario A3)

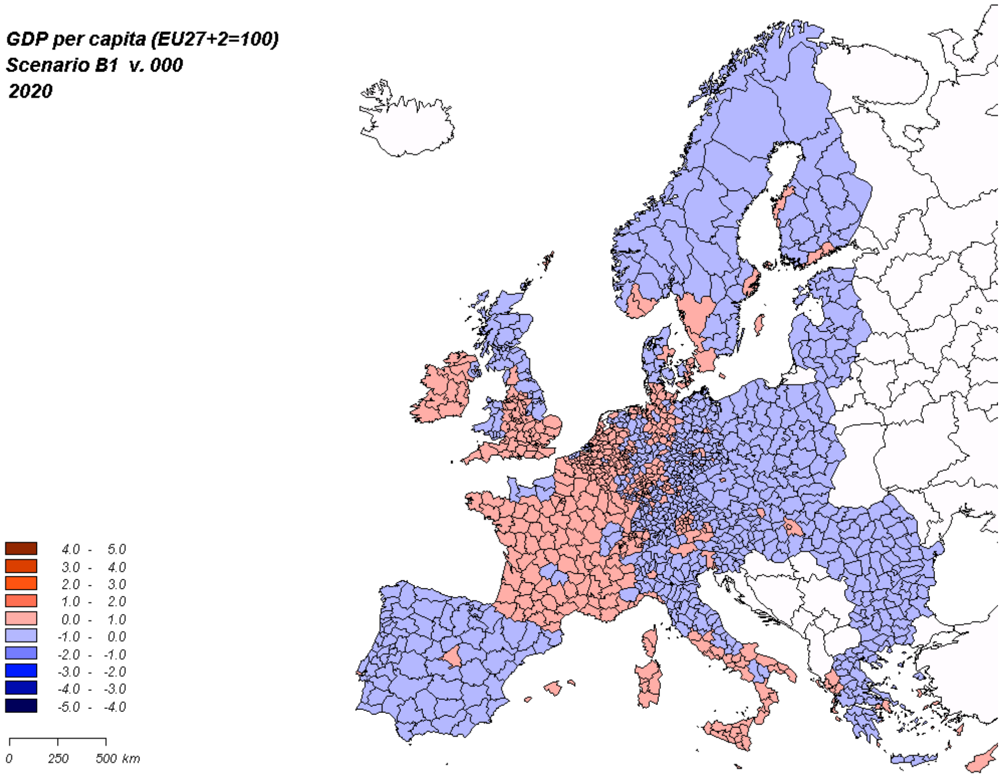


Figure 3.20. Percent change in GDP per capita (E27+2=100) by freight road pricing (Scenario B1)

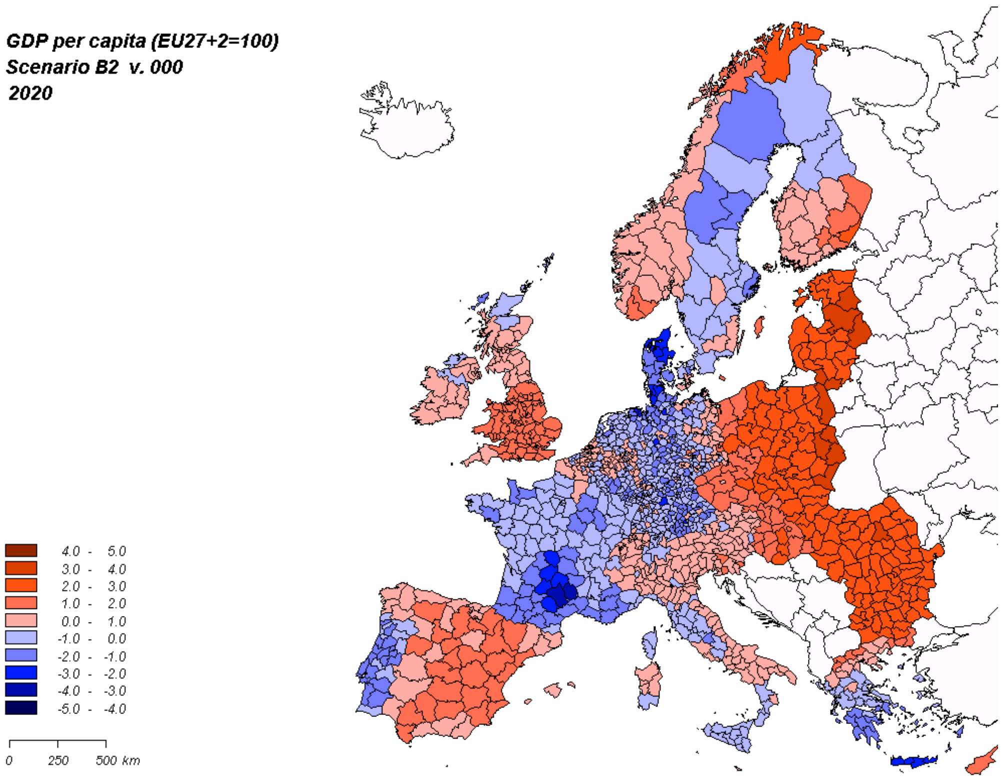


Figure 3.21. Percent change in GDP per capita (E27+2=100) by pricing of all modes (Scenario B2)

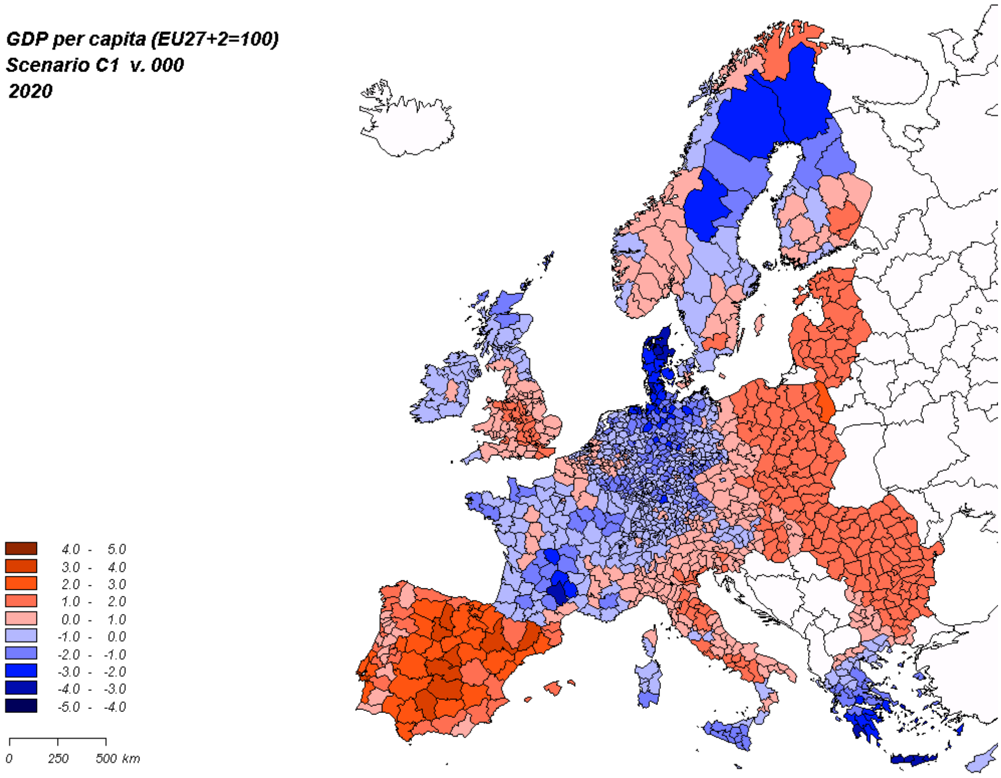


Figure 3.22. Percent change in GDP per capita (E27+2=100) by combination of scenarios A1+B2 (Scenario C1)

Table 3.3 and Figures 3.25 and 3.26 summarise the GDP per capita effects of all simulated policy scenarios.

Table 3.3 shows for each policy scenario the percentage difference in GDP per capita between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). GDP per capita shown is the total of GDP of the six sectors used in SASI divided by population, unstandardised. The standardised values used to draw the maps in Figures 3.18 to 3.24 can be found in Table B.5 of Annex B, the unstandardised values in Table B4.

In this unstandardised form, all network scenarios have a positive effect on GDP per capita. As with accessibility, the largest effects are associated with the more comprehensive investment programmes: all TEN projects (Scenario A1), all TEN and TINA projects (Scenario A3) and the larger version of the additional projects in CC12 (Scenario A62). Also in economic terms, high-speed rail is more effective than conventional rail, and rail is more effective than road – but again with the caveat that this result may be due to the larger proportion of rail, and in particular high-speed rail, projects among the projects of the two priority lists. In economic terms, the dedicated rail network is not so successful as its accessibility effect might suggest.

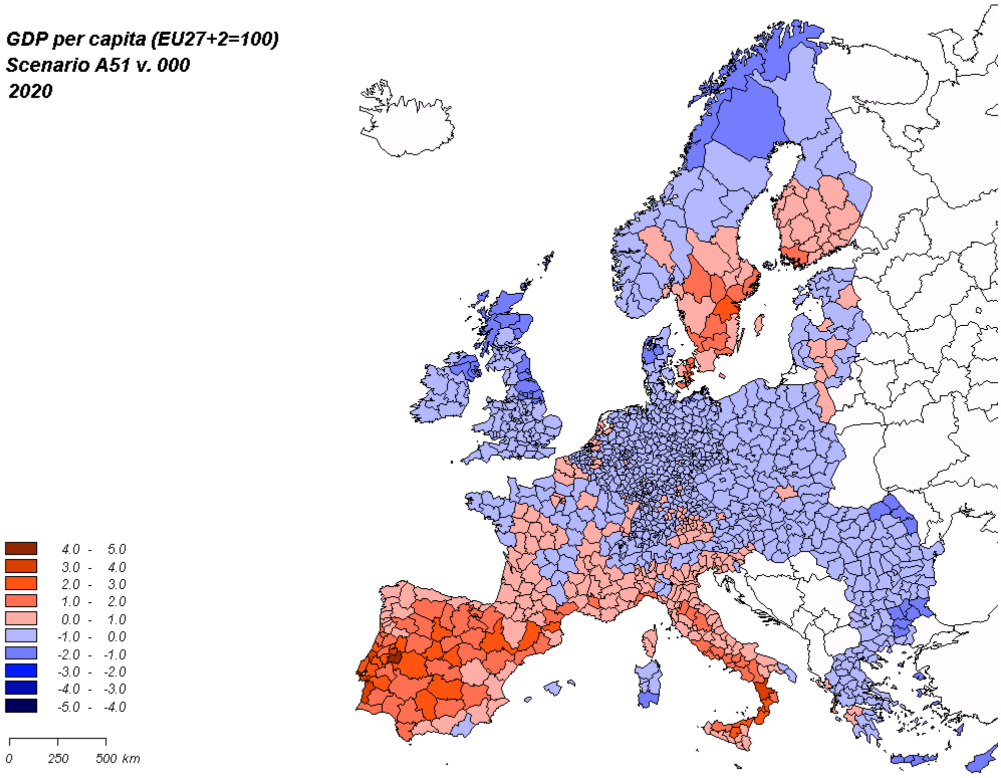


Figure 3.23. Percent change in GDP per capita (E27+2=100) by new priority projects (Scenario A51)

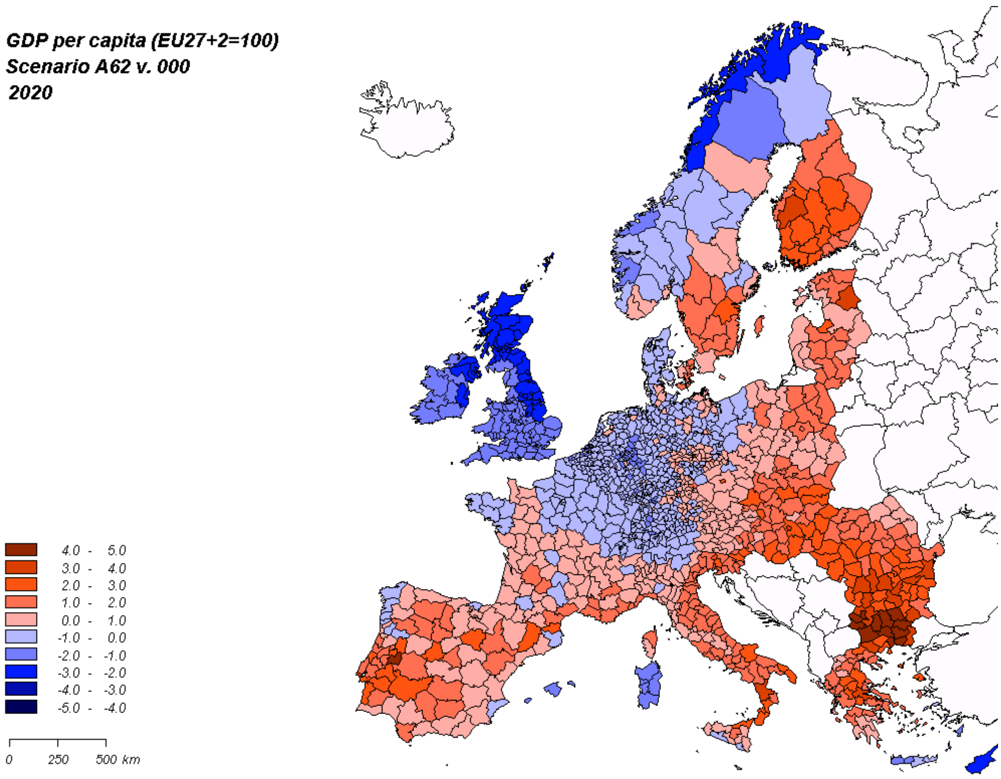


Figure 3.24. Percent change in GDP per capita (E27+2=100) by A3 + maximum projects in eastern Europe (Scenario A62)

Table 3.3. SASI model results: GDP per capita

Scenario		GDP per capita difference between policy scenario and reference scenario in 2020 (%)			
		EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+1.25	+0.88	+0.32	+1.19
A21	High-speed rail priority projects	+1.07	+0.55	+0.28	+1.01
A22	Other rail priority projects	+0.14	+0.20	+0.01	+0.13
A23	Road priority projects	+0.09	+0.18	+0.03	+0.09
A24	Rail priority projects	+1.17	+0.74	+0.30	+1.11
A3	All TEN/TINA projects	+2.59	+2.14	+2.90	+2.58
A4	All TEN projects	+2.19	+1.84	+0.78	+2.11
A51	New priority projects	+1.62	+1.31	+1.02	+1.58
A52	New priority rail projects	+1.54	+1.17	+0.86	+1.49
A53	New priority road projects	+0.12	+0.20	+0.21	+0.13
A61	A3 + additional projects in CC12	+2.84	+2.30	+3.70	+2.85
A62	A3 + maximum projects in CC12	+3.10	+2.48	+5.16	+3.16
B1	SMC pricing road freight	–0.10	–0.16	–0.19	–0.11
B2	SMC pricing all modes travel/freight	–3.84	–3.38	–1.62	–3.72
C1	A1+B2	–2.38	–2.47	–1.23	–2.33
D1	Dedicated rail freight network	+1.71	+1.61	+1.06	+1.68
E1	TIPMAC business-as-usual scenario	+2.54	+2.03	+2.89	+2.52
E2	TIPMAC fast TEN + SMC	+0.33	–0.84	+2.20	+0.35

Transport pricing policies reduce not only accessibility but also GDP per capita. Remarkably, pricing of only freight transport on roads (Scenario B1), has only little economic effect despite its significant negative effect on accessibility (see Table 3.2). However, if all modes and both travel and goods transport are subjected to pricing as in Scenario B2, the negative effect is very strong and is in fact the strongest effect of all scenarios whether positive or negative. If both network and pricing scenarios are combined as in Scenario C1, the negative effect of pricing by far outweighs the positive impact of the network improvements.

Figures 3.25 and 3.26 present the same information in graphical form. Figure 3.25 shows the development of GDP per capita between 1981 and 2021 in the present European Union (EU15) and Figure 3.26 the same for the twelve candidate countries (CC12). Each line in the diagram represents the development of GDP per capita in one scenario, the heavy black line the reference scenario. As noted before, all scenarios are identical until the year 2001. The lines are colour-coded to indicate the scenario groups.

A comparison of Figures 3.25 and 3.26 with the same diagrams for accessibility (Figures 3.16 and 3.17) demonstrates that relatively large changes in accessibility translate into only very small changes in economic performance (note the difference in scale of the two pairs of diagrams). In fact the changes in GDP per capita caused by transport policy are tiny in relation to the changes caused by other driving forces, such as innovation, productivity gains or globalisation. For instance it is assumed for all SASI scenarios that total GDP in the study area grows by 70 percent until 2021, or by 2.66 percent annually. Even the economic effect of the implementation of all TEN and TINA projects would amount to less than one year's growth or increase the annual growth rate by a mere 0.08 percent.

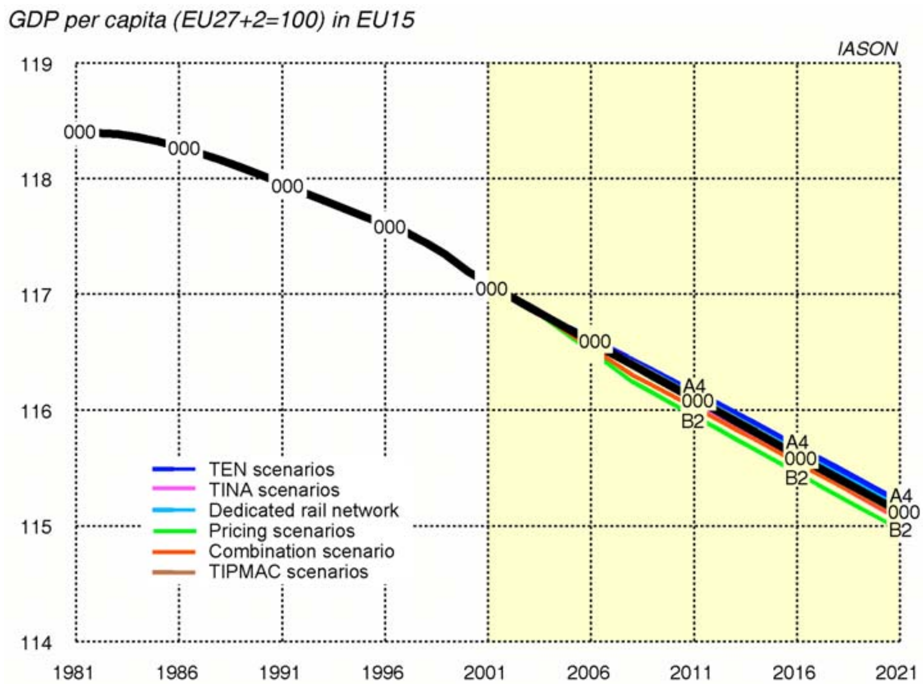


Figure 3.25. GDP per capita (EU27+2=100) in the European Union

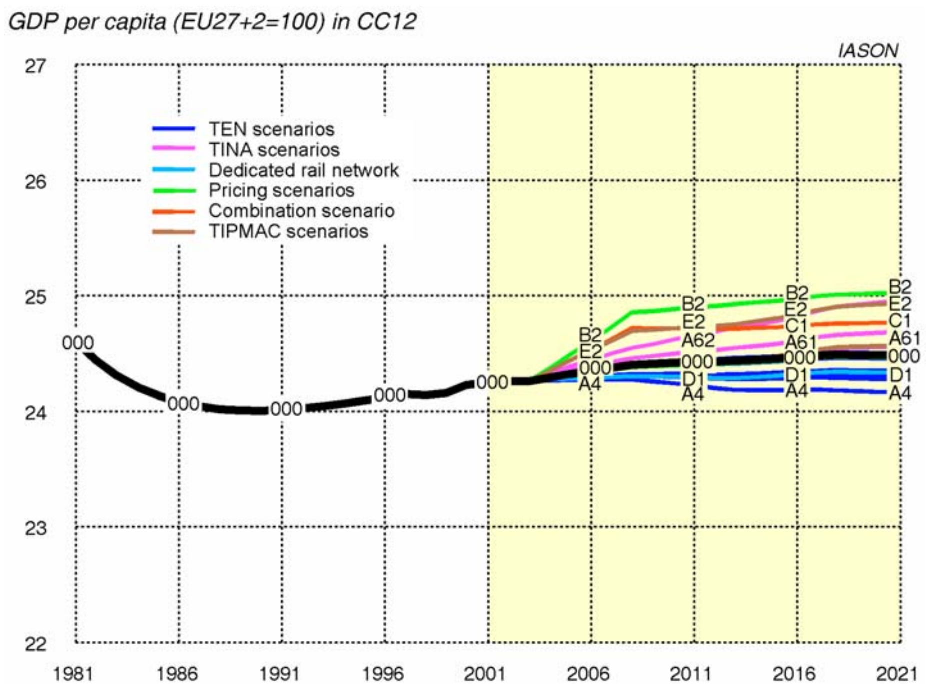


Figure 3.26. GDP per capita (EU27+2=100) in the candidate countries

A further look at Figures 3.25 and 3.26 shows that the average GDP per capita in the candidate countries is less than one fifth of that in the member states of the present European Union, and that this vast gap in is narrowing, though very slowly. Transport policy seems to contribute only very little to this convergence, and if it does it does so by improving accessibility in the candidate countries rather than reducing accessibility in the European core. The comprehensive pricing scenario B2 and the massive transport infrastructure programme of Scenario 62 accomplish most in closing the gap, whereas the dedicated rail freight network (Scenario D1) and the implementation of all TEN projects (Scenario A4) tend to increase it. This leads to the issue of cohesion.

3.5.3 Cohesion

Strengthening cohesion between the regions in the European Union and reducing the economic and social disparities between them is one of the main goals of the European Union. Transport policy is one of the major policy instruments of the European Union to serve this goal in conjunction with the goal to increase the economic competitiveness of regions. With the enlargement of the European Union and the accession of ten of the twelve candidate countries, cohesion issues become of growing importance.

There are many possible ways to measure the cohesion effects of transport policy measures. Five indicators of territorial cohesion were applied to the results of the scenario simulations (see Section 3.2). The five indicators are:

- *Coefficient of variation*. This indicator is the standard deviation of region indicator values expressed in percent of their European average. The coefficient of variation ranges between zero (no variation) and one (extreme polarisation).

- *Gini coefficient*. The Gini coefficient measures the area between the accumulated distribution of sorted indicator values and the straight line representing an equal distribution. Like the coefficient of variation, the Gini coefficient ranges between zero (equal distribution) and one (extreme polarisation).

- *Geometric/arithmetic mean*. This indicator compares two methods of averaging among observations: geometric (multiplicative) and arithmetic (additive) averaging. If all observations are equal, the geometric and arithmetic mean are identical, i.e. their ratio is one. If the observations are very heterogeneous, the geometric mean and hence the ratio between the geometric and the arithmetic mean go towards zero.

- *Correlation between relative change and level*. This indicator proposed by Johannes Bröcker examines the relationship between the percentage change of an indicator and its magnitude by calculating the correlation coefficient between them. If for instance the correlation between the changes in GDP per capita of the region and the levels of GDP per capita in the regions is positive, the more affluent regions gain more than the poorer regions and that disparities in income are increased. If the correlation is negative, the poorer regions gain more than the rich regions and disparities decrease.

- *Correlation between absolute change and level*. This indicator also proposed by Johannes Bröcker is constructed as the previous one except that absolute changes are considered.

The distinction between the last two indicators will be demonstrated by calculating them for the three scenarios A1, B2 and C1.

Figures 3.27 to 3.29 show for each scenario four scatter diagrams. Each dot in the scatter diagram represents a predicted value for one of the 1,321 NUTS-3 regions of the study area in 2021. The dots are colour-coded to allow to identify the regions by country or group of countries. The horizontal axis of each scatter diagram represents the values of one of two variables, accessibility and GDP per capita in the reference scenario in 2020. The vertical axes represent the change of these variables caused by the policy examined, i.e. the difference between the variable in the policy scenario and the reference scenario. The upper row of scatter diagrams refer to accessibility, the lower row to GDP per capita. In each row the left-hand diagram refers to relative (percentage) change, whereas the right-hand diagram refers to absolute change. In each diagram, the correlation coefficient is indicated and the regression line representing the cloud of dots is drawn. The slope of the regression line corresponds to the sign of the correlation coefficient.

It can be seen that in the network scenario A1 (Figure 3.27) the correlation between relative change and level of accessibility is negative, i.e. the regression line slopes downward. This indicates, as the cloud of dots testifies, that the largest gains in accessibility tend to be in the more peripheral regions, in particular in Portugal and Spain and in the Nordic countries. However, one should be careful. The right-hand diagram indicates that in absolute terms the more central, already highly accessibly regions gain more. This is reflected in the lower two diagrams. The regression line in the left-hand diagram (relative change) has a positive slope because the regions in the candidate countries (the red dots) remain poor. The anti-cohesion effect of Scenario A1 is becoming even more obvious in the right-hand diagram (absolute change).

Figure 3.28 shows the same four diagrams for the comprehensive pricing scenario B2. Here accessibility declines less in relative terms in the more central regions (which would classify the scenario as anti-cohesion). However, in absolute terms the scenario is strongly pro-cohesion because the more central regions suffer much larger losses in accessibility than the peripheral regions. In economic terms, the scenario is pro-cohesion in both relative and absolute terms.

The superposition of both scenarios in Scenario C1 is shown in Figure 3.29. Now the negative slope of the regression line in the top-left diagram (relative change of accessibility) and the positive slope of the corresponding diagram in Scenario B2 combine to a slightly negative slope in Scenario C1 making the scenario fully pro-cohesion.

The four correlation coefficients demonstrated for the three scenarios were calculated for all scenarios for each year of the simulation. The results are shown in Figures 3.30 to 3.33. The colour code is the same as in Figures 3.16 to 3.19. The diagrams are interpreted as follows: lines above the heavy black line represent positive correlation coefficients, i.e. belong to scenarios which are anti-cohesion. Lines below the black line represent negative correlation, i.e. belong to pro-cohesion scenarios. The distance from the black line indicates the intensity of the relationship between change and level.

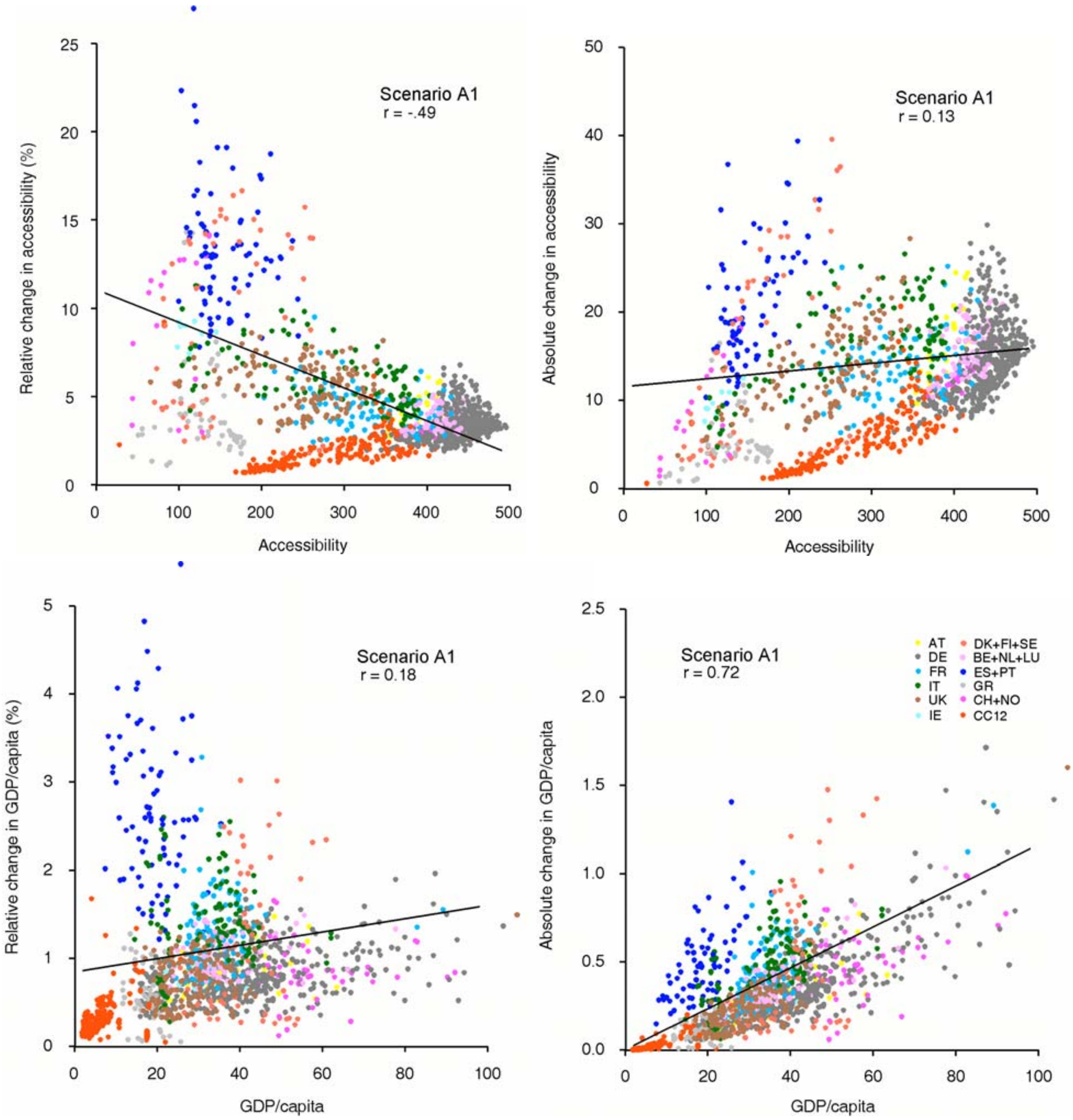


Figure 3.27. Change v. level: accessibility (top), GDP per capita (bottom), Scenario A1

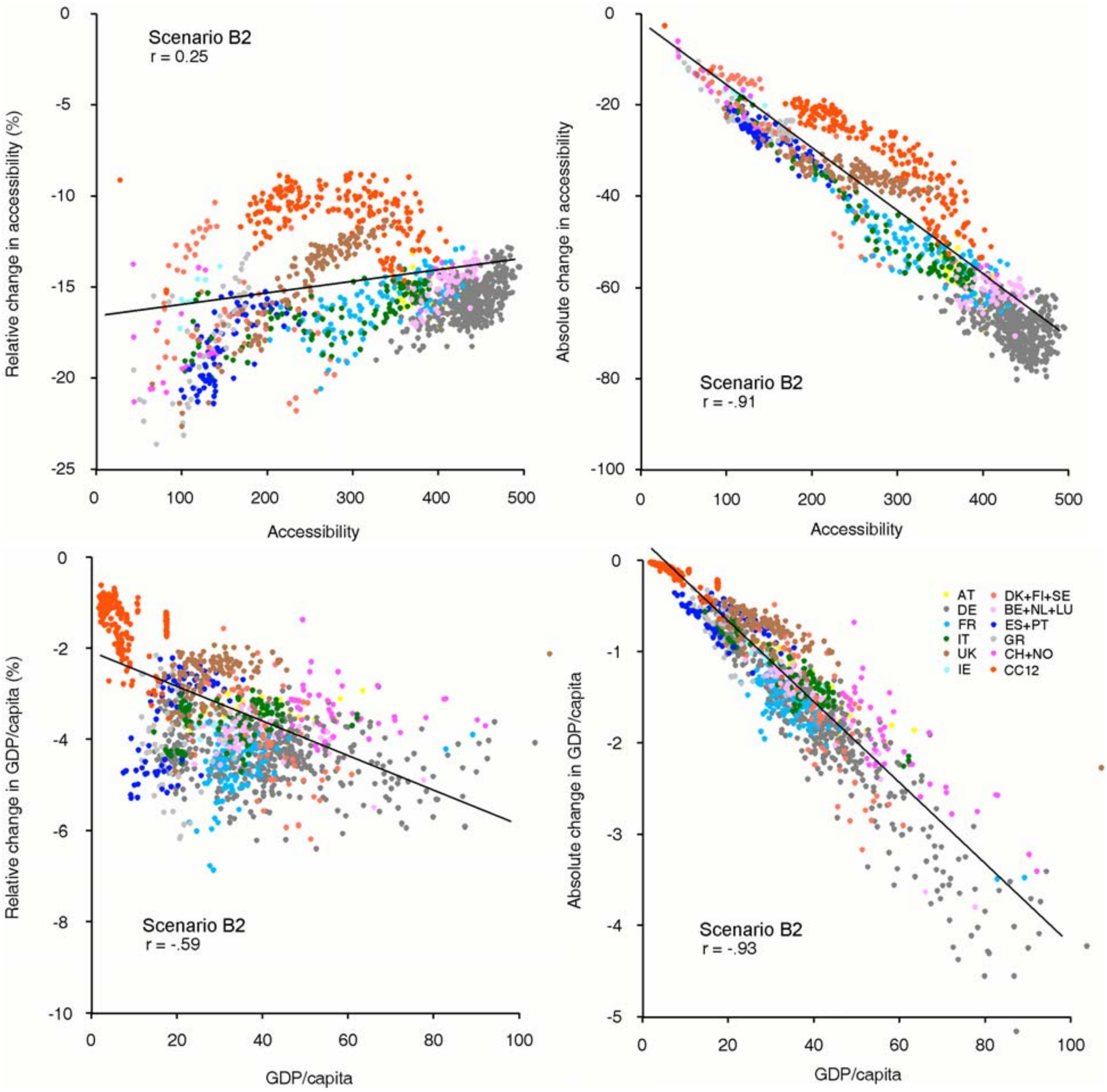


Figure 3.28. Change v. level: accessibility (top), GDP per capita (bottom), Scenario B2

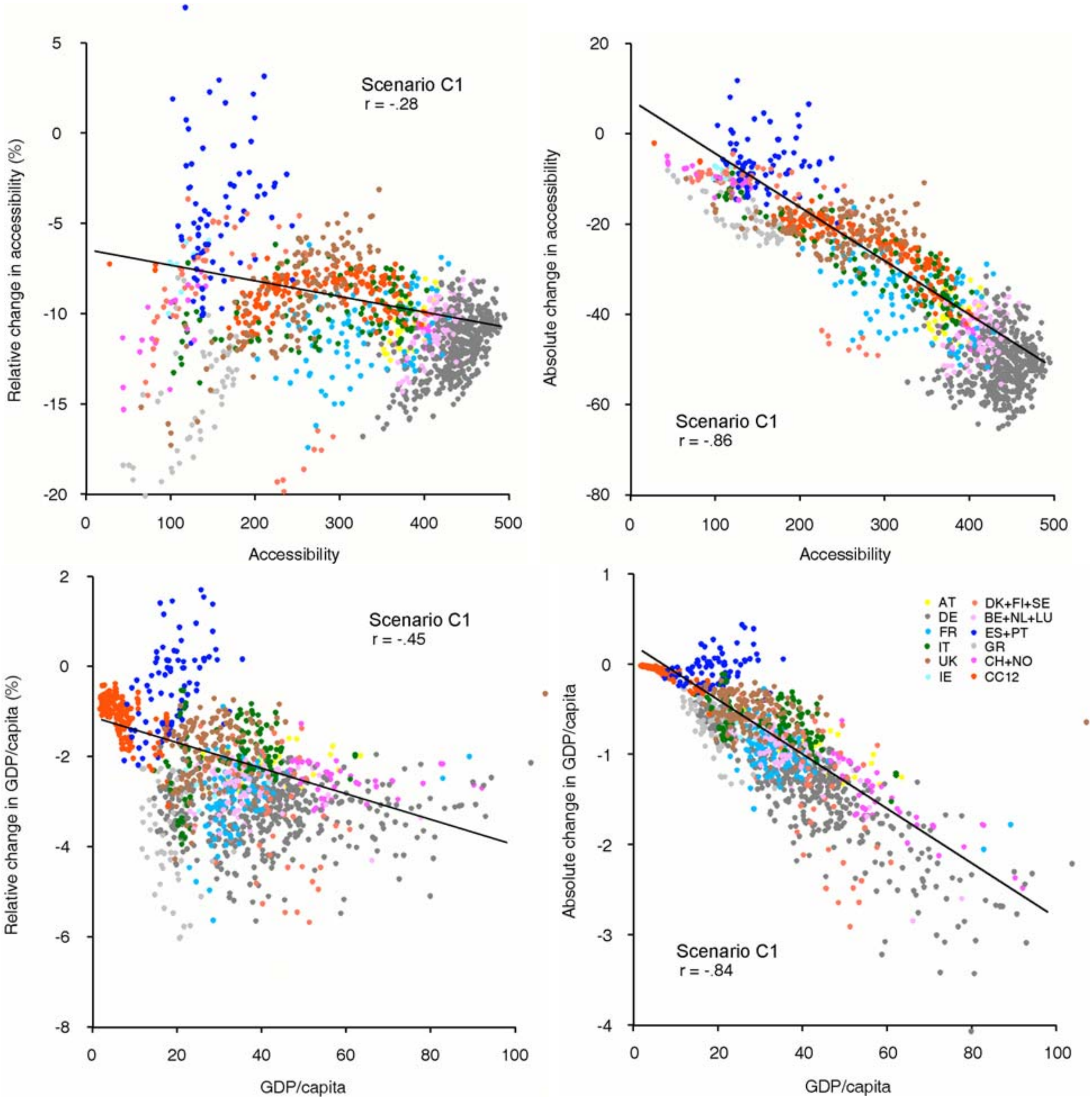


Figure 3.29. Change v. level: accessibility (top), GDP per capita (bottom), Scenario C1

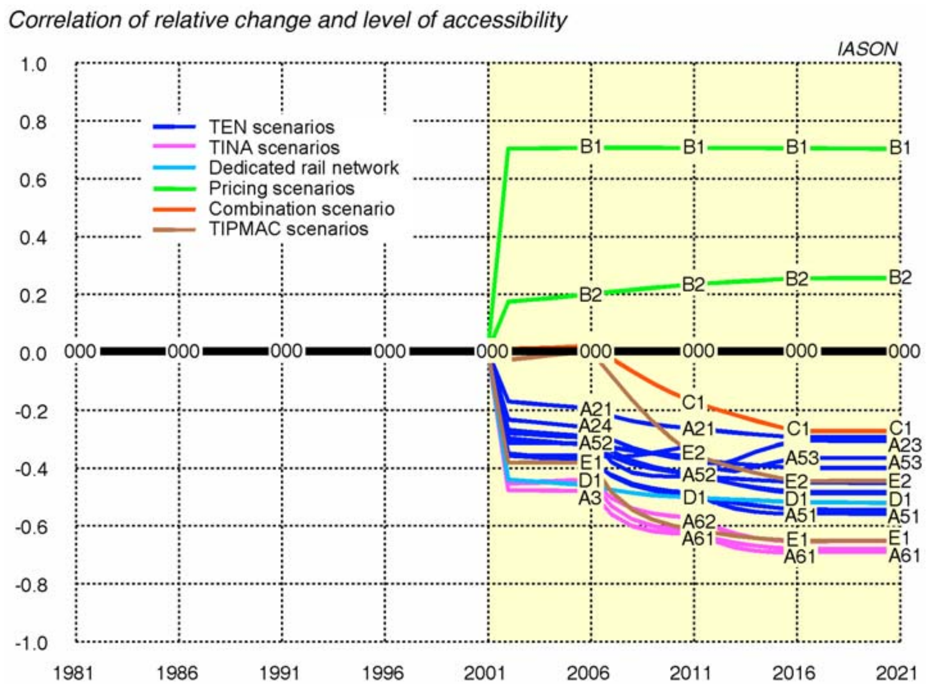


Figure 3.30. Correlation of relative change and level of accessibility

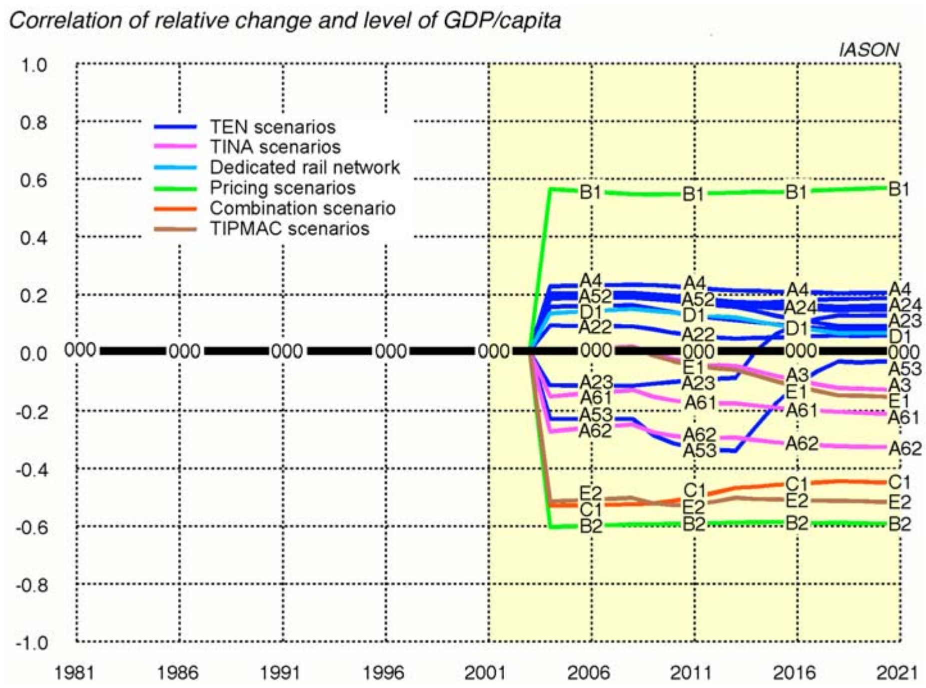


Figure 3.31. Correlation of relative change and level of GDP per capita

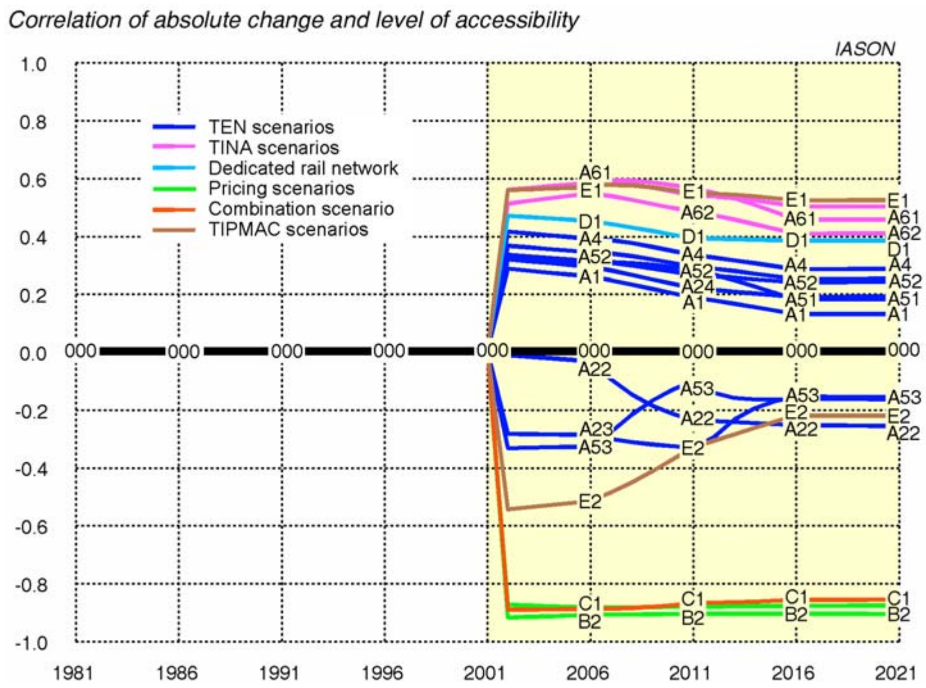


Figure 3.31. Correlation of absolute change and level of accessibility

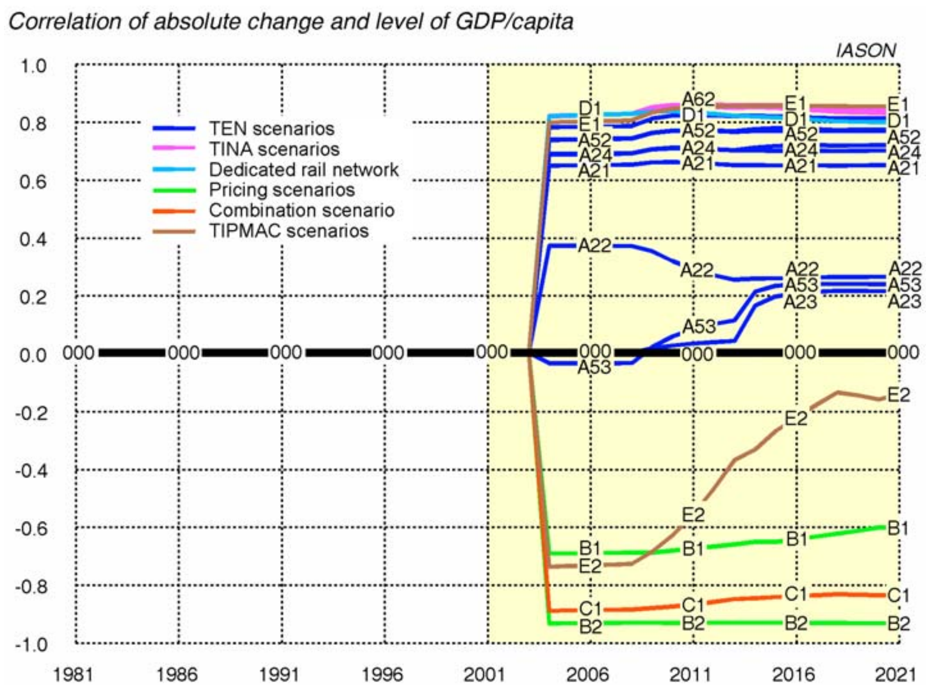


Figure 3.33. Correlation of absolute change and level of GDP per capita

Tables 3.4 and 3.5 summarise the information gained from the five cohesion indicators for accessibility and GDP per capita. The two tables show that with respect to accessibility, almost all policy examined contribute to cohesion, except the two pricing scenarios B1 and B2 – if one applies one of the first four indicators, coefficient of variation, Gini coefficient, geometric/arithmetic mean or relative correlation. However, if one consults also the fifth indicator, absolute correlation, the picture is more complex as more often than not the sign of the indicator is reversed. In terms of GDP per capita, the choice of indicator is even more critical as now even the relative correlation indicator signals polarisation where the coefficient of variation and the Gini coefficient signal cohesion.

It is therefore not easy to assess whether a transport policy supports economic cohesion. Of the policy scenarios examined here, most network scenarios are pro-cohesion except the two road-only scenarios. The scenario assuming road pricing for lorries (Scenario B1) is clearly anti-cohesion, whereas the comprehensive transport pricing scenario B2 is strongly pro-cohesion. However, it is not clear whether these effects are caused by the fact that the two pricing schemes were only applied to the present European Union.

The lesson to be learned from this exercise is that the choice of cohesion indicator is critical in assessing the socio-economic impacts of transport policies and that classifications relying on only one indicator should be avoided.

3.6 Conclusions

The conclusions that can be drawn from the scenario simulations with the extended SASI model can be summarised as follows.

Methodological

The SASI model differs from other approaches to modelling the impacts of transport on regional development by modelling not only regional production (the demand side of regional labour markets) but also regional population (the supply side of regional labour markets). A major advantage of the model is its comprehensive geographical coverage. Its study area are all regions of the fifteen member states of the European Union and the 12 candidate countries plus Switzerland and Norway at the Nuts-3 or equivalent level. A third feature is its dynamic network database. Based on a 'strategic' subset of highly detailed pan-European road, rail and air networks, the model uses one of the most sophisticated transport network representations available in Europe today, allowing both backcasting of network development as far back as 1981 and forecasting network development until the year 2020.

The SASI model uses regional production functions in which transport infrastructure is represented by accessibility. The model is particularly flexible in incorporating 'soft' non-transport factors of regional economic development beyond the economic factors traditionally included in regional production functions. These may be 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. In addition to these tangible endowment indicators, regional residuals taking account of intangible factors not considered are included in the production functions.

Table 3.4. SASI model: accessibility cohesion effects

		Accessibility cohesion effects (+/–)				
Scenario		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	+	++	+	–
A21	High-speed rail priority projects	+	+	+	+	–
A22	Conventional rail priority projects	+	+	+	+	+
A23	Road priority projects	+	+	+	+	+
A24	Rail priority projects	+	+	+	+	–
A3	All TEN/TINA projects	++	++	++	++	–
A4	All TEN projects	+	+	++	++	–
A51	New priority projects	+	+	++	++	–
A52	New priority rail projects	+	+	++	+	–
A53	New priority road projects	+	+	+	+	+
A61	A3 + additional projects in CC12	++	++	++	++	–
A62	A3 + additional projects in CC12	++	++	++	++	–
B1	SMC pricing road freight	–	–	–	—	++
B2	SMC pricing all modes travel/freight	–	–	–	–	++
C1	A1+B2	+	+	+	+	++
D1	Dedicated rail freight network	++	++	++	++	–
E1	TIPMAC business-as-usual scenario	++	++	++	++	—
E2	TIPMAC fast TEN + SMC	+	++	++	+	+

Table 3.5. SASI model: GDP per capita cohesion effects

		GDP per capita cohesion effects (+/–)				
Scenario		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	+	·	–	—
A21	High-speed rail priority projects	+	+	·	–	—
A22	Conventional rail priority projects	+	+	·	–	–
A23	Road priority projects	–	–	·	–	–
A24	Rail priority projects	+	+	·	–	—
A3	All TEN/TINA projects	+	+	·	+	—
A4	All TEN projects	+	+	–	–	—
A51	New priority projects	+	+	·	–	—
A52	New priority rail projects	+	+	·	–	—
A53	New TEN priority road projects	–	–	·	+	–
A61	A3 + additional projects in CC12	+	+	+	+	—
A62	A3 + additional projects in CC12	+	+	+	+	—
B1	SMC pricing road freight	–	–	·	—	++
B2	SMC pricing all modes travel/freight	+	+	+	++	++
C1	A1+B2	+	+	+	+	++
D1	Dedicated rail freight network	+	+	·	–	—
E1	TIPMAC business-as-usual scenario	+	+	·	+	—
E2	TIPMAC fast TEN + SMC	+	+	+	++	+

+/++	Weak/strong cohesion effect: disparities reduced	CoV	Coefficient of variation (%)
–/—	Weak/strong anti-cohesion effect: disparities increased	Gini	Gini coefficient (%)
·	Little or no cohesion effect	G/A	Geometric/arithmetic mean
		RC	Correlation relative change v. level
		AC	Correlation absolute change v. level

An important feature of the model is its dynamic character. Regional socio-economic development is determined by interacting processes with a vast range of different dynamics. Whereas changes of accessibility due to transport infrastructure investments and transport system improvements become effective immediately, their impacts on regional production are felt only two or three years later as newly located industries start operation. Regional productivity and labour force participation are affected even more slowly. The sectoral composition of the economy and the age structure of the population change only in the course of many years or even decades. A model that is to capture these dynamics will not be an equilibrium model but proceed in time increments shorter than the time lags of interest.

Results

The main general result from the scenario simulations is that the overall effects of transport infrastructure investments and other transport policies are small compared with those of socio-economic and technical macro trends, such as globalisation, increasing competition between cities and regions, ageing of the population, shifting labour force participation and increases in labour productivity. These trends have a much stronger impact on regional socio-economic development than transport policies. If one considers that under normal economic circumstances the long-term growth of regional economies is in the range between two and three percent per year, additional regional economic growth of less than one or two percent over twenty years is almost negligible.

The second main result is that even large increases in regional accessibility translate into only very small increases in regional economic activity. However, this statement needs to be qualified, as the magnitude of the effect seems to depend strongly on the already existing level of accessibility. For regions in the European core with all the benefits of a central geographical location *plus* an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines may will bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions.

If the different types of policies are compared, high-speed rail projects seem to be more effective in terms of promoting regional economic activity than conventional rail projects, and rail projects seem to be more effective than road projects. All transport pricing scenarios have negative economic effects but these can be mitigated by their combination with network scenarios with positive economic effects, although the net effect depends on the magnitude of the two components. Not surprisingly, large comprehensive programmes have more substantial effects than isolated projects.

As regards the cohesion goal, the situation is very complex. There are several methods and indicators to measure the contribution of a policy or policy combination to the cohesion objective. However, these methods and indicators give partly contradictory results. In particular the most frequently applied indicator of cohesion, the coefficient of variation, tends to signal convergence where in many cases in fact divergence occurs. The coefficient of variation, the Gini coefficient and the ratio between geometric and arithmetic mean measure *relative* differences between regions and classify a policy as pro-cohesion if economically lagging regions grow faster (in relative terms) than economically more advanced, i.e. more affluent regions. However, one percent growth in a poor region in absolute terms is much less than one percent growth in a rich region. Even if poorer regions grow faster than rich regions (in relative terms), in most cases the income gap between rich and poor regions (in absolute terms) is widening. Which of the two concepts of cohesion (or convergence or divergence) is used, is a matter of definition. It is therefore of great importance to clearly state which type of cohesion indicator is used.

Beyond these methodological difficulties, it has become clear that many infrastructure investment programmes of the past have been anti-cohesion, i.e. have contributed to widening the spatial disparities between central and peripheral regions in Europe. This is even true for the 'old' list of TEN priority projects. The 'new' list of priority projects is a clear advance in this respect. However, there is room for improvement, as some of the scenarios have shown. The simulations have demonstrated that rapid upgrading and extending of the rail and road infrastructure in eastern Europe would contribute to the economic and social integration of the accession countries after the enlargement of the European Union.

Further Work

In work in IASON has proved that the model is operational, that its data requirements – beyond the network database – can be largely met by existing statistical data sources and that it is capable of providing policy-relevant results.

The extension of the study are to EU27+2 and the increase of the spatial resolution of the model from NUTS-2 to NUTS-3 regions and the associated refinement of the network database have greatly enhanced the applicability of the model for issues of enlargement of the European Union and the analysis of regional issues or individual projects. The substitution of travel time by generalised cost in the accessibility submodel was an important improvement of the model. The disaggregation of the model to six economic sectors was less successful because it greatly aggravated the data collection problems and has led to innumerable problems of small-scale inconsistencies without improving the predictive performance of the model. The former three economic sectors (agriculture, manufacturing, services) might have been sufficient. The replacement of GDP as the dependent variable of the regional production functions by GDP per capita was a necessary step but may prove problematic in the future when demand and supply on the regional labour market are to be modelled.

Future work will aim at completing the model enhancements begun in IASON, the endogenous modelling of regional labour productivity and the conversion of the migration submodel from net migration to migration flows. It is also planned to investigate whether the responses of the model to changes in accessibility may be too strong. To better control the magnitude of the response, a suggestion by Bröcker to explicitly model mobility of capital, just as in the migration model mobility of labour is modelled, will be followed.

4 The CGEurope Model

4.1 Introduction

CGEurope comes in two versions, one with a single aggregated sector for tradable goods (plus a non-tradable sector), and another with sectoral disaggregation. In the following, the first will be called CGEuropeI, the second CGEuropeII. CGEuropeI has been developed already before the IASON project. It has been extended within IASON for allowing to deal with multimodal transport and by including cost of business travel beyond cost of freight. Furthermore, CGEuropeI has been adapted to a new and more detailed regional system within IASON, and has been calibrated by a newly developed data set. Finally, a more sophisticated and reliable set of cost data is now used as input to the scenario simulations. This cost data set has been produced within IASON by S&W, based on the SASI multimodal transport networks and on cost parameters stemming from the SCENES project. CGEuropeII had been newly developed within the IASON project from scratch. This model is multisectoral, conceptually allowing for an arbitrary number of sectors. Data availability, knowledge about non-calibrated parameters (elasticities) and computational capacity highly restrict the sectoral detail that can be handled in practice, however, if the number of regions is large, as it is the case in the IASON project focusing inter alia on the spatial impact of transport initiatives.

While the methodological innovation envisaged in Deliverable 2 is mainly related to CGEuropeII, it turned out in the course of empirical work that both versions of the model are suitable for specific purposes and have their respective advantages and disadvantages, strengths and weaknesses. It has therefore been decided not to substitute CGEuropeII for CGEuropeI, but to keep CGEuropeI updated as well and to apply it for evaluating policy scenarios.

The strength of the multisector version is to generate more detailed results. In particular, the impact of transport initiatives on the sectoral structure of regions can be quantified by the multisectoral version, while the other model is silent on that aspect; it is able to predict shifts between the output of local and tradable goods, but not shifts between industries in the usual sense. Another strength is that the multisectoral model takes into account that regions may be affected differently by a transport initiative not only because of their respective locations, but also because of different sectoral structures. A region may be particularly strongly affected (in one or the other direction) because it specializes in sectors strongly affected by transport cost changes, either on the input or on the output side.

These advantages are not without a cost, however. For calibrating the model, much more information is needed, in terms of data as well as in terms of behavioural parameters that can not be inferred from the calibration procedure. The extra data required are sectorally detailed social accounting data, sectoral trade flows, activity data (output or employment) by sector and region, and sectoral transport cost data. Ideally one would like to have all data on a regional level, but only very few information such as aggregated GDP and some more or less comparable and reliable data on sectoral structures are available on a regional level. Even if they are, one never has both, regionally and sectorally fine disaggregations. For the IASON study area, even for the 6-sector disaggregation we are unable to calibrate the model on a NUTS 3 level. To be sure, 6 sectors is a high level of aggregation, not capturing the differentiation with regard to transport intensity that we like to incorporate into a multisectoral approach. Hence, there is a trade-off between available sectoral and regional detail. Sectoral disaggregation requires regional aggregation and vice versa. Hence, CGEuropeI can be applied for obtaining NUTS 3 results for the entire IASON space, but without sectoral detail, while CGEuropeII is available for sectoral more refined impacts, but regionally more aggregated.

Data availability is not the only problem for CGEuropeII. The more disaggregation is introduced, the more free parameters have to be fixed. Reaction parameters (elasticities or similar coefficients) can not be estimated from a benchmark data set. One has to rely on econometric estimates or intuitive guesses. Even econometric estimates are not reliable, because they usually stem from econometric studies referring to completely different environments, and in most cases are based on partial equilibrium theories contradicting the general equilibrium theory underlying CGE models. Hence, the more sectoral detail is allowed for, the more arbitrariness enters into the results due to arbitrary choices of parameters. Results are more detailed, but it is less clear which detail is due to reliable data, and which is due to more or less arbitrary assumptions.

A final drawback of CGEuropeII is that it is more expensive to keep it up to date, of course, such that CGEuropeI may be the better choice for an approach routinely updated and applied to project evaluation in the future. We conclude that we should work with both approaches within IASON and for spatial project evaluation without an explicit sectoral focus we prefer CGEuropeI as a standard evaluation tool.

The following two sections describe the essentials of CGEuropeI's and CGEuropeII's design. Regarding details we refer to publications (see e.g. Bröcker, 1995, 1998a, 1998b, 2001, 2002, Bröcker and Richter, 2001) and Deliverable 2. We give a summary exposition and focus on the differences between the model design as explained in the above references and that actually implemented in the empirical study. Regarding CGEuropeI, the IASON implementation is extended in comparison to earlier versions, as already mentioned. Regarding CGEuropeII, modifications of the approach envisaged in Deliverable 2 turned out to be necessary in the course of empirical implementation. As compared to the plans the actual approach is simplified in one respect and is made more flexible in another. The simplification regards trade costs: the plan to introduce a separate industry producing the transportation service had to be abandoned; it would have led to more complicated equations, more data requirements and very likely almost no impact on results. We therefore stick to the commonly used "iceberg-form" of transportation cost for goods and services. The other modification is that our original ideas only allowed for two cases regarding the market structure of an industry: it could either be perfectly competitive with so-called "Armington-preferences" (i.e. preferences of customers regarding the place of origin of their purchases) or pure "Dixit-Stiglitz". Following Gasiorek and Venables (1999) we now admit a continuum controlled by a market form parameter ranging from perfect competition to pure Dixit/Stiglitz.

4.2 CGEuropeI

4.2.1 Model Design

Our Model is a static general equilibrium model for a closed system of regions covering the whole world, consisting of the IASON regions plus one region representing the rest of world. In each region reside identical immobile households owning the regional stock of production factors that are immobile as well. Their incomes stem from regional factor returns as well as from an interregional income transfer that can have a positive or negative sign. Income transfers are exogenous (in real terms) and add up to zero for the entire world. They are negligible with regard to quantitative results, but needed for keeping budget constraints closed. Households spend their income for buying goods and services partly produced in their own regions and partly produced in other regions. Households' demand represents total final demand, that means private as well as public consumption and investment. There is no separate public sector in the model; that is households have to be regarded as an aggregate of private and public households, their budget constraint is the consolidated budget constraint of private and public households in the region.

Households are price takers on all markets. They maximize a Cobb-Douglas utility depending on the quantity of local goods and the quantity of an index of diversified tradable goods. Hence, they spend fixed shares ε and $1-\varepsilon$ of their income for local and tradable goods, respectively. Utility changes of households, measured in monetary terms by Hicks' equivalent variation concept, are our measure of regional welfare effects of transport initiatives (see chapter 4.3.2 below).

The production sector is represented by firms, whose technologies are identical up to a region-specific productivity scaler.. There are two types of firms: 1) firms producing local goods and 2) firms producing tradable product varieties. There is no further sectoral differentiation. Local goods are produced under constant returns to scale and, as the name says, can only be used within the region itself. Tradable goods, however, are produced by a “Dixit-Stiglitz-Industry”. Each firm is an exclusive producer of a single product variety supplied under monopolistic competition. The number of firms is determined endogenously. For each product variety a fixed amount of the local good as well as a variable amount is required, that is proportional to the output. With a constant price elasticity of demand (which is given in our case) this is well known to imply a constant output per product variety. Hence, a region's output of tradable goods is proportional to the number of supplied varieties, and the product price equals unit cost. With an appropriate choice of units the mill price in the diversified sector equals the mill price for local goods, which is called p_r for region r.

For the sake of simplicity local goods are assumed to be produced by a Cobb-Douglas-technology with cost shares α, β and γ for primary factors, local goods and tradable goods that are used as inputs, respectively. Primary factors are modelled as a single homogeneous factor. One may also regard them as a composite of an arbitrary number of factors combined by a linear homogeneous technology. As we do not distinguish between sectors having different factor intensities, this would be formally equivalent.

Analogous to household consumption, firms use tradable goods as a composite index that is composed of all variants produced anywhere in the world. The same index is used for final demand as for intermediate inputs. As usual, varieties are composed by a symmetrical CES-index, with elasticity of substitution between varieties equal to $\sigma > 1$.

The decisive assumption for the issue under study in this project is that there are transaction costs for goods delivered from region r to region s, amounting to a share of $\tau_{rs} - 1$ in the traded value. The local price of a good available in s and stemming from r is therefore $p_r \tau_{rs}$. Transaction costs have two components, one depending on costs of transportation and business travel, and another representing the extra cost of international trade.

The latter cost component is not measured directly, but drops out from the calibration procedure. One cost component per pair of countries is calibrated such that international trade flows generated in the models' equilibrium are equal to observed trade flows for each pair of countries. It is well documented in the literature that cross border transactions are much smaller than transactions within a country, everything else being equal. This holds true within the present EU, but even more so for transactions between EU countries and other countries and those among other countries (Helliwell, 1998). This is due to a wide range of barriers to interaction ranging from institutional differences, different languages and cultural barriers to obvious costs like time costs for border controls outside the Schengen area or tariffs, quotas et cetera outside the EU. Omitting this cost component would lead to a severe overestimation of cross border flows and hence to a bias in project evaluation in favour of cross border links.

Introducing this international impediment is also essential for the calibration of the model for 2020. The situation in 2020 is supposed to differ from the benchmark year 1997 in four respects: (1) the infrastructure will be extended and improved, as described by the infrastructure scenarios; (2) GDP per capita will be larger everywhere due to a general growth trend; (3) there will be a catch-up of EU countries – in particular present candidate countries – that are now poor in comparison to the EU average; (4) integration will be deepened. In particular the present candidates will enjoy a level of integration with the other members comparable to the present degree of integration within the EU. The latter development will be simulated in our predictions by reducing the estimated impediments among candidate countries as well as those between candidate countries and the present EU down to the level now prevailing among present EU members.

The other component of transaction costs depending on costs for freight and business travel represents the channel through which transport initiatives lead to a change of prices and quantities in the economy. Eventually, these changes affect the households' utilities, which – translated into monetary equivalents – are our ultimate welfare measure. Subsection 4.2.2 describes how we measure this cost component for the benchmark, and how the change of theses costs resulting from a transport initiative is quantified.

In the general equilibrium one also has to specify where resources for performing the transactions come from. The standard approach is the iceberg-assumption saying that, for performing the transaction, a certain share of a transferred good itself is used up (smelts). We use a slightly different approach. According to our assumption, not the individual good, but a certain amount of the composite tradable that is available in the region of destination, is used up. Hence, the composite tradable serves a triple purpose, it is used for transactions, it is used for consumption, and it is used as an intermediate good in production.

The explained assumptions imply the equilibrium to consist of a system with four equations per region determining four unknowns per region. This system of equations describes the market for tradable goods. The four unknowns are:

- S_r: value of tradable goods supply from region r, valued at mill prices;
- D_r: value of demand for tradable goods in region r valued at local prices, that is including transaction cost;
- p_r: mill price for goods from region r;
- q_r: composite price per unit of tradable goods used in region r.

The corresponding four equations are (see the Appendix C for derivation):

$$S_r = \phi_r p_r (p_r / q_r)^{\gamma/\alpha} - \varepsilon G_r, \tag{4.1}$$

$$D_r = S_r + G_r, \tag{4.2}$$

$$q_r = \psi \left[\sum_s S_s p_s^{-\sigma} \tau_{sr}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{4.3}$$

$$p_r = \left[\sum_s \frac{\tau_{rs}^{-\sigma} D_s}{\sum_t S_t (p_t \tau_{ts})^{-\sigma}} \right]^{1/\sigma}. \tag{4.4}$$

γ, α, ε, σ and τ_{rs} are parameters that have already been explained. ϕ_r is further parameter measuring the effective regional stock of factors. ψ is a parameter scaling units of the composite good; its choice is arbitrary, having no consequences for the result. Finally, G_r is the exogenous interregional transfer already mentioned.

Note that the system of equations fixes nominal variables only up to a factor, as it should be. If, for any solution, all prices and values (including G_r) are multiplied by an arbitrary positive factor, we obtain another solution that is however unchanged in real terms. Even though the equation system is not simple it can be solved for a world with more than 1000 regions.

4.2.2 Measuring transaction cost

The design of the model implies trade flows to fulfil a gravity equation of interregional trade, that can be estimated with econometric methods. With additional information on the parameter σ, the elasticity of substitution between varieties, we are able to derive an estimate of distance dependent trade cost in the whole economy. This is explained in the next subsection. These estimates lead to the conclusion that these costs amount to almost 6% of GDP within the EU. Calculating total freight cost – out of pocket as well as time cost – from the SCENES estimates, however, amounts to no more than 3.35%. Our interpretation of this discrepancy is that interregional transfer of goods incurs further distance dependent cost, beyond mere freight cost. These costs are costs of communication, that is costs related to negotiating, contracting, service, marketing and so on. To a large extent, this communication requires face to face contact and hence business travel between the location of origin and destination of trade. In fact, if we add cost of long distance travel (out of pocket as well as time cost), as obtained from the SCENES estimates, to the mere freight cost, we end up with 5.9% of GDP, which is about the same as the estimated trade cost implied by the calibration of our model. Hence, we assume the cost τ_{rs} to be the sum of two components, freight cost and cost of long distance business travel.

Both, freight cost and cost of business travel are measured as expected composite cost derived from a logit model of mode choice:

$$f_{rs} = -\frac{\mu}{\lambda}\log\left[\sum_m \exp(\alpha_m - \lambda c_{mrs})\right] + \frac{\mu}{\lambda}\log\left[\sum_m \exp(\alpha_m)\right]. \tag{4.5}$$

f_{rs} is the share of composite cost in the value of goods shipped from region r to region s. c_{mrs} is the cost per unit from r to s by mode m. μ, λ, and $\alpha_m > 0$ are parameters. μ is a scaling parameter transforming cost per unit to value shares. Units of measurement are defined in the SCENES data (tons per day, trips per day). λ is the semielasticity of mode choice, measuring the relative change of mode shares per absolute change of unit cost. Finally, α_m is a mode specific preference parameter allowing to reproduce observed average mode shares. Note that the logit model fixes composite cost only up to an additive constant, because the mean of the random term in the model can be chosen arbitrarily. The natural choice of this constant is $f_{rs} = 0$ for $c_{mrs} = 0$ for all m; hence the second term in the formula. Note also that cost changes determining our results remain unaffected by the choice of this constant.

It seems straightforward to calibrate the model with $\tau_{rs} - 1 = f_{rs}^f + f_{rs}^b + \theta_{kl}$ with f_{rs}^f (f_{rs}^b) calculated according to the above formula for freight (business travel). θ_{kl} denotes the tariff equivalent of international trade impediments, if region r belongs to country k and region s belongs to country l. $\theta_{kl} = 0$ for $k = l$. We go a different way, however, as already described in Deliverable 2 (pp. 40-41). It turns out that a better fit with trade data is obtained by assuming trade cost to be a function of distance,

$$\tau_{rs} - 1 = \zeta g_{rs}^{\omega} + \theta_{kl}. \tag{4.6}$$

g_{rs} is a simple distance measure, minutes of road travel time on the shortest route. This is a much simpler measurement, but due to an additional parameter ω controlling the curvature of the functional form, also more flexible. The parameter ω is in the order of ½, according to our econometric estimates, implying τ_{rs}, plotted over distance, to have a pronounced concave shape. This corresponds to the fact that for shorter distances the distance decay of trade flows is steeper than it would be implied by a linear relationship between τ_{rs} and measured multimodal cost. This may be explained by the fact that the commodity composition of flows itself depends on distance, which is not reflected in the model dealing with flows aggregated over many commodities. Goods with high transport cost per unit of distance and unit of value dominate for shorter distances, such that the distance sensitivity is larger for shorter distances. The flexible form of the distance function is a short-cut for taking this fact into account. In the scenario simulations, cost changes calculated by formula (4.5) are added to τ_{rs} according to (4.6) in order to obtain the cost representing the respective scenario.

4.2.3 Calibration for Benchmark

In order to perform simulations we have to assign numerical values to all parameters. In the above equation system everything with a Greek symbol is a parameter. From national accounts data described in Deliverable 2 one finds a ratio of factor costs to costs of intermediate inputs of 0.97 for the weighted average of EU countries. Furthermore, as a plausible guess, we assume a ratio of 2:3 between the respective shares of tradable and local goods in consumption and in production cost. This implies $\alpha = 0.493$, $\beta = 0.305$, $\gamma = 0.202$ and $\varepsilon = 0.6$. As we regard the EU data as more reliable than those for other countries, we apply these parameters uniformly to all regions under study. Anyway, sensitivity analysis shows that deviations from these specifications in a plausible range are non-critical. The parameter ϕ_r is chosen such that the regional GDPs in the equilibrium solution coincide with observations. Observations are taken from the benchmark year 1997.

The remaining parameters are σ as well as those parameters determining τ according to equation (4.6), namely ζ, ω and θ. In this context we exploit the fact that trade flows, measured in mill prices, follow a gravity equation (see equation (C.2) in Appendix C):

$$t_{rs} = a_r \tau_{rs}^{-\sigma} b_s \tag{4.7}$$

with

$$a_r = S_r p_r^{-\sigma} \tag{4.8}$$

and

$$b_s = \frac{D_s}{\sum_t S_t (p_t \tau_{ts})^{-\sigma}} \quad . \tag{4.9}$$

According to (4.6)

$$\tau_{rs} \approx \exp\left(\zeta g_{rs}^{\omega} + \theta_{kl}\right), \tag{4.10}$$

because τ_{rs} is sufficiently close to 1. Inserting this into (4.7) yields

$$t_{rs} = \exp\left(\tilde{a}_r + \tilde{b}_s - \sigma\zeta g_{rs}^{\omega} - \sigma\theta_{kl}\right), \tag{4.11}$$

with $\tilde{a}_r = \log a_r$ and $\tilde{b}_s = \log b_s$. We estimate this equation by a non-linear regression using data on international trade, because interregional trade data on a sub-national level are lacking. $\tilde{a}_r$ and $\tilde{b}_s$ are estimated as fixed effects, associated with the countries of origin and destination, respectively. θ_{kl} is estimated as a linear function of dummies representing common languages and other influences. Unfortunately, σ is however not identified, but only the combinations $\sigma\zeta$ and $\sigma\theta_{kl}$ (the latter only up to an additive constant). We obtain highly significant and robust estimates for $\sigma\zeta$ (0.036, if distance is measured in minutes) and ω (0.58), which means that one obtains the expected concave shape of the transaction cost function.

Unfortunately, the gravity estimate does not allow for a separate identification of σ and ζ, respectively. There is another way to separate those two parameters, however. If all parameters are fixed except σ and ζ, one can regard all endogenous variables of the solution as a function of σ, holding the product $\sigma\zeta = 0.036$ fixed (or equivalently as a function of ζ). Hence, among others regional GDPs per capita predicted by the model are (non-linear) functions of σ. Hence, we can estimate σ in a non-linear regression, choosing the estimate such that predicted GDPs per capita optimally fit observed ones. We have done such regressions controlling for other variables that explain productivity differentials, in particular controlling for the belonging or not belonging of regions to the former socialist block. A typical result with one dummy is given in table 4.1. Results are from an instrument variable estimate, with a sandwich estimator of standard errors. R-square (a statistic of questionable meaning in this context) equals 0.78. Note that the small standard error renders the estimate very reliable. The estimate is robust against modified specifications. If one dummy per country is introduced, controlling for all national factors influencing factor productivity, the estimate is slightly smaller (11.63, with standard error 1.92). Hence, we think to have a fairly reliable estimate with choosing $\sigma = 12$.

Table 4.1. Estimation of σ from a cross section of GDP per capita

	parameter estimate	robust standard error
σ	12.25	1.13
Dummy, former socialist country	-1.00	0.04

With the choice of σ the parameter ζ and hence the cost function ζg_{rs}^{ω} is also specified. We therefore are able to calculate the cost share for interregional goods transfer in GDP for the entire EU in the equilibrium solution. The outcome is 5.87 %.

For simulating the scenarios, we must also fix the parameters in the multi-modal cost functions (4.5) for freight and business travel. We discuss the choices for λ, α_m and μ for passenger travel:

- The only information we have on λ is the parameter used in the SCENES estimates, that assume mode shares to be logit functions of mode disutilities. We use the information for the categories "commuting and business – long trips" and "international business". As the parameter depends on the units of measurement for the disutilities plugged into the logsum formula (4.5), however, we can not transfer it one to one, because the cost data we use are from SASI. We therefore first calculate a scale factor transforming SASI cost units to SCENES disutility units, and then multiply this scale factor by the semielasticity in the logit choice function from SCENES. The outcome is a λ-parameter applicable to the SASI cost estimates. Another source of information is the regression performance of accessibility indicators based on multimodal composite costs calculated by a logsum formula. Tests of different parameter choices in the SASI cross section regressions led to a smaller estimate (0.03 per € trip cost, about one half of the outcome of the before mentioned procedure). We use this estimate in order to keep comparability of the results from the two models within IASON.

- The mode specific shift parameters α_m are chosen such that estimated mode shares in the model are the same as in the SCENES data set, on average. Note that the α_m are identified only up to an additive constant. We can set one of them equal to zero.
- The most critical parameter is the scale parameter μ. This parameter controls the overall level of costs. Doubling the μ-parameters for freight and business travel costs would (roughly) double the level of welfare effects resulting form the simulation experiments. Hence, the magnitude of this parameter is essential for the magnitude of results. We obtain the parameter by assuming that 30 % of the above mentioned cost of goods transfer is cost of business travel (including time cost), thus amounting to 1.76 % of GDP (30 % of 5.87 % = 1.76 %) . This is somewhat less than what we can calculate from the SCENES data (2.56 %), which however also includes long-distance commuting, that should not be covered by our definition of business travel. The scaling parameter μ is fixed such that summing up $t_{rs} f_{rs}^b$ over all intra-EU flows amounts to 1.76 % of GDP.

Similar procedures apply to the parameter choices for freight. All freight cost estimates are based on information for the flow category 12 ("small machinery") from SCENES. As the hope to obtain cost and cost change information for all scenarios and averaged over all flow types from SCENES could not be fulfilled within the IASON budget, we had to rely on one characteristic flow category. The category has been suggested by the SCENES modellers. For choosing the scale parameter μ for freight we assumed the remaining 70 % of the above mentioned cost of goods transfer to be freight cost, thus amounting to 4.10 % of GDP (70 % of 5.87 % = 4.10 %). This is a bit more than we obtain by adding up all transport costs over all goods from the SCENES data for intra-EU long-distance flows (3.35 %). Hence, it might be appropriate to scale down our overall results by about 20 %, if one relies on the direct cost estimates from SCENES rather than our indirect estimates resulting from econometric estimation of model parameters.

Finally, the tariff equivalents θ_{kl} have to be determined. They are calibrated such that international trade flows in the equilibrium solution coincide with observed international trade for 1995. Thereby we assume symmetry, $\theta_{kl} = \theta_{lk}$, because otherwise the tariff equivalent would not be identified.

Beyond parameters, exogenous transfers G_r have to be specified as well. As already mentioned, these equal the regional trade balance deficits. There are no observations for regional trade balance deficits. Therefore we simply distribute the national trade balance deficit across regions proportional to regional GDPs.

4.2.4 Calibration for 2020

We perform a series for experiments taking the year 2020 instead of 1997 as a reference, i.e. we compare a hypothetical world of 2020, that has the respective projects of the scenario installed, with another hypothetical world without these projects. The world “without” is constructed by recalibrating the model for 2020. In this recalibration all parameters remain the same as for 1997 with two exceptions: the regional factor stock parameter ϕ_r and the trade impediments θ_{kl}. ϕ_r increases from 1997 to 2020 due to technical progress as well as factor accumulation. θ_{kl} decreases for those pairs of countries that are involved in an integration process.

Recalibration proceeds as follows. We introduce assumptions about the increase of regional GDPs from 1997 to 2020 and about the decrease of impediments. Then the calibration is redone for 2020 just in the same way as for 1997 with one modification: there is no adjustment to observed international trade flows. Instead estimates of these flows are an outcome of the calibration, resulting from the predicted impediments. To put it differently: for 1997 we know international trade flows and infer on impediments, while for 2020 we know impediments and infer on international trade flows.

We assume that all present candidate countries will be integrated with all EU countries to the same degree, as present EU countries are integrated among each other. Thus the impediments θ_{kl}, with k or l indicating a candidate country and $k \neq l$, are reduced by a factor such that on average they attain the same level as the average θ_{kl} for k and l indicating a present EU member, $k \neq l$. One could also speculate about a further deepening of the EU due to a common currency and further institutional harmonization. We have no reliable evidence on trends of further integration that could be used in this context and therefore keep the level of integration within the EU constant.

With regard to GDP we assume a 2% rate of growth per annum for the EU15 average and a rate of convergence for countries (EU members and candidate countries) of 1.5% per annum. A 2% average rate of growth until 2020 corresponds to the medium path between the "high" and "low" scenario of the OECD (see Deliverable 2, p.19). The country with the highest GDP per capita is taken as the frontier country, and other countries are assumed to catch up with this frontier country. 1.5% rate of convergence means that the differences between logs of GDP per capita of each country and the frontier country diminish by 1.5% per year. Furthermore, no convergence or divergence is assumed among regions within each country. This roughly corresponds with the stylised facts about unconditional convergence documented in the literature (Tondl, 2001).

4.3 CGEuropeII

4.3.1 Basic features of CGEuropeII

CGEuropeII has the basic features in common with CGEuropeI: it is a multiregional computable general equilibrium model with households in each region representing final demand and firms representing the production sector. There is a fixed amount of a single primary factor of production in each region, owned by the households of the respective region. There is no public sector, and no monetary system. What distinguishes the two versions is that in CGEuropeII the simplifying distinction between tradables and locals is abandoned. Instead, the model allows for subdividing the economy into an arbitrary number of sectors, each of which may have its own characteristics with regard to its respective degree of localness or of tradability of its output. The current data set allows for a subdivision into six sectors, but with restrictions regarding regional subdivision. Results presented in this report are for a three sectors subdivision. There would be little extra insight by going from three to six sectors, because the disaggregation would be in the service sector; anyway there is little information about trade in this sector and parameterisation of the model for a disaggregated service sector introduces a lot of arbitrariness.

CGEuropeI allows only for two polar cases regarding market structure: the tradables sector is characterized by monopolistic competition à la Dixit-Stiglitz, while the local sector is perfectly competitive with constant returns to scale. As we remove the polarity of the two extreme cases, tradables and non-tradables, in favour of sectors that can have varying degrees of tradability, it is also desirable to remove the polarity of two market forms, Dixit-Stiglitz competition and perfect competition. Instead we admit sector specific degrees of perfect versus monopolistic competition. An extra sector specific parameter varying between zero and one controls the position of the market between the two extremes. This larger flexibility of the model design has its cost, however; we must introduce so-called Armington preferences for obtaining a realistic picture, as to how prices, production and trade flows respond to changing transportation cost. Armington preferences mean that customers of goods have preferences, distinguishing goods with regard to regions of origin. In particular, it is allowed that customers prefer locally produced goods to imported ones, or domestic to foreign suppliers to a certain degree.

Armington preferences are sometimes criticized for being ad-hoc; but dispensing with them causes technical difficulties. Without Armington preferences one would implicitly assume almost perfect product homogeneity, if competition is close to perfect. As a consequence, the elasticity of quantities with respect to prices goes to infinity implying bang-bang solutions. Regions would specialize completely as a response to minimal price differences.

Beyond the multisectoral design, another distinctive feature of CGEuropeII is the incorporation of private passenger travel in final demand. Like demand for goods, demand for travel is derived from utility maximization, taking out-of-pocket costs for travel as well a disutility due to time spent for travel into account. A technically detailed description of CGEuropeII is given in Deliverable 2, pp. 36-41. As the design has been slightly modified during implementation, and also to make this report self-contained, we briefly present the formal structure of the model in the next subsection.

4.3.2 The Equations of the Equilibrium

We start with notation. Subscripts $r = 1, \ldots, R$ denote regions, superscripts i or $j = 1, \ldots, I$ denote sectors.

- $\mathbf{A}_r$ — $(I \times I)$-matrix of intermediate input-coefficients with typical entry a_r^{ij} denoting the input of goods from sector i per unit of sector j's output. Inputs are CES-composites made of all the varieties bought from region r as well as from all other regions. This composite is the same for firms using it as an input as for households consuming it.
- $\mathbf{B}_r$ — $(1 \times I)$-vector of factor-input coefficients with typical entry b_r^j denoting the factor input per output unit of sector j.
- $\mathbf{X}_r$ — $(I \times 1)$-vector of regional outputs with typical entry X_r^i.
- $\mathbf{p}_r$ — The corresponding price vector with typical entry p_r^i.
- $\mathbf{D}_r$ — $(I \times 1)$-vector of regional demand for (composite) goods with typical entry D_r^i.
- $\mathbf{q}_r$ — The corresponding price vector with typical entry q_r^i.
- $\mathbf{F}_r$ — Vector of regional final demand for (composite) goods.
- S_r — Regional factor supply.

w_r The corresponding factor price.

t^i_{rs} Trade flow from sector *i* delivered from region *r* to region *s*, measured in value terms.

φ^i_{rs} Armington preference factor for sector *i*, measuring preferences of customers in region *s* for goods from region *r*.

τ^i_{rs} Mark-up for transport costs. The costs for shipping one unit of *i*-goods from region *r* to region *s* is $p^i_r(\tau^i_{rs}-1)$, such that the price for this unit in region *s* equals $p^i_r\tau^i_{rs}$.

σ_i Elasticity of substitution between regions of origin for sector i.

ε_i Elasticity of substitution between varieties within regions of origin for sector i.

γ_i Competition parameter for sector *i*, varying between zero (perfect competition) and one (monopolistic competition).

$c^i_r(\cdot)$ Unit cost function derived from cost minimisation subject to the representative firm's technology. The function's argument is the vector of input prices $(\mathbf{q}'_r\ w_r)'$ [1], its value is the cost per unit of sector i 's output.

$\mathbf{y}_r$ $(L\times 1)$-vector of households' travel activities with typical entry y^ℓ_r denoting the travel demand of kind ℓ by households living in region *r*. A kind of activity is travel for a certain purpose to a certain destination like tourism travel to destination *s*, say. Currently we allow for one travel purpose only. Hence, index ℓ indicates destinations.

θ_r $(L\times 1)$-vector of travel times, with typical entry θ^ℓ_r denoting the travel time required per unit of activity of kind ℓ by households living in region *r*.

ϑ_r $(L\times 1)$-vector of travel cost, with typical entry ϑ^ℓ_r denoting the real cost required per unit of activity of kind ℓ by households living in region *r*. Real costs are measured in terms of the amount of a composite good. Expenditures for that good represent out-of-pocket costs for travel. Real costs times the price of the composite good equal expenditures.

N_r Net income transfers from other regions to region *r*.

$\mathbf{d_r}(\cdot)$ Household's behaviour function, assigning vectors of final goods demand and passenger travel demand to vectors of prices, travel times and transport costs, and to income .

The general equilibrium of the multiregional economy is summarised by the following system of equations, which we will explain step by step:

$$\mathbf{D}_r = \mathbf{A}_r\mathbf{X}_r + \mathbf{F}_r \qquad (4.12)$$

$$S_r = \mathbf{B}_r\mathbf{X}_r \qquad (4.13)$$

$$a^{ij}_r = \frac{\partial c^j_r(\mathbf{q}_r, w_r)}{\partial q^i_r} \qquad (4.14)$$

$$b^j_r = \frac{\partial c^j_r(\mathbf{q}_r, w_r)}{\partial w_r} \qquad (4.15)$$

$$p^i_r = c^i_r(\mathbf{q}_r, w_r) \qquad (4.16)$$

$$q^i_s = \left(\sum_r \varphi^i_{rs}(X^i_r)^{\gamma_i}(p^i_r\tau^i_{rs})^{1-\sigma_i}\right)^{\frac{1}{1-\sigma_i}} \qquad (4.17)$$

[1] Apostroph $'$ denotes transposition. Vectors without apostroph are column vectors.

$$p_r^i = \left((X_r^i)^{\gamma_i - 1} \sum_s \varphi_{rs}^i (\tau_{rs}^i)^{1-\sigma_i} q_s^{\sigma_i} D_s^i \right)^{\frac{1}{\sigma_i}} \tag{4.18}$$

$$\begin{pmatrix} \mathbf{F}_r \\ \mathbf{y}_r \end{pmatrix} = \mathbf{d}_r(\mathbf{q}_r, \theta_r, \vartheta_r, w_r S_r + N_r) \tag{4.19}$$

Equations (4.12) and (4.13) are the familiar input-output equations of a Leontief system, giving the total (intermediate plus final) demand for goods and factor demand. As already noted, the same composition index for varieties is assumed for firms and households, such that their respective demands for a composite good can be merged into one aggregate regional demand for that good.

Equations (4.14) and (4.15), stating Shephard's Lemma, give the goods-input and factor-input coefficients. Note that coefficients are endogenous. We assume a CES form for the cost function. That means that inputs are substitutes. It is common in CGE analysis to assume fixed coefficients and to allow substitution only between primary factors. There is no theoretical reason or empirical evidence, however, why substitution should not be possible between other inputs as well. Hence, we assume a positive, though rather low elasticity of substitution.
Equation (4.16) states that goods prices equal unit costs. It is implied by the assumption of free entry, which holds under perfect competition as well as under monopolistic competition.

Equations (4.17) and (4.18) need some explanation. As explained before, firms and households buy composite goods, composed of deliveries from all regions. A composite good produced by industry i is composed according to a two-level nested CES index. On the upper level customers choose between regions of origin, on the lower level they choose between varieties within regions of origin. In each supply region sector i poduces a homogeneous "raw output", that is itself the only input for producing varieties of final output. A fixed amount of that raw output per variety plus a constant marginal amount per unit of final output is required for producing final goods. Entry into and exit from the industry is free. Hence, there is Dixit-Stiglitz competition within each region. The elasticity of substitution of the lower CES nest controls the degree of homogeneity. If it goes to infinity, we are approaching perfect competition.

Due to a constant mark-up and free entry the price per unit in region r equals p_r^i, the average cost, and the number of varieties equals X_r^i (up to a constant). The composite of regional varieties therefore has the unit cost

$$\upsilon_r^i = \left[X_r^i (p_r^i)^{1-\varepsilon_i} \right]^{\frac{1}{1-\varepsilon_i}} \tag{4.20}$$

(constants are absorbed in the choice of units). Inserting this into the composite price formula for the upper nest with preference parameters φ_{rs}^i yields equation (4.17), with

$$\gamma_i = \frac{1-\sigma_i}{1-\varepsilon_i}. \tag{4.21}$$

For $\varepsilon_i > \sigma_i > 1$ we have $\gamma_i < 1$.

Equation (4.18) is obtained from the conditions that supply equals demand for each sector in each region as follows. Assuming transport costs of the "iceberg-form", the value of region *s*'s demand for goods from region *r* is

$$t_{rs}^{i} = \varphi_{rs}^{i} (\upsilon_{r}^{i} \tau_{rs}^{i})^{1-\sigma_i} (q_{s}^{i})^{\sigma_i} D_{s}^{i} . \tag{4.22}$$

Summing over *s*, inserting υ_r^i according to (4.20), using the equilibrium condition

$$p_r^i X_r^i = \sum_s t_{rs}^i \tag{4.23}$$

and solving for p_r^i yields equation (4.18).

Introducing the γ-parameter gives the price equations a nice interpretation in terms of a "degree of monopolistic competition". If γ_i goes to zero, the impact of supply market size on the composite price vanishes. At the same time, there is full "market-crowding" according to equation (4.18). A one percent increase of supply leads to a $1/\sigma_i$ decrease of the supply price in equilibrium, ceteris paribus. The other polar case is γ_i equal to one. This is the pure Dixit-Stiglitz case. Market size is fully reflected in the composite price according to equation (4.17), and there is no direct crowding effect on the supply price according to equation (4.18).

There is another, mathematically equivalent interpretation of the equations. Assume production functions to be homogeneous of degree α_i, $1 \le \alpha_i \le \sigma_i /(\sigma_i - 1)$, and let markets be contestable such that firms are forced to set prices equal to average cost. Then it can be shown that the above equations continue to hold, with $\gamma_i = (\alpha_i - 1)(\sigma_i - 1)$, and with X_r^i denoting output raised to the power $1/\alpha_i$. As far as we know, this reinterpretation of Gasiorek's and Venables' (1999) approach in more traditional terms has not been noticed elsewhere in the literature. A proof of the mathematical equivalence is given in Appendix D.

Equation (4.19) models household behaviour. Households in region *r* decide upon goods consumption $\mathbf{F}_r$ and passenger travel $\mathbf{y}_r$. Goods are either directly consumed, or they are required as an input for travel. The decision depends on goods prices $\mathbf{q}_r$, on travel times and costs, θ_r and ϑ_r, and on income, which is factor income plus net transfer received.

The decision of households is derived from maximizing the utility

$$U_r(\mathbf{G}_r, \mathbf{y}_r) = V(\mathbf{G}_r, \mathbf{y}_r) - \eta_r \theta_r' \mathbf{y}_r \tag{4.24}$$

subject to the budget constraint

$$\mathbf{G}_r' \mathbf{q}_r + p_r^T \vartheta_r' \mathbf{y}_r = w_r S_r + N_r \tag{4.25}$$

$\mathbf{G}_r$ is the $(I \times 1)$-vector of goods consumption excluding travel expenditure. η_r is a parameter, weighting the disutility of travel time in the utility function. p_r^T is the composite price of the composite good representing out-of-pocket travel expenditures. V is assumed to have a two-level nested CES form. On the upper level households choose goods and a composite good called travel. For travel there is a lower nest representing choice between destinations (see Figure 4.1).

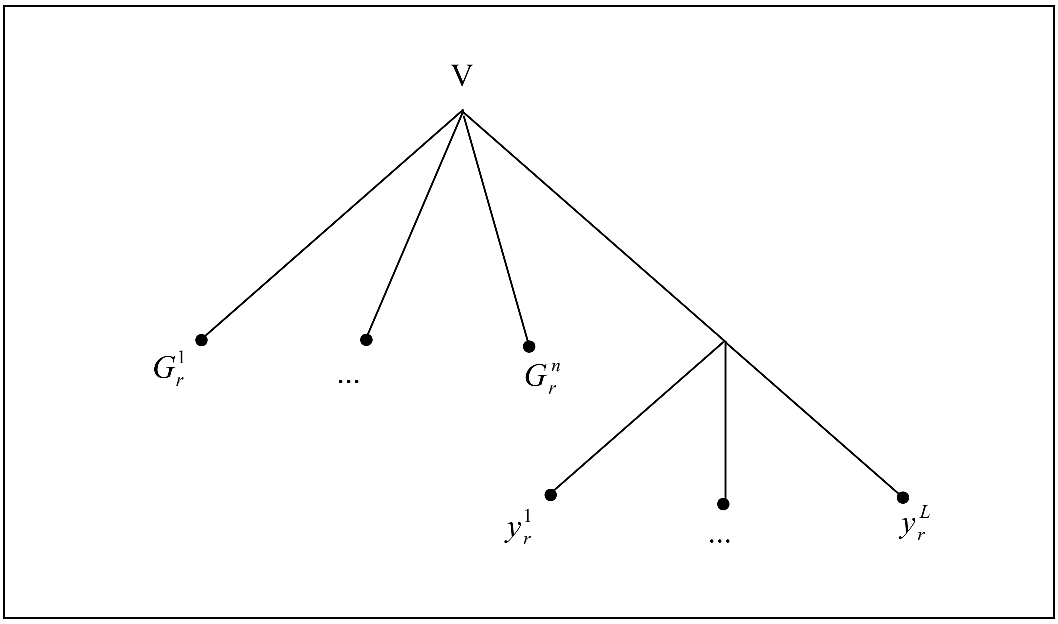


Figure 4.1. Consumption decision of households

Final demand consists of two components, goods demand $\mathbf{G}_r$ resulting from the above optimisation problem, and demand for goods used for travel. For goods from sector i we have

$$F_r^i = G_r^i + \frac{\partial c_r^T(\mathbf{q}_r)}{\partial q_r^i} \vartheta_r' \mathbf{y}_r . \tag{4.26}$$

c_r^T is the cost function for the composite good used for travel, which is also assumed to have CES form.

The consistent micro-foundation of household behaviour allows for a welfare measurement fully in line with the ideas of cost-benefit analysis. Welfare effects of any exogenous change like a decrease in transport costs are measured by comparing utility levels by region before and after the change. As utility levels have no meaning in a metric sense (they measure only on an ordinal scale), utility changes are translated to equivalent monetary values by Hicks' concept of equivalent variation (EV). Let us call the situation before the change the benchmark, and the situation after the change the alternative. The EV of the respective change is defined as the amount of money one would have to add to the household's benchmark income (everything else held constant on benchmark levels) in order to make the household as well off as in the alternative. Note that EV is not the same as the income increase generated by the change. This would be so only if no variable influencing utility but income changed. Other variables like prices and travel times do change, however, as a consequence of transport initiatives. Regional EVs can be reported as per capita amounts or as shares in benchmark regional GDP (relative EV).

4.3.3 Calibration

Technologies

Technologies of firms in industry *i* and region *r* are represented by the CES cost functions $c_r^i(\cdot)$. They are characterised by two types of parameters, position parameters (sometimes called shift or share parameters) and elasticities. The former fix input-output coefficients at a desired point, given the input prices; they shift in other words the input demand functions to a desired position. The latter define how input ratios react on changing input price ratios. As we have input-output information only on the national level, we assume identical technologies within each country. But technologies differ in general between countries. The position parameters are calibrated such that the values of interindustry flows and primary inputs, when aggregated over regions of a country for the benchmark equilibrium, exactly add up to the values observed in the national accounts. Hence, the fixing of these parameters is fully determined by the data.

Fixing he elasticities is more problematic, because a data set just showing value information for a single cross section does not allow for estimating elasticities empirically. For such an estimate one would need data that, first, explicitly separate price and quantity information, and second, show sufficient variation in quantities and prices in a time series. Such information is very rare and not available for estimating elasticities in a large model. One therefore has to rely on information from the literature. The estimates found in econometric literature are also quite diverse, so that there is a lot of subjective judgement in the choice of elasticities. Usually it is assumed that the degree of elasticity between inputs is between what a Cobb-Douglas function implies, which assumes constant value shares of inputs, and what a Leontief function implies, which assumes constant quantity ratios. Hence, the elasticities should be between zero and one. Relying on the literature survey discussed in Bröcker and Schneider (2002) we choose elasticities of 0.4, 0.8 and 0.8 for agriculture, manufacturing and services, respectively.

A technology has also to be specified for the production of the travel service consumed by private households, represented by the cost function $c_r^T(\cdot)$, see equation (4.26). Here a low degree of substitutability is plausible (0.4). The position parameters are those for the transport sector from the German input-output table, and assumed to be identical for all regions. It should be noted that due to the smallness of this demand component the specification of this technology is virtually irrelevant for any of the results.

Preferences

Households' preferences for goods are also specified as CES forms, whose parameters are obtained from national accounts in the same way as the technology parameters of firms. The elasticity of substitution is 0.8. Another aspect of households' preferences is the preference for travel, differentiated by destination. It is also represented by a CES function making up the lower nest in Figure 4.1. The position parameters are fixed such that for each region the travel demand obtained from the SCENES data set is reproduced.

We include only long distance travel of two categories, namely “holiday trips” and “visiting friends”. Furthermore, the SCENES data are available only for EU15. Hence, we neglect private passenger travel completely for all other regions, i.e. we treat the households as if their travel demand was zero. As this implies that results for EU15 and non-EU15 are not really comparable, we also simulate a model version excluding private passenger travel completely. This is also done for comparing results from CGEuropeII with those from CGEuropeI, which does not contain private passenger travel either.

The corresponding elasticity of substitution is assumed to be smaller than the upper level elasticity, namely 0.2. This is because travel costs are only one component of the full cost of an activity (holidays, visiting friends) to be performed in a destination. If the elasticity of substitution between these activities was 0.8, say, and travel costs amounted to one fourth of these costs, than the elasticity with respect to travel cost would just be one fourth of 0.8, that is 0.2. This elasticity can also be shown to equal approximately the direct price elasticity of demand for travel to a specific destination. This is usually estimated to be much smaller than one. That also justifies a small elasticity.

Finally, the weight of travel time disutility in the utility function, parameter η_r, is calibrated such that the value of time in the SCENES data equals the willingness to pay for time savings, that is implied by the utility function in the benchmark equilibrium. While the parameter η_r is fixed in the simulation, the value of time is endogenous and varies with prices and income. The benchmark travel times θ_r are directly taken from the SCENES data. The real travel costs ζ_r are obtained from theses data by dividing the monetary costs through the benchmark price of the travel service. We have no data on changes of these costs for our scenarios. Therefore we approximate the percentage changes of these times and costs by the percentage changes of the unit costs for business travel. Cost information for holiday trips and trips for visiting friends etc. for all scenarios would be preferable, of course, but the extra effort would be large and the impact on results is likely to be small.

Trade

Goods and services flowing to a destination region are aggregated to a composite good according to a CES aggregator, that can be understood as a lower nest in technologies and preferences, see equation (4.22). This aggregator has again two types of parameters, the position parameter φ^i_{rs}, called Armington parameter in this context, and the elasticity of substitution. A theoretical strength of the CGEuropeI model is that it is able to dispense with Armington parameters completely. The gravity pattern of trade is completely explained by transfer cost without any reference to regional preferences, which are somewhat ad-hoc. This turned out to be impossible in multisectoral version of the model for technical reasons. One would always end up with at least one of three unpleasant results: (1) much too large average distances of trade flows, and as a consequence unplausibly high trade impediments required to bring international trade flows down to observed numbers; (2) much too large scale parameters for interregional transfer costs; (2) much too high elasticities of substitution in interregional trade, that lead to unstable reactions of the equilibrium solution. Hence, we introduce the Armington preference parameters to account for those parts of distance and international impediment impacts on trade that can not plausibly be explained by costs, given non-excessive elasticities of substitution.

A look at equation (4.22) shows trade flows to follow a gravity equation with distance resistance term $\varphi^i_{rs}(\tau^i_{rs})^{1-\sigma_i}$. For services we assume the majority of trade to be local by setting $\varphi^i_{rs} = 10$ for *r*=*s*, equal to one for intranational interregional flows, and equal to a country-specific factor less than one for imports from foreign countries. The latter factor is obtained from calibration by equating imports of services in the benchmark equilibrium with observed imports from national accounts for each country. Note that in CGEuropeI we accounted for the fact that a large part of output is sold only locally by admitting only two extremes, a tradable sector without local preferences and a local sector with φ^i_{rs} implicitly set equal to zero for $r \neq s$. That approach is difficult to realise in a multisectoral setting, and a preference parameter allows for more flexibility, but of course also adds some arbitrariness, because the factor 10 is ad-hoc and hard to justify by empirical observations.

For agriculture and manufacturing we assume the whole resistance term $\varphi^i_{rs}(\tau^i_{rs})^{1-\sigma_i}$ to be a function of distance, measured by car travel time, and of an international impediment represented by dummies for international flows. This is justified by the observation that a doubly constrained gravity model with a simple distance function is known to reproduce observed trade very well. The distance function is obtained by estimating gravity equations for international trade in logs with a Box-Cox transformed distance and fixed effects representing all variables assigned to the country of origin or country of destination. For a positive Box-Cox parameter this is equivalent to the combination of an exponential with a power function as in equation (4.11). For manufacturing we obtain parameters very close to those used in CGEuropeI for total trade ($0.045g^{0.58}_{rs}$). g_{rs} is travel time in minutes. For agriculture the Box-Cox parameter turns out to be close to zero, which means that the distance function becomes a power function. The distance exponent is –1.53, which is similar to the estimates from many econometric studies in the literature.

Substitution elasticities are set equal to 6 for all three sectors, following the literature survey referred to in Bröcker and Schneider (2002). Note that this is only half of what we assumed in CGEuropeI. The high estimate in CGEuropeI is less in line with the standard literature, but it is what one needs for making that model coincide with the data without relying on Armington preferences.

Market form

The parameter γ_i specifies for each sector the market form, that is its position between perfect competition ($\gamma_i = 0$) and Dixit-Stiglitz competition ($\gamma_i = 1$). We assume agriculture to be close to perfect competition, as the goods are rather homogeneous ($\gamma_i = 0.1$), services to be close to Dixit-Stiglitz competition ($\gamma_i = 0.7$) and manufacturing to lie in between ($\gamma_i = 0.5$). Jointly with the trade elasticity the γ-parameter determines the price mark-up on marginal cost. With these parameter choices it is 2 %, 10 %, and 14 % for agriculture, manufacturing, and services, respectively.

Trade cost

Trade cost is specified in the same way as for CGEuropeI. For manufacturing we assume trade costs to be a combination of transport cost and cost of business travel, as in CGEuropeI. Trade cost in agriculture is assumed to consist of transport cost only, because it is regarded as less information intensive. To the contrary, trade cost for services is assumed to consist of business travel cost only. We therefore need four cost-scaling parameters (μ-parameters, see equation 4.5), one for scaling transport cost for agriculture, one for scaling travel cost for services, and two for scaling both types of cost for manufacturing. They are found by imposing the following restrictions:

1. total transport cost amounts to 3.35 % of GDP (this estimate is from the SCENES data, including time cost);
2. total cost of business travel amounts to 2.55 % of GDP (dito);
3. the ratio of transport to business travel cost in manufacturing is 5:1;
4. the share of transport cost in the value of trade is in agriculture twice as large as in manufacturing.

Clearly there is considerable arbitrariness also in assumptions 3 and 4. Assumption 4 could be justified with the findings of Combes and Lafourcade (2001), though the cost level estimated by these authors is much lower than what we assume, in fact that low that all our scenarios would generate welfare effects close to nothing and would render all infrastructure initiatives far from profitable. Restriction 3 is just a plausible guess, we are not aware of any serious estimate usable in this respect. One should also be aware that total logistic cost is usually estimated to be much larger than 2.55 % plus 3.35 % of GDP. Estimates for European countries varying between 10 % and 13 % can be found in the literature (OECD/TRILOG). But these contain components not dependent and transportation distance and the state of infrastructure, and thus should not be included for fixing the cost-scaling parameters.

4.4 CGEurope Data Base

The data to be used in CGEurope can roughly be subdivided into four categories, namely (1) national accounts data, (2) regional data, (3) international trade data and (4) transportation cost data.

A detailed description of the data requirements is given in Deliverable 2, pp. 45-51, while the common spatial database as a whole is the subject of Deliverable 3. In the following chapters we will therefore only outline the adjustments that had to be made after the completion of Deliverable 3 in order to meet the model requirements of CGEurope. Most of these changes were made to achieve overall data consistency, which is an important prerequisite for a general equilibrium approach. Additional adaptions of the data input resulted from restrictions both in data availability and reliability.

4.4.1 National Accounts

For the sectoral disaggregation of CGEurope, data are needed on input-output coefficients as well as trade flows by sector. Ideally, CGEuropeII would like to make use of regional accounting identities in order to take account of region specific differences in economic activity. However, there is no data available to provide such a social accounting matrix (SAM) on a sub-national scale. To cope with this lack of detailed information, CGEurope assumes that production technologies and households' preferences do not depend on location. By doing so, the number of parameters to be calibrated reduces so that national input-output data are sufficient for the calibration process. Regional information enters in terms of sectoral activity indicators as well as regional GDP values (see the following Subsection).

The IO-tables as part of the database already described in Deliverable 3, are of vital importance for the calibration of CGEuropeII. They contain important information on the sectoral interaction within each country as well as its imports and exports with regard to all other countries. Moreover, it characterizes countries in terms of the differences in their sectoral factor productivities. The main sources for the input-output-tables are the data sets of Beutel (for current EU member states) and Banse (for the candidate countries) as well as national statistics (for details see IASON Deliverable 3, p.54).

In order to achieve overall consistency necessary for the calibration of CGEurope, the IO-tables were scaled such that the sectoral GDP values for each country sum up to the corresponding GDP value provided by Eurostat and World Bank. This way was chosen, since original GDP data is regarded as being more reliable than those resulting from the IO-tables. In fact, in the cases of Malta and Cyprus it turned out that there was no useful IO information available at all. For those countries import and export shares did not have plausible orders of magnitude. Therefore, we had to abstain from using these data for the calibration process of CGEuropeII. Note also that additional data sources were used in the case of Bulgaria, since the IO tables provided by the Banse dataset also contained implausible data concerning the relations between GDP, total production and trade. The Bulgarian data have therefore been newly compiled, using an IO-table for 1997 recently published by the Bulgarian National Statistical Institute (Nacionalen Statisticeski Institut, 2002). Moreover, since IO information for Albania, Macedonia and Belarus is not available, Bulgaria was used here as a proxy.

4.4.2 Regional Data

Apart from national accounting data, CGEurope needs regional GDP data for the calibration of the benchmark year. While for CGEuropeI sectoral aggregated GDP data are sufficient, CGEuropeII needs also information about the sectoral distribution of regional economic activity; that is data has to be disaggregated not only with regard to regions but also with regard to sectors. Unfortunately such fine data is not available in an overall consistent form, so that indicators on regional activity by sector had to be used to disaggregate regional GDP data with respect to sectors. However, those economic indicators also do not cover the whole IASON system of regions. In fact, it is only a minority of countries for which NUTS 3 level data exist. For most of the countries only NUTS 2 data or below is available. For this reason we decided to be content with the NUTS 2 level at all, since it would have made no sense to pretend a degree of regional detail which is not actually covered by the data. An overview about availability and sources of the used sectoral data is already given in Deliverable 3 by Table 5.1, p.56. With Table 4.2 below we give an updated version of this table. The original system of regions was already presented in Deliverable 3, p. 141ff. The aggregated regional system which was applied in CGEuropeII, is given in in Appendix E of this Deliverable. For the EU15 Member Countries it exactly corresponds to the system of regions used within SCENES. For the other countries a slightly more detailed disaggregation was chosen, depending on the data availability with respect to sectoral activity.

Table 4.2. Data availability of economic activity indicators for all 6 sectors

Country	NUTS level	Code	Year	Source
Austria	2	2	1998	Eurostat
Belgium	2	2	1998	Eurostat
Denmark	3	3	1997	Statistical Yearbook 1998
Finland	2	2	1998	Eurostat
France	2	2	1998	Eurostat
Germany	3	3	1997	Statistik Regional, 1999
Greece	2	2	1998	Eurostat
Ireland	2	2	1998	Eurostat
Italy	2	2	1998	Eurostat
Netherlands / Luxembourg	2	2	1998	Eurostat
Portugal	2	2	1998	Eurostat
Spain	2	2	1998	Eurostat
Sweden	2	2	1998	Eurostat
United Kingdom	2	1	1997	
Bulgaria	3			Stat. Commission / Econ. Comm. for Europe
Cyprus	0		1997	
Czech Republic	3	2	1997	National Statistical Office
Estonia	3	2	1997	National Statistical Office
Hungary	3	3	1997	Regional Statistical Yearbook, 1998
Latvia	3	3	1998	Statistical Yearbook 1998
Lithuania	3	3	1998	Department of Statistics
Malta	0		1997	
Poland	2=3	2	1998	Eurostat
Romania	3	3	1997	Territorial Statistics/Statistical Yearbook 1998
Slovakia	2	2	1998	Eurostat
Slovenia	3	2	1997	Statistical Yearbook 1998
Switzerland / Liechtenstein	2		1997	
Norway	3	3	1997	National Statistical Office
Albania	0		1997	

Belarus	0		
Bosnia & Herzegowina	0		1997
Croatia	0		1997
Iceland	0		1997
Macedonia	0		1997
Moldova	0		1997
Russia	0	3	1998
Turkey	0		1997
Ukraine	0		
Yugoslavia	0		1997
Rest of World	0		1997

4.4.3 International Trade

Information on interregional exchange of goods and services plays a key role in both versions of the CGEurope model. Since such trade data is not provided on a regional scale, CGEurope has to put up with trade matrices based on international data. Concerning CGEuropeII, it is also necessary to have those trade information subdivided by economic sectors.

For the first two sectors considered within CGEuropeII, "agriculture" and "manufacturing", trade data is mainly provided by Feenstra. Additional information for central and eastern Europe was used from the Vienna Institute for International Economic Studies (for details see Deliverable 3, p. 54).[2] Data consistency requires that the import and export sum for each country and sector has to be equal to the respective values given by the input-output-tables. This was achieved by using a RAS procedure.

A different strategy was chosen with respect to the remaining sectors, namely "services". As it has been already noted in chapter 4.3.1, we decided to subdivide CGEurope only into 3 sectors instead of 6. According to our earlier plan, the service sector would have been split up into three further sectors. For services, however, only limited trade data is available so that it was not possible to provide all necessary trade matrices covering all IASON countries. Furthermore, the delimitation within the service sector seems to be quite different between EU15 and the eastern European countries. More reliable results can therefore be expected with only one combined service sector under consideration, while the loss of insight by this aggregation is probably small. Unfortunately, even for an aggregated service sector it is not possible to provide a complete and consistent trade matrix for all countries. We therefore decided to go a different way. The calibration process of CGEuropeII has been adapted such that only information on export and import sums for each country are needed as input (see the item "Trade" in Subsection 4.3.3). Those data stem from the national input-output-tables described above.

4.5 Spatial Inequality and Global Benefits of Transport Initiatives

An important policy issue to be dealt with, is whether global benefit measures obtained from classical CBA need to be substantially corrected upwards or downwards, if the spatial distribution of welfare impacts is taken into consideration. This chapter develops a welfare indicator, measured in monetary terms, taking distribution effects into account.

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[2] The notation "Manufacturing" used in the following refers to an aggregation of manufacturing, energy and construction according to the original data sets.

Classical CBA measures money-metric benefits "on the network" without asking if the person to which the benefit eventually accrues is relatively rich or poor. It integrates over all savings of generalized costs on the network, thereby adding Euros to Euros, even though it may well be argued that a Euro gained by a poor man is worth more than a Euro gained by a rich man. This is to say that CBA is implicitly based on a utilitarian social welfare function

$$W = \sum_i u(e_i) \tag{4.27}$$

with linear utility $u(e_i) = e_i$. W is social welfare and e_i is per capita income. Note that W is measured in terms of Euro, if e_i is.

We ask whether it would matter if another function was substituted for u incorporating the idea of inequality aversion, i.e. taking into account that an extra Euro adds the less to welfare of the society, the richer the individual is, to whom the extra Euro flows. Ideally, we would like to know the impact of a transport initiative on each income group, using a delineation of income groups as fine as possible. We then would like to compare welfare gains with and without consideration of the distributional dimension.

No-one has information on incidences by individual income groups however. We restrict our interest to the spatial dimension of income distribution, that is we consider distribution across regions, while neglecting distribution within regions. Formally this is achieved by assuming each individual in a region to obtain the same per capita income. We stick to the utilitarian function (4.27), but incorporate constant relative inequality aversion into the utility function by specifying it as

$$u(e_i) = \begin{cases} \dfrac{e_i^{1-\rho} - 1}{1-\rho} & \text{for } \rho \geq 0 \text{ and } \rho \neq 1, \\ \log\ e_i & \text{for } \rho = 1 \end{cases} . \tag{4.28}$$

Note that the marginal utility is $u' = e_i^{-\rho}$. That means marginal utility decreases with increasing e_i and the Parameter ρ controls the steepness of this decrease. Hence, ρ is a measure of inequality aversion.

Consider a transportation initiative making the average per capita income in the regions change from e_r^0 (before) to e_r^1 (after). Hence, social welfare amounts to

$$W^t = \sum_r P_r u(e_r^t) \tag{4.29}$$

for $t \in \{0,1\}$. P_r is the population in region r, and per capita incomes are taken to be identical for all individuals in a region r.

The relative equivalent income of the initiative is defined to be the proportional income change generating the same social welfare as the initiative under consideration. Formally, it is the factor $\overline{a}$ solving

$$\sum_r P_r u(e_r^0 \overline{a}) = \sum_r P_r u(e_r^1). \tag{4.30}$$

Solving for $\overline{a}$ with the utility function specified above yields

$$\overline{a}(\rho) = \left(\frac{\sum_r P_r (e_r^1)^{1-\rho}}{\sum_r P_r (e_r^0)^{1-\rho}} \right)^{\frac{1}{1-\rho}} \tag{4.31}$$

Comparing $\overline{a}\,(\rho)$ for $\rho > 0$ with $\overline{a}\,(0)$ shows to what extent the aggregated percentage income gain has to be corrected upwards or downwards due to decreased or increased inequality.

Calculating the first order approximation of (4.31) in logs helps to elucidate the interpretation of the measure. Let

$$\alpha_r = \log(e_r^1 / e_r^0) \text{ and} \tag{4.32}$$

$$\overline{\alpha}(\rho) = \log(\overline{a}(\rho)). \tag{4.33}$$

As we deal with small changes in the order of less than one percent in most cases,

$$(e_r^1)^{1-\rho} \approx (e_r^0)^{1-\rho}(1 + (1-\rho)\alpha_r) \text{ and} \tag{4.34}$$

$$\overline{a}^{1-\varepsilon} \approx 1 + (1-\rho)\overline{\alpha} \tag{4.35}$$

are good approximations. Plugging them into (4.30) yields:

$$\sum_r P_r (e_r^0)^{1-\rho}(1 + (1-\rho)\overline{\alpha}) = \sum_r P_r (e_r^0)^{1-\rho}(1 + (1-\rho)\alpha_r). \tag{4.36}$$

Solving for $\overline{\alpha}$ gives

$$\overline{\alpha}(\rho) = \frac{\sum_r P_r (e_r^0)^{1-\rho} \alpha_r}{\sum_r P_r (e_r^0)^{1-\rho}}. \tag{4.37}$$

Thus, $\overline{\alpha}(\rho)$ is the weighted average of the relative changes α_r, with weights $P_r (e_r^0)^{1-\rho}$. For $\rho = 0$ the outcome is just the aggregated income change, because the weight $P_r e_r^0$ is the total regional income in the reference situation. For $\rho = 1$, i.e. for logarithmic utility, the weights are simply P_r; the outcome is the population weighted average of relative regional income changes. This is because equal relative changes are valued equally under logarithmic utility. Finally, for $\rho > 1$ a given percentage increase in a poor region is valued even higher than the same percentage increase in a rich region.

4.6 CGEuropeI Simulation Results

We begin with a description of the results for the scenarios in Subsection 4.6.1. For keeping the description short, we go into details only for a few of them. Aggregated welfare effects for 1997 are shown in Table 4.3 for EU15, EU27 and accession countries (CC12). The measure is the welfare measure corrected for changes in inequality, as described in Section 4.5. It measures welfare change for the respective group of countries in monetary terms as a percentage of GDP. We almost exclusively refer to the results for the 1997 comparative static experiment. Those for 2020 are very similar. We briefly compare results for 1997 and 2020 in Subsection 4.6.3 below. When we mention aggregated results we refer to the figures in Table 4.3 with no inequality correction ($\rho = 0$). In this figure aggregated welfare effects are just the sum of regional welfare effects. Relative effects are therefore averages of regional relative effects, weighted by regional GDP. In Subsection 4.6.4 we discuss more extensively whether the individual scenarios are enforcing cohesion or contradicting the cohesion objective. Referring to results for $\rho > 0$, we also give an answer as to whether welfare measures of traditional CBA have to be corrected when spatial distribution is taken into account in an aggregated welfare measure.

Table 4.3: Overview of model results for 1997, welfare effects for different degrees of inequality aversion (parameter ρ), percent of GDP

		A1	A21	A22	A23	A24	A3
EU27	$\rho = 0$	0.109	0.068	0.015	0.029	0.082	0.251
	$\rho = 1$	0.102	0.066	0.013	0.026	0.079	0.312
	$\rho = 2$	0.064	0.041	0.006	0.018	0.047	0.415
EU15	$\rho = 0$	0.111	0.070	0.015	0.030	0.084	0.242
	$\rho = 1$	0.120	0.078	0.016	0.030	0.093	0.268
	$\rho = 2$	0.132	0.089	0.016	0.031	0.105	0.298
CC12	$\rho = 0$	0.047	0.030	0.003	0.014	0.034	0.456
	$\rho = 1$	0.040	0.025	0.003	0.014	0.028	0.466
	$\rho = 2$	0.034	0.020	0.002	0.012	0.022	0.467

		A4	A51	A52	A53	A61	A62
EU27	$\rho = 0$	0.222	0.143	0.108	0.041	0.258	0.273
	$\rho = 1$	0.217	0.156	0.110	0.054	0.307	0.358
	$\rho = 2$	0.139	0.147	0.082	0.079	0.368	0.530
EU15	$\rho = 0$	0.227	0.143	0.110	0.039	0.253	0.261
	$\rho = 1$	0.253	0.161	0.123	0.045	0.284	0.292
	$\rho = 2$	0.284	0.185	0.140	0.054	0.320	0.329
CC12	$\rho = 0$	0.109	0.147	0.073	0.081	0.385	0.550
	$\rho = 1$	0.090	0.141	0.064	0.084	0.387	0.587
	$\rho = 2$	0.075	0.131	0.056	0.082	0.390	0.619

		B1	B2	C	D	E1	E2
EU27	$\rho = 0$	-0.275	-1.069	-0.902	0.248	0.233	-0.223
	$\rho = 1$	-0.290	-0.973	-0.814	0.243	0.297	-0.111
	$\rho = 2$	-0.308	-0.672	-0.570	0.169	0.405	0.178
EU15	$\rho = 0$	-0.275	-1.094	-0.923	0.251	0.224	-0.246
	$\rho = 1$	-0.288	-1.111	-0.925	0.269	0.252	-0.239
	$\rho = 2$	-0.301	-1.116	-0.909	0.288	0.285	-0.227
CC12	$\rho = 0$	-0.280	-0.502	-0.430	0.182	0.445	0.307
	$\rho = 1$	-0.297	-0.489	-0.425	0.151	0.455	0.337
	$\rho = 2$	-0.311	-0.475	-0.420	0.116	0.459	0.359

4.6.1 Results for the 1997 calibration

A1

This scenario covers the projects of the Essen list, including the extensions proposed in 2001. These projects are all located within the EU15 area; hence the impact is mainly visible in EU15 countries, even though there are also some smaller gains in the accession countries due to their interaction with E15 countries. The welfare gain amounts to around one tenth of one percent of GDP per annum. Taking the EU15 impact only, this amounts to about 9.3 billion Euro for the year 2000. Given the estimated investment cost of 235 billion Euro, the rate of return would be roughly 4 %. Note that this is exclusive of private passenger travel.

A look at the map in Figure 4.4a clearly shows the shadows of individual projects. Some of them have a strong impact such as the Nordic triangle plus the Øresund and Fehmarnbelt fixed links, the projects on the Iberian peninsula, the Irish road and rail projects, the road link and West cost main line in Britain and the Greek motorways.

In some cases gains generated by a certain link spread over a large area in the prolongation of the respective link. Cases in point are the Italian West coast south of Naples plus Sicily participating in the gains from the North-South high speed train (No. 1 from the Essen list), the French West coast participating in the gains from the multimodal link Portugal-Spain-Central Europe (No. 8) or North-East Germany and North-West Poland participating from the gains at the Northern end of the North-South high speed train.

Figure G.1b zooms the area of Germany and the Benelux countries in order to make details for NUTS3 regions, which are rather small in these countries, better visible. Note that colour classes have equal width in Figure 4.4, while “natural interrupts” are chosen in Figure 4.4b, revealing variations also in regions that are affected only little. Figure G.1b reveals nicely the impact of the North-south high speed train in Germany and of the high speed rail Paris-Karlsruhe/Luxembourg/Saarbrücken.

A2

Figure 4.5 shows the impact of rail projects (high speed and conventional) only (scenario A2.4). Again the individual projects already described show up on the map. The projects in this scenario are the union of those in scenarios A2.1 (high speed) and A2.2 (conventional). Therefore the effects are almost identical to the sum of the effects from these two scenarios. This is clearly shown by the scatter-plot in Figure 4.2, correlating the effects of scenario A2.4 against the sum of effects from scenarios A2.1 and A2.2.

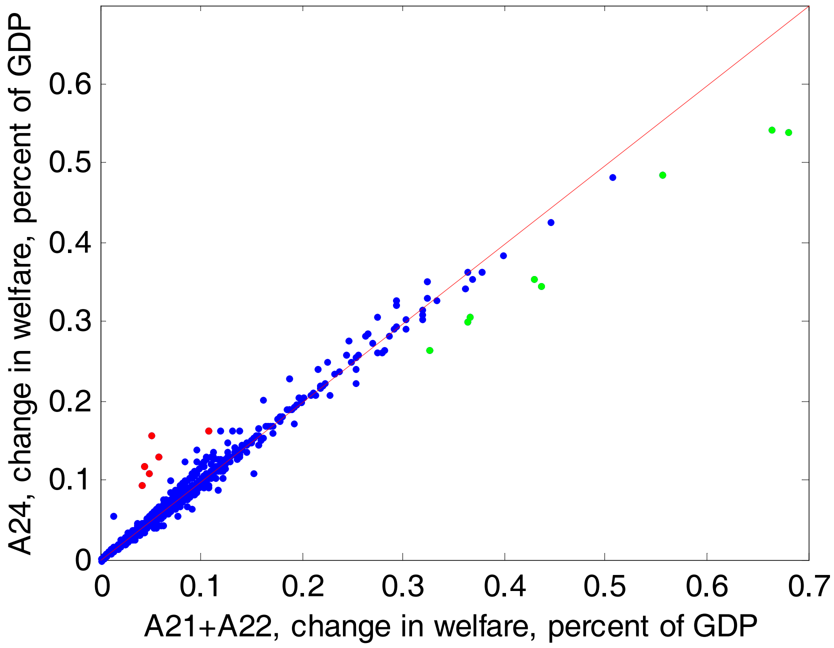

Figure 4.2. Additivity of rail projects

The red line marks equality. Obviously there is virtually no superadditivity or subadditivity of the two kinds of rail projects, with a few exceptions of slight supperadditivity in the North of Portugal (red dots) and slight subadditivity for some regions in Western Spain and central Portugal (green dots).

A similar conclusion applies to a comparison of scenario A1 with the sum of A2.3 (all rail projects) and A2.4 (all road projects). The comparison is illustrated by the scatter-plot in Figure 4.3. It is again obvious that there is virtually no superadditivity or subadditivity. Only for regions with comparatively large effects there is a tendency towards subadditivity. Typically, these are the regions close to parallel road and rail projects.

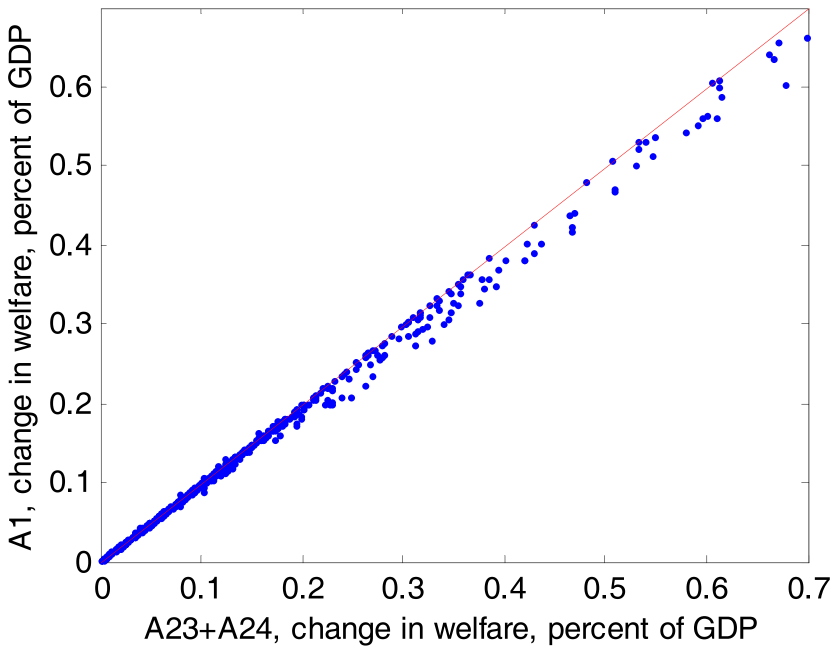

Figure 4.3. Additivity of road and rail projects

A3/E1 and A4

A3 is the most comprehensive scenario containing projects that cover more or less the whole area of EU27 except Switzerland. E1 is almost the same as this scenario. Most regions are positively affected. Only a few gain almost nothing like Paris, East-England and some central regions in Germany and agglomerations in Italy. Accession countries gain almost the double of what EU15 countries gain, in relative terms. Note, however, that in per capita terms gains are still smaller in accession countries because of the lower level of per capita GDP.

A4 is just the EU15 part of A3. Hence, the pattern is the same as that of A3 within EU15, while there are smaller, though still significant gains in accession countries. They are due the better access to Western markets. This effect is more pronounced in the 2020 calibration than in the 1997 calibration due to the higher level of integration in 2020.

A5

For the A5 scenarios most of what has already been said for the A1 and the A2 scenarios can be said, too, because the projects of the old list of priority projects are also part of the new list. Compared to the A1 scenario, the additional projects of the list of priority projects show additional positive impacts in Eastern Europe, especially in Poland, the Czech Republic, Hungary and Western Romania. Furthermore, the additional projects in England and Ireland and the Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen cause even higher positive impacts in England, Ireland and the Benelux than could be seen in the A1 scenario.

A6

The two A6 scenarios represent two alternative network development scenarios for the Eastern European countries combined with the full list of TEN projects. In both scenarios the highest impacts can be observed in the Eastern European countries in both cases of the minimum and the maximum implementation of the possible TINA networks. The additional road projects in the maximum implementation make the main difference between both scenarios, causing especially higher impacts in Romania, Bulgaria, Estonia, Latvia and Lithuania.

B and C

An interesting spatial pattern emerges from SMCP pricing, that leads to a general increase in travel cost and transportation cost. Note that, in order to isolate the spatial effect of the pricing itself, we assume no redistribution of revenues. Revenues are “burned”. Exactly the same spatial pattern would emerge, if a lump-sum redistribution proportional to GDP instead of burning was assumed. Only the level would be different, the weighted average of effects would be close to zero. In fact it would be slightly negative, because the welfare loss exceeds the revenue slightly. Note, however, that this is only the case because the intended welfare gain resulting from internalisation of externalities is not included in our model. Neither do travel times react on a reduction of travel flows induced by higher out-of-pocket costs, nor is an improved environment felt by the households as a utility gain in our model. We explain this in order to emphasise that the overall negative welfare impact of the pricing scenarios

must not be misinterpreted as a statement against efficiency gains from SMCP. Our experiments just isolate the effects form the cost side.
The spatial pattern is an overlay of two centre-periphery patterns, a national and a European one. Within each country, regions with a high market potential suffer from the smallest losses, those in the national periphery lose most. This is most clearly observable in large countries like UK, France, Germany, Spain, Italy and Poland, but even in smaller countries such as Greece (see the light colour around Athens on the map in Figure 4.9a) or Denmark. These national patterns are overlaid by a similar, though less pronounced pattern on a European scale, so that regions suffer most, that are far from national as well as from European markets, such as Portugal, Scotland, Southern Italy or Northern Norway and Finland.

It should also be noted that SMC pricing is enforcing spatial inequality, because the aggregated welfare loss is the larger, the bigger is the assumed inequality aversion. This is because peripheral regions tend to be poorer than central ones. The impact of the inequality aversion parameter is however small, which means that even though the spatial distribution is contradicting the cohesion objective, the degree of increasing inequality is too small to be regarded as a real problem.

Scenario C is a combination of scenarios A1 and B2. Hence, because of additivity holding also in this case, the spatial pattern is approximately the sum of those generated by these two scenarios and needs not extra discussion.

D

This scenario generates considerable gains in some regions at the European geographical periphery in Southern Portugal, Spain and Italy, in Ireland and Scandinavia. Large parts of Germany (except the North-East) and of France remain unaffected.

E

E1 is similar to A3, as already noted. Finally, E2 resembles a combination of E1 with a weaker form of SMC pricing as in B2. As the pricing in B2 applies to EU15 countries only, the positive TEN investment effects show up in the accession countries, with the same pattern as in E2. In EU15 the negative impact of pricing dominates, with the centre-periphery structure described above. Positive effects appear within EU15 only in some regions with strong infrastructure effects in Portugal, Spain, Sicily and Greece.

4.6.2 Maps for 1997 Simulation Results

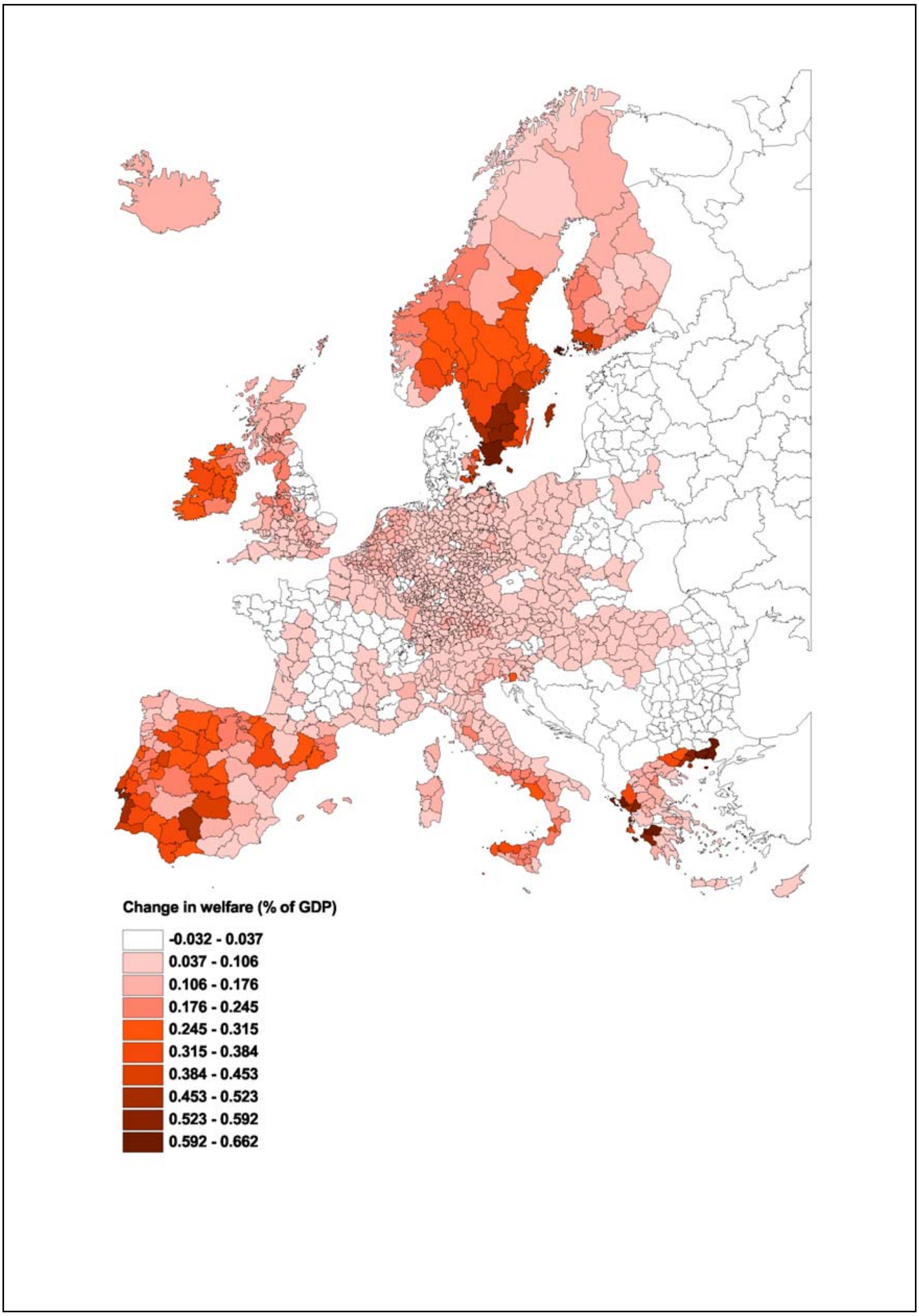

Figure 4.4. Scenario A1: Fast implementation of all TEN priority projects together

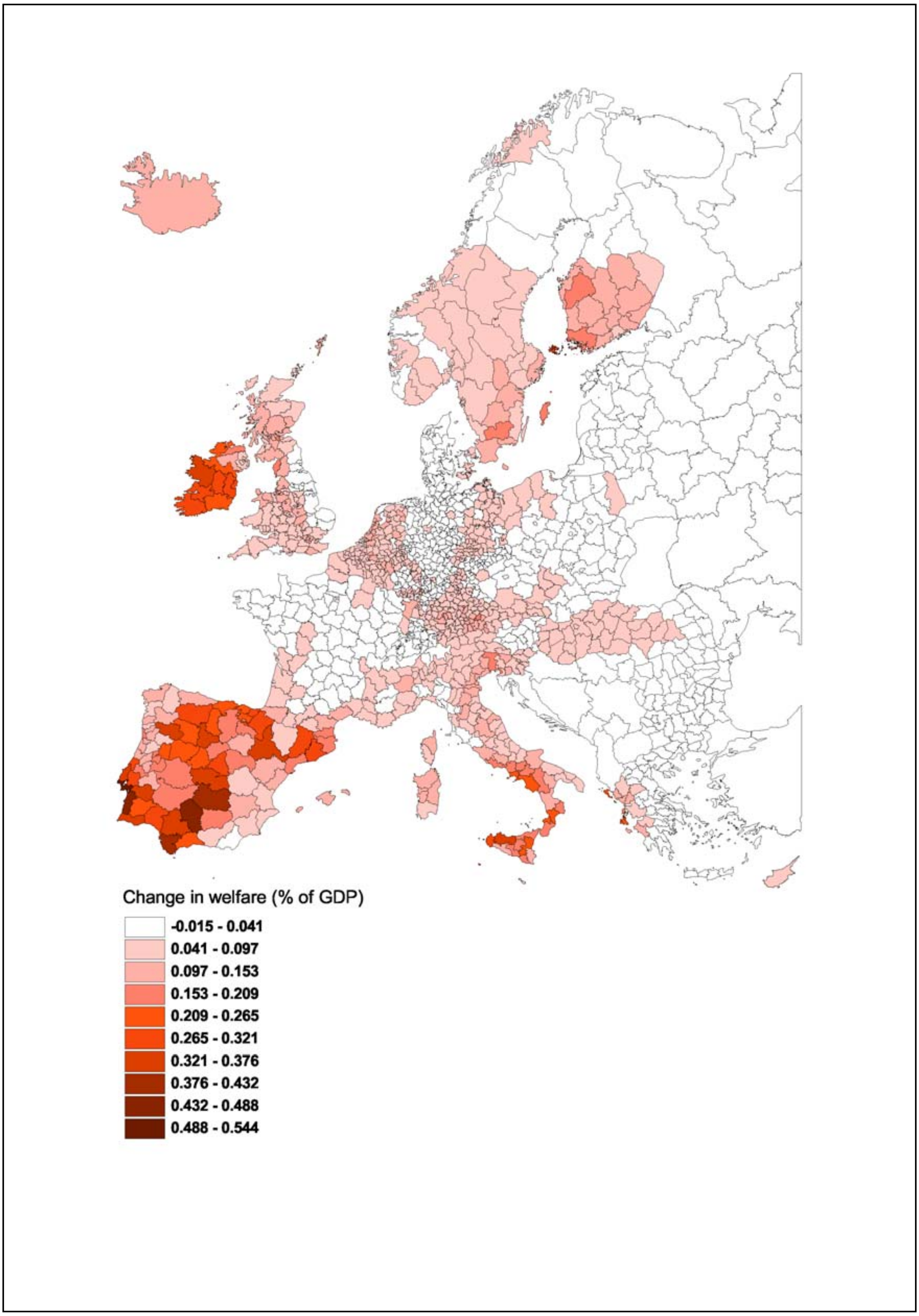

Figure 4.5. Scenario A2.4: Implementation of all rail (high speed and conventional) priority projects

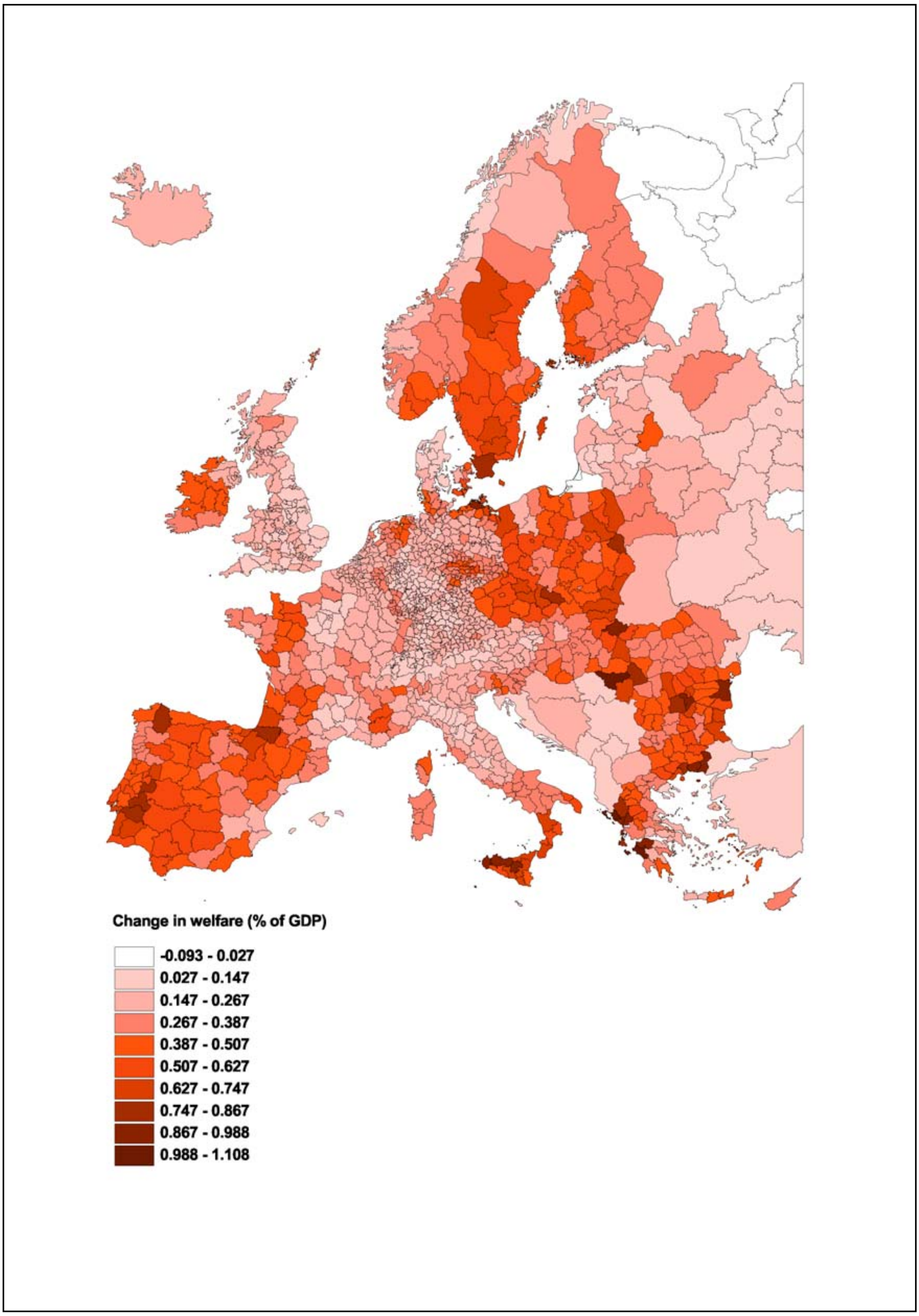

Figure 4.6 Scenario A3: Fast implementation of all TEN and TINA projects and network

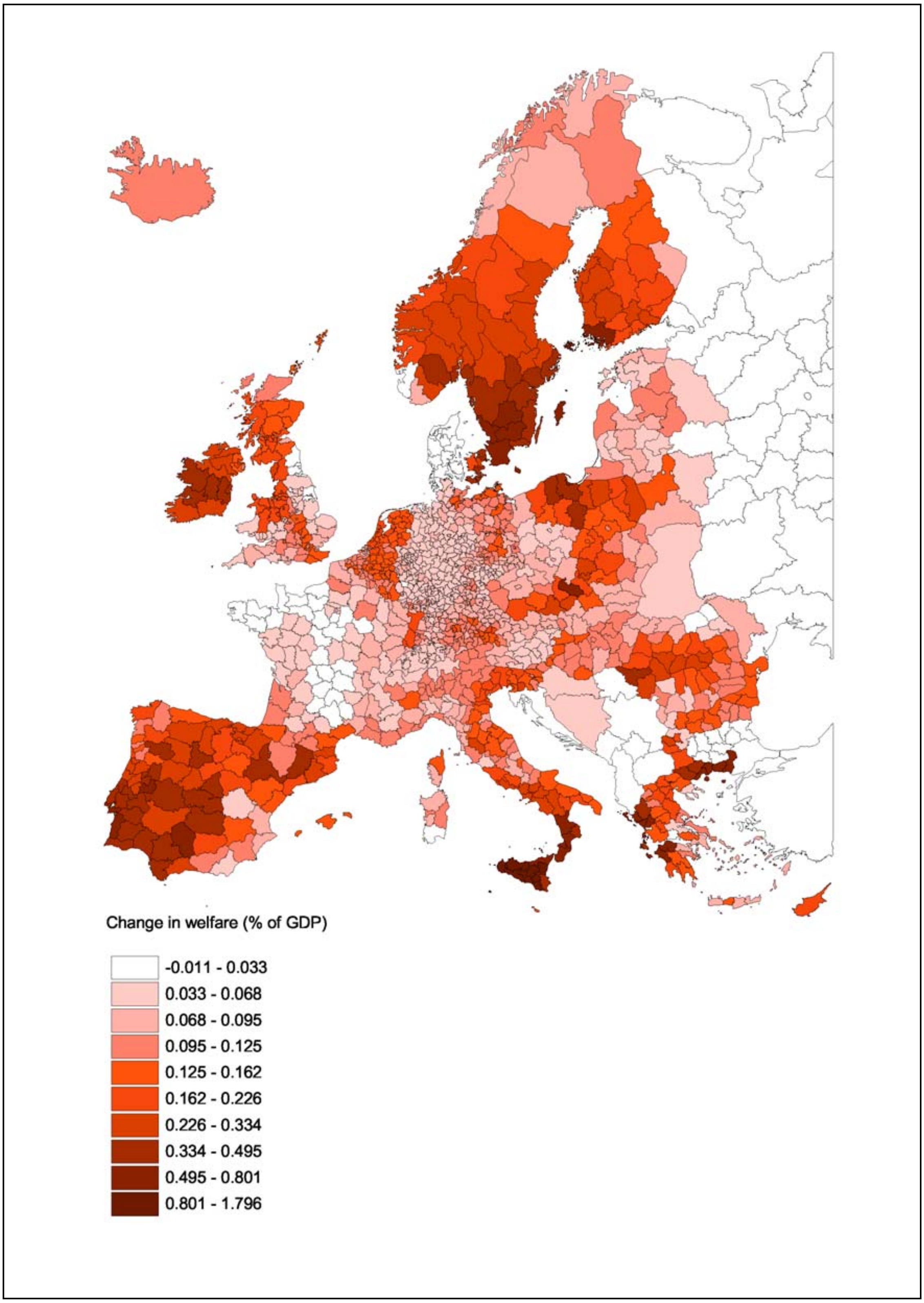

Figure 4.7 Scenario A51: Implementation of new list of priority projects for road and rail

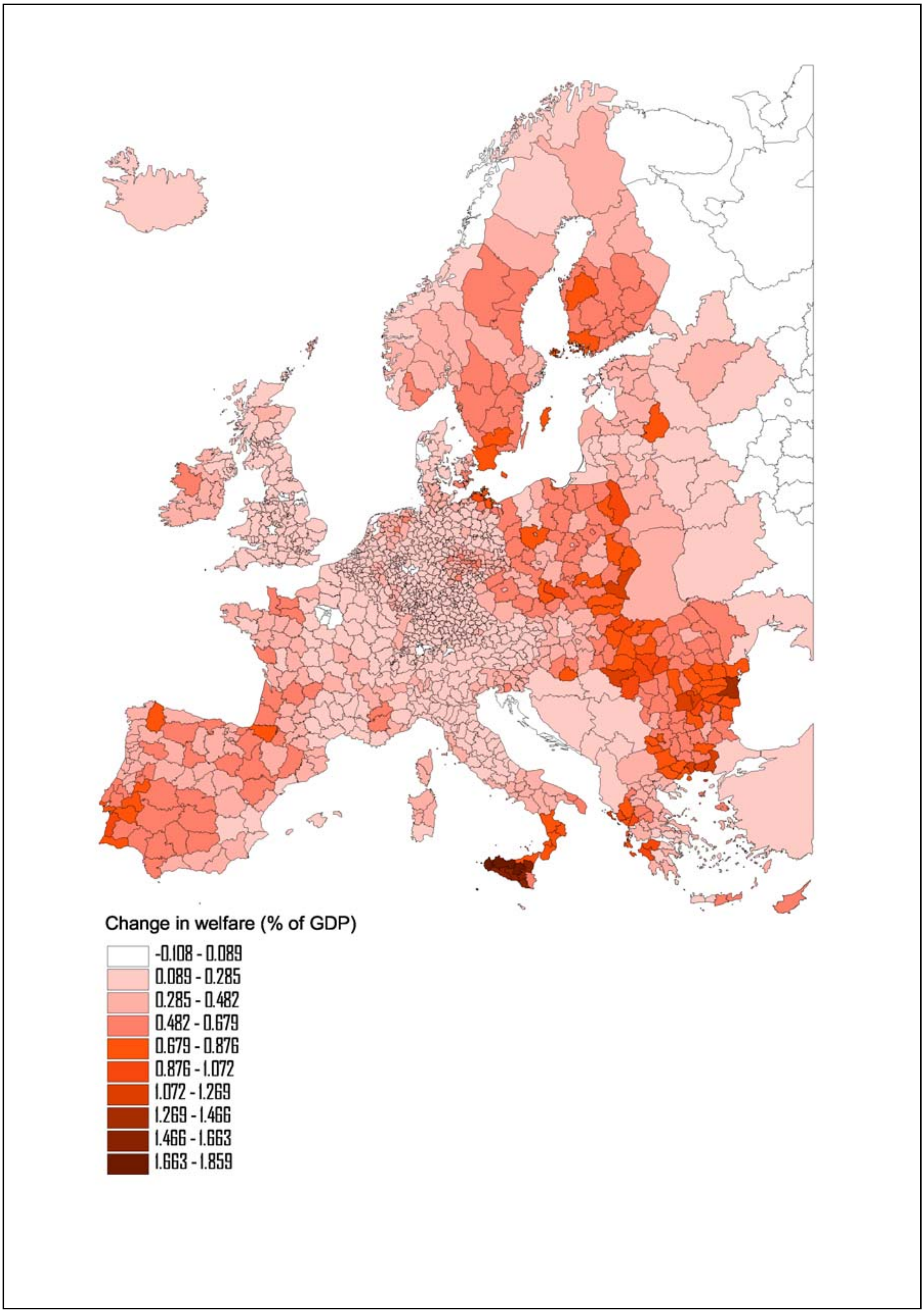

Figure 4.8. Scenario A62: Implementation of all TEN projects and maximum road/rail network development for accession countries

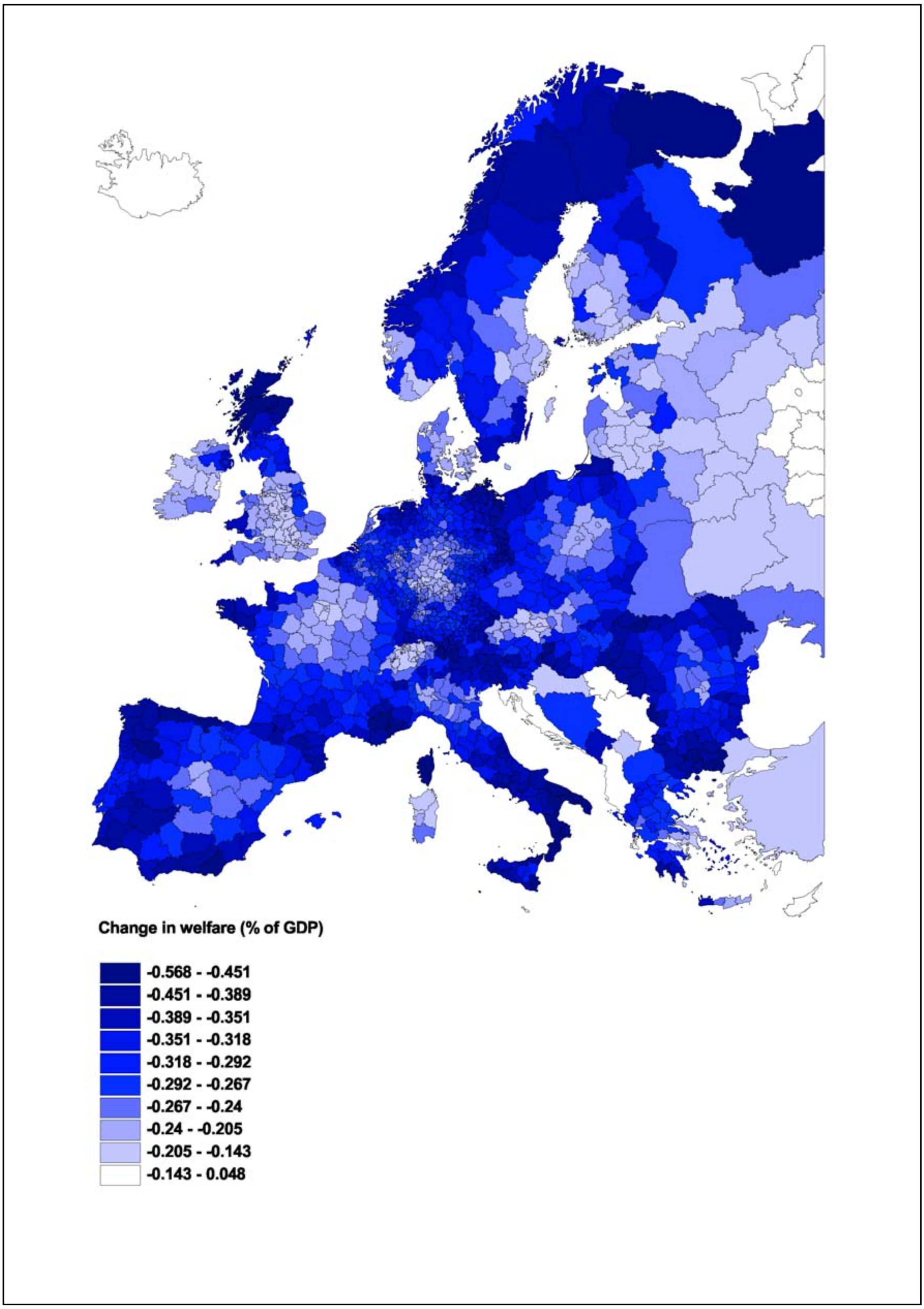

Figure 4.9. Scenario B1: SMCP applied to road freight

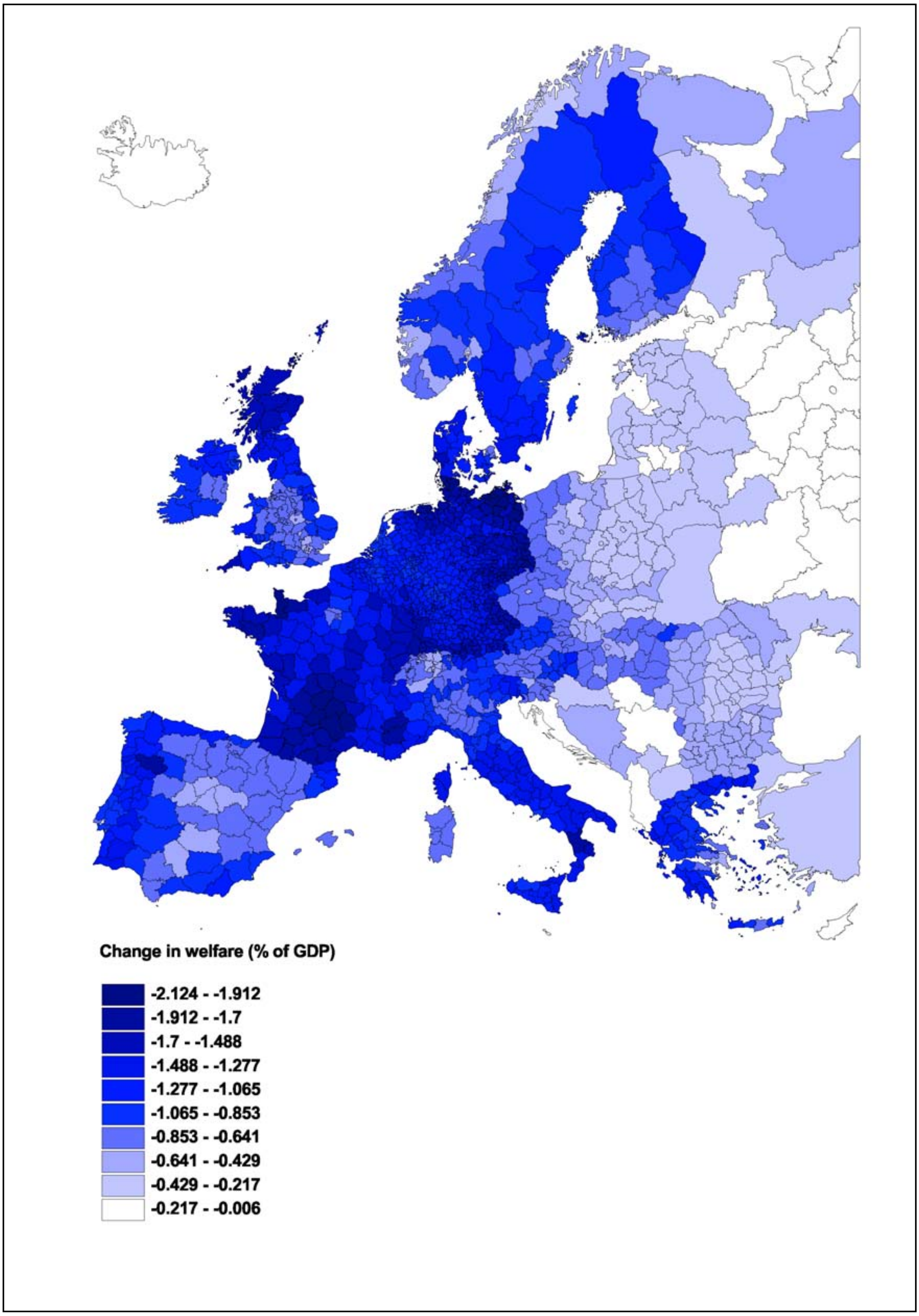

Figure 4.10 Scenario B2: SMCP applied to all modes

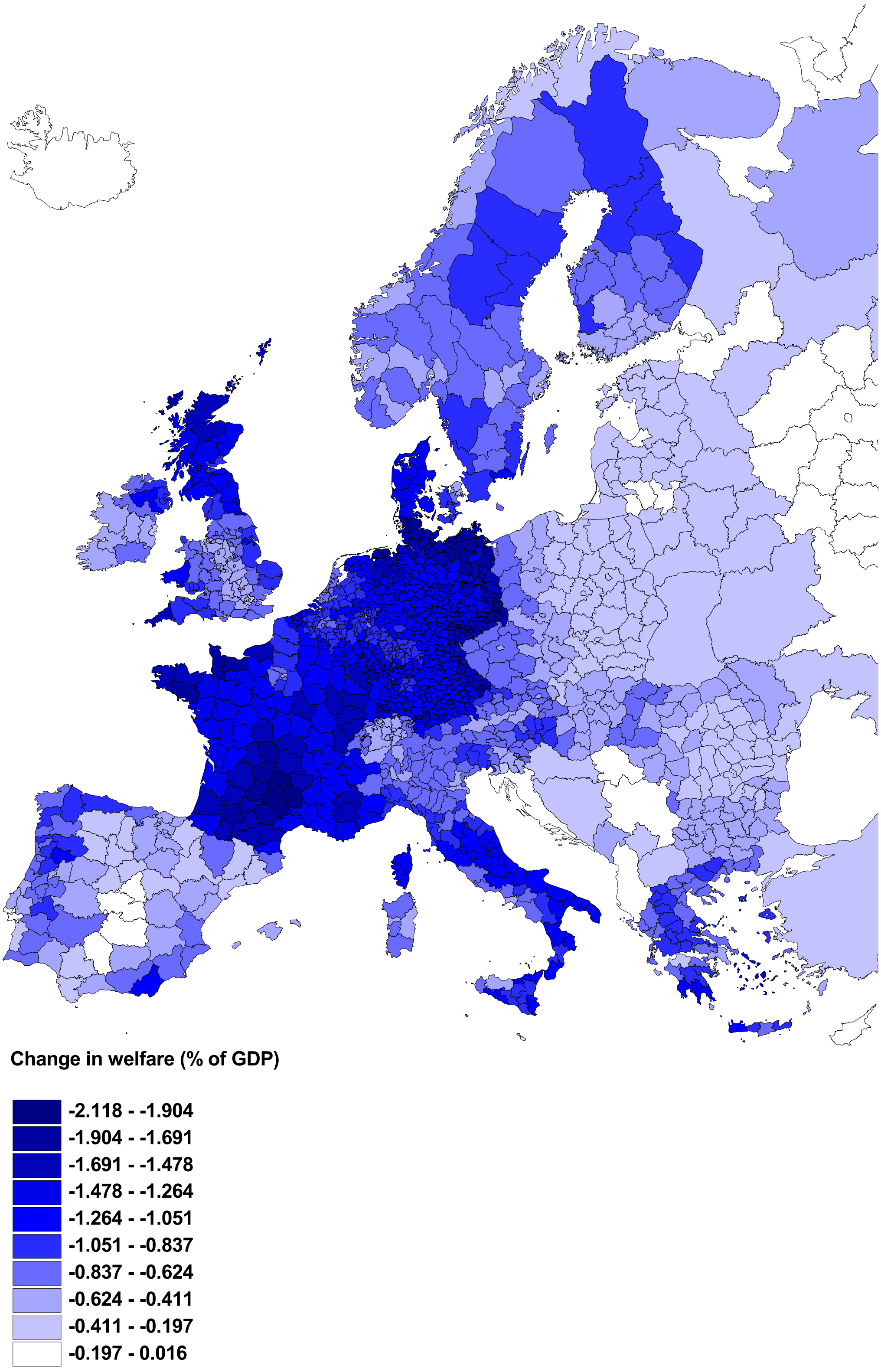

Figure 4.11. Scenario C1: SMCP applied to all modes and fast implementation of all TEN priority projects

4.6.3 Results for the 2020 calibration

For accession countries relative effects are uniformly larger in absolute terms for 2020 than for 1997. In most infrastructure scenarios effects are larger for 2020 than for 1997 by a factor between 2 and 3. The losses in the pricing scenarios are larger by a factor around 1.5. The reason is the higher degree of economic integration between accession countries as well as between these countries and the EU15 countries. This leads to an increase of trade until 2020 that is larger than the increase in GDP. Hence, the cost savings or cost increases amount to a larger share in GDP.

Note that the cost savings or cost increases per unit of good are assumed to remain constant in relation to GDP between 1997 and 2020. For infrastructure effects this means implicitly to assume no productivity gain in transport. If we introduce productivity gains in transport, the ratio of costs per unit to GDP will decline, and all effects would have to be downscaled. Assuming for example a productivity increase of 1 % per annum for transport between 1997 and 2020 would mean that effects would have to be reduced by about 20 %. For the pricing scenarios the implicit assumption is that fares grow by the same rate as GDP.

Outside accession countries, the estimated relative effects for 2020 are virtually the same as for 1997.

4.6.4 Spatial Distribution and Welfare

From Tables 4.3 and 4.4 one can infer the distributional impact of each scenario and translate it to a quantitative measure given in terms of a percentage of GDP. If the welfare gain for $\rho = 0$ is less (bigger) than that for $\rho > 0$, then the respective initiative is equality enhancing (reducing). The result for $\rho = 0$ measures the impact if one € counts one €, irrespective of whether it is gained in a rich or in a poor region. For $\rho > 0$ one € in a relatively poor region counts more than one € in a relatively rich region. All results can be interpreted as relative welfare effects, in percent of GDP. The rows for $\rho = 1$ and $\rho = 2$ correct for inequality to a smaller or larger degree, respectively. In fact, $\rho = 2$ has to be regarded as a strong inequality aversion, which is likely to overestimate the inequality aversion that most politicians would implicitly adhere to. Whatever, the degree of inequality aversion always remains a value judgement that can not be justified on scientific grounds. We take $\rho = 1$ as a "normal" degree of inequality aversion. For $\rho = 1$ the aggregated relative welfare change is just the mean of regional welfare changes, weighted by population (instead of GDP, as in the case of $\rho = 0$). To put it differently, not absolute but relative effects count equally in this case.

Given this, it turns out that the impact of the initiatives on spatial distribution is in almost any case of minor importance, as compared to the level effect measure by the index with $\rho = 0$. If we go from $\rho = 0$ to $\rho = 1$ or even $\rho = 2$, there is nowhere a sign reversal – with one exception: scenario E2 for EU27. This is a rather artificial case, however. It is due to the fact, that the pricing policy in the scenario only applies to EU15, while the infrastructure gains are also in the accession countries. Hence, the richer EU15 regions are the losers and the relatively poor regions in the accession countries are the winners. This is why the scenario is equality enhancing for the whole EU27.

Table 4.4. Overview of model results for 2020, welfare effects for different degrees of inequality aversion (parameter ρ), percent of GDP

		A1	A21	A22	A23	A24	A3
EU27	$\rho = 0$	0.113	0.071	0.015	0.031	0.085	0.271
	$\rho = 1$	0.118	0.076	0.014	0.031	0.089	0.377
	$\rho = 2$	0.102	0.063	0.008	0.032	0.072	0.597
EU15	$\rho = 0$	0.113	0.071	0.015	0.031	0.085	0.251
	$\rho = 1$	0.121	0.079	0.016	0.030	0.094	0.277
	$\rho = 2$	0.134	0.089	0.016	0.032	0.105	0.308
CC12	$\rho = 0$	0.126	0.082	0.008	0.038	0.090	0.723
	$\rho = 1$	0.107	0.066	0.007	0.036	0.073	0.728
	$\rho = 2$	0.088	0.052	0.005	0.032	0.058	0.725

		A4	A51	A52	A53	A61	A62
EU27	$\rho = 0$	0.232	0.151	0.113	0.045	0.280	0.299
	$\rho = 1$	0.249	0.184	0.128	0.065	0.377	0.445
	$\rho = 2$	0.213	0.216	0.127	0.101	0.563	0.786
EU15	$\rho = 0$	0.230	0.146	0.111	0.041	0.263	0.274
	$\rho = 1$	0.256	0.163	0.125	0.047	0.295	0.306
	$\rho = 2$	0.287	0.187	0.142	0.055	0.332	0.343
CC12	$\rho = 0$	0.267	0.278	0.165	0.130	0.669	0.881
	$\rho = 1$	0.221	0.255	0.142	0.129	0.667	0.932
	$\rho = 2$	0.180	0.229	0.121	0.122	0.665	0.984

		B1	B2	C	D	E1	E2
EU27	$\rho = 0$	-0.290	-1.092	-0.917	0.267	0.252	-0.211
	$\rho = 1$	-0.332	-1.051	-0.867	0.296	0.359	-0.078
	$\rho = 2$	-0.418	-0.879	-0.718	0.287	0.576	0.276
EU15	$\rho = 0$	-0.284	-1.103	-0.929	0.260	0.233	-0.238
	$\rho = 1$	-0.297	-1.121	-0.931	0.278	0.261	-0.231
	$\rho = 2$	-0.310	-1.126	-0.916	0.299	0.295	-0.219
CC12	$\rho = 0$	-0.430	-0.836	-0.650	0.430	0.694	0.413
	$\rho = 1$	-0.451	-0.807	-0.643	0.359	0.701	0.457
	$\rho = 2$	-0.466	-0.769	-0.630	0.282	0.702	0.495

Throughout, there are only small differences between effects for $\rho = 0$ and $\rho = 1$. Only for $\rho = 2$ more pronounced differences appear in some cases for EU27. They are due to the effect just described for E2, that the impact of policies differs between EU15 and accession countries. Taking EU15 or the CC12 in isolation, even for $\rho = 2$, i.e. for strong inequality aversion we do not observe remarkable differences between inequality-corrected measures and non-corrected measures.

Going through the scenarios in detail, we can distinguish between inequality enforcing and reducing initiatives – always keeping in mind that the distributional impact is moderate. We do not consider all scenarios, because the reader may draw the conclusions from Tables 4.3 and 4.4 herself or himself. We only refer to results from 1997; those for 2020 reveal similar patterns, in fact identical as afar as the EU15 is concerned.

- A1 enhances equality within EU15, but increases inequality for EU27, because the priority projects are located in EU15.
- A3 is equality enhancing in EU15 as well, and also equality enhancing in CC12, though to a lesser degree. It is clearly equality increasing for the whole EU27, because relative effects of the initiatives in accession countries are larger then those in EU15. The same pattern holds for E1, which is almost the same as A3, as already mentioned.
- A4 enhances equality within EU15. The increase of inequality for EU27 is again just due to the fact that the scenario does not include the TINA projects in the accession countries.
- A51 enhances equality within EU15 and EU27, but increases inequality in the accession countries, because the projects additional to the A1 scenario are mainly located in the better-off countries of the CC12.
- A61 and A62 are equality enhancing for all groups of countries.
- B1, SMC pricing for road freight, is inequality increasing for all groups of countries; the welfare loss is the larger, the stronger the inequality aversion.
- B2, SMC pricing for all modes, is also slightly inequality increasing within EU15. The reduction of inequality for EU27 is again just due to the fact, that the measures do not apply within accession countries.
- C is close to neutral within both, EU15 and CC12 (in fact slightly equalising). The strongly equalising effect for EU27 is also due to the different definition of the scenario for the two subgroups.
- D, like all other infrastructure scenarios, enforces equality in EU15. It increases inequality within CC12 and for the whole EU27, because relative gains are much smaller in accession countries than in EU15.
- E2 enforces equality within both groups of countries, EU15 and CC12. The strongly equalising effect for EU27 as a whole has already been characterised above as a rather artificial result due to the design of the scenario.

These observations can be summarised as follows: within both groups of countries, EU15 and CC12, the infrastructure scenarios are uniformly favouring regional income equality, that is they are in line with the cohesion objective. To the contrary, the pricing policies are uniformly enforcing inequality within both groups. Equality or inequality effects on the EU27 level are less interesting because they are usually caused by the fact, that certain policies only apply to EU15 countries. We repeat however, that altogether the distributional impacts, be they in the desirable direction of more income equality or not, are small in the light of a welfare index within a plausible range of inequality aversion.

4.6.5 Maps for 2020 Simulation Results

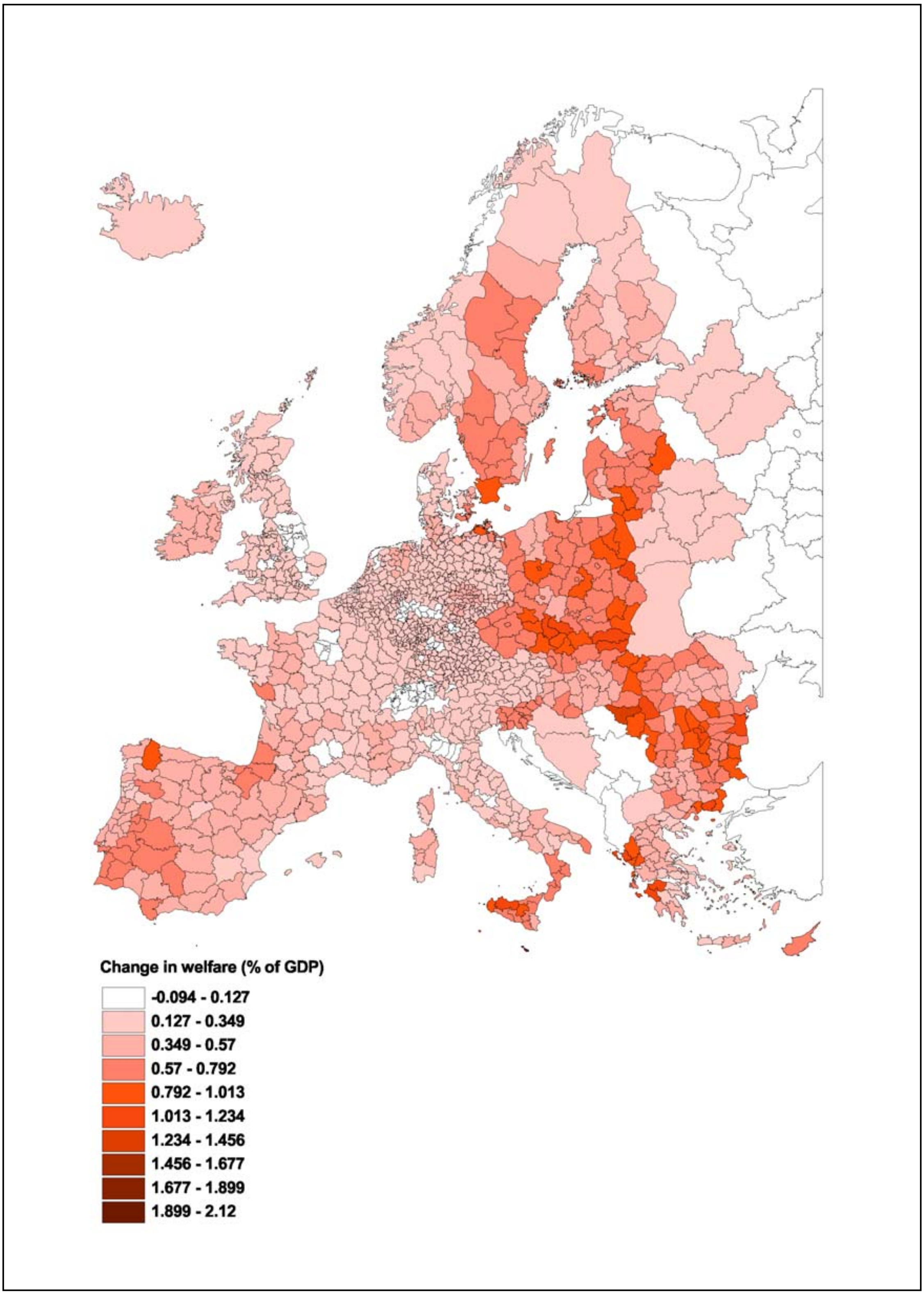

Figure 4.12. Scenario A3: Fast implementation of all TEN and TINA projects and network

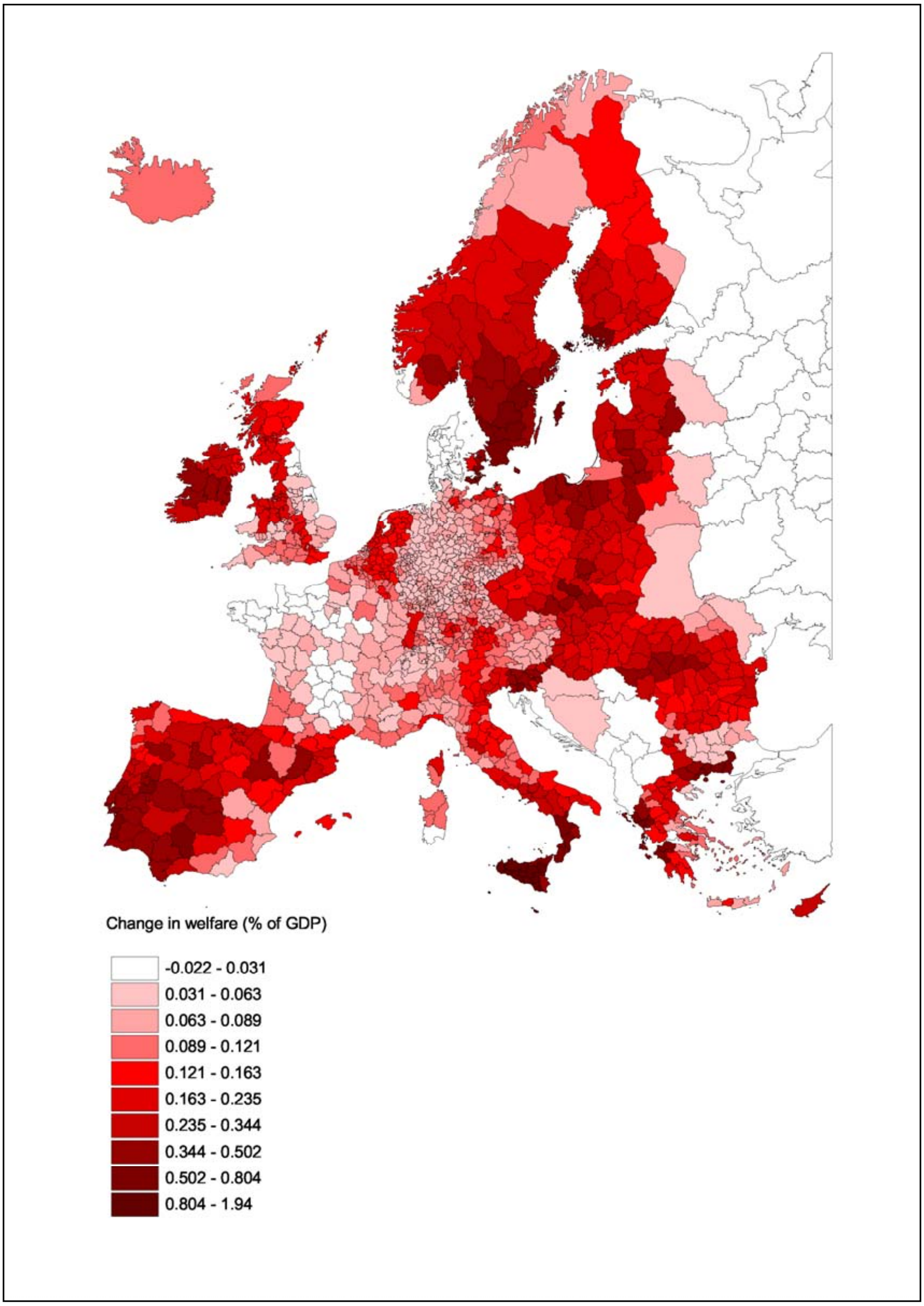

Figure 4.13. Scenario A51: Implementation of new list of priority projects for road and rail

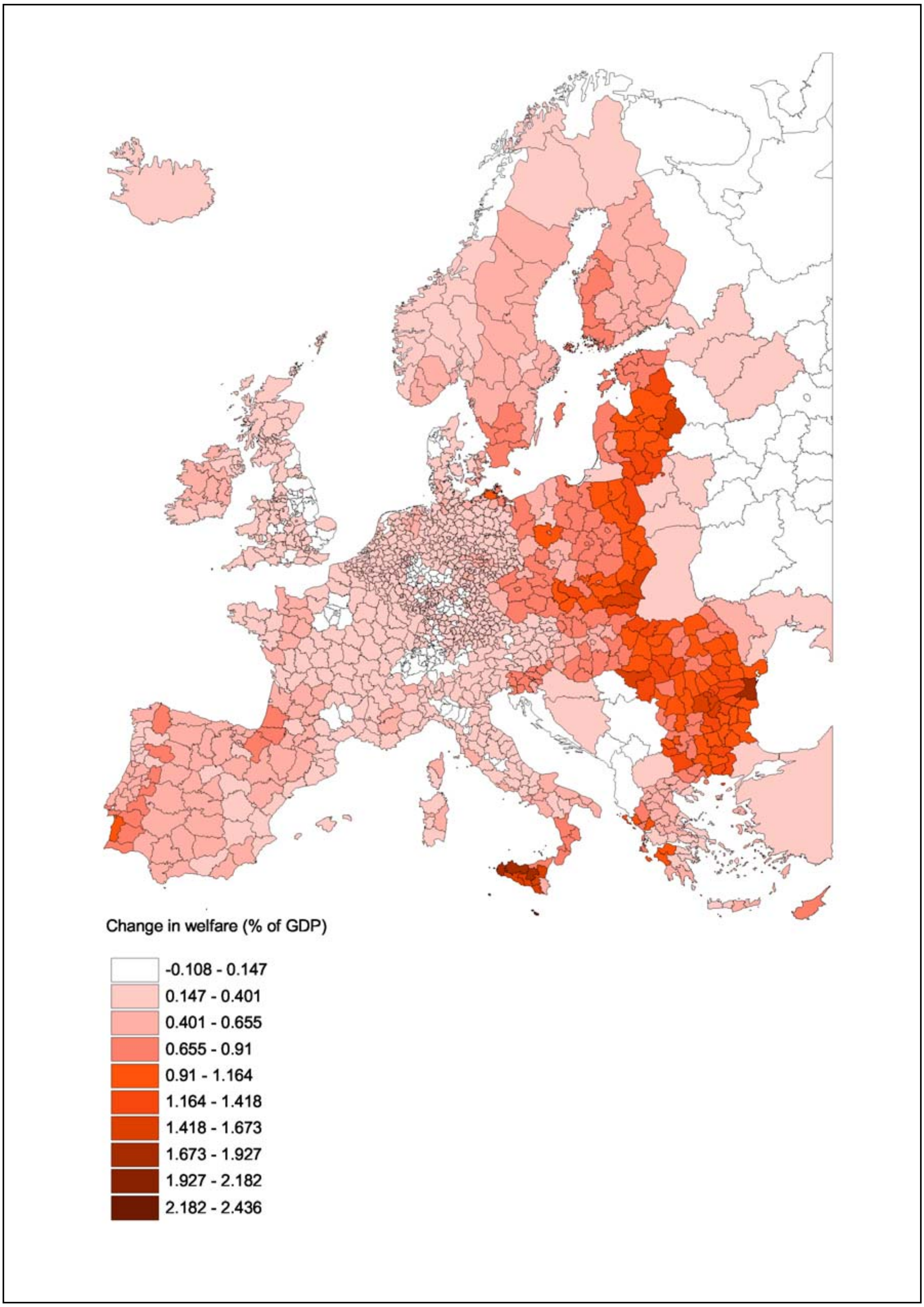

Figure 4.14. Scenario A62: Implementation of all TEN projects and maximum road/rail network development for accession countries

4.7 CGEuropeII Simulation Results

4.7.1 Comparison with CGEuropeI

We dispense with describing the simulation results for CGEuropeII in detail, because the conclusions largely coincide with what has already been said on the basis of the simulation results from CGEuropeI. The reason is that there is in fact a close similarity between results. This is revealed in Figure 4.15 to 4.17 showing welfare effects obtained by CGEuropeII plotted against those of CGEuropeI. These comparisons are done for 13 scenarios excluding the new A5 and A6 scenarios, which were computed only short time before the completion of this report. As the regional system of CGEuropeI is more aggregated, results for CGEuropeI have been aggregated over the respective sub-regions belonging to one region of the aggregated system. The red line is the 45^{o} identity line. The full version of CGEuropeII also includes effects from cost changes for private long distance passenger travel, though only for regions of EU15. But the comparison is based on a version of CGEuropeII without these effects in order to keep comparability with CGEuropeI, which does not cover these effects either.

As also shown in Table 4.5, levels as well as spatial patterns of effects largely coincide. Note that general equilibrium repercussions of the multisectoral system seem to play a larger role for relative large effects, which tend to deviate more from the 45^{o} line. Furthermore, the pricing scenarios turn out to have somewhat larger impacts according to the multisectoral model. Here we can see a tendency of the multisectoral model to generate higher effects for relatively large cost changes. The only exception with less similarities is scenario B1, where some differences can be seen in particular in Eastern Europe. The general centre-periphery pattern of effects described above however also applies to the results from CGEuropeII for the pricing scenarios.

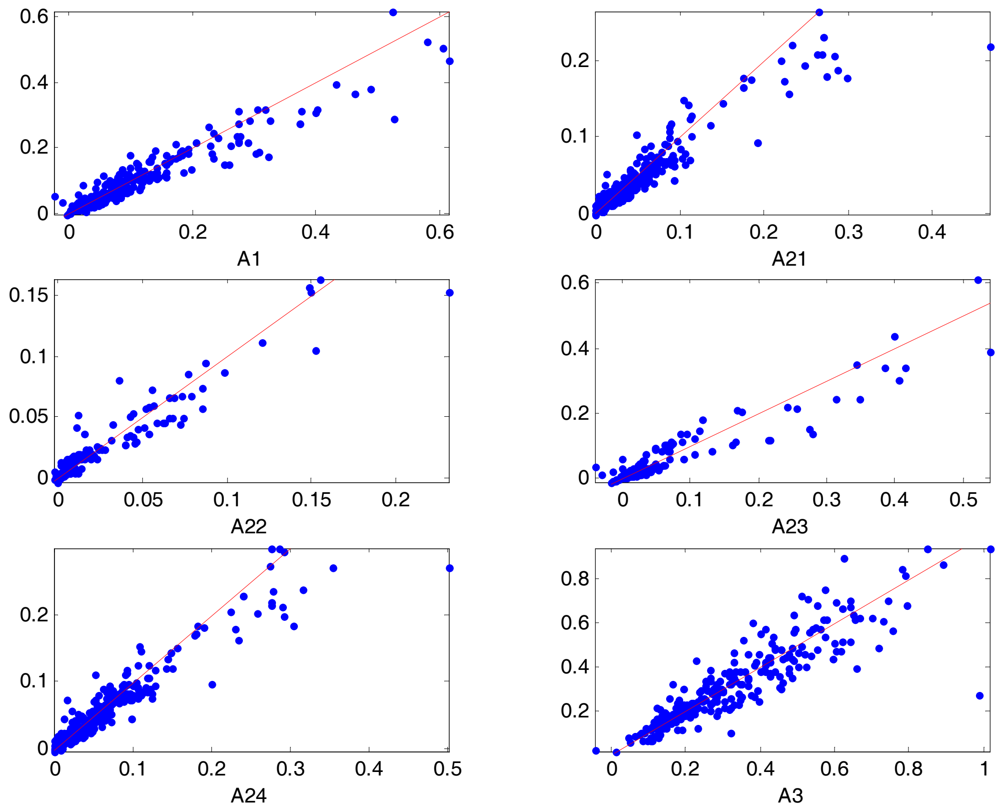

Figure 4.15. Comparison of welfare effects, CGEuropeI (horizontal) versus CGEuropeII (vertical), percent of GDP

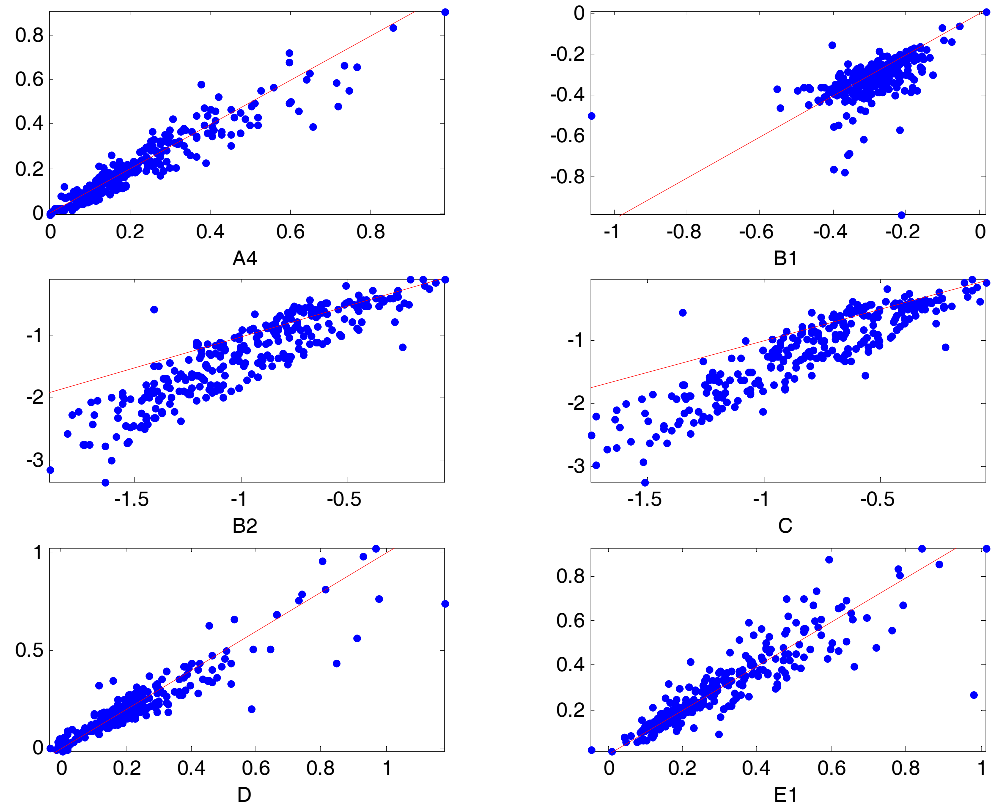

Figure 4. 16. Comparison of welfare effects, CGEuropeI (horizontal) versus CGEuropeII (vertical), percent of GDP

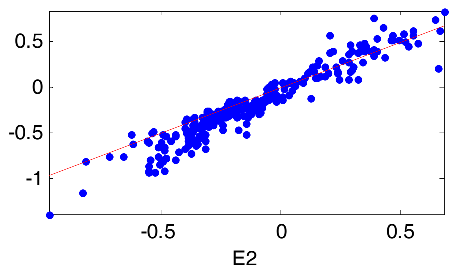

Figure 4.17. Comparison of welfare effects, CGEuropeI (horizontal) versus CGEuropeII (vertical), percent of GDP

Table 4.5. Comparison of welfare effects, CGEuropeI versus CGEuropeII (excluding private passenger travel)

	CGEuropeI welfare effect percent of GDP weighted average[3]	CGEuropeII welfare effect percent of GDP weighted average	ratio CGEuropII/ CGEuropeI	correlation
A1	0.10	0.09	0.88	0.95
A21	0.06	0.05	0.85	0.94
A22	0.01	0.01	0.97	0.95
A23	0.03	0.03	0.89	0.95
A24	0.07	0.06	0.87	0.94
A3	0.24	0.23	0.94	0.90
A4	0.20	0.20	0.97	0.95
B1	-0.27	-0.29	1.06	0.51
B2	-0.99	-1.31	1.31	0.90
C	-0.84	-1.17	1.39	0.90
D	0.23	0.22	0.93	0.92
E1	0.22	0.21	0.95	0.90
E2	-0.20	-0.29	1.47	0.96

Results mapped in Figures 4.23 to 4.29 and Appendix I are somewhat different from those used in this comparison, as they also include effects from private long distance passenger travel for EU15. This does not make a fundamental difference, however, as shown by Figure 4.18 and Table 4.6. The red line in Figure 4.18 is again the identity line. Regions of EU15 are marked by blue dots, all others by green dots. Clearly there are differences between the two versions only for regions of EU15, as only for these regions the effect is taken account of. Theoretically, there can be general equilibrium repercussions on other regions as well, but they are negligible. There are no differences between both versions for scenarios B1 and D, because they do not affect passenger travel. Hence, they are omitted from the comparison.

Obviously, the effects are uniformly larger in absolute value, if long-distance private passenger travel is taken account of. It can be shown, that general equilibrium analysis is however not really required for quantifying the extra effects from private passenger travel, because there is no interaction with the supply side, as in trade. Private passenger travel is just a demand component, changing due to price and travel time changes. The general equilibrium repercussions of the change of this relatively small demand component are just too small to be felt in the rest of the economy.

[3] The average is taken over all 288 regions of the system.

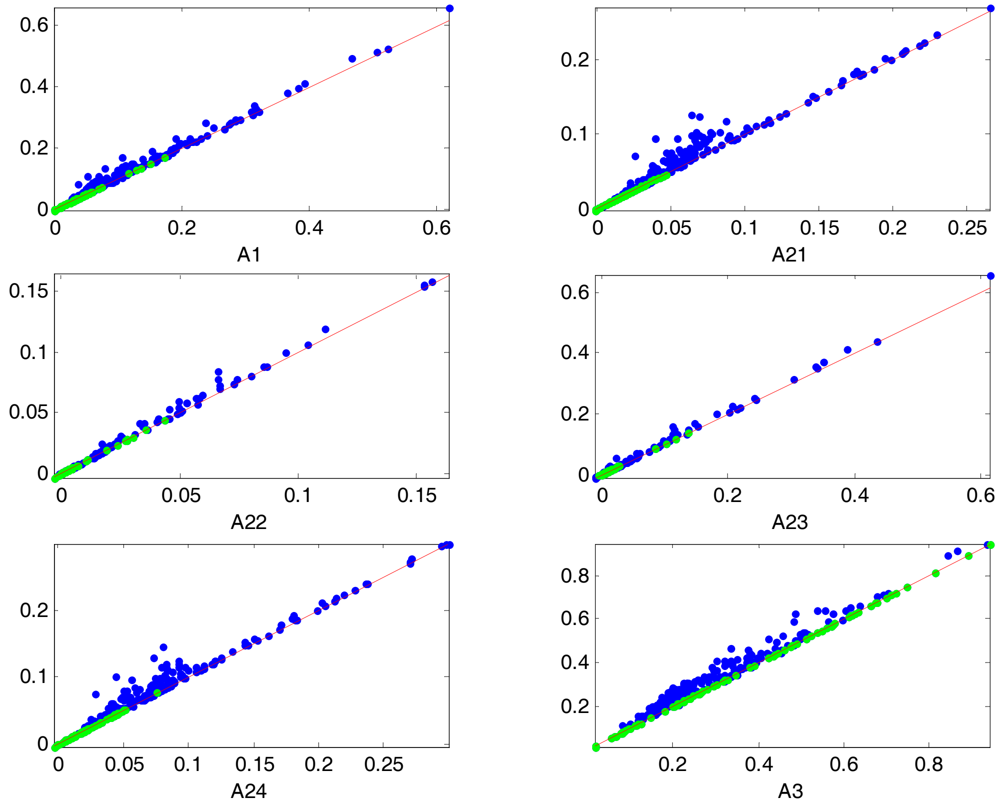

Figure 4.18. Comparison of welfare effects, CGEuropeII excluding private passenger travel (horizontal) versus CGEuropeII including private passenger travel (vertical), percent of GDP

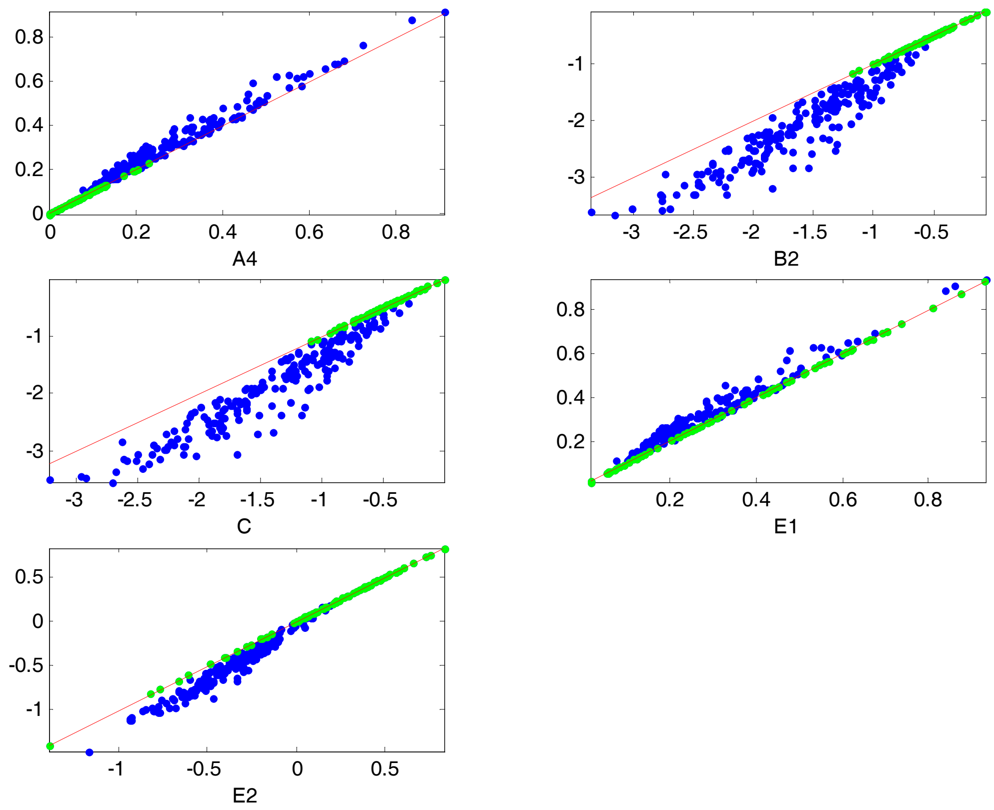

Figure 4.19. Comparison of welfare effects, CGEurpeII excluding private passenger travel (horizontal) versus CGEuropeII including private passenger travel (vertical), percent of GDP

Table 4.6. Comparison of welfare effects, CGEuropeII excluding private passenger travel versus CGEuropeII including private passenger travel

	welfare effect percent of GDP weighted average excl. priv. pass. travel	welfare effect percent of GDP weighted average incl. priv. pass. travel	ratio including/ excluding	correlation
A1	0.09	0.10	1.11	0.99
A21	0.05	0.06	1.15	0.98
A22	0.01	0.01	1.07	1.00
A23	0.03	0.03	1.05	1.00
A24	0.06	0.07	1.13	0.99
A3	0.23	0.26	1.13	0.99
A4	0.20	0.22	1.14	0.99
B2	-1.31	-1.68	1.29	0.97
C	-1.17	-1.53	1.31	0.97
E1	0.21	0.24	1.13	0.99
E2	-0.29	-0.40	1.35	0.99

4.7.2 Indirect Effects

Beyond the spatial distribution issue discussed already at length, another main question to be answered by the IASON project is whether there are indirect effects to be considered in cost-benefit analysis (CBA) that are not covered by traditional methods, and for which we need more advanced tools like CGE models for. The notion of "indirect effects" is vague. This is discussed in Deliverable 5 at length. Any impact of a transport initiative other than the cost changes for the users of the transport system can be called indirect effects. In this sense almost any economic impact of transport initiatives is indirect.

A more narrow notion is to consider only those effects, that are relevant in a welfare sense but not covered in a traditional CBA (where traditional CBA is meant to include technological externalities). This is what the SACTRA (1999) report calls "wider economic effects". They stem from quantity changes on imperfect markets where prices deviate from marginal social cost (or wages deviate from marginal reservation wages) and from changes in competitive regimes. The latter are called "pro-competitive effects", if a transport initiative reduces the price-cost margin. In principle, these wider economic effects can be positive, requiring upward correction of traditional CBA, or negative, requiring downwards correction of traditional CBA.

The following results are consistently supporting the use of traditional CBA as a good approximation to welfare measurement. Note that this conclusion is made by an author trying to earn scientific merits by the application of CGE methods to transport project evaluation. As it devaluates his own efforts, the reader should take this conclusion particularly serious.

Figure 4.20 plots for all scenarios the estimated welfare effects from CGEuropeII against the direct cost changes for all deliveries from a region, that is regional exports plus intraregional flows. The red line again marks identity. One could also plot them against cost changes for deliveries to a region with similar conclusions. The cost changes are given as percentages of regional GDP, just like welfare effects are measured as percentages of regional GDP. The experiments are done with the model version without private passenger travel, because for private passenger travel no indirect effects are to be expected anyway.

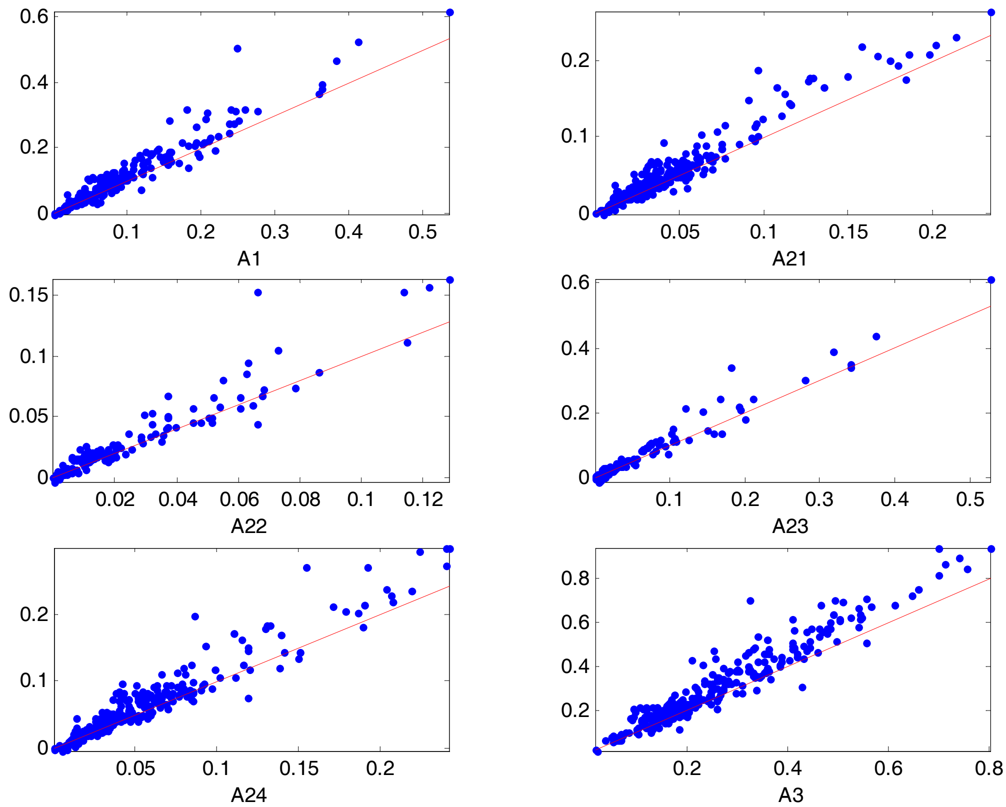

Figure 4.20. CGEuropeII (excluding private passenger travel): Relation between direct cost savings for deliveries from a region (horizontal) and welfare effects (vertical)

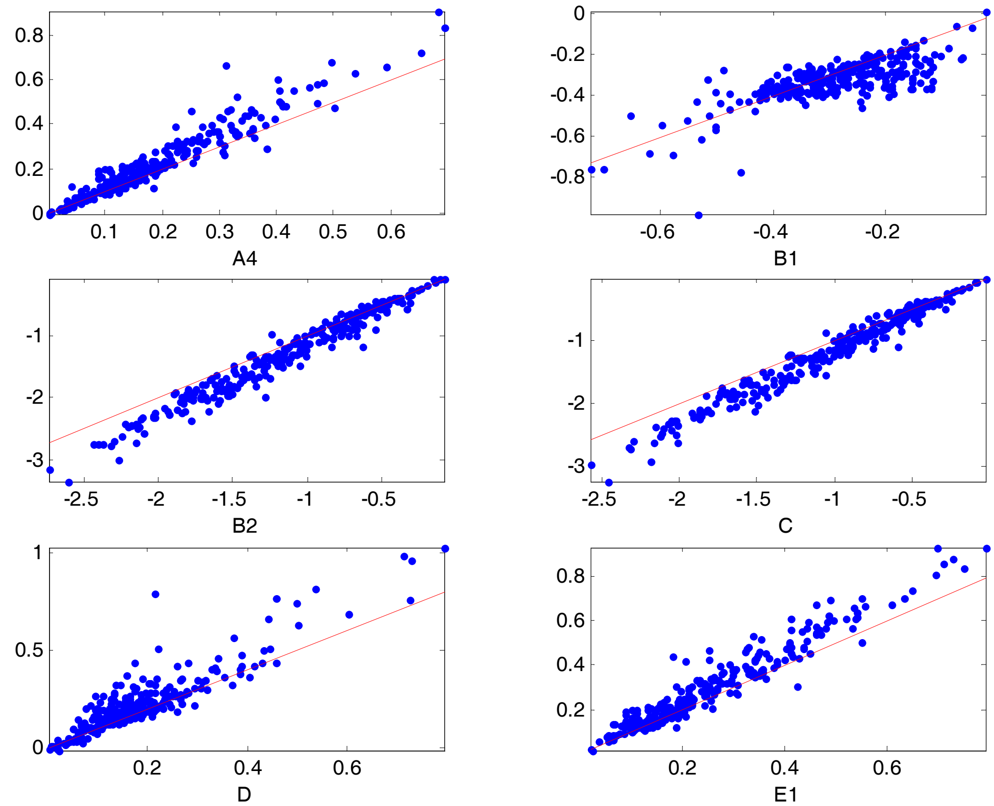

Figure 4.21. CGEuropeII (excluding private passenger travel): Relation between direct savings for deliveries from a region (horizontal) and welfare effects (vertical)

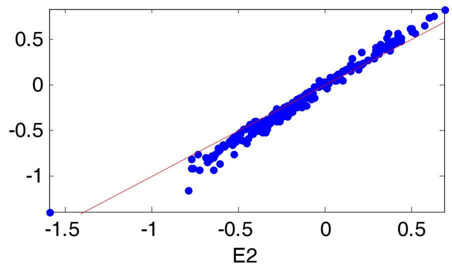

Figure 4.22. CGEuropeII (excluding private passenger travel): Relation between direct cost savings for deliveries from a region (horizontal) and welfare effects (vertical)

Two conclusions emerge from these plots: first, the direct cost savings per region fairly well approximate regional welfare effects; second, welfare effects tend to be a little bigger in absolute value than direct cost savings. Note that negative cost savings indicate cost increase, corresponding to welfare losses. This can also be seen in Table 4.7. Welfare effects closely correlate with cost savings over regions. Only for B1 the correlation is not close to perfect. The excess of welfare effects over direct cost savings is the indirect or wider economic effect, which is consistently positive. Note that wider economic effects amplify direct cost savings for both, positive as well as negative effects.

The ratio of welfare effects to direct cost savings can be regarded as the "total benefit multiplier" (TBM), that is the factor by which direct effects have to be multiplied in order to obtain the total welfare effect. The average multiplier can be estimated by the slope of a regression line through the origin, if we regress the welfare effect against the direct cost saving. The respective estimates are shown in the second to last column in Table 4.7. Except for B1, which seems to be always a special case, the multiplier lies consistently between 1.15 and 1.21, in most cases it equals 1.17. In other words, welfare effects are well approximated by calculating direct cost savings (which may be positive or negative) and multiplying them by 1.17. To put it again differently, an extra amount of 17 % for accounting for indirect effects is a rule of thumb resulting from these estimates.

Table 4.7. CGEuropeII (excluding private passenger travel): Comparison of estimated welfare effects versus direct cost savings

	direct cost change percent of GDP weighted average	welfare effect percent of GDP weighted average	welfare effect/ direct cost change	slope of a regression through origin (TBM)	correlation
A1	0.07	0.09	1.20	1.17	0.96
A21	0.04	0.05	1.18	1.17	0.97
A22	0.01	0.01	1.24	1.18	0.96
A23	0.02	0.03	1.20	1.15	0.98
A24	0.05	0.06	1.19	1.17	0.96
A3	0.19	0.23	1.17	1.17	0.96
A4	0.17	0.20	1.19	1.19	0.96
B1	-0.24	-0.29	1.20	1.06	0.73
B2	-1.19	-1.31	1.10	1.14	0.98
C	-1.06	-1.17	1.10	1.15	0.98
D	0.17	0.22	1.24	1.21	0.90
E1	0.18	0.21	1.17	1.17	0.97
E2	-0.25	-0.29	1.16	1.17	0.99

This TBM is rather small, as compared to what some policymakers seem to suspect (or hope) to be the outcome of imperfect competition models. It should be noted, however, that this multiplier estimate is less robust than the estimate of the spatial distribution of effects. It strongly depends on the price mark-up, which itself depends on the assumed elasticities, that are fairly uncertain. Our parameters imply mark-ups of 2 %, 10 %, and 14 % for agriculture, manufacturing, and services, respectively. Slightly larger mark-up estimates are found in econometric studies in the literature (Röger, 1995) which, if applied in the model, would yield correspondingly larger, though not dramatically larger total benefit multipliers. Higher mark-ups, however, imply lower elasticities in interregional trade, which are implausible because they make it difficult to explain distance sensitivity of trade flows without assuming extremely large transport cost.

One should furthermore keep in mind, that the model does not cover all indirect effects that could stem from market imperfections. In particular, indirect effects resulting from a change of employment with a non equilibrated labour market are not taken into consideration. Such effects could lead to considerable indirect effects. Bröcker and Schneider (2002) for example find welfare gains from Eastern expansion of the EU for Austrian regions, that are three times larger in a fixed wage that in a flexible wage scenario. It is doubtful, however, whether decisions upon transport initiatives should be based on such labour market effects. It would in fact mean to try to misuse transport policy for solving problems, that have their routes in the labour markets rather than the transport market. Another indirect effect is the pro-competitive effect already mentioned, that is not considered in our model either, due to the constant mark-up that characterises Dixit-Stiglitz competition.

In an earlier paper we have studied the relation between the trade elasticity and the total benefit multiplier in CGEuropeI (Bröcker, 2001). The assumed elasticity of substitution in trade is larger in CGEuropeI than in CGEuropeII, and hence the TBM is even smaller in CGEuropeI than the one presented here. With an elasticity equal to 6, which is assumed in CGEuropeII, following standard assumptions in the literature, the TBM in CGEuropeI would be almost exactly the same (TBM ≈ 1.17) as the estimate given here (see Figure 5 in Bröcker, 2001).

4.7.3 Maps for CGEuropeII Simulation Results

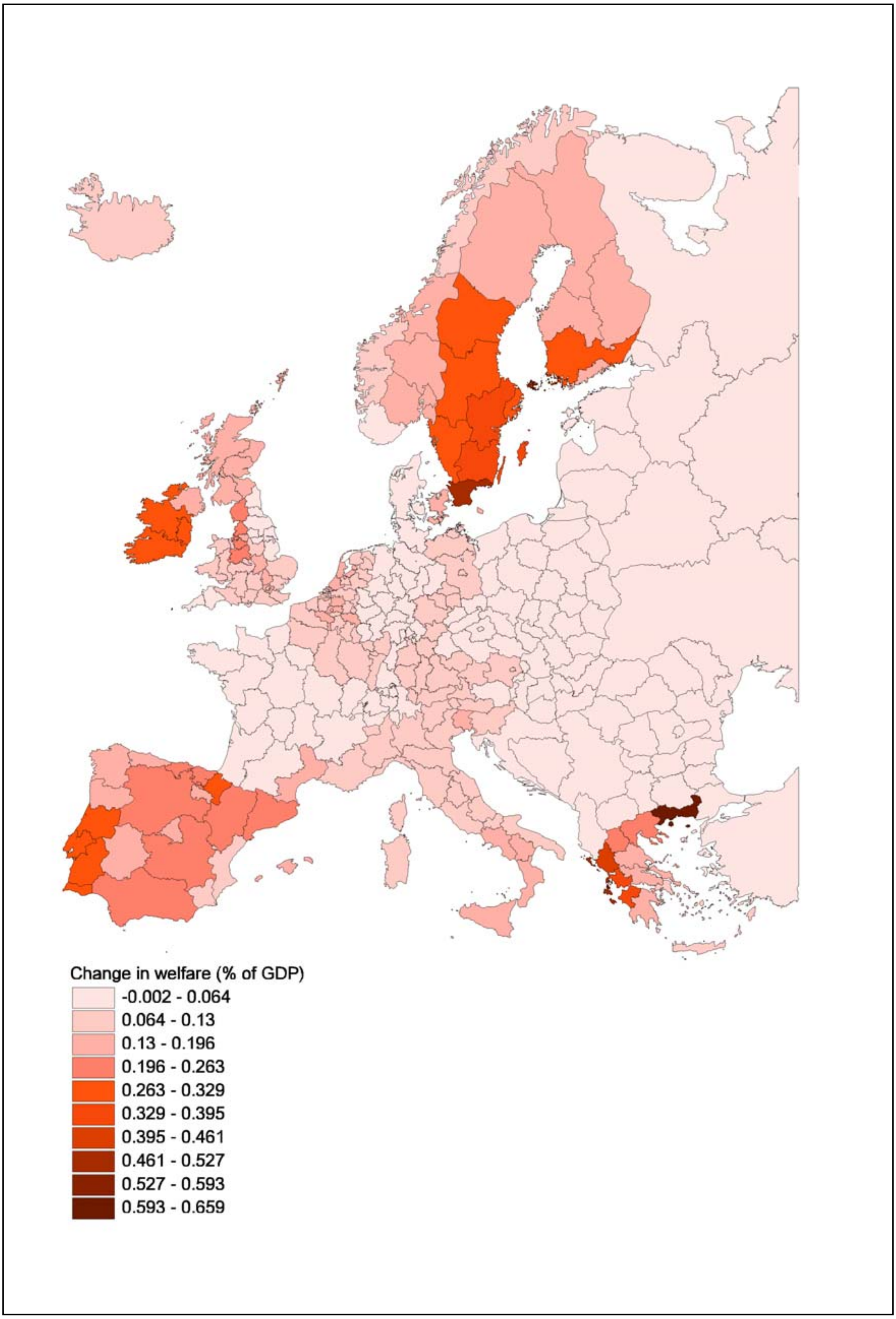

Figure 4.23. Scenario A1: Fast implementation of all TEN priority projects together

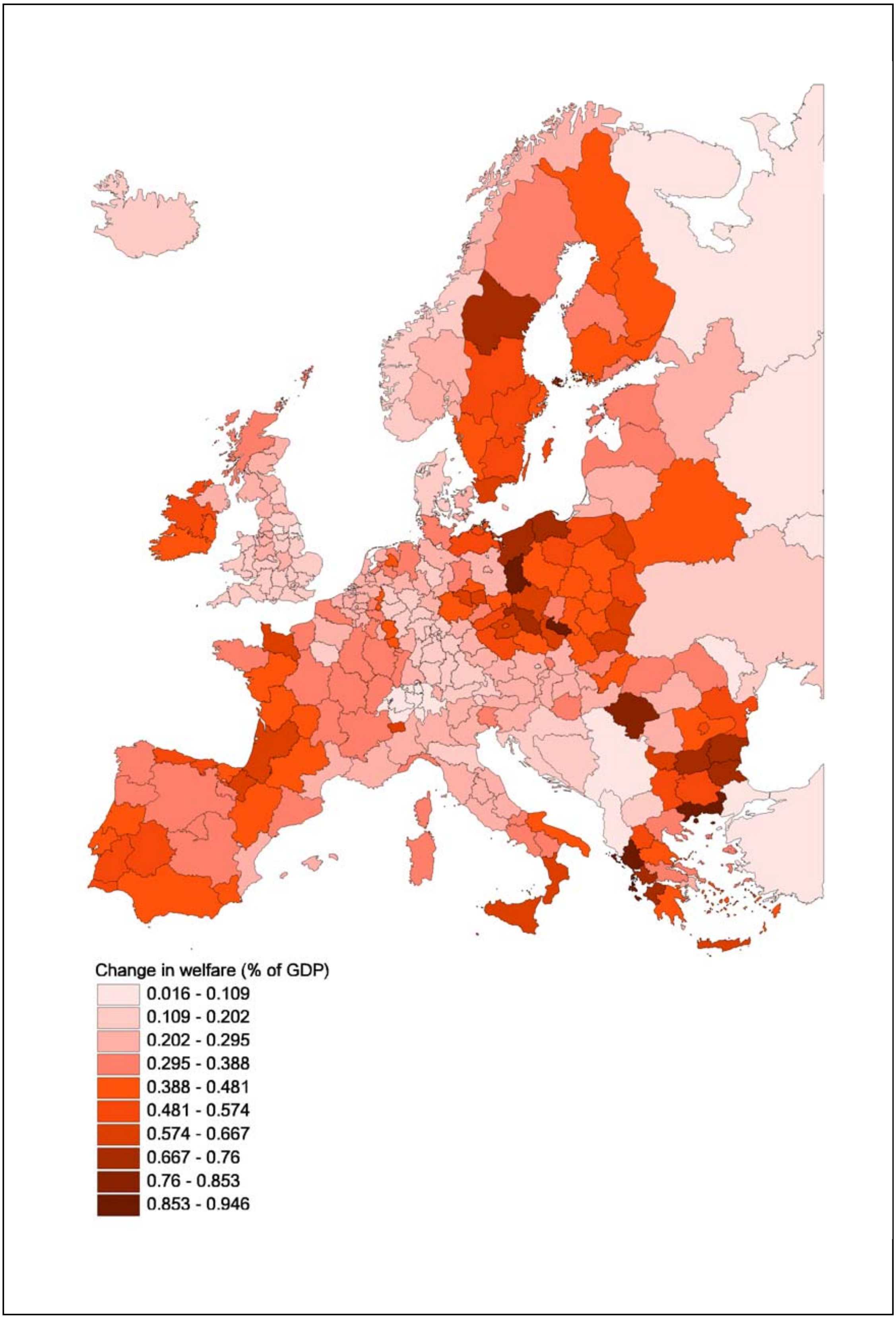

Figure 4.24. Scenario A3: Fast implementation of all TEN and TINA projects and network

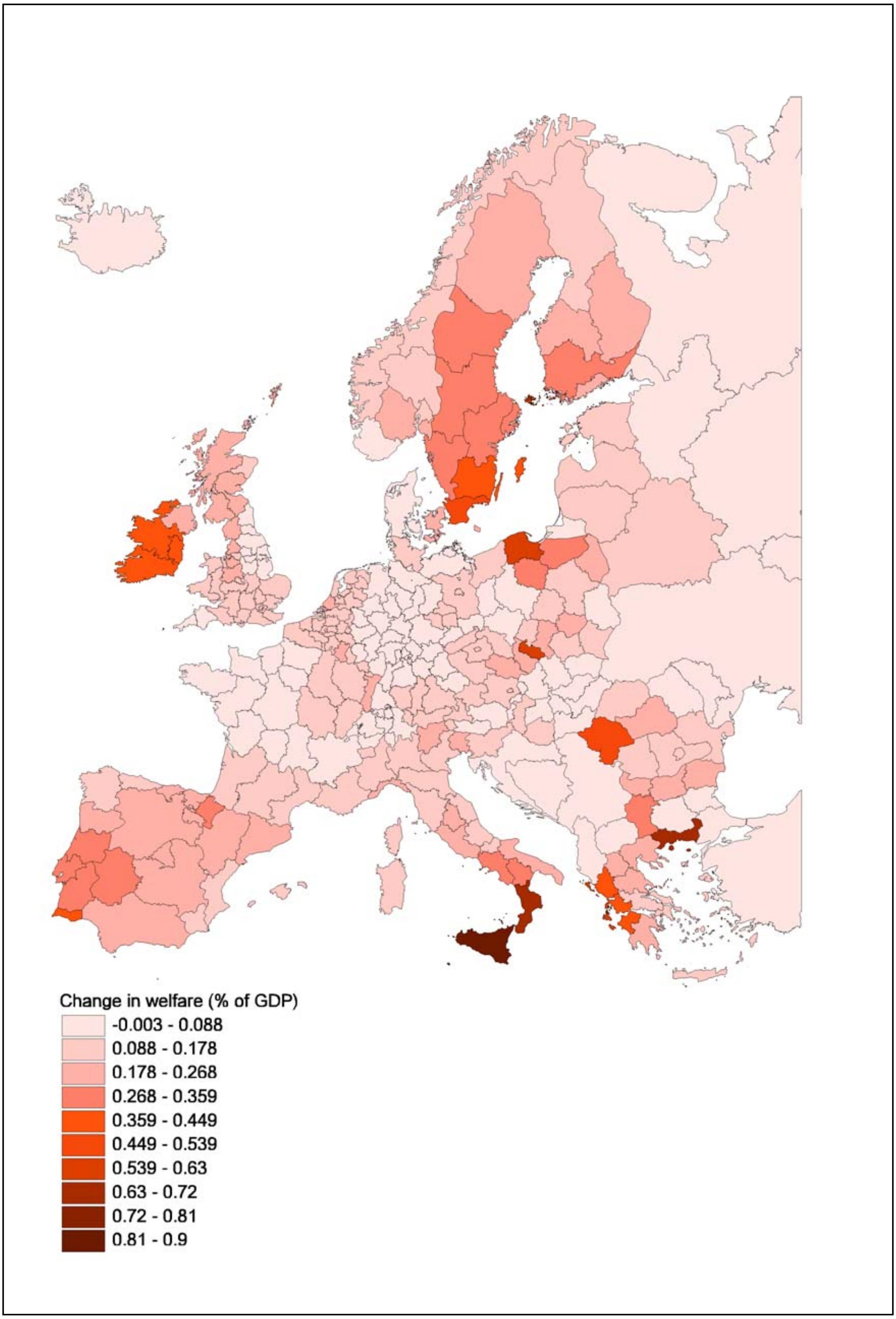

Figure 4.25 Scenario A51: Implementation of new list of priority projects for road and rail

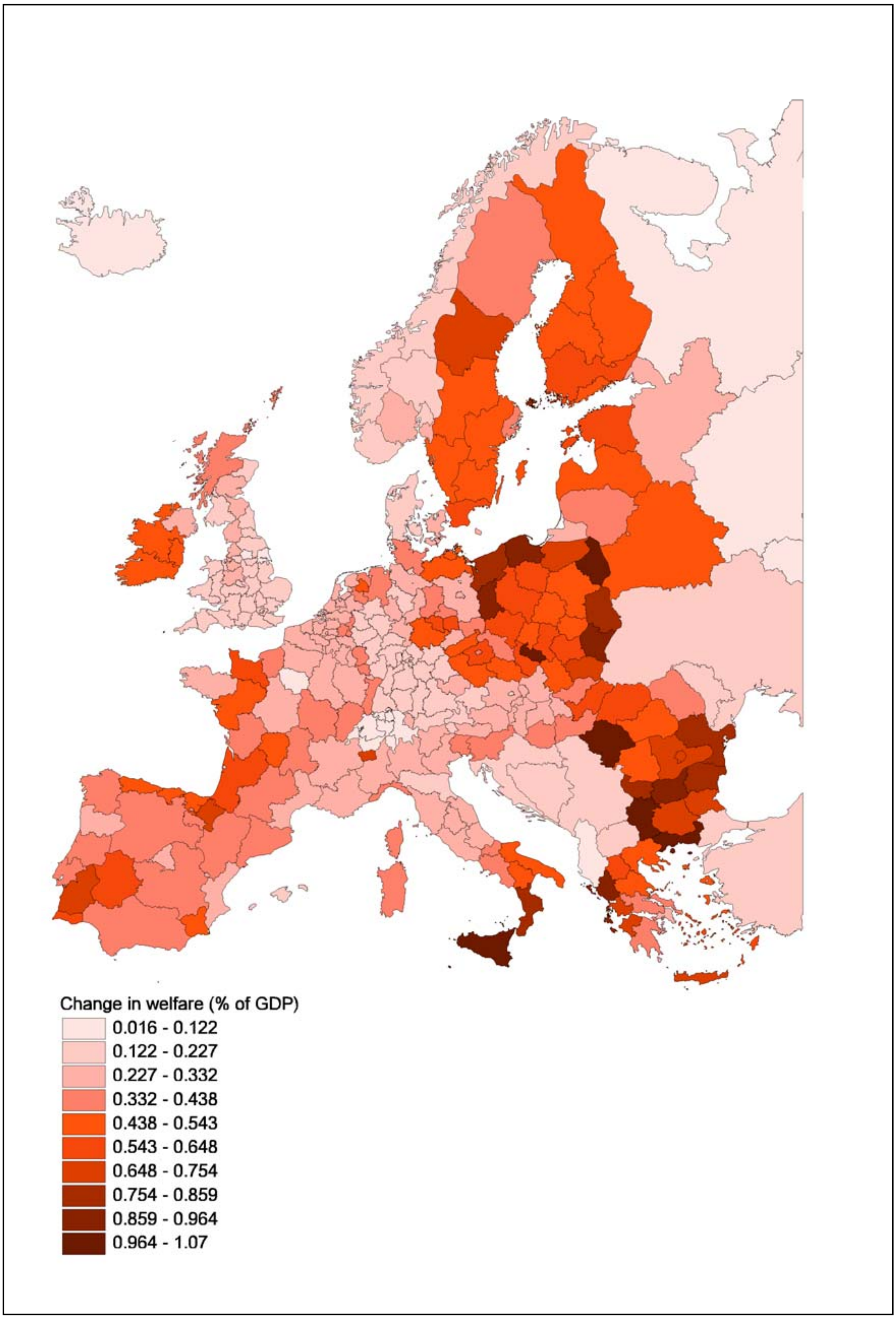

Figure 4.26. Scenario A62: Implementation of all TEN projects and maximum road/rail network development for accession countries

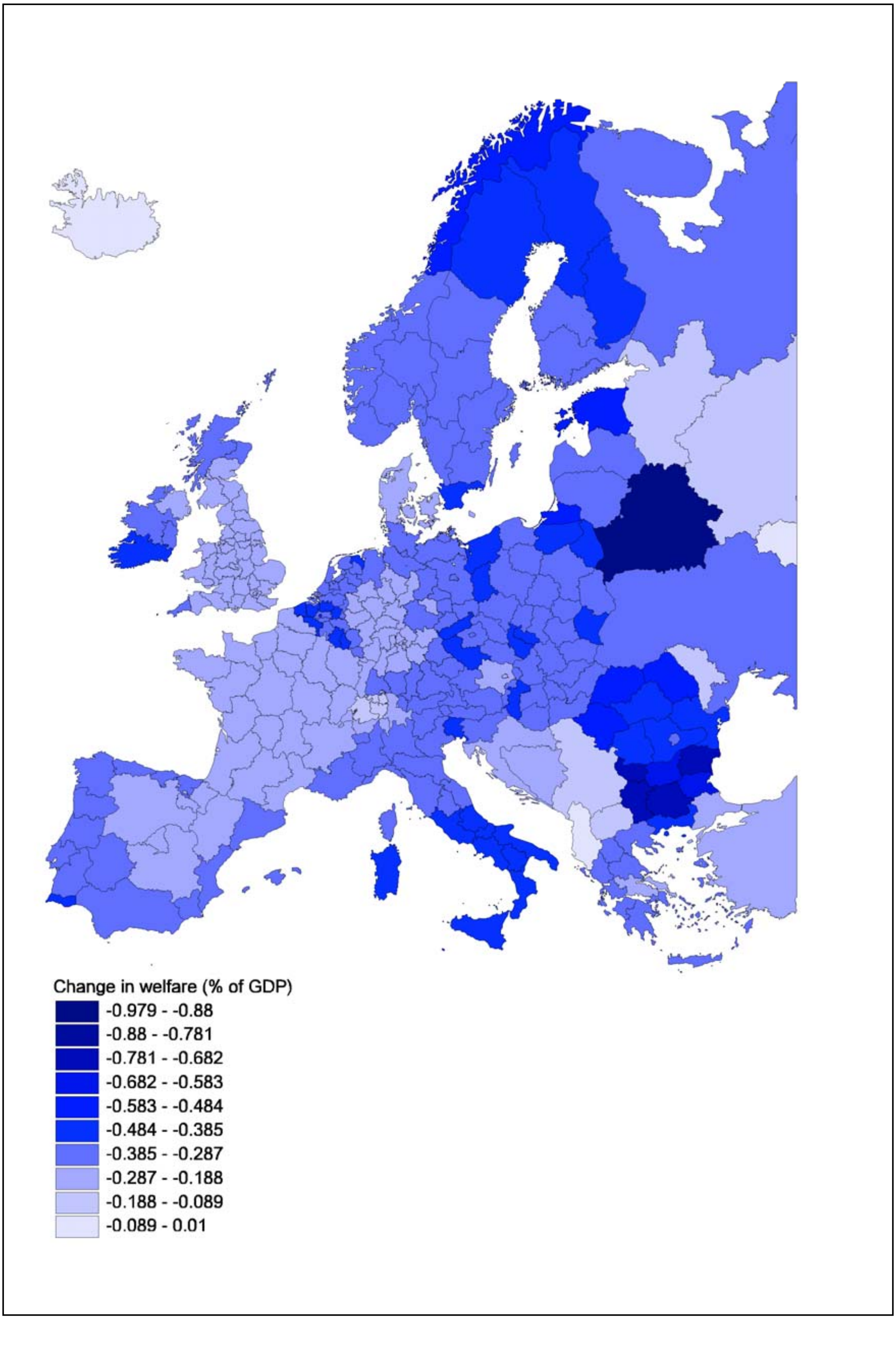

Figure 4.27. Scenario B1: SMCP applied to road freight

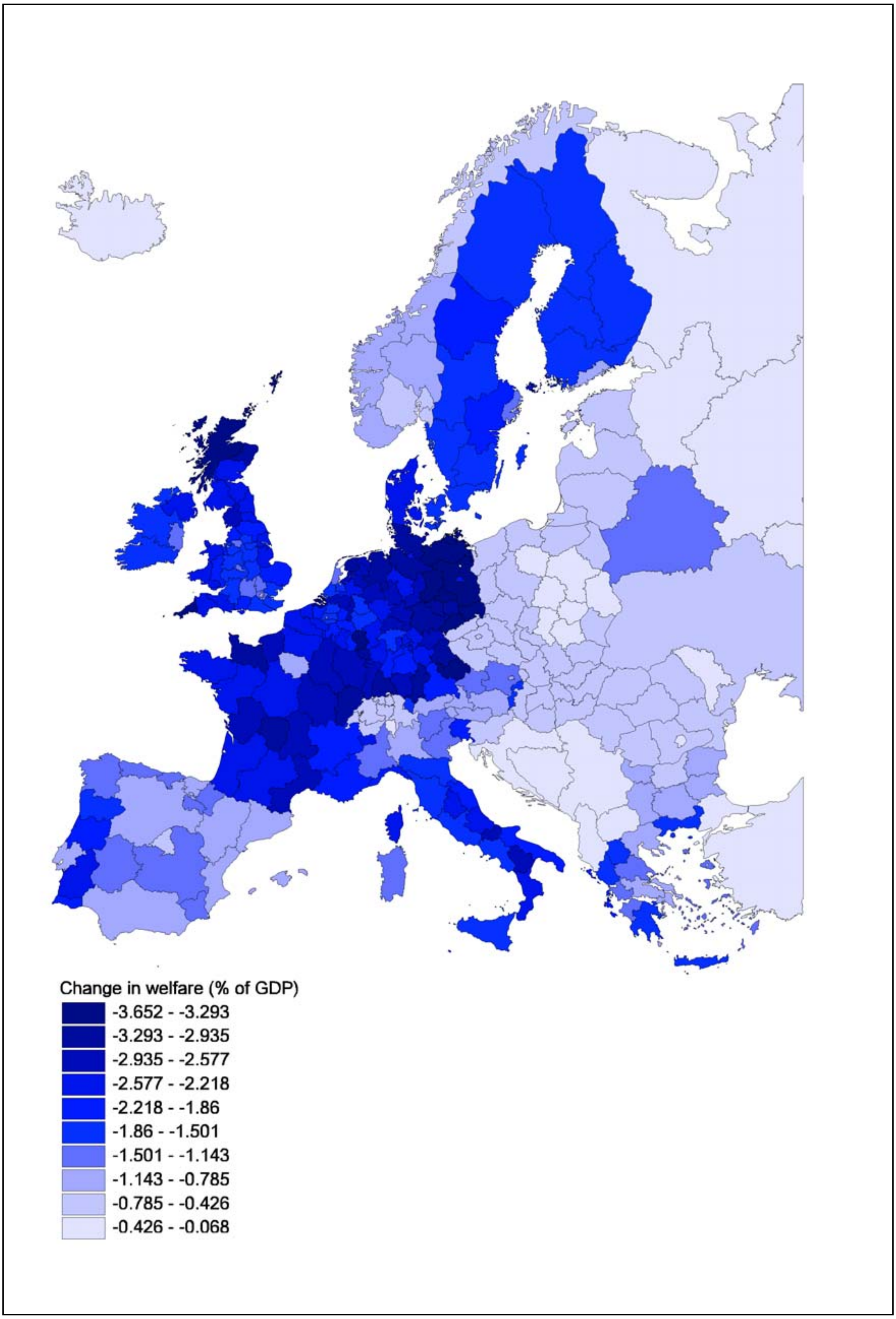

Figure 4.28. Scenario B2: SMCP applied to all modes

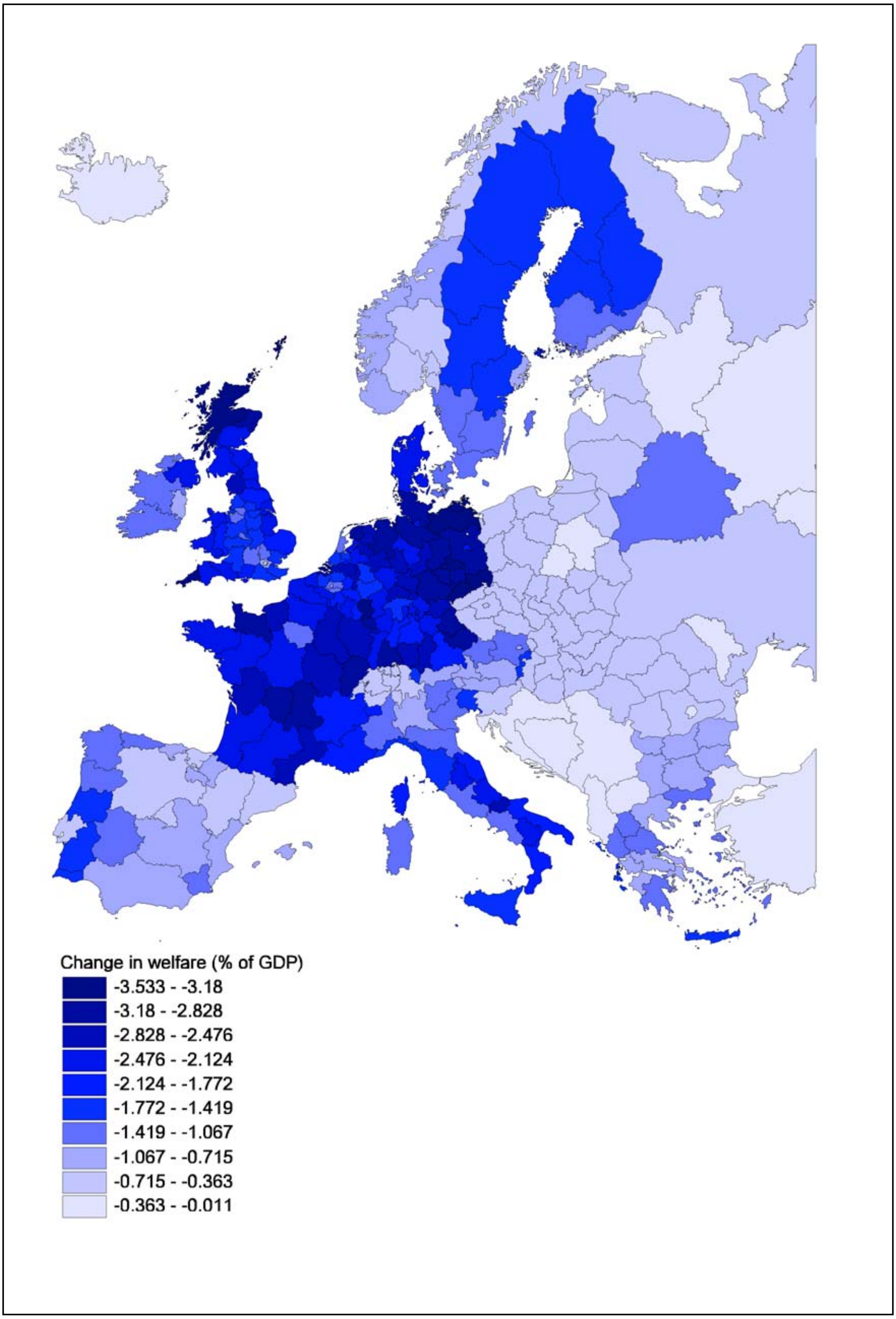

Figure 4.29. Scenario C1: SMCP applied to all modes and fast implementation of all TEN priority projects

4.8 Conclusions from CGEurope Simulations

Our first conclusion is a policy conclusion concerning the spatial distribution aspect of European transport policy initiatives, the other conclusions are methodological in nature and concern recommendations for future project evaluation.

Regarding the spatial distribution issue, we find all infrastructure scenarios considered to have spatial impacts that coincide with the cohesion objective. There is a tendency to favour regions the more, the lower their GDP per capita is in the reference situation. The opposite holds true for all pricing scenarios. The characteristic spatial pattern of the pricing scenarios is to disfavour geographically peripheral regions, both peripheral with regard to their respective national markets as well as peripheral with respect to Europe as a whole. As peripheral regions tend to be poorer than central ones, on average, pricing disfavours poorer regions more than richer ones. Another important observation is however, that all spatial distribution effects are very moderate, when measured in terms of a plausible welfare index. In fact, correcting the aggregated monetary welfare measure for equality gains (increasing welfare) or equality losses (reducing welfare) modifies the quantitative results only slightly, even if a strong inequality aversion is assumed.

The methodological conclusion to be drawn from the latter observation is that results from traditional CBA that disregard distributional issues completely by adding Euro to Euro one-to-one is acceptable, as far as the spatial distribution impact is concerned. Of course, this can not be said without an implied value judgement hidden in the welfare indicator, and it holds with the qualification, that it is only true if the regions affected by an initiative do not show much higher inequality of GDP per capita than those in our study area. In fact it turned out that correcting for the distribution impact can have a considerable impact and even reverse the sign of welfare change, if an initiative for example affects accession countries positively and EU15 countries negatively or vice versa.

In general, the question whether a scenario leads to convergence or divergence between rich and poor regions depends on the specific inequality indicator used. Indicators that measure relative differences between regions (like the Gini coefficient) classify a policy as pro-cohesion if less developed regions grow faster in *relative* terms than more affluent regions. Measured in *absolute* terms, however, such a policy may still widen the gap between rich and poor regions. Table 4.8 and 4.9 give an overview about the cohesion effects of the actual scenarios, according to different equality indicators.

Another methodological conclusion that is rather favourable for the traditional CBA approach is that the spatial distribution of welfare effects is quite well approximated simply be cost savings applying to all flows from or all flows to the respective regions. This is bad news for advocates of applying CGE as a standard tool in transport project evaluation. What seems more important than sophisticated procedures for quantifying indirect general equilibrium repercussions is a precise prediction of direct effects. A transportation model that is precise in predicting flows, costs, and times but neglects general equilibrium repercussions is better than a sophisticated general equilibrium approach with crude flow and cost information. Note that this conclusion is made by an author with a personal bias towards CGE methods. Of course, this conclusion might not be true anymore, if other imperfect market effects like effects from rigid labour markets are included. But within the framework applied in this study it would not be serious to keep this conclusion a secret!

Table 4.8. CGEurope Model: Welfare Cohesion Effects for 1997

	Scenario	Welfare cohesion effects (+/–)				
		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	-	-	-	–
A21	High-speed rail priority projects	+	-	-	-	–
A22	Conventional rail priority projects	+	·	-	-	-
A23	Road priority projects	+	-	+	+	-
A24	Rail priority projects	+	-	-	-	–
A3	All TEN/TINA projects	+	+	++	++	–
A4	All TEN projects	+	+	+	+	–
A51	New priority projects	+	+	+	++	–
A52	New priority rail projects	+	-	+	+	–
A53	New priority road projects	+	+	+	+	-
A61	A3 + additional projects in CC12	+	+	++	++	–
A62	A3 + additional projects in CC12	+	+	++	++	–
B1	SMC pricing road freight	-	-	–	—	++
B2	SMC pricing all modes travel/freight	-	-	+	+	++
C1	A1+B2	-	-	+	+	++
D1	Dedicated rail freight network	+	·	-	-	–
E1	TIPMAC business-as-usual scenario	+	+	++	++	–
E2	TIPMAC fast TEN + SMC	+	+	++	++	++

Table 4.9. CGEurope Model: Welfare Cohesion Effects for 2020

	Scenario	welfare cohesion effects (+/–)				
		CoV	Gini	G/A	RC	AC
A1	TEN priority projects	+	-	·	+	–
A21	High-speed rail priority projects	+	-	·	+	–
A22	Conventional rail priority projects	+	·	·	+	–
A23	Road priority projects	+	+	·	–	–
A24	Rail priority projects	+	-	·	+	–
A3	All TEN/TINA projects	+	+	+	++	–
A4	All TEN projects	+	+	+	+	–
A51	New priority projects	+	+	+	+	–
A52	New priority rail projects	+	+	+	+	–
A53	New TEN priority road projects	+	+	+	+	–
A61	A3 + additional projects in CC12	+	+	+	+	–
A62	A3 + additional projects in CC12	+	+	+	+	–
B1	SMC pricing road freight	-	-	-	+	++
B2	SMC pricing all modes travel/freight	-	-	+	++	++
C1	A1+B2	-	-	+	+	++
D1	Dedicated rail freight network	+	+	+	+	–
E1	TIPMAC business-as-usual scenario	+	+	+	+	–
E2	TIPMAC fast TEN + SMC	+	+	+	++	++

+/++ Weak/strong cohesion effect: disparities reduced
–/— Weak/strong anti-cohesion effect: disparities increased
· Little or no cohesion effect

CoV Coefficient of variation (%)
Gini Gini coefficient (%)
G/A Geometric/arithmetic mean
RC Correlation relative change v. level
AC Correlation absolute change v. level

What also counts in favour of simpler rather than more complicated methods is the fact that the multisectoral model leads to results not dramatically differing from the simpler approach with just a single tradables sector. Only if we are also interested in structural effects on a regional level, or if we have good input information on transport costs differing by industry it seems worthwhile to set up a multisectoral framework.

A final result, that is rather disappointing for general equilibrium modellers as well, is the relatively moderate total benefit multiplier (TBM). Welfare effects (positive as well as negative ones) are underestimated by something less than 20 % by a simple direct cost or surplus approach. We also found a quite uniform multiplier not varying over scenarios, so that blowing up traditional estimates by something like a factor of 1.2 seems to be an acceptable approximation. Again one has to stress that this holds true only as long as a moderate degree of monopoly power, as assumed in our approach, is the only market imperfection. Pro-competitive effects that are assumed away a priori in the Dixit-Stiglitz model, might significantly blow up the multiplier. The same holds true for effects emerging on imperfect labour markets; but as discussed above, including the latter effects in a multiplier might produce misleading evaluation results, because they induce decision makers to solve labour market problems by the wrong tools, namely by transport policy.

5 SASI and CGEurope: a Comparison

The two models, SASI and CGEurope, are based on completely different philosophies. It would therefore come as a surprise if they delivered identical of very similar results. SASI results are based on econometric evidence about the relation between accessibility and output, observed in the past. Regional variations of output are a function of accessibility and other factors, that is parameterised such that the evidence is reproduced by this function. CGEurope, however, is calibrated, but not tested against time-series data from the past. The model is rather assumed to be correct. The model, however, has not the black-box character of the production function in the SASI model, but explicitly describes how transport cost changes affect endogenous variables in a general equilibrium framework. If, despite of the completely different methodology, predictions of both models are close to one another, one may take this as a support for both. CGEurope could be regarded as a theoretical underpinning of SASI, and SASI as an empirical test of CGEurope.

The next section shows that there are similarities as well as differences between the results of both models. Correlations show that the spatial patterns of effects generated by the two models are similar, but the range is different.

5.1 Comparison of Numerical results

Table 5.1 shows coefficients obtained by regressing relative GDP effects of the scenarios, predicted by the SASI model, against relative equivalent variations (REV) and relative GDP effects from CGEuropeI.

Table 5.1. Regression Results, Percentage GDP Effects According to SASI Against CGEurope Results

SASI Impact on GDP Per Capita vs	Relative Equivalent Variation		Relative Change of GDP Per Capita	
	Coefficient of Correlation	Regression Coefficient	Coefficient of Correlation	Regression Coefficient
A1	0.56	7.05	0.47	5.05
A21	0.77	11.76	0.70	9.10
A22	0.73	6.64	0.68	4.64
A23	0.82	2.49	0.80	1.76
A24	0.71	10.75	0.62	8.17
A3	0.56	7.40	0.50	5.62
A4	0.63	6.93	0.56	5.10
B1	0.28	0.42	0.08	0.30
B2	0.74	3.19	0.73	2.36
C1	0.71	2.55	0.69	1.87
D1	0.54	5.10	0.46	3.64
E1	0.57	7.59	0.52	5.80
E2	0.71	1.25	0.70	0.89

For almost identical results both, the correlation and regression coefficients in the table should be close to one. Obviously, the positive correlations show similarities between the spatial patterns of results, but the regression coefficients reveal a much larger range of SASI results as compared to CGEurope results. How can this be explained? The next section presents a theoretical reason why we should in fact observe similarities between results of the two models. The sections to follow then explain why different assumptions about capital and knowledge mobility could explain the different range of results. It turns out that these assumptions, which remain untested in the project, are of fundamental importance for political conclusions to be drawn from the modelling experiments

5.2 Why Are Spatial Patterns Similar?

Assume transport cost of deliveries between a region *r* and several regions *s* to decline, such that $\mathrm{d}c_{rs} < 0$ for a given *r* and several *s*. Which impact will this have in terms of a percentage change of GDP in region *r* according to the SASI model and in terms of the relative equivalent variation according to CGEurope?

In CGEurope there will be a welfare gain in region *r* stemming from two sources. First, firms can realize higher output prices because they save transport cost for delivering goods to their respective markets. Of course, all prices respond to that change, but as a first approximation the increase in factor income correlates with the cost saving, which equals $-\sum_s t_{rs}\ \mathrm{d}c_{rs}$, if t_{rs} denotes trade flows in value terms and c_{rs} denotes the cost per unit of value. Second, firms and consumers pay lower prices for goods they buy. Again, as a first approximation this generates a welfare gain in region *r* correlating with the cost saving for deliveries to region *r*, which equals $-\sum_s t_{sr}\ \mathrm{d}c_{sr}$. As trade flows show a high degree of symmetry, both types of cost savings are also correlated with each other, and hence both approximate the welfare gain. The scattergrams in figures 5.1(a) and 5.1(b) plot for scenario A3 relative cost savings for deliveries from *r*,

$$\mathrm{d}C_r^f = -\frac{\sum_s t_{rs}\ \mathrm{d}c_{rs}}{Q_r}, \tag{5.1}$$

and relative cost savings for deliveries to *r*,

$$\mathrm{d}C_r^t = -\frac{\sum_s t_{sr}\ \mathrm{d}c_{sr}}{Q_r} \tag{5.2}$$

against the relative equivalent variation. Trade flows are those calibrated in CGEuropeI (average without and with the respective initiatives). Q_r is output in region *r*.

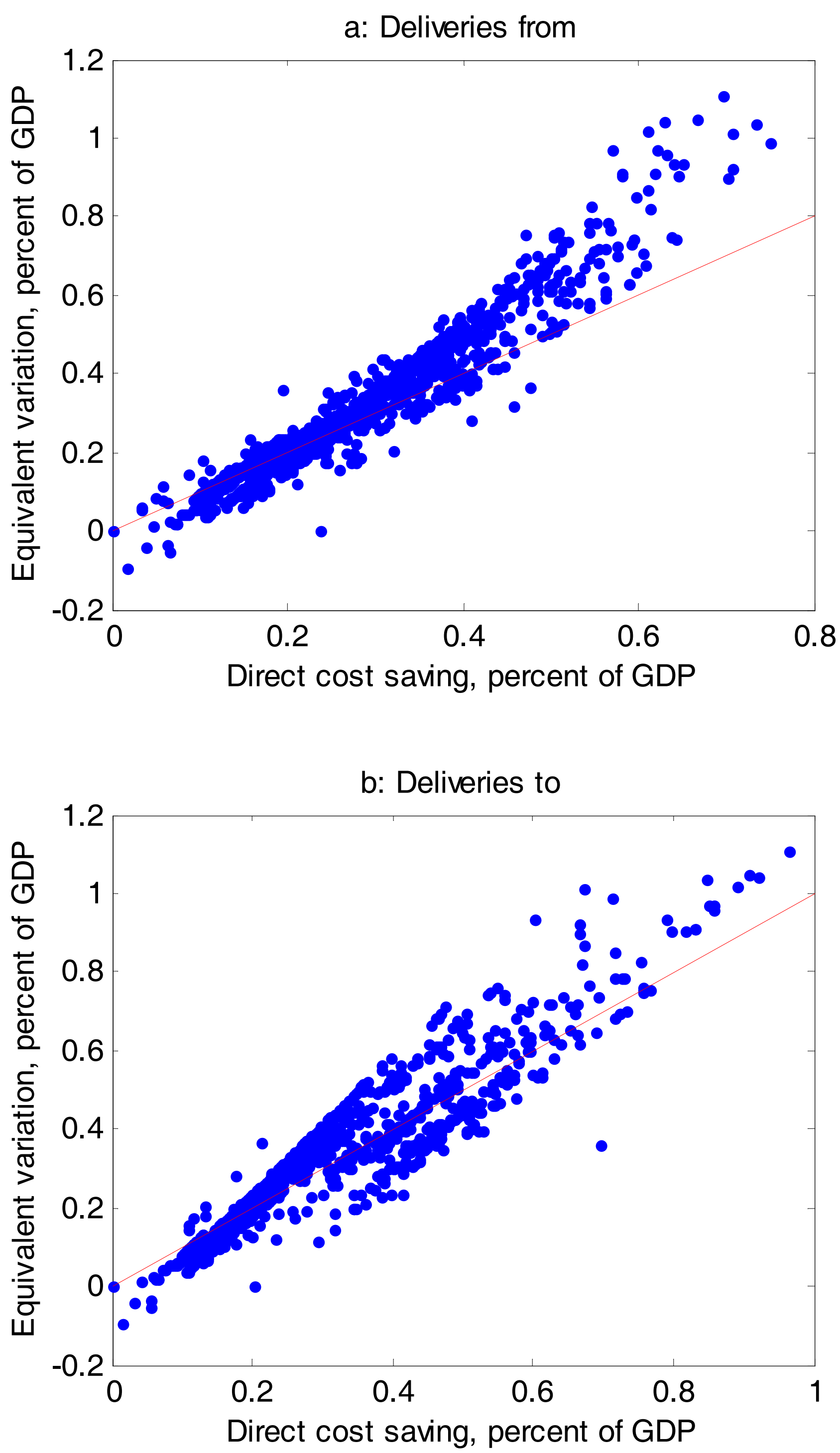

Figure 5.1: Relation between direct cost savings and equivalent variation

The Figure shows that in fact the approximations are good. The correlations are 0.97 and 0.95 for (a) and (b), respectively. Red lines mark identity.

It has been shown in section 4.2.3 that t_{rs} has a gravity form. Let us for a moment assume the distance decay function in this gravity form to be the exponential (though in fact CGEurope uses a more complex form), then we may write

$$t_{rs} = a_r b_s \exp(-\beta c_{rs}) . \tag{5.3}$$

Furthermore, note that $\sum_s t_{rs}$ is proportional to Q_r in CGEurope. Hence we obtain

$$\mathrm{d}C_r^f = -\frac{\sum_s t_{rs}\,\mathrm{d}c_{rs}}{\sum_s t_{rs}}$$

$$= -\frac{\sum_s \mathrm{d}c_{rs} b_s \exp(-\beta c_{rs})}{\sum_s b_s \exp(-\beta c_{rs})} . \tag{5.4}$$

The first equality holds up to a multiplicative constant.

It remains to be shown that relative GDP effects according to the SASI model also correlate with these cost savings. Note that due to the Cobb-Douglas form of the quasi production-function of SASI we have (see equations (3.5) and (3.6))

$$\mathrm{d}\log Q_r = \gamma\,\mathrm{d}\log A_r \tag{5.5}$$

(omitting the industry subscript). Q_r denotes output, A_r denotes accessibility. γ is the estimated elasticity. Inserting the potential formula (see equation (3.1)), omitting the mode subscript, yields

$$\mathrm{d}\log Q_r = -\gamma \frac{\beta}{A_r} \sum_s \mathrm{d}c_{rs} \exp(-\beta c_{rs}) W_s .$$

$$= -\frac{\sum_s \mathrm{d}c_{rs} W_s \exp(-\beta c_{rs})}{\sum_s W_s \exp(-\beta c_{rs})} . \tag{5.6}$$

The second equality holds up to a multiplicative constant.

We find that, given identical distance decay functions in both models, the only difference between (5.4) and (5.6) is the weights for destination regions b_s in equation (5.4) versus W_s in equation (5.6). According to equation (4.9)

$$b_s = D_s \left(\sum_r S_r (p_r \tau_{rs})^{-\sigma} \right)^{-1} , \tag{5.7}$$

where the demand value D_s is proportional to GDP; that is, up to a multiplicative constant it is almost the same as W_s in equation (5.6). Hence, there is only one difference remaining between formula (5.4) and (5.6). In (5.6) unmodified GDPs are used as weights indicating market size, while in (5.4) GDPs are modified by the second term on the right-hand side of equation (5.7). This term is an inverse supply potential; it is interpreted as a competition or market crowding term. The weight of a market is down-scaled if it is crowded by other supply regions close by. CGEurope takes this competition into account, while it is neglected in SASI's accessibility measure. The results of both models are similar, because this correction term in the accessibility formula is of secondary importance, but they are not identical, because the correction term is not negligible.

So far we have assumed the distance decay to be identical in SASI and CGEurope. In fact it is not. CGEurope plugs a power function of c_{rs} into the exponential instead of the plain c_{rs}. Furthermore, CGEurope uses calibrated border impediments in the distance function that are much bigger than those assumed in the SASI model. This gives further reasons for the results of the two models to differ. Finally, dealing with mode specific accessibilities makes a comparison more involved and causes further deviations between the two nodels.

So far we only dealt with identity or similarity of the results up to a multiplicative constant. Still the range of effects could differ even if they were proportional to one another. This hinges upon the estimated elasticity χ in equation (5.5). The next section tries to explain, why the range of SASI effects is much wider than that of CGEurope effects.

5.3 Why are Ranges of Effects Different?

In the quasi production-function of SASI there is no explicit treatment of mobile capital. In a simplified form, the estimated function reads, omitting time and industry indices (see equation (3.5))

$$Q_r = L_r^{\alpha} A_r^{\gamma} R_r . \tag{5.8}$$

A_r is Accessibility, as before. Other explaining variables are absorbed in L_r, for he sake of simplicity, which measures therefore labour and immobile endowments. R_r is the residual.

Assume there is a third factor, capital K_r, that is perfectly mobile in the long run. The production function including this factor is

$$Q_r = L_r^{\tilde{\alpha}} A_r^{\tilde{\gamma}} K_r^{\tilde{\chi}} \tilde{R}_r . \tag{5.9}$$

If the rate of return of K_r is its marginal productivity, and if the factor is perfectly mobile, then the capital-output ratio K_r / Q_r must not vary over space, i.e. $K_r / Q_r = c$. c is either fixed by the interest rate in the rest of the world (small open economy), or it is determined by the equilibrium condition on the capital market within a closed economy.

Inserting $K_r = Q_r\, c$ into (5.9) yields

$$Q_r = L_r^{\alpha} A_r^{\gamma} R_r , \tag{5.10}$$

with

$$\alpha = \frac{\widetilde{\alpha}}{1-\chi}, \quad \chi = \frac{\widetilde{\gamma}}{1-\chi}, \quad R_r = (\widetilde{R}_r c^{\chi})^{\frac{1}{1-\chi}}.$$

This is the estimated equation (5.8).

These considerations reveal the necessity to distinguish between the partial production elasticity $\widetilde{\gamma}$ and the estimated elasticity γ of accessibility. The former measures the percentage effect of a one percent increase of A_r, holding all other factors constant, while the latter measures the percentage effect of a one percent increase of A_r, holding just immobile factors constant, but including the impact of attracting factors from outside. A comparison with CGEurope results should be made by applying the former elasticity, because the factor stock is held constant in CGEurope, whereas the latter elasticity is the estimated one, applied in the SASI simulations documented in this report. As the former elasticity $\widetilde{\gamma}$ is smaller than the latter γ by the factor c, all percentage effect of SASI should be scaled down by the factor $1-\chi$ in order to obtain results comparable to CGEurope.

Is χ big enough to explain the difference? Note that in order to scale down the range by a factor of 5, say, the factor $1-\chi$ must be 1/5, i.e. χ must be 0.8. If there are no capital externalities, χ is the income share of capital, which is around 0.3, clearly implying an insufficient down-scaling. Recent literature on growth (Romer, 1986, 1990, Barro and Sala-i-Martin, 1995) and agglomeration (Fujita and Thisse, 2002, Baldwin et al., 2003) believes social returns to capital, which also include the stock of accumulated knowledge, to be much bigger, may be even close to one. If we follow this wide interpretation of social returns to capital and assume this capital to be perfectly mobile in the long run, then we end up with a viable explanation of the differences between result of the two approaches.

To summarize, SASI estimates include effects due to attracting mobile factors, that prevail in the long run after returns to mobile factors are equalized through interregional factor flows, while CGEurope measures the smaller impact, assuming a fixed factor stock in each region.

5.4 Political Implications

If we take the story just told to explain the large estimates of the SASI model with $\chi = 0.8$ as truth, then only 20% of a GDP increase in a region brought about by a transport initiative is generative, 80% is distributive. Other regions lose an amount summing up to this 80%. It is important to think about which regions are losers. In a small open economy the losses are in the whole world; they are negligible in the study area. But if Europe is taken as a closed economy, then the losses are all within Europe. They are proportional to GDP in all regions.

To be precise let superscripts 0 and 1 indicate worlds without and with the initiative, respectively. Then we have (assuming constant L_r)

$$\frac{Q_r^1}{Q_r^0} = \left(\frac{c^1}{c^0}\right)^{\frac{\chi}{1-\chi}} \left(\frac{A_r^1}{A_r^0}\right)^{\gamma}. \tag{5.11}$$

With a constant capital stock for Europe as a whole, one has

$$\frac{c^1}{c^0} = \frac{\sum_r Q_r^0}{\sum_r Q_r^1}, \tag{5.12}$$

where summation is over all regions of Europe. Inserting into the foregoing equation and solving for Q_r^1 / Q_r^0 yields

$$\frac{Q_r^1}{Q_r^0} = \left(\frac{A_r^1}{A_r^0}\right)^{\gamma} \left(\frac{\sum_r Q_r^0}{\sum_r Q_r^0 \left(A_r^1 \big/ A_r^0\right)^{\gamma}}\right)^{\chi}. \tag{5.13}$$

The last term is the redistribution factor. If $\chi = 0$, it is one, all effects are generative; if $\chi = 1$, all effects are re-distributive, because output remains unchanged for Europe as a whole. To see this, multiply the equation by Q_r^0 and sum over *r*.

For the case $0 < \chi < 1$ take $A_{r*}^1 / A_{r*}^0 > 1$ for one region *r** and constant A_r for all others as an example. The re-distribution factor is less than one. Q_{r*} increases by the factor $\left(A_{r*}^1 / A_{r*}^0\right)^{\gamma}$ times the redistribution factor. In all other regions Q_r declines by the redistribution factor.

If χ is close to one ($\chi = 0.8$, say), then infrastructure initiatives first and foremost redistribute economic activity by attracting mobile capital to locations with improved accessibility. Applying the definition of European added value put forward in Deliverable 4, one would have to conclude that practically no project will have positive European added value. New links would usually benefit a few locations improving their accessibilities, but harm the others by withdrawing mobile resources towards the locations with improved accessibility. Local and national authorities would generally have an excessive incentive to over-invest into transport infrastructure to make their citizens better off – though to a considerable extent at the cost of the population in the rest of Europe. There would be no case for interventions in favour of certain projects by the commission. To the contrary, one would have to think about preventing over-investment in a way resembling subsidy control. Whether this story holds true has to be left open at the present state of research. Current IASON models do not allow for a direct test of the impact of transport initiatives on interregional capital flows.

5.5 Short-term Versus Long-term

There is another interpretation of the different ranges of effects predicted by the two models, leading to the same down-scaling of SASI effects, but without the dramatic political implications just described.

Let the production function be as stated in equation (5.9) and assume the economy to be in a steady state according to a Solow model without capital mobility. Assume regions to be identical with respect to technologies and parameters *s*, *n*, *δ*, and *x*, denoting the saving rate, rate of population change, rate of capital depreciation, and rate of exogenous technical progress, respectively.

In the steady state the capital-output ratio is

$$\frac{K_r}{Q_r} = \frac{s}{\delta + n + x}, \tag{5.14}$$

which is the same for all regions. With $c = s/(\delta + n + x)$ the same formalism as in section 5.3 applies, but c is now a fixed parameter. As before, $\tilde{\gamma}$ is the short-term elasticity of output with respect to accessibility, with a given capital stock, and γ is the long-term elasticity including the adjustment of the capital stock after attaining the steady state. The estimation of equation (5.8) is based on cross sections representing an economy that had sufficient time to adjust to regional differences in accessibilities. Hence, what we estimate is the long-term elasticity γ, that has to be down-scaled by the factor $1-\chi$ to obtain the short-term elasticity $\tilde{\gamma}$. Thus, the same conversion factor applies as before, to make results of the two models comparable.

There is an important difference between this and the previous explanation in terms of policy conclusion, however. The long-term effect is not re-distributive, that is the GDP increase is not partially due to a decrease elsewhere. The long-term effect is generated by the fact that regional saving and investments lead to an adjustment of the steady-state capital stock to its higher steady-state value after an increase of accessibility brought about by a transport initiative.

It should also be noted, however, that this interpretation implies a long convergence time to the new steady-state, if $\chi = 0.8$. The rate of convergence is (see Barro and Sala-i-Martin, 1995)

$$\lambda = (1-\chi)(\delta + n + x) = (1-\chi)s \, {}^{Q_r}\!\!\diagup_{K_r} . \tag{5.15}$$

Given standard parameterisations, this corresponds to a convergence half-life of roughly half a century. To put it differently, only 20% of the effect predicted by the SASI model would materialize instantaneously. For another 40% it takes half a century, for another 20% another half of a century, and so forth.

6 Conclusions

The general goal of Work Package 2 of IASON was to perform a systematic and quantitative analysis of the socio-economic and spatial impacts of transport investments and other transport policies by refining existing EU-level models and carrying out scenario simulations in order to improve the understanding of the impact of transportation policies on short- and long-term spatial development in Europe. Work Package 2 was unique in that it provided a framework in which two existing forecasting models of socio-economic and spatial impacts of transport policies with different modelling philosophies, theoretical foundations and modelling techniques, the SASI model and the CGEurope model, examined an identical set of transport policy scenarios using a common system of regions, the same network data and a common database of regional socio-economic data.

The conclusions that can be drawn form the modelling work with the two models can be subdivided into two parts. The first set of conclusions is methodological and addresses issues of modelling techniques, model data and cross-validation between the two models. The second set of conclusions is based on the results of the two models and summarises in which respect the two models agree on the socio-economic and spatial impacts of the policies analysed in the scenarios and how these forecasts can contribute to policy making and planning.

Two Models

The two forecasting models applied in Work Package 2 differ in their modelling philosophies, theoretical foundations and modelling techniques:

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 study area (the 1,321 'internal' IASON regions) as a whole and transport infrastructure investments and transport system improvements, in particular of the trans-European transport networks. 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. 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 the spatial development objectives of the European Union. Its application is restricted, however, in other respects: The model generates mainly distributive and only to a limited extent generative effects of transport cost reductions, and it does not produce regional welfare assessments fitting into the framework of cost-benefit analysis.

CGEurope is a computable general equilibrium model of a multiregional economy. Models in this family are routed in modern neoclassical economic theory assuming that the behaviour of firms and households is the outcome of rational choice under technological and financial constraints. Firms choose supply and demand such that profits are maximised, households choose consumption of goods, services and travel such that they attain a maximal utility. In a multiregional setting all these choices are affected by transport cost including time costs.

Therefore changes of these costs, as represented by the scenarios, change all endogenous variables in the system such as prices, outputs, trade and travel flows, and – most importantly – utility. Utility, translated into a monetary measure, is the ultimate variable of interest in our context.

So the SASI model and the CGEurope model are based on completely different philosophies. SASI results are based on econometric evidence about the relation between accessibility and economic output observed in the past. Regional variations of output are a function of accessibility and other factors that is parameterised such that the evidence is reproduced. CGEurope, however, is calibrated but not tested against time-series data from the past. The model is rather assumed to be correct. However, it differs from SASI in that it explicitly describes how changes in transport cost affect endogenous variables in a general equilibrium framework. If despite of the completely different methodology predictions of both models are close to another, one may take this as a support for both. CGEurope might be regarded as a theoretical underpinning of SASI and SASI as an empirical test of CGEurope.

Results

Both models, the SASI model and the CGEurope model, were applied to examine the same set of 18 transport policy scenarios described in Chapter 2. The scenarios could be classified into six groups:

Network scenarios:	A1-A62
Pricing scenarios:	B1-B2
Combination scenario:	C1
Rail freight scenario:	D1
TIPMAC scenarios:	E1-E2

In addition, the do-nothing or base scenario 000 was simulated as reference or benchmark for comparing the policy scenarios. For the SASI model, the reference scenario is a fictitious development in which no transport policies are implemented after 2001. All assumptions for the policy scenarios (e.g. with respect to fertility, mortality, migration, productivity and labour force participation) are identical to those for the reference scenario, so that all differences between the policy scenarios and the reference scenario can be unequivocally attributed to the policies examined. For the CGEurope model, the reference scenario consists of the rail, road and air travel and freight cost matrices reflecting the network state in 1997.

In SASI a policy scenario is a time-sequenced programme for addition or upgrading of links of the trans-European road, rail and air networks or other transport policies, such as different regimes of social marginal cost pricing between 2001 and 2021. For CGEurope, a policy scenario consists of the rail, road and air travel and freight cost matrices reflecting the network with the network or pricing policies implemented, which can be combined with either 1997 or 2020 regional data.

Both models used the same system of regions, the same network data and a common database of regional socio-economic data to examine the above policy scenarios. Both models forecast changes in regional GDP per capita in 2020 induced by the policies, or more precisely, differences in regional GDP per capita between the policy scenarios and the reference scenario in 2020. The results of the two models can therefore be compared.

The comparison shows that there are similarities as well as differences between the results of the two models. In general, the models agree with respect to the direction and spatial distribution of the effects of the policies and whether they contribute to greater economic cohesion or greater polarisation between the regions in Europe. The differences lie in the predicted magnitude of the effects, with the SASI model in general forecasting larger positive or negative impacts. Possible reasons for these differences in magnitude are discussed in Chapter 5. The summary here concentrates on the aspects in which the two models agree.

The main general result from the scenario simulations is that the overall effects of transport infrastructure investments and other transport policies are small compared with those of socio-economic and technical macro trends, such as globalisation, increasing competition between cities and regions, ageing of the population, shifting labour force participation and increases in labour productivity. These trends have a much stronger impact on regional socio-economic development than transport policies. If one considers that under normal economic circumstances the long-term growth of regional economies is in the range between two and three percent per year, additional regional economic growth of less than one or two percent over twenty years is almost negligible.

The second main result is that even large increases in regional accessibility translate into only very small increases in regional economic activity. However, this statement needs to be qualified, as the magnitude of the effect seems to depend strongly on the already existing level of accessibility. For regions in the European core with all the benefits of a central geographical location *plus* an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines will bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions. Not surprisingly, large comprehensive programmes have more substantial effects than isolated projects.

If the different types of policies are compared, high-speed rail projects seem to be more effective in terms of promoting regional economic activity than conventional rail projects, and rail projects seem to be more effective than road projects. All transport pricing scenarios have negative economic effects, but these can be mitigated by their combination with network scenarios with positive economic effects, although the net effect depends on the magnitude of the two components. A caveat for these results is that both models only consider the cost side of the pricing scenarios and disregard effects resulting from redistributing the revenue. This is done in order to isolate the spatial impact of the pricing itself. Any desired spatial distribution of effects can be generated by an appropriate pattern of revenue redistribution. Net effects are of course always negative if fees are imposed not generating utility somewhere in the economy.

As regards the cohesion goal, the situation is very complex. There are several methods and indicators to measure the contribution of a policy or policy combination to the cohesion objective: the coefficient of variation, the Gini coefficient, the ratio between the geometric and arithmetic mean and the correlation coefficients between relative and absolute change and level of the variable of interest. Furthermore, as suggested in Chapter 4, aggregated welfare measures can incorporate the spatial distribution aspect of the effects resulting from a transport initiative.

However, these methods and indicators give partly contradictory results. In particular the most frequently applied indicator of cohesion, the coefficient of variation, tends to signal convergence where in many cases in fact divergence occurs, when judged in terms of absolute rather than relative income differences betweeen regions. The coefficient of variation, the Gini coefficient and the ratio between geometric and arithmetic mean measure *relative* differences between regions and classify a policy as pro-cohesion if economically lagging regions grow faster (in relative terms) than economically more advanced, i.e. more affluent regions. Judging the distributional impact by comparing welfare indices with inequality aversion with those without leads to a similar conclusion. However, one percent additional income for a poor person (or region) is much less in absolute terms than one percent income gain for a rich person (or region). Even if poorer regions grow faster than rich regions (in relative terms), in most cases the income gap between rich and poor regions (in absolute terms) is widening. Which concept of cohesion (or convergence or divergence) is used, is a matter of definition. It is therefore of great importance to clearly state which type of cohesion indicator is used or should be used.

Beyond these methodological difficulties, a few general observations about the cohesion effects of the examined policies can be made. In general, network policies, i.e. transport infrastructure improvements, coincide with the cohesion objective, i.e. have a tendency to favour poorer peripheral regions – in relative terms. However, in absolute terms usually the richer and more central regions gain more. The opposite holds true for the pricing scenarios. The characteristic spatial pattern of the pricing scenarios is to disfavour geographically peripheral regions, both peripheral with regard to their respective national markets as well as peripheral with respect to Europe as a whole. As peripheral regions tend to be poorer than central ones, on average, pricing disfavours poorer regions more than richer ones. However, for the whole EU27 the comprehensive pricing scenario B2 is found to be pro-cohesion, because it is only applied to the (richer) present European Union. In absolute terms, all pricing scenarios are pro-cohesion because the rich central regions lose more with respect to all three indicators considered, accessibility, GDP, and welfare (measured in monetary terms). Based on an inequality corrected welfare index, it could however also be shown that the inequality corrected gains or losses resulting from a certain scenario do not differ much from those measured without such a correction, if the assumed inequality aversion lies within a plausible range.

In summary it can be concluded that many transport policies of the past had in a sense an ambiguous impact with regard to spatial distribution: though they have contributed to cohesion, when measured in relative terms, they at the same time have also contributed to widening absolute disparities between central and peripheral regions in Europe. This is even true for the 'old' list of TEN priority projects. The 'new' list of priority projects is a clear advance in this respect. However, there is room for improvement, as some of the scenarios have shown. The simulations have demonstrated that rapid upgrading and extending of the rail and road infrastructure in Eastern Europe would contribute to the economic and social integration of the accession countries after the enlargement of the European Union.

Further Work

The application of the two models in Work Package 2 has demonstrated that both models are operational, that their data requirements – beyond the network database – can be largely met by existing statistical data sources and that they are capable of providing policy-relevant results. At the same time the work has given valuable insights into the potential and problems of modelling socio-economic and spatial impacts of transport policies. These insights lead to conclusions for further work.

For the SASI model, the extension of the study area to EU27+2 and the increase of the spatial resolution of the model from NUTS-2 to NUTS-3 regions and the associated refinement of the network database have greatly enhanced the applicability of the model for issues of enlargement of the European Union and the analysis of regional issues or individual projects. The substitution of travel time by generalised cost in the accessibility submodel was an important improvement of the model. The disaggregation of the model to six economic sectors was less successful because it greatly aggravated the data collection problems and has led to innumerable problems of small-scale inconsistencies without improving the predictive performance of the model. The former three economic sectors (agriculture, manufacturing, services) might have been sufficient. The replacement of GDP as the dependent variable of the regional production functions by GDP per capita was a necessary step but may prove problematic in the future when demand and supply on the regional labour market are to be modelled.

Future work for SASI will aim at completing the model enhancements begun in IASON, the endogenous modelling of regional labour productivity and the conversion of the migration submodel from net migration to migration flows. It is also planned to investigate whether the responses of the model to changes in accessibility may be too strong. To better control the magnitude of the response, a suggestion by Bröcker to explicitly model mobility of capital, just as in the migration model mobility of labour is modelled, will be followed.

For the CGEurope model, the conclusion drawn from the observation that all spatial distribution effects are very moderate is that traditional cost-benefit analysis, which disregards distributional issues, is acceptable. In fact, correcting the aggregated monetary welfare measure for equality gains (increasing welfare) or equality losses (reducing welfare) modifies the quantitative results only slightly, even if a strong inequality aversion is assumed. Of course, this conclusion implies a value judgement hidden in the welfare indicator and holds only if the regions affected by a policy do not differ too much in GDP per capita. Correcting for the distribution impact can have a considerable impact and even reverse the sign of welfare change if a policy affects accession countries positively and countries in the present European Union negatively or vice versa.

Another methodological conclusion favourable for the traditional cost-benefit analysis is that the spatial distribution of welfare effects is well approximated simply by cost savings applying to all flows from or all flows to the respective regions. This is bad news for advocates of applying CGE models as standard tools in transport project evaluation. What seems more important than sophisticated procedures for quantifying indirect general equilibrium repercussions is a precise prediction of direct effects. A transportation model that is precise in predicting flows, costs, and times but neglects general equilibrium repercussions is better than a sophisticated general equilibrium approach with crude flow and cost information. Of course, this conclusion might not be true if other imperfect market effects like effects from rigid labour markets are included.

Another argument that counts in favour of simpler rather than more complicated methods is the fact that the multisectoral version of CGEurope has led to results not dramatically differing from the simpler approach with a single tradables sector. Only if also structural effects on a regional level are of interest or if good information on transport costs by industry are available, it seems worthwhile to set up a multisectoral framework.

A final rather disappointing result for general equilibrium modellers is the relatively moderate total benefit multiplier. Welfare effects (positive as well as negative) are underestimated by some 20 percent by a simple direct cost or surplus approach. Moreover, the multiplier does not vary much over scenarios, so that increasing traditional estimates by a factor of 1.2 seems an acceptable approximation. Again this holds true only as long as a moderate degree of monopoly power, as assumed in CGEurope, is the only market imperfection. Pro-competitive effects assumed away a priori in the Dixit-Stiglitz model might significantly blow up the multiplier. The same holds true for effects emerging in imperfect labour markets; but as discussed above, including the latter effects in a multiplier might produce misleading evaluation results, because they induce decision makers to solve labour market problems by the wrong tools, namely by transport policy.

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Appendix A

The annex contains information on all road and rail projects in the *TEN Implementation Report* (European Commission, 1998) and the latest revisions of the TEN guidelines provided by the European Commission (1999; 2002a).

Table A1. Overview of TEN projects.

Country code	Road network		Railway network	
	Project number (project sections)	Road number	Project number (project sections)	From/to
BE	1	N49 (E34)	1	Paris-Brussels-Cologne
	2	N74	2	Paris-Brussels-Cologne
	3	A18 (E40)	3	Paris-Brussels-Cologne
	4	E429	4	Paris-Brussels-Cologne
	5	E25	5	Paris-Brussels-Cologne
	6	E411	6	Brussels-Amsterdam
	7	E42	7	Brussels-Amsterdam
DK	1 (1.1, 1.2, 1.3, 1.4)		1 (1.1,1.2,1.3,1.4,1.5, 1.6)	Øresund-København-Esbjerg
	2 (2.1, 2.2)		2 (2.1, 2.2, 2.3)	Alborg-Frederica-Germany
	3 (3.1, 3.2)		3 (3.1, 3.2)	Ringsted-Fehmern Belt
	4			
	5 (5.1, 5.2)			
	6			
DE	1 (1.1, 1.2)	A1 / B207	1	
	2 (2.1, 2.2, 2.3, 2.4, 2.5, 2.6)	A20	2	
	3	A28	3	
	4	B402	4 (4.1, 4.2, 4.3, 4.4, 4.5)	Hub Berlin
	5 (5.1, 5.2)	A31	5	
	6	A30	6 (6.1, 6.2, 6.3)	Nuernberg-Berliln
	7 (7.1, 7.2)	A33	7	
	8	A46 / A57	8	
	9	A61	9	
	10 (10.1, 10.2)	A52	10	
	11	A12	11	
	12	A15	12	
	13 (13.1, 13.2, 13.3, 13.4)	A14	13	
	14 (14.1, 14.2, 14.3, 14.4)	A38 / A143	14	
	15	A44	15	
	16	A49	16	
	17 (17.1, 17.2, 17.3, 17.4)	A1	17	
	18	A60	18	
	19 (19.1, 19.2, 19.3)	A4	19	
	20	A17	20	
	21 (21.1, 21.2)	A4	21	
	22 (22.1, 22.2)	A71	22	
	23	A70	23	
	24 (24.1, 24.2)	A6	24	
	25	A8	25	
	26	A65	26	
	27	L98	27	
	28 (28.1,28.2,28.3, 28.4,28.5)	A94	28	
	29 (29.1, 29.2)	A99		
	30 (30.1, 30.2, 30.3, 30.4)	A96		
	31	A81		

GR	1	E90	1	
	2		2	
	3	E92 / E65	3	
	4 (4.1, 4.2, 4.3)	E952	4	
	5 (5.1, 5.2, 5.3)	E65	5	
	6 (6.1, 6.2, 6.3)		6	
	7		7	
	8 (8.1, 8.2, 8.3, 8.4)	E65 / E75	8	
	9 (9.1, 9.2, 9.3)		9	
	10 (10.1->10.14)	E853/E951/E55/65	10	
	11 (11.1, 11.2, 11.3)		11	
	12 (12.1, 12.2)	E75		
	13 (13.1->13.21)	E79/E90/E75/E94		
	14 (14.1, 14.2, 14.3)	E65		
	15 (15.1, 15.2)	E961		
	16	E962		
	17 (17.1)			
	18 (18.1, 18.2)	E85		
ES	1 (1.1, 1.2, 1.3)	N-330	1 (1.1, 1.2, 1.3, 1.4, 1.5)	Madrid-Zaragoza-Francia
	2	N-234	2 (2.1, 2.2, 2.3)	Madrid-Valladolid-Vitoria
	3	N-340	3	Y-Vasca
	4	N-V	4 (4.1, 4.2, 4.3)	
	5 (5.1, 5.2)	N-525/N-120/N-VI	5 (5.1->5.11)	Murcia-Barcelona
	6 (6.1, 6.2)	N-340 / N-430	6 (6.1-> 6.7)	
	7 (7.1, 7.2)	N-II	7	Zaragoza-Francia
	8	N-340 / N-II / N-323	8 (8.1, 8.2)	
	9 (9.1, 9.2)	N-620	9 (9.1, 9.2)	
	10	N-III	10 (10.1, 10.2, 10.3)	
	11	N-431	11 (11.1, 11.2)	
	12	M-50	12 (12.1, 12.2)	
	13	M-40	13	
	14		14 (14.1, 14.2, 14.3)	
	15	N-634	15	Castejon-Alsasua
	16 (16.1, 16.2)	N-301	16	Caceres-Badajoz
	17 (17.1, 17.2)	N-630		
	18	GC / C-810		
FR	1	A89	1	
	2	A41	2	
	3	A39	3	
	4	A26	4	
	5	A77	5	
	6 (6.1, 6.2)	A16	6 (6.1, 6.2)	
	7	A66	7	
	8	A20	8	
	9	A19	9 (9.1, 9.2)	
	10	A29	10	
	11 (11.1, 11.2)	A28	11	
	12	A88	12 (12.1, 12.2)	
	13 (13.1, 13.2)	A24	13 (13.1, 13.2)	
	14 (14.1, 14.2)	A85	14	
	15	A83	15	
	16	A48	16	
	17	A432	17	
	18	A460	18 (18.1, 18.2)	
	19	A43	19	
	20	A65	20 (20.1, 20.2)	
	21 (21.1, 21.2)	A87		

	22	RN11		
	23	RN7		
	24	RN117 / A64		
	25	Somport		
	26	A84		
	27	A28		
	28	N13		
	29	RCEA / RN141		
	30	RCEA / RN145		
	31	RCEA / RN79		
	32	RN88		
	33	A75		
	34	A20		
	35 (35.1, 35.2, 35.3)	N58 / A34		
	36	A51		
IE	1	M1	1	
	2	M1	2	
	3	N2	3	
	4	N4	4	
	5	N4	5	
	6	N4		
	7	N6		
	8	N7		
	9	N7		
	10	N7		
	11	N7		
	12	N8		
	13	N8		
	14	N11		
	15	N18		
	16	N25		
	17	N25		
	18	M50		
IT	1	A10	1	Nodo di Torino
	2	A26	2	Nodo di Milano
	3	A10	3 (3.1, 3.2)	Nodo di Venezia
	4	A4	4	Nodo di Genova
	5	A5	5	
	6	A5	6	
	7	A6	7 (7.1, 7.2)	Nodo di Napoli
	8		8 (8.1, 8.2, 8.3)	Linea Genova-Ventimiglia
	9	A10	9	Linea Vernoa-Brennero
	10	A12	10	Linea Bologna-Verona
	11	A12	11	Linea Bologna-Venezia
	12	A1	12	Linea Venezia-Trieste
	13	A4	13	Linea Udine-Tarvisio
	14	A2	14	
	15	A22	15	
	16	A3	16	
	17 (17.1, 17.2)	A20	17	
	18	A18	18 (18.1, 18.2, 18.3, 18.4)	Linea Adriatica
	19	A6	19	Linea Baro-Taranto
	20	A5	20	
	21	A22	21 (21.1, 21.2)	Linea Bari-Lecce
	22	A4	22	Linea Roma-Napoli
	23	A8	23	Linea Orte-Falconara
	24	A1	24	Linea Caserta-Foggia

	25	A16	25	
	26	G.R.A.	26	Rete Calabra
	27	A3	27	
	28	A3	28 (28.1-> 28.8)	Rete Siciliana
	29		29 (29.1-> 29.6)	Rete Sarda
	30	SSI	30 (30.1, 30.2)	Linea Genoca-Domodossola
	31	G.R.A.	31 (31.1, 31.2)	Linea Milano-Chiasso
	32	Roma-Fiumicino	32	
	33	SS80	33 (33.1, 33.2)	Linea Torino-Lione
	34	SS309	34 (34.1, 34.2)	
	35	SS71/3bis	35	
	36	SS204	36	
	37	SS16/379	37	
	38	SS71/3bis	38	
	39	SS534		
	40	SS106		
	41	SS114		
	42			
	43	A19 / A29		
LU	1	A3	1	Bettembourg-Germany
	2	A6		
	3	A13		
NL	1	RW37	1	Woerden-Harmelen
	2	RW15	2	Rotterdam
	3	RW73	3	
	4	RW73	4	
	5	RW74	5	
	6	RW68	6	
	7	RW50	7	Amsterdam – Belgium
	8	RW69	8	Randstad-Rhine/Ruhr
	9	RW15	9	Betuweline
	10	RW4/16		
AT	1	S18	1 (1.1, 1.2, 1.3, 1.4)	Brennerachse
	2	A14	2 (2.1, 2.2, 2.3)	Tauernachse
	3	S16	3 (3.1, 3.2, 3.3)	Pyhrn/Schöber-Achse
	4	A8	4 (4.1->4.7)	Donauachse
	5	A9	5 (5.1-> 5.7)	Pontebbana-Achse
	6	A9	6 (6.1,6.2,6.3,6.4,6.5,6.6)	Arlbergachse
	7	A9		
	8	A2		
	9	A2		
	10	B301		
PT	1	IP1.1	1	Lisboa-Porto
	2	IP1.2	2	Pampilhose-V. Formoso
	3	IP1.9	3	Porto-Valenca
	4	IP1.11	4	Entroncamento-Guarda
	5	IP1.12		
	6	IP1.13		
	7	IP1.14		
	8	IP2.2		
	9	IP2.3		
	10	IP2.5		
	11	IP2.6		
	12	IP2.7		
	13	IP2.8		
	14	IP2.9		

	15	IP2.10		
	16	IP2.11		
	17	IP2.12		
	18	IP2.14		
	19	IP2.16		
	20	IP2.17		
	21	IP2.18		
	22	IP2.21		
	23	IP2.23		
	24	IP3.1		
	25	IP3.2		
	26	IP3.3		
	27	IP3.4		
	28	IP3.5		
	29	IP3.6		
	30	IP3.9		
	31	IP3.11		
	32	IP4.1		
	33	IP4.2		
	34	IP4.6		
	35	IP4.7		
	36	IP5.2		
	37	IP5.3		
	38	IP5.4		
	39	IP5.5		
	40	IP6.2		
	41	IP7.3		
	42	IP7.4		
	43	IP7.5		
	44	IP7.6		
	45	IP8.3		
	46	IP8.4		
	47	IP8.5		
	48	IP9.1		
	49	IP5.2		
	50	IP25.1		
	51	IP25.2		
FI	1	E18 / 1 / 50 / 7	1	Helsinki-Turku
	2 (2.1>2.8)	E75 / 4	2	Helsinki-Tikkurila
	3 (3.1, 3.2)	E12 / 3	3	Helsinki-Tampere
	4 (4.1, 4.2)	E63 / 9	4	Inkeroinen-Juurikorpi
	5	E63 / 5	5	Tampere-Seinäjoki
	6	5	6 (6.1, 6.2)	
	7 (7.1, 7.2)	6	7	Turku-Toijala
	8	13	8	Vainikkala-Kouvola-Kotka
	9 (9.1, 9.2)	17		
	10 (10.1, 10.2)	E4 / 21		
	11	22		
	12	82		
	13	89		
SE	1	40	1	
	2 (2.1, 2.2, 2.3, 2.4, 2.5, 2.6)	45	2	
	3	E10	3	
	4	E20	4	
	5	E22	5	
	6	E4	6	
	7	E6	7	

	8	E65	8	
	9	E18	9	
			10	
			11	
			12	
			13	
			14	
UK	1	A69	1	London-Glasgow
	2	A74	2	London-Bristol/Cardiff
	3	A1	3	Belfast-Larne
	4		4	Channel Tunnel Rail Link
	5	A1		
	6	A1		
	7	A1		
	8	A1		
	9 (9.1, 9.2)	A1		
	10	A550		
	11	M6		
	12 (12.1, 12.2)	A5		
	13 (13.1)	A14		
	14	A14		
	15	A34		
	16	A30		
	17	A9		
	18	A96		
	19	A90		
	20	A702		
	21	A702		
	22	A77		
	23	A1		
	24	A1		
	25	A1		
	26	M4		
	27	A55		
	28	A40		
	29	M1 / A4		
	30	A6		
	31	A8 / M2 / M1 / A1		
	32	A5		

Appendix B

The six tables on the following pages show all SASI results aggregated by country and for the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total region (EU27+2).

Each table contains percentage differences between each policy scenario and the reference scenario in 2200:

- The first group (Tables B1. to B.3) shows differences in accessibility. As accessibility indicator, the sum of two of the four accessibility indicators used in SASI was applied: accessibility rail/road/air (travel) and accessibility rail/road (freight).

- The second group (Tables B.4 to B.5) shows differences in GDP per capita: GDP totalled over all six sectors used in SASI divided by population.

In each group, the first table shows the original model results including generative effects. The following two tables in each group show the same results standardised as percent of the average of the total study area (EU27+2=100) and of the present European Union (EU15=100), i.e. show only the distributional effects.

Table B.1. SASI model results: accessibility

	Accessibility difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	+5.36	+5.05	+0.17	+0.14	+5.24	+13.63	+9.15	+7.44	+6.62	+1.04	+14.85	+17.40	–5.11	–13.30	–7.24	+17.37	+13.53	+6.47
BE	+4.90	+4.34	+0.58	+0.15	+4.78	+9.38	+8.37	+6.13	+6.01	+0.17	+10.10	+11.09	–3.90	–12.49	–7.00	+14.24	+9.30	+2.08
BG	+1.22	+0.91	+0.05	+0.27	+0.96	+14.41	+2.38	+3.59	+2.64	+1.03	+18.97	+31.46	–7.26	–10.15	–8.73	+4.04	+14.36	+13.46
CH	+3.70	+3.38	+0.25	+0.10	+3.62	+9.70	+8.30	+5.98	+5.82	+0.23	+10.41	+11.29	–4.58	–12.59	–8.52	+14.70	+9.64	+1.28
CY	+2.22	+2.13	+0.12	+0.00	+2.22	+22.85	+19.15	+7.02	+7.02	+0.00	+26.73	+32.70	+0.00	–8.38	–6.63	+9.35	+22.85	+17.31
CZ	+2.97	+2.63	+0.15	+0.19	+2.80	+15.38	+6.53	+6.03	+5.02	+1.20	+15.76	+20.64	–5.07	–10.89	–7.49	+14.63	+15.27	+11.01
DE	+4.28	+3.79	+0.41	+0.22	+4.09	+10.16	+7.88	+5.64	+5.41	+0.30	+10.96	+12.49	–4.28	–13.60	–8.77	+13.28	+10.01	+2.60
DK	+7.02	+3.23	+1.74	+3.55	+3.85	+16.93	+14.52	+9.97	+7.13	+3.57	+17.71	+19.23	–5.61	–16.47	–10.81	+23.83	+14.47	+5.51
EE	+1.04	+0.65	+0.41	+0.04	+1.01	+10.77	+2.75	+6.73	+6.43	+0.48	+20.47	+23.83	–7.59	–10.03	–8.76	+15.42	+10.74	+8.92
ES	+16.10	+15.51	+1.29	+0.12	+16.02	+25.23	+24.36	+18.89	+18.80	+0.16	+26.31	+26.94	–5.91	–15.00	+1.86	+34.83	+25.16	+14.66
FI	+5.19	+1.00	+3.82	+0.62	+4.70	+17.29	+10.31	+11.26	+10.58	+0.95	+25.56	+27.85	–4.93	–11.62	–6.58	+29.67	+16.95	+11.43
FR	+5.42	+5.00	+0.52	+0.11	+5.34	+11.54	+10.53	+7.12	+7.02	+0.16	+12.39	+13.18	–4.41	–13.35	–7.31	+17.43	+11.47	+3.22
GR	+3.49	+1.24	+0.06	+2.23	+1.30	+16.89	+11.38	+6.10	+3.39	+2.86	+18.36	+26.16	–8.05	–16.78	–14.02	+6.05	+16.86	+9.01
HU	+3.62	+3.38	+0.12	+0.12	+3.51	+14.37	+6.11	+6.53	+6.11	+0.54	+17.49	+22.50	–5.23	–9.74	–5.68	+13.37	+14.30	+11.57
IE	+10.35	+4.39	+5.37	+0.17	+10.22	+15.27	+14.62	+12.26	+12.13	+0.18	+16.04	+16.67	–2.00	–12.83	–3.09	+36.86	+15.15	+7.39
IT	+7.69	+7.41	+0.23	+0.08	+7.64	+15.88	+13.78	+10.79	+10.32	+0.73	+17.71	+18.90	–5.22	–13.78	–5.42	+25.27	+15.85	+6.90
LT	+1.52	+1.31	+0.21	+0.09	+1.43	+13.52	+3.58	+7.70	+7.24	+0.70	+19.01	+22.43	–6.33	–8.61	–6.89	+14.23	+13.46	+11.86
LU	+3.62	+3.19	+0.31	+0.16	+3.48	+8.51	+7.36	+5.46	+5.30	+0.20	+9.06	+9.93	–4.36	–14.42	–10.25	+13.09	+8.41	+0.17
LV	+1.37	+1.08	+0.32	+0.06	+1.31	+12.30	+3.00	+7.48	+7.10	+0.62	+20.71	+24.53	–7.01	–9.33	–7.71	+11.88	+12.25	+10.57
MT	+9.82	+9.59	+0.27	+0.01	+9.81	+27.90	+26.05	+22.17	+20.98	+2.15	+31.09	+31.83	–0.78	–12.73	–4.07	+52.28	+27.90	+17.23
NL	+4.64	+3.89	+0.69	+0.20	+4.47	+9.82	+8.56	+5.87	+5.70	+0.22	+10.61	+11.59	–4.16	–12.98	–8.11	+14.17	+9.70	+2.03
NO	+10.54	+2.65	+4.64	+4.89	+6.52	+18.97	+17.05	+13.20	+9.48	+4.92	+19.68	+20.91	–6.75	–15.32	–6.61	+36.45	+15.76	+3.19
PL	+2.28	+1.98	+0.26	+0.13	+2.16	+14.06	+5.30	+5.58	+4.69	+1.13	+16.30	+21.15	–5.20	–8.90	–6.41	+14.27	+13.96	+10.83
PT	+20.08	+16.12	+6.11	+1.28	+19.33	+27.76	+27.00	+22.56	+21.82	+1.35	+28.66	+29.21	–8.14	–19.01	+2.51	+44.17	+27.69	+15.13
RO	+1.98	+1.78	+0.07	+0.14	+1.86	+14.53	+3.31	+4.97	+4.03	+1.10	+18.28	+26.22	–6.56	–8.91	–6.60	+7.02	+14.47	+13.18
SE	+13.15	+3.12	+5.28	+6.72	+7.61	+21.78	+19.18	+16.30	+11.25	+6.74	+22.93	+24.41	–5.16	–14.12	–3.97	+33.05	+17.68	+9.64
SI	+5.13	+4.75	+0.17	+0.23	+4.93	+16.24	+9.49	+8.40	+7.44	+1.20	+18.70	+21.34	–5.55	–12.25	–6.73	+18.39	+16.16	+10.44
SK	+3.54	+3.27	+0.12	+0.13	+3.42	+15.23	+6.22	+6.77	+6.14	+0.80	+16.43	+21.86	–5.33	–9.80	–5.90	+14.34	+15.14	+12.06
UK	+6.88	+5.01	+1.63	+0.19	+6.72	+10.71	+10.10	+7.72	+7.57	+0.20	+11.35	+11.99	–3.00	–11.40	–4.64	+18.87	+10.57	+4.80
EU15	+6.42	+5.50	+0.82	+0.32	+6.16	+12.74	+11.06	+8.20	+7.84	+0.48	+13.74	+14.93	–4.44	–13.37	–6.55	+18.78	+12.55	+4.75
CH+NO	+4.72	+3.28	+0.90	+0.81	+4.05	+11.09	+9.61	+7.06	+6.37	+0.92	+11.80	+12.73	–4.90	–13.01	–8.24	+17.95	+10.56	+1.59
CC12	+2.48	+2.20	+0.18	+0.15	+2.35	+14.40	+5.07	+5.78	+4.96	+1.01	+17.18	+22.96	–5.65	–9.46	–6.68	+12.42	+14.32	+11.58
EU27+2	+5.68	+4.86	+0.71	+0.30	+5.43	+12.99	+9.96	+7.74	+7.29	+0.59	+14.30	+16.30	–4.67	–12.67	–6.61	+17.63	+12.82	+5.89

Table B.2. SASI model results: accessibility (EU27+2=100)

	Accessibility difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	–0.31	+0.18	–0.53	–0.16	–0.18	+0.57	–0.74	–0.28	–0.63	+0.45	+0.48	+0.94	–0.46	–0.73	–0.67	–0.22	+0.63	+0.55
BE	–0.74	–0.50	–0.13	–0.15	–0.61	–3.20	–1.44	–1.49	–1.20	–0.41	–3.68	–4.48	+0.80	+0.21	–0.42	–2.88	–3.12	–3.59
BG	–4.22	–3.77	–0.66	–0.03	–4.24	+1.25	–6.89	–3.85	–4.34	+0.44	+4.08	+13.03	–2.73	+2.88	–2.26	–11.55	+1.36	+7.15
CH	–1.88	–1.41	–0.46	–0.20	–1.72	–2.91	–1.51	–1.64	–1.38	–0.36	–3.41	–4.31	+0.10	+0.08	–2.05	–2.49	–2.82	–4.35
CY	–3.27	–2.61	–0.58	–0.30	–3.04	+8.73	+8.36	–0.67	–0.26	–0.58	+10.87	+14.10	+4.89	+4.90	–0.01	–7.04	+8.90	+10.78
CZ	–2.57	–2.12	–0.55	–0.12	–2.49	+2.11	–3.11	–1.59	–2.12	+0.62	+1.27	+3.73	–0.42	+2.03	–0.94	–2.55	+2.18	+4.84
DE	–1.33	–1.02	–0.30	–0.08	–1.27	–2.51	–1.89	–1.95	–1.76	–0.28	–2.93	–3.28	+0.41	–1.06	–2.31	–3.70	–2.48	–3.11
DK	+1.27	–1.55	+1.02	+3.23	–1.50	+3.49	+4.15	+2.07	–0.16	+2.97	+2.98	+2.52	–0.99	–4.36	–4.49	+5.27	+1.47	–0.36
EE	–4.39	–4.01	–0.30	–0.26	–4.20	–1.97	–6.56	–0.93	–0.80	–0.10	+5.40	+6.47	–3.07	+3.02	–2.30	–1.88	–1.84	+2.87
ES	+9.86	+10.16	+0.58	–0.19	+10.05	+10.83	+13.10	+10.35	+10.72	–0.43	+10.50	+9.15	–1.30	–2.67	+9.08	+14.63	+10.94	+8.29
FI	–0.46	–3.68	+3.09	+0.32	–0.69	+3.80	+0.32	+3.27	+3.06	+0.36	+9.85	+9.93	–0.28	+1.20	+0.04	+10.24	+3.67	+5.23
FR	–0.25	+0.14	–0.19	–0.20	–0.08	–1.29	+0.52	–0.58	–0.26	–0.42	–1.68	–2.69	+0.27	–0.79	–0.74	–0.17	–1.20	–2.52
GR	–2.07	–3.45	–0.64	+1.92	–3.91	+3.45	+1.30	–1.53	–3.64	+2.26	+3.55	+8.48	–3.55	–4.71	–7.93	–9.84	+3.58	+2.95
HU	–1.95	–1.41	–0.58	–0.18	–1.82	+1.22	–3.50	–1.12	–1.11	–0.05	+2.79	+5.33	–0.59	+3.36	+1.00	–3.62	+1.31	+5.36
IE	+4.41	–0.45	+4.62	–0.13	+4.54	+2.02	+4.24	+4.20	+4.51	–0.41	+1.52	+0.32	+2.80	–0.19	+3.78	+16.35	+2.07	+1.42
IT	+1.90	+2.44	–0.48	–0.22	+2.09	+2.55	+3.47	+2.83	+2.82	+0.14	+2.98	+2.23	–0.58	–1.27	+1.28	+6.50	+2.68	+0.95
LT	–3.94	–3.39	–0.50	–0.21	–3.79	+0.47	–5.80	–0.04	–0.05	+0.12	+4.11	+5.27	–1.74	+4.65	–0.30	–2.89	+0.57	+5.64
LU	–1.95	–1.60	–0.40	–0.14	–1.85	–3.96	–2.36	–2.11	–1.86	–0.38	–4.59	–5.48	+0.32	–2.00	–3.89	–3.86	–3.91	–5.40
LV	–4.08	–3.61	–0.38	–0.24	–3.91	–0.61	–6.33	–0.24	–0.18	+0.03	+5.61	+7.07	–2.46	+3.82	–1.17	–4.88	–0.50	+4.42
MT	+3.91	+4.51	–0.43	–0.29	+4.15	+13.20	+14.64	+13.39	+12.75	+1.56	+14.68	+13.35	+4.08	–0.08	+2.73	+29.46	+13.37	+10.71
NL	–0.98	–0.93	–0.01	–0.10	–0.91	–2.81	–1.27	–1.73	–1.49	–0.36	–3.24	–4.05	+0.53	–0.36	–1.60	–2.94	–2.76	–3.65
NO	+4.60	–2.10	+3.90	+4.57	+1.04	+5.29	+6.45	+5.07	+2.03	+4.31	+4.70	+3.97	–2.18	–3.03	+0.00	+16.00	+2.61	–2.55
PL	–3.22	–2.75	–0.45	–0.17	–3.10	+0.94	–4.23	–2.00	–2.42	+0.54	+1.74	+4.17	–0.56	+4.31	+0.21	–2.85	+1.01	+4.67
PT	+13.63	+10.74	+5.36	+0.97	+13.19	+13.07	+15.50	+13.76	+13.53	+0.76	+12.56	+11.10	–3.65	–7.26	+9.77	+22.57	+13.18	+8.72
RO	–3.50	–2.94	–0.64	–0.17	–3.39	+1.36	–6.04	–2.57	–3.04	+0.51	+3.48	+8.53	–1.99	+4.30	+0.02	–9.02	+1.46	+6.88
SE	+7.07	–1.66	+4.53	+6.40	+2.07	+7.78	+8.39	+7.94	+3.69	+6.12	+7.55	+6.97	–0.52	–1.66	+2.83	+13.11	+4.31	+3.54
SI	–0.52	–0.10	–0.54	–0.07	–0.47	+2.87	–0.43	+0.61	+0.13	+0.61	+3.85	+4.33	–0.93	+0.48	–0.12	+0.65	+2.96	+4.29
SK	–2.03	–1.51	–0.58	–0.17	–1.91	+1.98	–3.40	–0.90	–1.08	+0.22	+1.86	+4.78	–0.69	+3.29	+0.77	–2.79	+2.06	+5.83
UK	+1.13	+0.14	+0.91	–0.11	+1.22	–2.02	+0.13	–0.01	+0.25	–0.38	–2.58	–3.71	+1.75	+1.46	+2.11	+1.05	–2.00	–1.02
EU15	+0.70	+0.61	+0.11	+0.02	+0.69	–0.23	+1.00	+0.42	+0.51	–0.10	–0.49	–1.18	+0.24	–0.81	+0.07	+0.98	–0.24	–1.07
CH+NO	–0.91	–1.51	+0.19	+0.51	–1.30	–1.68	–0.32	–0.63	–0.86	+0.34	–2.19	–3.07	–0.24	–0.39	–1.74	+0.27	–2.00	–4.06
CC12	–3.03	–2.54	–0.53	–0.16	–2.92	+1.25	–4.45	–1.82	–2.18	+0.42	+2.52	+5.73	–1.03	+3.68	–0.07	–4.43	+1.33	+5.38
EU27+2	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00

Table B.3. SASI model results: accessibility (EU15=100)

	Accessibility difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	–1.00	–0.42	–0.64	–0.18	–0.86	+0.80	–1.72	–0.70	–1.14	+0.55	+0.98	+2.15	–0.70	+0.08	–0.74	–1.18	+0.87	+1.64
BE	–1.43	–1.10	–0.24	–0.17	–1.30	–2.98	–2.42	–1.91	–1.70	–0.31	–3.20	–3.34	+0.56	+1.02	–0.49	–3.82	–2.89	–2.55
BG	–4.89	–4.35	–0.77	–0.05	–4.90	+1.48	–7.81	–4.26	–4.82	+0.55	+4.60	+14.38	–2.96	+3.71	–2.33	–12.41	+1.60	+8.31
CH	–2.56	–2.01	–0.57	–0.22	–2.39	–2.69	–2.48	–2.05	–1.88	–0.25	–2.93	–3.17	–0.14	+0.90	–2.11	–3.43	–2.59	–3.31
CY	–3.95	–3.20	–0.70	–0.32	–3.71	+8.98	+7.29	–1.08	–0.76	–0.48	+11.42	+15.46	+4.64	+5.76	–0.08	–7.94	+9.15	+11.99
CZ	–3.25	–2.72	–0.66	–0.13	–3.16	+2.35	–4.07	–2.01	–2.62	+0.72	+1.77	+4.97	–0.66	+2.86	–1.01	–3.49	+2.42	+5.97
DE	–2.01	–1.62	–0.41	–0.10	–1.95	–2.28	–2.86	–2.37	–2.26	–0.18	–2.45	–2.12	+0.17	–0.26	–2.38	–4.63	–2.25	–2.06
DK	+0.56	–2.15	+0.91	+3.21	–2.17	+3.72	+3.12	+1.64	–0.66	+3.08	+3.49	+3.74	–1.23	–3.58	–4.55	+4.25	+1.71	+0.72
EE	–5.06	–4.60	–0.41	–0.28	–4.85	–1.75	–7.48	–1.35	–1.31	+0.00	+5.92	+7.74	–3.30	+3.86	–2.36	–2.83	–1.61	+3.98
ES	+9.09	+9.49	+0.47	–0.20	+9.29	+11.08	+11.98	+9.88	+10.16	–0.32	+11.05	+10.45	–1.54	–1.88	+9.00	+13.52	+11.21	+9.46
FI	–1.15	–4.27	+2.97	+0.30	–1.37	+4.04	–0.67	+2.83	+2.54	+0.47	+10.40	+11.25	–0.51	+2.02	–0.03	+9.17	+3.91	+6.38
FR	–0.94	–0.47	–0.30	–0.21	–0.77	–1.06	–0.48	–0.99	–0.76	–0.32	–1.19	–1.53	+0.03	+0.02	–0.81	–1.14	–0.96	–1.47
GR	–2.75	–4.04	–0.75	+1.91	–4.57	+3.69	+0.29	–1.94	–4.13	+2.37	+4.06	+9.77	–3.78	–3.94	–7.99	–10.72	+3.83	+4.07
HU	–2.64	–2.01	–0.69	–0.20	–2.49	+1.45	–4.46	–1.54	–1.61	+0.05	+3.30	+6.59	–0.82	+4.20	+0.93	–4.56	+1.55	+6.51
IE	+3.69	–1.06	+4.51	–0.15	+3.83	+2.25	+3.21	+3.76	+3.98	–0.30	+2.02	+1.52	+2.56	+0.62	+3.70	+15.22	+2.31	+2.52
IT	+1.19	+1.81	–0.59	–0.24	+1.39	+2.79	+2.45	+2.39	+2.29	+0.25	+3.49	+3.45	–0.81	–0.47	+1.21	+5.47	+2.93	+2.05
LT	–4.61	–3.97	–0.61	–0.23	–4.45	+0.70	–6.73	–0.46	–0.56	+0.22	+4.63	+6.53	–1.98	+5.50	–0.37	–3.83	+0.80	+6.79
LU	–2.63	–2.19	–0.51	–0.16	–2.52	–3.74	–3.32	–2.53	–2.36	–0.28	–4.12	–4.35	+0.08	–1.21	–3.96	–4.79	–3.68	–4.38
LV	–4.75	–4.19	–0.49	–0.26	–4.57	–0.39	–7.25	–0.66	–0.69	+0.13	+6.13	+8.35	–2.69	+4.67	–1.24	–5.80	–0.27	+5.55
MT	+3.19	+3.88	–0.55	–0.31	+3.44	+13.45	+13.50	+12.91	+12.18	+1.66	+15.25	+14.71	+3.83	+0.74	+2.66	+28.21	+13.64	+11.91
NL	–1.67	–1.53	–0.13	–0.12	–1.59	–2.59	–2.25	–2.15	–1.99	–0.25	–2.75	–2.90	+0.29	+0.45	–1.67	–3.88	–2.53	–2.60
NO	+3.87	–2.70	+3.79	+4.55	+0.34	+5.53	+5.39	+4.62	+1.52	+4.41	+5.22	+5.21	–2.41	–2.24	–0.07	+14.88	+2.85	–1.49
PL	–3.89	–3.34	–0.56	–0.19	–3.76	+1.17	–5.18	–2.41	–2.92	+0.64	+2.25	+5.41	–0.79	+5.16	+0.14	–3.79	+1.25	+5.80
PT	+12.84	+10.07	+5.24	+0.95	+12.41	+13.32	+14.36	+13.28	+12.96	+0.87	+13.11	+12.42	–3.87	–6.51	+9.70	+21.38	+13.45	+9.90
RO	–4.17	–3.53	–0.75	–0.19	–4.05	+1.59	–6.97	–2.99	–3.54	+0.61	+3.99	+9.82	–2.22	+5.15	–0.05	–9.90	+1.70	+8.04
SE	+6.32	–2.25	+4.42	+6.38	+1.37	+8.02	+7.32	+7.49	+3.16	+6.23	+8.08	+8.25	–0.76	–0.87	+2.76	+12.01	+4.56	+4.66
SI	–1.22	–0.71	–0.65	–0.09	–1.15	+3.11	–1.41	+0.18	–0.38	+0.71	+4.36	+5.58	–1.17	+1.30	–0.19	–0.32	+3.21	+5.43
SK	–2.71	–2.11	–0.69	–0.19	–2.58	+2.21	–4.36	–1.32	–1.58	+0.32	+2.36	+6.03	–0.93	+4.13	+0.69	–3.73	+2.30	+6.98
UK	+0.43	–0.47	+0.80	–0.13	+0.53	–1.80	–0.86	–0.44	–0.26	–0.28	–2.10	–2.56	+1.51	+2.28	+2.04	+0.07	–1.76	+0.05
EU15	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00
CH+NO	–1.60	–2.11	+0.08	+0.49	–1.98	–1.46	–1.30	–1.05	–1.36	+0.44	–1.71	–1.91	–0.48	+0.42	–1.81	–0.70	–1.77	–3.02
CC12	–3.70	–3.13	–0.64	–0.17	–3.59	+1.48	–5.39	–2.23	–2.67	+0.53	+3.03	+6.99	–1.27	+4.52	–0.14	–5.35	+1.57	+6.52
EU27+2	–0.70	–0.61	–0.11	–0.02	–0.68	+0.23	–0.99	–0.42	–0.51	+0.10	+0.50	+1.19	–0.24	+0.81	–0.07	–0.97	+0.24	+1.08

Table B.4. SASI model results: GDP per capita

	GDP per capita difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	+0.87	+0.84	+0.01	+0.02	+0.86	+2.72	+1.63	+1.31	+1.16	+0.21	+3.12	+3.69	–0.16	–3.28	–2.10	+1.78	+2.70	+0.90
BE	+1.15	+1.04	+0.11	+0.02	+1.13	+2.16	+1.96	+1.45	+1.43	+0.03	+2.30	+2.53	–0.09	–3.83	–2.36	+1.51	+2.14	+0.11
BG	+0.13	+0.06	+0.00	+0.07	+0.06	+2.98	+0.33	+0.67	+0.49	+0.20	+4.23	+7.13	–0.19	–1.48	–1.35	+0.18	+2.97	+2.61
CH	+0.83	+0.80	+0.02	+0.01	+0.82	+2.19	+1.88	+1.36	+1.33	+0.04	+2.37	+2.55	–0.12	–3.62	–2.63	+1.55	+2.18	–0.36
CY	+0.05	+0.05	+0.00	+0.00	+0.05	+0.77	+0.68	+0.18	+0.18	+0.00	+0.85	+1.03	+0.00	–2.43	–2.38	+0.19	+0.77	–1.17
CZ	+0.45	+0.40	+0.01	+0.03	+0.42	+3.13	+1.06	+1.15	+0.94	+0.26	+3.40	+4.49	–0.18	–2.34	–1.74	+1.43	+3.12	+2.01
DE	+0.89	+0.81	+0.06	+0.05	+0.85	+2.33	+1.71	+1.22	+1.17	+0.07	+2.56	+2.96	–0.10	–4.46	–3.26	+1.31	+2.29	–0.13
DK	+1.20	+0.42	+0.28	+0.79	+0.51	+3.21	+2.60	+1.67	+1.10	+0.79	+3.37	+3.70	–0.11	–5.06	–4.27	+1.23	+2.70	–0.20
EE	+0.11	+0.05	+0.06	+0.00	+0.11	+2.16	+0.28	+1.47	+1.44	+0.06	+4.45	+5.21	–0.21	–1.26	–1.11	+1.01	+2.16	+1.70
ES	+2.48	+2.40	+0.22	+0.02	+2.47	+3.69	+3.60	+2.81	+2.80	+0.02	+3.80	+3.86	–0.17	–2.78	+0.00	+2.95	+3.67	+1.90
FI	+0.65	+0.04	+0.53	+0.11	+0.57	+3.06	+1.25	+2.09	+1.96	+0.17	+5.13	+5.59	–0.12	–3.14	–2.42	+1.11	+2.95	+1.28
FR	+1.40	+1.33	+0.09	+0.02	+1.39	+2.82	+2.62	+1.77	+1.76	+0.03	+3.02	+3.17	–0.08	–4.31	–2.57	+1.92	+2.80	+0.31
GR	+0.54	+0.09	+0.00	+0.45	+0.09	+2.79	+1.96	+0.86	+0.32	+0.56	+2.96	+4.54	–0.17	–4.31	–4.09	+0.22	+2.77	+0.13
HU	+0.46	+0.43	+0.01	+0.02	+0.44	+3.24	+0.95	+1.25	+1.16	+0.12	+4.18	+5.56	–0.13	–1.94	–1.30	+1.20	+3.23	+2.47
IE	+0.75	+0.22	+0.43	+0.03	+0.73	+1.07	+1.04	+0.90	+0.88	+0.03	+1.10	+1.13	–0.07	–3.52	–2.66	+1.49	+1.04	–1.41
IT	+1.54	+1.52	+0.02	+0.01	+1.54	+3.43	+2.95	+2.19	+2.14	+0.09	+3.89	+4.13	–0.12	–3.56	–1.74	+2.54	+3.43	+1.15
LT	+0.22	+0.19	+0.03	+0.01	+0.21	+2.56	+0.56	+1.48	+1.43	+0.11	+3.84	+4.51	–0.21	–0.91	–0.66	+1.52	+2.56	+2.30
LU	+0.89	+0.79	+0.05	+0.03	+0.86	+2.25	+1.95	+1.41	+1.38	+0.04	+2.35	+2.55	–0.06	–5.49	–4.28	+1.24	+2.22	–0.69
LV	+0.17	+0.14	+0.04	+0.00	+0.17	+2.42	+0.42	+1.58	+1.53	+0.10	+4.43	+5.22	–0.21	–0.98	–0.76	+1.30	+2.41	+2.15
MT	+0.45	+0.45	+0.01	+0.00	+0.45	+2.32	+2.14	+1.53	+1.50	+0.06	+2.54	+2.60	–0.02	–3.54	–3.09	+2.09	+2.32	–0.62
NL	+1.05	+0.93	+0.11	+0.04	+1.02	+2.23	+1.96	+1.36	+1.33	+0.04	+2.38	+2.59	–0.09	–3.87	–2.67	+1.40	+2.21	–0.03
NO	+0.96	+0.17	+0.48	+0.46	+0.60	+2.05	+1.76	+1.22	+0.90	+0.46	+2.19	+2.37	–0.23	–2.98	–2.21	+1.69	+1.77	–1.61
PL	+0.30	+0.27	+0.03	+0.01	+0.29	+2.67	+0.81	+1.00	+0.82	+0.25	+3.25	+4.22	–0.18	–1.27	–0.91	+1.37	+2.65	+2.02
PT	+3.89	+3.03	+1.40	+0.25	+3.76	+4.90	+4.82	+4.23	+4.11	+0.26	+5.01	+5.07	–0.19	–4.70	–0.05	+4.30	+4.85	+2.39
RO	+0.22	+0.20	+0.00	+0.02	+0.20	+2.82	+0.42	+0.86	+0.69	+0.21	+3.78	+5.41	–0.35	–1.10	–0.82	+0.58	+2.81	+2.53
SE	+1.96	+0.31	+0.79	+1.27	+0.96	+3.47	+2.89	+2.51	+1.66	+1.27	+3.80	+4.09	–0.11	–4.34	–3.03	+1.39	+2.77	–0.16
SI	+1.01	+0.96	+0.00	+0.04	+0.97	+3.87	+1.93	+1.75	+1.57	+0.26	+4.65	+5.26	–0.21	–2.81	–1.63	+1.93	+3.86	+2.42
SK	+0.48	+0.45	+0.01	+0.02	+0.46	+3.37	+1.06	+1.28	+1.14	+0.20	+3.91	+5.29	–0.16	–2.00	–1.38	+1.48	+3.36	+2.49
UK	+0.87	+0.66	+0.15	+0.03	+0.84	+1.25	+1.21	+0.96	+0.94	+0.03	+1.30	+1.36	–0.10	–2.46	–1.54	+1.17	+1.22	–0.08
EU15	+1.25	+1.07	+0.14	+0.09	+1.17	+2.59	+2.19	+1.62	+1.54	+0.12	+2.84	+3.10	–0.10	–3.84	–2.38	+1.71	+2.54	+0.33
CH+NO	+0.88	+0.55	+0.20	+0.18	+0.74	+2.14	+1.84	+1.31	+1.17	+0.20	+2.30	+2.48	–0.16	–3.38	–2.47	+1.61	+2.03	–0.84
CC12	+0.32	+0.28	+0.01	+0.03	+0.30	+2.90	+0.78	+1.02	+0.86	+0.21	+3.70	+5.16	–0.19	–1.62	–1.23	+1.06	+2.89	+2.20
EU27+2	+1.19	+1.01	+0.13	+0.09	+1.11	+2.58	+2.11	+1.58	+1.49	+0.13	+2.85	+3.16	–0.11	–3.72	–2.33	+1.68	+2.52	+0.35

Table B.5. SASI model results: GDP per capita (EU27+2=100)

	GDP per capita difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	–0.31	–0.16	–0.12	–0.07	–0.25	+0.13	–0.47	–0.26	–0.32	+0.08	+0.26	+0.52	–0.05	+0.45	+0.24	+0.10	+0.17	+0.54
BE	–0.04	+0.03	–0.03	–0.07	+0.02	–0.41	–0.14	–0.13	–0.06	–0.10	–0.53	–0.61	+0.03	–0.11	–0.03	–0.16	–0.37	–0.24
BG	–1.05	–0.94	–0.13	–0.03	–1.04	+0.39	–1.74	–0.90	–0.99	+0.07	+1.34	+3.85	–0.08	+2.33	+1.00	–1.47	+0.43	+2.25
CH	–0.35	–0.21	–0.11	–0.08	–0.28	–0.38	–0.22	–0.22	–0.16	–0.09	–0.47	–0.59	+0.00	+0.10	–0.31	–0.12	–0.33	–0.71
CY	–1.12	–0.95	–0.13	–0.09	–1.05	–1.77	–1.40	–1.37	–1.29	–0.13	–1.94	–2.06	+0.11	+1.34	–0.05	–1.46	–1.71	–1.52
CZ	–0.73	–0.60	–0.12	–0.06	–0.68	+0.54	–1.02	–0.42	–0.54	+0.13	+0.53	+1.29	–0.07	+1.43	+0.61	–0.24	+0.58	+1.65
DE	–0.29	–0.19	–0.08	–0.05	–0.26	–0.25	–0.40	–0.35	–0.31	–0.06	–0.28	–0.19	+0.01	–0.77	–0.95	–0.36	–0.23	–0.48
DK	+0.02	–0.58	+0.15	+0.69	–0.59	+0.61	+0.48	+0.10	–0.39	+0.66	+0.51	+0.52	+0.00	–1.40	–1.98	–0.44	+0.17	–0.55
EE	–1.06	–0.94	–0.07	–0.09	–0.99	–0.41	–1.79	–0.11	–0.05	–0.06	+1.56	+1.99	–0.09	+2.56	+1.25	–0.65	–0.36	+1.34
ES	+1.28	+1.38	+0.08	–0.07	+1.34	+1.08	+1.46	+1.21	+1.29	–0.10	+0.93	+0.69	–0.06	+0.97	+2.39	+1.25	+1.12	+1.54
FI	–0.53	–0.96	+0.40	+0.02	–0.54	+0.46	–0.85	+0.51	+0.47	+0.05	+2.21	+2.36	–0.01	+0.60	–0.09	–0.56	+0.42	+0.92
FR	+0.21	+0.32	–0.04	–0.08	+0.28	+0.23	+0.50	+0.19	+0.26	–0.10	+0.16	+0.01	+0.03	–0.62	–0.24	+0.24	+0.27	–0.05
GR	–0.64	–0.91	–0.13	+0.36	–1.01	+0.21	–0.14	–0.71	–1.15	+0.43	+0.11	+1.34	–0.06	–0.62	–1.80	–1.44	+0.24	–0.22
HU	–0.72	–0.57	–0.13	–0.08	–0.66	+0.64	–1.13	–0.32	–0.32	–0.01	+1.30	+2.33	–0.02	+1.85	+1.05	–0.47	+0.69	+2.11
IE	–0.43	–0.78	+0.29	–0.07	–0.38	–1.48	–1.05	–0.67	–0.60	–0.10	–1.70	–1.96	+0.04	+0.20	–0.34	–0.19	–1.44	–1.76
IT	+0.35	+0.50	–0.12	–0.08	+0.42	+0.83	+0.83	+0.60	+0.64	–0.04	+1.01	+0.94	+0.00	+0.16	+0.60	+0.85	+0.88	+0.80
LT	–0.96	–0.80	–0.11	–0.09	–0.89	–0.02	–1.51	–0.10	–0.06	–0.02	+0.96	+1.31	–0.10	+2.92	+1.72	–0.16	+0.03	+1.94
LU	–0.30	–0.21	–0.08	–0.06	–0.25	–0.32	–0.15	–0.16	–0.11	–0.08	–0.49	–0.59	+0.05	–1.84	–2.00	–0.43	–0.29	–1.04
LV	–1.01	–0.86	–0.10	–0.09	–0.94	–0.16	–1.66	+0.00	+0.04	–0.03	+1.54	+2.00	–0.09	+2.85	+1.61	–0.38	–0.11	+1.79
MT	–0.72	–0.55	–0.13	–0.09	–0.65	–0.25	+0.03	–0.05	+0.01	–0.06	–0.30	–0.54	+0.09	+0.18	–0.77	+0.41	–0.20	–0.97
NL	–0.13	–0.07	–0.03	–0.06	–0.09	–0.35	–0.15	–0.21	–0.15	–0.09	–0.46	–0.55	+0.03	–0.16	–0.34	–0.28	–0.31	–0.38
NO	–0.22	–0.83	+0.35	+0.37	–0.50	–0.52	–0.34	–0.35	–0.58	+0.34	–0.64	–0.77	–0.12	+0.76	+0.13	+0.02	–0.73	–1.96
PL	–0.87	–0.73	–0.10	–0.08	–0.81	+0.08	–1.27	–0.57	–0.66	+0.12	+0.39	+1.03	–0.07	+2.54	+1.46	–0.30	+0.13	+1.66
PT	+2.67	+2.01	+1.27	+0.16	+2.63	+2.26	+2.65	+2.61	+2.58	+0.14	+2.10	+1.86	–0.08	–1.02	+2.33	+2.58	+2.27	+2.03
RO	–0.96	–0.80	–0.13	–0.08	–0.90	+0.23	–1.65	–0.70	–0.78	+0.08	+0.91	+2.18	–0.23	+2.72	+1.55	–1.08	+0.28	+2.17
SE	+0.77	–0.69	+0.65	+1.18	–0.14	+0.86	+0.76	+0.92	+0.16	+1.15	+0.92	+0.91	+0.00	–0.65	–0.72	–0.28	+0.24	–0.51
SI	–0.18	–0.04	–0.13	–0.06	–0.13	+1.26	–0.18	+0.17	+0.08	+0.13	+1.75	+2.04	–0.09	+0.94	+0.72	+0.25	+1.31	+2.06
SK	–0.70	–0.55	–0.12	–0.08	–0.64	+0.77	–1.03	–0.29	–0.35	+0.07	+1.03	+2.07	–0.04	+1.79	+0.98	–0.19	+0.81	+2.13
UK	–0.31	–0.34	+0.02	–0.06	–0.26	–1.30	–0.88	–0.60	–0.55	–0.09	–1.51	–1.74	+0.01	+1.31	+0.81	–0.49	–1.28	–0.44
EU15	+0.06	+0.06	+0.00	+0.00	+0.06	+0.01	+0.08	+0.04	+0.05	–0.01	–0.01	–0.06	+0.01	–0.13	–0.05	+0.03	+0.01	–0.02
CH+NO	–0.30	–0.45	+0.06	+0.09	–0.37	–0.43	–0.27	–0.27	–0.32	+0.08	–0.53	–0.66	–0.05	+0.35	–0.14	–0.07	–0.49	–1.19
CC12	–0.85	–0.71	–0.12	–0.07	–0.81	+0.31	–1.31	–0.55	–0.62	+0.08	+0.83	+1.94	–0.08	+2.18	+1.14	–0.61	+0.35	+1.84
EU27+2	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00

Table B.6. SASI model results: GDP per capita (EU15=100)

	GDP per capita difference between policy scenario and reference scenario in 2020 (%)																	
	A1	A21	A22	A23	A24	A3	A4	A51	A52	A53	A61	A62	B1	B2	C1	D1	E1	E2
AT	–0.37	–0.22	–0.13	–0.07	–0.31	+0.12	–0.55	–0.30	–0.37	+0.09	+0.27	+0.58	–0.05	+0.58	+0.28	+0.07	+0.16	+0.56
BE	–0.10	–0.03	–0.03	–0.07	–0.05	–0.42	–0.22	–0.17	–0.11	–0.09	–0.52	–0.55	+0.02	+0.02	+0.02	–0.20	–0.38	–0.22
BG	–1.11	–1.00	–0.13	–0.02	–1.10	+0.38	–1.82	–0.94	–1.04	+0.08	+1.35	+3.91	–0.09	+2.46	+1.05	–1.51	+0.42	+2.27
CH	–0.41	–0.27	–0.11	–0.08	–0.35	–0.39	–0.30	–0.26	–0.21	–0.08	–0.46	–0.53	–0.01	+0.23	–0.26	–0.16	–0.34	–0.69
CY	–1.18	–1.01	–0.13	–0.09	–1.11	–1.78	–1.49	–1.42	–1.34	–0.12	–1.93	–2.01	+0.10	+1.47	+0.00	–1.49	–1.72	–1.50
CZ	–0.79	–0.66	–0.12	–0.06	–0.75	+0.53	–1.10	–0.47	–0.59	+0.14	+0.54	+1.35	–0.08	+1.57	+0.66	–0.28	+0.57	+1.67
DE	–0.35	–0.26	–0.08	–0.04	–0.32	–0.26	–0.48	–0.39	–0.36	–0.05	–0.27	–0.13	+0.01	–0.64	–0.90	–0.39	–0.24	–0.46
DK	–0.04	–0.65	+0.15	+0.70	–0.65	+0.60	+0.40	+0.05	–0.44	+0.67	+0.52	+0.58	–0.01	–1.27	–1.93	–0.47	+0.16	–0.53
EE	–1.12	–1.00	–0.08	–0.09	–1.05	–0.42	–1.87	–0.15	–0.10	–0.05	+1.57	+2.05	–0.10	+2.69	+1.30	–0.69	–0.37	+1.36
ES	+1.22	+1.32	+0.08	–0.07	+1.28	+1.07	+1.38	+1.17	+1.24	–0.09	+0.94	+0.75	–0.07	+1.10	+2.44	+1.22	+1.11	+1.56
FI	–0.59	–1.02	+0.40	+0.02	–0.60	+0.45	–0.93	+0.46	+0.42	+0.05	+2.23	+2.42	–0.02	+0.73	–0.04	–0.59	+0.41	+0.94
FR	+0.15	+0.25	–0.04	–0.08	+0.21	+0.22	+0.42	+0.15	+0.21	–0.09	+0.17	+0.07	+0.02	–0.49	–0.20	+0.20	+0.26	–0.02
GR	–0.70	–0.97	–0.13	+0.36	–1.07	+0.20	–0.22	–0.75	–1.20	+0.44	+0.12	+1.41	–0.06	–0.49	–1.76	–1.47	+0.23	–0.20
HU	–0.78	–0.63	–0.13	–0.08	–0.72	+0.63	–1.22	–0.37	–0.37	+0.00	+1.31	+2.39	–0.03	+1.98	+1.10	–0.51	+0.67	+2.13
IE	–0.49	–0.84	+0.29	–0.07	–0.44	–1.49	–1.13	–0.71	–0.65	–0.09	–1.69	–1.90	+0.04	+0.34	–0.29	–0.22	–1.45	–1.74
IT	+0.29	+0.44	–0.12	–0.08	+0.36	+0.82	+0.74	+0.56	+0.59	–0.03	+1.02	+1.00	–0.01	+0.29	+0.65	+0.81	+0.87	+0.82
LT	–1.02	–0.87	–0.11	–0.09	–0.95	–0.03	–1.59	–0.14	–0.11	–0.01	+0.97	+1.37	–0.11	+3.06	+1.77	–0.19	+0.02	+1.96
LU	–0.36	–0.27	–0.08	–0.06	–0.31	–0.33	–0.23	–0.21	–0.16	–0.07	–0.48	–0.53	+0.05	–1.71	–1.95	–0.47	–0.30	–1.02
LV	–1.07	–0.92	–0.10	–0.09	–1.00	–0.17	–1.74	–0.05	–0.01	–0.02	+1.55	+2.07	–0.10	+2.98	+1.66	–0.41	–0.12	+1.81
MT	–0.79	–0.61	–0.13	–0.09	–0.71	–0.26	–0.05	–0.09	–0.04	–0.06	–0.29	–0.48	+0.09	+0.32	–0.72	+0.37	–0.21	–0.95
NL	–0.19	–0.13	–0.03	–0.05	–0.15	–0.36	–0.23	–0.26	–0.20	–0.08	–0.44	–0.49	+0.02	–0.03	–0.29	–0.31	–0.32	–0.36
NO	–0.28	–0.89	+0.35	+0.37	–0.57	–0.53	–0.42	–0.39	–0.63	+0.34	–0.63	–0.71	–0.13	+0.89	+0.18	–0.02	–0.74	–1.94
PL	–0.93	–0.79	–0.11	–0.08	–0.87	+0.07	–1.35	–0.61	–0.71	+0.13	+0.40	+1.09	–0.07	+2.68	+1.51	–0.34	+0.12	+1.68
PT	+2.61	+1.94	+1.26	+0.16	+2.56	+2.25	+2.57	+2.57	+2.53	+0.14	+2.12	+1.92	–0.09	–0.89	+2.38	+2.55	+2.26	+2.05
RO	–1.02	–0.86	–0.13	–0.07	–0.96	+0.22	–1.73	–0.75	–0.83	+0.09	+0.92	+2.24	–0.24	+2.85	+1.60	–1.12	+0.27	+2.19
SE	+0.70	–0.75	+0.65	+1.18	–0.21	+0.85	+0.68	+0.87	+0.11	+1.15	+0.94	+0.97	–0.01	–0.52	–0.67	–0.32	+0.23	–0.49
SI	–0.24	–0.10	–0.13	–0.06	–0.20	+1.25	–0.26	+0.13	+0.03	+0.14	+1.77	+2.10	–0.10	+1.07	+0.77	+0.22	+1.30	+2.08
SK	–0.76	–0.61	–0.13	–0.07	–0.70	+0.76	–1.11	–0.34	–0.40	+0.08	+1.04	+2.13	–0.05	+1.92	+1.02	–0.22	+0.80	+2.15
UK	–0.37	–0.40	+0.02	–0.06	–0.33	–1.31	–0.96	–0.65	–0.60	–0.08	–1.50	–1.68	+0.01	+1.44	+0.86	–0.53	–1.29	–0.41
EU15	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00
CH+NO	–0.36	–0.51	+0.06	+0.09	–0.43	–0.44	–0.35	–0.31	–0.37	+0.08	–0.52	–0.60	–0.06	+0.48	–0.09	–0.10	–0.50	–1.17
CC12	–0.91	–0.78	–0.12	–0.06	–0.87	+0.30	–1.39	–0.59	–0.67	+0.09	+0.84	+2.00	–0.08	+2.31	+1.18	–0.64	+0.34	+1.86
EU27+2	–0.06	–0.06	+0.00	+0.00	–0.06	–0.01	–0.08	–0.04	–0.05	+0.01	+0.01	+0.06	–0.01	+0.13	+0.05	–0.03	–0.01	+0.02

Appendix C. Derivation of Equations (4.1) to (4.4)

Let F_r denote the stock of factors, w_r the factor price and P_r the value of production in region r. From the Cobb-Douglas assumption we get $w_r F_r = \alpha P_r$ and $p_r = w_r^{\alpha} p_r^{\beta} q_r^{\gamma} / v_r$, with the level of productivity of v_r. Solve the latter equation for w_r and insert w_r as well as $P_r = w_r F_r / \alpha$ into the equation $S_r = P_r - \beta P_r - \varepsilon(w_r F_r + G_r)$ stating that tradables supply equals output minus local goods, both in value terms. The value of local goods is the value of intermediate (βP_r) and final ($\varepsilon(w_r F_r + G_r)$) use of local goods. This yields equation (4.1) with

$$\phi_r = (1 + \gamma/\alpha - \varepsilon) v_r^{1/\alpha} F_r .$$

Equation (4.2) is the regional budget constraint. Equation (4.3) is the well-known CES-price-index

$$q_r^{1-\sigma} = \sum_s \ell_s (p_s \tau_{rs})^{1-\sigma} \tag{C.1}$$

with number of variants ℓ_s in region s. ℓ_s is proportional to the real output S_s / p_s, which yields equation (4.3).

Finally, as to equation (4.4): The expenditure share of the respective region of origin r in expenditures for tradables in region s is proportional to $\ell_r (p_r \tau_{rs})^{1-\sigma}$, hence proportional to $S_r p_r^{-\sigma} \tau_{rs}^{1-\sigma}$. These shares include the respective transaction cost. Hence, expenditures for purchases from r, valued at mill prices, are proportional to $S_r (p_r \tau_{rs})^{-\sigma}$. Summing these purchases over r yields D_s. Thus deliveries from r to s, valued at mill prices, are

$$t_{rs} = \frac{S_r (p_r \tau_{rs})^{-\sigma}}{\sum_t S_t (p_t \tau_{ts})^{-\sigma}} D_s . \tag{C.2}$$

Inserting t_{rs} from equation (C.2) into the equilibrium condition $S_r = \sum_s t_{rs}$ and solving for p_r yields equation (4.4). A similar expression would be obtained from the standard iceberg assumption, with the only difference that the τ s in the nominator and denominator are raised to the power $1-\sigma$ rather than $-\sigma$. This difference is negligible for large σ.

Appendix D. Equivalence of Dixit-Stiglitz and Contestable Markets

Let Z_r^j denote output in sector i and region *r*. If firms produce according to a degree-*α* homogeneous production function, then total production cost can be written as

$$C_r^i = c_r^i(\mathbf{q}_r, w_r)(Z_r^i)^{\frac{1}{\alpha_i}} \tag{D.1}$$

c_r^i is a unit-cost function as before, only depending on prices. Hence the price is

$$v_r^i = p_r^i (Z_r^i)^{1/\alpha_i - 1} \tag{D.2}$$

with $p_r^i := c_r^i(q_r, w_r)$. Plugging this into the CES formula for composite prices yields

$$q_s^i = \left(\sum_r \varphi_{rs}^i (Z_r^i)^{\left(1/\alpha_i - 1\right)(1-\sigma_i)} \left(p_r^i \tau_{rs}^i\right)^{1-\sigma_i} \right)^{\frac{1}{1-\sigma_i}}. \tag{D.3}$$

Defining $X_r^i := \left(Z_r^i\right)^{1/\alpha_i}$ yields $Z_r^i := \left(X_r^i\right)^{\alpha_i}$. Inserting into the last equation yields (4.19).

For deriving (4.18), insert (4.22), still giving the value of interregional trade, into the equilibrium condition which (instead of (4.23)) now reads

$$v_r^i Z_r^i = \sum_s t_{rs}^i. \tag{D.4}$$

The outcome is

$$v_r^i Z_r^i = \sum_s \varphi_{rs}^i (\tau_{rs}^i)^{1-\sigma_i} q_i^{\sigma_i} D_S^i. \tag{D.5}$$

Substitute the expression in (D.2) for v_r^i and then $\left(X_r^i\right)^{\alpha_i}$ for Z_r^i to obtain (4.18).

Finally, the input from industry *i* into industry *j* is obtained by derivating (D.1) for industry *j* with respect to q_r^i. This yields

$$\frac{\partial c_r^j(\mathbf{q}_r, w_r)}{\partial q_r^i} \left(Z_r^j\right)^{1/\alpha_i} = a_r^{ij} X_r^j \tag{D.6}$$

with a_r^{ij} as in equation (4.14). Similarly for the factor input.

Note that $\sigma_i > 1$ and $1 \le \alpha_i \le \sigma_i / (\sigma_i - 1)$ implies $0 \le \gamma_i \le 1$. $\gamma_i = (\alpha_i - 1)(\sigma_i - 1)$ is strictly increasing in α_i. The restriction on α_i means that economies of scale must not be so large as to render the average cost curve to be steeper than the demand curve in quantity-price space.

Appendix E

Table E1. Aggregated System of Regions for CGEuropeII

Country Status	Region	Region Name	Country	IASON Regions
EU 15	1	Burgenland	Aus	1 - 3
	2	Niederösterreich	Aus	4 - 10
	3	Wien	Aus	11
	4	Kärnten	Aus	12 - 14
	5	Steiermark	Aus	15 - 20
	6	Oberösterreich	Aus	21 - 25
	7	Salzburg	Aus	26 - 28
	8	Tirol	Aus	29 - 33
	9	Vorarlberg	Aus	34 - 35
	10	Bruxelles	BLu	36
	11	Antwerpen	BLu	37 - 39
	12	Limburg B	BLu	40 - 42
	13	Oost-Vlaanderen	BLu	43 - 48
	14	Vlaams-Brabant	BLu	49 - 50
	15	West-Vlaanderen	BLu	51 - 58
	16	Brabant Wallon	BLu	59
	17	Hainaut	BLu	60 - 66
	18	Liege	BLu	67 - 70
	19	Luxembourg B	BLu	71 - 75
	20	Namur	BLu	76 - 78
	21	Stuttgart	Ger	148 - 160
	22	Karlsruhe	Ger	161 - 172
	23	Freiburg	Ger	173 - 182
	24	Tübingen	Ger	183 - 191
	25	Oberbayern	Ger	192 - 214
	26	Niederbayern	Ger	215 - 226
	27	Oberpfalz	Ger	227 - 236
	28	Oberfranken	Ger	237 - 249
	29	Mittelfranken	Ger	250 - 261
	30	Unterfranken	Ger	262 - 273
	31	Schwaben	Ger	274 - 287
	32	Berlin	Ger	288 - 289
	33	Brandenburg	Ger	290 - 307
	34	Bremen	Ger	308 - 309
	35	Hamburg	Ger	310
	36	Darmstadt	Ger	311 - 324
	37	Giessen	Ger	325 - 329
	38	Kassel, Landkreis	Ger	330 - 330
	39	Mecklenburg-Vorpommern	Ger	337 - 354
	40	Braunschweig	Ger	355 - 365
	41	Hannover	Ger	366 - 373
	42	Lüneburg	Ger	374 - 384

Country Status	Region	Region Name	Country	IASON Regions
	43	Weser-Ems	Ger	385 - 401
	44	Düsseldorf	Ger	402 - 416
	45	Köln	Ger	417 - 428
	46	Münster	Ger	429 - 436
	47	Detmold	Ger	437 - 443
	48	Arnsberg	Ger	444 - 455
	49	Koblenz	Ger	456 - 466
	50	Trier	Ger	467 - 471
	51	Rheinhessen-Pfalz	Ger	472 - 491
	52	Saarland	Ger	492 - 497
	53	Chemnitz	Ger	498 - 509
	54	Dresden	Ger	510 - 520
	55	Leipzig	Ger	521 - 526
	56	Dessau	Ger	527 - 532
	57	Halle	Ger	533 - 539
	58	Magdeburg	Ger	540 - 550
	59	Schleswig-Holstein	Ger	551 - 565
	60	Thüringen	Ger	566 - 588
	61	Vest for Storebaelt	Den	589 - 595
	62	Hovedstadt & Ost f Storebaelt	Den	596 - 603
	63	Galicia	Spa	609 - 612
	64	Principado de Asturias	Spa	613 - 613
	65	Cantabria	Spa	614
	66	Pais Vasco	Spa	615 - 617
	67	Communidad Foral de Navarra	Spa	618
	68	La Rioja	Spa	619
	69	Aragon	Spa	620 - 622
	70	Communidad de Madrid	Spa	623
	71	Castilla y Leon	Spa	624 - 632
	72	Castilla-la Mancha	Spa	633 - 637
	73	Extremadura	Spa	638 - 639
	74	Cataluna	Spa	640 - 643
	75	Comunidad Valenciana	Spa	644 - 646
	76	Islas Baleares	Spa	647
	77	Andalucia	Spa	648 - 655
	78	Region de Murcia	Spa	656 - 658
	79	Uusimaa	Fin	659 - 662
	80	Etela-Suomi	Fin	663 - 666
	81	Ita-Suomi	Fin	667 - 668
	82	Vali-Suomi	Fin	669 - 670
	83	Pojois-Suomi	Fin	671 - 677
	84	Ahvenanmaa/Aland	Fin	678
	85	Ile de France	Fra	679 - 686
	86	Champagne-Ardenne	Fra	687 - 690
	87	Picardie	Fra	691 - 693
	88	Haute-Normandie	Fra	694 - 695
	89	Centre	Fra	696 - 701

Country Status	Region	Region Name	Country	IASON Regions
	90	Basse-Normandie	Fra	702 - 704
	91	Bourgogne	Fra	705 - 708
	92	Nord-pas-de-Calais	Fra	709 - 710
	93	Lorraine	Fra	711 - 714
	94	Alsace	Fra	715 - 714
	95	Franche-Comte	Fra	717 - 720
	96	Pays de la Loire	Fra	721 - 725
	97	Bretagne	Fra	726 - 729
	98	Poitou-Charentes	Fra	730 - 733
	99	Aquitaine	Fra	734 - 738
	100	Midi-Pyrenees	Fra	739 - 746
	101	Limousin	Fra	747 - 749
	102	Rhone-Alpes	Fra	750 - 757
	103	Auvergne	Fra	758 - 761
	104	Languedoc-Roussillon	Fra	762 - 766
	105	Provence-Alpes-Cote D'Azur	Fra	767 - 772
	106	Corse	Fra	773 - 774
	107	Anatoliki Makedonia, Thraki	Gre	775 - 779
	108	Kentriki Makedonia	Gre	780 - 786
	109	Dytiki Makedonia	Gre	787 - 790
	110	Thessalia	Gre	791 - 794
	111	Ipeiros	Gre	795 - 798
	112	Ionia Nisia	Gre	799 - 802
	113	Dytiki Ellada	Gre	803 - 805
	114	Sterea Ellada	Gre	806 - 810
	115	Peloponnisos	Gre	811 - 815
	116	Attiki	Gre	816 - 816
	117	Voreio Aigaio	Gre	817 - 819
	118	Notio Aigaio	Gre	820 - 821
	119	Kriti	Gre	822 - 825
	120	Ireland (East)	Ire	849 - 850
	121	Ireland (North West)	Ire	846 - 848
	122	Ireland (South)	Ire	851 - 853
	123	Piemonte	Ita	854 - 861
	124	Valle D'Aosta	Ita	862 - 862
	125	Liguria	Ita	863 - 866
	126	Lombardia	Ita	867 - 877
	127	Trentino-Alto Adige	Ita	878 - 879
	128	Veneto	Ita	880 - 886
	129	Friuli-Venezia Giulia	Ita	887 - 890
	130	Emilia-Romagna	Ita	891 - 899
	131	Toscana	Ita	900 - 909
	132	Umbria	Ita	910 - 911
	133	Marche	Ita	912 - 915
	134	Lazio	Ita	916 - 920
	135	Abruzzo	Ita	921 - 924
	136	Molise	Ita	925 - 926
	137	Campania	Ita	927 - 931

Country Status	Region	Region Name	Country	IASON Regions
	138	Puglia	Ita	932 - 936
	139	Basilicata	Ita	937 - 938
	140	Calabria	Ita	939 - 943
	141	Sicilia	Ita	944 - 952
	142	Sardegna	Ita	953 - 956
	143	Luxembourg (Grand-Duchy)	BLu	967
	144	Groningen	Ned	975 - 977
	145	Friesland	Ned	978 - 980
	146	Drenthe	Ned	981 - 983
	147	Overijssel	Ned	984 - 986
	148	Gelderland	Ned	987 - 990
	149	Flevoland	Ned	991
	150	Utrecht	Ned	992
	151	Noord-Holland	Ned	993 - 999
	152	Zuid-Holland	Ned	1000 - 1005
	153	Zeeland	Ned	1006 - 1007
	154	Noord-Brabant	Ned	1008 - 1011
	155	Limburg NL	Ned	1012 - 1014
	156	Norte	Por	1078 - 1085
	157	Centro (P)	Por	1086 - 1095
	158	Lisboa e Vale do Tejo	Por	1096 - 1100
	159	Alentejo	Por	1101 - 1104
	160	Algarve	Por	1105
	161	Stockholm	Swe	1148
	162	Ostra Mellansverige	Swe	1149 - 1153
	163	Smaland med oarna	Swe	1154 - 1155
	164	Sydsverige	Swe	1156 - 1158
	165	Vastsverige	Swe	1159 - 1160
	166	Nora Mellansverige	Swe	1161 - 1162
	167	Mellersta Norrland	Swe	1163 - 1166
	168	Ovre Norrland	Swe	1167 - 1168
	169	Tees Valley and Durham	UK	1189 - 1192
	170	Northumberland, Tyne and Wear	UK	1193 - 1195
	171	Cumbria	UK	1196 - 1197
	172	Chesire	UK	1198 - 1199
	173	Greater Manchester	UK	1200 - 1201
	174	Lancashire	UK	1202 - 1204
	175	Merseyside	UK	1205 - 1208
	176	East Riding and North Lincs	UK	1209 - 1211
	177	North Yorkshire	UK	1212 - 1213
	178	South Yorkshire	UK	1214 - 1215
	179	West Yorkshire	UK	1216 - 1218
	180	Derbyshire and Notts	UK	1219 - 1224
	181	Leices, Rutland, Northhants	UK	1225 - 1227
	182	Lincolnshire	UK	1228 - 1228
	183	Herefordshire	UK	1229 - 1231
	184	Shrops and Staffs	UK	1232 - 1235
	185	West Midlands	UK	1236 - 1240

Country Status	Region	Region Name	Country	IASON Regions
	186	East Anglia	UK	1241 - 1244
	187	Bedfordshire, Herts	UK	1245 - 1247
	188	Essex	UK	1248 - 1250
	189	Inner London	UK	1251 - 1252
	190	Outer London	UK	1253 - 1255
	191	Berks, Bucks, Oxfordshire	UK	1256 - 1259
	192	Surrey, Sussex	UK	1260 - 1263
	193	Hampshire	UK	1264 - 1267
	194	Kent	UK	1268 - 1269
	195	Glouc, Wilts, North Somerset	UK	1270 - 1274
	196	Dorset and Somerset	UK	1275 - 1277
	197	Cornwall	UK	1278
	198	Devon	UK	1279 - 1281
	199	West Wales and The Valleys	UK	1282 - 1289
	200	East Wales	UK	1290 - 1293
	201	North East Scotland	UK	1294
	202	Eastern Scotland	UK	1295 - 1302
	203	South West Scotland	UK	1303 - 1310
	204	Highlands And Islands	UK	1311 - 1316
	205	North Ireland	UK	1317 - 1321
CEEC	206	Vidin	BG	79 - 81
	207	Veliko Tarnovo	BG	82 - 86
	208	Varna	BG	87 - 92
	209	Sofija	BG	93 - 97
	210	Kardzali	BG	98 - 103
	211	Burgas	BG	104 - 106
	212	Prague	CZR	134
	213	Central Bohemian Region	CZR	135
	214	South Bohemian Region	CZR	136 - 137
	215	West Bohemian Region	CZR	138 - 139
	216	North Bohemian Region	CZR	140 - 142
	217	East Bohemian Region	CZR	143 - 144
	218	South Moravian Region	CZR	145 - 146
	219	North Moravian Region	CZR	147
	220	Estonia	Est	604 - 608
	221	Central Hungary	Hun	826 - 827
	222	Central Transdanubia	Hun	828 - 830
	223	Western Transdanubia	Hun	831 - 833
	224	Southern Transdanubia	Hun	834 - 836
	225	Northern Hungary	Hun	837 - 839
	226	Northern Great Plain	Hun	840 - 842
	227	Southern Great Plain	Hun	843 - 845
	228	Lithuania	Lit	957 - 966
	229	Latvia	Lat	968 - 972
	230	Zachodniopomorskie	Pol	1034 - 1037
	231	Pomorskie	Pol	1038 - 1039
	232	Warminsko-Mazurskie	Pol	1040 - 1042

Country Status	Region	Region Name	Country	IASON Regions
	233	Kujawsko-Pomorskie	Pol	1043 - 1044
	234	Mazowieckie	Pol	1045 - 1047
	235	Podlaskie	Pol	1048 - 1050
	236	Lubuskie	Pol	1051 - 1055
	237	Wielkopolskie	Pol	1056
	238	Lodzkie	Pol	1057 - 1058
	239	Lubelskie	Pol	1059 - 1060
	240	Dolnoslaskie	Pol	1061 - 1063
	241	Opolskie	Pol	1064 - 1066
	242	Slaskie	Pol	1067 - 1067
	243	Swietokrzyskie	Pol	1068 - 1070
	244	Malopolskie	Pol	1071 - 1075
	245	Podkarpackie	Pol	1076 - 1077
	246	Bacau	RO	1106 - 1111
	247	Braila	RO	1112 - 1117
	248	Arges	RO	1118 - 1124
	249	Dolj	RO	1125 - 1129
	250	Arad	RO	1130 - 1133
	251	Bihor	RO	1134 - 1139
	252	Alba	RO	1140 - 1145
	253	Buccuresti	RO	1146 - 1147
	254	Slovenia	Slo	1169 - 1180
	255	Bratislava	SK	1181 - 1181
	256	Zapadne Slovensko	SK	1182 - 1184
	257	Stredne Slovensko	SK	1185 - 1186
	258	Vychodne Slovensko	SK	1187 - 1188
Rest of EU27	259	Lausanne	CH	107 - 109
	260	Bern	CH	110 - 114
	261	Basel	CH	115 - 117
	262	Zürich	CH	118
	263	St. Gallen	CH	119 - 125
	264	Luzern	CH	126 - 131
	265	Bellinzona	CH	132
	266	Oslo	NO	1015 - 1016
	267	Hedmark	NO	1017 - 1018
	268	Østfold	NO	1019 - 1022
	269	Aust-Agder	NO	1023 - 1025
	270	Hordaland	NO	1026 - 1028
	271	Sør-Trøndelag	NO	1029 - 1030
	272	Nordland	NO	1031 - 1033
	273	Liechtenstein	LI	1333
Rest of Europe	274	Albania	AL	1322
	275	Belarus	BY	1324 - 1329
	276	Bosnia Hercegovina	BA	1323
	277	Croatia	HR	1330 - 1331
	278	Iceland	IS	1332
	279	Macedonia	MK	1335

Country Status	Region	Region Name	Country	IASON Regions
	280	Moldova	MD	1334
	281	Archangelsk	RU	1336 - 1341
	282	Sankt Peterburg	RU	1342 - 1345
	283	Moskva	RU	1346 - 1358
	284	Kursk	RU	1359 - 1361
	285	Kaliningrad	RU	1362 - 1363
	286	Turkey	TR	1364
	287	Ukraine	UA	1365 - 1368
	288	Yugoslavia	YU	1369 - 1372

Appendix F

Table F.1. IASON system of regions

Country	No.	Region	Code	Status	Centroid
Austria	1	MITTELBURGENLAND	AT111	Member State	GUESSING
	2	NORDBURGENLAND	AT112	Member State	EISENSTADT
	3	SUEDBURGENLAND	AT113	Member State	OBERWART
	4	MOSTVIERTEL-EISENWURZEN	AT121	Member State	AMSTETTEN
	5	NIEDEROESTERREICH-SUED	AT122	Member State	WIENER NEUSTADT
	6	SANKT POELTEN	AT123	Member State	ST. POELTEN
	7	WALDVIERTEL	AT124	Member State	ZWETTL
	8	WEINVIERTEL	AT125	Member State	POYSDORF
	9	WIENER UMLAND/NORDTEIL	AT126	Member State	KLOSTERNEUBURG
	10	WIENER UMLAND/SUEDTEIL	AT127	Member State	MOEDLING
	11	WIEN	AT13	Member State	WIEN
	12	KLAGENFURT-VILLACH	AT211	Member State	KLAGENFURT
	13	OBERKAERNTEN	AT212	Member State	SPITTAL
	14	UNTERKAERNTEN	AT213	Member State	ST. VEIT
	15	GRAZ	AT221	Member State	GRAZ
	16	LIEZEN	AT222	Member State	LIEZEN
	17	OESTLICHE OBERSTEIERMARK	AT223	Member State	KAPFENBERG
	18	OSTSTEIERMARK	AT224	Member State	FUERSTENFELD
	19	WEST-UND SUEDSTEIERMARK	AT225	Member State	WOLFSBERG
	20	WESTLICHE OBERSTEIERMARK	AT226	Member State	MURAT
	21	INNVIERTEL	AT311	Member State	RIET
	22	LINZ-WELS	AT312	Member State	LINZ
	23	MUEHLVIERTEL	AT313	Member State	FREISTADT
	24	STEYR-KIRCHDORF	AT314	Member State	KIRCHDORF A. D. KREMS
	25	TRAUNVIERTEL	AT315	Member State	GMUNDEN
	26	LUNGAU	AT321	Member State	TAMSWEG
	27	PINZGAU-PONGAU	AT322	Member State	SAALFELDEN
	28	SALZBURG UND UMGEBUNG	AT323	Member State	SALZBURG
	29	AUSSERFERN	AT331	Member State	REUTE
	30	INNSBRUCK	AT332	Member State	INNSBRUCK
	31	OSTTIROL	AT333	Member State	LIENZ
	32	TIROLER OBERLAND	AT334	Member State	LANDECK
	33	TIROLER UNTERLAND	AT335	Member State	KUFSTEIN
	34	BLUDENZ-BREGENZER WALD	AT341	Member State	BLUDENZ
	35	RHEINTAL-BODENSEEGEBIET	AT342	Member State	DORNBIRN
Belgium	36	REG. BRUXELLES-CAP	BE1	Member State	BRUXELLES
	37	ANTWERPEN	BE211	Member State	ANTWERPEN
	38	MECHELEN	BE212	Member State	MECHELEN
	39	TURNHOUT	BE213	Member State	TURNHOUT
	40	HASSELT	BE221	Member State	HASSELT
	41	MAASEIK	BE222	Member State	MAASEIK
	42	TONGEREN	BE223	Member State	TONGEREN
	43	AALST	BE231	Member State	AALST
	44	DENDERMONDE	BE232	Member State	DENDERMONDE
	45	EEKLO	BE233	Member State	EEKLO
	46	GENT-ARRONDISSEMENT	BE234	Member State	GENT
	47	OUDENAARDE	BE235	Member State	OUDENAARDE
	48	SINT-NIKLAAS	BE236	Member State	ST.NIKLAAS
	49	HALLE-VILVOORDE	BE241	Member State	HALLE
	50	LEUVEN	BE242	Member State	LEUVEN
	51	BRUGGE	BE251	Member State	BRUGGE
	52	DIKSMUIDE	BE252	Member State	DIKSMUIDE
	53	IEPER	BE253	Member State	IEPER
	54	KORTRIJK	BE254	Member State	KORTRIJK
	55	OOSTENDE	BE255	Member State	OOSTENDE
	56	ROESELARE	BE256	Member State	ROESELARE
	57	TIELT	BE257	Member State	TIELT
	58	VEURNE	BE258	Member State	VEURNE
	59	BRABANT WALLON	BE31	Member State	WAVRE
	60	ATH	BE321	Member State	ATH
	61	CHARLEROI	BE322	Member State	CHARLEROI
	62	MONS	BE323	Member State	MONS
	63	MOUSCRON	BE324	Member State	MOUSCRON
	64	SOIGNIES	BE325	Member State	LA LOUVIERE
	65	THUIN	BE326	Member State	THUIN
	66	TOURNAI	BE327	Member State	TOURNAI
	67	HUY	BE331	Member State	HUY
	68	LIEGE ARRONDISSEMENT	BE332	Member State	LIEGE
	69	VERVIERS	BE333	Member State	VERVIERS
	70	WAREMME	BE334	Member State	WAREMME
	71	ARLON	BE341	Member State	ARLON
	72	BASTOGNE	BE342	Member State	BASTOGNE
	73	MARCHE-EN-FAMENNE	BE343	Member State	MARCHE-EN-FAMENNE

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Belgium (cont.)	74	NEUFCHATEAU	BE344	Member State	NEUFCHATEAU
	75	VIRTON	BE345	Member State	VIRTON
	76	DINANT	BE351	Member State	DINANT
	77	NAMUR ARRONDISSEMENT	BE352	Member State	NAMUR
	78	PHILIPPEVILLE	BE353	Member State	PHILIPPEVILLE
Bulgaria	79	VIDIN	BG011	Candidate Countries	VIDIN
	80	VRATSA	BG012	Candidate Countries	BJALA SLATINA
	81	MONTANA	BG013	Candidate Countries	MICHAJLOVGRAD
	82	VELIKO TURNOVA	BG021	Candidate Countries	VELIKO TARNOVO
	83	GABROVO	BG022	Candidate Countries	GABROVO
	84	LOVECH	BG023	Candidate Countries	LOVEC
	85	PLEVEN	BG024	Candidate Countries	PLEVEN
	86	RUSE	BG025	Candidate Countries	RUSE
	87	VARNA	BG031	Candidate Countries	VARNA
	88	DOBRICH	BG032	Candidate Countries	DOBRIH
	89	RAZGRAD	BG033	Candidate Countries	RAZGRAD
	90	SILISTRA	BG034	Candidate Countries	SILISTRA
	91	TARGOVISHTE	BG035	Candidate Countries	TARGOVISTE
	92	SHUMEN	BG036	Candidate Countries	SUMEN
	93	SOFIA STOLITSA	BG041	Candidate Countries	SOFIJA
	94	BLAGOEVGRAD	BG042	Candidate Countries	BLAGOEVGRAD
	95	KYUSTENDIL	BG043	Candidate Countries	KJUSTENDIL
	96	PERNIK	BG044	Candidate Countries	PERNIK
	97	SOFIA	BG045	Candidate Countries	BOTEVGRAD
	98	KURDJALI	BG051	Candidate Countries	KARDZALI
	99	PAZARDZHIK	BG052	Candidate Countries	PAZARDZIK
	100	PLOVDIV	BG053	Candidate Countries	PLOVDIV
	101	SMOLYAN	BG054	Candidate Countries	SMOLJAN
	102	STARA ZAGORA	BG055	Candidate Countries	STARA ZAGORA
	103	HASKOVO	BG056	Candidate Countries	CHASKOVO
	104	BURGAS	BG061	Candidate Countries	BURGAS
	105	SLIVEN	BG062	Candidate Countries	SLIVEN
	106	YAMBOL	BG063	Candidate Countries	JAMBOL
Switzerland	107	VAUD	CH011	Other Countries	LAUSANNE
	108	VALAIS	CH012	Other Countries	SION
	109	GENEVE	CH013	Other Countries	GENEVE
	110	BERN	CH021	Other Countries	BERN
	111	FREIBURG	CH022	Other Countries	FRIBOURG
	112	SOLOTHURN	CH023	Other Countries	SOLOTHURN
	113	NEUCHATEL	CH024	Other Countries	NEUCHATEL
	114	JURA	CH025	Other Countries	DELEMONT
	115	BASEL-STADT	CH031	Other Countries	BASEL
	116	BASEL-LANDSCHAFT	CH032	Other Countries	LIESTAL
	117	AARGAU	CH033	Other Countries	AARAU
	118	ZUERICH	CH04	Other Countries	ZUERICH
	119	GLARUS	CH051	Other Countries	GLARUS
	120	SCHAFFHAUSEN	CH052	Other Countries	SCHAFFHAUSEN
	121	APPENZELL-AUSSERRHODEN	CH053	Other Countries	HERISAU
	122	APPENZELL-INNERRHODEN	CH054	Other Countries	APPENZELL
	123	ST.GALLEN	CH055	Other Countries	ST.GALLEN
	124	GRAUBUENDEN	CH056	Other Countries	CHUR
	125	THURGAU	CH057	Other Countries	FRAUENFELD
	126	LUZERN	CH061	Other Countries	LUZERN
	127	URI	CH062	Other Countries	ALTDORF
	128	SCHWYZ	CH063	Other Countries	SCHWYZ
	129	OBWALDEN	CH064	Other Countries	SARNEN
	130	NIDWALDEN	CH065	Other Countries	STANS
	131	ZUG	CH066	Other Countries	ZUG
	132	TICINO	CH07	Other Countries	BELLINZONA
Cyprus	133	CYPRUS	CY	Candidate Countries	NICOSIA
Czech Republic	134	PRAHA	CZ01	Candidate Countries	PRAHA
	135	STREDOCESKY	CZ02	Candidate Countries	KLADNO
	136	CESKOBUDEJOVICKY	CZ031	Candidate Countries	CESKE BUDEJOVICE
	137	PLZENSKY	CZ032	Candidate Countries	PLZEN
	138	KARLOVARSKY	CZ041	Candidate Countries	KARLOVY VARY
	139	USTECKY	CZ042	Candidate Countries	TEPLICE
	140	LIBERECKY	CZ051	Candidate Countries	LIBEREC
	141	KRALOVEHRADECKY	CZ052	Candidate Countries	HRADEC KRALOVE
	142	PARDUBICKY	CZ053	Candidate Countries	PARDUBICE
	143	JIHLAVSKY	CZ061	Candidate Countries	JIHLAVA
	144	BRNENSKY	CZ062	Candidate Countries	BRNO

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Czech Republic (cont.)	145	OLOMOUCKY	CZ071	Candidate Countries	OLOMOUC
	146	ZLINSKY	CZ072	Candidate Countries	ZLIN
	147	OSTRAVSKY	CZ08	Candidate Countries	OSTRAVA
Germany	148	STUTTGART, STADTKREIS	DE111	Member State	STUTTGART
	149	BOEBLINGEN	DE112	Member State	BOEBLINGEN
	150	ESSLINGEN	DE113	Member State	ESSLINGEN AM NECKAR
	151	GOEPPINGEN	DE114	Member State	GOEPPINGEN
	152	LUDWIGSBURG	DE115	Member State	LUDWIGSBURG
	153	REMS-MURR-KREIS	DE116	Member State	WAIBLINGEN
	154	HEILBRONN, STADTKREIS	DE117	Member State	HEILBRONN
	155	HEILBRONN, LANDKREIS	DE118	Member State	HEILBRONN
	156	HOHENLOHEKREIS	DE119	Member State	KUENZELSAU
	157	SCHWAEBISCH HALL	DE11A	Member State	SCHWAEBISCH HALL
	158	MAIN-TAUBER-KREIS	DE11B	Member State	TAUBERBISCHOFSHEIM
	159	HEIDENHEIM	DE11C	Member State	HEIDENHEIM AN DER BR
	160	OSTALBKREIS	DE11D	Member State	AALEN
	161	BADEN-BADEN, STADTKREIS	DE121	Member State	BADEN-BADEN
	162	KARLSRUHE, STADTKREIS	DE122	Member State	KARLSRUHE
	163	KARLSRUHE, LANDKREIS	DE123	Member State	KARLSRUHE
	164	RASTATT	DE124	Member State	RASTATT
	165	HEIDELBERG, STADTKREIS	DE125	Member State	HEIDELBERG
	166	MANNHEIM, STADTKREIS	DE126	Member State	MANNHEIM
	167	NECKAR-ODENWALD-KREIS	DE127	Member State	MOSBACH
	168	RHEIN-NECKAR-KREIS	DE128	Member State	HEIDELBERG
	169	PFORZHEIM, STADTKREIS	DE129	Member State	PFORZHEIM
	170	CALW	DE12A	Member State	CALW
	171	ENZKREIS	DE12B	Member State	PFORZHEIM
	172	FREUDENSTADT	DE12C	Member State	FREUDENSTADT
	173	FREIBURG IM BREISGAU, STADT	DE131	Member State	FREIBURG IM BREISGAU
	174	BREISGAU-HOCHSCHWARZWALD	DE132	Member State	FREIBURG
	175	EMMENDINGEN	DE133	Member State	EMMENDINGEN
	176	ORTENAUKREIS	DE134	Member State	OFFENBURG
	177	ROTTWEIL	DE135	Member State	ROTTWEIL
	178	SCHWARZWALD-BAAR-KREIS	DE136	Member State	VILLINGEN-SCHWENNING
	179	TUTTLINGEN	DE137	Member State	TUTTLINGEN
	180	KONSTANZ	DE138	Member State	KONSTANZ
	181	LOERRACH	DE139	Member State	LOERRACH
	182	WALDSHUT	DE13A	Member State	WALDSHUT-TIENGEN
	183	REUTLINGEN	DE141	Member State	REUTLINGEN
	184	TUEBINGEN, LANDKREIS	DE142	Member State	TUEBINGEN
	185	ZOLLERNALBKREIS	DE143	Member State	BALINGEN
	186	ULM, STADTKREIS	DE144	Member State	ULM
	187	ALB-DONAU-KREIS	DE145	Member State	ULM
	188	BIBERACH	DE146	Member State	BIBERACH
	189	BODENSEEKREIS	DE147	Member State	FRIEDRICHSHAFEN
	190	RAVENSBURG	DE148	Member State	RAVENSBURG
	191	SIGMARINGEN	DE149	Member State	SIGMARINGEN
	192	INGOLSTADT, KRFR. STADT	DE211	Member State	INGOLSTADT
	193	MUENCHEN, KRFR. STADT	DE212	Member State	MUENCHEN
	194	ROSENHEIM, KRFR. STADT	DE213	Member State	ROSENHEIM
	195	ALTOETTING	DE214	Member State	ALTOETTING
	196	BERCHTESGADENER LAND	DE215	Member State	BAD REICHENHALL
	197	BAD TOELZ-WOLFRATSHAUSEN	DE216	Member State	BAD TOELZ
	198	DACHAU	DE217	Member State	DACHAU
	199	EBERSBERG	DE218	Member State	EBERSBERG
	200	EICHSTAETT	DE219	Member State	EICHSTAETT
	201	ERDING	DE21A	Member State	ERDING
	202	FREISING	DE21B	Member State	FREISING
	203	FUERSTENFELDBRUCK	DE21C	Member State	FUERSTENFELDBRUCK
	204	GARMISCH-PARTENKIRCHEN	DE21D	Member State	GARMISCH-PARTENKIRCH
	205	LANDSBERG A. LECH	DE21E	Member State	LANDSBERG A.LECH
	206	MIESBACH	DE21F	Member State	MIESBACH
	207	MUEHLDORF A. INN	DE21G	Member State	MUEHLDORF A.INN
	208	MUENCHEN, LANDKREIS	DE21H	Member State	MUENCHEN
	209	NEUBURG-SCHROBENHAUSEN	DE21I	Member State	NEUBURG AN DER DONAU
	210	PFAFFENHOFEN AN DER ILM	DE21J	Member State	PFAFFENHOFEN
	211	ROSENHEIM, LANDKREIS	DE21K	Member State	ROSENHEIM
	212	STARNBERG	DE21L	Member State	STARNBERG
	213	TRAUNSTEIN	DE21M	Member State	TRAUNSTEIN
	214	WEILHEIM-SCHONGAU	DE21N	Member State	WEILHEIM I. OB.
	215	LANDSHUT, KRFR. STADT	DE221	Member State	LANDSHUT
	216	PASSAU, KRFR. STADT	DE222	Member State	PASSAU
	217	STRAUBING, KRFR. STADT	DE223	Member State	STRAUBING

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	218	DEGGENDORF	DE224	Member State	DEGGENDORF
	219	FREYUNG-GRAFENAU	DE225	Member State	FREYUNG
	220	KELHEIM	DE226	Member State	KELHEIM
	221	LANDSHUT, LANDKREIS	DE227	Member State	LANDSHUT
	222	PASSAU, LANDKREIS	DE228	Member State	PASSAU
	223	REGEN	DE229	Member State	REGEN
	224	ROTTAL-INN	DE22A	Member State	PFARRKIRCHEN
	225	STRAUBING-BOGEN	DE22B	Member State	STRAUBING
	226	DINGOLFING-LANDAU	DE22C	Member State	DINGOLFING
	227	AMBERG, KRFR. STADT	DE231	Member State	AMBERG
	228	REGENSBURG, KRFR. STADT	DE232	Member State	REGENSBURG
	229	WEIDEN I. D. OPF., KRFR. STADT	DE233	Member State	WEIDEN I. D. OBERPFALZ
	230	AMBERG-SULZBACH	DE234	Member State	AMBERG
	231	CHAM	DE235	Member State	CHAM
	232	NEUMARKT IN DER OBERPFALZ	DE236	Member State	NEUMARKT I. D. OPF.
	233	NEUSTADT AN DER WALDNAAB	DE237	Member State	NEUSTADT A. D. WALDNA
	234	REGENSBURG, LANDKREIS	DE238	Member State	REGENSBURG
	235	SCHWANDORF	DE239	Member State	SCHWANDORF
	236	TIRSCHENREUTH	DE23A	Member State	TIRSCHENREUTH
	237	BAMBERG, KRFR. STADT	DE241	Member State	BAMBERG
	238	BAYREUTH, KRFR. STADT	DE242	Member State	BAYREUTH
	239	COBURG, KRFR. STADT	DE243	Member State	COBURG
	240	HOF, KRFR. STADT	DE244	Member State	HOF
	241	BAMBERG, LANDKREIS	DE245	Member State	BAMBERG
	242	BAYREUTH, LANDKREIS	DE246	Member State	BAYREUTH
	243	COBURG, LANDKREIS	DE247	Member State	COBURG
	244	FORCHHEIM	DE248	Member State	FORCHHEIM
	245	HOF, LANDKREIS	DE249	Member State	HOF
	246	KRONACH	DE24A	Member State	KRONACH
	247	KULMBACH	DE24B	Member State	KULMBACH
	248	LICHTENFELS	DE24C	Member State	LICHTENFELS
	249	WUNSIEDEL I. FICHTELGEBIR	DE24D	Member State	WUNSIEDEL
	250	ANSBACH, KRFR. STADT	DE251	Member State	ANSBACH
	251	ERLANGEN, KRFR. STADT	DE252	Member State	ERLANGEN
	252	FUERTH, KRFR. STADT	DE253	Member State	FUERTH
	253	NUERNBERG, KREISFR. STADT	DE254	Member State	NUERNBERG
	254	SCHWABACH, KRFR. STADT	DE255	Member State	SCHWABACH
	255	ANSBACH, LANDKREIS	DE256	Member State	ANSBACH
	256	ERLANGEN-HOECHSTADT	DE257	Member State	ERLANGEN
	257	FUERTH, LANDKREIS	DE258	Member State	FUERTH
	258	NUERNBERGER LAND	DE259	Member State	LAUF AN DER PEGNITZ
	259	NEUSTADT AN DER AISCH-BAD	DE25A	Member State	NEUSTADT AN DER AISCH
	260	ROTH	DE25B	Member State	ROTH
	261	WEISSENBURG-GUNZENHAUSEN	DE25C	Member State	WEISSENBURG IN BAYERN
	262	ASCHAFFENBURG, KRFR. STADT	DE261	Member State	ASCHAFFENBURG
	263	SCHWEINFURT, KRFR. STADT	DE262	Member State	SCHWEINFURT
	264	WUERZBURG, KREISFR. STADT	DE263	Member State	WUERZBURG
	265	ASCHAFFENBURG, LANDKREIS	DE264	Member State	ASCHAFFENBURG
	266	BAD KISSINGEN	DE265	Member State	BAD KISSINGEN
	267	RHOEN-GRABFELD	DE266	Member State	BAD NEUSTADT A. D. S
	268	HASSBERGE	DE267	Member State	HASSFURT
	269	KITZINGEN	DE268	Member State	KITZINGEN
	270	MILTENBERG	DE269	Member State	MILTENBERG
	271	MAIN-SPESSART	DE26A	Member State	KARLSTADT
	272	SCHWEINFURT, LANDKREIS	DE26B	Member State	SCHWEINFURT
	273	WUERZBURG, LANDKREIS	DE26C	Member State	WUERZBURG
	274	AUGSBURG, KREISFR. STADT	DE271	Member State	AUGSBURG
	275	KAUFBEUREN, KRFR. STADT	DE272	Member State	KAUFBEUREN
	276	KEMPTEN (ALLGAEU), KRFR. STADT	DE273	Member State	KEMPTEN
	277	MEMMINGEN, KRFR. STADT	DE274	Member State	MEMMINGEN
	278	AICHACH-FRIEDBERG	DE275	Member State	AICHACH
	279	AUGSBURG, LANDKREIS	DE276	Member State	AUGSBURG
	280	DILLINGEN AN DER DONAU	DE277	Member State	DILLINGEN A. D. DONAU
	281	GUENZBURG	DE278	Member State	GUENZBURG
	282	NEU-ULM	DE279	Member State	NEU-ULM
	283	LINDAU (BODENSEE)	DE27A	Member State	LINDAU
	284	OSTALLGAEU	DE27B	Member State	MARKTOBERDORF
	285	UNTERALLGAEU	DE27C	Member State	MINDELHEIM
	286	DONAU-RIES	DE27D	Member State	DONAUWOERTH
	287	OBERALLGAEU	DE27E	Member State	SONTHOFEN
	288	BERLIN-WEST, STADT	DE301	Member State	BERLIN
	289	BERLIN-OST, STADT	DE302	Member State	BERLIN
	290	BRANDENBURG AN DER HAVEL,	DE401	Member State	BRANDENBURG A. D. H.
	291	COTTBUS, KRFR. STADT	DE402	Member State	COTTBUS

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	292	FRANKFURT (ODER), KRFR. STADT	DE403	Member State	FRANKFURT/ODER
	293	POTSDAM, KRFR. STADT	DE404	Member State	POTSDAM
	294	BARNIM	DE405	Member State	EBERSWALDE
	295	DAHME-SPREEWALD	DE406	Member State	LOEBBEN-SPREEWALD
	296	ELBE-ELSTER	DE407	Member State	HERZBERG-ELSTER
	297	HAVELLAND	DE408	Member State	RATHENOW
	298	MAERKISCH-ODERLAND	DE409	Member State	SEELOW
	299	OBERHAVEL	DE40A	Member State	ORANIENBURG
	300	OBERSPREEWALD-LAUSITZ	DE40B	Member State	SENFTENBERG
	301	ODER-SPREE	DE40C	Member State	BEESKOW
	302	OSTPRIGNITZ-RUPPIN	DE40D	Member State	NEURUPPIN
	303	POTSDAM-MITTELMARK	DE40E	Member State	BELZIG
	304	PRIGNITZ	DE40F	Member State	PERLEBERG
	305	SPREE-NEISSE	DE40G	Member State	FORST-LAUSITZ
	306	TELTOW-FLAEMING	DE40H	Member State	LUCKENWALDE
	307	UCKERMARK	DE40I	Member State	PRENZLAU
	308	BREMEN	DE501	Member State	BREMEN
	309	BREMERHAVEN, KRFR. STADT	DE502	Member State	BREMERHAVEN
	310	HAMBURG, FREIE-UND HANSES	DE6	Member State	HAMBURG
	311	DARMSTADT, KRFR. STADT	DE711	Member State	DARMSTADT
	312	FRANKFURT AM MAIN, KRFR.S	DE712	Member State	FRANKFURT AM MAIN
	313	OFFENBACH AM MAIN, KRFR.S	DE713	Member State	OFFENBACH AM MAIN
	314	WIESBADEN, KRFR. STADT	DE714	Member State	WIESBADEN
	315	BERGSTRASSE	DE715	Member State	HEPPENHEIM-BERGSTR.
	316	DARMSTADT-DIEBURG	DE716	Member State	DARMSTADT
	317	GROSS-GERAU	DE717	Member State	GROSS-GERAU
	318	HOCHTAUNUSKREIS	DE718	Member State	BAD HOMBURG V. D. HOEH
	319	MAIN-KINZIG-KREIS	DE719	Member State	HANAU
	320	MAIN-TAUNUS-KREIS	DE71A	Member State	HOFHEIM AM TAUNUS
	321	ODENWALDKREIS	DE71B	Member State	ERBACH
	322	OFFENBACH, LANDKREIS	DE71C	Member State	OFFENBACH
	323	RHEINGAU-TAUNUS-KREIS	DE71D	Member State	BAD SCHWALBACH
	324	WETTERAUKREIS	DE71E	Member State	FRIEDBERG HESSEN
	325	GIESSEN, LANDKREIS	DE721	Member State	GIESSEN
	326	LAHN-DILL-KREIS	DE722	Member State	WETZLAR
	327	LIMBURG-WEILBURG	DE723	Member State	LIMBURG AN DER LAHN
	328	MARBURG-BIEDENKOPF	DE724	Member State	MARBURG
	329	VOGELSBERGKREIS	DE725	Member State	LAUTERBACH
	330	KASSEL, KRFR. STADT	DE731	Member State	KASSEL
	331	FULDA	DE732	Member State	FULDA
	332	HERSFELD-ROTENBURG	DE733	Member State	BAD HERSFELD
	333	KASSEL, LANDKREIS	DE734	Member State	KASSEL
	334	SCHWALM-EDER-KREIS	DE735	Member State	HOMBERG
	335	WALDECK-FRANKENBERG	DE736	Member State	KORBACH
	336	WERRA-MEISSNER-KREIS	DE737	Member State	ESCHWEGE
	337	GREIFSWALD, KRFR. STADT	DE801	Member State	GREIFSWALD
	338	NEUBRANDENBURG, KRFR. STADT	DE802	Member State	NEUBRANDENBURG
	339	ROSTOCK, KREISFR. STADT	DE803	Member State	ROSTOCK
	340	SCHWERIN, KRFR. STADT	DE804	Member State	SCHWERIN
	341	STRALSUND, KRFR. STADT	DE805	Member State	STRALSUND
	342	WISMAR, KRFR. STADT	DE806	Member State	WISMAR
	343	BAD DOBERAN	DE807	Member State	BAD DOBERAN
	344	DEMMIN	DE808	Member State	DEMMIN
	345	GUESTROW	DE809	Member State	GUESTROW
	346	LUDWIGSLUST	DE80A	Member State	LUDWIGSLUST
	347	MECKLENBURG-STRELITZ	DE80B	Member State	NEUSTRELITZ
	348	MUERITZ	DE80C	Member State	WAREN
	349	NORDVORPOMMERN	DE80D	Member State	GRIMMEN
	350	NORDWESTMECKLENBURG	DE80E	Member State	GREVESMUEHLEN
	351	OSTVORPOMMERN	DE80F	Member State	ANKLAM
	352	PARCHIM	DE80G	Member State	PARCHIM
	353	RUEGEN	DE80H	Member State	BERGEN
	354	UECKER-RANDOW	DE80I	Member State	PASEWALK
	355	BRAUNSCHWEIG, KRFR. STADT	DE911	Member State	BRAUNSCHWEIG
	356	SALZGITTER, KRFR. STADT	DE912	Member State	SALZGITTER
	357	WOLFSBURG, KRFR. STADT	DE913	Member State	WOLFSBURG
	358	GIFHORN	DE914	Member State	GIFHORN
	359	GOETTINGEN	DE915	Member State	GOETTINGEN
	360	GOSLAR	DE916	Member State	GOSLAR
	361	HELMSTEDT	DE917	Member State	HELMSTEDT
	362	NORTHEIM	DE918	Member State	NORTHEIM
	363	OSTERODE AM HARZ	DE919	Member State	OSTERODE
	364	PEINE	DE91A	Member State	PEINE
	365	WOLFENBUETTEL	DE91B	Member State	WOLFENBUETTEL

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	366	HANNOVER, KRFR. STADT	DE921	Member State	HANNOVER
	367	DIEPHOLZ	DE922	Member State	DIEPHOLZ
	368	HAMELN-PYRMONT	DE923	Member State	HAMELN
	369	HANNOVER, LANDKREIS	DE924	Member State	HANNOVER
	370	HILDESHEIM	DE925	Member State	HILDESHEIM
	371	HOLZMINDEN	DE926	Member State	HOLZMINDEN
	372	NIENBURG (WESER)	DE927	Member State	NIENBURG
	373	SCHAUMBURG	DE928	Member State	STADTHAGEN
	374	CELLE	DE931	Member State	CELLE
	375	CUXHAVEN	DE932	Member State	CUXHAVEN
	376	HARBURG	DE933	Member State	WINSEN
	377	LUECHOW-DANNENBERG	DE934	Member State	LUECHOW
	378	LUENEBURG, LANDKREIS	DE935	Member State	LUENEBURG
	379	OSTERHOLZ	DE936	Member State	OSTERHOLZ-SCHARMBECK
	380	ROTENBURG (WUEMME)	DE937	Member State	ROTENBURG
	381	SOLTAU-FALLINGBOSTEL	DE938	Member State	FALLINGBOSTEL
	382	STADE	DE939	Member State	STADE
	383	UELZEN	DE93A	Member State	UELZEN
	384	VERDEN	DE93B	Member State	VERDEN
	385	DELMENHORST, KRFR. STADT	DE941	Member State	DELMENHORST
	386	EMDEN, KRFR. STADT	DE942	Member State	EMDEN
	387	OLDENBURG (OLDENBURG), KR	DE943	Member State	OLDENBURG
	388	OSNABRUECK, KRFR. STADT	DE944	Member State	OSNABRUECK
	389	WILHELMSHAVEN, KRFR. STADT	DE945	Member State	WILHELMSHAVEN
	390	AMMERLAND	DE946	Member State	WESTERSTEDE
	391	AURICH	DE947	Member State	AURICH
	392	CLOPPENBURG	DE948	Member State	CLOPPENBURG
	393	EMSLAND	DE949	Member State	MEPPEN
	394	FRIESLAND	DE94A	Member State	JEVER
	395	GRAFSCHAFT BENTHEIM	DE94B	Member State	NORDHORN
	396	LEER	DE94C	Member State	LEER
	397	OLDENBURG , LANDKREIS	DE94D	Member State	OLDENBURG
	398	OSNABRUECK, LANDKREIS	DE94E	Member State	OSNABRUECK
	399	VECHTA	DE94F	Member State	VECHTA
	400	WESERMARSCH	DE94G	Member State	BRAKE(UNTERWESER)
	401	WITTMUND	DE94H	Member State	WITTMUND
	402	DUESSELDORF, KRFR. STADT	DEA11	Member State	DUESSELDORF
	403	DUISBURG, KRFR. STADT	DEA12	Member State	DUISBURG
	404	ESSEN, KRFR. STADT	DEA13	Member State	ESSEN
	405	KREFELD, KRFR. STADT	DEA14	Member State	KREFELD
	406	MOENCHENGLADBACH, KRFR. STADT	DEA15	Member State	MOENCHENGLADBACH
	407	MUELHEIM A.D.RUHR, KRFR. STADT	DEA16	Member State	MUELHEIM
	408	OBERHAUSEN, KRFR. STADT	DEA17	Member State	OBERHAUSEN
	409	REMSCHEID, KRFR. STADT	DEA18	Member State	REMSCHEID
	410	SOLINGEN, KRFR. STADT	DEA19	Member State	SOLINGEN
	411	WUPPERTAL, KRFR. STADT	DEA1A	Member State	WUPPERTAL
	412	KLEVE	DEA1B	Member State	KLEVE
	413	METTMANN	DEA1C	Member State	METTMANN
	414	NEUSS	DEA1D	Member State	NEUSS
	415	VIERSEN	DEA1E	Member State	VIERSEN
	416	WESEL	DEA1F	Member State	WESEL
	417	AACHEN, KRFR. STADT	DEA21	Member State	AACHEN
	418	BONN, KRFR. STADT	DEA22	Member State	BONN
	419	KOELN, KRFR. STADT	DEA23	Member State	KOELN
	420	LEVERKUSEN, KRFR. STADT	DEA24	Member State	LEVERKUSEN
	421	AACHEN, LANDKREIS	DEA25	Member State	AACHEN
	422	DUEREN	DEA26	Member State	DUEREN
	423	ERFTKREIS	DEA27	Member State	BERGHEIM
	424	EUSKIRCHEN	DEA28	Member State	EUSKIRCHEN
	425	HEINSBERG	DEA29	Member State	HEINSBERG
	426	OBERBERGISCHER KREIS	DEA2A	Member State	GUMMERSBACH
	427	RHEINISCH-BERGISCHER-KREI	DEA2B	Member State	BERGISCH-GLADBACH
	428	RHEIN-SIEG-KREIS	DEA2C	Member State	SIEGBURG
	429	BOTTROP, KRFR. STADT	DEA31	Member State	BOTTROP
	430	GELSENKIRCHEN, KRFR. STADT	DEA32	Member State	GELSENKIRCHEN
	431	MUENSTER, KRFR. STADT	DEA33	Member State	MUENSTER
	432	BORKEN	DEA34	Member State	BORKEN
	433	COESFELD	DEA35	Member State	COESFELD
	434	RECKLINGHAUSEN	DEA36	Member State	RECKLINGHAUSEN
	435	STEINFURT	DEA37	Member State	STEINFURT
	436	WARENDORF	DEA38	Member State	WARENDORF
	437	BIELEFELD, KRFR. STADT	DEA41	Member State	BIELEFELD
	438	GUETERSLOH	DEA42	Member State	GUETERSLOH
	439	HERFORD	DEA43	Member State	HERFORD

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	440	HOEXTER	DEA44	Member State	HOEXTER
	441	LIPPE	DEA45	Member State	DETMOLD
	442	MINDEN-LUEBBECKE	DEA46	Member State	MINDEN
	443	PADERBORN	DEA47	Member State	PADERBORN
	444	BOCHUM, KRFR. STADT	DEA51	Member State	BOCHUM
	445	DORTMUND, KRFR. STADT	DEA52	Member State	DORTMUND
	446	HAGEN, KRFR. STADT	DEA53	Member State	HAGEN
	447	HAMM, KRFR. STADT	DEA54	Member State	HAMM
	448	HERNE, KRFR. STADT	DEA55	Member State	HERNE
	449	ENNEPE-RUHR-KREIS	DEA56	Member State	SCHWELM
	450	HOCHSAUERLANDKREIS	DEA57	Member State	MESCHEDE
	451	MAERKISCHER KREIS	DEA58	Member State	LUEDENSCHEID
	452	OLPE	DEA59	Member State	OLPE
	453	SIEGEN-WITTGENSTEIN	DEA5A	Member State	SIEGEN
	454	SOEST	DEA5B	Member State	SOEST
	455	UNNA	DEA5C	Member State	UNNA
	456	KOBLENZ, KRFR. STADT	DEB11	Member State	KOBLENZ
	457	AHRWEILER	DEB12	Member State	BAD NEUENAHR-AHRWEIL
	458	ALTENKIRCHEN (WESTERWALD)	DEB13	Member State	ALTENKIRCHEN (WESTW.)
	459	BAD KREUZNACH	DEB14	Member State	BAD KREUZNACH
	460	BIRKENFELD	DEB15	Member State	BIRKENFELD
	461	COCHEM-ZELL	DEB16	Member State	COCHEM
	462	MAYEN-KOBLENZ	DEB17	Member State	KOBLENZ
	463	NEUWIED	DEB18	Member State	NEUWIED
	464	RHEIN-HUNSRUECK-KREIS	DEB19	Member State	SIMMERN (HUNSRUECK)
	465	RHEIN-LAHN-KREIS	DEB1A	Member State	BAD EMS
	466	WESTERWALDKREIS	DEB1B	Member State	MONTABAUR
	467	TRIER, KRFR. STADT	DEB21	Member State	TRIER
	468	BERNKASTEL-WITTLICH	DEB22	Member State	WITTLICH
	469	BITBURG-PRUEM	DEB23	Member State	BITBURG
	470	DAUN	DEB24	Member State	DAUN
	471	TRIER-SAARBURG	DEB25	Member State	TRIER
	472	FRANKENTHAL(PFALZ), KRFR.	DEB31	Member State	FRANKENTHAL (PFALZ)
	473	KAISERSLAUTERN, KRFR. STADT	DEB32	Member State	KAISERSLAUTERN
	474	LANDAU IN DER PFALZ, KRFR	DEB33	Member State	LANDAU IN DER PFALZ
	475	LUDWIGSHAFEN AM RHEIN, KR	DEB34	Member State	LUDWIGSHAFEN AM RHEI
	476	MAINZ, KRFR. STADT	DEB35	Member State	MAINZ
	477	NEUSTADT AN DER WEINSTRAS	DEB36	Member State	NEUSTADT AN DER WEIN
	478	PIRMASENS, KRFR. STADT	DEB37	Member State	PIRMASENS
	479	SPEYER, KRFR. STADT	DEB38	Member State	SPEYER
	480	WORMS, KRFR. STADT	DEB39	Member State	WORMS
	481	ZWEIBRUECKEN, KRFR. STADT	DEB3A	Member State	ZWEIBRUECKEN
	482	ALZEY-WORMS	DEB3B	Member State	ALZEY-WORMS
	483	BAD DUERKHEIM	DEB3C	Member State	BAD DUERKHEIM
	484	DONNERSBERGKREIS	DEB3D	Member State	KIRCHHEIM-BOLANDEN
	485	GERMERSHEIM	DEB3E	Member State	GERMERSHEIM
	486	KAISERSLAUTERN, LANDKREIS	DEB3F	Member State	KAISERSLAUTERN
	487	KUSEL	DEB3G	Member State	KUSEL
	488	SUEDLICHE WEINSTRASSE	DEB3H	Member State	LANDAU IN DER PFALZ
	489	LUDWIGSHAFEN, LANDKREIS	DEB3I	Member State	LUDWIGSHAFEN A. RHEIN
	490	MAINZ-BINGEN	DEB3J	Member State	MAINZ
	491	SUEDWESTPFALZ	DEB3K	Member State	PIRMASENS
	492	STADTVERBAND SAARBRUECKEN	DEC01	Member State	SAARBRUECKEN
	493	MERZIG-WADERN	DEC02	Member State	MERZIG
	494	NEUNKIRCHEN	DEC03	Member State	NEUNKIRCHEN
	495	SAARLOUIS	DEC04	Member State	SAARLOUIS
	496	SAARPFALZ-KREIS	DEC05	Member State	HOMBURG
	497	SANKT WENDEL	DEC06	Member State	ST. WENDEL
	498	CHEMNITZ, KRFR. STADT	DED11	Member State	CHEMNITZ
	499	PLAUEN, KREISFR. STADT	DED12	Member State	PLAUEN
	500	ZWICKAU, KRFR. STADT	DED13	Member State	ZWICKAU
	501	ANNABERG	DED14	Member State	ANNABERG-BUCHHOLZ
	502	CHEMNITZER LAND	DED15	Member State	GLAUCHAU
	503	FREIBERG	DED16	Member State	FREIBERG
	504	VOGTLANDKREIS	DED17	Member State	REICHENBACH
	505	MITTLERER ERZGEBIRGKREIS	DED18	Member State	MARIENBERG
	506	MITTWEIDA	DED19	Member State	MITTWEIDA
	507	STOLLBERG	DED1A	Member State	STOLLBERG (ERZGEBIRGE)
	508	AUE-SCHWARZENBERG	DED1B	Member State	AUE
	509	ZWICKAUER LAND	DED1C	Member State	WERDAU
	510	DRESDEN, KRFR. STADT	DED21	Member State	DRESDEN
	511	GOERLITZ, KRFR. STADT	DED22	Member State	GOERLITZ
	512	HOYERSWERDA, KREISFREIE S	DED23	Member State	HOYERSWERDA
	513	BAUTZEN	DED24	Member State	BAUTZEN

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	514	MEISSEN	DED25	Member State	MEISSEN
	515	NIEDERSCHLESISCHER OBERLA	DED26	Member State	GOERLITZ
	516	RIESA-GROSSENHAIN	DED27	Member State	GROSSENHAIN
	517	LOEBAU-ZITTAU	DED28	Member State	ZITTAU
	518	SAECHSISCHE SCHWEIZ	DED29	Member State	PIRNA
	519	WEISSERITZKREIS	DED2A	Member State	DIPPOLDISWALDE
	520	KAMENZ	DED2B	Member State	KAMENZ
	521	LEIPZIG, KREISFR. STADT	DED31	Member State	LEIPZIG
	522	DELITZSCH	DED32	Member State	DELITZSCH
	523	DOEBELN	DED33	Member State	DOEBELN
	524	LEIPZIGER LAND	DED34	Member State	LEIPZIG
	525	MULDENTALKREIS	DED35	Member State	GRIMMA
	526	TORGAU-OSCHATZ	DED36	Member State	TORGAU
	527	DESSAU	DEE11	Member State	DESSAU
	528	ANHALT-ZERBST	DEE12	Member State	ZERBST
	529	BERNBURG	DEE13	Member State	BERNBURG
	530	BITTERFELD	DEE14	Member State	BITTERFELD
	531	KOETHEN	DEE15	Member State	KOETHEN
	532	WITTENBERG	DEE16	Member State	WITTENBERG
	533	HALLE/SAALE STADTKREIS	DEE21	Member State	HALLE
	534	BURGENLANDKREIS	DEE22	Member State	NAUMBURG
	535	MANSFELDER LAND	DEE23	Member State	EISLEBEN
	536	MERSEBURG-QUERFURT	DEE24	Member State	MERSEBURG
	537	SAALKREIS	DEE25	Member State	HALLE
	538	SANGERHAUSEN	DEE26	Member State	SANGERHAUSEN
	539	WEISSENFELS	DEE27	Member State	WEISSENFELS
	540	MAGDEBURG, KRFR. STADT	DEE31	Member State	MAGDEBURG
	541	ASCHERSLEBEN-STASSFURT	DEE32	Member State	ASCHERSLEBEN
	542	BOERDEKREIS	DEE33	Member State	OSCHERSLEBEN
	543	HALBERSTADT	DEE34	Member State	HALBERSTADT
	544	JERICHOWER LAND	DEE35	Member State	BURG
	545	OHREKREIS	DEE36	Member State	HALDENSLEBEN
	546	STENDAL	DEE37	Member State	STENDAL
	547	QUEDLINBURG	DEE38	Member State	QUEDLINBURG
	548	SCHOENEBECK	DEE39	Member State	SCHOENEBECK
	549	WERNIGERODE	DEE3A	Member State	WERNIGERODE
	550	ALTMARKKREIS SALZWEDEL	DEE3B	Member State	SALZWEDEL
	551	FLENSBURG, KRFR. STADT	DEF01	Member State	FLENSBURG
	552	KIEL, KRFR. STADT	DEF02	Member State	KIEL
	553	LUEBECK, KRFR. STADT	DEF03	Member State	LUEBECK
	554	NEUMUENSTER, KRFR. STADT	DEF04	Member State	NEUMUENSTER
	555	DITHMARSCHEN	DEF05	Member State	HEIDE
	556	HERZOGTUM LAUENBURG	DEF06	Member State	RATZEBURG
	557	NORDFRIESLAND	DEF07	Member State	HUSUM
	558	OSTHOLSTEIN	DEF08	Member State	EUTIN
	559	PINNEBERG	DEF09	Member State	PINNEBERG
	560	PLOEN	DEF0A	Member State	PLOEN
	561	RENDSBURG-ECKERNFOERDE	DEF0B	Member State	RENDSBURG
	562	SCHLESWIG-FLENSBURG	DEF0C	Member State	SCHLESWIG
	563	SEGEBERG	DEF0D	Member State	BAD SEGEBERG
	564	STEINBURG	DEF0E	Member State	ITZEHOE
	565	STORMARN	DEF0F	Member State	BAD OLDESLOE
	566	ERFURT	DEG01	Member State	SAALFELD
	567	GERA, KRFR. STADT	DEG02	Member State	GERA
	568	JENA, KRFR. STADT	DEG03	Member State	JENA
	569	SUHL, KRFR. STADT	DEG04	Member State	SUHL
	570	WEIMAR, KRFR. STADT	DEG05	Member State	WEIMAR
	571	EICHSFELD	DEG06	Member State	HEILIGENSTADT
	572	NORDHAUSEN	DEG07	Member State	NORDHAUSEN
	573	UNSTRUT-HAINICH-KREIS	DEG09	Member State	MUEHLHAUSEN/TH.
	574	KYFFHAEUSERKREIS	DEG0A	Member State	SONDERSHAUSEN
	575	SCHMALKALDEN-MEININGEN	DEG0B	Member State	MEININGEN
	576	GOTHA	DEG0C	Member State	GOTHA
	577	SOEMMERDA	DEG0D	Member State	SOEMMERDA
	578	HILDBURGHAUSEN	DEG0E	Member State	HILDBURGHAUSEN
	579	ILM-KREIS	DEG0F	Member State	ARNSTADT
	580	WEIMARER LAND	DEG0G	Member State	APOLDA
	581	SONNEBERG	DEG0H	Member State	SONNEBERG
	582	SAALFELD-RUDOLSTADT	DEG0I	Member State	SAALFELD/SAALE
	583	SAALE-HOLZLAND-KREIS	DEG0J	Member State	EISENBERG
	584	SAALE-ORLA-KREIS	DEG0K	Member State	SCHLEIZ
	585	GREIZ	DEG0L	Member State	GREIZ
	586	ALTENBURGER LAND	DEG0M	Member State	ALTENBURG
	587	EISENACH, KREISFREIE STAD	DEG0N	Member State	EISENACH

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Germany (cont.)	588	WARTBURGKREIS	DEG0P	Member State	BAD SALZUNGEN
Denmark	589	KOEBENHAVN OG FREDERIKSBE	DK001	Member State	KOEBENHAVN
	590	KOEBENHAVNS AMT	DK002	Member State	KOEBENHAVN
	591	FREDERIKSBORG AMT	DK003	Member State	HELSINGOER
	592	ROSKILDE AMT	DK004	Member State	ROSKILDE
	593	VESTSJAELLANDS AMT	DK005	Member State	SLAGELSE
	594	STORSTROEMS AMT	DK006	Member State	NAESTVED
	595	BORNHOLMS AMT	DK007	Member State	ROENNE
	596	FYNS AMT	DK008	Member State	ODENSE
	597	SOENDERJYLLANDS AMT	DK009	Member State	AABENRAA
	598	RIBE AMT	DK00A	Member State	ESBJERG
	599	VEJLE AMT	DK00B	Member State	VEJLE
	600	RINGKOEBING AMT	DK00C	Member State	HOLSTEBRO
	601	AARHUS AMT	DK00D	Member State	ARHUS
	602	VIBORG AMT	DK00E	Member State	VIBORG
	603	NORDJYLLANDS AMT	DK00F	Member State	ALBORG
Estland	604	POHJA-EESTI	EE001	Candidate Countries	TALLIN
	605	KESK-EESTI	EE002	Candidate Countries	PAIDE
	606	KIRDE-EESTI	EE003	Candidate Countries	KOHTLA-JAERVE
	607	LAEAENE-EESTI	EE004	Candidate Countries	PAERNU
	608	LOUNA-EESTI	EE005	Candidate Countries	TARTU
Spain	609	LA CORUNA	ES111	Member State	SANTIAGO DE COMPOSTE
	610	LUGO	ES112	Member State	LUGO
	611	ORENSE	ES113	Member State	ORENSE
	612	PONTEVEDRA	ES114	Member State	VIGO
	613	PRINCIPADO DE ASTURIAS	ES12	Member State	OVIEDO
	614	CANTABRIA	ES13	Member State	SANTANDER
	615	ALAVA	ES211	Member State	VITORIA
	616	GUIPUZCOA	ES212	Member State	DONOSTIA-SAN SEBASTI
	617	VIZCAYA	ES213	Member State	BILBAO
	618	COMUNIDAD FORAL DE NAVARR	ES22	Member State	PAMPLONA
	619	LA RIOCHA	ES23	Member State	LOGRONO
	620	HUESCA	ES241	Member State	HUESKA
	621	TERUEL	ES242	Member State	TERUEL
	622	ZARAGOZA	ES243	Member State	ZARAGOZA
	623	COMUNIDAD DE MADRID	ES3	Member State	MADRID
	624	AVILA	ES411	Member State	AVILA
	625	BURGOS	ES412	Member State	BURGOS
	626	LEON	ES413	Member State	LEON
	627	PALENCIA	ES414	Member State	PALENCIA
	628	SALAMANCA	ES415	Member State	SALAMANCA
	629	SEGOVIA	ES416	Member State	SEGOVIA
	630	SORIA	ES417	Member State	SORIA
	631	VALLADOLID	ES418	Member State	VALLADOLID
	632	ZAMORA	ES419	Member State	ZAMORA
	633	ALBACETE	ES421	Member State	ALBACETE
	634	CIUDAD REAL	ES422	Member State	CIUDAD REAL
	635	CUENCA	ES423	Member State	CUENCA
	636	GUADALAJARA	ES424	Member State	GUADALAJARA
	637	TOLEDO	ES425	Member State	TOLEDO
	638	BADAJOZ	ES431	Member State	BADAJOZ
	639	CACERES	ES432	Member State	CACERES
	640	BARCELONA	ES511	Member State	BARCELONA
	641	GIRONA	ES512	Member State	GIRONA
	642	LLEIDA	ES513	Member State	LLEIDA
	643	TARRAGONA	ES514	Member State	TARRAGONA
	644	ALICANTE	ES521	Member State	ALICANTE
	645	CASTELLON DE LA PLANA	ES522	Member State	CASTELLON DE LA PLAN
	646	VALENCIA	ES523	Member State	VALENCIA
	647	ISLAS BALEARES	ES53	Member State	PALMA
	648	ALMERIA	ES611	Member State	ALMERIA
	649	CADIZ	ES612	Member State	CADIZ
	650	CORDOBA	ES613	Member State	CORDOBA
	651	GRANADA	ES614	Member State	GRANADA
	652	HUELVA	ES615	Member State	HUELVA
	653	JAEN	ES616	Member State	JAEN
	654	MALAGA	ES617	Member State	MALAGA
	655	SEVILLA	ES618	Member State	SEVILLA
	656	REGION DE MURCIA	ES62	Member State	MURCIA
	657	CEUTA	ES631	Member State	CEUTA
	658	MELILLA	ES632	Member State	MELILLA

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Finland	659	ETELAE-SAVO	FI131	Member State	MIKKELI
	660	POHJOIS-SAVO	FI132	Member State	JOENSUU
	661	POHJOIS-KARJALA	FI133	Member State	JOENSUU
	662	KAINUU	FI134	Member State	KAJAANI
	663	KESKI-SUOMI	FI141	Member State	JYVAESKYLA
	664	ETELAE-POHJANMAA	FI142	Member State	KAJAANI
	665	POHJANMAA	FI143	Member State	VAASA
	666	KESKI-POHJANMAA	FI144	Member State	KOKKOLA
	667	POHJOIS-POHJANMAA	FI151	Member State	OULU
	668	LAPPI	FI152	Member State	ROVANIEMI
	669	UUSIMAA	FI161	Member State	HELSINKI
	670	ITAE-UUSIMAA	FI162	Member State	KOTKA
	671	VARSINAIS-SUOMI	FI171	Member State	TURKU ABO
	672	SATAKUNTA	FI172	Member State	PORI
	673	KANTA-HAEME	FI173	Member State	HAEMEENLINNA
	674	PIRKANMAA	FI174	Member State	TAMPERE
	675	PAEIJAET-HAEME	FI175	Member State	LAHTI
	676	KYMENLAAKSO	FI176	Member State	KOUVOLA
	677	ETELAE-KARJALA	FI177	Member State	LAPPEENRANTA
	678	ALAND	FI2	Member State	MARIEHAMN
France	679	PARIS	FR101	Member State	PARIS
	680	SEINE-ET-MARNE	FR102	Member State	MELUN
	681	YVELINES	FR103	Member State	VERSAILLES
	682	ESSONNE	FR104	Member State	EVRY
	683	HAUTS-DE-SEINE	FR105	Member State	BOULOGNE-BILLANCOURT
	684	SEINE-SAINT-DENIS	FR106	Member State	ST. DENIS
	685	VAL-DE-MARNE	FR107	Member State	SAINT-MAUR
	686	VAL D OISE	FR108	Member State	PONTOISE
	687	ARDENNES	FR211	Member State	CHARLEVILLE-MEZIERES
	688	AUBE	FR212	Member State	TROYES
	689	MARNE	FR213	Member State	REIMS
	690	HAUTE-MARNE	FR214	Member State	CHAUMONT
	691	AISNE	FR221	Member State	SAINT-QUENTIN
	692	OISE	FR222	Member State	BEAUVAIS
	693	SOMME	FR223	Member State	AMIENS
	694	EURE	FR231	Member State	EVREUX
	695	SEINE-MARITIME	FR232	Member State	LE HAVRE
	696	CHER	FR241	Member State	BOURGES
	697	EURE-ET-LOIR	FR242	Member State	CHARTRES
	698	INDRE	FR243	Member State	CHATEAUROUX
	699	INDRE-ET-LOIRE	FR244	Member State	TOURS
	700	LOIR-ET-CHER	FR245	Member State	BLOIS
	701	LOIRET	FR246	Member State	ORLEANS
	702	CALVADOS	FR251	Member State	CAEN
	703	MANCHE	FR252	Member State	SAINT-LO
	704	ORNE	FR253	Member State	ALENCON
	705	COTE-D OR	FR261	Member State	DIJON
	706	NIEVRE	FR262	Member State	NEVERS
	707	SAONE-ET-LOIRE	FR263	Member State	MACON
	708	YONNE	FR264	Member State	AUXERRE
	709	NORD	FR301	Member State	LILLE
	710	PAS-DE-CALAIS	FR302	Member State	ARAS
	711	MEURTHE-ET-MOSELLE	FR411	Member State	NANCY
	712	MEUSE	FR412	Member State	VERDUN-SUR-MEUSE
	713	MOSELLE	FR413	Member State	METZ
	714	VOSGES	FR414	Member State	EPINAL
	715	BAS-RHIN	FR421	Member State	STRASBOURG
	716	HAUT-RHIN	FR422	Member State	COLMAR
	717	DOUBS	FR431	Member State	BESANCON
	718	JURA	FR432	Member State	LONS-LE-SAUNIER
	719	HAUTE-SAONE	FR433	Member State	VESOUL
	720	TERRITOIRE DE BELFORT	FR434	Member State	BELFORT
	721	LOIRE-ATLANTIQUE	FR511	Member State	NANTES
	722	MAINE-ET-LOIRE	FR512	Member State	ANGERS
	723	MAYENNE	FR513	Member State	LAVAL
	724	SARTHE	FR514	Member State	LE MANS
	725	VENDEE	FR515	Member State	LA ROCHE-SUR-YON
	726	COTES D AMOR	FR521	Member State	SAINT-BRIEUC
	727	FINISTERE	FR522	Member State	BREST
	728	ILLE-ET-VILAINE	FR523	Member State	RENNES
	729	MORBIHAN	FR524	Member State	LORIENT
	730	CHARENTE	FR531	Member State	ANGOULEME
	731	CHARENTE-MARITIME	FR532	Member State	LA ROCHELLE

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
France (cont.)	732	DEUX-SEVRES	FR533	Member State	NIORT
	733	VIENNE	FR534	Member State	POITIERS
	734	DORDOGNE	FR611	Member State	PERIGUEUX
	735	GIRONDE	FR612	Member State	BORDEAUX
	736	LANDES	FR613	Member State	MONT-DE-MARSAN
	737	LOT-ET-GARONNE	FR614	Member State	AGEN
	738	PYRENEES-ATLANTIQUES	FR615	Member State	PAU
	739	ARIEGE	FR621	Member State	FOIX
	740	AVEYRON	FR622	Member State	RODEZ
	741	HAUTE-GARONNE	FR623	Member State	TOULOUSE
	742	GERS	FR624	Member State	AUCH
	743	LOT	FR625	Member State	CAHORS
	744	HAUTES-PYRENEES	FR626	Member State	TARBES
	745	TARN	FR627	Member State	ALBI
	746	TARN-ET-GARONNE	FR628	Member State	MONTAUBAN
	747	CORREZE	FR631	Member State	BRIVE-LA-GAILLARDE
	748	CREUSE	FR632	Member State	GUERET
	749	HAUTE-VIENNE	FR633	Member State	LIMOGES
	750	AIN	FR711	Member State	BOURG-EN-BRESSE
	751	ARDECHE	FR712	Member State	PRIVAS
	752	DROME	FR713	Member State	VALENCE
	753	ISERE	FR714	Member State	GRENOBLE
	754	LOIRE	FR715	Member State	SAINT-ETIENNE
	755	RHONE	FR716	Member State	LYON
	756	SAVOIE	FR717	Member State	CHAMBERY
	757	HAUTE-SAVOIE	FR718	Member State	ANNECY
	758	ALLIER	FR721	Member State	MOULINS
	759	CANTAL	FR722	Member State	AURILLAC
	760	HAUTE-LOIRE	FR723	Member State	LE PUY
	761	PUY-DE-DOME	FR724	Member State	CLERMONT-FERRANT
	762	AUDE	FR811	Member State	CARCASSONNE
	763	GARD	FR812	Member State	NIMES
	764	HERAULT	FR813	Member State	MONTPELLIER
	765	LOZERE	FR814	Member State	MENDE
	766	PYRENEES-ORIENTALES	FR815	Member State	PERPIGNAN
	767	ALPES-DE-HAUTE-PROVENCE	FR821	Member State	DIGNE
	768	HAUTES-ALPES	FR822	Member State	GAP
	769	ALPES-MARITIMES	FR823	Member State	NICE
	770	BOUCHES-DU-RHONE	FR824	Member State	MARSEILLE
	771	VAR	FR825	Member State	TOULON
	772	VAUCLUSE	FR826	Member State	AVIGNON
	773	CORSE-DU-SUD	FR831	Member State	AJACCIO
	774	HAUTE-CORSE	FR832	Member State	BASTIA
Greece	775	EVROS	GR111	Member State	ALEXANDROUPOLIS
	776	XANTHI	GR112	Member State	XANTHI
	777	RODOPI	GR113	Member State	KOMOTINI
	778	DRAMA	GR114	Member State	DRAMA
	779	KAVALA	GR115	Member State	KAVALLA
	780	IMATHIA	GR121	Member State	VEROIA
	781	THESSALONIKI	GR122	Member State	THESSALONIKI
	782	KILKIS	GR123	Member State	KILKIS
	783	PELLA	GR124	Member State	YIANNITSA
	784	PIERIA	GR125	Member State	KATERINI
	785	SERRES	GR126	Member State	SERRES
	786	CHALKIDIKI	GR127	Member State	SALONIKA
	787	GREVENA	GR131	Member State	GREVENA
	788	KASTORIA	GR132	Member State	KASTORIA
	789	KOZANI	GR133	Member State	KOZANI
	790	FLORINA	GR134	Member State	FLORINA
	791	KARDITSA	GR141	Member State	KARDITSA
	792	LARISA	GR142	Member State	LARISA
	793	MAGNISIA	GR143	Member State	VOLOS
	794	TRIKALA	GR144	Member State	TRIKALA
	795	ARTA	GR211	Member State	ARTA
	796	THESPROTIA	GR212	Member State	PARGA
	797	IOANNINA	GR213	Member State	IOANNINA
	798	PREVEZA	GR214	Member State	PREVEZA
	799	ZAKYNTHOS	GR221	Member State	ZAKYNTHOS
	800	KERKYRA	GR222	Member State	LIAPATHES
	801	KEFALLINIA	GR223	Member State	ARGOSTOLION
	802	LEFKADA	GR224	Member State	LEVKAS
	803	AITOLOAKARNANIA	GR231	Member State	AITOLIKON
	804	ACHAIA	GR232	Member State	PATRAI

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Greece (cont.)	805	ILEIA	GR233	Member State	PIRGOS
	806	VOIOTIA	GR241	Member State	AMFIKLIA
	807	EVVOIA	GR242	Member State	CHALKIS
	808	EVRYTANIA	GR243	Member State	KARPENISION
	809	FTHOITIDA	GR244	Member State	LAMIA
	810	FOKIDA	GR245	Member State	AMFISSA
	811	ARGOLIDA	GR251	Member State	NAVPLION
	812	ARKADIA	GR252	Member State	TRIPOLIS
	813	KORINTHIA	GR253	Member State	KORINTHOS
	814	LAKONIA	GR254	Member State	SPARTI
	815	MESSINIA	GR255	Member State	KALAMAI
	816	ATTIKI	GR3	Member State	ATHINAI
	817	LESVOS	GR411	Member State	MYTILINI
	818	SAMOS	GR412	Member State	SAMOS
	819	CHIOS	GR413	Member State	CHIOS
	820	DODEKANISOS	GR421	Member State	RODOS
	821	KYKLADES	GR422	Member State	ERMUPOLIS
	822	IRAKLEIO	GR431	Member State	IRAKLION
	823	LASITHI	GR432	Member State	SITIA
	824	RETHYMNI	GR433	Member State	RETHIMNON
	825	CHANIA	GR434	Member State	KISSAMOS
Hungary	826	BUDAPEST	HU011	Candidate Countries	BUDAPEST
	827	PEST	HU012	Candidate Countries	GOEDOELLOE
	828	FEJER	HU021	Candidate Countries	SZEKESFEHERVAR
	829	KOMAROM-ESZTERGOM	HU022	Candidate Countries	TATABANYA
	830	VESZPREM	HU023	Candidate Countries	VESZPREM
	831	GYOR-MOSON-SOPRON	HU031	Candidate Countries	GYOER
	832	VAS	HU032	Candidate Countries	SZOMBATHELY
	833	ZALA	HU033	Candidate Countries	ZALAEGERSZEG
	834	BARANYA	HU041	Candidate Countries	PECS
	835	SOMOGY	HU042	Candidate Countries	KAPOSVAR
	836	TOLNA	HU043	Candidate Countries	SZEKSZARD
	837	BORSOD-ABAUJ-ZEMPLEN	HU051	Candidate Countries	MISKOLC
	838	HEVES	HU052	Candidate Countries	EGER
	839	NOGRAD	HU053	Candidate Countries	SALGOTARJAN
	840	HAJDU-BIHAR	HU061	Candidate Countries	DEBRECEN
	841	JASZ-NAGYKUN-SZOLNOK	HU062	Candidate Countries	SZOLNOK
	842	SZABOLCS-SZATMAR-BEREG	HU063	Candidate Countries	NYIREGYHAZA
	843	BACS-KISKUN	HU071	Candidate Countries	KECSKEMET
	844	BEKES	HU072	Candidate Countries	BEKESCSABA
	845	CSONGRAD	HU073	Candidate Countries	SZEGED
Ireland	846	BORDER	IE011	Member State	SLIGO
	847	MIDLAND	IE012	Member State	PORT LAOISE
	848	WEST	IE013	Member State	GALWAY
	849	DUBLIN	IE021	Member State	DUBLIN
	850	MID-EAST	IE022	Member State	NAAS
	851	MID-WEST	IE023	Member State	LIMERICK
	852	SOUTH-EAST (IRL)	IE024	Member State	WATERFORD
	853	SOUTH-WEST (IRL)	IE025	Member State	CORK
Italy	854	TORINO	IT111	Member State	TORINO
	855	VERCELLI	IT112	Member State	VERCELLI
	856	BIELLA	IT113	Member State	BIELLA
	857	VERBANO-CUSIO-OSSOLA	IT114	Member State	VERBANIA
	858	NOVARA	IT115	Member State	NOVARA
	859	CUNEO	IT116	Member State	CUNEO
	860	ASTI	IT117	Member State	ASTI
	861	ALESSANDRIA	IT118	Member State	ALESSANDRIA
	862	VALLE D AOSTA	IT12	Member State	AOSTA
	863	IMPERIA	IT131	Member State	SAN REMO
	864	SAVONA	IT132	Member State	SANONA
	865	GENOVA	IT133	Member State	GENOVA
	866	LA SPEZIA	IT134	Member State	LA SPEZIA
	867	VARESE	IT201	Member State	VARESE
	868	COMO	IT202	Member State	COMO
	869	LECCO	IT203	Member State	LECCO
	870	SONDRIO	IT204	Member State	SONDRIO
	871	MILANO	IT205	Member State	MILANO
	872	BERGAMO	IT206	Member State	BERGAMO
	873	BRESCIA	IT207	Member State	BRESCIA
	874	PAVIA	IT208	Member State	PAVIA
	875	LODI	IT209	Member State	LODI
	876	CREMONA	IT20A	Member State	CREMONA

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Italy	877	MANTOVA	IT20B	Member State	MANTOVA
(cnt.)	878	BOLZANO-BOZEN	IT311	Member State	BOZEN
	879	TRENTO	IT312	Member State	TRENTO
	880	VERONA	IT321	Member State	VERONA
	881	VICENZA	IT322	Member State	VICENZA
	882	BELLUNO	IT323	Member State	BELLUNO
	883	TREVISO	IT324	Member State	TREVISO
	884	VENEZIA	IT325	Member State	VENEZIA
	885	PADOVA	IT326	Member State	PADUA
	886	ROVIGO	IT327	Member State	ROVIGO
	887	PORDENONE	IT331	Member State	PORDENONE
	888	UDINE	IT332	Member State	UDINE
	889	GORIZIA	IT333	Member State	GORIZIA
	890	TRIESTE	IT334	Member State	TRIESTE
	891	PIACENZA	IT401	Member State	PIACENZA
	892	PARMA	IT402	Member State	PARMA
	893	REGGIO NELL`EMILIA	IT403	Member State	REGGIO
	894	MODENA	IT404	Member State	MODENA
	895	BOLOGNA	IT405	Member State	BOLOGNA
	896	FERRARA	IT406	Member State	FERRARA
	897	RAVENNA	IT407	Member State	RAVENNA
	898	FORLI-CESENA	IT408	Member State	FORLI
	899	RIMINI	IT409	Member State	RIMINI
	900	MASSA-CARRARA	IT511	Member State	MASSA
	901	LUCCA	IT512	Member State	LUCCA
	902	PISTOIA	IT513	Member State	PISTOIA
	903	FIRENZE	IT514	Member State	FLORENZ
	904	PRATO	IT515	Member State	PRATO
	905	LIVORNO	IT516	Member State	LIVORNO
	906	PISA	IT517	Member State	PISA
	907	AREZZO	IT518	Member State	AREZZO
	908	SIENA	IT519	Member State	SIENA
	909	GROSSETO	IT51A	Member State	GROSSETO
	910	PERUGIA	IT521	Member State	PERUGIA
	911	TERNI	IT522	Member State	TERNI
	912	PESARO E URBINO	IT531	Member State	PESARO
	913	ANCONA	IT532	Member State	ANCONA
	914	MACERATA	IT533	Member State	MACERATA
	915	ASCOLI PICENO	IT534	Member State	ASCOLI PICENO
	916	VITERBO	IT601	Member State	VITERBO
	917	RIETI	IT602	Member State	RIETI
	918	ROM	IT603	Member State	ROM
	919	LATINA	IT604	Member State	LATINA
	920	FROSINONE	IT605	Member State	FROSINONE
	921	L AQUILA	IT711	Member State	L AQUILA
	922	TERAMO	IT712	Member State	TERAMO
	923	PESCARA	IT713	Member State	PESCARA
	924	CHIETI	IT714	Member State	CHIETI
	925	ISERNIA	IT721	Member State	ISERNIA
	926	CAMPOBASSO	IT722	Member State	CAMPOBASSO
	927	CASERTA	IT801	Member State	CASERTA
	928	BENEVENTO	IT802	Member State	BENEVENTO
	929	NAPOLI	IT803	Member State	NAPOLI
	930	AVELLINO	IT804	Member State	AVELLINO
	931	SALERNO	IT805	Member State	SALERNO
	932	FOGGIA	IT911	Member State	FOGGIA
	933	BARI	IT912	Member State	BARI
	934	TARANTO	IT913	Member State	TARENT
	935	BRINDISI	IT914	Member State	BRINDISI
	936	LECCE	IT915	Member State	LECCE
	937	POTENZA	IT921	Member State	POTENZA
	938	MATERA	IT922	Member State	MATERA
	939	COSENZA	IT931	Member State	COSENZA
	940	CROTONE	IT932	Member State	CROTONE
	941	CATANZARO	IT933	Member State	CATANZARO
	942	VIBO VALENTIA	IT934	Member State	VIBO VALENTIA
	943	REGGIO DI CALABRIA	IT935	Member State	REGGIO DI CALABRIA
	944	TRAPANI	ITA01	Member State	TRAPANI
	945	PALERMO	ITA02	Member State	PALERMO
	946	MESSINA	ITA03	Member State	MESSINA
	947	AGRIGENTO	ITA04	Member State	AGRIGENTO
	948	CALTANISSETTA	ITA05	Member State	CALTANISSETTA
	949	ENNA	ITA06	Member State	ENNA
	950	CATANIA	ITA07	Member State	CATANIA

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Italy (cont.)	951	RAGUSA	ITA08	Member State	RAGUSA
	952	SIRACUSA	ITA09	Member State	SIRACUSA
	953	SASSARI	ITB01	Member State	SASSARI
	954	NUORO	ITB02	Member State	NUORO
	955	ORISTANO	ITB03	Member State	ORISTANO
	956	CAGLIARI	ITB04	Member State	CAGLIARI
Lithuania	957	ALYTAUS (APSKRITIS)	LT001	Candidate Countries	ALYTUS
	958	KAUNO (APSKRITIS)	LT002	Candidate Countries	KAUNAS
	959	KLAIPEDOS (APSKRITIS)	LT003	Candidate Countries	KLAIPEDA
	960	MARIJAMPOLES (APSKRITIS)	LT004	Candidate Countries	MARIJAMPOLE
	961	PANEVEZIO (APSKRITIS)	LT005	Candidate Countries	PANEVEZYS
	962	SIAULIU (APSKRITIS)	LT006	Candidate Countries	SIAULIAI
	963	TAURAGES (APSKRITIS)	LT007	Candidate Countries	TAURAGE
	964	TELSIU (APSKRITIS)	LT008	Candidate Countries	PLUNGE
	965	UTENOS (APSKRITIS)	LT009	Candidate Countries	UTENA
	966	VILNIAUS (APSKRITIS)	LT00A	Candidate Countries	VILNIUS
Luxembourg	967	LUXEMBOURG	LU	Member State	LUXEMBOURG
Latvia	968	RIGA	LV001	Candidate Countries	RIGA
	969	VIDZEME	LV002	Candidate Countries	VALMIERA
	970	KURZEME	LV003	Candidate Countries	LIEPAJA
	971	KURZEME	LV004	Candidate Countries	JELGAVA
	972	LATGALE	LV005	Candidate Countries	DAUGAVPILS
Malta	973	MALTA	MT001	Candidate Countries	VALETTA
	974	GOZO AND COMINO	MT002	Candidate Countries	GOZO
Netherlands	975	OOST-GRONINGEN	NL111	Member State	WINSCHOTEN
	976	DELFZIJL EN OMGEVING	NL112	Member State	APPINGEDAM
	977	OVERIG GRONINGEN	NL113	Member State	HAREN
	978	NOORD-FRIESLAND	NL121	Member State	LEEUWARDEN
	979	ZUIDWEST-FRIESLAND	NL122	Member State	SNEEK
	980	ZUIDOOST-FRIESLAND	NL123	Member State	DRACHTEN
	981	NOORD-DRENTHE	NL131	Member State	ASSEN
	982	ZUIDOOST-DRENTHE	NL132	Member State	EMMEN
	983	ZUIDWEST-DRENTHE	NL133	Member State	HOOGEVEEN
	984	NOORD-OVERIJSSEL	NL211	Member State	ZWOLLE
	985	ZUIDWEST-OVERIJSSEL	NL212	Member State	DEVENTER
	986	TWENTE	NL213	Member State	ENSCHEDE
	987	VELUWE	NL221	Member State	APELDOORN
	988	ACHTERHOEK	NL222	Member State	DOETINCHEN
	989	ARNHEM/NIJMEGEN	NL223	Member State	ARNHEM
	990	ZUIDWEST-GELDERLAND	NL224	Member State	HERTOGENBOSCH
	991	FLEVOLAND	NL23	Member State	LELYSTAD
	992	UTRECHT	NL31	Member State	UTRECHT
	993	KOP VAN NOORD-HOLLAND	NL321	Member State	HOORN
	994	ALKMAAR EN OMGEVING	NL322	Member State	ALKMAAR
	995	IJMOND	NL323	Member State	IJMUIDEN
	996	AGGLOMERATIE HAARLEM	NL324	Member State	HAARLEM
	997	ZAANSTREEK	NL325	Member State	ZAANSTADT
	998	GROOT-AMSTERDAM	NL326	Member State	AMSTERDAM
	999	HET GOOI EN VECHTSTREEK	NL327	Member State	HILVERSUM
	1000	AGGL. LEIDEN EN BOLLENSTR	NL331	Member State	LEIDEN
	1001	AGGLOMERATIE S-GRAVENHAGE	NL332	Member State	DEN HAAG
	1002	DELFT EN WESTLAND	NL333	Member State	DELFT
	1003	OOST ZUID-HOLLAND	NL334	Member State	GOUDA
	1004	GROOT-RIJNMOND	NL335	Member State	ROTTERDAM
	1005	ZUIDOOST ZUID-HOLLAND	NL336	Member State	DODRECHT
	1006	ZEEUWSCH-VLAANDEREN	NL341	Member State	TERNEUZEN
	1007	OVERIG ZEELAND	NL342	Member State	MIDDELBURG
	1008	WEST-NOORD-BRABANT	NL411	Member State	ROSENDAAL EN NISPEN
	1009	MIDDEN-NOORD-BRABANT	NL412	Member State	TILBURG
	1010	NOORDOOST-NOORD-BRABANT	NL413	Member State	OSS
	1011	ZUIDOOST-NOORD-BRABANT	NL414	Member State	EINDHOVEN
	1012	NOORD-LIMBURG	NL421	Member State	VENLO
	1013	MIDDEN-LIMBURG	NL422	Member State	ROERMOND
	1014	ZUID-LIMBURG	NL423	Member State	MAASTRICHT
Norway	1015	OSLO	NO011	Other Countries	OSLO
	1016	AKERSHUS	NO012	Other Countries	LILLESTROEM
	1017	HEDMARK	NO021	Other Countries	HAMAR
	1018	OPPLAND	NO022	Other Countries	LILLEHAMMER
	1019	ØSTFOLD	NO031	Other Countries	MOSS
	1020	BUSKERUD	NO032	Other Countries	DRAMMEN

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Norway (cont.)	1021	VESTFOLD	NO033	Other Countries	TONSBERG
	1022	TELEMARK	NO034	Other Countries	SKIEN
	1023	AUST-AGDER	NO041	Other Countries	ARENDAL
	1024	VEST-AGDER	NO042	Other Countries	KRISTIANSAND
	1025	ROGALAND	NO043	Other Countries	STAVANGER
	1026	HORDALAND	NO051	Other Countries	BERGEN
	1027	SOGN OG FJORDANE	NO052	Other Countries	HERMANSVERK
	1028	MØRE OG ROMSDAL	NO053	Other Countries	MOLDE
	1029	SØR-TRØNDELAG	NO061	Other Countries	TRONDHEIM
	1030	NORD-TRØNDELAG	NO062	Other Countries	STEINKJER
	1031	NORDLAND	NO071	Other Countries	BODO
	1032	TROMS	NO072	Other Countries	TROMSO
	1033	FINNMARK	NO073	Other Countries	VADSO
Poland	1034	JELENIOGARSKO-WALBRZYSKI	PL011	Candidate Countries	WALDENBURG
	1035	LEGNICKI	PL012	Candidate Countries	LIEGNITZ
	1036	WROCLAWSKI	PL013	Candidate Countries	OLESNICA
	1037	M. WROCLAW	PL014	Candidate Countries	WROCLAW
	1038	BYDGOSKI	PL021	Candidate Countries	INOWROCLAW
	1039	TORUNSKO_WLOCLAWSKI	PL022	Candidate Countries	TORUN
	1040	BIALSKOPODLASKI	PL031	Candidate Countries	BIALA PODLASKA
	1041	CHELMSKO-ZAMOJSKI	PL032	Candidate Countries	CHELM
	1042	LUBELSKI	PL033	Candidate Countries	LUBLIN
	1043	GORZOWSKI	PL041	Candidate Countries	LANDSBERG
	1044	ZIELONOGARSKI	PL042	Candidate Countries	ZIELONA GORA
	1045	LADZKI	PL051	Candidate Countries	PABIANICE
	1046	PIOTRKOWSKO-SKIERNIEWICKI	PL052	Candidate Countries	PIOTRKOW-TRYBUNALSKI
	1047	M. LADZ	PL053	Candidate Countries	LADZ
	1048	KRAKOWSKO-TARNOWSKI	PL061	Candidate Countries	TARNOW
	1049	NOWOSADECKI	PL062	Candidate Countries	NOWY SACZ
	1050	M.KRAKAW	PL063	Candidate Countries	KRAKOW
	1051	CIECHANOWSKO-PLOCKI	PL071	Candidate Countries	PLOCK
	1052	OSTROLECKO-SIEDLECKI	PL072	Candidate Countries	SIEDLCE
	1053	WARZAWSKI	PL073	Candidate Countries	PRUSZKOW
	1054	RADOMSKI	PL074	Candidate Countries	RADOM
	1055	M. WARZAWA	PL075	Candidate Countries	WARSZAWA
	1056	OPOLSKI	PL08	Candidate Countries	OPOLE
	1057	RZESZOWSKO-TARNOBRZESKI	PL091	Candidate Countries	RZESZOW
	1058	KRASNIENSKO-PRZEMYSKI	PL092	Candidate Countries	PRZEMYSL
	1059	BIALYSTOCKO-SUWALSKI	PL0A1	Candidate Countries	BIALYSTOK
	1060	LOMZYNSKI	PL0A2	Candidate Countries	LOMZA
	1061	SLUPSKI	PL0B1	Candidate Countries	SLUPSK
	1062	GDANKSI	PL0B2	Candidate Countries	TCZEW
	1063	GDANSK-GDYNIA-SOPOT	PL0B3	Candidate Countries	GDANSK
	1064	PALNOCNOSLASKI	PL0C1	Candidate Countries	CZESTOCHOWA
	1065	POLUDNIOWOSLASKI	PL0C2	Candidate Countries	BIALSKO-BIALA
	1066	CENTRALNKY SLASKI	PL0C3	Candidate Countries	KATOWICE
	1067	SWIETOKRZYSKI	PL0D	Candidate Countries	KIELCE
	1068	ELBLASKI	PL0E1	Candidate Countries	ELBLAG
	1069	OLSTYNSKI	PL0E2	Candidate Countries	ALLENSTEIN
	1070	ELCKI	PL0E3	Candidate Countries	ELK
	1071	PILSKI	PL0F1	Candidate Countries	PILA
	1072	POSNANSKI	PL0F2	Candidate Countries	GNIEZNO
	1073	KALISKI	PL0F3	Candidate Countries	KALISZ
	1074	KONINSKI	PL0F4	Candidate Countries	KONIN
	1075	M.POZNAN	PL0F5	Candidate Countries	POZNAN
	1076	SZCZECINSKNI	PL0G1	Candidate Countries	SZCZECIN
	1077	KOSZALINSKI	PL0G2	Candidate Countries	KOESLIN
Portugal	1078	MINHO-LIMA	PT111	Member State	VIANA DO CASTELO
	1079	CAVADO	PT112	Member State	BRAGA
	1080	AVE	PT113	Member State	SANTO TIRSO
	1081	GRANDE PORTO	PT114	Member State	PORTO
	1082	TAMEGA	PT115	Member State	VILA REAL
	1083	ENTRE DOURO E VOUGA	PT116	Member State	SAO JOAO DE MADEIRA
	1084	DOURO	PT117	Member State	MIRANDELA
	1085	ALTO TRAS-OS-MONTES	PT118	Member State	BRAGANCA
	1086	BAIXO VOUGA	PT121	Member State	AVEIRO
	1087	BAIXO MONDEGO	PT122	Member State	COIMBRA
	1088	PINHAL LITORAL	PT123	Member State	POMBAL
	1089	PINHAL INTERIOR NORTE	PT124	Member State	PENELA
	1090	DAO-LAFOES	PT125	Member State	VISEU
	1091	PINHAL INTERIOR SUL	PT126	Member State	SERTA
	1092	SERRA DA ESTRELA	PT127	Member State	GOIS

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Portugal (cont.)	1093	BEIRA INTERIOR NORTE	PT128	Member State	GUARDA
	1094	BEIRA INTERIOR SUL	PT129	Member State	CASTELO BRANCO
	1095	COVA DA BEIRA	PT12A	Member State	COVILHA
	1096	OESTE	PT131	Member State	LEIRIA
	1097	GRANDE LISBOA	PT132	Member State	LISBOA
	1098	PENINSULA DE SETUBAL	PT133	Member State	SETUBAL
	1099	MEDIO TEJO	PT134	Member State	ABRANTES
	1100	LEZIRIA DO TEJO	PT135	Member State	SANTAREM
	1101	ALENTEJO LITORAL	PT141	Member State	SINES
	1102	ALTO ALENTEJO	PT142	Member State	PORTALEGRE
	1103	ALENTEJO CENTRAL	PT143	Member State	EVORA
	1104	BAIXO ALENTEJO	PT144	Member State	BEJA
	1105	ALGARVE	PT15	Member State	FARO
Romania	1106	BACAU	RO011	Candidate Countries	BACAU
	1107	BOTOSANI	RO012	Candidate Countries	BOTOSANI
	1108	IASI	RO013	Candidate Countries	IASI
	1109	NEAMT	RO014	Candidate Countries	PIATRA-NEAMT
	1110	SUCEAVA	RO015	Candidate Countries	SUCEAVA
	1111	VASLUI	RO016	Candidate Countries	VASLUI
	1112	BRAILA	RO021	Candidate Countries	BRAILA
	1113	BUZAU	RO022	Candidate Countries	BUZAU
	1114	CONSTANTA	RO023	Candidate Countries	CONSTANTA
	1115	GALATI	RO024	Candidate Countries	GALATI
	1116	TULCEA	RO025	Candidate Countries	TULCEA
	1117	VRANCEA	RO026	Candidate Countries	FOCSANI
	1118	ARGES	RO031	Candidate Countries	PITESTI
	1119	CALARASI	RO032	Candidate Countries	CALARASI
	1120	DAMBOVITA	RO033	Candidate Countries	TIRGOVISTE
	1121	GIURGIU	RO034	Candidate Countries	GIURGIU
	1122	IALOMITA	RO035	Candidate Countries	SLOBOZIA
	1123	PRAHOVA	RO036	Candidate Countries	PLOIESTI
	1124	TELEORMAN	RO037	Candidate Countries	ALEXANDRIA
	1125	DOLJ	RO041	Candidate Countries	CRAIOVA
	1126	GORJ	RO042	Candidate Countries	TIRGU JIU
	1127	MEHEDINTI	RO043	Candidate Countries	DROBETA-TURNU SEVERI
	1128	OLT	RO044	Candidate Countries	SLATINA
	1129	VALCEA	RO045	Candidate Countries	RIMNICU VILCEA
	1130	ARAD	RO051	Candidate Countries	ARAD
	1131	CARAS-SEVERIN	RO052	Candidate Countries	RESITA
	1132	HUNEDOARA	RO053	Candidate Countries	DEVA
	1133	TIMIS	RO054	Candidate Countries	TIMISOARA
	1134	BIHOR	RO061	Candidate Countries	ORADEA
	1135	BISTRITA-NASAUD	RO062	Candidate Countries	BISTRITA
	1136	CLUJ	RO063	Candidate Countries	CLUJ-NAPOCA
	1137	MARAMURES	RO064	Candidate Countries	BAIA MARE
	1138	SATU MARE	RO065	Candidate Countries	SATU MARE
	1139	SALAJ	RO066	Candidate Countries	ZALAU
	1140	ALBA	RO071	Candidate Countries	ALBA IULIA
	1141	BRASOV	RO072	Candidate Countries	BRASOV
	1142	COVASNA	RO073	Candidate Countries	SFINTU GHEORGHE
	1143	HARGHITA	RO074	Candidate Countries	MIERCUREA-CIUC
	1144	MURES	RO075	Candidate Countries	TIRGU MURES
	1145	SIBIU	RO076	Candidate Countries	SIBIU
	1146	BUCURESTI	RO081	Candidate Countries	BUCURESTI
	1147	ILFOV	RO082	Candidate Countries	AFUMATI
Sweden	1148	STOCKHOLMS LAEN	SE011	Member State	STOCKHOLM
	1149	UPPSALA LAEN	SE021	Member State	UPPSALA
	1150	SOEDERMANLANDS LAEN	SE022	Member State	NYKOEPING
	1151	OESTERGOETLANDS LAEN	SE023	Member State	LINKOEPING
	1152	OEREBRO LAEN	SE024	Member State	OEREBRO
	1153	VAESTMANLANDS LAEN	SE025	Member State	VAESTERAS
	1154	BLEKINGE LAEN	SE041	Member State	KARLSKRONA
	1155	SKANE LAEN	SE044	Member State	MALMOE
	1156	VAERMLANDS LAEN	SE061	Member State	KARLSTADT
	1157	DALAMAS LAEN	SE062	Member State	FALUN
	1158	GAEVLEBORGS LAEN	SE063	Member State	GAEVLE
	1159	VAESTERNORRLANDS LAEN	SE071	Member State	OERNSKOELDSVIK
	1160	JAEMTLANDS LAEN	SE072	Member State	OESTERSUND
	1161	VAESTERBOTTENS LAEN	SE081	Member State	UMEA
	1162	NORRBOTTENS LAEN	SE082	Member State	LULEA
	1163	JOENKOEPINGS LAEN	SE091	Member State	JOENKOEPING
	1164	KRONOBERGS LAEN	SE092	Member State	VAEXJOE

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
Sweden (cont.)	1165	KALMAR LAEN	SE093	Member State	KALMAR
	1166	GOTLANDS LAEN	SE094	Member State	VISBY
	1167	HALLANDS LAEN	SE0A1	Member State	HALMSTAD
	1168	VAESTRA GOETALANDS LAEN	SE0A2	Member State	GOETEBORG
Slovenia	1169	POMURSKA	SI001	Candidate Countries	MURSKA SOBOTA
	1170	PODRAVSKA	SI002	Candidate Countries	MARIBOR
	1171	KOROSKA	SI003	Candidate Countries	RAVNE NA KOROSKEM
	1172	SAVINJSKA	SI004	Candidate Countries	CELJE
	1173	ZASAVSKA	SI005	Candidate Countries	TRBOVLJE
	1174	SPODNJEPOSAVSKA	SI006	Candidate Countries	BREZICE
	1175	DOLENJSKA	SI007	Candidate Countries	NOVO MESTO
	1176	OSREDNJESLOVENSKA	SI008	Candidate Countries	LJUBLJANA
	1177	GORENJSKA	SI009	Candidate Countries	KRANJ
	1178	NOTRANJSKO-KRASKA	SI00A	Candidate Countries	POSTOJNA
	1179	GORISKA	SI00B	Candidate Countries	NOVA GORICA
	1180	OBALNO-KRASKA	SI00C	Candidate Countries	KOZINA
Slovakia	1181	BRATISLAVSKY KRAJ	SK01	Candidate Countries	BRATISLAVA
	1182	TMAVSKY KRAJ	SK021	Candidate Countries	TRNAVA
	1183	TRENCIANSKY KRAJ	SK022	Candidate Countries	TRENCIN
	1184	NITRIANSKY KRAJ	SK023	Candidate Countries	NITRA
	1185	ZILINSKY KRAJ	SK031	Candidate Countries	ZILINA
	1186	BANSKOBYSTRICKY KRAJ	SK032	Candidate Countries	BANSKA BYSTRICA
	1187	PRESOVSKY KRAJ	SK041	Candidate Countries	PRESOV
	1188	KOSICKY KRAJ	SK042	Candidate Countries	KOSICE
United Kingdom	1189	HARTLEPOOL A. STOCKTON-ON-TEES	UKC11	Member State	STOCKTON-ON-TEES
	1190	SOUTH TEESSIDE	UKC12	Member State	MIDDLESBROUGH
	1191	DARLINGTON	UKC13	Member State	DARLINGTON
	1192	DURHAM CC	UKC14	Member State	DURHAM
	1193	NORTHUMBERLAND	UKC21	Member State	BLYTH
	1194	TYNESIDE	UKC22	Member State	NEWCASTLE UPON TYNE
	1195	SUNDERLAND	UKC23	Member State	SUNDERLAND
	1196	WEST CUMBRIA	UKD11	Member State	WORKINGTON
	1197	EAST CUMBRIA	UKD12	Member State	CARLISLE
	1198	HALTON AND WARRINGTON	UKD21	Member State	WARRINGTON
	1199	CHESHIRE CC	UKD22	Member State	CHESTER
	1200	GREATER MANCHESTER SOUTH	UKD31	Member State	MANCHESTER
	1201	GREATER MANCHESTER NORTH	UKD32	Member State	BOLTON
	1202	BLACKBURN WITH DARWEN	UKD41	Member State	BLACKBURN
	1203	BLACKPOOL	UKD42	Member State	BLACKPOOL
	1204	LANCASHIRE CC	UKD43	Member State	PRESTON
	1205	EAST MERSEYSIDE	UKD51	Member State	KIRKBY
	1206	LIVERPOOL	UKD52	Member State	LIVERPOOL
	1207	SEFTON	UKD53	Member State	SOUTHPORT
	1208	WIRRAL	UKD54	Member State	BIRKENHEAD
	1209	KINGSTON UPON HULL, CITY	UKE11	Member State	KINGSTON UPON HULL
	1210	EAST RIDING OF YORKSHIRE	UKE12	Member State	BRIDLINGTON
	1211	N.A.NE. LINCOLNSHIRE	UKE13	Member State	SCUNTHORPE
	1212	YORK	UKE21	Member State	YORK
	1213	NORTH YORKSHIRE	UKE22	Member State	HARROGATE
	1214	BARNSLEY, DONCASTER, ROTH	UKE31	Member State	ROTHERHAM
	1215	SHEFFIELD	UKE32	Member State	SHEFFIELD
	1216	BRADFORD	UKE41	Member State	BRADFORD
	1217	LEEDS	UKE42	Member State	LEEDS
	1218	CALDERDALE, KIRKLEES, WAKEFIELD	UKE43	Member State	WAKEFIELD
	1219	DERBY	UKF11	Member State	DERBY
	1220	EAST DERBYSHIRE	UKF12	Member State	CHESTERFIELD
	1221	SOUTH AND WEST DERBYSHIRE	UKF13	Member State	BUXTON
	1222	NOTTINGHAM	UKF14	Member State	NOTTINGHAM
	1223	NORTH NOTTINGHAMSHIRE	UKF15	Member State	MANSFIELD
	1224	SOUTH NOTTINGHAMSHIRE	UKF16	Member State	NEWARK-ON-TRENT
	1225	LEICESTER	UKF21	Member State	LEICESTER
	1226	LEICESTERSHIRE CC, RUTLAN	UKF22	Member State	HINCKLEY
	1227	NORTHAMPTONSHIRE	UKF23	Member State	NORTHAMPTON
	1228	LINCOLNSHIRE	UKF3	Member State	LINCOLN
	1229	HEREFORDSHIRE, COUNTY OF	UKG11	Member State	HEREFORD
	1230	WORCESTERSHIRE	UKG12	Member State	WORCESTER
	1231	WARWICKSHIRE	UKG13	Member State	WARWICK
	1232	TELFORD AND WREKIN	UKG21	Member State	TELFORD
	1233	SHROPSHIRE CC	UKG22	Member State	SHREWSBURY
	1234	STOKE-ON-TRENT	UKG23	Member State	STOKE-ON-TRENT
	1235	STAFFORDSHIRE CC	UKG24	Member State	NEWCASTLE U.-L.
	1236	BIRMINGHAM	UKG31	Member State	BIRMINGHAM

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
United Kingdom (cont.)	1237	SOLIHULL	UKG32	Member State	SOLIHULL
	1238	COVENTRY	UKG33	Member State	COVENTRY
	1239	DUDLEY AND SANDWELL	UKG34	Member State	DUDLEY
	1240	WALSALL AND WOLVERHAMPTON	UKG35	Member State	WOLVERHAMPTON
	1241	PETERBOROUGH	UKH11	Member State	PETERBOROUGH
	1242	CAMBRIDGESHIRE	UKH12	Member State	CAMBRIDGE
	1243	NORFOLK	UKH13	Member State	NORWICH
	1244	SUFFOLK	UKH14	Member State	IPSWICH
	1245	LUTON	UKH21	Member State	LUTON
	1246	BEDFORDSHIRE CC	UKH22	Member State	BEDFORD
	1247	HERTFORDSHIRE	UKH23	Member State	WATFORD
	1248	SOUTHEND-ON-SEA	UKH31	Member State	SOUTHEND-ON-SEA
	1249	THURROK	UKH32	Member State	GRAYS
	1250	ESSEX CC	UKH33	Member State	CHELMSFORD
	1251	INNER LONDON-WEST	UKI11	Member State	LONDON
	1252	INNER LONDON-EAST	UKI12	Member State	LONDON
	1253	OUTER LONDON-E.A.N. EAST	UKI21	Member State	LONDON
	1254	OUTHER LONDON-SOUTH	UKI22	Member State	LONDON
	1255	OUTER LONDON-W.A. NORTH W	UKI23	Member State	LONDON
	1256	BERKSHIRE	UKJ11	Member State	READING
	1257	MILTON KEYNES	UKJ12	Member State	MILTON KEYNES
	1258	BUCKINGHAMSHIRE CC	UKJ13	Member State	AYLESBURY
	1259	OXFORDSHIRE	UKJ14	Member State	OXFORD
	1260	BRIGHTON AND HOVE	UKJ21	Member State	BRIGHTON
	1261	EAST SUSSEX CC	UKJ22	Member State	HASTINGS
	1262	SURREY	UKJ23	Member State	GUILDFORD
	1263	WEST SUSSEX	UKJ24	Member State	CHICHESTER
	1264	PORTSMOUTH	UKJ31	Member State	PORTSMOUTH
	1265	SOUTHAMPTON	UKJ32	Member State	SOUTHAMPTON
	1266	HAMPSHIRE CC	UKJ33	Member State	WINCHESTER
	1267	ISLE OF WIGHT	UKJ34	Member State	NEWPORT
	1268	MEDWAY	UKJ41	Member State	CHATHAM
	1269	KENT	UKJ42	Member State	MAIDSTONE
	1270	BRISTOL, CITY OF	UKK11	Member State	BRISTOL
	1271	N. A. NE. SOMERSET, SOUTH	UKK12	Member State	BATH
	1272	GLOUCESTERSHIRE	UKK13	Member State	GLOUCESTER
	1273	SWINDON	UKK14	Member State	SWINDON
	1274	WILTSHIRE CC	UKK15	Member State	SALISBURY
	1275	BOURNEMOUTH AND POOLE	UKK21	Member State	BOURNEMOUTH
	1276	DORSET	UKK22	Member State	DORCHESTER
	1277	SOMERSET	UKK23	Member State	TAUNTON
	1278	CORNWALL, ISLE OF SCILLY	UKK3	Member State	TRURO
	1279	PLYMOUTH	UKK41	Member State	PLYMOUTH
	1280	TORBAY	UKK42	Member State	TORQUAY
	1281	DEVON CC	UKK43	Member State	EXETER
	1282	ISLE OF ANGLESEY	UKL11	Member State	HOLYHEAD
	1283	GWYNEDD	UKL12	Member State	CAERNARFON
	1284	CONWY AND DENBIGHSHIRE	UKL13	Member State	COLWYN BAY
	1285	SOUTH WEST WALES	UKL14	Member State	LLANELLI
	1286	CENTRAL VALLEYS	UKL15	Member State	RHONDDA
	1287	GWENT VALLEYS	UKL16	Member State	ABERTILLERY
	1288	BRIDGEND, NEATH PORT TALB	UKL17	Member State	NEATH
	1289	SWANSEA	UKL18	Member State	SWANSEA
	1290	MONMOUTHSHIRE, NEWPORT	UKL21	Member State	MONMOUTH
	1291	CARDIFF, VALE OF GLAMORGAN	UKL22	Member State	CARDIFF
	1292	FLINTSHIRE AND WRAXHAM	UKL23	Member State	WREXHAM
	1293	POWYS	UKL24	Member State	NEWTOWN
	1294	ABERDEENSHIRE, NORTH EAST	UKM11	Member State	ABERDEEN
	1295	ANGUS, DUNDEE CITY	UKM21	Member State	DUNDEE
	1296	CLACKMANNANSHIRE AND FIFE	UKM22	Member State	DUNFERMLINE
	1297	EAST LOTHIAN AND MIDLOTHIAN	UKM23	Member State	DUNBAR
	1298	SCOTTISH BORDERS,THE	UKM24	Member State	GORDON
	1299	EDINBURGH, CITY OF	UKM25	Member State	EDINBURGH
	1300	FALKIRK	UKM26	Member State	FALKIRK
	1301	PERTH, KINROSS, STIRLING	UKM27	Member State	STIRLING
	1302	WEST LOTHIAN	UKM28	Member State	LIVINGSTON
	1303	EAST A. WEST DUNBARTONSHIRE	UKM31	Member State	DUMBARTON
	1304	DUMFRIES AND GALLOWAY	UKM32	Member State	DUMFRIES
	1305	E.A.N. AYRSHIRE, MAINLAND	UKM33	Member State	KILMARNOCK
	1306	GLASGOW CITY	UKM34	Member State	GLASGOW
	1307	INVERCLYDE, EAST RENFREWS	UKM35	Member State	PAISLY
	1308	NORTH LANARKSHIRE	UKM36	Member State	COATBRIDGE
	1309	SOUTH AYRSHIRE	UKM37	Member State	AYR
	1310	SOUTH LANARKSHIRE	UKM38	Member State	EAST KILBRIDE

Table F.1. IASON system of regions (cont.).

Country	No.	Region	Code	Status	Centroid
United Kingdom (cont.)	1311	CAITHNESS, SUTHERLAND, ROSS	UKM41	Member State	WICK
	1312	BADENOCH, STRATHSPEY, LOC	UKM42	Member State	INVERNESS
	1313	LOCHABER, SKYE, LOCHALSH, AR	UKM43	Member State	OBAN
	1314	EILEAN SIAR (WESTERN ISLE	UKM44	Member State	STORNOWAY
	1315	ORKNEY ISLANDS	UKM45	Member State	KIRKWALL
	1316	SHETLAND ISLANDS	UKM46	Member State	LERWICK
	1317	BELFAST	UKN01	Member State	BELFAST
	1318	OUTER BELFAST	UKN02	Member State	LISBURN
	1319	EAST OF NORTHERN IRELAND	UKN03	Member State	BALLYMENA
	1320	NORTH OF NORTHERN IRELAND	UKN04	Member State	LONDONDERRY
	1321	W.A.S. OF NOTRTHERN IRELAND	UKN05	Member State	OMAGH
Albania	1322	SHQIPERIA	AL	Rest of Europe	TIRANE
Bosnia i Herce-govina	1323	BOSNA I HERCEGOVINA	BA	Rest of Europe	SARAJEVO
Belarus	1324	MINSK	BY001	Rest of Europe	MINSK
	1325	WITEBSK	BY002	Rest of Europe	WITEBSK
	1326	MOGILJOW	BY003	Rest of Europe	MOGILJOW
	1327	GOMEL	BY004	Rest of Europe	GOMEL
	1328	BREST	BY005	Rest of Europe	BREST
	1329	GRODNO	BY006	Rest of Europe	GRODNO
Croatia	1330	ZAGREB	HR001	Rest of Europe	ZAGREB
	1331	DALMACIJA	HR002	Rest of Europe	SPLIT
Iceland	1332	ISLAND	IS	Rest of Europe	REYKJAVIK
Liechtenstein	1333	LIECHTENSTEIN	LI	Other Countries	VADUZ
Moldova	1334	MOLDOVA	MD	Rest of Europe	CHISINAU
Makedonia	1335	MAKEDONIJA	MK	Rest of Europe	SKOPJE
Russia	1336	ARCHANGELSKAJA OBLAST	RU101	Rest of Europe	ARCHANGELSK
	1337	VOLOGODSKAJA OBLAST	RU102	Rest of Europe	VOLOGDA
	1338	MURMANSKAJA OBLAST	RU103	Rest of Europe	MURMANSK
	1339	KARELIJAL, REPUBLIKA	RU104	Rest of Europe	PETROZAVODSK
	1340	KOMI, RESPUBLIKA	RU105	Rest of Europe	UCHTA
	1341	NENECKIJ AVTONOMNYI OKRUG	RU106	Rest of Europe	NARJAN MAR
	1342	LENINGRADSKAJA OBLAST	RU201	Rest of Europe	PETRODVOREC
	1343	SANKT-PETERBURG, GOROD	RU202	Rest of Europe	SANKT PETERBURG
	1344	NOVGORODSKAJA OBLAST	RU203	Rest of Europe	NOVGOROD
	1345	PSKOVSKAJA OBLAST	RU204	Rest of Europe	PSKOV
	1346	BRJANSKAJA OBLAST	RU301	Rest of Europe	BRJANSK
	1347	VLADIMIRSKAJA OBLAST	RU302	Rest of Europe	VLADIMIR
	1348	IVANOVSKAJA OBLAST	RU303	Rest of Europe	IVANOVO
	1349	KALUZSKAJA OBLAST	RU304	Rest of Europe	KALUGA
	1350	KOSTROMSKAJA OBLAST	RU305	Rest of Europe	KOSTROMA
	1351	MOSKVA OBLAST	RU306	Rest of Europe	PODOLSK
	1352	MOSKVA, GOROD	RU307	Rest of Europe	MOSKVA
	1353	ORLOVSKAJA OBLAST	RU308	Rest of Europe	ORJOL
	1354	RJASAN OBLAST	RU309	Rest of Europe	RJASAN
	1355	SMOLENSKAJA OBLAST	RU310	Rest of Europe	SMOLENSK
	1356	TVERSKAJA OBLAST	RU311	Rest of Europe	TVER
	1357	TULSKAJA OBLAST	RU312	Rest of Europe	TULA
	1358	JAROSLAVSKAJA OBLAST	RU313	Rest of Europe	JAROSLAVL
	1359	BELGORODSKAJA OBLAST	RU501	Rest of Europe	BELGOROD
	1360	KURSKAJA OBLAST	RU502	Rest of Europe	KURSK
	1361	LIPECKAJA OBLAST	RU503	Rest of Europe	LIPETSK
	1362	KALININGRAD	RUA	Rest of Europe	KALININGRAD
	1363	OTHER RUSSIA	RUB	Rest of Europe	OMSK
Turkey	1364	TUERKIYE	TR	Rest of Europe	ISTANBUL
Ukraina	1365	SUEDWESTLICHES WIRTSCHAFTGEB.	UA001	Rest of Europe	KYIV
	1366	SUEDLICHES WIRTSCHAFTSGEBIET	UA002	Rest of Europe	ODESSA
	1367	DONEZK-DNEPR-GEBIET	UA003	Rest of Europe	DNEPROPETROWSK
	1368	WESTLICHES WIRTSCHAFTSGEBIET	UA004	Rest of Europe	LVIV
Yugoslavia	1369	SERBIA	YU001	Rest of Europe	BEOGRAD
	1370	VOIVODINA	YU002	Rest of Europe	NOVI SAD
	1371	KOSOVO	YU003	Rest of Europe	PRISTINA
	1372	MONTENEGRO	YU004	Rest of Europe	PODGORICA