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AlpenCorS
Alpen Corridor South
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Modelling Regional Development in AlpenCorS
Scenario Results

Final Report

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1 Introduction

AlpenCorS is a multi-sectoral and inter-regional bottom-up development project of economy and transport matters focused on the central segment of the Paneuropean Corridor V between France, Italy and Slovenia-Austria south of the Alps. The AlpenCorS project is being conducted within the Interreg III B Programme "Alpine Space" (2000-2006).

AlpencorS aims at contributing to the development of a Corridor policy concept as a common strategy of economic and space development for this part of the European territory. The research presented in this report contributes to Work Package 10 of AlpenCorS. The objective of Work Package 10 is to contribute to the AlpenCorS strategy by assessing the potential of the intersection of Corridor V with the major trans-Alpine north-south corridor linking the AlpenCorS regions with the European regions north of the Alps, Corridor I, the Brenner corridor. The projections of the regional economic impacts of various transport policy options for the Brenner corridor presented in this report contribute to a broader Territorial Impact Assessment of these policy options produced at the Dipartimento di Ingegneria Gestionale of the Politecnico di Milano aiming at uncovering the general economic and transport evolution within Corridor I and providing basic information for future corridor policy.

Scenarios of future economic development in the regions within and outside the AlpenCorS study area are a prerequisite for making forecasts of the development of travel and goods transport in the Corridor. However, regional economic development is itself a function of the efficiency of the transport system in the Corridor and of how the Corridor is linked with the rest of the European territory. Forecasting regional economic development in the Corridor therefore requires a forecasting model able to capture the interaction between spatial development and transport.

The SASI model presented in this report is a model of this kind. The SASI model is used to forecast economic development in the regions within and outside the Corridor subject to (a) assumptions about economic development in Europe at large, (b) assumptions about the process of European integration in particular with respect to the new EU member states and future potential accession countries and (c) assumptions about the implementation of European and national policies in the fields of economic policy, migration policy and transport policy, and to analyse the effects of these scenarios on interregional cohesion, i.e. socio-economic convergence between the regions.

The First Interim Report (June 2004) presented the structure of the SASI model and of its database as it was developed and applied in previous EU projects, in particular the projects IASON (Integrated Appraisal of Spatial Economic and Network Effects of Transport Investments and Policies) of the 5th Research Framework of the European Union and ESPON 2.1.1 (Territorial Impacts EU Transport and TEN Policies) of the European Spatial Planning Observation Network (ESPON). In addition, the study area analysed in AlpenCorS and the extensions of the model database performed to prepare the model for the tasks in AlpenCorS were presented in tables and maps.

The Second Interim Report (December 2004) presented first results of the application of the SASI model to the AlpenCorS study area. In that report only two transport policy scenarios could be presented. This Final Report presents the results of a larger set of transport policy scenarios, including those incorporating the implementation of the Valdastico and Pedemontana Veneta motorways and the development of the Valsugana road and rail corridor. This final set of scenarios was made compatible with the scenarios examined in the Territorial Impact Assessment conducted by at the Dipartimento di Ingegneria Gestionale of the Politecnico di Milano.

This report starts with a brief recapitulation of the SASI model, its further development for AlpenCorS and the character of its results. It then presents the reference scenario, which serves as the benchmark for the comparison of the transport infrastructure scenarios to be studied. Typical output indicators of the reference scenario are presented in diagrams and maps with special focus on the AlpenCorS regions and in particular the Autonomous Provinces of Trento and Bolzano. Then the transport infrastructure scenarios studied are explained and their results presented and compared. The report closes with a discussion of the relevance and reliability of the results and their implications for a coherent Corridor strategy.

The work reported is the outcome of a co-operation with the Dipartimento di Ingegneria Gestionale of the Politecnico di Milano. The support by Roberto Camagni and Tomaso Pompili is gratefully acknowledged. At the Provincia Autonoma di Trento, Claudio Tiso and Maurizio Castagnini provided valuable information and helpful guidance. Maria Teresa Gabardi and her colleagues at the Dipartimento Interateneo Territorio (DIT) at the Politecnico and Università di Torino kindly provided information on transport infrastructure projects in the AlpenCorS area for cross-checking the European network database used with the SASI model. Special thanks go to Carsten Schürmann of RRG Spatial Planning and Geoinformation for integrating this information and specifying the transport infrastructure scenarios in that database.

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Michael Wegener

2 The SASI Model

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, such as transport investment, has a positive influence on private investment.
- *Regional growth approaches* assume that regional economic growth is a function of regional endowment factors including public capital such as transport infrastructure.
- *Production function approaches* model economic activity in a region as a function of production factors including infrastructure as a public input used by firms within the region.
- *Accessibility approaches* substitute more complex accessibility indicators for the simple infrastructure endowment in the regional production function.
- *Regional input-output* approaches model interregional and inter-industry linkages as a function of transport cost and technical inter-industry input-output coefficients.
- *Trade integration approaches* model interregional trade flows as a function of interregional transport costs and regional product prices.

The SASI model belongs to the group of accessibility approaches in which regional production functions are extended by accessibility indicators representing the locational advantage of regions provided by the transport system. In this chapter, the SASI model is briefly presented. A more comprehensive description of the model is contained in AlpenCorS Deliverable D2.2 *Modelling Regional Development in AlpenCorS: Construction of the Economic Impact Model* (Spiekermann and Wegener, 2004).

2.1 Model Design

The SASI model (Wegener and Bökemann, 1998; Bröcker et al., 2002) 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..

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.

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 2.1 visualises the interactions between these submodels.

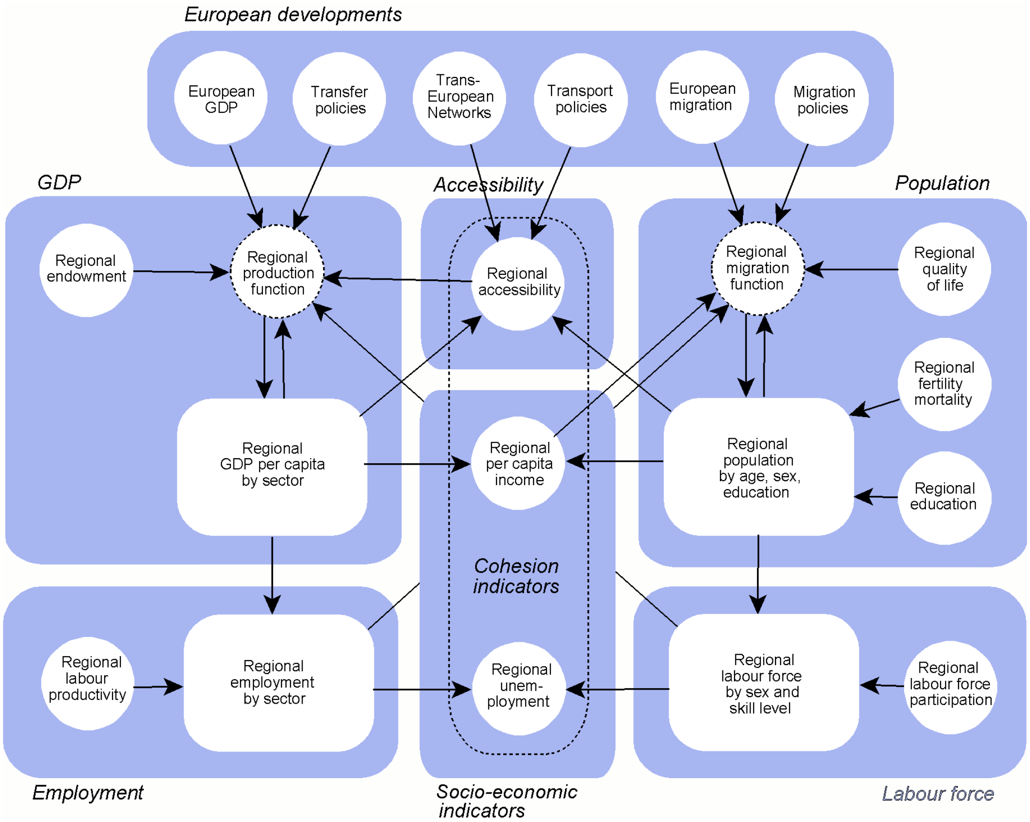

Figure 2.1. The SASI model

The *spatial* dimension of the model is established by the subdivision of the 25 present countries of the European Union plus Norway and Switzerland and the two candidate countries Bulgaria and Romania and for AlpenCorS also the five western Balkan countries Albania, Bosnia and Herzegowina, Croatia, Makedonia and Yugoslavia into 1,330 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.

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 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.

2.3 Model Developments for AlpenCorS

The SASI model was applied in the projects IASON (Integrated Appraisal of Spatial Economic and Network Effects of Transport Investments and Policies) of the 5th Research Framework of the European Union (Bröcker et al., 2004a) and ESPON 2.1.1 (Territorial Impacts EU Transport and TEN Policies) of the European Spatial Planning Observation Network ESPON (Bröcker et al., 2003, 2004b).

For its application in AlpenCorS three extensions of the model database were performed to make the model better prepared for the tasks in AlpenCorS:

(1) The system of regions of the model was extended to include the western Balkan countries Albania, Bosnia and Herzegowina, Croatia, Makedonia and Yugoslavia. By this the number of regions considered in the model was increased to 1,330.

(2) The network database of the model was represented in greater detail in the AlpenCorS study area in order to make the model more sensitive to local improvements.

(3) The model database was updated using recently made available regional data for GDP, employment and population for the year 2001.

(4) The regional production functions of the model were re-calibrated using the 2001 data. The results of the new calibration are presented in the following section.

2.4 Model Calibration

The regional production functions of the SASI model were estimated by linear regression of the logarithmically transformed Cobb-Douglas regional production functions for the 1,330 internal regions and the six industrial sectors used in AlpenCorS for the years 1981, 1986, 1991, 1996 and 2001. 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 accession countries in eastern Europe, which underwent the transition from planned economies to market economies, information on regional GDP was inconsistent or completely missing. It was therefore necessary to adjust regional sectoral GDP data for the years 1981 to 1991 to conform to estimates of regional GDP totals by Eurostat. In a similar way the sectoral composition of regional economies was cross-checked by comparison with the sectoral composition of gross value added in the Eurostat New Cronos database.

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

*sgdp**n***	Share of GDP of sector ***n*** (%)
*gdpw**n***	GDP per worker in sector ***n*** (1,000 Euro of 1998)
acct	Accessibility road/rail/air travel
accf	Accessibility road/rail freight
rlmp	Regional labour market potential (accessibility to labour)
pdens	Population density (pop/ha)
devld	Developed land (%)
rdinv	R&D investment (% of GDP)
eduhi	Share of population with higher education (%)
quali	Quality of life indicator (0-100)

To take account of the slow process of economic structural change, independent variables *sgdp**n*** and *gdpw**n*** 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 2.1 shows the regression coefficients for the selected variables for 2001. 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 the simulations for the years 1981 to 2001, predicted GDP values were corrected by their residuals to match observed values. The regression parameters and residuals for 2001 were used for the simulations for the years 2002 to 2021.

Table 2.1. SASI model: calibration results (2001)

Variables	Regression coefficients					
	Agriculture	Manufac-turing	Construc-tion	Trade, tourism, transport	Financial services	Other services
sgdpn	0.484066	0.992386	1.164469	1.086756	1.223099	1.142765
gdpwn	0.529735	0.850462	0.935339	0.874363	0.317379	0.874044
acct				0.261673	0.123609	0.224719
acctf	0.396847	0.161951	0.264272			
rlmp		0.050725		0.057370	0.035458	0.049688
pdens	–0.156644		0.035371	–0.036171	0.032480	
devld				–0.145818		
rdinv		0.101437			0.307833	0.086143
eduhi		0.123613			0.607406	0.110765
quali				0.341000		
Constant	–2.608195	–1.379831	–1.734054	–1.510096	1.667133	–1.325561
r^2	0.635	0.581	0.644	0.676	0.614	0.711

3 The Study Area

The AlpenCorS study area extends over six countries: Austria, Switzerland, Germany, France, Italy and Slovenia. It covers the whole of Austria, Switzerland and Slovenia and parts of Germany, France and Italy. Altogether there are 33 NUTS-2 regions in the study area.

Table 3.1 lists the 33 NUTS-2 regions by country and the number of NUTS-3 regions in each NUTS-2 region. There are 186 NUTS-3 regions in the study area – a significant part of the 1,330 NUTS-3 regions in Europe modelled by the SASI model. The table in the Annex lists the region codes, names and major cities of the 186 NUTS-3 regions of the study area according to the 2003 revision of the NUTS system. Figure 3.1 presents the system of regions in the study area. The heavy lines in the shaded area represent boundaries between NUTS-2 regions, the white lines boundaries between NUTS-3 regions.

Table 3.1. NUTS-2 regions in the AlpenCorS area

Country	No.	Region	Code	NUTS 2	NUTS 3	
Austria	1	Burgenland	AT11		3	
	2	Niederösterriech	AT12		7	
	3	Wien	AT13		1	
	4	Kärnten	AT21		3	
	5	Steiermark	AT22		6	
	6	Oberösterreich	AT31		5	
	7	Salzburg	AT32		3	
	8	Tirol	AT33		5	
	9	Vorarlberg	AT34	9	2	35
Switzerland	10	Genève/Lausanne	CH01		3	
	11	Bern	CH02		5	
	12	Basel	CH03		3	
	13	Zürich	CH04		1	
	14	St. Gallen	CH05		7	
	15	Luzern	CH06		6	
	16	Bellinzona	CH07	7	1	26
Germany	17	Freiburg	DE13		10	
	18	Tübingen	DE14		9	
	19	Oberbayern	DE21		23	
	20	Schwaben	DE27	4	14	56
France	21	Alsace	FR42		2	
	22	Franche-Comté	FR43		4	
	23	Rhône-Alpes	FR71		8	
	24	Provence-Alpes-Côte d'Azur	FR82	4	6	20
Italy	25	Piemonte	ITC1		8	
	26	Valle d'Aosta	ITC2		1	
	27	Liguria	ITC3		4	
	28	Lombardia	ITC4		11	
	29	Alto Adige	ITD1		1	
	30	Trento	ITD2		1	
	31	Veneto	ITD3		7	
	32	Friuli-Venezia Giulia	ITD4	8	4	37
Slovenia	33	Slovenia	SI	1	12	12
Total				33	186	186

The transport networks used with the SASI model rely on the European transport network GIS database developed by the Institute of Spatial Planning of the University of Dortmund (IRPUD, 2001). The *strategic* road and rail networks used in the model comprise the trans-European transport networks (TEN-T) specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996; European Commission, 1998), further specified in the *TEN Implementation Report* and latest revisions of the TEN guidelines provided by the European Commission (2002a; 2002b) and the latest documents on the priority projects (High Level Group, 2003; European Commission, 2003; 2004) and the transport networks of European importance identified in eastern Europe by the Transport Needs Assessment (TINA) committee 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 IRPUD networks were cross-checked for transport projects in the AlpenCorS study area for AlpenCorS using information made available by the Dipartimento Interateneo Territorio, Politecnico e Università di Torino (Gabardi et al., 2004).

The maps in Figures 3.2 and 3.3 show the existing road and rail networks used by the SASI model for the study area. In both maps the heavy red lines represent the links of the TEN and TINA networks as defined by the European Union. They are completely included in the SASI model network database. The lighter yellow lines are other important links also included in the SASI model network database.

Figure 3.4 shows the airports of the study area indicated by their IATA code and classified by their TEN airport category. The flight database used by the SASI model contains all scheduled flights in Europe.

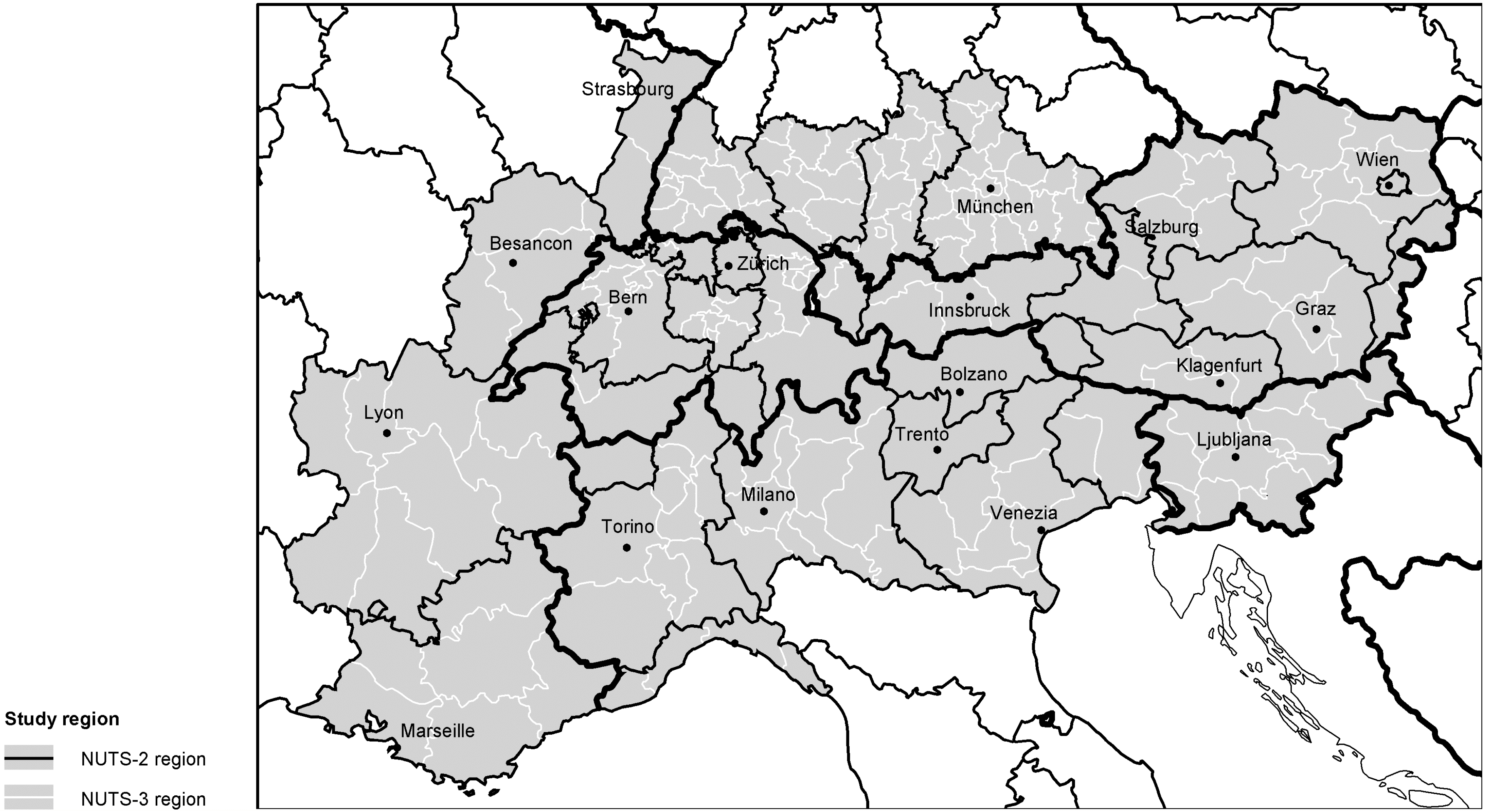

Figure 3.1. The system of regions in the AlpenCorS study area

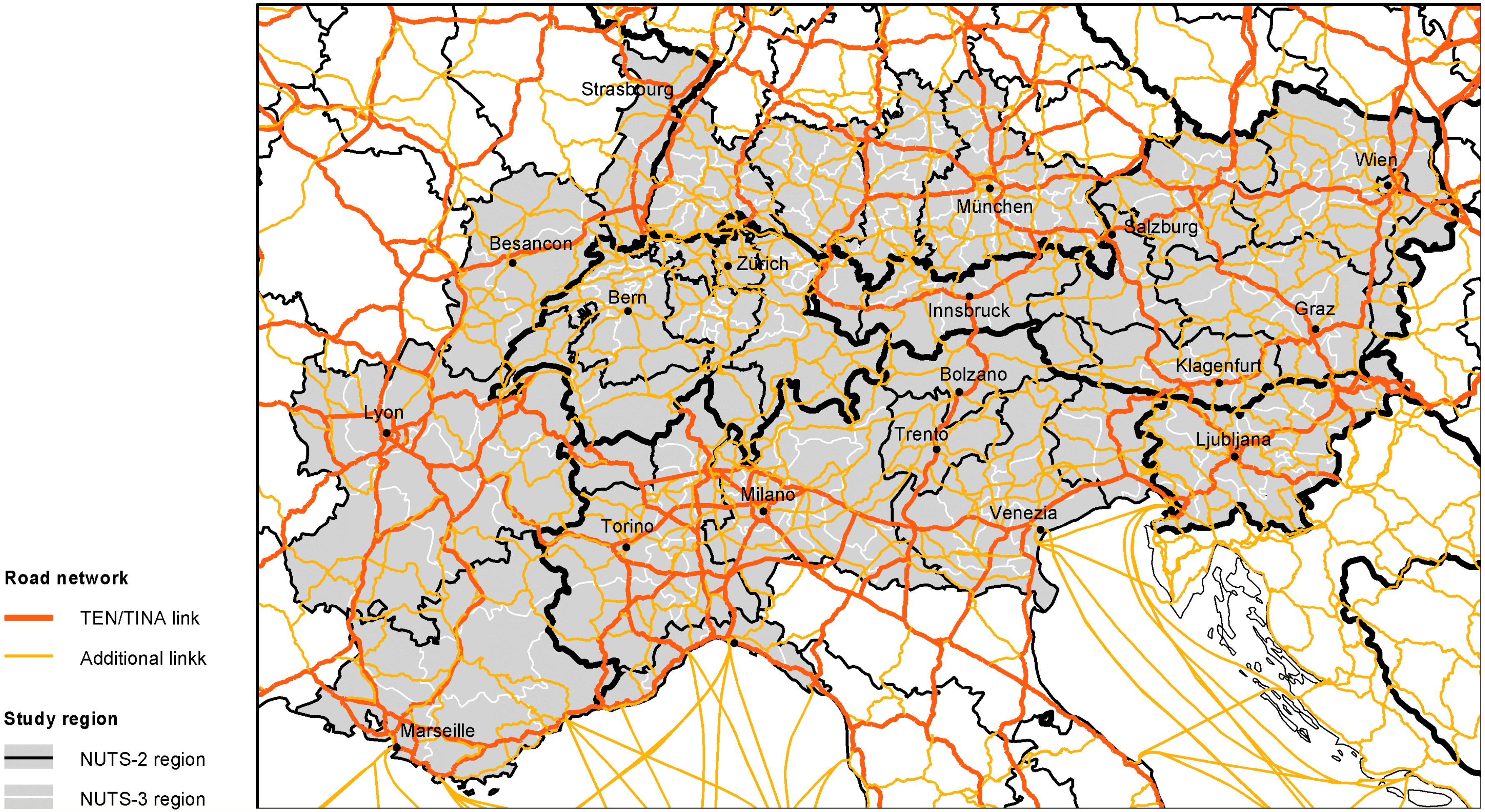

Figure 3.2. The road network in the AlpenCorS study area

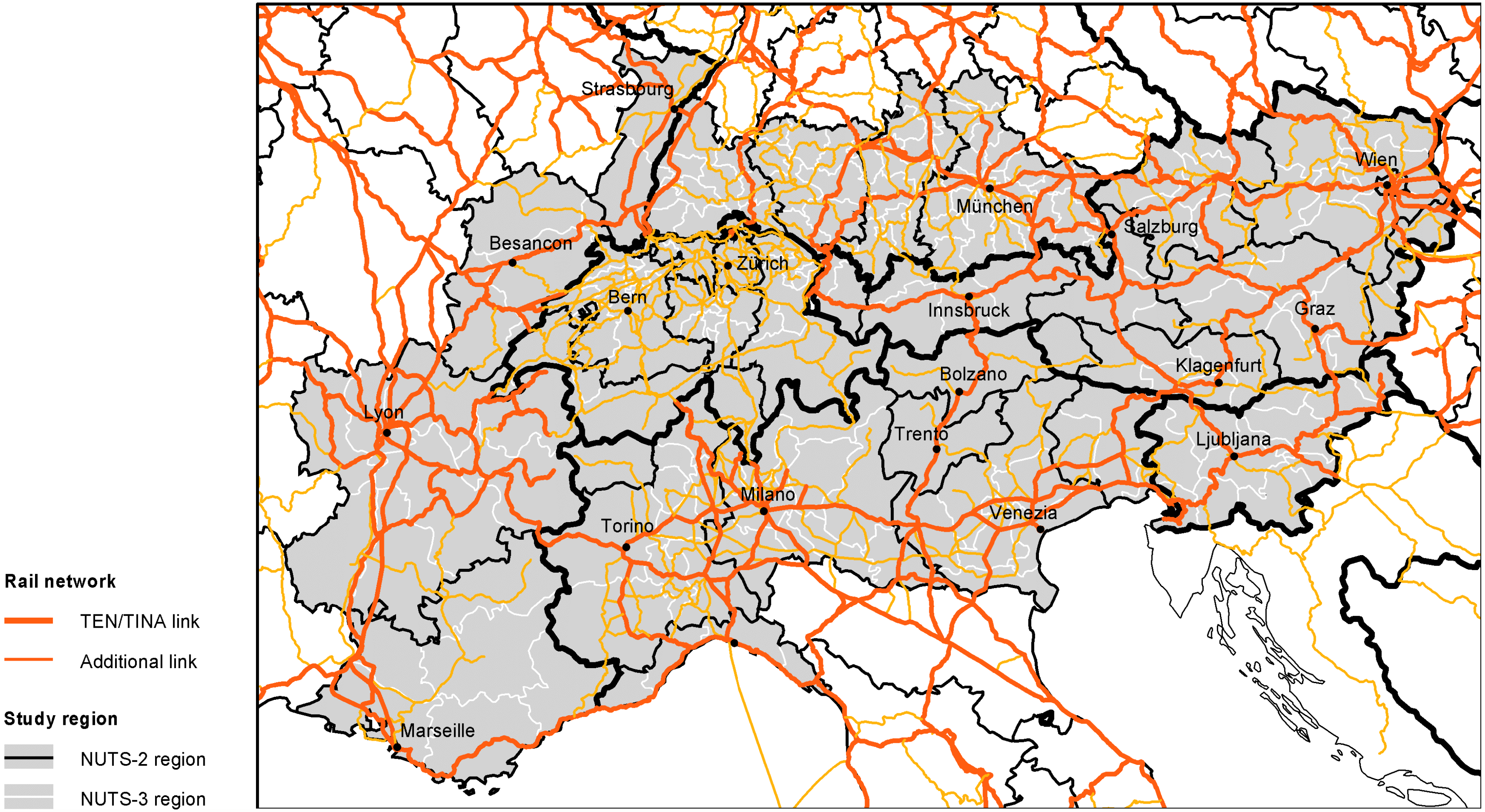

Figure 3.3. The rail network in the AlpenCorS study area

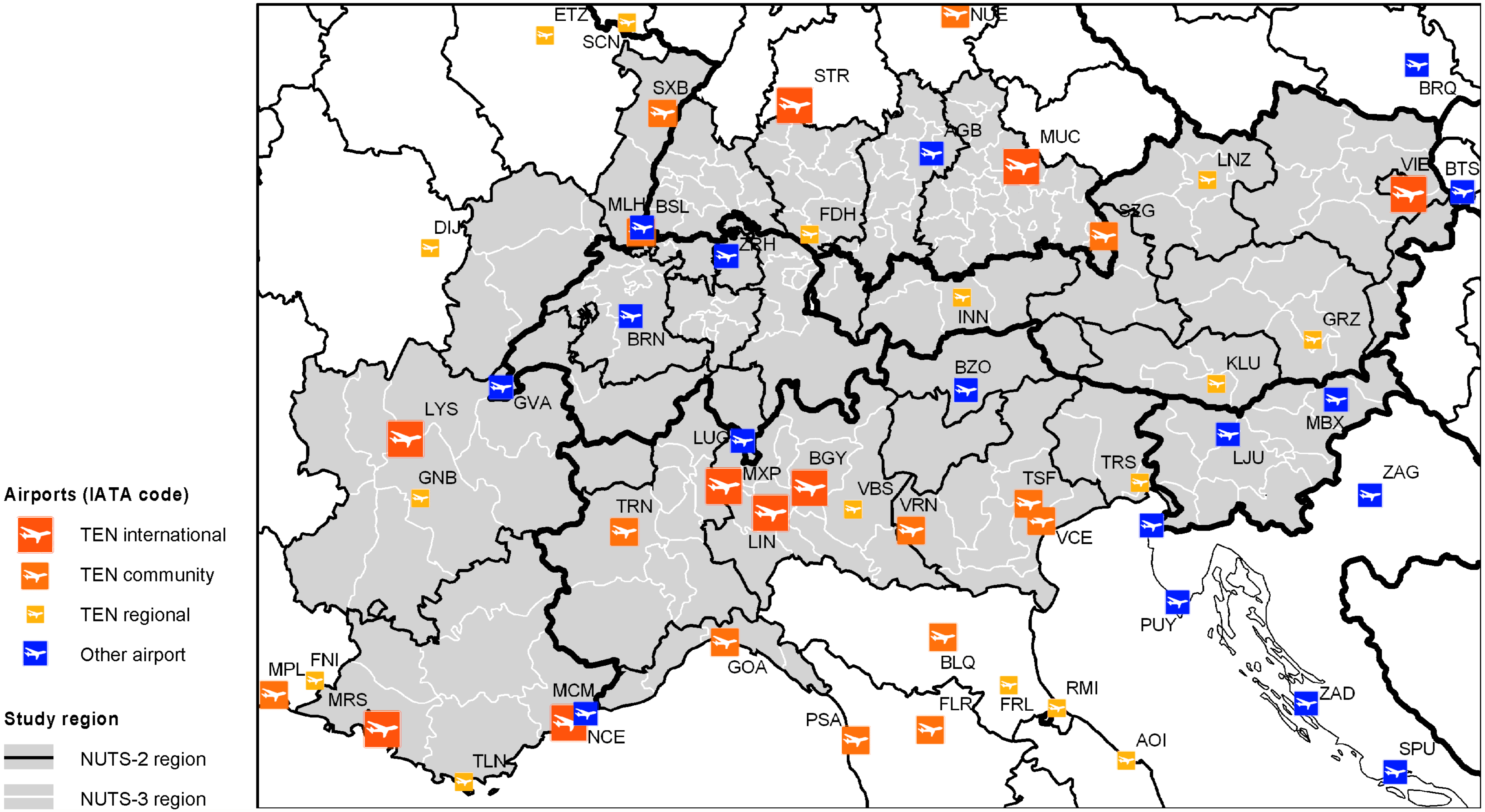

Figure 3.4. Airports in the AlpenCorS study area

4 Scenarios

This chapter describes the scenarios modelled with the SASI model for AlpenCorS. First, a reference scenario is defined which includes the most important infrastructure projects in Europe but not the Brenner tunnel. Then six transport infrastructure scenarios are defined to analyse the effects of the Brenner tunnel and other transport infrastructure projects at the intersection of Corridors I and V.

4.1 The Reference Scenario (Scenario 000)

The Reference Scenario 000 serves as benchmark for the comparison between policy scenarios. For the reference scenario in AlpenCorS (Scenario 000) a number of assumptions are made:

- For the period between 1981 and 2001, it is assumed for the reference scenario that the rail, road and air networks have developed as they have in reality. This means that new transport infrastructure projects or upgrades of existing infrastructure, e.g. from national roads to motorways, are implemented in the model network database in the year in which they were opened in reality. The same network evolution in the years 1981 to 2001 is also used in all policy scenarios, i.e. the policy scenarios differ only from 2001 onwards.

- For the period between 2001 and 2021, it is assumed for the reference scenario that only transport infrastructure projects that are part of the new list of TEN priority projects defined by the European Union (European Commission, 2004) are implemented. However, it is assumed that the Brenner tunnel, although it is part of the priority projects, is *not* implemented – this assumption was made in order to analyse the effect of the Brenner tunnel separately (in Scenario AS1, see below). In addition, major railway tunnel projects in Switzerland, which have similar importance as the TEN priority projects, are included in the reference scenario. The new infrastructure projects are assumed to be implemented in the implementation year published. However, in the past expectations with respect to the implementation schedule of major transport infrastructure projects have been too optimistic in many cases. No other transport infrastructure developments in Europe are included in the reference scenario. Figure 4.1 shows the TEN priority projects and the major rail projects in Switzerland. Table 4.1 lists these projects and their major links affecting the AlpenCorS study area.

4.2 Infrastructure Scenarios

Besides the reference scenario, six transport infrastructure scenarios were simulated. The first five of these were designed to be compatible with the scenarios examined in the Territorial Impact Analysis of the Dipartimento di Ingegneria Gestionale of the Politecnico di Milano (Camagni and Musolino, 2003 and Camagni et al., 2004). In addition, a sixth scenario assuming the implementation of the full list of projects envisaged in the TEN and TINA programmes was simulated.

4.2.1 The Brenner Tunnel (Scenario AS1)

Although the Brenner tunnel is part of TEN Priority Project No 1, the rail axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermao (see Table 4.1), its implementation was not included in Reference Scenario 000 in order to analyse it separately. This is done in the first transport infrastructure scenario, Scenario AS1.

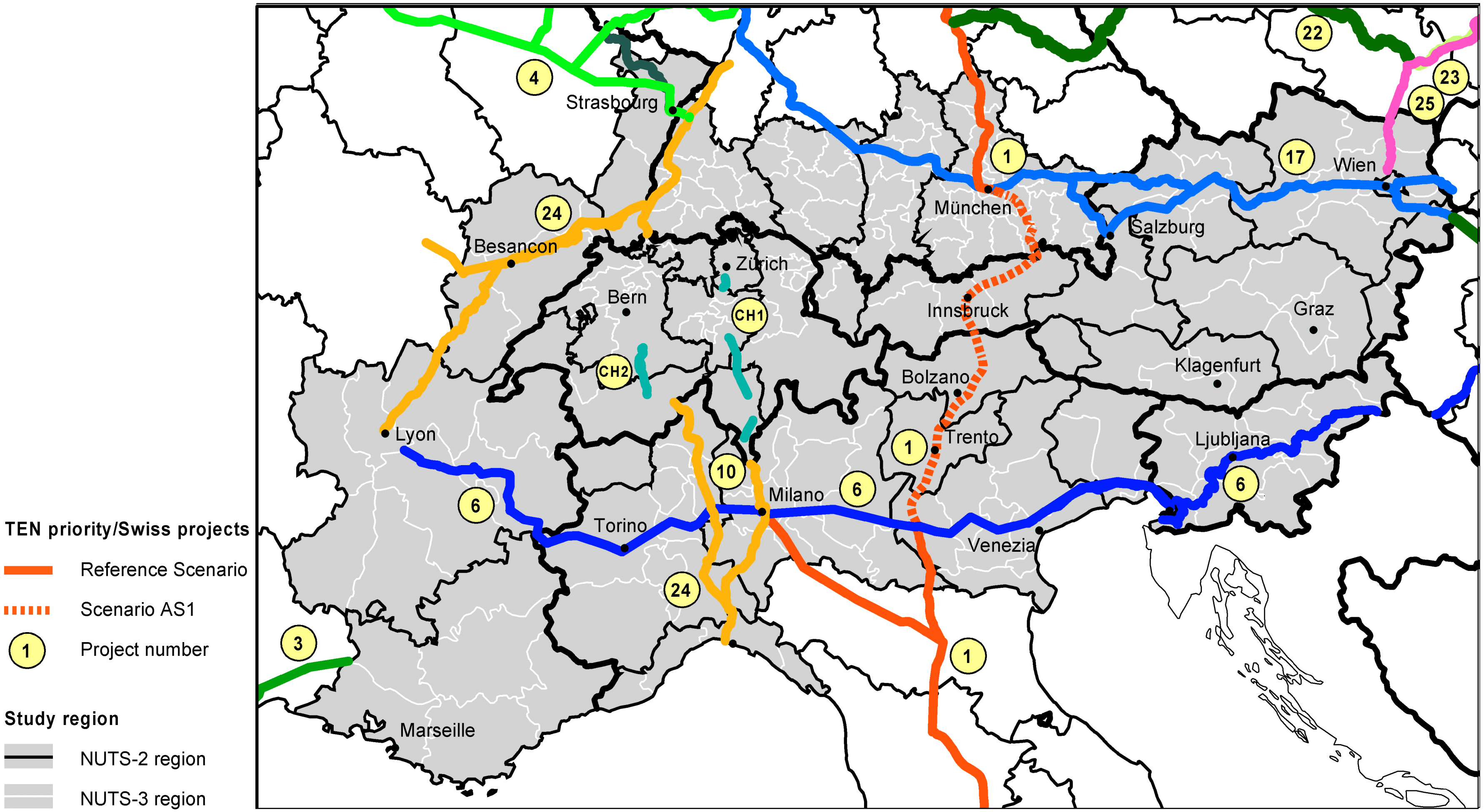

Figure 4.1. Transport projects of the Reference Scenario 000 and Scenario AS1 in the AlpenCorS study area

Table 4.1 TEN priority projects and major Swiss projects in the AlpenCorS study area

No.	TEN project	Completion date
1	Rail axis Berlin-Verona/Milan-Bologna-Napoli-Messina-Palermo - Munich-Kufstein (2015) - Kufstein-Innsbruck (2009) - Brenner tunnel (2015)* ** - Verona-Naples (2007) - Milan-Bologna (2006)	2006-2015
3	High-speed rail axis of South West Europe - Pvontepellier- Nîmes (2010)	2005-2020
4	TGV Est Paris-Saarbrücken-Mannheim	2007
6	Rail axis Lyon-Trieste/Koper-Ljubljana-Budapest-Ukraine - Lyon-St-Jean-de-Maurienne (2015) - Mont Cenis tunnel (2015-2017)* - Bussoleno-Turin (2011) - Turin-Venice (2010) - Venice-Trieste/Koper-Ljubljana (2015) - Ljubljana-Budapest (2015)	2010-2015
10	Malpesa airport	2001
17	Rail axis Paris-Strasbourg-Stuttgart-Wien-Bratsilava -Baudrecourt-Strasbourg-Stuttgart (2015) - Kehl bridge (2015) - Stuttgart-Ulm (2012) - Munich-Salzburg (2015)* - Salzburg-Vienna (2012) - Vienna-Bratislava (2010)*	2010-2015
22	Rail axis Athens-Sofia-Budapest-Vienna-Prague-Nuremberg - Budapest-Vienna (2010)* - Brno-Prague-Nuremberg (2010)*	2010-2015
23	Rail axis Gdanks-Warsaw-Brno/Bratislava-Vienna - Katowice-Brno-Breclav (2010) - Katowice-Zilina-Nove Misto n.V. (2010)	2010-2015
24	Rail axis Lyon/Genoa-Basel-Buisburg-Rotterdam/Antwerp - Lyon-Mulhouse-Mülheim (2018)* - Genoa-Milan/Novara-Swiss border (2013) - Basel-Karlsruhe (2015)	2009-2010
25	Motorway Gdansk-Brno/Bratislava-Vienna - Gdansk-Katowice (2010) - Katowice-Brno/Zilina (2019* - Brno-Vienna (2009)*	2009-2010
No.	**Swiss project**	**Completion date**
CH1	Gotthard axis - Zimmerberg tunnel (2011) - Gotthard tunnel (2015) - Ceneri tunnel (2015)	2011-2015
CH2	Lötschberg tunnel	-2015

* Cross-border link   ** The Brenner tunnel was not included in the reference scenario (see text).

Because of the importance for the AlpenCorS area and in particular for the Autonomous Province of Trento, the assumptions for the Brenner corridor are described in more detail. The Brenner rail axis between München and Verona is the core element of TEN Priority Project No. 1, a rail corridor from Berlin via the Alps to southern Italy. Parts of the planned transport infrastructure in this corridor is already in operation, e.g. the high-speed rail link between Firenze and Roma, other parts are under construction or in the planning phase. The Brenner tunnel and its northern and southern approaches are key projects to overcome a major transport bottleneck and reduce environmental effects of transport in Europe.

The Brenner rail corridor and in particular the tunnel was the subject of a large number of feasibility and other studies (for a summary see EURAC-Research et al., 2003). The plan foresees a four-track rail line for the 400 km between München and Verona consisting of two tracks of the existing line and two new tracks for high-speed passenger and freight services. For the northern and southern approaches to the Brenner tunnel, national transport planning in Italy, Austria and Germany made the necessary decisions to implement the new line. In 2004 a treaty between Austria and Italy was signed in which the construction of the Brenner tunnel was concluded.

Similar to many other major transport infrastructure projects, different parts of the Brenner rail axis will become operational at different points in time. Parts of the northern approach in Austria and related links in Germany giving more capacity to the Brenner axis and the Bozen bypass will be in operation by the end of this decade. The Brenner tunnel is expected to be in operation by 2015 as well as its southern exit south of Franzensfeste and the approach into Verona. The Trento bypass is expected to be in operation by 2020. However, other links between the Brenner tunnel and Verona will probably not be in operation before 2030 (e.g. EURAC-Research, et al., 2003) and are therefore not included in Scenario AS1, but an earlier implementation is assumed in Scenario AS2 (see below).

For passenger transport, the Brenner axis will bring substantial improvements in travel time. The design speed for high-speed trains on the link will be 250 km/h and 200 km/h in the Brenner tunnel (BBT, 2002a). Rail travel times between München and Verona will go down from 5.5 hours today to less than three hours in the future and probably down to 2.5 hours in the far future. The Brenner tunnel itself will lead to a reduction in rail travel time between Innsbruck and Bozen/Bolzano from 124 to 50 minutes. It is assumed that high-speed trains will call at the main stations of München, Innsbruck, Bozen/Bolzano, Trento and Verona (AG Brennerbahn, 2004)

Figure 4.1 shows the part of the Brenner axis upgraded in Scenario AS1. Table 4.2 shows the current travel times of EC trains and, based on the expected implementation years indicated above, the SASI model assumptions for future high-speed train travel times between the major centres in the corridor assumed for Scenario AS1. These assumptions do not include the further reductions on the section between Trento and Verona assumed in Scenario AS2 (see below).

Table 4.2 Current passenger travel times and assumptions for future years (minutes).

From	to	2004	2011	2016	2021
München	Innsbruck	116	88	70	60
Innsbruck	Bozen/Bolzano	124	124	50	50
Bozen	Trento	34	30	25	20
Trento	Verona	55	55	43	40
München	Verona	329	297	188	170

However most of the future capacity of the Brenner rail axis will be used for rail freight transport. 80 percent of the future capacity of 400 trains will be freight trains. The rail freight capacity will be increased from 15 million tons per year to 40 million tons per year in order to accommodate the expected growth in freight transport in the corridor (AG Brennerbahn, 2004). The design speed for freight trains in the Brenner tunnel will be 100 to 120 km/h for ordinary trains and up to 160 km/h for a limited number of express freight trains (BBT, 2002a). Rail freight transport times between München and Verona are currently about ten hours including terminal times and will finally be reduced to 5 hours.

Important for the modal shift of freight from road to rail are the combined transport terminals enabling freight transport chains lorry to freight train to lorry. There are five intermodal transport terminals along the Brenner corridor which all have space for capacity extensions (ARGE ALP, 2003; BBT, 2002b):

- Verona: Terminal Quadrante Europa
- Trento: Interbrennero S.P.A.
- Hall in Tirol: TSSU
- Wörgl
- München-Riem

In addition, there are plans to implement a combined transport terminal in Bozen/Bolzano. For the reference scenario of the SASI model it is assumed that the six combined transport terminals will provide shuttle services for lorries through the Brenner tunnel. It is assumed that from each combined transport terminal on either side of the Brenner tunnel there will be shuttle services to all three combined transport terminals on the other side of the tunnel, e.g. there will be shuttle services from Trento to Hall, Wörgl and München.

4.2.2 Southern Rail Bypass (Scenario AS2)

In this scenario it is assumed that, in addition to the implementation of the Brenner tunnel, the Italian part of the Brenner axis south of the Brenner tunnel will be further improved by a series of long rail tunnels by 2020. In the Provincia Autonoma di Trento this means tunnels between Faedo and Mattarello and again from south of Mattarello to Peri in the Provincia di Verona. These improvements will allow full separation of freight and passenger transport and make the trans-Alpine rail link more competitive for passengers. It is assumed that the passnger travel times between Trento and Verona will go down to 25 minutes until 2021. Figure 4.3 shows the southern rail bypass. In every other respect Scenario AS2 is identical to Scenario AS1.

4.2.3 Motorways Valdastico and Pedemontana (Scenario AS3)

In this scenario it is assumed that, in addition to the implementation of the Brenner tunnel, the northern part of the Italian motorway A31 (Valdastico) will be built. The motorway section is about 40 km long. The completed A31 will directly link Trento with Vicenza, allow better separation of freight and passenger transport and will benefit the intermodal freight terminal in Trento. In addition it is assumed that the Pedemontana Veneta motorway will be continued to link Vicenza with Treviso. Both motorway projects will link the north-eastern parts of Italy with the Brenner corridor and northern Europe without the detour via Verona. Figure 4.2 shows the alignment of the Valdastico and Pedemontana motorways. In every other respect Scenario AS3 is identical to Scenario AS1.

4.2.4 Valsugana Road and Rail Corridor (Scenario AS4)

In this scenario it is assumed that, in addition to the implementation of the Brenner tunnel, the level of service of the Valsugana corridor will be improved. The Valsugana corridor is located east of Trento and offers an alternative connection from the Brenner corridor to the Veneto region. The measures of the scenario aim at improving the safety standards of national road SS 47 and an increase of travel speed and train frequency and promotion of the intermodal freight terminal in Trento. Figure 4.3 shows the alignment of the Valsugana corridor. In every other respect Scenario AS4 is identical to Scenario AS1.

4.2.5 Combination Scenario AS1+AS2+AS3+AS4 (Scenario AS5)

In this scenario it is assumed that, in addition to the implementation of the Brenner tunnel, the three infrastructure projects examined in scenarios AS2, AS3 and AS4 are implemented together: the southern rail bypass, the Valdastico and Pedemontana motorways and the Valsugana road and rail corridor. In every other respect Scenario AS5 is identical to Scenario AS1.

4.2.6 Other European Infrastructure Improvements (Scenario AS6)

The current plans for infrastructure development in Europe go far beyond the TEN priority projects included in the reference scenario. It is therefore assumed in this scenario that, besides the implementation of the Brenner tunnel, the complete TEN and TINA investment programme for road and rail will be implemented according to realistic assumptions on the year of implementation, including the local transport infrastructure projects as combined in Scenario AS5. This scenario will allow to assess both the impacts of local transport infrastructure projects and the impacts of more strategic options with a wider European scope. In every other respect Scenario AS6 is identical to Scenario AS1.

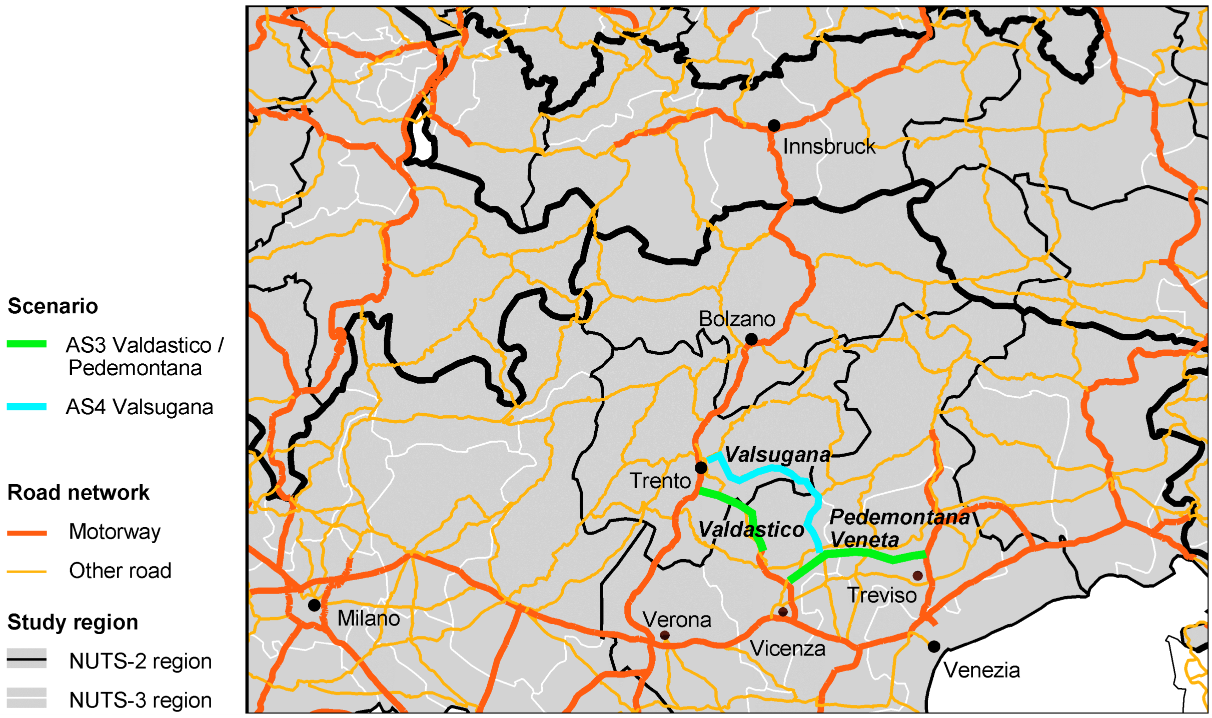

Figure 4.2. Further transport infrastructure scenarios (road): Valdastico/Pedemontana (Scenario AS3) and Valsugana (Scenario AS4)

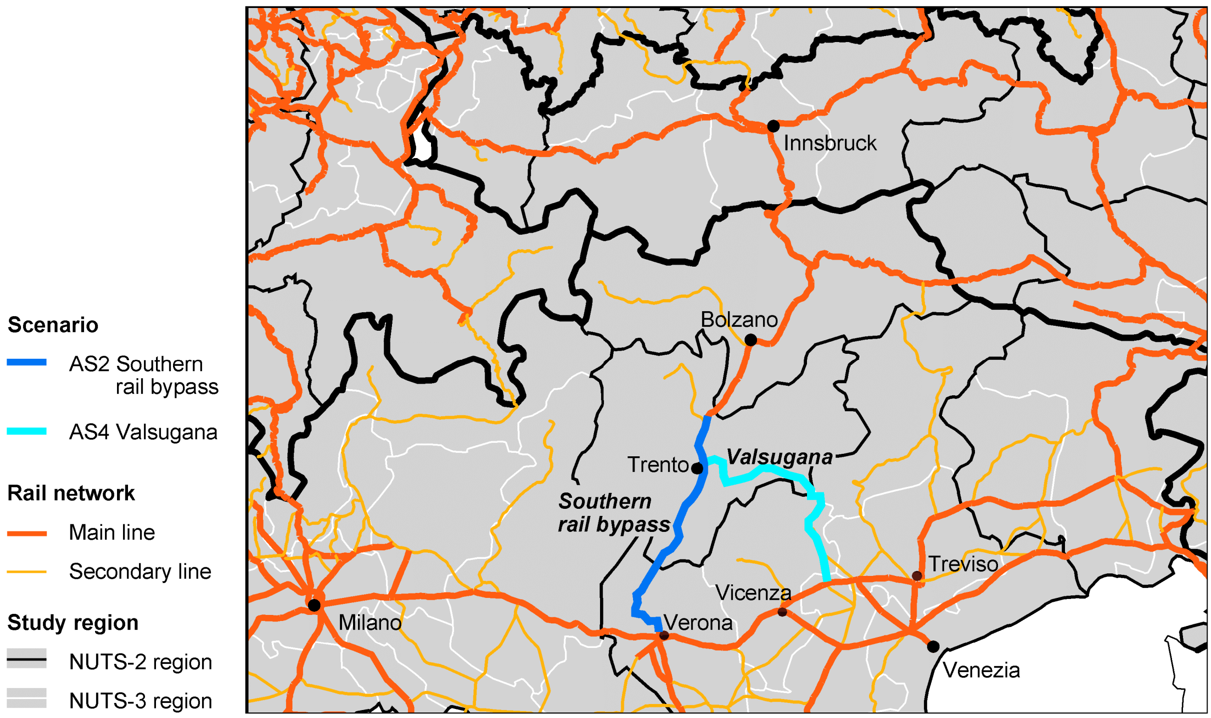

Figure 4.3. Further transport infrastructure scenarios (rail): Southern rail bypass (Scenario AS2) and Valsugana (Scenario AS4)

5 Simulation Results

In this chapter the results of the six transport infrastructure scenarios defined in the previous chapter are reported.

5.1 The Reference Scenario (Scenario 000)

The Reference Scenario 000 as defined in the previous chapter serves as benchmark for the comparison of the transport infrastructure policy scenarios. Figures 5.1 to 5.16 show selected results of the simulation of the reference scenario with the SASI model.

Figures 5.1 and 5.2 illustrate the temporal and spatial scope of the simulations. All simulations start in the year 1981 and continue over 40 years until 2021 in one-year increments. The years 2001 to 2021 are the actual forecasting period, as the most recent Europe-wide regional data are of 2001. The years 1981 to 2001 serve to illustrate the development in the past. Each line in the diagram corresponds to one of 34 countries including the 25 present countries of the European Union plus Norway and Switzerland and the candidate countries Bulgaria and Romania and the western Balkan countries Albania, Bosnia and Herzegowina, Croatia, Makedonia and Yugoslavia. The heavy black line labelled EU represents the average of the 34 countries. The variable GDP per capita is used as an example To exclude the effects of inflation, all GDP-per-capita values are expressed in Euro of 1998.

Figure 5.1 shows average GDP per capita of all 34 countries. Except the former "cohesion" countries Portugal, Spain and Greece, all old member states of the EU have GDP per capita above the European average, whereas all new member states and the Balkan countries have GDP per capita below the European average. According to the model these differences will persist over a long time.

Figure 5.2 shows the same variable, GDP per capita for the 33 AlpenCorS NUTS-2 regions (see Table 3.1). The letters associated with each line in the diagram indicate the 34 regions:

BL	Burgenland	NO	Niederösterreich	VI	Wien
CA	Kärnten	ST	Steiermark	OO	Oberösterreich
SB	Salzburg	TY	Tirol	VA	Vorarlberg
GE	Genève/Lausanne	BE	Bern	BS	Basel
ZU	Zürich	SG	St. Gallen	LZ	Luzern
BA	Bellinzona	FB	Freiburg	TB	Tübingen
MU	Oberbayern	AU	Schwaben	AL	Alsace
FC	Franche-Comté	RA	Rhône-Alpes	PA	Provence-Alpes
PI	Piemonte	VD	Valle d'Aosta	LI	Liguria
LO	Lombardia	VE	Veneto	FV	Friuli Venezia Giulia
BO	Bolzano	TR	Trento	SI	Slovenia

The heavy black line labelled AC represents the average of the AlpenCorS study area. It is obvious that the AlpenCorS region as a whole has a GDP per capita well above the European average. The regions in Switzerland, topped by Zürich, are the most productive and wealthiest AlpenCorS regions, followed by the regions in southern Germany and Austria. The Italian regions are below the average of the AlpenCorS regions but above the European average. The Autonomous Province of Trento is among the most productive and most affluent regions of the Italian AlpenCorS regions.

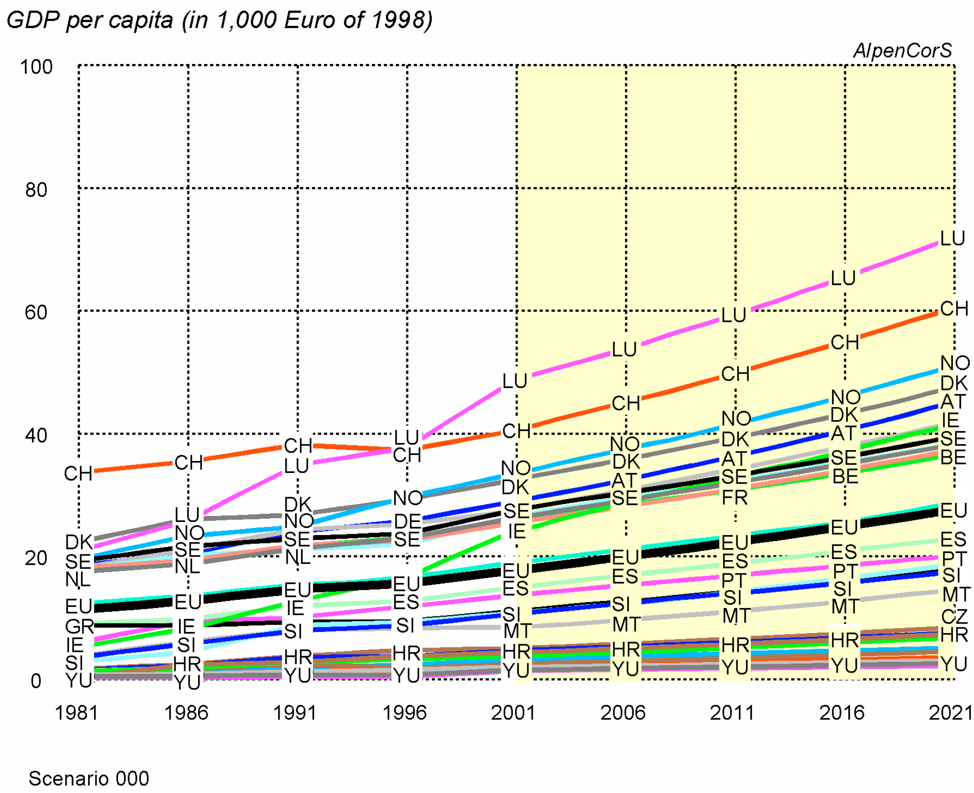

Figure 5.1. Reference Scenario 000: GDP per capita (in 1,000 Euro of 1998) by country 1981-2021

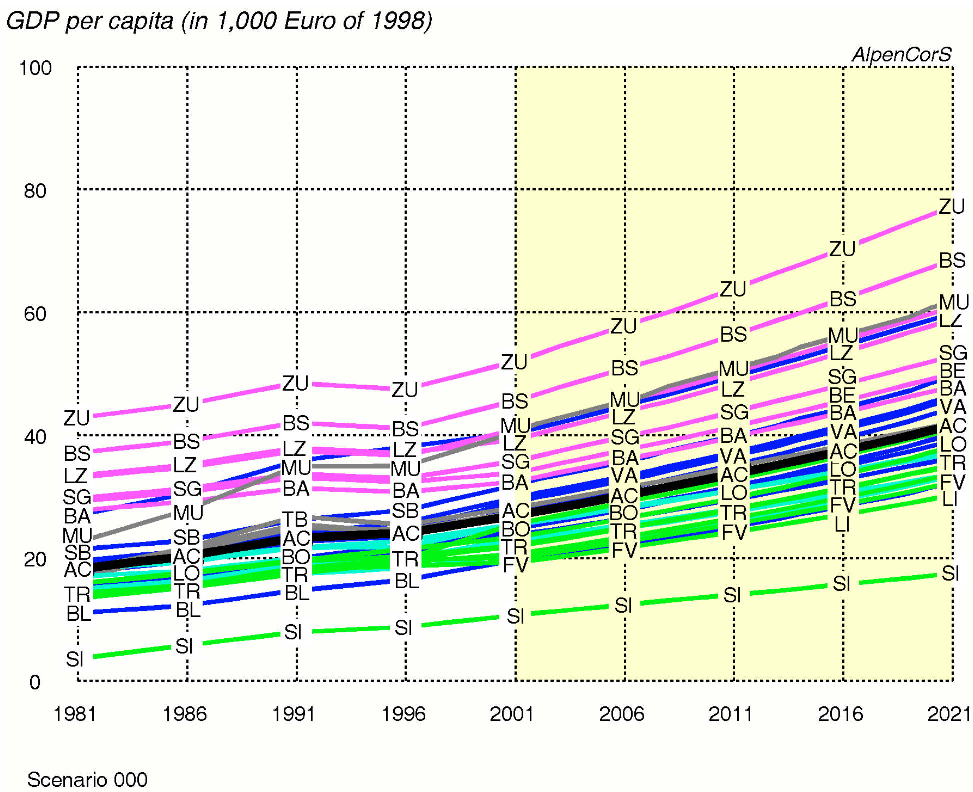

Figure 5.2. Reference Scenario 000: GDP per capita (in 1,000 Euro of 1998) by AlpenCorS region 1981-2021 (for explanation of region codes see text)

Figures 5.3 and 5.4 show the spatial distribution of GDP per capita in the Reference Scenario 000 in the year 2021. In Figure 5.3 the familiar North-South axis of affluence from the Nordic countries through Germany and Switzerland to northern Italy is clearly seen, with the rest of the old EU member states in the middle range and the new member states and the Balkan countries far below. Also the gap in income between urban and rural regions is apparent. Figure 5.4 shows the same data enlarged for the AlpenCorS regions. Again the top position in GDP per capita of the Swiss regions becomes apparent. The two autonomous provinces of Bolzano and Trento have a GDP per capita of more than 125 percent of the European average.

As in this project the role of transport infrastructure for regional economic development is the focus of attention, Figures 5.5 to 5.12 show the spatial distribution of accessibility. As it was explained in AlpenCorS Deliverable D2.2 (Spiekermann and Wegener, 2004a), four accessibility indicators enter the production functions of the SASI model: (i) accessibility by road and rail for travel (ii) accessibility by road, rail and air for travel, (iii) accessibility by road for freight and (iv) accessibility by road and rail for freight (Schürmann et al., 1997).

The accessibility maps at the European scale (Figures 5.5, 5.7, 5.9 and 5.11) show the decline in accessibility from the European core in north-western Europe to the peripheral regions in the Nordic and Baltic countries, northern England, Scotland and Ireland, the south of France, Spain and Portugal, southern Italy, Greece and the Balkan countries.

The enlarged maps of the AlpenCorS study area (Figures 5.6, 5.8, 5.10 and 5.12) show this in more detail. In Figure 5.6, which shows combined road and rail accessibility for travel, the high-accessibility road and rail corridors between Torino and Venezia and between Milano and Genova stand out. The Brenner corridor, however, is not visible. In Figure 5.8, which shows the combination of road, rail and air accessibility, regions with major airports, such as München, Wien, Milano, Zürich and Innsbruck, are highlighted. Accessibility for freight is more spread out as freight transport is dominated by road and the road network is more dispersed than the rail network. Nevertheless, also freight accessibility shows a decline from the countries north of the Alps to those south of the Alps. This tendency may be sharpened by the fact that the motorway charge recently introduced on German motorways has not yet been incorporated in the reference scenario. Therefore Figure 5.10, which shows only road accessibility for freight, highlights the Alpine divide, which is even more pronounced in Figure 5.12, which shows combined road and rail accessibility for freight.

Figures 5.13 to 5.16 visualise the same information in three-dimensional form. The comparison between accessibility for travel (Figures 5.13 and 5.14) and accessibility for freight (Figures 5.15 and 5.16) confirm that accessibility for travel is more peaked and declines from centre to periphery more sharply.

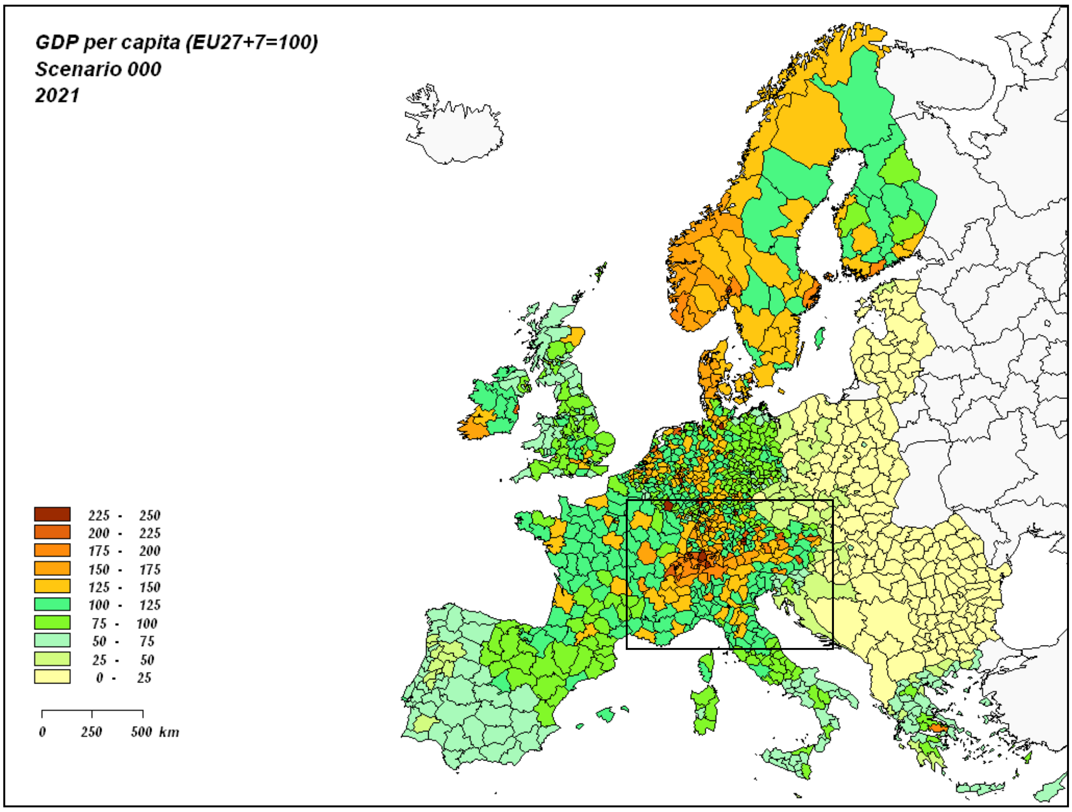

Figure 5.3. Reference Scenario 000: GDP per capita (EU27+7=100) in 2021

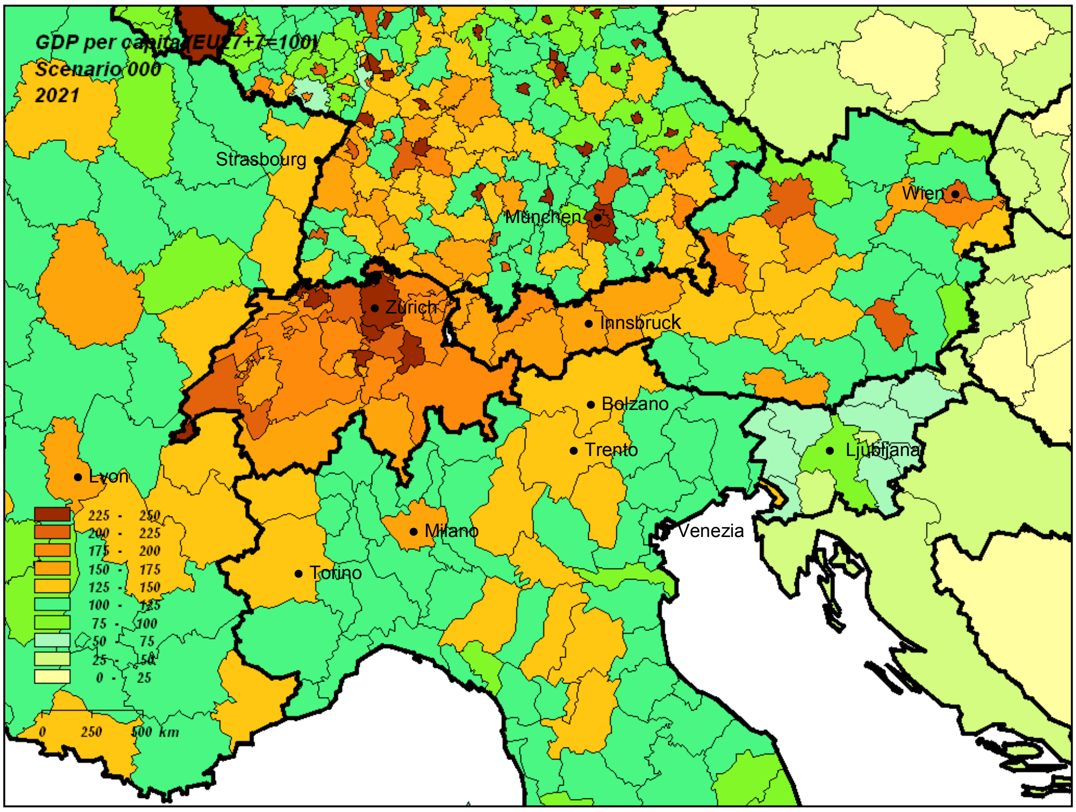

Figure 5.4. Reference Scenario 000: GDP per capita (EU27+7=100) in the AlpenCorS regions in 2021

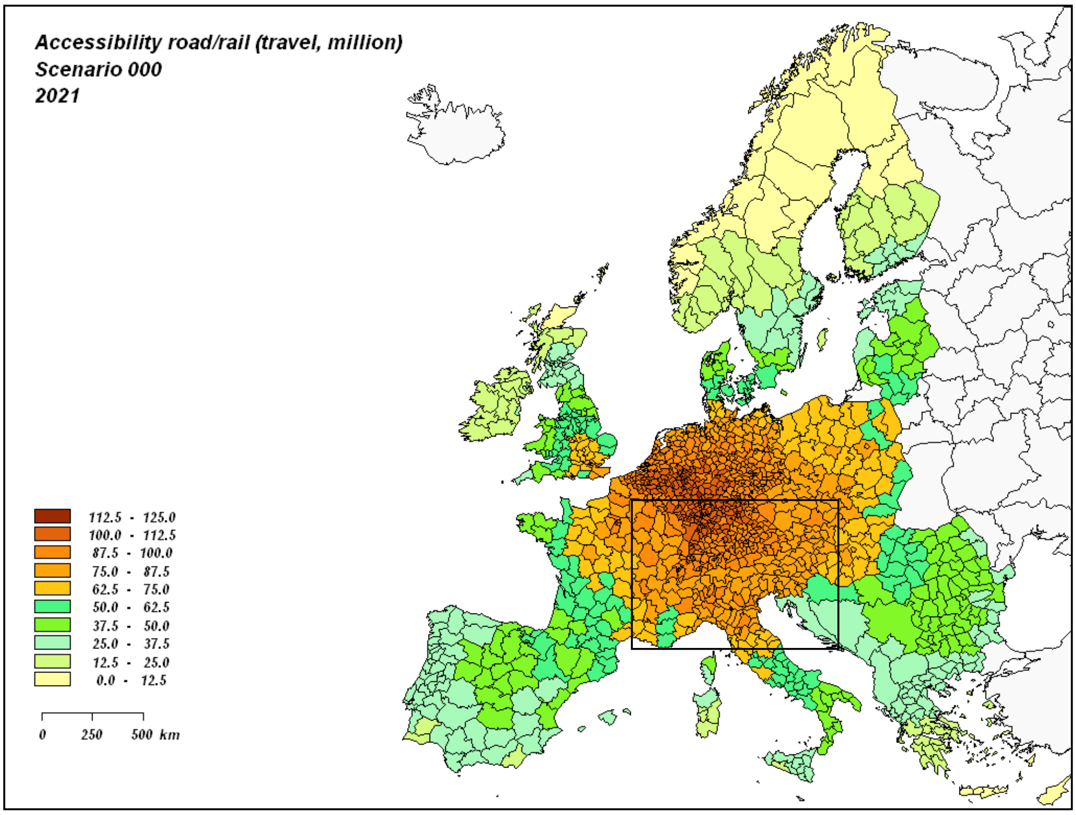

Figure 5.5. Reference Scenario 000: Accessibility road/rail (travel, million) in 2021

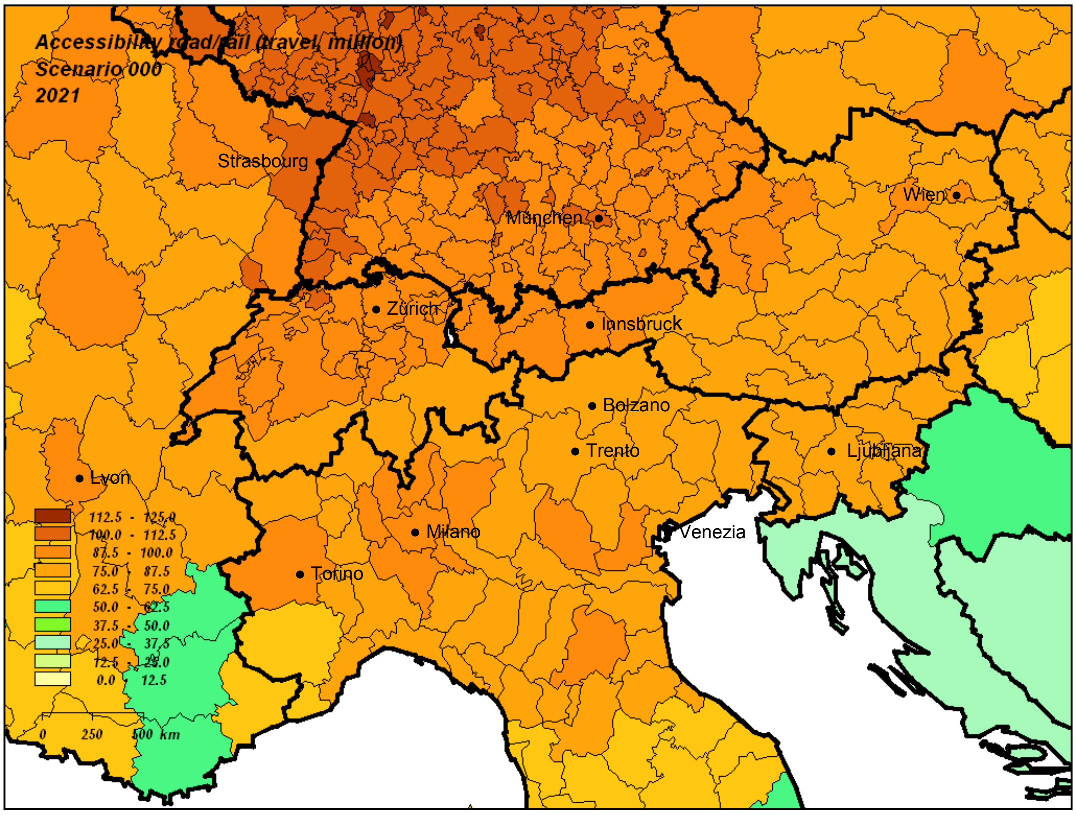

Figure 5.6. Reference Scenario 000: Accessibility road/rail (travel, million) in the AlpenCorS regions in 2021

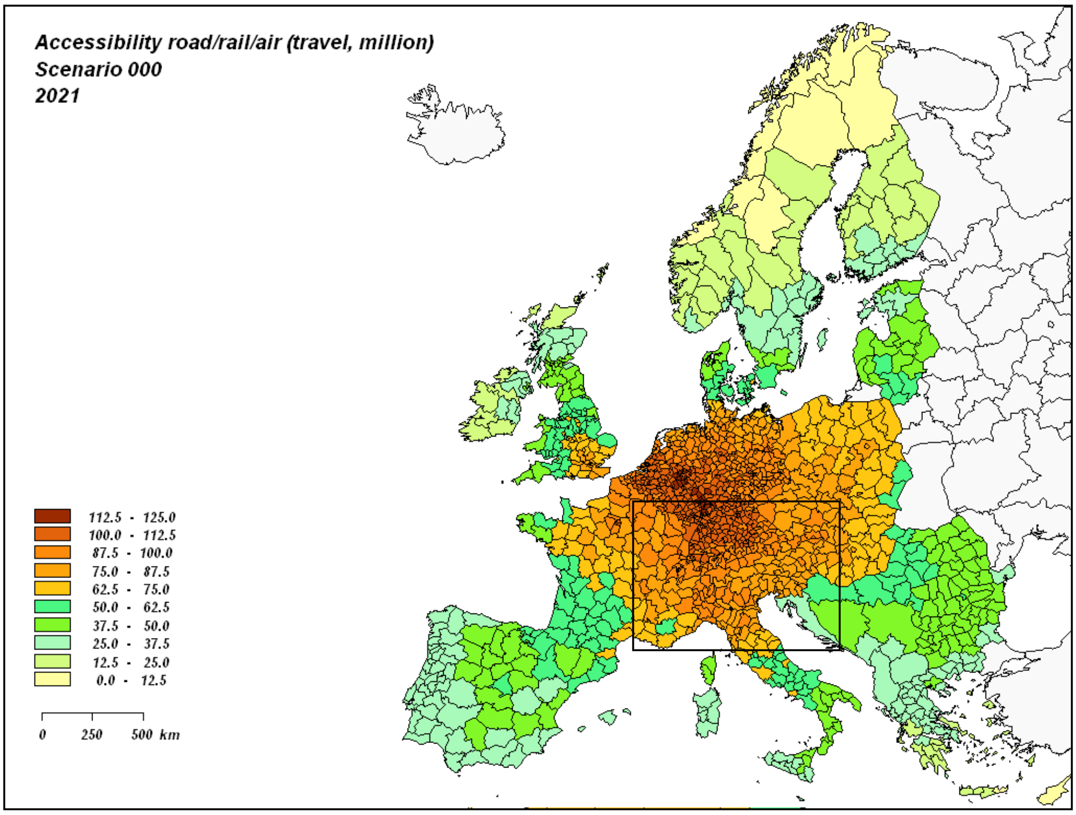

Figure 5.7. Reference Scenario 000: Accessibility road/rail/air (travel, million) in 2021

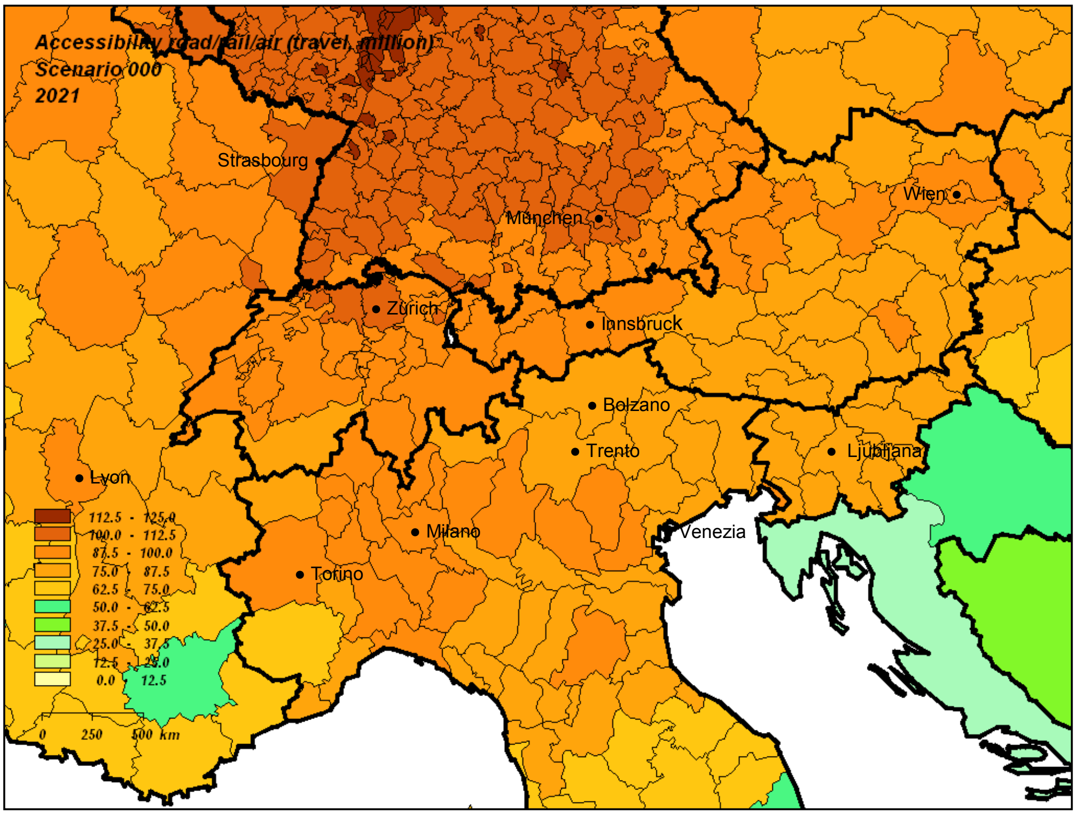

Figure 5.8. Reference Scenario 000: Accessibility road/rail/air (travel, million) in the AlpenCorS regions in 2021

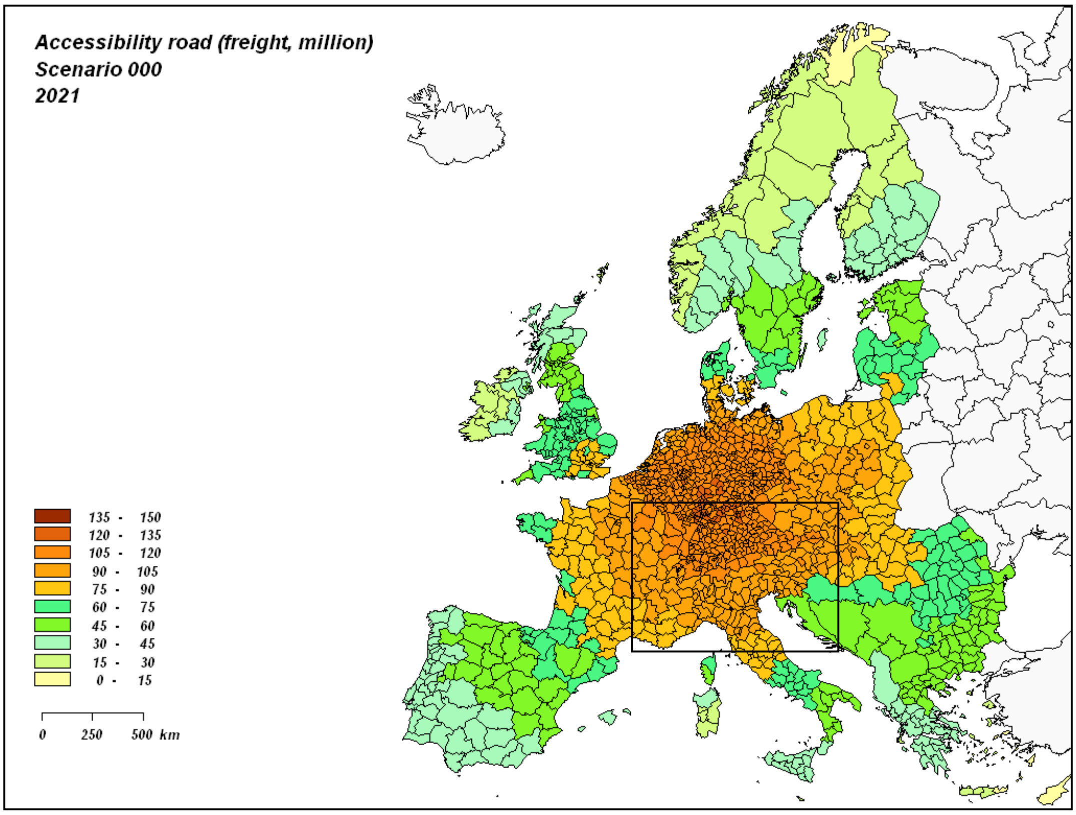

Figure 5.9. Reference Scenario 000: Accessibility road (freight, million) in 2021

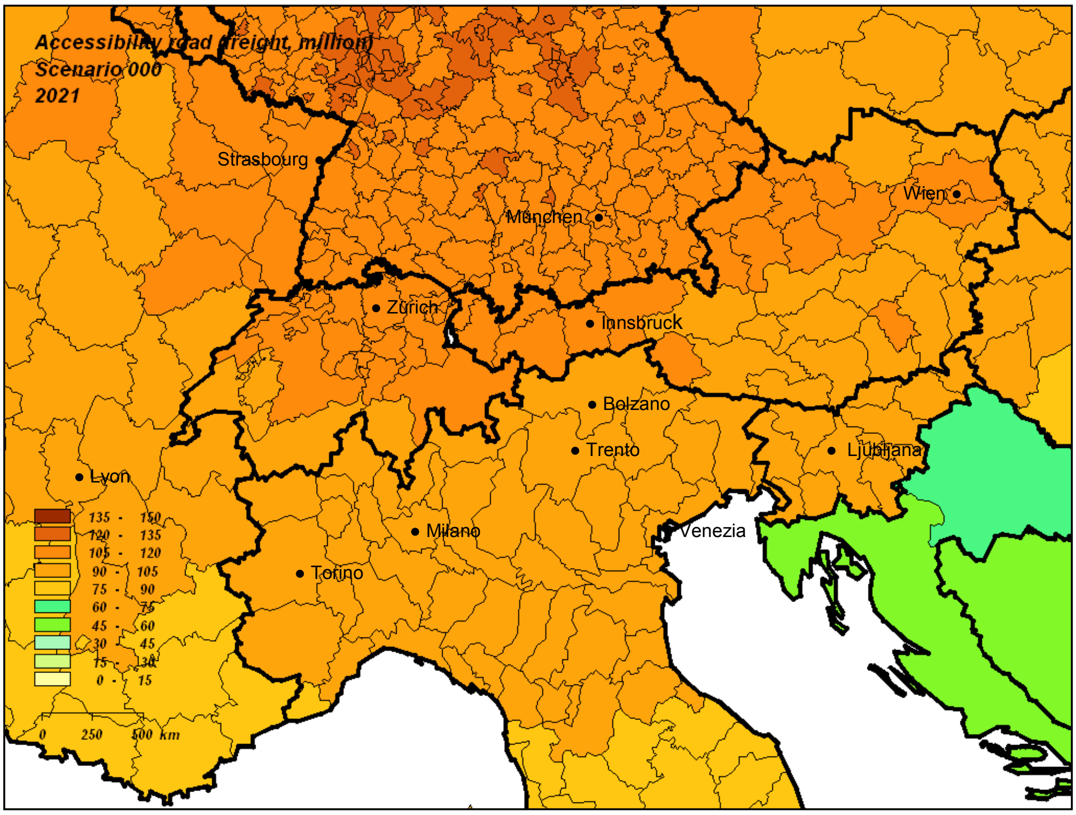

Figure 5.10. Reference Scenario 000: Accessibility road (freight, million) in the AlpenCorS regions in 2021

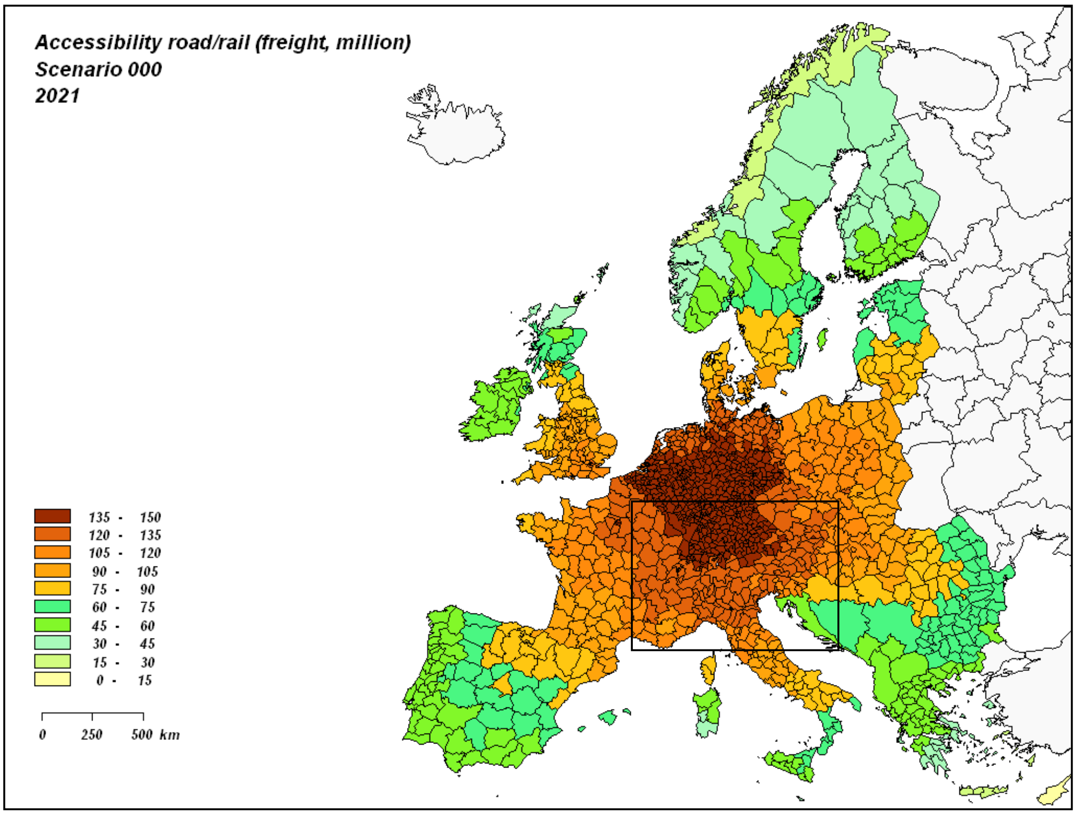

Figure 5.11. Reference Scenario 000: Accessibility road/rail (freight, million) in 2021

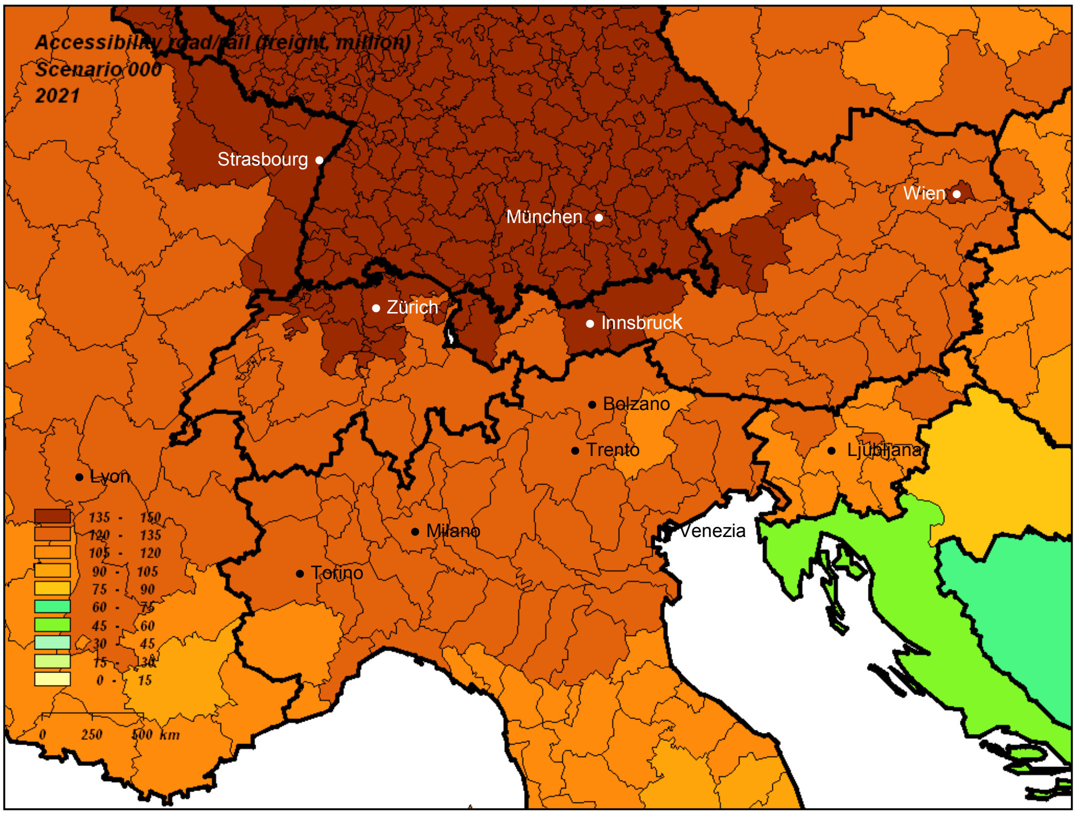

Figure 5.12. Reference Scenario 000: Accessibility road/rail (freight, million) in the AlpenCorS regions in 2021

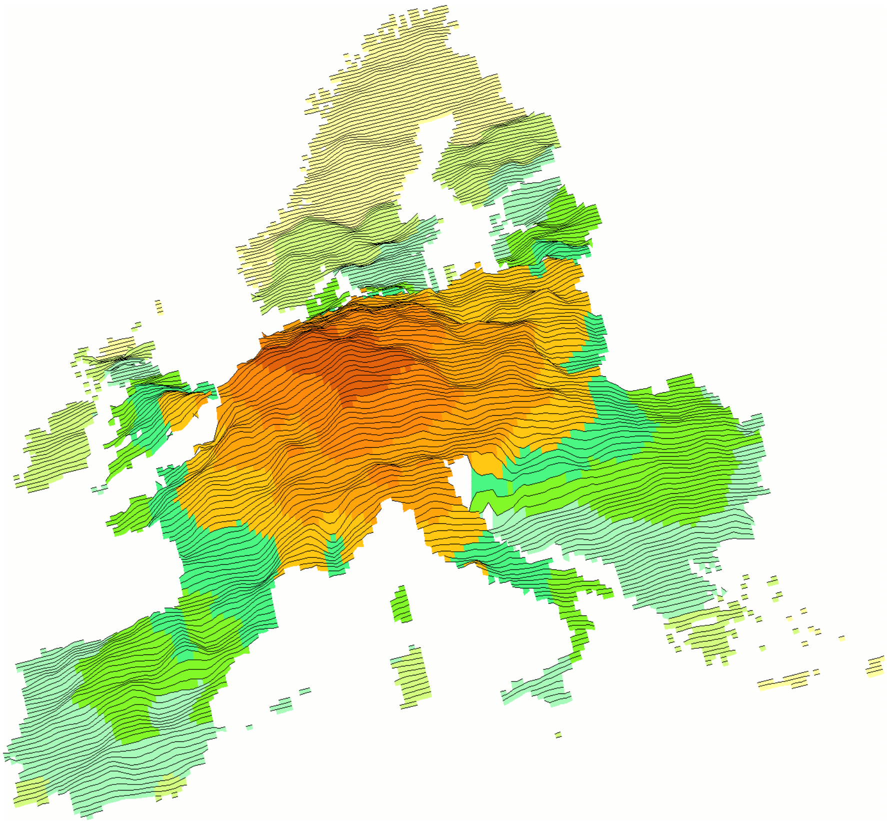

Figure 5.13. Reference Scenario 000: Accessibility road/rail (travel, million) in 2021

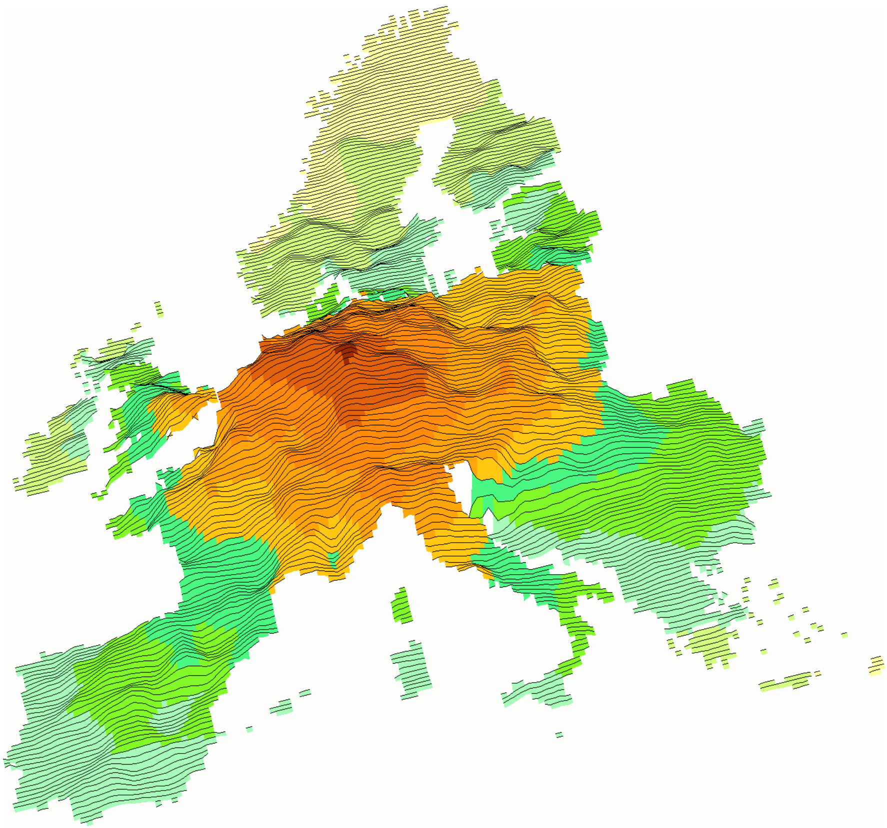

Figure 5.14. Reference Scenario 000: Accessibility road/rail/air (travel, million) in 2021

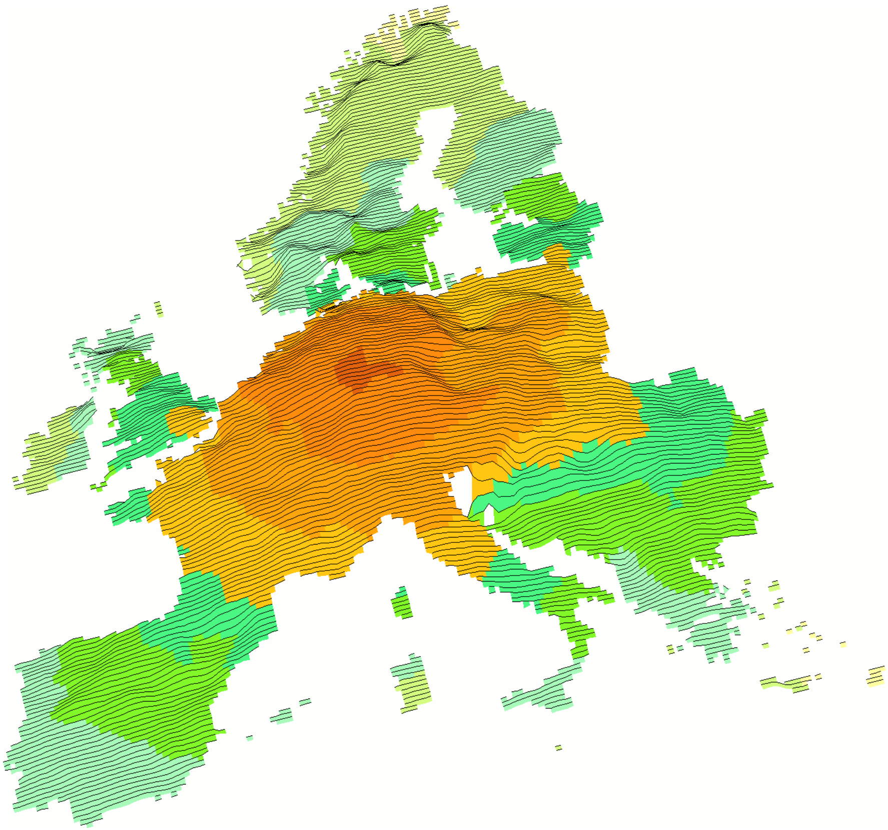

Figure 5.15. Reference Scenario 000: Accessibility road (freight, million) in 2021

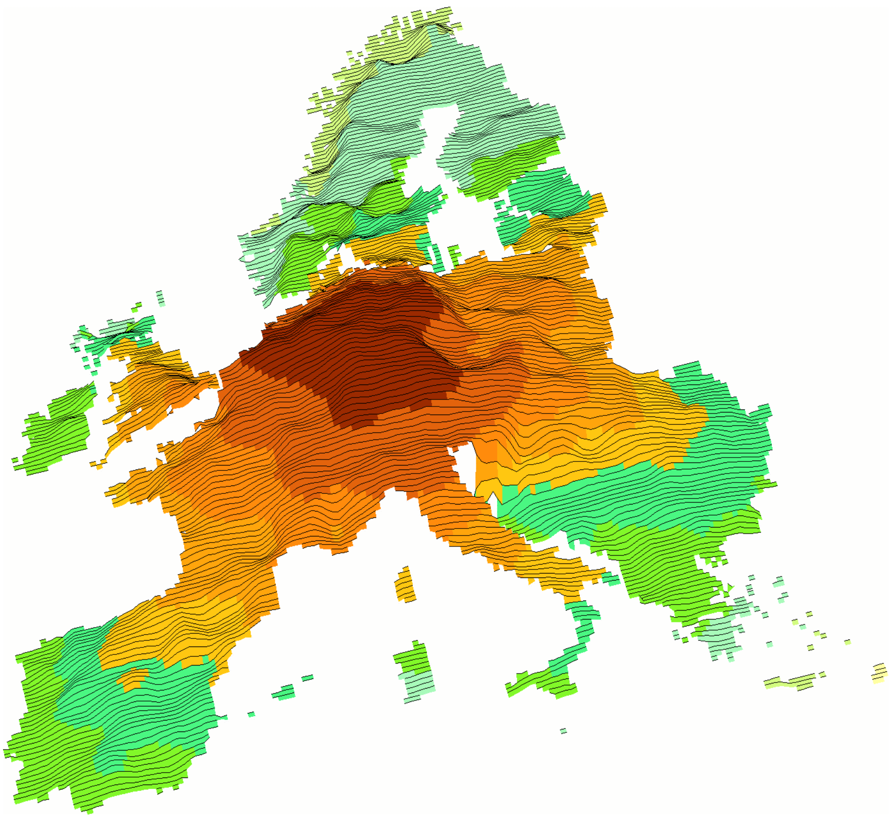

Figure 5.16. Reference Scenario 000: Accessibility road/rail (freight, million) in 2021

5.2 Infrastructure Scenarios

In the remainder of this chapter the six infrastructure scenarios examined are presented. The scenarios are systematically compared in Chapter 6.

5.2.1 Effects of the Brenner Tunnel (Scenario AS1)

Figures 5.17 to 5.26 show the results of the simulation of Scenario AS1, which is in every respect identical to the Reference Scenario 000 except that it is assumed that the Brenner tunnel and its northern and southern approaches will be completed until 2015 (see Chapter 4).

Because the causal chain in the SASI model goes from accessibility to GDP, first the changes in accessibility are presented. Because these changes are small, it would not be possible to detect any differences between the "with" and the "without" scenarios by looking at the absolute numbers Therefore the changes are highlighted by *difference maps* showing the difference in accessibility between Scenario AS1 with the Brenner tunnel and the Reference Scenario 000 without the Brenner tunnel.

Figures 5.17 to 5.24 show these differences for the four accessibility indicators used in the SASI model. The colour scheme of the difference maps is scaled in a way that light grey indicates no change, blue a negative difference and red a positive difference. As to be expected, all maps are grey or red because if the Brenner tunnel is built, all regions are either not affected or experience a gain in accessibility.

Figures 5.17 to 5.20 show the effect of the Brenner tunnel on accessibility for travel. It can be seen in Figures 5.17 and 5.18, which show the effects of the tunnel on accessibility by road and rail, that the effects are concentrated at the tunnel exits but extend far across the European continent, down the Italian peninsula and in north-eastern direction towards München, Wien and beyond, but also along the east-west corridor in northern Italy between Milano and Venezia, Corridor V. The results are similar if also air travel is considered (Figures 5.19 and 5.20).

Figures 5.21 and 5.22 show the effects of the Brenner tunnel on accessibility for freight by road. Here the effects are even more far-reaching, but now the strongest impacts north of the Alps are in Germany, the Czech Republic and Poland as well as in the Baltic and Nordic states. Remarkably, the regions closest to the tunnel exits, Bozen/Bolzano and Innsbruck, are less affected than the area around Verona. The reason for this is that from the regions close to the Brenner tunnel the use of the shuttle trains for carrying lorries through the tunnel is not attractive because of the time and cost of loading lorries on trains, which makes it attractive only for longer distances, e.g. from München to Verona. Remarkably, regions farther east and west of the Brenner tunnel axis are not affected at all (indicated by the colour grey) as these regions use other Alpine crossings. If, however, also rail is considered as in Figures 5.23 and 5.24, Bozen/Bolzano and Trento have the strongest gains in accessibility.

Figures 5.25 and 5.26, finally, show how these changes in accessibility affect regional economic development. Now a different type of difference map is used. This map, too, shows negative differences in blue and positive differences in red. However, the variable GDP per capita is standardised to the European average (EU27+7=100). This makes it possible that the maps show relative winners and losers: regions shaded in blue suffer in relative terms if the Brenner tunnel is built; regions shaded in red benefit in relative terms – but both types of regions may grow in absolute terms.

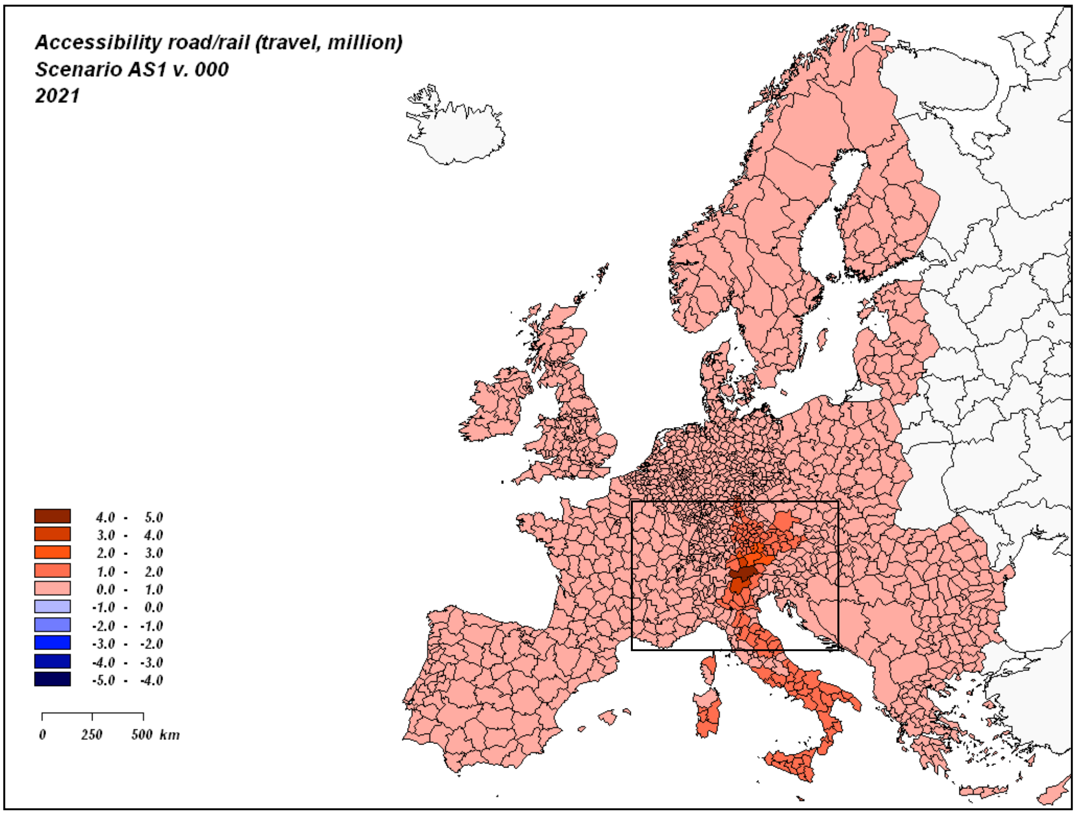

Figure 5.17. Effect of the Brenner tunnel: Difference in accessibility road/rail (travel, million), between Scenario AS1 and Scenario 000 in 2021 (%)

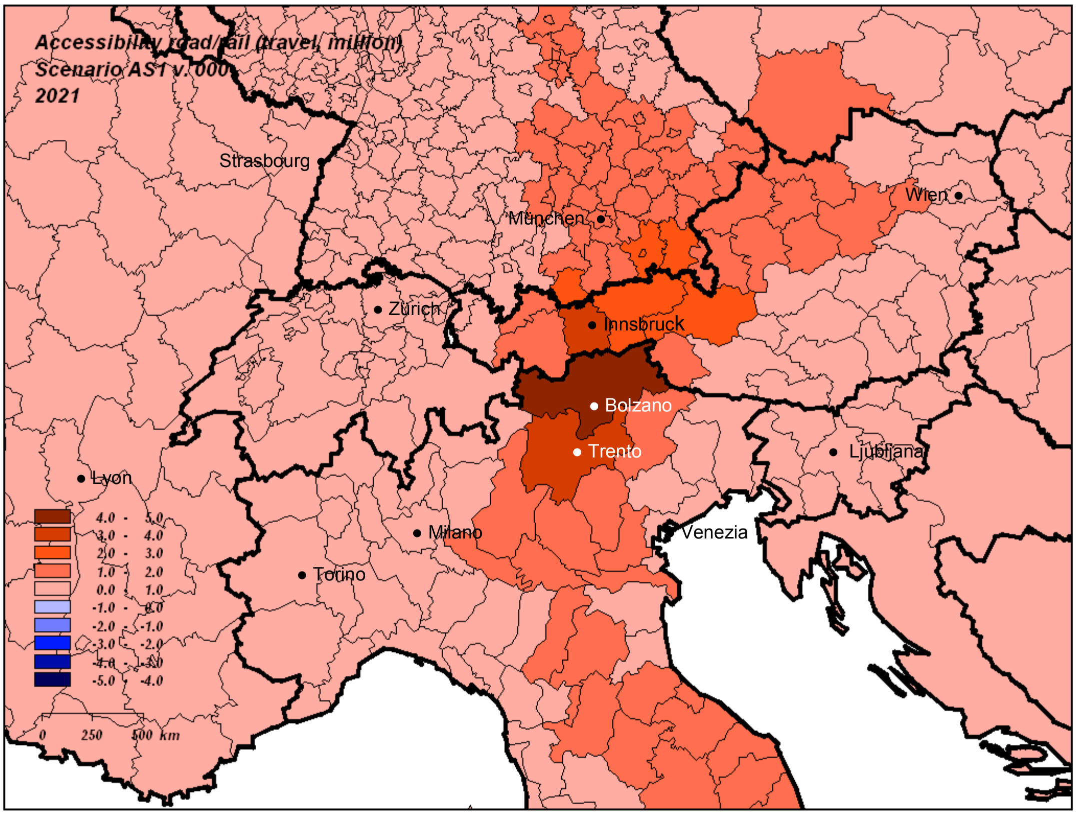

Figure 5.18. Effect of the Brenner tunnel: Difference in accessibility road/rail (travel, million), between Scenario AS1 and Scenario 000 in the AlpenCorS regions in 2021 (%)

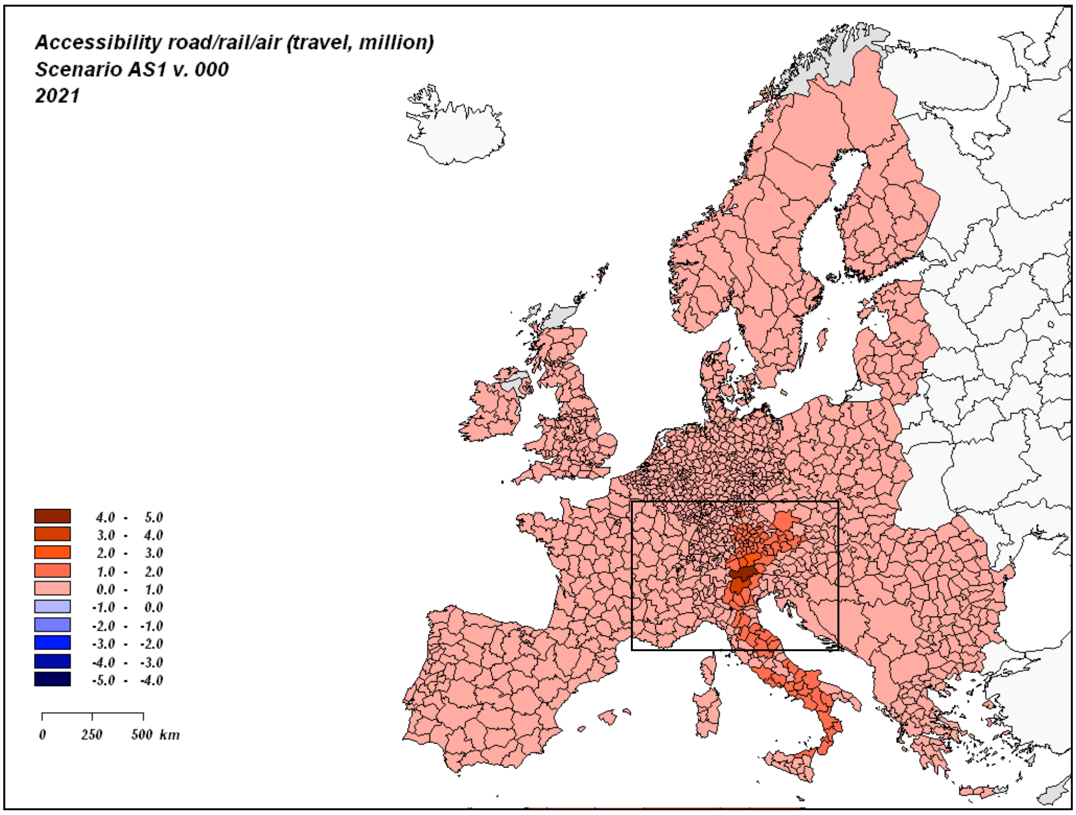

Figure 5.19. Effect of the Brenner tunnel: Difference in accessibility road/rail/air (travel, million), between Scenario AS1 and Scenario 000 in 2021 (%)

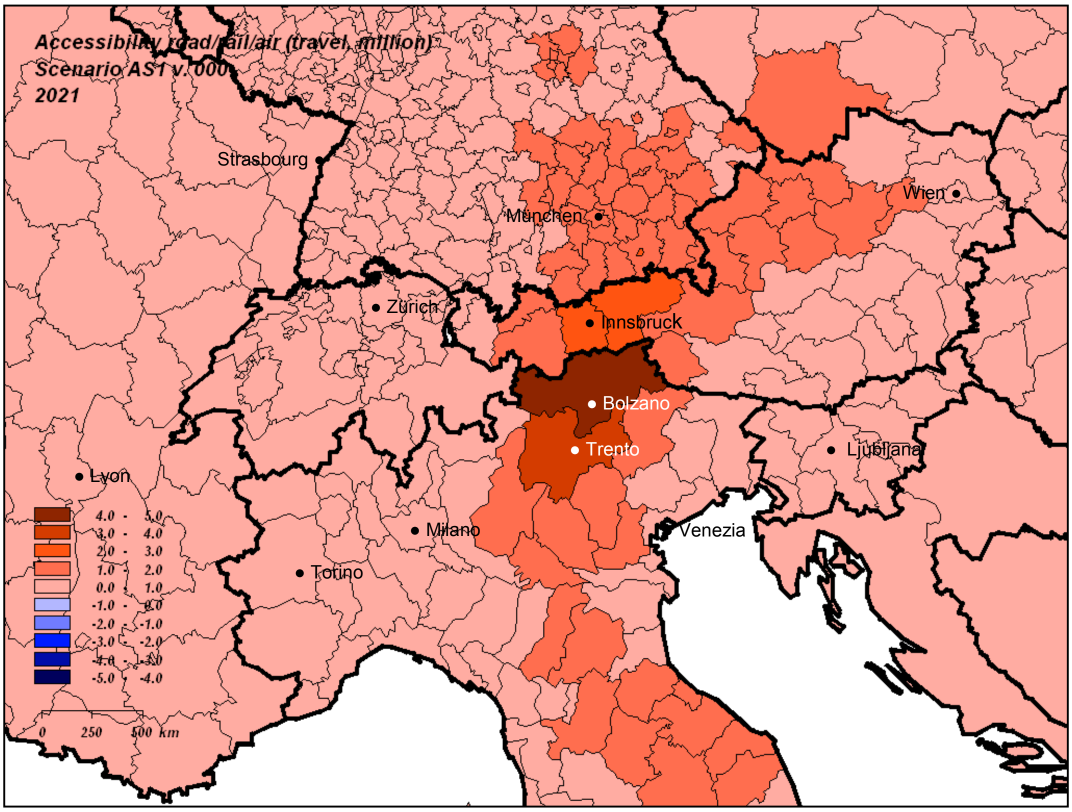

Figure 5.20. Effect of the Brenner tunnel: Difference in accessibility road/rail/air (travel, million), between Scenario AS1 and Scenario 000 in the AlpenCorS regions in 2021 (%)

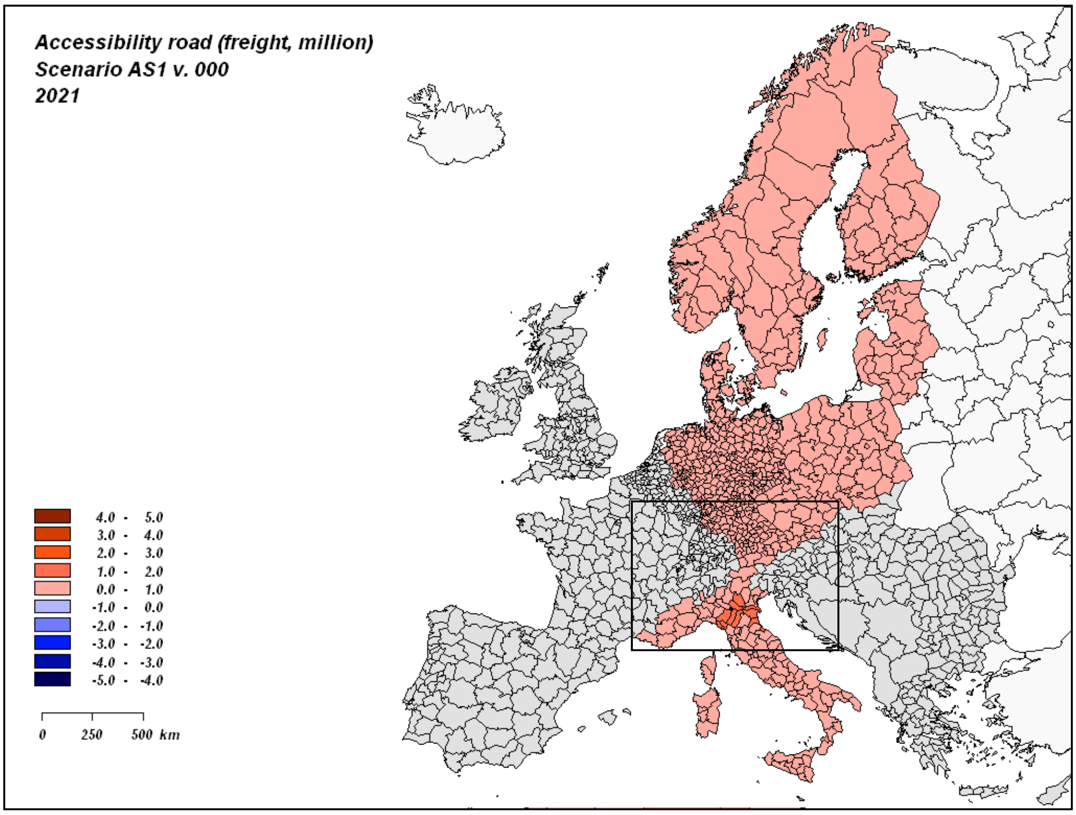

Figure 5.21. Effect of the Brenner tunnel: Difference in accessibility road (freight, million), between Scenario AS1 and Scenario 000 in 2021 (%)

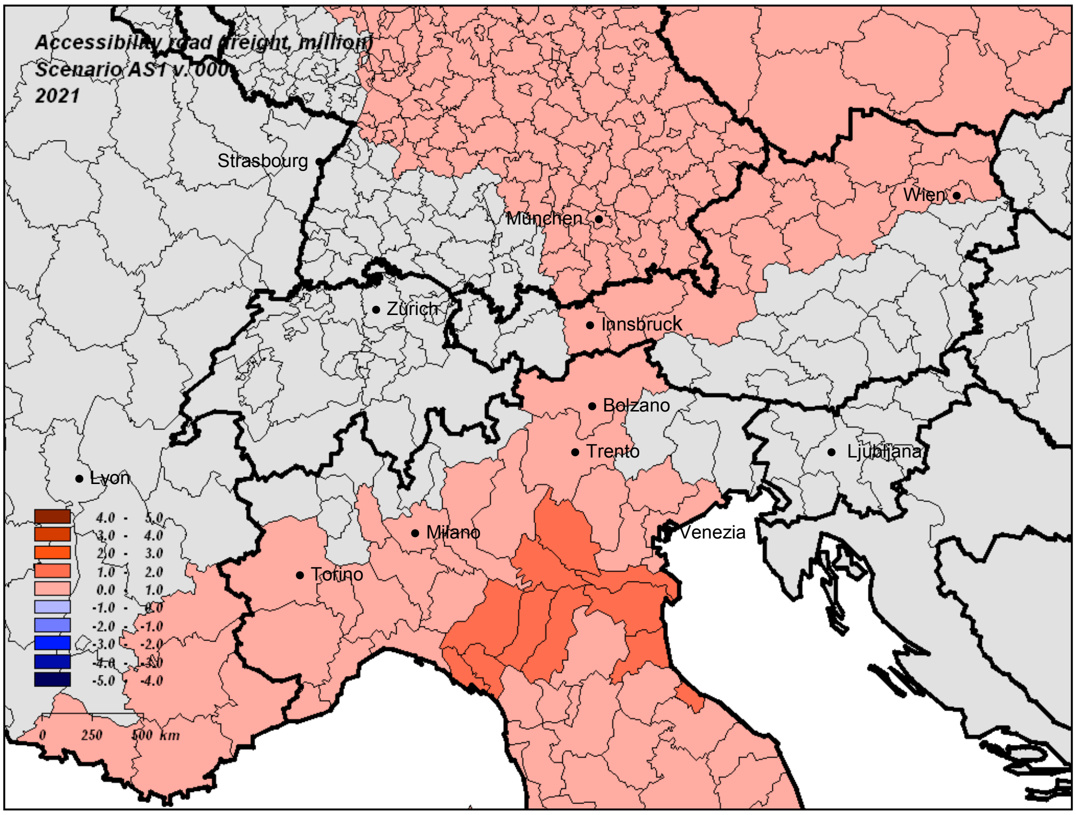

Figure 5.22. Effect of the Brenner tunnel: Difference in accessibility road (freight, million), between Scenario AS1 and Scenario 000 in the AlpenCorS regions in 2021 (%)

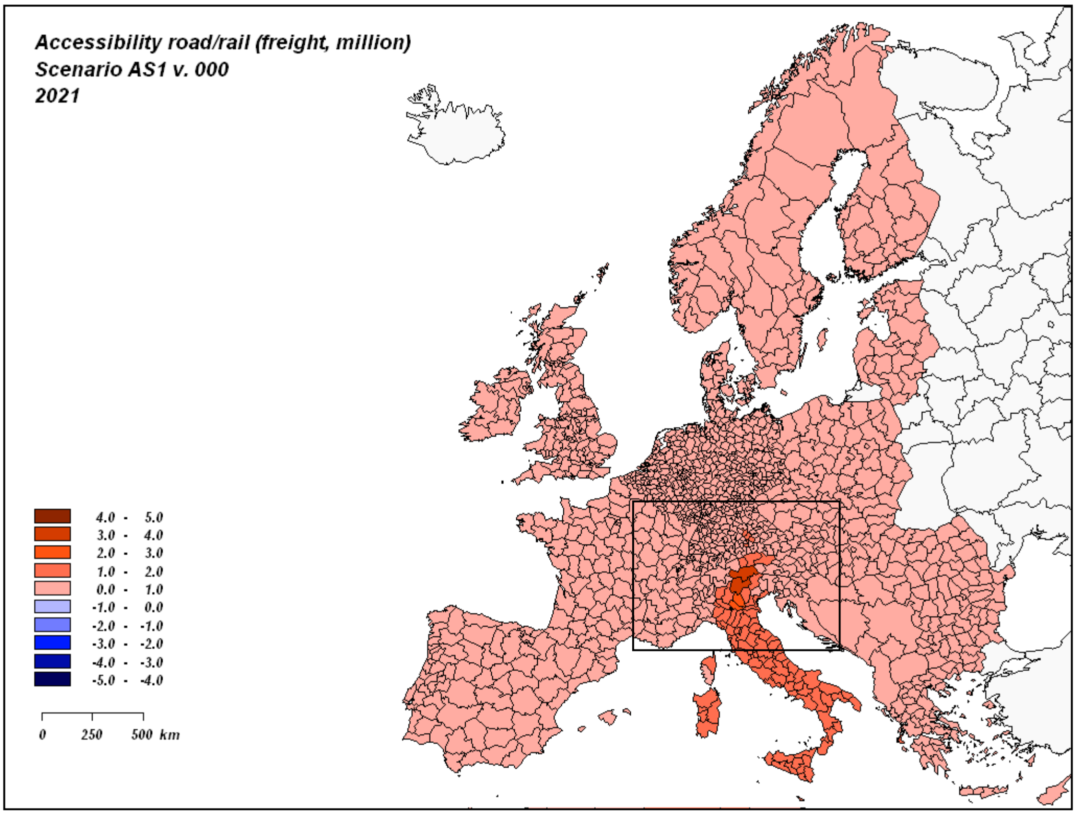

Figure 5.23. Effect of the Brenner tunnel: Difference in accessibility road/rail (freight, million), between Scenario AS1 and Scenario 000 in 2021 (%)

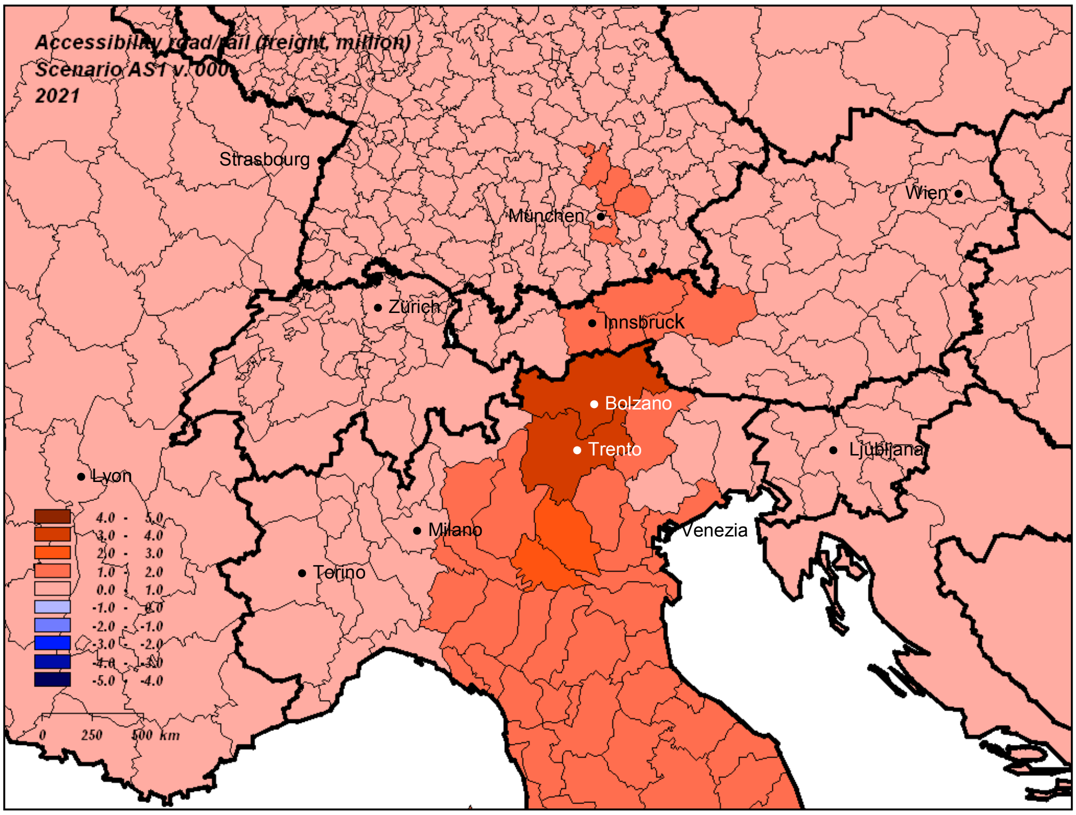

Figure 5.24. Effect of the Brenner tunnel: Difference in accessibility road/rail (freight, million), between Scenario AS1 and Scenario 000 in the AlpenCorS regions in 2021 (%)

The two maps 5.25 and 5.26 show that, like the effects on accessibility, the effects of the Brenner tunnel on regional economic development spread far across the European continent: to the south along the Italian peninsula, to the north as far as southern Sweden and Norway and to the west along Corridor V. The regions south of the tunnel, Bozen/Bolzano and Trento, benefit most from the implementation of the tunnel followed by Innsbruck and other regions in Tirol as well as in southern Bavaria and regions around Verona.

However, the map legend tells that these benefits are not very large compared with the changes in accessibility through the tunnel presented in Figures 5.19 to 5.24. As it will be shown later (see Chapter 6), the Trento region can expect to gain 0.76 percent of annual GDP from the Brenner tunnel (in 2021). Applied to the GDP forecasts for the region this translates into about 120 million Euro of 1998 per year for Trento. Translated into Euro of today this would be 175 million in total or 300 Euro for each inhabitant. Note, however, that these figures relate to 2021. In the years until 2021 the benefits are smaller as the effects gradually build up following the implementation of the infrastructure.

5.2.2 Effects of other Transport Projects (Scenarios AS2 to AS6)

Figures 5.27 to 5.38 show the impacts of the remaining transport infrastructure scenarios on regional economic development.

The first four of these scenarios can be treated en bloc as their results are very similar. In all cases the effects are small but far-reaching in geographical terms. In all scenarios the north-south corridor from eastern Germany to southern Italy is clearly pronounced and very similar to the spatial pattern of impacts of Scenario AS1 shown in Figures 5.25 and 5.26. In all scenarios, the provinces south of the Brenner tunnel, Bozen/Bolzano and Trento, benefit most, but in no case by more than one percent of their GDP. The scenarios which aim at improving the transport network south of the Brenner tunnel succeed in spreading the tunnel effects to adjacent regions, in particular to Vicenza, Padova, Belluno, Treviso and Venezia. Scenario AS3 assuming the Valdastico and Pedemontana motorway extensions is most successful in promoting other regions, whereas Scenario AS4 assuming the upgrading of the Valsugana road and rail corridor has more local effects. Not surprisingly Scenario AS5, in which the infrastructure improvements of Scenarios AS2 to AS4 are combined, has the strongest effects in spreading the tunnel effects to other Italian regions.

The last scenario, AS6, is a special case as it considers, besides the local transport projects combined in Scenario AS5, also transport infrastructure improvements outside the AlpenCorS area. Figure 5.35 and 5.36 show that, as to be expected, the effects of these other projects are much stronger than those of the local transport projects considered so far. Moreover, because the focus of these programmes has been recently re-directed towards improving the transport systems of the new EU member states, the largest economic impacts by the projects appear in southern and eastern Europe. Because of this, large parts of France, Germany, Switzerland and north-western Italy become relative losers in economic terms as the new member states take advantage of these improvements in accessibility. However, due to the influence of the Brenner tunnel and the associated local transport projects, the provinces of Bolzano and Trento and their neighbouring regions remain on the winner side.

Figures 5.37 and 5.38 visualise the huge difference in magnitude between the economic effects of the local projects (as combined in Scenario AS5) and the much larger impacts of the European TEN and TINA programmes in three-dimensional form drawn to the same vertical scale.

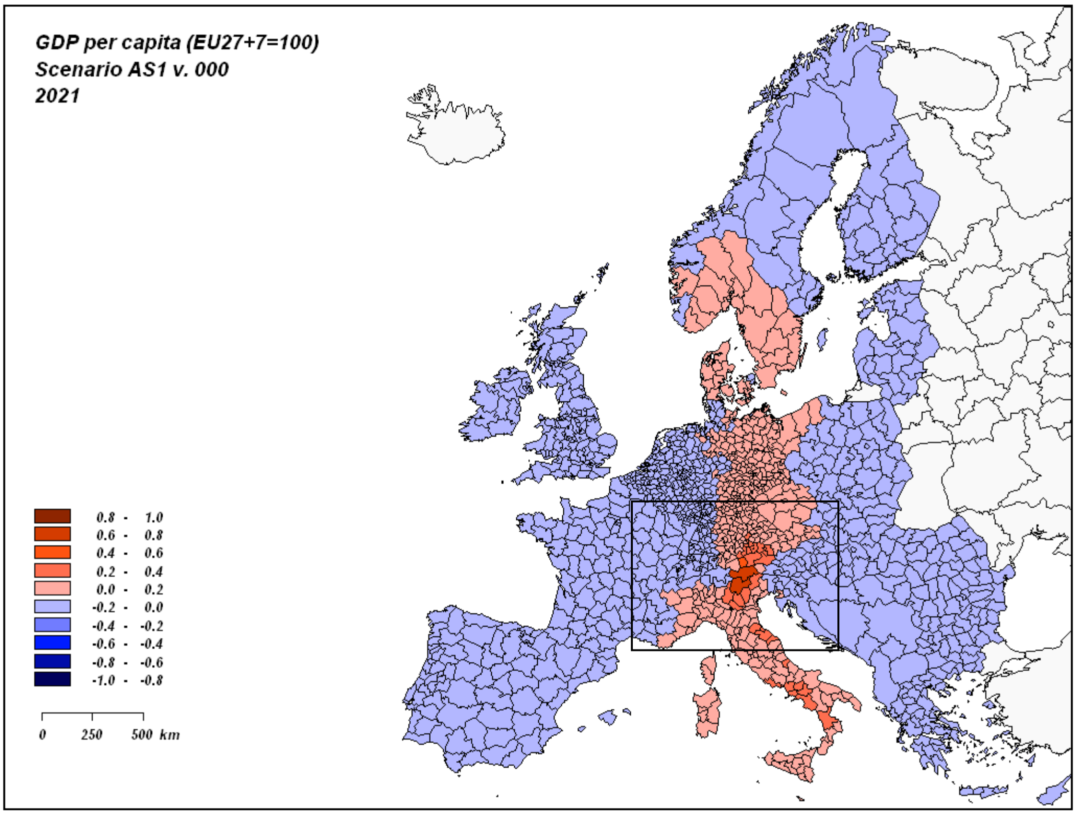

Figure 5.25. Effect of the Brenner tunnel: Difference in GDP per capita between Scenario AS1 and Scenario 000 in 2021 (%)

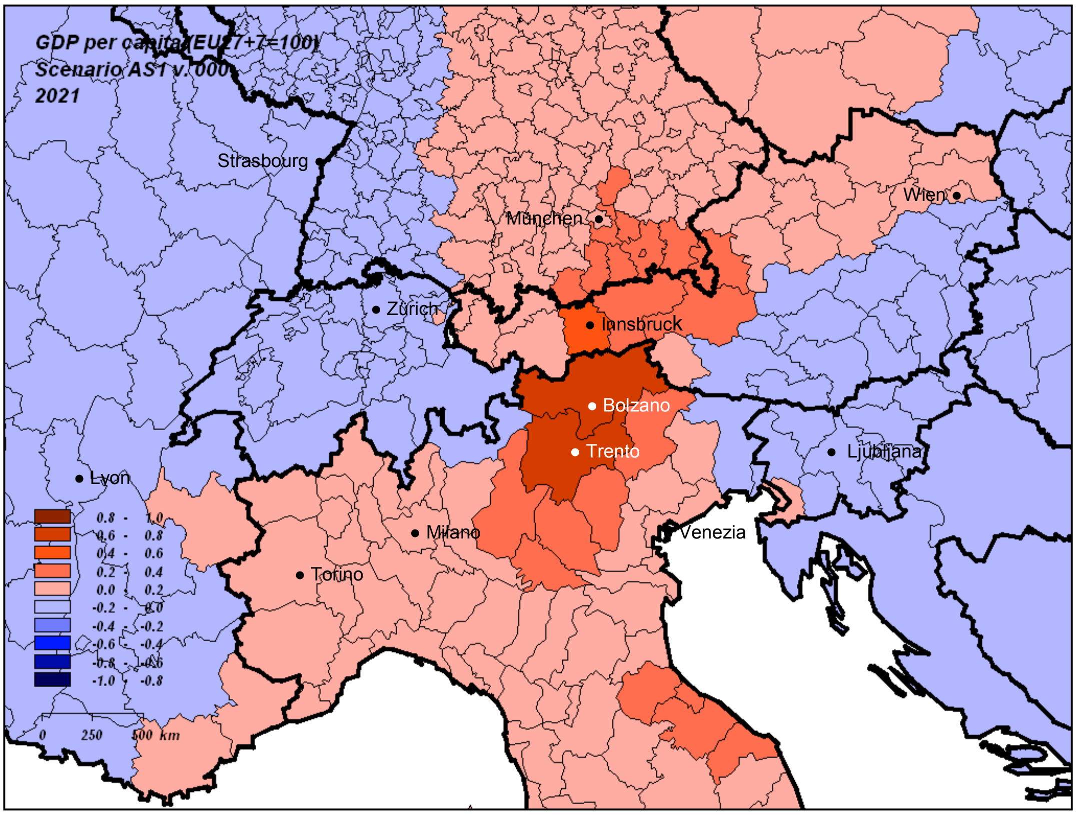

Figure 5.26. Effect of the Brenner tunnel: Difference in GDP per capita between Scenario AS1 and Scenario 000 in the AlpenCorS regions in 2021 (%)

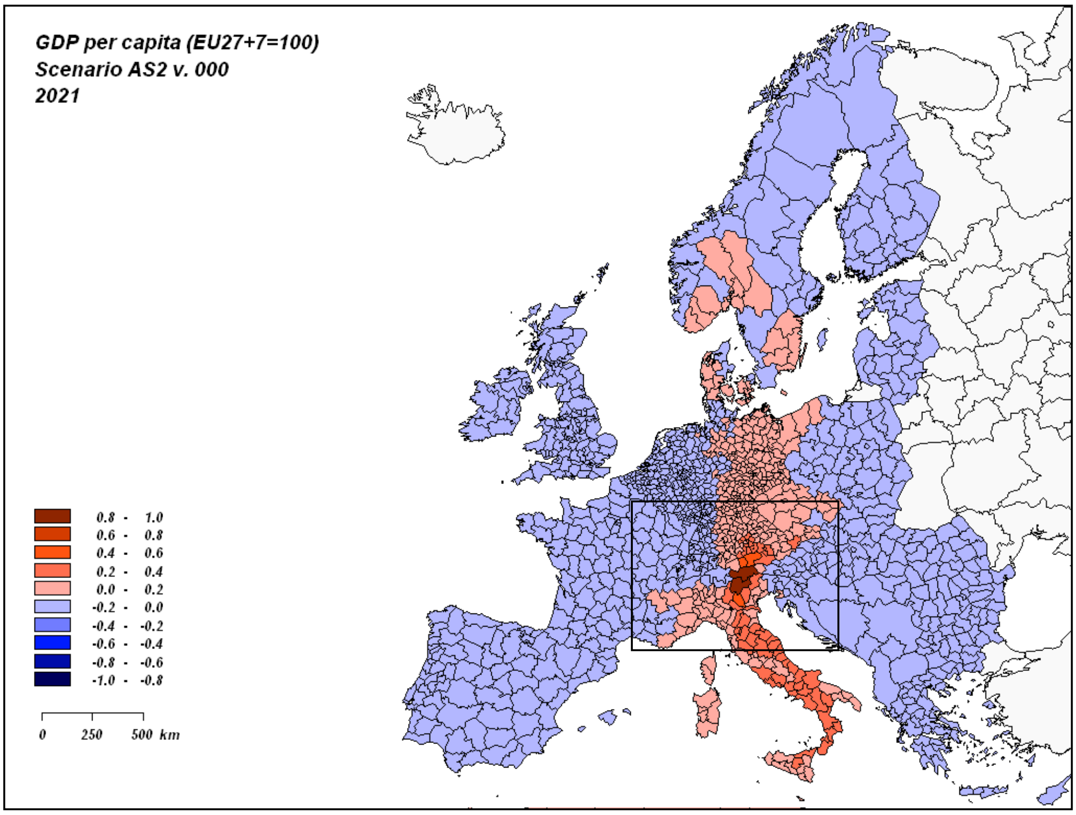

Figure 5.27. Effect of the Brenner tunnel (AS1) plus southern rail bypass: Difference in GDP per capita between Scenario AS2 and Scenario 000 in 2021 (%)

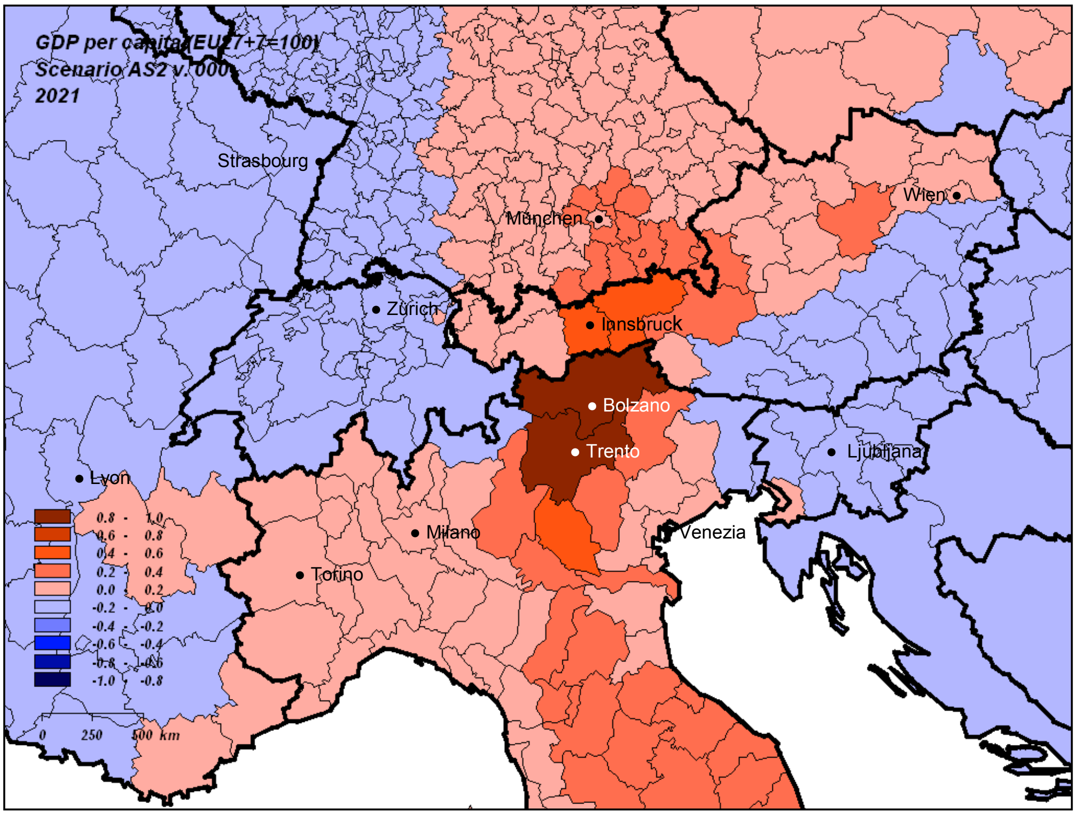

Figure 5.28. Effect of the Brenner tunnel (AS1) plus southern rail bypass: Difference in GDP per capita between Scenario AS2 and Scenario 000 in the AlpenCorS regions in 2021 (%)

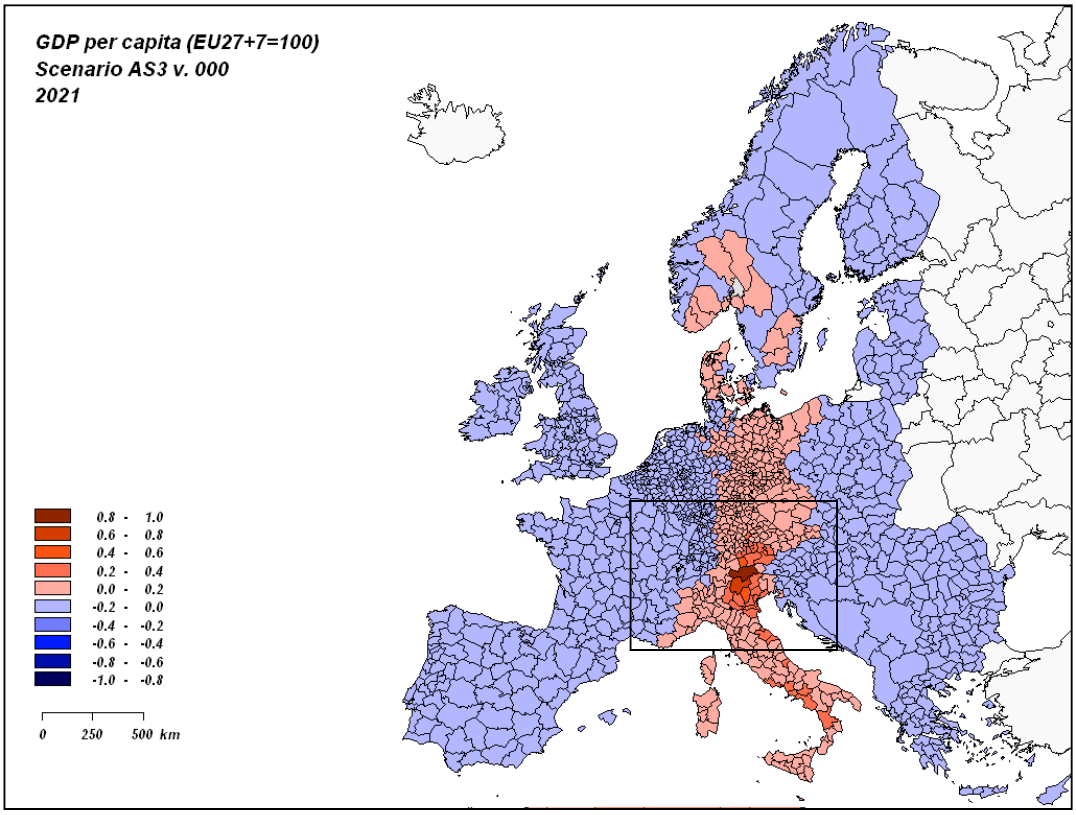

Figure 5.29. Effect of the Brenner tunnel (AS1) plus Valdastico/Pedemontana: Difference in GDP per capita between Scenario AS3 and Scenario 000 in 2021 (%)

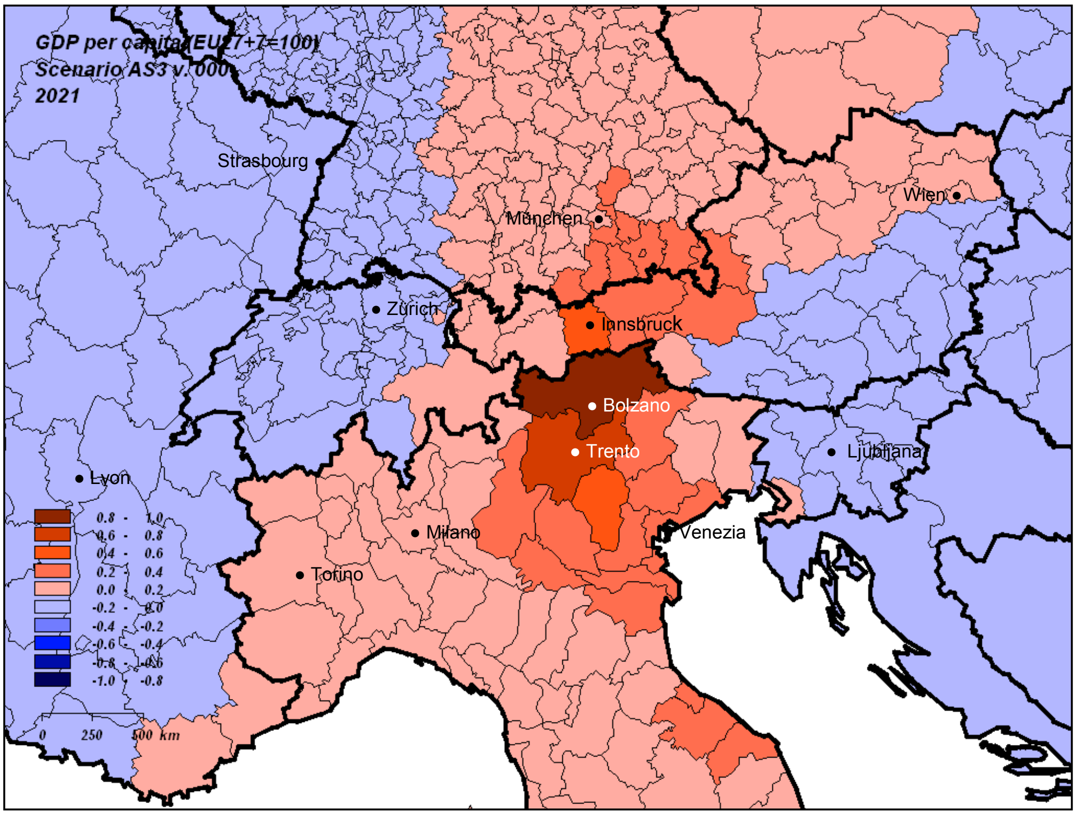

Figure 5.30. Effect of the Brenner tunnel (AS1) plus Valdastico/Pedemontana: Difference in GDP per capita between Scenario AS3 and Scenario 000 in the AlpenCorS regions in 2021 (%)

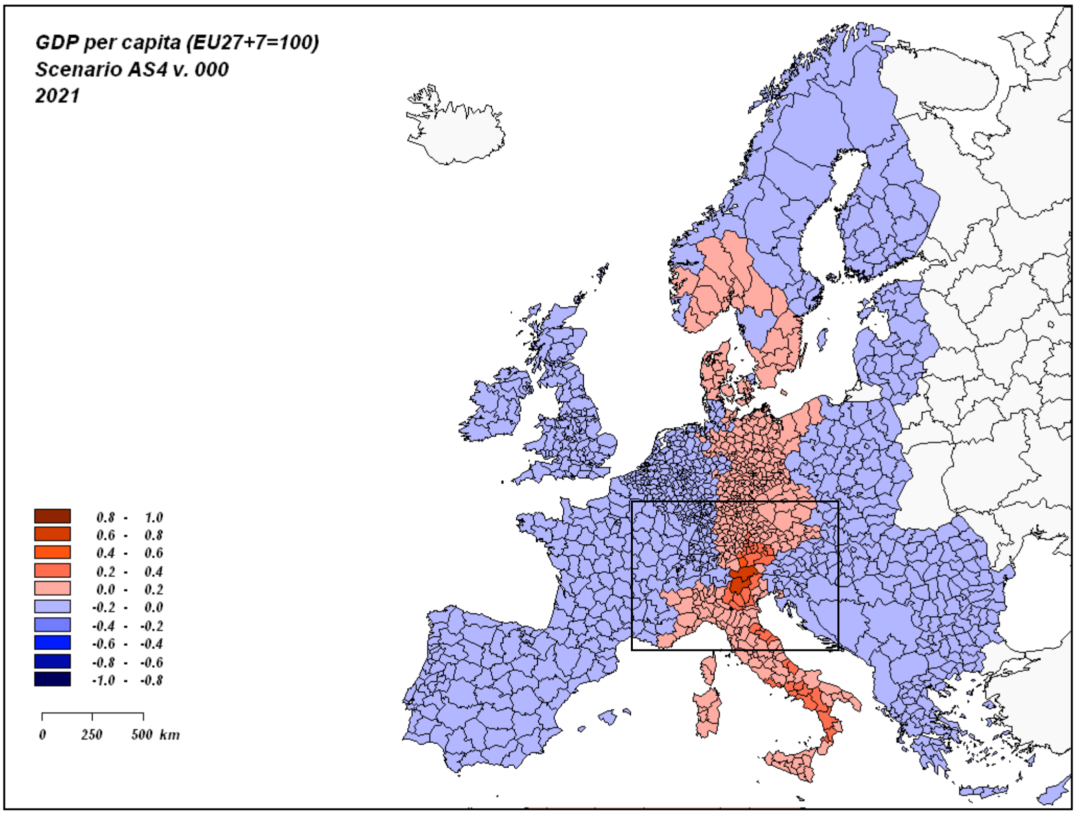

Figure 5.31. Effect of the Brenner tunnel (AS1) plus Valsugana road/rail corridor: Difference in GDP per capita between Scenario AS4 and Scenario 000 in 2021 (%)

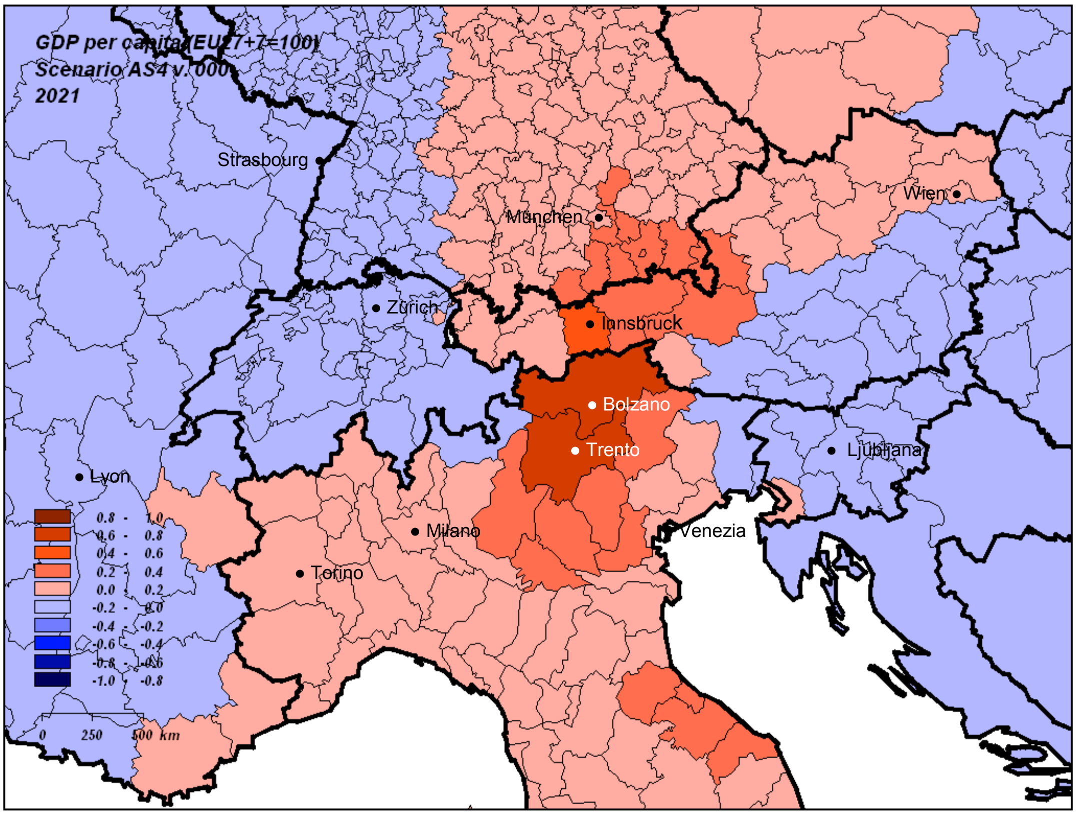

Figure 5.32. Effect of the Brenner tunnel (AS1) plus Valsugana road/rail corridor: Difference in GDP per capita between Scenario AS4 and Scenario 000 in the AlpenCorS regions in 2021 (%)

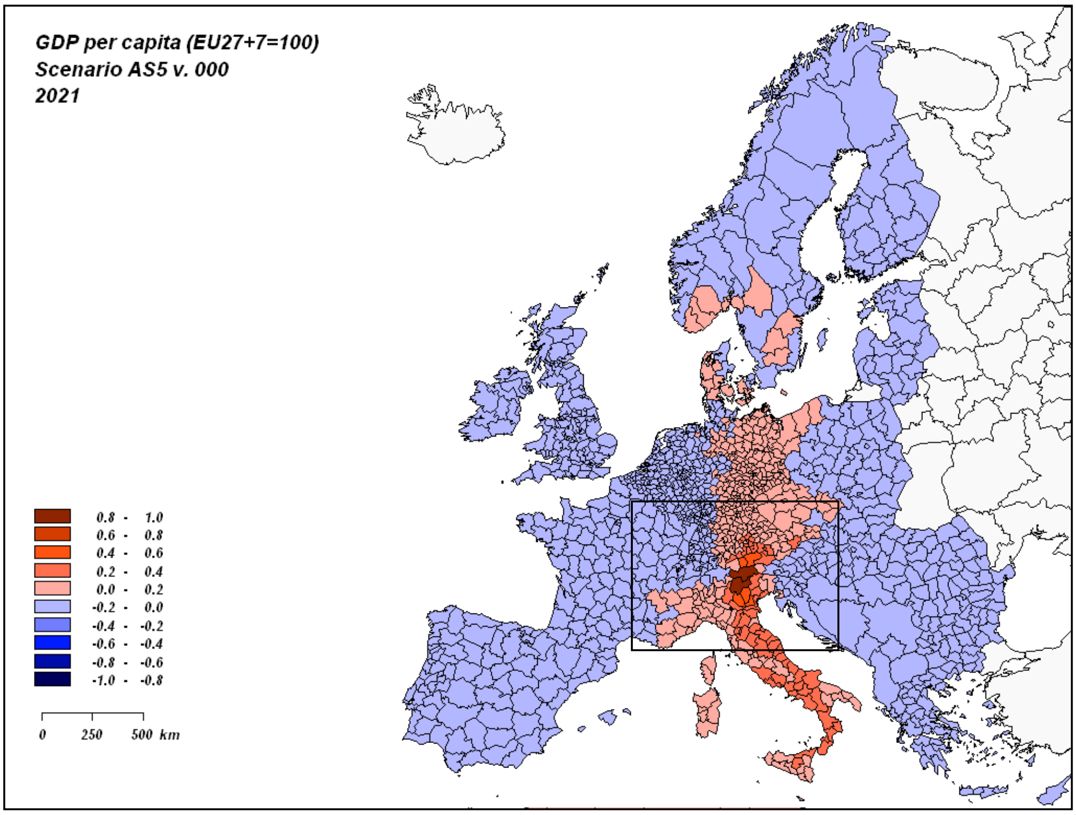

Figure 5.33. Effect of the Brenner tunnel (AS1) plus AS2+AS3+AS4: Difference in GDP per capita between Scenario AS5 and Scenario 000 in 2021 (%)

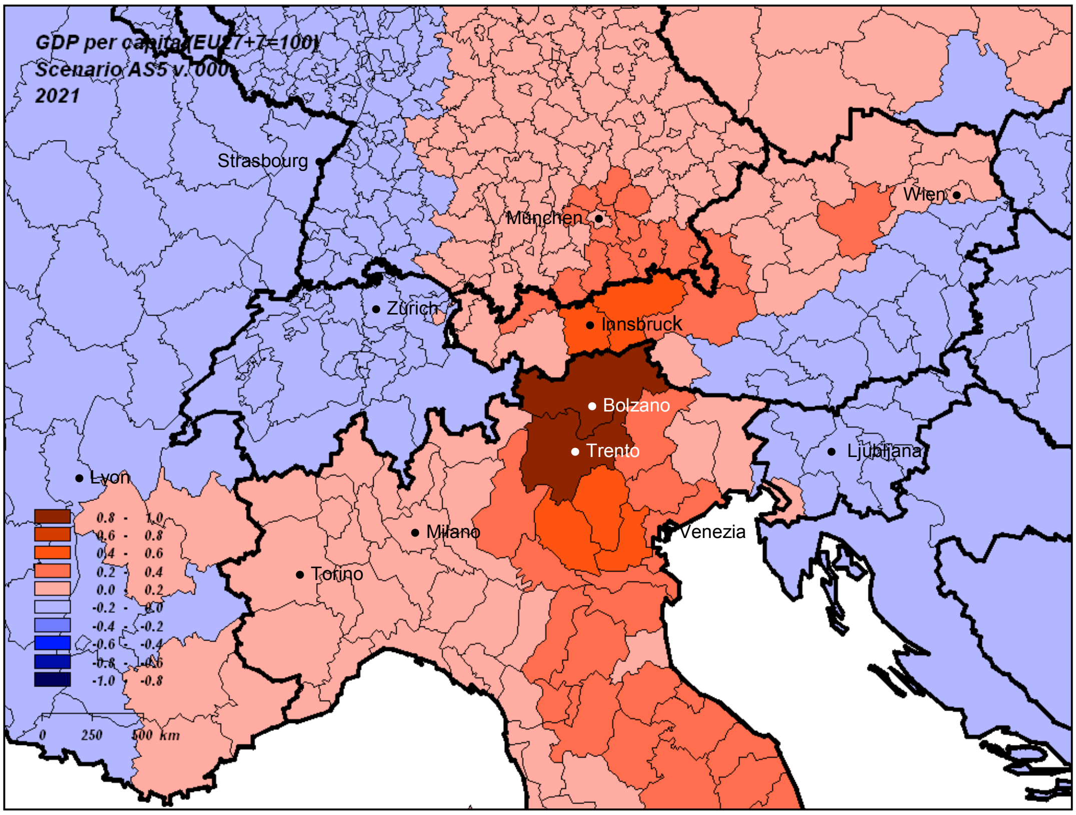

Figure 5.34. Effect of the Brenner tunnel (AS1) plus AS2+AS3+AS4: Difference in GDP per capita between Scenario AS5 and Scenario 000 in the AlpenCorS regions in 2021 (%)

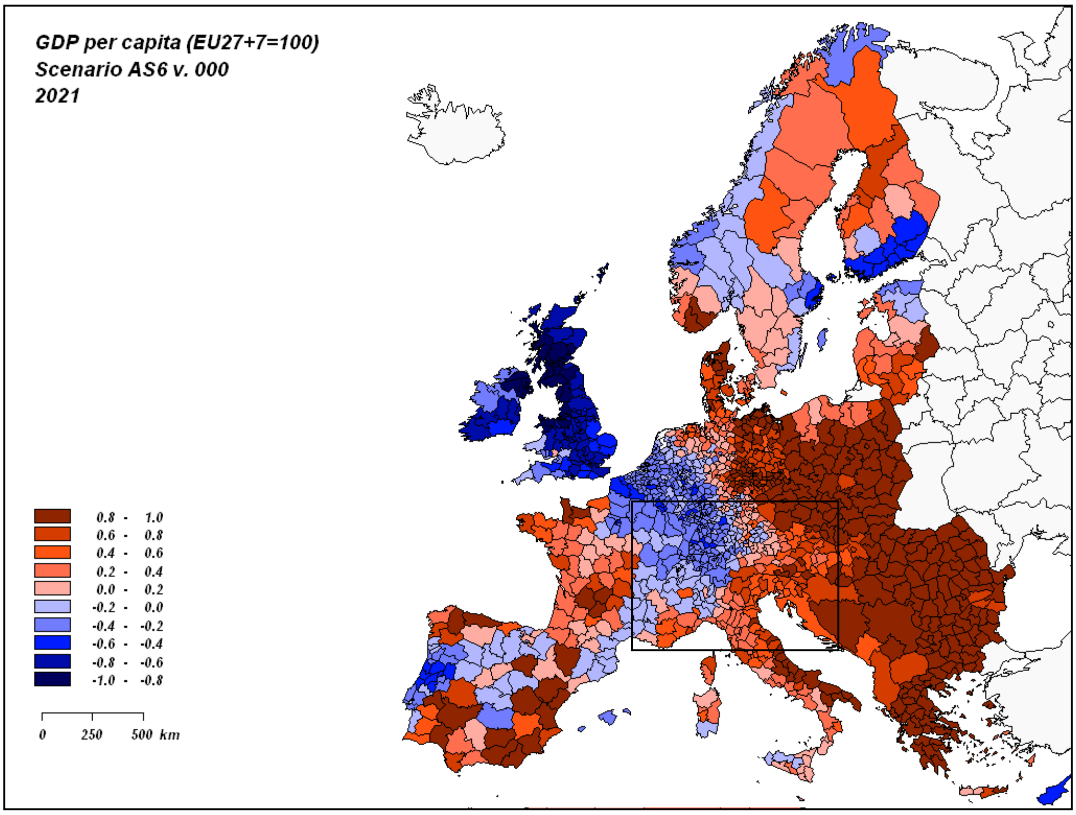

Figure 5.35. Effect of all TEN and TINA road and rail projects: Difference in GDP per capita between Scenario AS6 and Scenario 000 in 2021 (%)

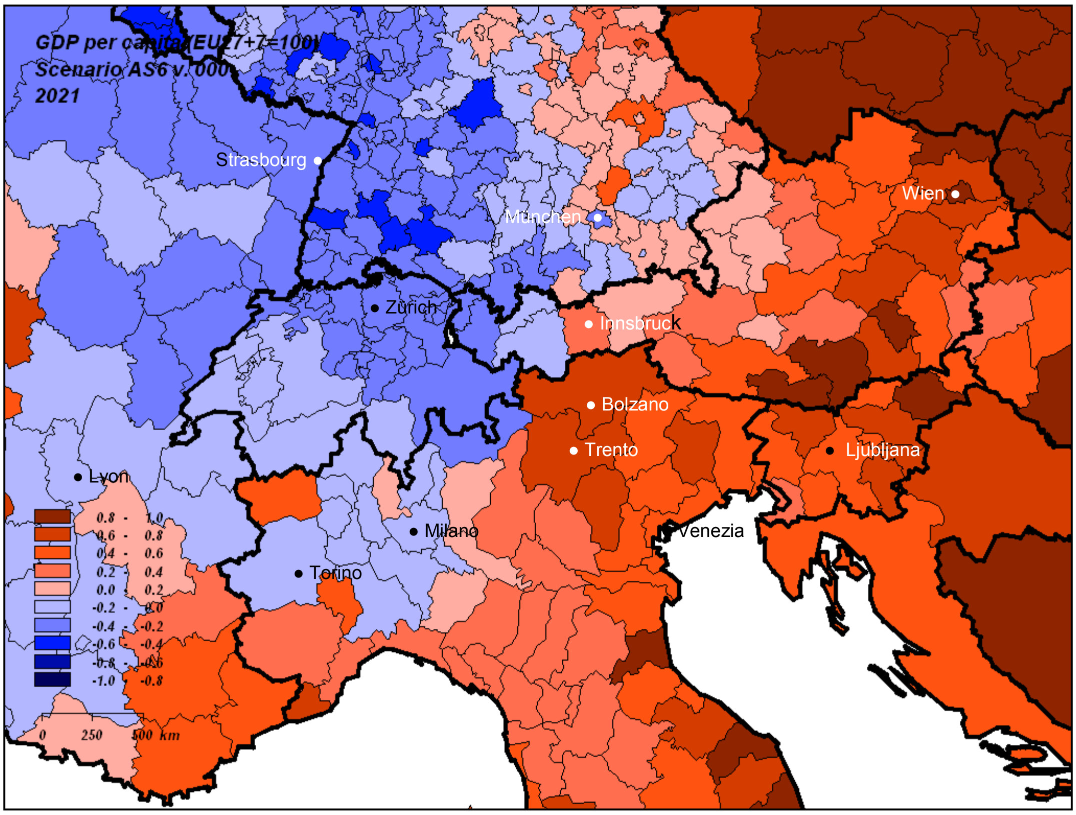

Figure 5.36. Effect of all TEN and TINA road and rail projects: Difference in GDP per capita between Scenario AS6 and Scenario 000 in the AlpenCorS regions in 2021 (%)

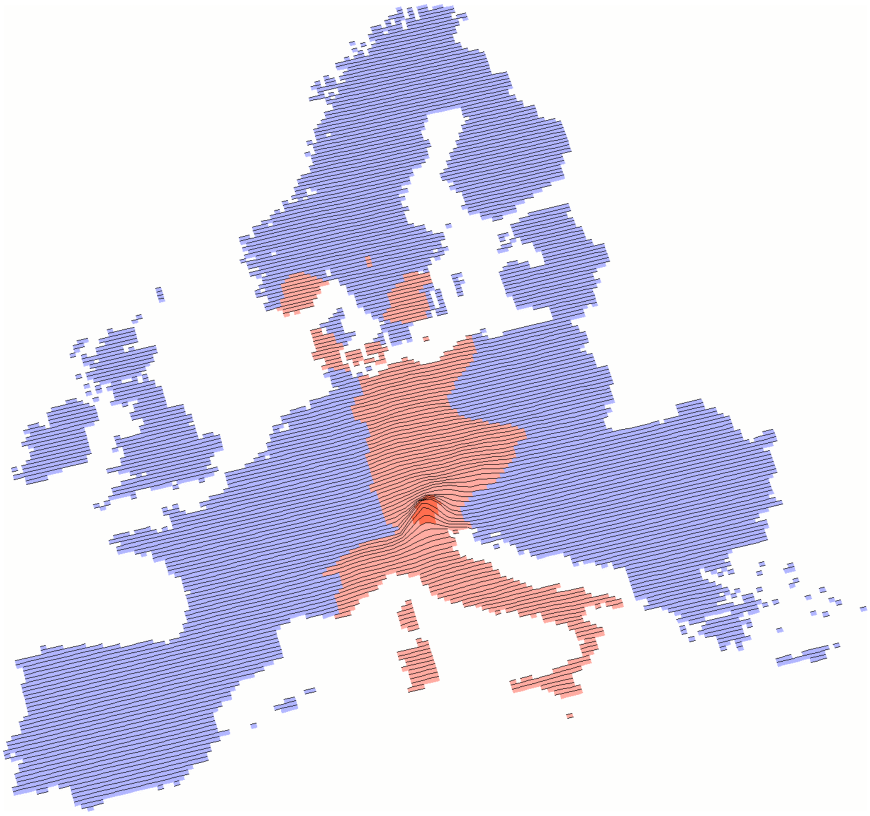

Figure 5.37. Effect of the Brenner tunnel plus AS2+AS3+AS4: Difference in GDP per capita between Scenario AS5 and Scenario 000 in 2021

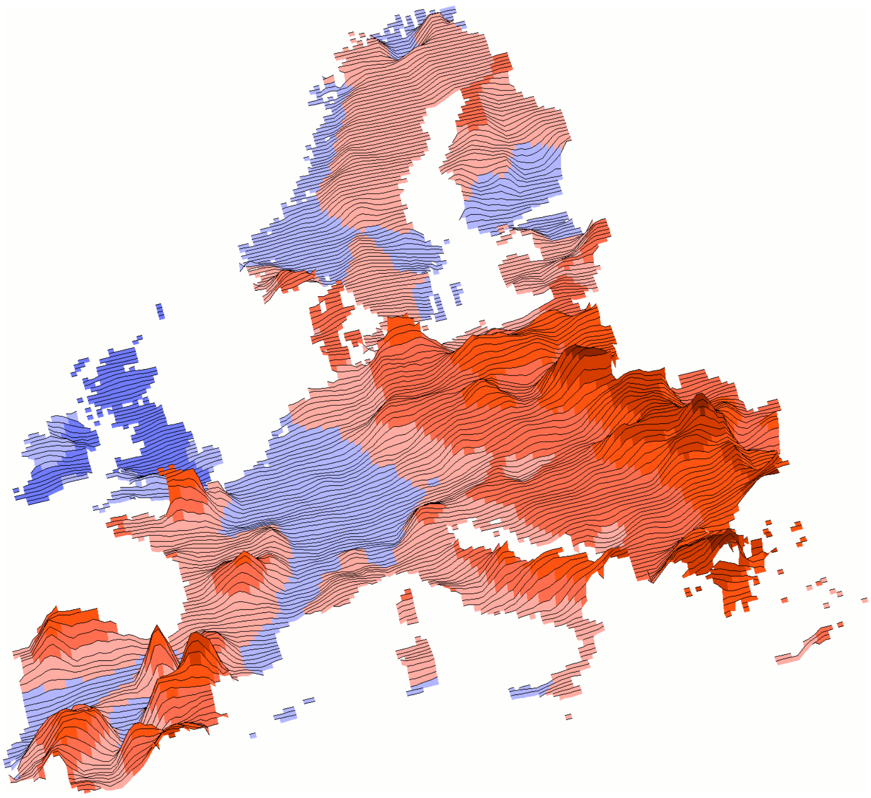

Figure 5.38. Effect of all TEN and TINA road and rail projects: Difference in GDP per capita between Scenario AS6 and Scenario 000 in 2021

6 Scenario Comparison

The tables on the following pages compare the results of the six transport infrastructure scenarios with the Reference Scenario 000 in the target year 2021.

The model results were aggregated from the 186 NUTS-3 regions in the AlpenCorS area to the 33 NUTS-2 regions in the area and to the AlpenCorS area as a whole. This aggregation provides also information on the provinces of Bozen/Bolzano and Trento as these two regions are both NUTS-2 and NUTS-3 regions.

In each table the first column contains the simulation results in the Reference Scenario 000 for the target year 2021. The remaining six columns of each table contain differences between the corresponding results of the six transport infrastructure scenarios and the results of the Reference Scenario 000 in percent of the value in the first column.

Accessibility

Tables 6.1 to 6.4 show the effects of the seven scenarios on the four accessibility indicators used in the SASI model in the year 2021. Tables 6.1 and 6.2 show the effects of the scenarios on accessibility for travel by road and rail (Table 6.1) and by road, rail and air (Table 6.2). Tables 6.3 and Table 6.4 show the effects of the scenarios on accessibility for freight by road (Table 6.3) and road and rail (Table 6.4).

The first column in each table shows the distribution of accessibility in the AlpenCorS regions in Reference Scenario 000 in the year 2021 aggregated to NUTS-2 regions. The original NUTS-3 values were presented in map form in Figures 5.5 to 5.12. The numbers confirm that the regions north of the Alps have higher accessibility values because they are close to the large agglomerations in north-west Europe. Southern Germany and Switzerland have the highest accessibility values followed by the Austrian and Italian regions; however, there are considerable differences between urban and rural regions in each country.

The remaining columns show the effects of the six transport infrastructure scenarios on regional accessibility as differences between policy scenario and Reference Scenario 000 in 2021:

In all scenarios all types of accessibility are improved in all regions. This is not surprising because only transport infrastructure improvements were examined. The Brenner tunnel (Scenario AS1) is the project with the largest effect of the Scenarios AS1 to AS5. The implementation of the tunnel increases accessibility at its southern end, in the regions of Bozen/Bolzano and Trento, by about 4 % and at its northern end, in Tirol, by about 3 %. The effects in Scenarios AS2 to AS5 are always stronger than those of Scenario AS1 because the Brenner tunnel is included in all other scenarios except the reference scenario. However, the improvements through the additional transport infrastructure projects are small. The largest additional effects are due to the southern rail bypass between Trento and Verona (Scenario AS2), the additional effect is no more than one quarter of the initial effect of the tunnel. The additional effects of the two regional transport infrastructure projects, the extension of the Valdastico and Pedemontana motorways (Scenario AS3) and the upgrading of the Valsugana road and rail corridor (Scenario AS4), are much smaller. However, these projects are important for the nearby regions Vicenza and Padova and to a lesser extent Belluno, Treviso and Venezia, because they link these regions better to the tunnel. The effect of the Valsugana road and rail corridor (Scenario AS4) is smaller than that of the Valdastico and Pedemontana motorway extensions (Scenario AS3).

-able 6.1. Accessibility road/rail (travel, million)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	80.6	+0.03	+0.03	+0.09	+0.03	+0.10	+10.1
	NO	Niederösterreich	85.2	+0.60	+0.74	+0.63	+0.61	+0.77	+10.5
	VI	Wien	93.5	+0.37	+0.57	+0.41	+0.38	+0.60	+11.4
	CA	Kärnten	79.4	+0.02	+0.02	+0.07	+0.02	+0.07	+12.4
	ST	Steiermark	80.9	+0.03	+0.05	+0.07	+0.03	+0.09	+11.9
	OO	Oberösterreich	89.2	+1.64	+1.93	+1.67	+1.66	+1.95	+9.73
	SB	Salzburg	89.5	+1.93	+2.26	+1.96	+1.95	+2.29	+7.70
	TY	Tirol	91.1	+2.59	+3.01	+2.67	+2.62	+3.08	+7.60
	VA	Vorarlberg	94.0	+0.75	+0.92	+0.83	+0.77	+0.99	+5.88
CH	GE	Genève/Lausanne	88.1	+0.14	+0.17	+0.15	+0.14	+0.17	+5.45
	BE	Bern	90.7	+0.19	+0.19	+0.20	+0.19	+0.20	+4.88
	BS	Basel	99.9	+0.19	+0.19	+0.20	+0.19	+0.20	+4.12
	ZU	Zürich	97.6	+0.21	+0.21	+0.25	+0.22	+0.25	+4.15
	SG	St. Gallen	91.2	+0.19	+0.20	+0.25	+0.19	+0.26	+4.65
	LZ	Luzern	94.3	+0.17	+0.18	+0.18	+0.17	+0.19	+4.02
	BA	Bellinzona	86.9	+0.21	+0.32	+0.21	+0.21	+0.33	+5.46
DE	FB	Freiburg	100.1	+0.05	+0.05	+0.06	+0.05	+0.06	+4.29
	TB	Tübingen	97.5	+0.32	+0.41	+0.38	+0.33	+0.47	+5.07
	MU	Oberbayern	99.4	+1.59	+1.90	+1.66	+1.62	+1.96	+6.70
	AU	Schwaben	98.8	+0.98	+1.16	+1.05	+1.00	+1.22	+5.86
FR	AL	Alsace	98.8	+0.03	+0.03	+0.03	+0.03	+0.04	+4.19
	FC	Franche-Comté	88.4	+0.10	+0.10	+0.10	+0.10	+0.11	+4.62
	RA	Rhône-Alpes	81.9	+0.18	+0.29	+0.18	+0.19	+0.29	+5.78
	PA	Provence-Alpes	65.5	+0.28	+0.40	+0.30	+0.28	+0.42	+8.58
IT	PI	Piemonte	85.2	+0.67	+0.90	+0.70	+0.69	+0.93	+6.69
	VD	Valle d'Aosta	79.2	+0.49	+0.66	+0.51	+0.50	+0.68	+8.69
	LI	Liguria	83.5	+0.70	+0.94	+0.74	+0.72	+0.98	+7.36
	LO	Lombardia	91.2	+0.84	+1.08	+0.88	+0.86	+1.12	+6.72
	VE	Veneto	86.2	+1.18	+1.42	+2.06	+1.25	+2.27	+8.86
	FV	Friuli Venezia Giulia	82.6	+0.19	+0.27	+0.42	+0.19	+0.49	+9.02
	BO	**Bolzano**	**83.2**	**+4.45**	**+5.31**	**+4.66**	**+4.52**	**+5.52**	**+9.76**
	TR	**Trento**	**83.7**	**+3.81**	**+4.77**	**+4.34**	**+3.88**	**+5.29**	**+9.70**
SI	SI	Slovenia	79.1	+0.03	+0.05	+0.05	+0.03	+0.07	+10.0
	AC	AlpenCorS	87.8	+0.66	+0.82	+0.75	+0.67	+0.91	+6.94

Table 6.2. Accessibility road/rail/air (travel, million)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	83.3	+0.03	+0.03	+0.09	+0.03	+0.09	+8.88
	NO	Niederösterreich	87.7	+0.54	+0.67	+0.57	+0.55	+0.70	+9.39
	VI	Wien	96.7	+0.33	+0.50	+0.36	+0.34	+0.53	+9.95
	CA	Kärnten	81.6	+0.01	+0.01	+0.06	+0.01	+0.06	+11.3
	ST	Steiermark	82.7	+0.03	+0.04	+0.07	+0.03	+0.09	+11.0
	OO	Oberösterreich	91.0	+1.53	+1.80	+1.56	+1.55	+1.83	+8.99
	SB	Salzburg	92.4	+1.75	+2.05	+1.79	+1.78	+2.08	+6.87
	TY	Tirol	93.7	+2.36	+2.75	+2.43	+2.39	+2.82	+6.84
	VA	Vorarlberg	97.3	+0.66	+0.81	+0.73	+0.68	+0.87	+5.12
CH	GE	Genève/Lausanne	90.4	+0.13	+0.15	+0.13	+0.13	+0.15	+4.81
	BE	Bern	93.3	+0.16	+0.16	+0.17	+0.16	+0.17	+4.22
	BS	Basel	103.4	+0.16	+0.16	+0.16	+0.16	+0.16	+3.43
	ZU	Zürich	102.0	+0.18	+0.18	+0.21	+0.18	+0.21	+3.28
	SG	St. Gallen	95.1	+0.16	+0.17	+0.21	+0.16	+0.22	+3.85
	LZ	Luzern	97.8	+0.14	+0.14	+0.15	+0.14	+0.15	+3.32
	BA	Bellinzona	89.5	+0.19	+0.28	+0.20	+0.19	+0.29	+4.72
DE	FB	Freiburg	103.4	+0.04	+0.04	+0.05	+0.04	+0.05	+3.62
	TB	Tübingen	101.5	+0.28	+0.36	+0.33	+0.29	+0.41	+4.28
	MU	Oberbayern	103.3	+1.44	+1.71	+1.50	+1.47	+1.77	+5.78
	AU	Schwaben	101.9	+0.88	+1.04	+0.94	+0.90	+1.10	+5.15
FR	AL	Alsace	101.3	+0.03	+0.03	+0.03	+0.03	+0.03	+3.68
	FC	Franche-Comté	89.8	+0.10	+0.10	+0.10	+0.10	+0.10	+4.22
	RA	Rhône-Alpes	83.9	+0.17	+0.27	+0.17	+0.17	+0.27	+5.17
	PA	Provence-Alpes	68.1	+0.25	+0.36	+0.27	+0.26	+0.38	+7.41
IT	PI	Piemonte	87.6	+0.63	+0.84	+0.65	+0.65	+0.87	+5.93
	VD	Valle d'Aosta	82.0	+0.43	+0.59	+0.45	+0.44	+0.61	+7.64
	LI	Liguria	85.7	+0.67	+0.90	+0.70	+0.69	+0.93	+6.65
	LO	Lombardia	94.4	+0.77	+0.98	+0.81	+0.78	+1.02	+5.84
	VE	Veneto	88.2	+1.10	+1.32	+1.92	+1.16	+2.12	+8.23
	FV	Friuli Venezia Giulia	84.5	+0.17	+0.24	+0.39	+0.18	+0.46	+8.36
	BO	**Bolzano**	**85.1**	**+4.02**	**+4.83**	**+4.21**	**+4.09**	**+5.00**	**+8.91**
	TR	**Trento**	**85.4**	**+3.51**	**+4.41**	**+3.99**	**+3.58**	**+4.89**	**+8.99**
SI	SI	Slovenia	81.0	+0.03	+0.05	+0.05	+0.03	+0.06	+9.25
	AC	AlpenCorS	90.6	+0.60	+0.74	+0.69	+0.61	+0.83	+6.13

Table 6.3. Accessibility road (freight, million)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	102.3	0.00	0.00	+0.11	0.00	+0.11	+3.38
	NO	Niederösterreich	105.5	+0.07	+0.10	+0.10	+0.07	+0.13	+3.43
	VI	Wien	110.0	+0.01	+0.05	+0.07	+0.01	+0.07	+3.23
	CA	Kärnten	101.9	0.00	0.00	+0.13	0.00	+0.13	+2.92
	ST	Steiermark	102.7	0.00	0.00	+0.12	0.00	+0.12	+3.13
	OO	Oberösterreich	108.9	+0.20	+0.28	+0.20	+0.20	+0.28	+3.81
	SB	Salzburg	108.8	+0.14	+0.20	+0.14	+0.14	+0.20	+2.62
	TY	Tirol	109.2	+0.21	+0.31	+0.24	+0.22	+0.33	+2.34
	VA	Vorarlberg	111.9	0.00	0.00	+0.05	+0.02	+0.05	+2.85
CH	GE	Genève/Lausanne	103.3	0.00	0.00	+0.01	0.00	0.01	+3.05
	BE	Bern	106.0	0.00	0.00	0.00	0.00	0.00	+2.73
	BS	Basel	111.7	0.00	0.00	+0.02	0.00	+0.02	+2.64
	ZU	Zürich	111.0	0.00	0.00	+0.03	+0.01	+0.03	+2.48
	SG	St. Gallen	109.0	0.00	0.00	+0.05	+0.02	+0.05	+2.61
	LZ	Luzern	109.8	0.00	0.00	+0.01	0.00	+0.01	+2.31
	BA	Bellinzona	103.7	0.00	0.00	+0.01	0.00	+0.01	+2.51
DE	FB	Freiburg	114.9	0.00	0.00	+0.02	+0.01	+0.02	+2.71
	TB	Tübingen	115.8	0.00	0.00	+0.05	+0.01	+0.05	+2.80
	MU	Oberbayern	116.4	+0.55	+0.66	+0.56	+0.55	+0.67	+3.42
	AU	Schwaben	116.8	+0.14	+0.19	+0.18	+0.15	+0.22	+3.01
FR	AL	Alsace	110.4	0.00	0.00	+0.01	0.00	+0.01	+2.75
	FC	Franche-Comté	104.9	0.00	0.00	+0.01	0.00	+0.01	+2.86
	RA	Rhône-Alpes	95.4	0.00	0.00	+0.01	0.00	+0.01	+3.36
	PA	Provence-Alpes	83.0	+0.22	+0.33	+0.32	+0.22	+0.41	+2.69
IT	PI	Piemonte	97.4	+0.09	+0.18	+0.20	+0.09	+0.28	+2.45
	VD	Valle d'Aosta	100.4	0.00	0.00	+0.08	0.00	+0.08	+4.08
	LI	Liguria	95.1	+0.49	+0.64	+0.61	+0.49	+0.75	+2.43
	LO	Lombardia	103.0	+0.32	+0.44	+0.44	+0.32	+0.55	+3.12
	VE	Veneto	99.4	+0.66	+0.85	+1.46	+0.87	+1.55	+4.22
	FV	Friuli Venezia Giulia	98.3	0.00	0.00	+0.44	0.00	+0.44	+3.08
	BO	**Bolzano**	**102.5**	**+0.17**	**+0.17**	**+0.28**	**+0.20**	**+0.28**	**+2.27**
	TR	**Trento**	**101.5**	**+0.55**	**+0.55**	**+0.75**	**+0.60**	**+0.77**	**+3.01**
SI	SI	Slovenia	95.3	0.00	0.00	+0.03	0.00	+0.03	+3.52
	AC	AlpenCorS	103.0	+0.18	+0.24	+0.29	+0.20	+0.34	+3.07

Table 6.4. Accessibility road/rail (freight, million)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	124.4	+0.05	+0.09	+0.11	+0.06	+0.15	+5.64
	NO	Niederösterreich	129.4	+0.42	+0.51	+0.43	+0.42	+0.53	+5.60
	VI	Wien	136.4	+0.41	+0.52	+0.43	+0.42	+0.52	+5.80
	CA	Kärnten	125.7	+0.01	+0.01	+0.06	+0.01	+0.06	+6.22
	ST	Steiermark	125.6	+0.03	+0.03	+0.08	+0.03	+0.09	+6.15
	OO	Oberösterreich	135.5	+0.73	+0.88	+0.73	+0.74	+0.88	+5.06
	SB	Salzburg	137.1	+0.84	+1.00	+0.84	+0.85	+1.00	+3.92
	TY	Tirol	136.5	+1.33	+1.54	+1.35	+1.34	+1.55	+4.22
	VA	Vorarlberg	137.6	+0.40	+0.47	+0.43	+0.41	+0.50	+3.73
CH	GE	Genève/Lausanne	130.5	+0.05	+0.05	+0.05	+0.05	+0.06	+3.67
	BE	Bern	133.6	+0.05	+0.05	+0.05	+0.05	+0.05	+3.41
	BS	Basel	141.9	+0.04	+0.04	+0.05	+0.04	+0.05	+3.02
	ZU	Zürich	139.3	+0.09	+0.09	+0.10	+0.09	+0.10	+2.94
	SG	St. Gallen	134.4	+0.06	+0.09	+0.09	+0.07	+0.11	+3.04
	LZ	Luzern	136.8	+0.06	+0.06	+0.07	+0.07	+0.07	+2.82
	BA	Bellinzona	126.6	+0.18	+0.26	+0.19	+0.18	+0.26	+3.27
DE	FB	Freiburg	145.3	+0.01	+0.01	+0.02	+0.01	+0.02	+3.08
	TB	Tübingen	144.9	+0.31	+0.37	+0.33	+0.31	+0.40	+3.44
	MU	Oberbayern	147.1	+0.94	+1.10	+0.95	+0.95	+1.10	+4.00
	AU	Schwaben	146.1	+0.61	+0.72	+0.63	+0.62	+0.74	+3.68
FR	AL	Alsace	140.9	+0.01	+0.01	+0.01	+0.01	+0.01	+3.13
	FC	Franche-Comté	133.1	+0.00	+0.01	+0.01	+0.01	+0.01	+3.24
	RA	Rhône-Alpes	125.1	+0.07	+0.10	+0.07	+0.07	+0.10	+3.89
	PA	Provence-Alpes	110.0	+0.25	+0.34	+0.30	+0.25	+0.38	+5.03
IT	PI	Piemonte	125.1	+0.71	+0.89	+0.76	+0.72	+0.94	+4.37
	VD	Valle d'Aosta	121.6	+0.55	+0.67	+0.59	+0.55	+0.71	+5.29
	LI	Liguria	122.5	+0.92	+1.15	+0.98	+0.93	+1.21	+4.99
	LO	Lombardia	130.4	+0.99	+1.22	+1.05	+1.00	+1.28	+4.51
	VE	Veneto	126.0	+1.57	+1.92	+1.94	+1.68	+2.24	+5.95
	FV	Friuli Venezia Giulia	123.5	+0.16	+0.24	+0.34	+0.17	+0.42	+5.06
	BO	**Bolzano**	**126.5**	**+3.36**	**+3.71**	**+3.42**	**+3.42**	**+3.77**	**+6.29**
	TR	**Trento**	**126.4**	**+3.15**	**+3.53**	**+3.27**	**+3.20**	**+3.64**	**+6.26**
SI	SI	Slovenia	118.5	+0.02	+0.03	+0.03	+0.02	+0.04	+5.34
	AC	AlpenCorS	130.6	+0.55	+0.67	+0.60	+0.56	+0.72	+4.36

Scenarios AS5 and AS6 show the effects of policy combinations. In Scenario AS5 it is assumed that not only the Brenner tunnel and its access links are built (Scenario AS1) but that also the southern rail bypass between Trento and Verona is completed (Scenario AS2), the Valdastico and Pedemontana motorways are extended (Scenario AS3) and the Valsugana road and rail corridor is upgraded (Scenario AS4). In Scenario AS6 all these infrastructure improvements are examined together with the implementation of all presently discussed TEN and TINA road and rail project all over Europe.

As expected, the effects on accessibility of Scenario AS5 are larger than those of all previous scenarios including Scenario AS1. This seems to speak in favour of implementing all infrastructure projects included in Scenario AS5, i.e. in Scenarios AS1 to AS4. But is this justified? Are all these projects necessary to achieve the desired improvement in accessibility? Do the projects complement one another? This is the synergy question. Synergies between policies exist if the sum of their individual effects is smaller than the total effect of their combined implementation in a policy package. Table 6.5 examines this question using the region of Trento as an example.

Table 6.5. Effects of infrastructure projects on accessibility of Trento

Accessibility	Effects of scenarios (%)						
	Effect AS1	Additional effect AS2	Additional effect AS3	Additional effect AS4	Total	Effect AS5	Synergy
Road/rail (travel)	+3.81	+0.96	+0.53	+0.07	+5.37	+5.29	–0.08
Road/rail/air (travel)	+3.51	+0.90	+0.48	+0.07	+4.96	+4.89	–0.07
Road (freight)	+0.55	0.00	+0.20	+0.05	+0.80	+0.77	–0.03
Road/rail (freight)	+3.15	+0.38	+0.12	+0.05	+3.70	+3.64	–0.06

The table shows the effects on accessibility of Scenarios AS1 to AS5 for Trento. As the Brenner tunnel (Scenario AS1) is included in Scenarios AS2 to AS4, only additional effects of these scenarios (after subtracting the effects of AS1) are listed. The last column compares the total of the effects of Scenario AS1 plus the additional effects of Scenarios AS2 to AS4 with the effect of their combined application in Scenario AS5. For all four types of accessibility the effect of Scenario AS5 is less than the total of the effects of Scenarios AS1 to AS4, i.e. their synergy is negative. The conclusion is that the Valdastico and Pedemontana motorway extensions (Scenario AS3) and the Valsugana road and rail corridor upgrading (Scenario AS4) partly achieve the same result in different ways. This does not exclude that they have important local effects in the regions through which they pass and adjacent regions. There may also be good reasons to upgrade the Valsugana rail line for environmental reasons, i.e. in order to reduce road traffic in the valley.

Scenario AS6 shows the changes in accessibility that could be expected from the implementation of all TEN and TINA projects in Europe, including those in Scenarios AS1 to AS5. The effects are by an order of magnitude larger than those of the regional and local projects in the other scenarios, even though the main emphasis of the TEN and TINA programmes are on the new member states in eastern Europe. Even for the regions close to the Brenner tunnel, which benefit most from the tunnel, the effects on accessibility are about twice as large. This demonstrates that in the long run European developments in transport infrastructure may be more important than local transport infrastructure improvements.

GDP per capita

Tables 6.6 to 6.8 show the effects of the seven scenarios on regional GDP: Table 6.6 on total regional GDP, Table 6.7 on GDP per capita Euro of 1998 and Table 6.8 on GDP per capita in percent of the European average (EU27+7=100).

The first column in each table shows the distribution of GDP or GDP per capita in the AlpenCorS regions in Reference Scenario 000 in the year 2021 aggregated to NUTS-2 regions. The original NUTS-3 values of GDP per capita in 1,000 Euro of 1998 were presented in the diagram of Figure 5.2. The original NUTS-3 values of GDP per capita (EU27+7=100) were presented in map form in Figures 5.3 and 5.4. The numbers confirm that the AlpenCorS region as a whole has a GDP per capita well above the European average, that the regions in Switzerland, topped by Zürich, are the most productive and wealthiest AlpenCorS regions, followed by the regions in southern Germany and Austria, that the Italian regions are below the average of the AlpenCorS regions but above the European average, and that the Autonomous Province of Trento is among the most productive and most affluent regions of the Italian AlpenCorS regions.

The remaining columns show the effects of the six transport infrastructure scenarios on regional GDP as differences between policy scenario and Reference Scenario in 2021. The original NUTS-3 values underlying these NUTS-2 aggregates were presented in map form and as 3D surfaces in Figures 5.25 to 5.38.

Table 6.6 presents the results of the GDP forecasts in absolute terms, expressed in Euro of 1998. Not surprisingly, all differences are positive, i.e. all regions experience a gain in production and affluence due to the transport infrastructure improvements examined. However, the gains are much smaller than the gains in accessibility presented in Tables 6.1 to 6.4, and even in the regions close to the tunnel do not exceed one percent except in the two scenarios combining several transport infrastructure projects, Scenarios AS5 and AS6. As in the case of accessibility, the effects of the European projects outside the AlpenCorS area are much stronger than those of the local projects of Scenarios AS2 to AS5, even for the regions close to the Brenner tunnel.

Table 6.7 shows the effects on regional GDP per capita. Here, too, the unit is Euro of 1998, which means that only gains in GDP per capita are recorded. Again the regions near the Brenner axis are most affected, most notably Bozen/Bolzano and Trento, and the much larger effects associated with Scenario AS6 are notable. The relative gains in GDP per capita are slightly smaller than for total GDP in Table 6.6 because economically successful regions attract migrants from other regions and so have to allocate their GDP to more people.

Table 6.8 shows the same indicator, GDP per capita, but standardised to the European average, i.e. the weighted average of all regions in the European Union plus Norway and Switzerland and Bulgaria, Romania and the western Balkan countries (EU27+7=100). Now also negative differences appear, i.e. relative winners (with positive differences) and relative losers (with negative differences) can be distinguished. As noted in the discussion of individual scenarios in Chapter 5, the positive effects are spread out along a north-south corridor at both ends of the Brenner axis. The effects of Scenario AS6 are now much smaller, as many of the regions in central Europe, including Swiss, German and most French regions in the AlpenCorS area, become relative losers. However, the regions close to the Brenner tunnel remain on the winner side. If the six transport infrastructure scenarios are compared, the effects of all six scenarios on the relative position of the regions are very similar. For the provinces of Bozen/Bolzano and Trento, for instance, the combination of the Brenner tunnel with additional projects brings only little extra benefit, except where all three infrastructure measures, the southern rail bypass, the Valdastico and Pedemontana motorways and the Valsugana road and rail corridor, are combined (Scenario AS5).

Table 6.6. GDP (Billion Euro of 1998)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	8.5	+0.01	+0.01	+0.02	+0.01	+0.03	+1.54
	NO	Niederösterreich	53.9	+0.10	+0.12	+0.11	+0.10	+0.13	+1.76
	VI	Wien	94.7	+0.07	+0.10	+0.08	+0.08	+0.11	+1.94
	CA	Kärnten	21.1	+0.01	+0.01	+0.02	+0.01	+0.02	+1.96
	ST	Steiermark	45.9	+0.01	+0.01	+0.02	+0.01	+0.02	+1.86
	OO	Oberösterreich	59.5	+0.22	+0.25	+0.22	+0.22	+0.26	+1.34
	SB	Salzburg	25.2	+0.31	+0.36	+0.32	+0.31	+0.37	+1.24
	TY	Tirol	30.2	+0.42	+0.48	+0.43	+0.42	+0.49	+1.23
	VA	Vorarlberg	16.0	+0.11	+0.13	+0.12	+0.11	+0.14	+0.86
CH	GE	Genève/Lausanne	84.2	+0.02	+0.02	+0.02	+0.02	+0.03	+1.01
	BE	Bern	85.2	+0.03	+0.03	+0.03	+0.03	+0.03	+0.88
	BS	Basel	72.6	+0.03	+0.03	+0.03	+0.03	+0.03	+0.71
	ZU	Zürich	102.4	+0.03	+0.03	+0.04	+0.03	+0.04	+0.68
	SG	St. Gallen	57.2	+0.03	+0.03	+0.04	+0.03	+0.04	+0.79
	LZ	Luzern	42.1	+0.03	+0.03	+0.03	+0.03	+0.03	+0.69
	BA	Bellinzona	15.2	+0.03	+0.05	+0.04	+0.04	+0.05	+0.97
DE	FB	Freiburg	85.1	+0.01	+0.01	+0.01	+0.01	+0.01	+0.70
	TB	Tübingen	73.7	+0.06	+0.07	+0.07	+0.06	+0.08	+0.81
	MU	Oberbayern	248.4	+0.25	+0.29	+0.26	+0.25	+0.30	+1.00
	AU	Schwaben	69.4	+0.15	+0.18	+0.16	+0.16	+0.19	+0.91
FR	AL	Alsace	70.2	+0.00	+0.00	+0.00	+0.00	+0.00	+0.72
	FC	Franche-Comté	39.7	+0.01	+0.01	+0.01	+0.01	+0.01	+0.78
	RA	Rhône-Alpes	226.1	+0.02	+0.04	+0.02	+0.02	+0.04	+0.99
	PA	Provence-Alpes	163.5	+0.05	+0.06	+0.05	+0.05	+0.07	+1.43
IT	PI	Piemonte	126.6	+0.13	+0.16	+0.13	+0.13	+0.17	+1.12
	VD	Valle d'Aosta	3.8	+0.10	+0.13	+0.11	+0.10	+0.14	+1.65
	LI	Liguria	41.3	+0.15	+0.19	+0.15	+0.15	+0.20	+1.40
	LO	Lombardia	319.1	+0.15	+0.19	+0.16	+0.16	+0.20	+1.07
	VE	Veneto	141.9	+0.24	+0.29	+0.40	+0.26	+0.44	+1.63
	FV	Friuli Venezia Giulia	33.6	+0.04	+0.06	+0.09	+0.04	+0.10	+1.60
	BO	**Bolzano**	**18.2**	**+0.85**	**+0.99**	**+0.89**	**+0.86**	**+1.03**	**+1.87**
	TR	**Trento**	**15.8**	**+0.76**	**+0.92**	**+0.86**	**+0.78**	**+1.02**	**+1.90**
SI	SI	Slovenia	30.8	+0.01	+0.01	+0.01	+0.01	+0.01	+1.70
	AC	AlpenCorS	2,521.0	+0.11	+0.14	+0.13	+0.12	+0.15	+1.14

Table 6.7. GDP per capita (1,000 Euro of 1998)

Region			Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	32.1	+0.01	+0.01	+0.02	+0.01	+0.03	+1.52
	NO	Niederösterreich	36.1	+0.10	+0.12	+0.11	+0.10	+0.13	+1.73
	VI	Wien	59.6	+0.07	+0.10	+0.08	+0.08	+0.11	+1.90
	CA	Kärnten	38.9	+0.01	+0.01	+0.02	+0.01	+0.02	+1.94
	ST	Steiermark	39.9	+0.01	+0.01	+0.02	+0.01	+0.02	+1.82
	OO	Oberösterreich	44.1	+0.21	+0.25	+0.22	+0.22	+0.25	+1.33
	SB	Salzburg	49.2	+0.31	+0.35	+0.31	+0.31	+0.36	+1.24
	TY	Tirol	45.7	+0.41	+0.47	+0.42	+0.42	+0.48	+1.22
	VA	Vorarlberg	46.1	+0.10	+0.13	+0.12	+0.11	+0.14	+0.87
CH	GE	Genève/Lausanne	60.7	+0.02	+0.03	+0.02	+0.02	+0.03	+1.01
	BE	Bern	49.8	+0.03	+0.03	+0.03	+0.03	+0.03	+0.89
	BS	Basel	68.3	+0.03	+0.03	+0.03	+0.03	+0.03	+0.73
	ZU	Zürich	77.0	+0.03	+0.03	+0.04	+0.03	+0.04	+0.70
	SG	St. Gallen	52.7	+0.03	+0.03	+0.04	+0.03	+0.04	+0.80
	LZ	Luzern	58.6	+0.03	+0.03	+0.03	+0.03	+0.03	+0.71
	BA	Bellinzona	47.8	+0.03	+0.05	+0.04	+0.04	+0.05	+0.97
DE	FB	Freiburg	40.6	+0.01	+0.01	+0.01	+0.01	+0.01	+0.71
	TB	Tübingen	41.9	+0.06	+0.07	+0.07	+0.06	+0.08	+0.82
	MU	Oberbayern	61.5	+0.24	+0.28	+0.25	+0.25	+0.29	+1.00
	AU	Schwaben	40.7	+0.15	+0.18	+0.16	+0.15	+0.19	+0.92
FR	AL	Alsace	37.3	+0.00	+0.00	+0.00	+0.00	+0.01	+0.73
	FC	Franche-Comté	33.5	+0.01	+0.01	+0.01	+0.01	+0.01	+0.79
	RA	Rhône-Alpes	36.8	+0.02	+0.04	+0.02	+0.02	+0.04	+0.99
	PA	Provence-Alpes	33.4	+0.05	+0.06	+0.05	+0.05	+0.07	+1.43
IT	PI	Piemonte	33.2	+0.13	+0.16	+0.13	+0.13	+0.17	+1.12
	VD	Valle d'Aosta	35.0	+0.10	+0.13	+0.11	+0.10	+0.14	+1.63
	LI	Liguria	30.1	+0.15	+0.19	+0.15	+0.15	+0.20	+1.40
	LO	Lombardia	37.9	+0.15	+0.19	+0.16	+0.16	+0.20	+1.07
	VE	Veneto	33.5	+0.24	+0.29	+0.40	+0.25	+0.44	+1.62
	FV	Friuli Venezia Giulia	32.1	+0.04	+0.06	+0.09	+0.04	+0.10	+1.58
	BO	**Bolzano**	**40.8**	**+0.84**	**+0.97**	**+0.87**	**+0.85**	**+1.01**	**+1.85**
	TR	**Trento**	**34.8**	**+0.75**	**+0.91**	**+0.85**	**+0.77**	**+1.00**	**+1.89**
SI	SI	Slovenia	17.4	+0.01	+0.01	+0.01	+0.01	+0.01	+1.69
	AC	AlpenCorS	41.4	+0.11	+0.14	+0.13	+0.12	+0.15	+1.14

Table 6.8. GDP per capita (EU27+7=100)

		Region	Reference Scenario 000 in 2021	Difference between policy scenario and Reference Scenario 000 in 2021 (%)					
				AS1	AS2	AS3	AS4	AS5	AS6
A	BL	Burgenland	116.8	-0.04	-0.05	-0.03	-0.04	-0.04	+0.43
	NO	Niederösterreich	131.5	+0.05	+0.06	+0.05	+0.05	+0.06	+0.64
	VI	Wien	216.9	+0.02	+0.04	+0.03	+0.03	+0.04	+0.80
	CA	Kärnten	141.4	-0.04	-0.05	-0.04	-0.04	-0.05	+0.84
	ST	Steiermark	145.3	-0.04	-0.05	-0.04	-0.04	-0.04	+0.73
	OO	Oberösterreich	160.5	+0.16	+0.19	+0.16	+0.17	+0.19	+0.24
	SB	Salzburg	179.2	+0.26	+0.29	+0.26	+0.26	+0.29	+0.15
	TY	Tirol	166.2	+0.36	+0.41	+0.37	+0.36	+0.42	+0.14
	VA	Vorarlberg	167.9	+0.06	+0.07	+0.06	+0.06	+0.07	–0.21
CH	GE	Genève/Lausanne	220.9	-0.03	-0.04	-0.03	-0.03	-0.04	–0.07
	BE	Bern	181.3	-0.02	-0.03	-0.02	-0.02	-0.03	–0.19
	BS	Basel	248.6	-0.02	-0.03	-0.03	-0.02	-0.04	–0.35
	ZU	Zürich	280.4	-0.02	-0.03	-0.02	-0.02	-0.03	–0.38
	SG	St. Gallen	191.9	-0.02	-0.03	-0.01	-0.02	-0.02	–0.28
	LZ	Luzern	213.4	-0.02	-0.03	-0.03	-0.02	-0.04	–0.37
	BA	Bellinzona	173.8	-0.01	-0.01	-0.02	-0.01	-0.01	–0.11
DE	FB	Freiburg	147.8	-0.04	-0.05	-0.04	-0.04	-0.05	–0.37
	TB	Tübingen	152.3	+0.01	+0.01	+0.01	+0.01	+0.02	–0.26
	MU	Oberbayern	223.9	+0.19	+0.22	+0.20	+0.20	+0.23	–0.08
	AU	Schwaben	148.0	+0.10	+0.12	+0.11	+0.10	+0.12	–0.16
FR	AL	Alsace	135.7	-0.05	-0.06	-0.05	-0.05	-0.06	–0.35
	FC	Franche-Comté	121.9	-0.04	-0.05	-0.04	-0.04	-0.05	–0.30
	RA	Rhône-Alpes	133.9	-0.03	-0.02	-0.03	-0.03	-0.03	–0.09
	PA	Provence-Alpes	121.7	0.00	0.00	0.00	0.00	0.00	+0.34
IT	PI	Piemonte	120.9	+0.08	+0.10	+0.08	+0.08	+0.10	+0.03
	VD	Valle d'Aosta	127.5	+0.05	+0.07	+0.05	+0.05	+0.07	+0.54
	LI	Liguria	109.4	+0.10	+0.13	+0.10	+0.10	+0.13	+0.31
	LO	Lombardia	138.0	+0.10	+0.13	+0.11	+0.10	+0.14	–0.01
	VE	Veneto	121.9	+0.19	+0.23	+0.34	+0.20	+0.37	+0.53
	FV	Friuli Venezia Giulia	116.8	-0.01	+0.00	+0.03	-0.01	+0.04	+0.49
	BO	**Bolzano**	**148.4**	**+0.79**	**+0.91**	**+0.82**	**+0.80**	**+0.94**	**+0.76**
	TR	**Trento**	**126.8**	**+0.70**	**+0.85**	**+0.79**	**+0.72**	**+0.94**	**+0.79**
SI	SI	Slovenia	63.3	-0.04	-0.05	-0.04	-0.05	-0.05	+0.60
	AC	AlpenCorS	150.7	+0.06	+0.07	+0.07	+0.06	+0.09	+0.05

This leads again to the issue of synergies between the transport infrastructure projects. In Table 6.9 the analysis of synergies between scenarios performed for accessibility in Table 6.5 is repeated for the three GDP indicator presented in Tables 6.6 to 6.8.

Table 6.9. Effects of infrastructure projects on regional GDP of Trento

GDP	Effects of scenarios (%)						
	Effect AS1	Additional effect AS2	AS3	AS4	Total	Effect AS5	Synergy
GDP	+0.76	+0.16	+0.10	+0.02	+1.04	+1.02	–0.02
GDP/capita (Euro)	+0.75	+0.16	+0.10	+0.02	+1.03	+1.00	–0.03
GDP/capita (EU27+7=100)	+0.70	+0.15	+0.09	+0.02	+0.96	+0.94	–0.02

The table shows that also with respect to GDP or GDP per capita there are no positive synergies between the infrastructure projects examined. The negative synergies in the last column indicate that the infrastructure projects, the southern rail bypass, the Valdastico and Pedemontana motorway extensions (Scenario AS3) and the Valsugana road and rail corridor upgrading (Scenario AS4) are at least in part substitutable as they achieve the same gain in GDP per capita for Trento by different means. However, this does not imply that these projects should not be implemented. They may have important local effects for the regions through which they pass and adjacent regions. There may also be good reasons to upgrade the Valsugana rail line for environmental reasons, i.e. in order to reduce road traffic in the valley.

To be on the safe side, the synergy analysis performed for accessibility and GDP for the region of Trento was also performed for all other regions of the AlpenCorS area. The analysis showed that only in very few regions positive synergies between the transport infrastructure projects examined appeared, and that these synergies were very small. The results are therefore not reproduced in detail here.

7 Territorial Cohesion

The results of the scenario simulations presented so far have shown how transport infrastructure investments improve the accessibility and hence economic competitiveness of regions. However, the transport policy of the European Union does not only serve competitiveness objectives. The European Union hopes to contribute by its transport policy also to *territorial cohesion*, a reduction of economic disparities between the central and peripheral regions in Europe. In particular after the enlargement of the European Union the great disparities in accessibility between the old and new member states pose serious problems of spatial equity, which are aggravated by the goal conflict between territorial cohesion and the competitiveness goal of the Lisbon strategy.

In this chapter it will be asked whether the implementation of the transport infrastructure projects examined will contribute to convergence or divergence of accessibility and economic development between the regions in Europe at large and in the AlpenCorS regions.

There are many possible ways to measure the cohesion effects of transport infrastructure projects. The most frequently applied indicators, the coefficient of variation and the Gini coefficient (see Bröcker et al., 2004a), measure the *relative* variation of regional values around their average. However, relative cohesion indicators hide the fact that if every region gains in income by ten percent, the richer regions receive far more than the poorer regions in absolute terms. When assessing transport infrastructure projects, it is therefore useful to consider both, relative and absolute measures of cohesion. If, for instance, as a consequence of a transport project a rich and a poor region gained both ten percent in GDP per capita, relative cohesion indicators indicate neither convergence nor divergence; however, in absolute terms the rich region would gain much more than the poor region. It is even possible that a region is a winner in relative terms but a loser in absolute terms.

Following a suggestion by Bröcker (Bröcker et al., 2004a) one relative and one absolute cohesion indicator are used in the analysis presented here:

- *Correlation between relative change and level*. This indicator examines the relationship between the 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 in percent and the levels of GDP per capita in a set of regions is positive, the more affluent regions in the set gain more in relative terms than the poorer regions and disparities in income increase. If the correlation is negative, the poorer regions gain more in relative term than the richer regions and disparities decrease.

- *Correlation between absolute change and level*. This indicator is constructed as the previous one except that absolute changes are considered. This indicator will indicate convergence only if the poorer regions gain more not only in relative but also in absolute terms, which is a much more stringent definition.

The different results produced by the two indicators are presented first for Scenario AS6, in which it is assumed that all TEN and TINA projects are implemented. Figure 7.1 shows four scatter diagrams visualising the correlation between change and level for accessibility and GDP per capita for the 1,330 regions in Europe forecast in the SASI model. Accessibility is here the total of the four accessibility indicators presented in Tables 6.1 to 6.4, and GDP per capita is GDP per capita in Euro of 1998 as in Table 6.7.

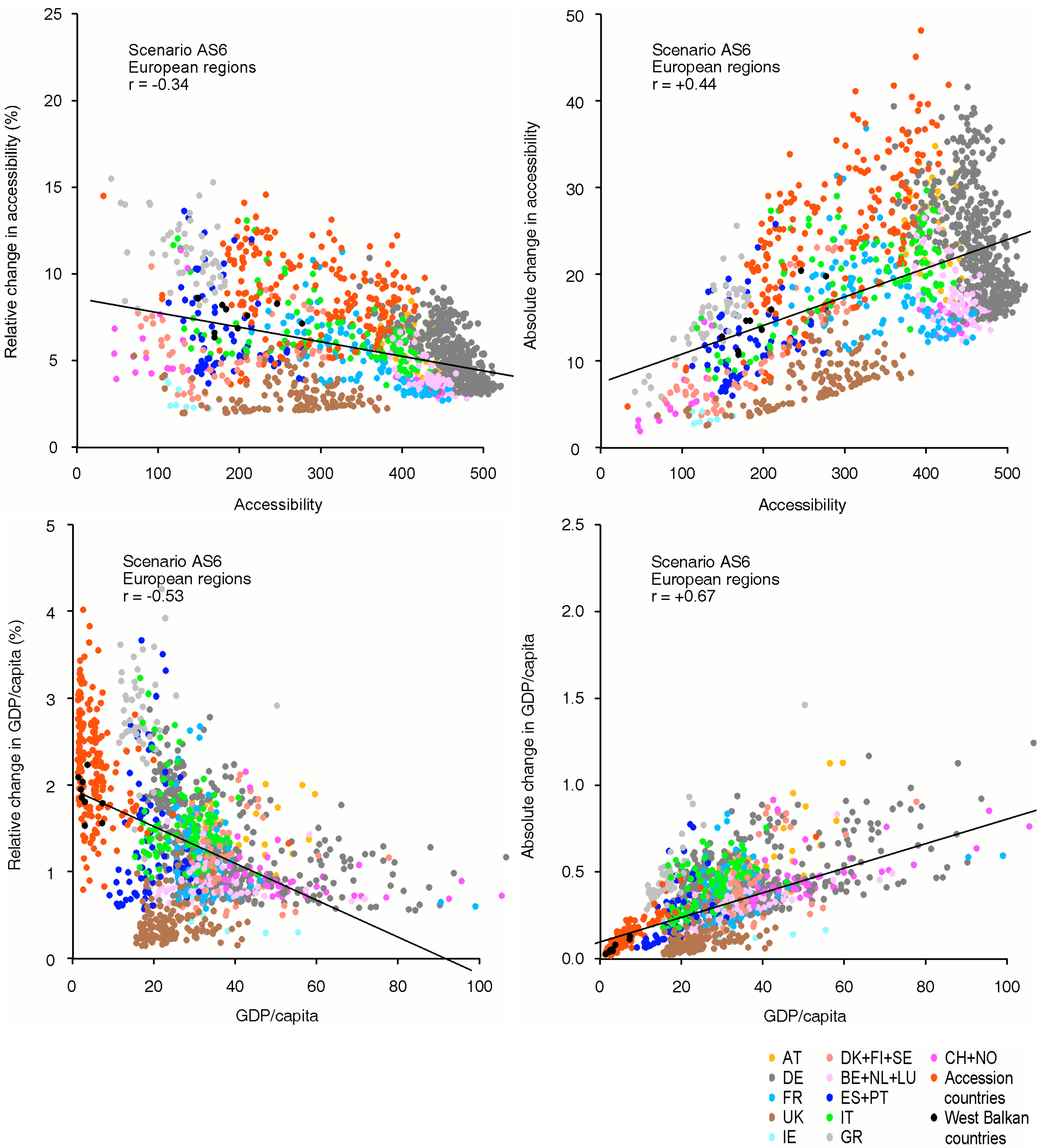

Figure 7.1. Effects of all TEN and TINA projects (Scenario AS6): relative convergence and absolute divergence in accessibility (top) and GDP/capita (bottom), all European regions

The two diagrams at the top of Figure 7.1 show the correlation between change and level of accessibility. The left diagram shows the correlation between relative change in accessibility and level of accessibility, where the term "relative change" indicates the percent difference in regional accessibility between Scenario AS6 and the reference scenario in 2021. It can be seen that the greatest changes in accessibility occur in the left half of the diagram, i.e. in the peripheral regions with lower accessibility. Hence the regression line slopes downward, and the coefficient of correlation *r* is negative. The right diagram shows the same data but now change in accessibility is plotted in absolute terms. Now the largest gains in accessibility occur in the right half of the diagram, i.e. in the central regions with high accessibility. Hence the regression line slopes upwards, and the coefficient of correlation is positive.

The two diagrams at the bottom Figure 7.1 show the correlation between change in GDP per capita and level of GDP per capita. The left diagram shows the correlation between relative change in GDP per capita and level of GDP per capita, where the term "relative change" indicates the percent difference in regional GDP per capita between Scenario AS6 and the reference scenario in 2021. It can be seen that the greatest changes in GDP per capita occur in the left half of the diagram, i.e. in the poorer regions, in particular the regions in the new member states. Hence the regression line slopes downward, and the coefficient of correlation *r* is negative. The right diagram shows the same data but now change in GDP per capita is plotted in absolute terms. Now the largest gains in GDP per capita occur in the right half of the diagram, i.e. in the richer regions. Hence the regression line slopes upwards, and the coefficient of correlation is positive.

In conclusion, the implementation of the vast infrastructure programme assumed in Scenario AS6 would result in convergence in both accessibility and GDP per capita in relative terms. However, in absolute terms, divergence would occur, i.e. the central regions with already high accessibility and GDP per capita would gain most.

Figure 7.2 shows the results of the same analysis for Scenario AS1, the Brenner tunnel scenario. Now the results are different: there is divergence also in relative terms. This is, however, not surprising because the regions gaining most from the Brenner tunnel are located in the centre of Europe and have above-average GDP per capita. The diagrams clearly show the large gains in accessibility and GDP per capita in the regions near the Brenner tunnel, Bozen/Bolzano, Trento, Verona and Innsbruck. As a rule, negative cohesion effects can be expected if a major transport infrastructure project is implemented in an area of already high accessibility.

This result is even more pronounced if the analysis is restricted to the 186 regions in the AlpenCorS area (Figure 7.3). Clearly the regions close to the tunnel exits, Bozen/Bolzano, Trento, Verona and Innsbruck, are gaining most in accessibility and GDP per capita, whereas other regions, particularly in Switzerland, are hardly affected. It must be concluded that the Brenner tunnel favours only few regions in the AlpenCorS area and so increases the existing imbalances in the area.

Do the remaining scenarios, in which additional local infrastructure projects are examined, counterbalance this divergence? Table 7.1 shows the cohesion effects of all six modelled scenarios in terms of relative and absolute coefficients of correlation between change and level of accessibility and GDP per capita for all European regions and for the regions in the AlpenCorS area. It can be seen that the additional effects of the local projects examined in Scenarios AS2 to AS4 are small. Scenarios AS3 (Brenner tunnel plus Valdastico/Pedemontana motorways) and Scenario AS5 (Brenner tunnel plus all local projects) are successful in spreading the tunnel effects to adjacent regions so that at least relative convergence between the AlpenCorS regions occurs, though in absolute terms the regions near the tunnel exits continue to gain most.

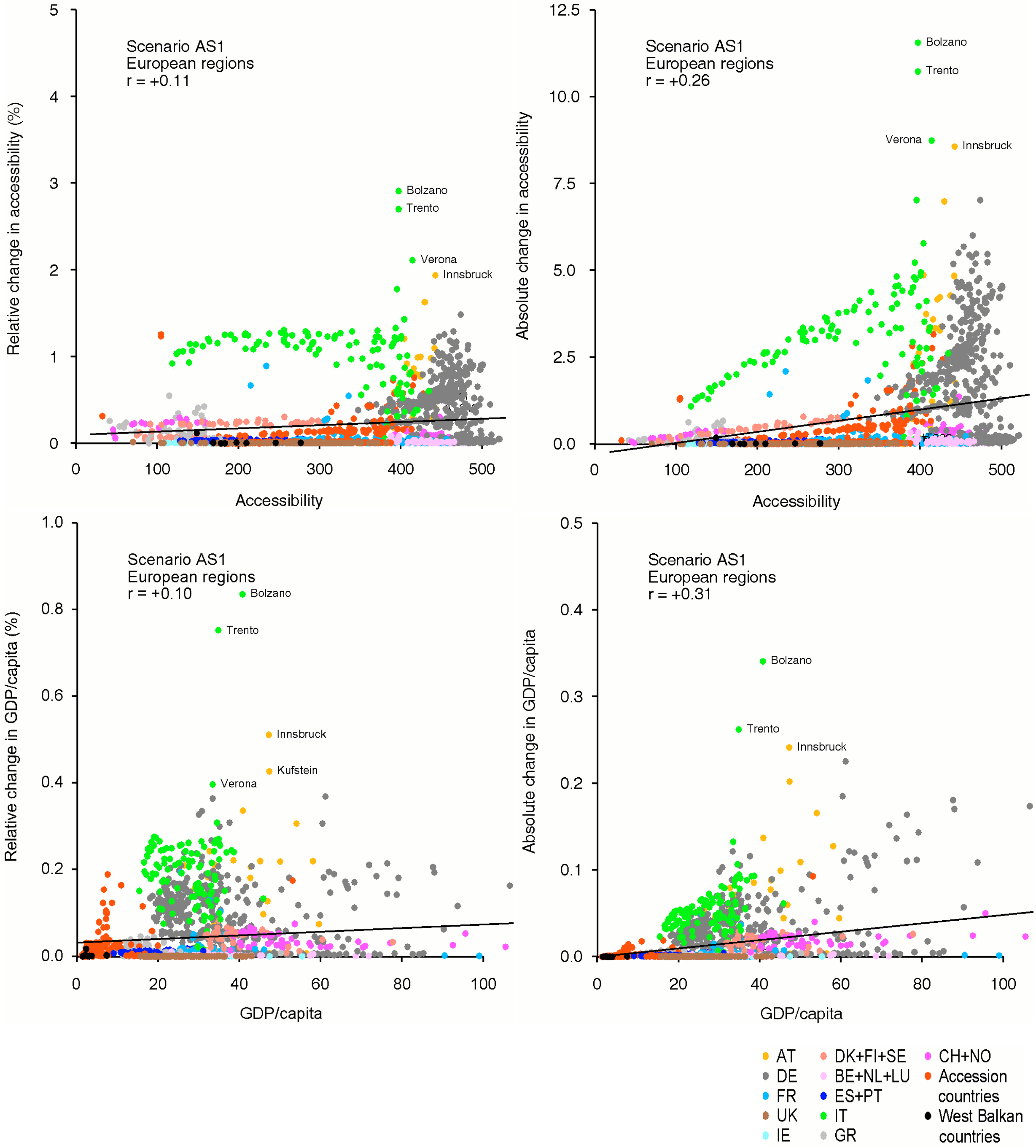

Figure 7.2. Effects of the Brenner tunnel (Scenario AS1): relative and absolute divergence in accessibility (top) and GDP/capita (bottom), all European regions

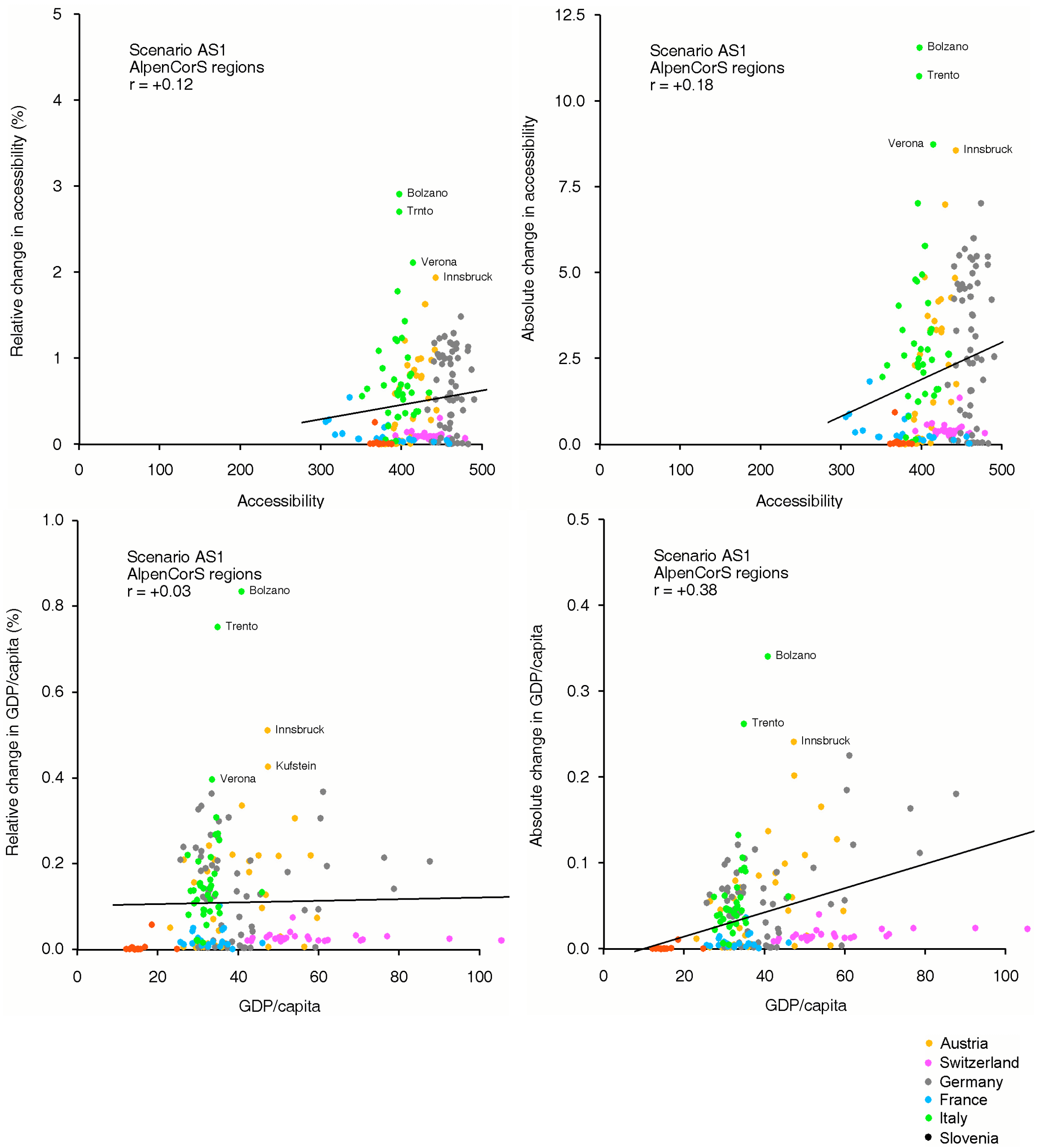

Figure 7.3. Effects of the Brenner tunnel (Scenario AS1): relative and absolute divergence in accessibility (top) and GDP/capita (bottom), AlpenCorS regions

Table 7.1. Territorial cohesion effects

	Coefficient of correlation between change and level							
	All European regions				AlpenCorS regions			
	Accessibility		GDP/capita		Accessibility		GDP/capita	
	rel	abs	rel	abs	rel	abs	rel	abs
AS1 Brenner tunnel	+0.11	+0.26	+0.10	+0.31	+0.12	+0.18	+0.03	+0.38
AS2 AS1+rail bypass	+0.11	+0.26	+0.09	+0.31	+0.10	+0.17	+0.01	+0.37
AS3 AS1+Valdastico	+0.12	+0.27	+0.11	+0.31	+0.07	+0.13	**–0.01**	+0.33
AS4 AS1+Valsugana	+0.11	+0.27	+0.10	+0.31	+0.11	+0.18	+0.02	+0.38
AS5 AS1+AS2+AS3+AS4	+0.12	+0.27	+0.09	+0.31	+0.06	+0.12	**–0.02**	+0.33
AS6 All TEN and TINA	**–0.34**	+0.44	**–0.53**	+0.67	**–0.42**	**–0.06**	**–0.29**	+0.64

– Convergence + Divergence

8 Conclusions

The analysis of different strategies for developing the transport infrastructure of the Brenner corridor near its intersection with Corridor V has shown that the implementation of the Brenner tunnel will be a key factor for linking northern and southern Europe. The spatial effects of the Brenner tunnel will be far reaching from the Baltic to the Mediterranean.

The effect of the Brenner tunnel on accessibility for travel extends far across the European continent, down the Italian peninsula and in north-eastern direction towards München, Wien and beyond, but also along the east-west corridor in northern Italy, Corridor V. The regions south of the tunnel, Bozen/Bolzano and Trento, have the largest gain in accessibility The effects of the tunnel on accessibility for freight are even more far-reaching, with the strongest impacts north of the Alps in Germany, the Czech Republic and Poland as well as in the Baltic and Nordic states. If only accessibility by road is considered, the regions closest to the tunnel exits, Bozen/Bolzano and Innsbruck, are less affected because the time and cost of loading lorries on trains makes the tunnel attractive for freight transport only for longer distances. Regions farther east and west of the Brenner tunnel axis are not affected as these regions use other Alpine crossings. If, however, also rail is considered, again Bozen/Bolzano and Trento have the largest gains in accessibility.

Like the effects on accessibility, the effects of the Brenner tunnel on regional economic development spread far across Europe: to the south along the Italian peninsula, to the north as far as southern Sweden and Norway and to the west along Corridor V. The regions south of the tunnel, Bozen/Bolzano and Trento, benefit most from it followed by Innsbruck and other regions in Tirol as well as southern Bavaria and regions around Verona. Even though these benefits are not very large compared with the changes in accessibility and not all indirect multiplier effects of the tunnel could be addressed, the impacts on the economic development of the two regions are significant and tangible and will build up over a longer period following the opening of the tunnel.

If the Brenner tunnel and its northern and southern approaches are complemented by other transport infrastructure improvements, such as the rail bypass between Trento and Verona, the Valdastico and Pedemontana motorway extensions or the Valsugana road and rail corridor upgrading, the effects are still small but far-reaching in geographical terms, extending from eastern Germany to southern Italy. In all scenarios, the provinces south of the Brenner tunnel, Bozen/Bolzano and Trento, benefit most. The scenarios aimed at improving the transport network south of the Brenner succeed in spreading the tunnel effects to adjacent regions, in particular to Vicenza, Padova, Belluno, Treviso and Venezia. The Valdastico and Pedemontana motorway extensions are most successful in promoting other regions, whereas the upgrading of the Valsugana road and rail corridor has more local effects. If all three infrastructure improvements are combined, the effect of spreading the tunnel effects to other Italian regions is most pronounced. For the provinces of Bozen/Bolzano and Trento the combination of the Brenner tunnel with additional transport infrastructure projects brings only little extra benefit, except where all three projects, the southern rail bypass, the Valdastico and Pedemontana motorways and the Valsugana road and rail corridor, are combined.

If, besides the local transport projects close to the Brenner tunnel, also European transport infrastructure improvements of the TEN and TINA programmes outside the AlpenCorS area are taken into account, the effects on accessibility and regional economic development are much stronger. Even though the TEN and TINA programmes have been recently re-directed towards improving the transport systems of the new EU member states and so have their largest economic impacts in southern and eastern Europe, the provinces of Bozen/Bolzano and Trento and their neighbouring regions remain on the winner side due to the influence of the Brenner tunnel and the associated local transport projects.

As to be expected, the scenario which besides the Brenner tunnel combines all three transport infrastructure projects, the rail bypass between Trento and Verona, the Valdastico and Pedemontana motorway extensions and the Valsugana road and rail corridor upgrading has larger effects than the scenarios in which only one of these projects is implemented. This seems to speak in favour of implementing all three projects. To examine in how far the three projects complement one another, a synergy analysis was performed, i.e. it was asked whether the effect of their combined implementation was smaller, equal or larger than the total of their individual effects. The analysis showed that there are only few positive synergies between the three projects in very few AlpenCorS regions but that there are also some negative synergies which indicate that the three infrastructure projects are at least in part substitutable because they achieve the same gains in accessibility and economic performance by different means. However, this does not imply that these projects should not be implemented. They may have important local effects for the regions through which they pass and adjacent regions. There may also be good reasons to upgrade the Valsugana rail line for environmental reasons, i.e. in order to reduce road traffic in the valley.

When discussing these results, the limits of this analysis need to be recognised. It did not analyse the impacts of different scenarios of transport costs of the Alpine crossings. Such an analysis would allow to reflect about a fair distribution of costs and benefits of the Alpine crossings. It did not analyse the impacts of different scenarios for the main east-west transport corridor (Corridor V) and its interactions with the Brenner corridor (Corridor I). Moreover, it looked only into technical and monetary economic benefits. Broader issues, such as social and environmental effects could not be addressed. Because of time constraints, the desirable integration of the economic analysis into the Territorial Impact Analysis of the Dipartimento di Ingegneria Gestionale of the Politecnico di Milano was not yet feasible. It is hoped that such integration will be possible in the future.

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Appendix

The annex contains region codes, names and the major city in the NUTS-3 regions included in the AlpenCorS study area region according to the 2003 revision of the NUTS system.

Country	SASI No.	Region	Code	Centroid
Austria	1	Mittelburgenland	AT111	Güssing
	2	Nordburgenland	AT112	Eisenstadt
	3	Südburgenland	AT113	Oberwart
	4	Mostviertel-Eisenwurzen	AT121	Amstetten
	5	Niederösterreich-Süd	AT122	Wiener Neustadt
	6	Sankt Pölten	AT123	St. Pölten
	7	Waldviertel	AT124	Zwettl
	8	Weinviertel	AT125	Poysdorf
	9	Wiener Umland/Nordteil	AT126	Klosterneuburg
	10	Wiener Umland/Südteil	AT127	Mödling
	11	Wien	AT130	Wien
	12	Klagenfurt-Villach	AT211	Klagenfurt
	13	Oberkärnten	AT212	Spittal
	14	Unterkärnten	AT213	St. Veit
	15	Graz	AT221	Graz
	16	Liezen	AT222	Liezen
	17	Östliche Obersteiermark	AT223	Kapfenberg
	18	Oststeiermark	AT224	Fürstenfeld
	19	West-Und Südsteiermark	AT225	Wolfsberg
	20	Westliche Obersteiermark	AT226	Murat
	21	Innviertel	AT311	Riet
	22	Linz-Wels	AT312	Linz
	23	Mühlviertel	AT313	Freistadt
	24	Steyr-Kirchdorf	AT314	Kirchdorf an der Krems
	25	Traunviertel	AT315	Gmunden
	26	Lungau	AT321	Tamsweg
	27	Pinzgau-Pongau	AT322	Saalfelden
	28	Salzburg und Umgebung	AT323	Salzburg
	29	Ausserfern	AT331	Reute
	30	Innsbruck	AT332	Innsbruck
	31	Osttirol	AT333	Lienz
	32	Tiroler Oberland	AT334	Landeck
	33	Tiroler Unterland	AT335	Kufstein
	34	Bludenz-Bregenzer Wald	AT341	Bludenz
	35	Rheintal-Bodenseegebiet	AT342	Dornbirn
Switzerland	107	Vaud	CH011	Lausanne
	108	Valais	CH012	Sion
	109	Genève	CH013	Genève
	110	Bern	CH021	Bern
	111	Freiburg	CH022	Fribourg
	112	Solothurn	CH023	Solothurn
	113	Neuchâtel	CH024	Neuchâtel
	114	Jura	CH025	Delémont
	115	Basel-Stadt	CH031	Basel
	116	Basel-Landschaft	CH032	Liestal
	117	Aargau	CH033	Aarau
	118	Zürich	CH040	Zürich
	119	Glarus	CH051	Glarus
	120	Schaffhausen	CH052	Schaffhausen
	121	Appenzell-Ausserrhoden	CH053	Herisau
	122	Appenzell-Innerrhoden	CH054	Appenzell

	123	St.Gallen	CH055	St.Gallen
	124	Graubünden	CH056	Chur
	125	Thurgau	CH057	Frauenfeld
	126	Luzern	CH061	Luzern
	127	Uri	CH062	Altdorf
	128	Schwyz	CH063	Schwyz
	129	Obwalden	CH064	Sarnen
	130	Nidwalden	CH065	Stans
	131	Zug	CH066	Zug
	132	Ticino	CH07	Bellinzona
Germany	173	Freiburg im Breisgau, Stadt	DE131	Freiburg Im Breisgau
	174	Breisgau-Hochschwarzwald	DE132	Freiburg
	175	Emmendingen	DE133	Emmendingen
	176	Ortenaukreis	DE134	Offenburg
	177	Rottweil	DE135	Rottweil
	178	Schwarzwald-Baar-Kreis	DE136	Villingen-Schwenning
	179	Tuttlingen	DE137	Tuttlingen
	180	Konstanz	DE138	Konstanz
	181	Lörrach	DE139	Lörrach
	182	Waldshut	DE13A	Waldshut-Tiengen
	183	Reutlingen	DE141	Reutlingen
	184	Tübingen, Landkreis	DE142	Tübingen
	185	Zollernalbkreis	DE143	Balingen
	186	Ulm, Stadtkreis	DE144	Ulm
	187	Alb-Donau-Kreis	DE145	Ulm
	188	Biberach	DE146	Biberach
	189	Bodenseekreis	DE147	Friedrichshafen
	190	Ravensburg	DE148	Ravensburg
	191	Sigmaringen	DE149	Sigmaringen
	192	Ingolstadt, Krfr. Stadt	DE211	Ingolstadt
	193	München, Krfr. Stadt	DE212	München
	194	Rosenheim, Krfr. Stadt	DE213	Rosenheim
	195	Altötting	DE214	Altötting
	196	Berchtesgadener Land	DE215	Bad Reichenhall
	197	Bad Tölz-Wolfratshausen	DE216	Bad Tölz
	198	Dachau	DE217	Dachau
	199	Ebersberg	DE218	Ebersberg
	200	Eichstaett	DE219	Eichstaett
	201	Erding	DE21A	Erding
	202	Freising	DE21B	Freising
	203	Fürstenfeldbruck	DE21C	Fürstenfeldbruck
	204	Garmisch-Partenkirchen	DE21D	Garmisch-Partenkirchen
	205	Landsberg am Lech	DE21E	Landsberg am Lech
	206	Miesbach	DE21F	Miesbach
	207	Mühldorf am Inn	DE21G	Mühldorf am Inn
	208	München, Landkreis	DE21H	München
	209	Neuburg-Schrobenhausen	DE21I	Neuburg an der Donau
	210	Pfaffenhofen an der Ilm	DE21J	Pfaffenhofen
	211	Rosenheim, Landkreis	DE21K	Rosenheim
	212	Starnberg	DE21L	Starnberg
	213	Traunstein	DE21M	Traunstein
	214	Weilheim-Schongau	DE21N	Weilheim in Obb.
	274	Augsburg, Krfr. Stadt	DE271	Augsburg
	275	Kaufbeuren, Krfr. Stadt	DE272	Kaufbeuren
	276	Kempten (Allgäu), Krfr. Stadt	DE273	Kempten
	277	Memmingen, Krfr. Stadt	DE274	Memmingen
	278	Aichach-Friedberg	DE275	Aichach
	279	Augsburg, Landkreis	DE276	Augsburg
	280	Dillingen an der Donau	DE277	Dillingen an der Donau
	281	Günzburg	DE278	Günzburg

	282	Neu-Ulm	DE279	Neu-Ulm
	283	Lindau (Bodensee)	DE27A	Lindau
	284	Ostallgäu	DE27B	Marktoberdorf
	285	Unterallgäu	DE27C	Mindelheim
	286	Donau-Ries	DE27D	Donauwörth
	287	Oberallgäu	DE27E	Sonthofen
France	715	Bas-Rhin	FR421	Strasbourg
	716	Haut-Rhin	FR422	Colmar
	717	Doubs	FR431	Besançon
	718	Jura	FR432	Lons-le-Saunier
	719	Haute-Saône	FR433	Vesoul
	720	Territoire de Belfort	FR434	Belfort
	750	Ain	FR711	Bourg-En-Bresse
	751	Ardèche	FR712	Privas
	752	Drôme	FR713	Valence
	753	Isère	FR714	Grenoble
	754	Loire	FR715	Saint-Etienne
	755	Rhône	FR716	Lyon
	756	Savoie	FR717	Chambéry
	757	Haute-Savoie	FR718	Annecy
	767	Alpes-de-Haute-Provence	FR821	Digne
	768	Hautes-Alpes	FR822	Gap
	769	Alpes-Maritimes	FR823	Nice
	770	Bouches-du-Rhône	FR824	Marseille
	771	Var	FR825	Toulon
	772	Vaucluse	FR826	Avignon
Italy	854	Torino	ITC11	Torino
	855	Vercelli	ITC12	Vercelli
	856	Biella	ITC13	Biella
	857	Verbano-Cusio-Ossola	ITC14	Verbania
	858	Novara	ITC15	Novara
	859	Cuneo	ITC16	Cuneo
	860	Asti	ITC17	Asti
	861	Alessandria	ITC18	Alessandria
	862	Valle d' Aosta	ITC20	Aosta
	863	Imperia	ITC31	San Remo
	864	Savona	ITC32	Sanona
	865	Genova	ITC33	Genova
	866	La Spezia	ITC34	La Spezia
	867	Varese	ITC41	Varese
	868	Como	ITC42	Como
	869	Lecco	ITC43	Lecco
	870	Sondrio	ITC44	Sondrio
	871	Milano	ITC45	Milano
	872	Bergamo	ITC46	Bergamo
	873	Brescia	ITC47	Brescia
	874	Pavia	ITC48	Pavia
	875	Lodi	ITC49	Lodi
	876	Cremona	ITC4A	Cremona
	877	Mantova	ITC4B	Mantova
	878	Bolzano - Alto Adige	ITD10	Bozen
	879	Trento	ITD20	Trento
	880	Verona	ITD31	Verona
	881	Vicenza	ITD32	Vicenza
	882	Belluno	ITD33	Belluno
	883	Treviso	ITD34	Treviso
	884	Venezia	ITD35	Venezia
	885	Padova	ITD36	Padua
	886	Rovigo	ITD37	Rovigo

	887	Pordenone	ITD41	Pordenone
	888	Udine	ITD42	Udine
	889	Gorizia	ITD43	Gorizia
	890	Trieste	ITD44	Trieste
Slovenia	1169	Pomurska	SI001	Murska Sobota
	1170	Podravska	SI002	Maribor
	1171	Koroška	SI003	Ravne na Koroškem
	1172	Savinjska	SI004	Celje
	1173	Zasavska	SI005	Trbovlje
	1174	Spodnjeposavska	SI006	Brežice
	1175	Gorenjska	SI009	Kranj
	1176	Notranjsko-kraška	SI00A	Postojna
	1177	Goriška	SI00B	Nova Gorica
	1178	Obalno-kraska	SI00C	Kozina
	1179	Dolenjska	SI00D	Novo Mesto
	1180	Osrednjeslovenska	SI00E	Ljubljana