EUROPEAN PARLIAMENT

Directorate-General for Internal Policies of the Union

STUDY

Policy Department Structural and Cohesion Policies

THE IMPACT OF TRANS-EUROPEAN NETWORKS ON COHESION AND EMPLOYMENT

REGIONAL DEVELOPMENT

15/06/2006

EN

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Content:

This study highlights all major aspects concerning Trans-European Networks (TENs) among which the interpretation of the relationships between the different conditions across regions, the type of investments, the type and direction of expected impacts. It analyses the most relevant elements that should be considered to predict the impact of TENs investments on the regional economies. The results could thus be considered as a reference point for further in-depth analysis on a local scale. The last chapter contains clear recommendations destined for decision-makers regarding all major aspects of the TEN-related projects.

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Executive summary

The aim of this study was to assess the territorial aspects of the Trans-European Networks (TENs) impacts in terms of employment and demographic change at different, future time horizons.

Different data and tool sources were used to explore the various aspects involved in the analysis and provide forecasts of the TENs networks impacts across the EU25 regions. The study was carried out, considering primarily the two main types of impacts expected from large transport infrastructure investments:

a) “macroeconomic” impacts, focused on direct investment impacts on GDP and employment;
b) “microeconomic” impacts, explained in terms of changes of relative accessibility of regions.

1. Study methodology

The analysis relied on modelling tools, integrated with additional procedures and data processing focusing on the rationalisation of the economic effects. The aspects related to the ‘macroeconomic’ impacts were analysed and quantified, mainly using the System Dynamics model ASTRA. The ‘microeconomic’ impacts were explored, by making use of the analysis conducted in ESPON(1), where the SASI model was applied to study the impact of TENs due to changed accessibility.

Both ASTRA and ESPON results were used as the basis for more detailed analysis and forecasts, developed according to a specific methodology set up for this study. The methodological steps followed include:

a) the analysis, at the macro (national) level, of the infrastructural investments impacts on the economy and the employment until 2030, using the ASTRA model and the updated list and timing of TENs investments and distinguishing different types of infrastructures;
b) the analysis of specific features of the EU regions according to ESPON and EUROSTAT data;
c) the analysis of accessibility impacts until 2030 starting from the ESPON data, the updated list and the timing of TENs investments;
d) the estimation of overall impacts, including demographic effects, changes on cohesion and long-term forecasts until 2050.

(1) The European Spatial Planning Observation Network (ESPON) programme aims at improving the knowledge and understanding on spatial development of an enlarging European Union.

2. The TENs projects

The TEN impact analysis concentrated mainly on future years because of the significant delay in the projects implementation. Actually, only three of the total projects were completed before 2005, in particular:

- Conventional rail link Cork–Dublin–Belfast–Larne–Stranraer;
- Malpensa airport, Milan;
- Øresund fixed rail/road link between Denmark and Sweden

The latest estimation available on the total cost of the 30 key TENs projects amounts to about € 333 billion. Railways account for the largest share of total TENs investments and 60% of all investments in railways projects focus on four countries: Italy (23%), France (15%), Germany (9%) and Spain (13%). Road projects absorb an about 13% share of the overall financial resources, while a relevant share is allocated for the implementation of project No.7 across the Greek territory. Investments in inland navigation and maritime infrastructures revolve around improved river and canal navigability, particularly in France and in the Eastern European countries. Lisbon and Malpensa Airports represent the only examples of air investments on TENs projects.

3. Main results and recommendations

This study highlights a number of points including the interpretation of the relationships between the different conditions across regions, the type of investments, the type and direction of expected impacts. In other words, the study allowed to highlight the most relevant elements that should be considered to predict the impact of TENs investments on the regional economies. The regional effects estimated in this study can be considered as a reference point for further in-depth analysis on a local scale. Such analysis may revolve around more detailed information (especially from the local economic specialization viewpoint) and could help refine and improve the detail of the estimates highlighted in this study.

This study dealt with the impacts of TENs infrastructures in terms of difference compared to a ‘no-TENs’ case, all other things being equal. Indeed, it can be readily inferred that the future economic performance of the European regions will depend on a number of local, national and international factors, and that the evolution of such factors is unknown, especially over longer periods. Therefore, this study estimated the impacts that may result from the TENs investments , in addition to a defined economic trend, unconsidered in this analysis. So, where this study proves that the impact of TENs is negative in a given region, this does not necessarily mean that in this region we should expect a reduction of either per capita value added or employment. Instead, this result shows that, in the region, value added would be lower and the unemployment rate would be higher if TENs were not implemented.

Additionally, the aforementioned observations show that if a negative impact resulting from the TEN networks occurs in a region with a highly positive base growth rate (due to all other factors relating to the economic development, therefore excluding TENs), the combined effect will translate into a drop in the regional economic growth. By contrast, if a positive impact due to the TEN networks occurs in a region whose base growth rate is modest, the combined effect will translate into a rise in the regional economic growth.

The main conclusions of the study can be summarised as follows:

a) The extent of the impacts produced by the TENs infrastructure investments is generally low during the operational phase. Generally, the magnitude of the changes in per capita GDP and employment does not exceed 2% of the reference values, with only very few regions showing over 3% increases. From this result, it can be implied that the implementation of the TENs networks is not enough to ensure relevant improvement in the economic performance of a EU region.

b) The impacts of the construction and operational phases do not differ from each other , even if they tend to reach their peak with a different time lag: the multiplier effect of investments produces positive effects in a relatively short term and tends to fade rapidly after the monetary flow of investments ceases. The accessibility effect needs time to become visible, yet, it lasts longer. This result shows that if one region does not invest to improve its accessibility, then occupational benefits may be temporary.

c) The local impacts of the construction phase depend heavily on the specialisation of the region. If the region attracting the investment lacks activities in some specific sectors, such as manufacturing of industrial machines, steel, construction equipment, and cannot provide a skilled workforce, the positive spur to investments and consumption may be limited to low-value services including security, cleaning, catering, etc., in addition to some unskilled jobs. Conversely, the regions specialising in those sectors playing a significant role as providers of input for infrastructure building can improve their economic performance even if no infrastructure is planned to be set in their territory.

d) As expected, the construction, the minerals and metals sectors are those benefiting from higher visibility resulting from investments. It is also heralded that the production of industrial machines will take significant advantage from TENs investments. However, there are other sectors that should not be neglected when forecasting the impacts of infrastructures, namely auxiliary transport services, trade and market services, whose development, yet later than in other sectors, is nevertheless relevant.

e) The effects of the operational phase of TENs networks, at least when interpreted mainly in terms of accessibility changes impacts, depend on complex 'network effects', i.e. the impact of a given infrastructure can spread well beyond the regions where it is actually placed. Therefore, if several infrastructures are completed, the overall impact on a given region is the sum of direct and indirect effects, which may be internal and external to the region.

f) The analysis produced different results, taking into account positive and negative impacts alike. Basically, the negative impacts of the TENs networks result from poorer economic performance generated by different accessibility levels. As TENs networks do not cover all regions and the impact of a new infrastructure on accessibility is highly different across regions and, finally, as the geographical position plays a significant role in explaining the accessibility level of a region, assuming that all TENs investments are made, <u>the relative accessibility</u> of each region compared to others changes. Some regions improve their position, while others worsen their conditions. In <u>absolute terms, their accessibility has improved</u> compared to current conditions. Given the direct link between accessibility and economic performance, if the former is reduced, the latter suffers a negative impact.

g) In terms of cohesion, two distinct effects should be taken into account. On the one hand, the regions of the central EU25 (France, Benelux, Germany), which are still among the most developed EU regions, are generally boosted by the TENs networks while, at the same time, some peripheral areas in Finland, Sweden and Italy gain no real advantage from the implementation of TENs networks and most of them are currently among the less developed areas (at least within EU15). Therefore, from this point of view, cohesion is not improved. On the other hand, however, in the longer period (2030), the positive impact of TENs networks on several other peripheral and currently not highly developed areas in Eastern Europe, Greece and Ireland improves the level of cohesion of the Union.

h) The EU25 inhabitants' tendency to migrate is not expected to change significantly upon the implementation of TENs networks. Consistently with the economic effects, some peripheral areas increase their tendency to lose people, while many central regions could attract more immigrants than in the 'no-TENs' case. However, only a comprehensive knowledge of local conditions would enable us to quantify these events.

Given the conclusions of the study summarised above, the following recommendations can be put forward.

1. Transport investments can play a key role to improve the economic performance of the regions, but they cannot be considered the only or the major leverage of the economic policy. At least within the EU, where the starting level of accessibility and of economic development is generally good, policy makers at any decisional level (local, national, etc.) should think of new infrastructures as one element of a policy mix rather than the key instrument to speed up economic development.

2. Given that transport infrastructures should be part of a more complex strategy aimed at developing regional economies, the choice of the elements to be included in the policy mix should be chosen carefully, according to their effectiveness and efficiency. It is therefore recommended that transport infrastructures projects are subjected to assessment of their performance (e.g. economic, financial, environmental, etc.) in order to collect elements to take informed decisions about the payoff of financial investments. Of course, assessment is also recommended for non-transport projects and initiatives.

3. Transport infrastructure investments produce positive spin-off on regional economies thanks to a multiplier effect, but such effect strictly depends on the economic structure of the region. Therefore, in order to take full advantage of the multiplier effect of infrastructure investments, regional economies should not be restricted to the production of low value added goods and services (e.g. building materials) but pursuing to extend their specialisation in higher value added goods and services (e.g. high technology building machines, trade).

4. The most lasting positive impact of transport infrastructure investments results from improved relative accessibility; at the same time, the effects of new infrastructures on accessibility can be very complex, involving changes for the regions far from the location of the investments as well. Therefore investments in new infrastructures should be planned carefully, taking into account the current main flows of transport demand to and from one

region, the impacts on crossing traffic, network effects and their potential effects on existing infrastructures, etc. Failing a careful planning, the overall impact might be reduced, instead of increased, cohesion.

5. New transport infrastructures enhance regions accessibility and pave the way for higher regional competitiveness. However, if independent projects are implemented in different regions without an overall strategy, unexpected effects could arise economically. Indeed, as the relevant accessibility variations are those in relative, and not in absolute terms, the infrastructures that contemporarily improve accessibility in different regions may leave their competitiveness level unchanged (other regions having improved their accessibility at the same time as well). Thus, infrastructures investments would have no practical effects on the regional economic performance, or effects could be less relevant than expected. It is therefore recommended to analyse the predictable changes of relative accessibility when several different projects are planned in different regions and economic benefit are expected.

6. As the improvements of relative accessibility are a major determinant of positive spin-off of transport infrastructures, such improvements should be retained in time to fully benefit from transport investments. From this viewpoint, land use policies (for instance, limited and uncontrolled sprawling of metropolitan areas) and transport demand regulation (i.e., improved goods logistics to reduce empty trips, thus reducing delivery distance) could be used to curb the new transport demand generation, which may thwart the accessibility benefits obtained in a relatively short time.

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Introduction

The aim of this study was to assess the territorial aspects of the Trans-European Networks (TENs) impacts in terms of employment and demographic changes at different time horizons in future, and to use the outcome of this study to provide recommendations for policy makers regarding the role of transport infrastructure investments.

Evidence suggests that the relationships between transport infrastructure and economic development seem to be (much) more complex than those assumed in the ‘simple’ models generally used in the past. The most successful regions located in the heart of Europe seemingly prove that accessibility is a key matter; yet, also central regions suffer an industrial decline and high unemployment rates. It should also be noted, however, that, most of the poorest regions stretch across peripheral areas of Europe even though said areas also include thriving regions. To make the situation even more complex, some of the regions that have recently experienced fastest rates in economic growth in Europe are among the most peripheral ones.

In this study different data and tools sources were used to explore the various aspects involved in the analysis and provide forecasts of the TENs networks impacts across the EU25 regions. The study was conducted, considering primarily the two main types of impacts expected from large transport infrastructural investments:

a) ‘macroeconomic’ impacts, focused on direct investment impacts on GDP and employment;

b) ‘microeconomic’ impacts explained in terms of changes of relative accessibility of regions.

This report lists the study results and has the following structure. Chapter 1 features the projects included in the TENs networks. Chapter 2 provides a theoretical scenario on the analysis of the impact of investments. Chapter 3 shows and examines the results of the analysis at the macro level. Chapter 4 focuses on the introduction of the EU regions, in terms of economic specialisation, demographic structure, etc. Chapter 5 includes the detailed results of the impacts of TENs networks on the EU regions from different points of view, namely value added, employment, demography and cohesion. Chapter 6 summarises the main findings and puts forward the main recommendations. References and a detailed annex on the regionalisation of TENs projects conclude the report.

1. Trans European Transport Networks (TENs): Classification of the TENs projects

In 1990 the European Council implemented an initial plan for a high-speed railway line proposed by the Commission. Four years later, a list of 14 key projects (the Essen list) was adopted by the Essen Council and the European Parliament. Two years later, Decision No. 1692/96/EC provided the guidelines for the development of a trans-European transport network (TENs). A Transport Infrastructures Needs Assessment was developed for the infrastructure project in Eastern Europe in accordance with the Commission's aim to bolster the transport system throughout the whole continent.

In 2003, in view of the forthcoming enlargement that would include 10 new countries, a high-profile group was appointed to deal with the Trans-European transport network. The group, chaired by Karel van Miert, was charged with identifying new projects to be added to the previous list (European Commission, 2003). After evaluating almost 100 projects proposed by Member States, this group developed a new list, including 30 projects. According to the Van Miert group these were:

"*…..the most important infrastructures for international traffic, bearing in mind the general objectives of the cohesion of the continent of Europe, modal balance, interoperability and the reduction of bottlenecks*"

The table below gives the list of TENs projects according to official EC documents. Annex 1 of this report lists additional information on the projects, with details on the relevant sub-projects. The information provided in the annex includes the type of investment (new rail, upgraded road, etc.), the expected completion year, the total investment and, given the specific objective of this study, the geographical reference to the NUTS2 regions involved in each sub-project.

Table 1.1. List of the TENs projects according to European Commission (2005)

P01	Railway line Berlin-Verona/Milan-Bologna-Naples-Messina	P16	Freight railway axis Sines-Madrid-Paris
P02	High-speed train PBKAL (Paris–Brussels–Cologne–Amsterdam–London)	P17	Railway axis Paris-Strasbourg-Stuttgart-Vienna-Bratislava
P03	High-speed railway axis of south-west Europe	P18	Rhine/Meuse-Main-Danube inland waterway axis
P04	High-speed railway axis east	P19	High-speed rail interoperability on the Iberian peninsula
P05	Betuwe Line	P20	Fehmarn Belt railway axis
P06	Railway axis Lyon-Trieste-Divaca/Koper/Divaca-Ljubljana-Budapest-Ukrainian border	P21	Motorways of the sea
P07	Motorway axis Igoumenitsa/Patras-Athens-Sofia-Budapest	P22	Railway axis Athens-Sofia-Budapest-Vienna-Prague-Nuremberg/Dresden
P08	Multimodal axis Portugal/Spain-rest of Europe	P23	Railway axis Gdansk-Warsaw-Brno/Bratislava-Vienna
P09	Railway axis Cork-Dublin-Belfast-Stranraer	P24	Railway axis Lyon/Genoa-Basel-Duisburg-Rotterdam/Antwerp
P10	Malpensa Airport (Milan)	P25	Motorway axis Gdansk-Brno/Bratislava-Vienna
P11	Öresund fixed link	P26	Railway-road axis Ireland/United Kingdom/continental Europe
P12	Nordic triangle railway-road axis	P27	Rail Baltica axis Warsaw-Kaunas-Riga-Tallinn-Helsinki
P13	UK-Ireland/Benelux road axis	P28	Eurocaprail on the Brussels-Luxembourg-Strasbourg railway axis
P14	West Coast Main Line	P29	Railway axis Ionian/Adriatic intermodal corridor
P15	Galileo	P30	Inland waterway Seine-Scheldt

The data reported in the annex highlight some observations. First of all, the evaluation of long delays in the projects implementation. Only three out of the total number of projects were completed until 2005, namely:

- Conventional rail link Cork–Dublin–Belfast–Larne–Stranraer,
- Malpensa airport- Milan,
- Øresund fixed rail/road link between Denmark and Sweden.

According to Rothengatter (2005), the critical problem concerning the delays in project implementation is closely related to the considerable amount of financial resources required. The total cost of the 30 TENs projects, in fact, amounts to about €333 billion; however, the financial resources needed for such projects keep on growing.

As regards the type of infrastructure, railways account for the largest share of total TENs investments (about 85% of the total amount, see table 1.2). Table 1.3 below shows that four countries (Italy, France, Germany and Spain) absorb about 56% of total TENs investments. Most of the railways projects are, in fact, located in these countries: Italy (23%), France (14%), Germany (14%) and Spain (12%) (see table 1.4). Road projects absorb a share of about 13% of the overall financial resources. A relevant share, instead, is allocated to the implementation of Project No.7 "Greek motorways, Pathe and Via Egnatia", whose route runs along the Greek territory. Investments in inland navigation and maritime infrastructures focus mainly on improving rivers and canals navigability, primarily in France and in the Eastern European countries.

Lisbon and Malpensa Airports are the only examples of air investments included in the TENs projects.

Table 1.2. Investments and kilometres modal split

Mode	Share (% of total Kms)	Investment (% of total TENs investments)
Rail	71.5	84.9
Road	23.8	12.6
IWW/Maritime	4.7	1.3
Air	n.a.	1.2

Source: TRT processing of DG TREN data

Table 1.3.Distribution of total investments among countries (%)

Country	Share (%)	Country	Share (%)	Country	Share (%)	Country	Share (%)
IT	19.7	**AT**	4.3	**CZ**	1.5	**CH**	0.6
FR	12.9	**SW**	3	**DK**	1.5	**LV**	0.3
DE	12.2	**IE**	2.5	**SL**	1.1	**EE**	0.2
ES	11.4	**PL**	2.4	**SF**	0.8	**HU**	0.2
UK	5.9	**NL**	2.1	**LU**	0.8	**LT**	0.2
GR	5.1	**RO**	1.9	**SK**	0.7		
PT	4.6	**BE**	1.8	**BG**	0.6		

Source: TRT processing of DG TREN data

Table 1.4. Distribution of railway investments among countries (%)

Country	Share (%)	Country	Share (%)	Country	Share (%)	Country	Share (%)
IT	23.0	**SE**	3.4	**CZ**	1.1	**SK**	0.3
FR	14.2	**NL**	2.5	**DK**	1.0	**EE**	0.3
DE	14.2	**IE**	2.4	**LU**	0.9	**LT**	0.2
ES	12.4	**BE**	2.0	**CH**	0.7	**HU**	0.2
UK	5.9	**RO**	1.4	**FI**	0.5	**PL**	0.0
AT	5.0	**EL**	1.4	**BG**	0.5		
PT	4.6	**SI**	1.3	**LV**	0.4		

Source: TRT processing of DG TREN data

Figure 1.1. Localisation of TENs Projects planned in European regions

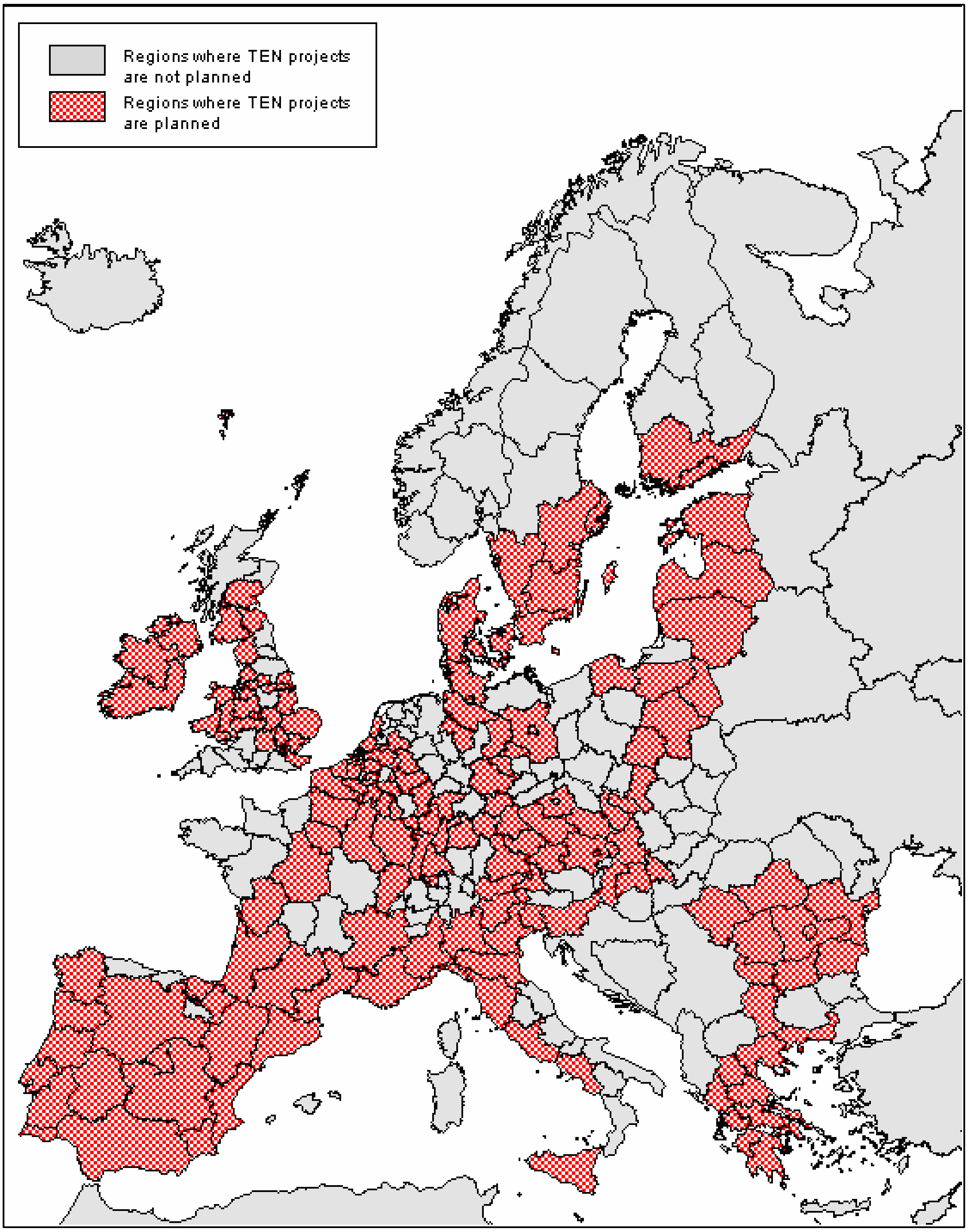
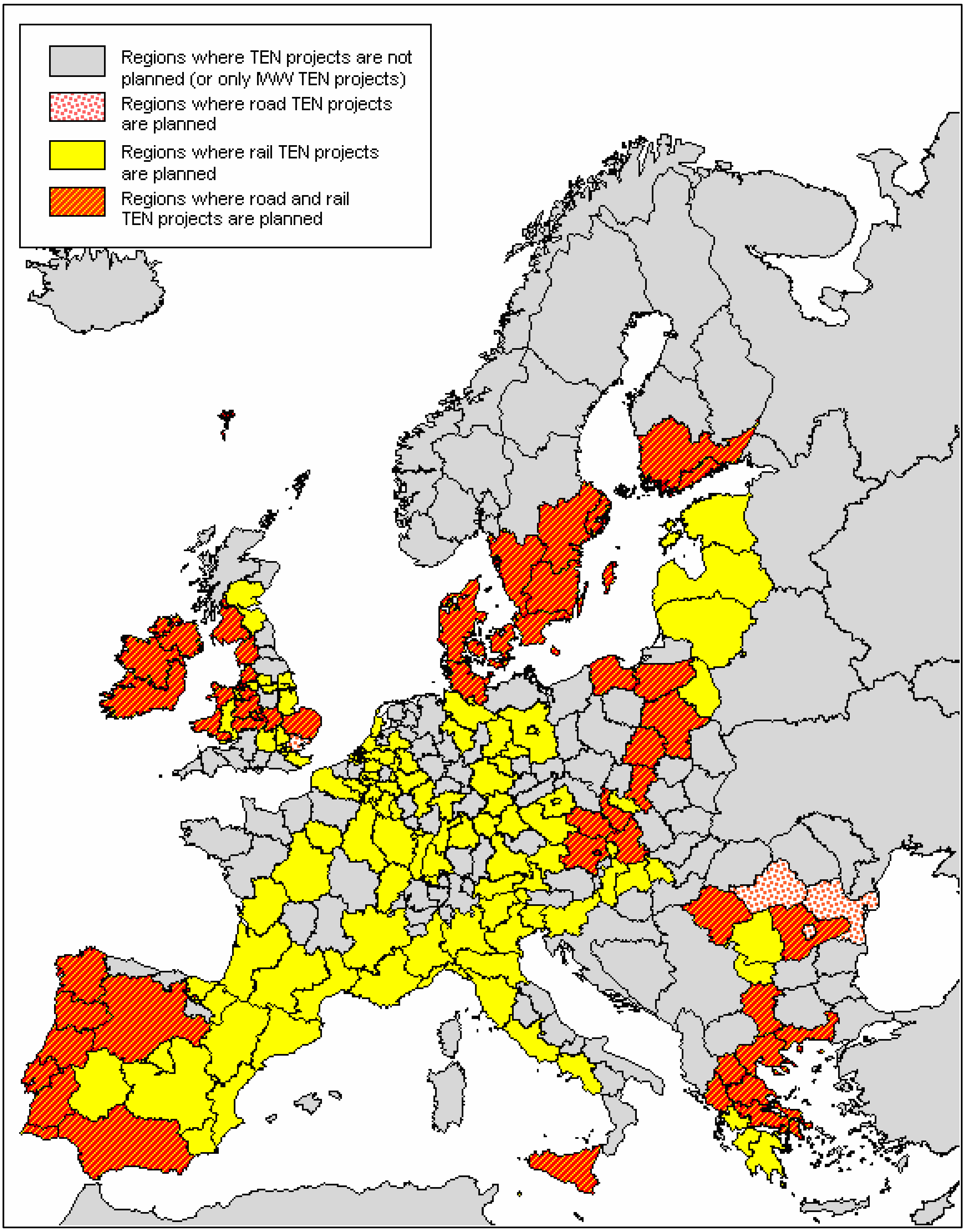


Figure 1.2. Localisation of road and rail TENs Projects planned in European regions



2. Theoretical and methodological background

This chapter summarises the main approaches and methods used to assess the economic impact of transport.

Economic literature suggests a wide range of different approaches to tackle the assessment of the economic impacts of transport investments. Most of them focus on the macroeconomic effects that can be generated by boosting transport investments. Microeconomic analyses, as well as the analysis of the spatial impact of transport policy, are generally used in locally-oriented studies, in an attempt to stress the contribution of transport to regional competitiveness.

Paragraph 2.1 below lists the different approaches found in literature, while paragraph 2.2 centres on the review of the models recently used in Europe to assess the economic transport impacts. Most of them were developed as part of European research programmes, or were carried out to examine the impacts of specific infrastructural projects.

2.1. Theoretical models for analysing effects of transport

2.1.1. National growth approach

This approach aims at identifying on the effects of public investments. The impact can have either a positive (multiplier effect) or a negative (crowding-out) influence on private investment. In general, this approach applies at the national level, while regional effects are ignored. The pioneer of this approach is economist Aschauer, whose article “Is public expenditure productive?” (Aschauer, 1989) assumes that an increase in public investment raises the marginal product of private capital and provides an incentive for a higher rate of private capital accumulation and labour productivity growth. The studies opting for this approach use time series analysis and growth model structures to link public infrastructure expenditures to movements in private sector productivity.

2.1.2. Regional growth models

This approach is based on the neo-classical growth model. According to this model, the real growth expressed in terms of per capita GDP is a function of regional endowment factors. Transport infrastructures are considered one of such regional endowment factors. Another important assumption of this approach is that, based on the presence of reduced capital returns, regions with similar factors will have a converging per capita income path over time. As a result of this, transport infrastructure investments in regions with a poor infrastructure endowment will accelerate the convergence path of the income *per capita*, while, once the level of infrastructure endowment becomes uniform across the regions, its role becomes less important.

2.1.3. Production function approach

The production function approach revolves around the assumption that the regional economic activity is a function of production factors. Typically, production factors consist of capital, labour and land. In modern production function approaches (see Jochimsen, 1996 and Buhr, 1975) infrastructures represent a public input used by the firms within the region. The main assumption of this approach is that the regions with a higher infrastructure provision will also have a higher level of output and that a low-cost and well-organized transport system will allow the production of more 'transport-intensive' goods.

2.1.4. Accessibility approach

This approach introduces accessibility indicators into the regional production function. Several different indicators can be used (see Shürmann et al. 1997), for instance some form of economic or population potential. These indicators reflect the concept of economic potential, which is based on the assumption that the regions that may easily access the markets are those showing the highest level of economic growth. For Europe, the empirical applications of this approach are the studies conducted by Keeble et al. (1982, 1988). Recently, approaches based on accessibility or potential measures have been replaced by hybrid approaches, where accessibility is one of the several explanatory factors for the regional economic growth. Also the definition of accessibility indicators has become more complex and diversified.

2.1.5. Regional input-output approach

The regional input-output approach is strictly linked to the Leontief (1966) multiregional input-output framework. According to this approach, the interregional trade flow is estimated as a function of transport costs and a fixed matrix of technical inter-industry input-output coefficients. The final demand in each region is exogenous. Within this framework, transport investments play a double role. First of all, they contribute to reducing transport costs and thus fostering regional supply. Then, they are an external increment of the final demand in the involved sectors (mainly construction) which, through the input-output mechanism, also affects the other sectors. By combining these two effects, the model allows one to make predictions on the regional economic development.

2.1.6. Trade integration approach

This approach considers interregional trade flows as a function of interregional transport and regional product prices. Applications of this approach can be found in the trade models estimated by Peschel (1981) and Bröcker and Peschel (1988) for a number of European countries. Such models are doubly constrained spatial interaction models with fixed supply and demand in each region. They were developed in order to assess the impact of economic integration in Europe in terms of reduced traffic barriers and border delays between European countries. The Peschel and Bröcker model could be used to foresee the impacts of transport infrastructure improvements on interregional trade flows. If the original constraint of fixed regional supply were relaxed, the model could also be used for predicting regional economic development.

2.1.7. System Dynamics approach

System Dynamics does not focus on the analysis of specific fields like economy or transport, but is a general methodology that can be applied to any system meeting some basic conditions. In brief, a System Dynamics model consists of a set of hypotheses on the relationship between causes and resulting effects. Hypotheses may be based on theory or only informed by theory,

but empirical inputs from statistics, surveys or other observations may also be used. Relationships are represented by equations that are written and solved by mathematical simulation. In other words, a System Dynamic model does not have a specific set of unknown parameters or variables whose value is estimated as a solution of the model. Instead, most of the model variables change over time as an effect of the existing reciprocal links (direct and indirect). The model never reaches equilibrium, yet it evolves continuously.
The System Dynamics approach has recently been applied to the analysis of transport systems and its links with the economy and the environment. An interesting feature of this model is that it is not constrained within any of the theoretical approaches described above. The open structure of a System Dynamics model allows incorporation and integration of the different relationships between variables. This feature allows for the analysis of a wider range of policies.

2.2. Examples of applications

Below, we will introduce some relevant applications of the methodological approaches outlined above. Some applications consist of specific projects, while others of modelling tools that incorporate a theoretical approach, as well as being used in different contexts.

2.2.1. The SASI model

The SASI (Socio-Economic and Spatial Impacts of Trans-European Transport Networks) model appraises the socio-economic and spatial impacts of transport infrastructural investments and transport system improvements in Europe, using the accessibility approach (see paragraph 2.1.4). The model is responsive to changes in the rail and road networks, and produces regional indicators of socio-economic development and cohesion.
The changes in the networks affect the distribution of accessibility advantages across regions. Regional socio-economic development is a function of accessibility plus other (non-transport) factors: underlying assumptions about European development as well as factors expressing the endowment, or suitability and capacity for economic activities, of single regions. When comparing different scenarios of transport network development, the non-transport factors are kept constant.
The SASI model was applied in different European projects like IASON and STEPs. SASI was also used as part of the ESPON project on the assessment of the territorial impact of EU transport and ICT policies.

For more details on the SASI model see Wegener, M., Bökemann, D. (1998): The SASI Model: Model Structure.

2.2.2. The CGEurope model

CGEurope is a static general equilibrium model for a closed system of regions covering the entire world. The CGEurope model applies the Regional growth models approach (see paragraph 2.1.2) to estimate the effects of transport investments.

In each modelled region, households spend their income buying goods and services, which could be produced in their own region or in some other region. As for production, the model is made up of firms using the same technologies on a region-specific productivity scale. The model considers two different types of firms: those producing local goods and those producing tradable goods. The model provides for the presence of transaction costs (for goods delivered between regions) consisting of two elements, one depending on transportation and business travel, and one representing the extra cost of international trade. A variation of the infrastructures is translated (exogenously) into a change in accessibility that modifies the equilibrium within each region. The model outputs consist of the measurement of welfare changes, as percentages of GDP, deriving from improvements in transport infrastructure.

Earlier applications of the model considered the effects of new road projects being part of the TENs programme on economic welfare, measured at a regional level (Bröcker, 1998a). The following road projects were examined: Crete-Corridors, Lisbon-Valladolid motorway, Nordic Triangle, Fehmarn-Belt Link, Dresden-Prague motorway.

For more details on the CGEurope model the reader is referred to Bröcker (2002).

2.2.3. The ASTRA model

The ASTRA system dynamics model is an integrated economy–transport–environment assessment model covering all the EU25 countries (plus Norway, Switzerland, Bulgaria and Romania). It was developed in order to assess the impact of transport policy on the national economies.

The ASTRA model consists of eight main interwoven modules. The Transport module and the Macroeconomic module are two distinctive features of ASTRA. As specified in paragraph 2.1.7, system dynamics models may use different theoretical approaches. The macroeconomics module of ASTRA consists of five key elements. First, a sectorial interchange model that reflects the economic interactions between 25 sectors of the national economies by an Input-Output table structure. Second, the demand side model depicts the four major components of final demand: consumption, investments, imports-exports (which is handled in detail in the foreign trade module) and government consumption. Third, a basic element of the supply side model is a production function of the Cobb-Douglas type[(2)], which calculates the potential output incorporating three major production factors: labour supply, capital stock and natural resources. Technical progress is considered as the Total Factor Productivity (TFP), the latter depending on sector investments, freight transport time-savings and labour productivity changes. The fourth element consists of the employment model based on value-added as an output from the input-output table calculations and labour productivity. The fifth element describes the government's policy.

Investments in transport infrastructures are included in the model as a contribution to the construction sector, in that they determine the final demand and the final use, so that their effect will spread across the Macroeconomic model: new investments change the variables described above, which influence the calculation of the Gross Domestic Product and the input-output table, respectively. From these, the effect spreads to such an extent as to affect the national economy (employment, production, etc.) as a whole.

(2) The general form of the Cobb-Douglas production function is: $Y = F(K,L) = A K^a L^b$, where Y is the income, K the capital, L the labour, A the technology and a and b are positive parameters.

The ASTRA model was developed for a selection of European projects, including, initially, the ASTRA project (1997), then the TIPMAC project (2002), and the LOTSE study (2004). Further developments are envisaged in the TRIAS project, currently in the pipeline for DG Research of the European Commission.
For more details on the ASTRA model see paragraph 3.1 below and Schade (2005).

2.2.4. The Venables and Gasiorek model

The Venables and Gasiorek model is a computable general equilibrium model based on the Trade Integration approach. It was developed to assess the economic impact of transport projects in four European countries: Greece, Ireland, Spain and Portugal. These projects were funded by the European Cohesion Fund and tend to help such countries in the integration process. The model, based on the implementation of the "New Economic Geography" theory[(3)], focuses on the effects of aggregate output (i.e. real income) and its distribution per region. Transport cost saving, in the short, medium and long run, are compared with the economy aggregate effects.
For more details on this model see Venables and Gasiorek (1998)

2.2.5. The CEBR model

The Centre for Economics and Business Research (CEBR) national model, and CEBR's related but subsidiary regional models of London and of the Rest of the South-East (RoSE), is "a comprehensive economic model of the UK economy that incorporates both monetarist and Keynesian considerations", using inter alia an input-output approach that can produce both quarterly short-term and annual long-term forecasts (CEBR, 1994, p. 21).
The model envisages employment and unemployment, GDP, imports and exports (and hence the balance of payments), tax receipts, benefit payments, house prices, investment, public sector borrowing requirements and inflation.
The CEBR's general approach to modelling the effect of transport investment, as represented in the 1994 study for the British Roads Federation, fall into the input-output approach (see paragraph 2.1.5)
For more details on this model see CEBR (1994).

2.2.6. The ECOPAC project

The ECOPAC project (ECOPAC - Final Summary Report, 1999) can be considered as an empirical study, since it is based on the analysis of regional socio-economic indicators, taken before and after the new transport investments.

Analyses were conducted at a regional level, carrying out multiple regressions in order to explain employment changes occurring during a given time period (period between two

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(3) The "New Economic Geography" is an analytical scenario described by Paul Krugman in early 1990s in order to geographically explain the formation of a large variety of such economic agglomerations, and has grown as one of the major branches of the spatial economics today. To date, this theory remains to be the only general equilibrium framework in which the location of agglomerations is determined explicitly through a microfounded mechanism.

censuses for instance), as a function of factors that can explain the phenomenon, including the following:

- the initial economy structure of the area under consideration,
- the investments made in sectors other than transport during the previous period or ongoing period,
- other characteristics of the production function,
- other indicators that could influence employment such as the active population skills, the distance from large cities or large conurbations, etc. and, obviously, the changes in the transport infrastructure found in the area.

2.2.7. The DSC model

The DSC European Model (Simmons and Jenkinson, 1993 and 1995) was developed to examine some of the economic impacts of changing levels of transport services in Europe. For instance, the model was applied to investigate the regional impact of the Channel Tunnel and the benefits of high-speed passenger services to and from North-West England. The model represents transport for both passengers and freight throughout Europe, converting passengers and freight services into measures of accessibility and hence into estimates of the intensity of determinants of economic growth.

Within the DSC model, the assessment of economic effects is made by the DSCMOD module, developed as a land-use "add-on" to an independent transport model set up either in a standard package or using an ad-hoc programme. DSCMOD operates according to the accessibility approach (see paragraph 2.1.4). It estimates the relocation of households and employment in response to changing accessibility within the area examined.

3. Analysis at the macro level

3.1. Reference scenario until 2050

In order to assess the impact of investments, a prerequisite is to examine the predicted future trend of the economies that may be affected by such investments. The aim of the analysis is to examine the trends in the main economic variables until 2050, as an indicator for subsequent evaluations.

3.1.1. Methodology and data

The projections of the ASTRA model were used to define the development of economic activities in European countries until 2050. The ASTRA model projections were adjusted during the ASSESS study(4) using recent forecasts recording the slowdown in European growth and revising previous projections.

The ASTRA model is a System Dynamics(5) model on a European scale focused on describing the links between transport, economy and environment. A brief description of the ASTRA model is provided in Box 1.

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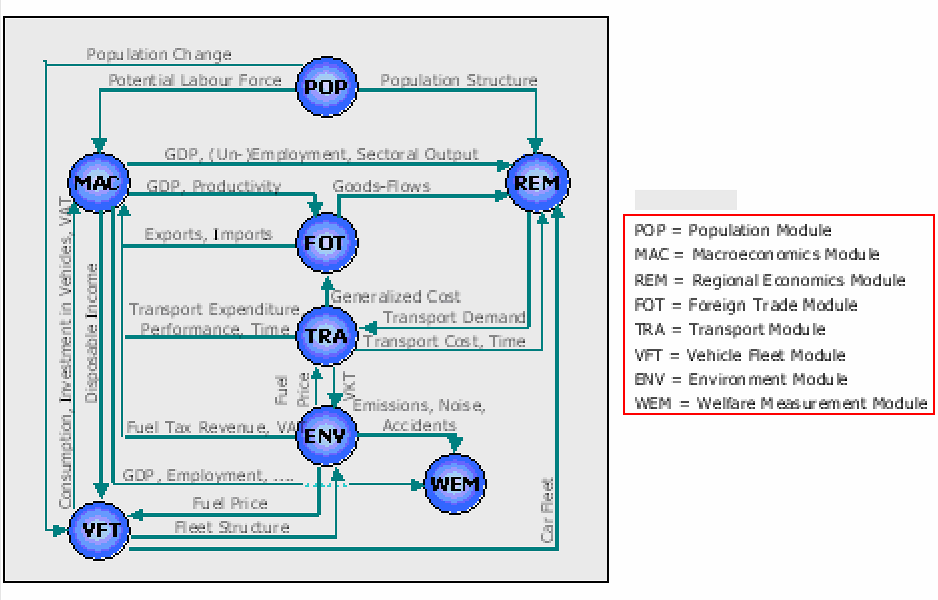
(4) The ASSESS study was carried out in 2005 with the aim of providing an assessment of the contribution of theTEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010. For more details see De Ceuster G. et al (2005).

(5) System Dynamics was developed during the 1960s by J.D. Forrester. The basic concept of System Dynamics is that systems consist of a set of interacting feedback loops whose development over time can be described by means of different equations.

Figure 3.1. The ASTRA model

The ASTRA model consists of the eight main modules indicated in the figure below, which also shows the main interrelationships between the modules and the major output variables coming from, and input variables going into, the modules themselves.



The *Population Module (POP)* provides the population development for each modelled country with one-year age cohorts. The model depends on exogenous factors like fertility rates, death rates, infant mortality rates and migration.

Five major elements constitute the *macroeconomics module (MAC)*. First, the sector interchange model reflects the economic interactions between 25 economic sectors of the national economies by an input-output table structure. Second, the demand model highlights the four major components of final demand: consumption, investments, imports-exports (which are described in detail in the foreign trade module) and government consumption. Third, the supply model has a production function of the Cobb-Douglas type as a basic element to calculate potential output incorporating the three major production factors: labour supply, capital and natural resources; technical progress is considered as Total Factor Productivity (TFP) the latter depending on sector investments, freight transport time-savings and labour productivity changes. The fourth element of MAC is the employment model that is based on value-added as an output from input-output table calculations and labour productivity. The fifth element describes the government's policy.

Investments in transport infrastructures add to the model as help for the construction sector, in that they determine the final demand and use so that their effect will spread across the MAC model: new investments change the variables described above, which, in turn, influence the calculation of the Gross Domestic Product and the input-output table. From these two the effect spreads across the national economy (employment, production, etc.) as a whole.

The parameters of the ASTRA model were re-adjusted in order to match the DG-TREN projections for the development of GDP by country until 2030. Following readjustment, the trend in the economic and demographic variables within the ASTRA model was consistent with the DG-TREN forecasts. Therefore, the model could provide projections for additional variables not included in the DG-TREN forecasts, namely employment per macro-sector and country.

As part of this study, we were asked to extend analysis until 2050. However, neither the ASTRA model nor the projections used for relevant adjustment go beyond 2030. Indeed, the development of the EU economy up to almost 50 years from now is subject to significant uncertainty and possible trend breaks (e.g. oil shortage). For that reason, the extension of the forecasts until 2050 was made by simply smoothing the ASTRA trends. Smoothing was applied to prevent countries and sectors with larger rates of change from reaching too extreme results over an additional period of 20 years. Therefore, projections in 2050 should only be intended to provide a reference development path, rather than a forecast of the future state of the economy.

3.1.2. Population and economic forecasts

Table 3.1 shows the demographic projections per country until 2050, while figure 3.2 provides an overview of the population development. EU15 and New Member States (i.e. countries which joined EU in 2004) can be distinguished in the table.

Data indicate that all the EU15 countries will record a slight increase in the number of inhabitants over the next ten years, while the trend for the subsequent period shows a gradual reduction, with the total population remaining basically unchanged. Ireland, the Netherlands and France appear to be the only positive cases, with more relevant increases until 2050, while Italy shows a slightly negative trend for the whole time period.

A “negative” scenario also emerges when looking at the New Member States (NMS): the population decreases constantly in all countries except Cyprus and Malta. According to this trend, the population of New Member States should be reduced to less than the 80% of the current value.

Table 3.2 on the next page shows the economic projections per country until 2050, giving the estimated annual growth in GDP and the trend in total employment according to the ASTRA model.

The GDP trend is forecasted to continue being positive until 2050, even though growth rates slow down over time. As expected, the NMS show faster average growth rates than the EU15 countries, and the slowdown is also less evident than in the rest of the EU. Within EU15, Ireland and Italy are well above and below the average respectively, while within NMS the Baltic countries show growth rates faster than the NSM average and Slovenia shows the lowest value among the NMS.

Employment data are less concentrated when compared to other data. For the EU15 countries the growth rates range from a slow decrease (e.g. Italy) to quite a significant increase (e.g. UK). However, average growth is always positive, decreasing over the time period in keeping with the GDP trend.

As regards the GDP, the New Member States record variable rates in two of the three periods analysed (2005-2030 and 2005-2050): Cyprus and Slovakia show a negative trend while Czech Republic and Estonia record a very high development rate. The resulting average growth rate for NMS is quite steady over the time period, with a positive annual growth of 0.5-0.6%.

Table 3.1. Population per country: average annual growth rates

Country	Annual growth rate in the population (%)		
	2005-2015	2005-2030	2005-2050
EU15	0.2	0.0	0.0
Austria	0.2	0.0	0.0
Belgium+Luxembourg	0.2	0.1	0.0
Denmark	0.2	0.1	0.0
Spain	0.1	-0.1	-0.2
Finland	0.1	0.0	0.0
France	0.3	0.2	0.1
United Kingdom	0.2	0.1	0.1
Germany	0.2	0.1	0.0
Greece	0.2	0.0	0.0
Ireland	0.8	0.6	0.5
Italy	-0.1	-0.2	-0.3
Netherlands	0.5	0.3	0.2
Portugal	0.2	0.0	0.0
Sweden	0.2	0.1	0.1
NMS	-0.2	-0.5	-0.5
Cyprus	0.8	0.5	0.4
Czech Republic	-0.4	-0.6	-0.6
Estonia	-0.8	-1.1	-1.2
Hungary	-0.7	-0.9	-1.0
Latvia	-0.9	-1.1	-1.3
Lithuania	-0.3	-0.6	-0.7
Malta	0.6	0.4	0.3
Poland	-0.1	-0.3	-0.4
Slovenia	-0.5	-0.8	-0.9
Slovakia	-0.1	-0.3	-0.4
Total EU25	**0.1**	**0.0**	**-0.1**

Table 3.2. GDP and total employment per country: average annual growth rates

Country	Annual growth in GDP (%)			Annual growth in employment (%)		
	2005-2015	2005-2030	2005-2050	2005-2015	2005-2030	2005-2050
EU15	2.0	0.6	0.3	0.1	1.8	1.6
Austria	2.0	0.3	0.0	-0.2	1.7	1.1
Belgium+Luxembourg	2.0	0.3	0.3	0.2	1.9	1.7
Denmark	1.8	1.0	0.6	0.4	1.7	1.3
Spain	2.5	1.2	1.5	1.3	2.1	1.6
Finland	2.2	0.1	-0.1	-0.2	2.0	1.6
France	2.2	1.3	0.6	0.2	2.1	2.1
United Kingdom	2.0	2.7	1.7	1.2	1.9	1.5
Germany	1.7	0.4	-0.1	-0.3	1.5	1.1
Greece	2.7	0.9	0.3	0.2	2.6	2.1
Ireland	4.2	0.5	0.4	0.3	3.1	2.4
Italy	1.2	-0.1	-0.3	-0.5	1.2	1.1
Netherlands	2.0	1.3	1.0	0.6	2.1	2.6
Portugal	2.6	1.1	0.4	0.2	2.4	2.2
Sweden	2.0	1.5	0.7	0.4	1.8	1.5
NMS	3.4	0.6	0.6	0.5	3.3	3.2
Cyprus	2.7	-0.4	-0.4	-0.5	2.5	2.2
Czech Republic	2.3	3.2	2.2	1.6	2.5	2.4
Estonia	4.9	3.1	2.3	1.8	4.1	4.0
Hungary	3.2	0.6	0.9	0.8	2.6	2.1
Latvia	6.3	0.7	0.0	-0.2	4.5	3.1
Lithuania	5.0	1.3	1.5	1.3	4.7	4.5
Malta	2.0	0.1	0.1	0.0	2.4	2.7
Poland	3.6	-0.1	0.1	0.1	3.7	3.7
Slovenia	1.8	1.4	1.4	1.2	1.9	1.9
Slovakia	3.7	-0.3	-0.5	-0.6	3.6	3.3
Total EU25	**2.0**	**0.6**	**0.4**	**0.2**	**1.9**	**1.7**

3.2. The impacts of TENs investments per sector and country

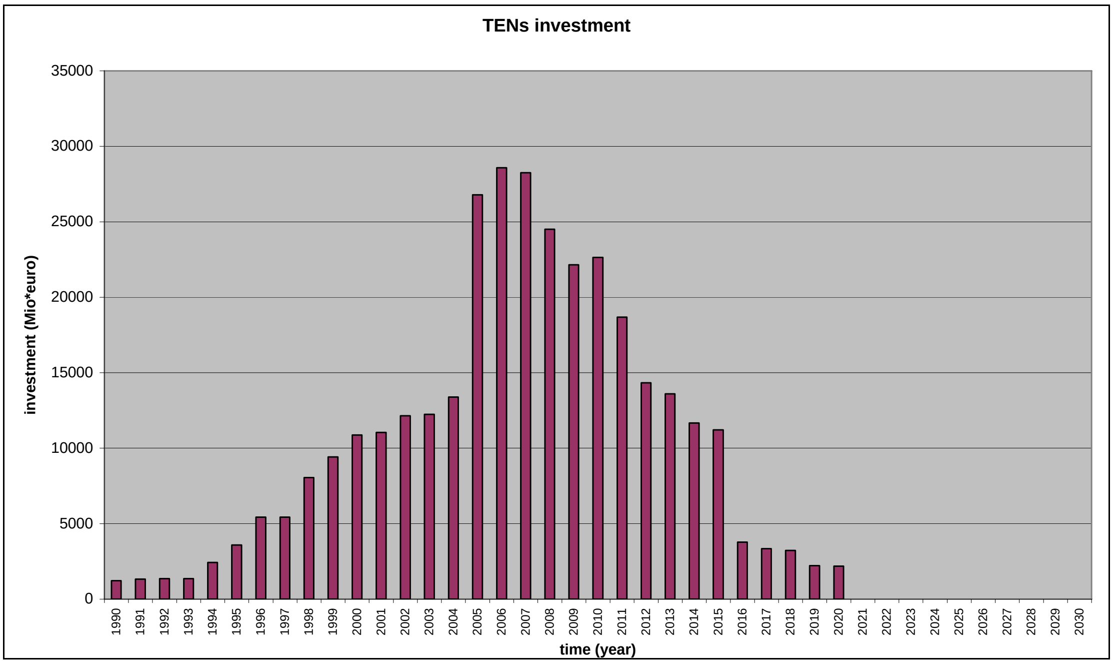
The use of the ASTRA model allowed the evaluation of the transport investments effect at a ‘macro’ level, i.e. on the economic activity of each country. The modelling results are based on the multiplier effect from construction investments, i.e. they refer to the approach described in paragraph 2.1.5. In fact, the ASTRA macro-economic module is organized so that the core of the economy is led by an Input-Output table defining the interactions between 25 sectors. Through the Input-Output table and its evolution during the time period, the effects of the investments in the construction sector may influence other related sectors. The multiplier effect is different for each country, according to the structure of its economy.

3.2.1. Modelling of TENs investments

The TENs projects were implemented in the ASTRA model as additional investments in the construction sector, according to the resources and timing described in chapter 1. Projects were distinguished by country and type of infrastructure (rail, road, etc.). The total investment was distributed over the whole period from the starting year of the project to the (foreseen) completion year, calculating the annual investment shares according to the timing of each investment section and the current status of investments (as defined in chapter 1). It was assumed that the resources required to finance the investments had already been included in the government budgets and therefore the simulation did not consider the need for additional taxes or charges.

The following figure 3.2 shows the timing of the development of TENs investments as a whole.

Figure 3.2. Timing of the development of total TENs investments (1990-2030)



The outcome of the modelling simulation consisted of the effects of the investments on employment and value added by country and sector. The weighted average elasticity by sector (or country), calculated as the ratio between the percentage variation of the economic variable and the percentage variation of the additional investments in construction, was selected as an indicator of the effect on economic activity, for both value added and employment.

As the TENs projects are expected to be completed by 2020, the impact of investments in terms of a multiplier, even if foreseen until 2030, is deemed to fade in 2050. Therefore, the results are only available until 2030.

3.2.2. Impact of all TENs investments

The absolute values obtained per sector and country were grouped according to the average data value, in order to provide a clearer picture of the effects of the investment. The ranges show the sectors (or countries) with poor elasticity (i.e. significantly lower than average), average elasticity and high elasticity (i.e. significantly higher than average).
Tables 3.3 below shows the results by sector and country, calculated for all implemented projects.

As for value added elasticity, construction investments turn out to mainly affect the construction sector, as well as the mineral and metal sectors, which show a considerable degree of elasticity over the entire time period. These results are consistent with the expectations, as the last two sectors include the production of building materials (sand, cement, steel, etc.), while the construction sector obviously becomes stronger as a consequence of direct investments in its own sector. Additionally, it can be noted that the positive effect on the construction sector is absorbed at the time the investment ceases (in fact, elasticity is null in 2030). This could be explained by the fact that the benefits for this sector are strictly related to the building phase of the construction activity.

Several other sectors benefit from TENs investments: industrial machinery, auxiliary transport services, trade and market services. All these sectors are involved in construction-supporting activities . Nevertheless, these sectors seem to react at a later time than investments, with higher values in 2030. This delay, mainly for trade and services, may be the result of the positive effect that the economic growth, and not only specific construction activities, has on these sectors. Obviously, the economic development needs some time to become evident, hence the reaction occurs at a later time than investments.

When examining the employment results (table 3.4), the sectors mostly influenced are the same mentioned above (construction, minerals and metals), even if the impacts are not that significant, probably because of the productivity growth. Additionally, TENs investments turn out to have a visible impact on the energy and chemical sectors.

Table 3.3. Elasticity indicators per sector (EU25) under the implementation of all projects

Sector	Value added elasticity		Employment elasticity	
	2015	2030	2015	2030
Agriculture	Little or none	Normal	Little or none	Little or none
Energy	Normal	Normal	Normal	Considerable
Metals	Considerable	Considerable	Considerable	Considerable
Minerals	Considerable	Considerable	Normal	Considerable
Chemicals	Normal	Normal	Normal	Considerable
Metal Products	Little or none	Little or none	Little or none	Little or none
Industrial Machines	Normal	Considerable	Normal	Considerable
Computers	Normal	Little or none	Normal	Normal
Electronics	Little or none	Little or none	Little or none	Little or none
Vehicles	Little or none	Normal	Little or none	Normal
Food	Normal	Normal	Normal	Normal
Textiles	Normal	Normal	Normal	Normal
Paper	Normal	Normal	Normal	Considerable
Plastics	Normal	Normal	Normal	Normal
Other Manufacturing	Little or none	Little or none	Little or none	Little or none
Construction	Considerable	Considerable	Considerable	Little or none
Trade	Normal	Considerable	Normal	Normal
Catering	Normal	Normal	Normal	Normal
Transport Inland	Normal	Little or none	Little or none	Little or none
Transport Air Maritime	Little or none	Little or none	Little or none	Little or none
Transport Auxiliary	Considerable	Considerable	Normal	Considerable
Communication	Normal	Considerable	Normal	Considerable
Banking	Considerable	Normal	Normal	Normal
Other Market Services	Considerable	Considerable	Normal	Considerable
Non Market Services	Little or none	Little or none	Little or none	Little or none
EU AVERAGE	0.3	0.7	0.3	0.5
Little or none	<= 0.15	<= 0.35	<= 0.15	<= 0.25
Normal	>0.15 and <= 0.45	>0.35 and <= 1.05	>0.15 and <= 0.45	>0.25 and <= 0.75
Considerable	> 0.45	> 1.05	> 0.45	> 0.75

Table 3.4 shows results by country. In general, it should be noted that the EU15 countries have stronger reactions than the NMS. Nevertheless, it is important to observe that the volume and the importance of the investments in the NMS countries is lower than in the others; moreover, they are quite concentrated over time so that it is difficult to have a strong reaction on the economic side.

The more reactive EU15 countries are Belgium and Luxemburg, Spain, Finland, France, the United Kingdom and Greece. The reason for this considerable elasticity seems to be the particular structure of the interrelationship between the construction sector and the rest of the economy of these countries.

Where the construction sector is strongly self-centred (i.e. a large part of the inputs are purchased from the construction sector itself), the economic impacts are generally modest. The investments are used to buy its own products (relationships between the sector companies), or they mainly relate to the sectors producing building materials (which slightly contribute to the development of value added); therefore, the effects on the overall economy are limited.

On the other hand, the economic impact is more significant where the other sectors that support construction (trade, market services, energy, industrial machinery) play a significant role in the input-output table (i.e. in terms of the value of goods and services purchased from the construction sector or sold to the construction sector).

Table 3.4. Elasticity indicator per country under the implementation of all projects

	Value added elasticity		Employment elasticity	
Country	**2015**	**2030**	**2015**	**2030**
EU15				
Austria	Normal	Normal	Normal	Normal
Belgium + Luxemburg	Considerable	Considerable	Considerable	Considerable
Denmark	Normal	Normal	Normal	Normal
Spain	Considerable	Little or none	Considerable	Little or none
Finland	Considerable	Normal	Normal	Normal
France	Considerable	Considerable	Considerable	Considerable
United Kingdom	Considerable	Considerable	Considerable	Considerable
Germany	Considerable	Normal	Normal	Normal
Greece	Considerable	Considerable	Considerable	Considerable
Ireland	Normal	Normal	Considerable	Normal
Italy	Normal	Normal	Normal	Normal
Netherlands	Considerable	Normal	Considerable	Normal
Portugal	Normal	Little or none	Normal	Little or none
Sweden	Normal	Normal	Normal	Normal
NMS				
Cyprus	Not computable	Not computable	Not computable	Not computable
Czech Republic	Normal	Little or none	Little or none	Little or none
Estonia	Considerable	Little or none	Considerable	Little or none
Hungary	Little or none	Little or none	Little or none	Little or none
Latvia	Considerable	Little or none	Considerable	Little or none
Lithuania	Normal	Little or none	Little or none	Little or none
Malta	Not computable	Not computable	Not computable	Not computable
Poland	Little or none	Little or none	Little or none	Little or none
Slovenia	Little or none	Little or none	Little or none	Little or none
Slovakia	Little or none	Little or none	Little or none	Little or none
EU AVERAGE	0.2	0.3	0.2	0.3
Little or none	<= 0.1	<= 0.15	<= 0.1	<= 0.15
Normal	>0.1 e <= 0.3	>0.15 e <= 0.45	>0.1 e <= 0.3	>0.15 e <= 0.45
Considerable	> 0.3	> 0.45	> 0.3	> 0.45

3.2.3. Impact of TENs investments by infrastructure type

The ASTRA model was used to simulate different investments scenarios, trying to isolate the effect of the different types of infrastructures implemented:

1) Simulation with all investments;
2) Simulation only with road investments;
3) Simulation only with rail investments;
4) Simulation only with air investments;
5) Simulation only with ship investments.

However, the last two simulations did not produce significant effects on the national economies, ,the size of the investments in the air and maritime sectors being small or nil compared to the other investments. Therefore, only the road and rail investments results are listed in the following table. Obviously, other types of infrastructures will be taken into account when examining regional effects (see chapter 5). Tables 3.5 and 3.6 show the development of elasticity by country when only partial investments (rail, roads, for instance) are implemented..

Tables 3.5 shows the results pertaining to road investments only. This data is not computable for a number of countries because only a limited number of road investments are included among TENs projects. If the results are compared to the estimated impact of all the TENs investments, only two countries seem to have the same behaviour (Spain and Greece), while the others either have no investments in road transport or just produce a slight response. Instead, it can be observed that Austria and Italy show a considerable elasticity to road investments, while their reaction to the implementation of all investments was on the average. The NMS involved in road investments seem to react very poorly on the economic side, in line with their behaviour when all the projects are supposed to be implemented. A similar scenario can be observed when considering both the value added and the employment elasticity.

Tables 3.6 shows the results obtained by simulating the rail investments only. This kind of transport encompasses most of the TENs investments, so that the data observed in the following tables do not differ much from the results analysed for all the TENs projects implemented. Among the EU15 countries Belgium and Luxemburg, Spain, Finland, France and the United Kingdom confirm their considerable degree of elasticity, while Greece shows a weaker response (whereas this country showed a strong reaction to road investments). Also in this case the NMS show only a limited reaction.

In short, if the analysis is carried out at the macro level, bearing in mind specific types of infrastructures, the results do not differ significantly from those resulting from the overall investments analysis. The main reason for this result is that rail investments account for the vast majority of TENs infrastructures and for the largest part of the economic impacts at the macro level.

Table 3.5. Elasticity indicator per country under the implementation of road projects

	Value added elasticity		Employment elasticity	
Country	**2015**	**2030**	**2015**	**2030**
EU15				
Austria	Considerable	Normal	Normal	Normal
Belgium + Luxembourg	Not computable	Not computable	Not computable	Not computable
Denmark	Normal	Normal	Normal	Normal
Spain	Considerable	Considerable	Considerable	Considerable
Finland	Normal	Normal	Normal	Normal
France	Not computable	Not computable	Not computable	Not computable
United Kingdom	Normal	Little or none	Normal	Little or none
Germany	Not computable	Not computable	Not computable	Not computable
Greece	Considerable	Considerable	Considerable	Considerable
Ireland	Normal	Normal	Considerable	Normal
Italy	Considerable	Normal	Considerable	Normal
Netherlands	Not computable	Not computable	Not computable	Not computable
Portugal	Little or none	Little or none	Little or none	Little or none
Sweden	Normal	Normal	Normal	Normal
NMS				
Cyprus	Not computable	Not computable	Not computable	Not computable
Czech Republic	Little or none	Little or none	Little or none	Little or none
Estonia	Not computable	Not computable	Not computable	Not computable
Hungary	Not computable	Not computable	Not computable	Not computable
Latvia	Not computable	Not computable	Not computable	Not computable
Lithuania	Not computable	Not computable	Not computable	Not computable
Malta	Not computable	Not computable	Not computable	Not computable
Poland	Little or none	Little or none	Little or none	Little or none
Slovenia	Not computable	Not computable	Not computable	Not computable
Slovakia	Not computable	Not computable	Not computable	Not computable
EU AVERAGE	0.2	0.4	0.2	0.4
Little or none	<= 0.1	<= 0.2	<= 0.1	<= 0.2
Normal	>0.1 e <= 0.3	>0.2 e <= 0.6	>0.1 e <= 0.3	>0.2 e <= 0.6
Considerable	> 0.3	> 0.6	> 0.3	> 0.6
Not computable				

Table 3.6. Elasticity indicator per country under the implementation of rail projects

	Value added elasticity		Employment elasticity	
Country	**2015**	**2030**	**2015**	**2030**
EU15				
Austria	Normal	Normal	Normal	Normal
Belgium + Luxembourg	Considerable	Considerable	Considerable	Considerable
Denmark	Normal	Normal	Normal	Normal
Spain	Considerable	Normal	Considerable	Normal
Finland	Considerable	Considerable	Considerable	Considerable
France	Considerable	Considerable	Considerable	Considerable
United Kingdom	Considerable	Considerable	Normal	Considerable
Germany	Normal	Little or none	Normal	Little or none
Greece	Normal	Normal	Normal	Normal
Ireland	Little or none	Little or none	Little or none	Little or none
Italy	Normal	Normal	Normal	Normal
Netherlands	Considerable	Normal	Considerable	Normal
Portugal	Normal	Normal	Normal	Normal
Sweden	Normal	Normal	Normal	Normal
NMS				
Cyprus	Not computable	Not computable	Not computable	Not computable
Czech Republic	Little or none	Little or none	Little or none	Little or none
Estonia	Normal	Little or none	Normal	Little or none
Hungary	Little or none	Little or none	Little or none	Little or none
Latvia	Normal	Little or none	Considerable	Little or none
Lithuania	Little or none	Little or none	Little or none	Little or none
Malta	Not computable	Not computable	Not computable	Not computable
Poland	Little or none	Little or none	Little or none	Little or none
Slovenia	Little or none	Little or none	Little or none	Little or none
Slovakia	Little or none	Little or none	Little or none	Little or none
EU AVERAGE	0.2	0.3	0.2	0.3
Little or none	<= 0.1	<= 0.15	<= 0.1	<= 0.15
Normal	>0.1 e <= 0.3	>0.15 e <= 0.45	>0.1 e <= 0.3	>0.15 e <= 0.45
Considerable	> 0.3	> 0.45	> 0.3	> 0.45
Not computable				

4. Overview of the NUTS2 regions of EU25

This chapter aims at providing a broad overview of the EU25-NUTS2 regions in terms of macro-economic indicators, demographic trends, and sectional specialisations. Later on, this analysis will be used to estimate the regional impacts of TENs investments. The aim of this analysis is to identify core-periphery patterns, which are relevant for the employment and demographic change impacts. According to this regional analysis, the study identifies common trends in economic performance and development models under which the different cohesion impacts can be assessed.

4.1. Methodological notes

The analysis is based on regional descriptive data at NUTS2 level(6). The NUTS2 classification is the second level of the common definition of territorial units for statistical purposes, and it is determined according to the population range, namely from a minimum of 800,000 to a maximum of 3 million.

Where the population of a Member State is below the minimum threshold for a NUTS level, that Member State constitutes a NUTS territorial unit of that level. Therefore, it should be stressed that, though necessary from a statistical point of view, this kind of classification implies an analysis of very heterogeneous territorial areas. The urban area of London, Italy's Sardinia and Estonia or Slovenia are considered altogether, not as separate regions . The reader should carefully consider this aspect while benchmarking the indicators of such a broad classification.

The data used for the analysis is based on primary and secondary sources of Eurostat indicators. The secondary source is the Third Cohesion Report on economic and social cohesion by the European Commission (2004). The regions are classified according to four aspects – economic performance, efficiency of labour markets, trends in population profiles, special concentration – as provided by the Mid-term results of the ESPON project(7). The method developed by ESPON, the Regional Classification of Europe (RCE), allows cluster analysis by means of combined indicators for a series of thematic fields, pursuant to an additive combination of single indicators.
The table below describes the indicators used for each classification area. The classification was made according to the range of values observed for the synthetic indicators at NUTS2 level.

(6) The NUTS nomenclature used by Eurostat was created for statistical purposes in order to split national territories into regions. The criteria used are *normative*, *general* and *hierarchical*. This means that the NUTS regions are based on the institutional divisions of the Member States, they exclude the specific territorial and local units in favour of general regional units, and that is a hierarchical classification, where the NUTS1 region is subdivided into a number of NUTS2 regions and so on.

(7) The European Spatial Planning Observation Network (ESPON) is aimed at supporting policy development and building a European scientific community in the field of European territorial development. For more details see ESPON website http://www.espon.lu/.

Table 4.1. Indicators for the ESPON classification of NUTS2 regions

Area	Indicators used
Economic performance indicators	Wealth: Per capita GDP 2002 in purchasing power parity. Economic Growth: the change in Per capita GDP between 1995 and 2002 is used as an indicator of the dynamics of economic performance.
Labour market efficiency	Unemployment (Unemployment rate 2003) – Development of unemployment (Change in unemployment rate 1999-2003 in percentages) – Youth unemployment (Unemployed < 25 years per 1,000 inhab. 15-<25 years 2003) – Labour force replacement ratio (Population ages 10-19 / population aged 55-64) + Employment density (Number of persons employed per km 2003) + Employment in tertiary sector (Share of total employment 2003) + Employment in primary sector (Share of total employment 2003) -
Trends in population profiles	Population density (Number of persons per km in 2002) + Ageing (Share of population aged over 65 in percentages) – Reproduction potential (20-29 years in 2020 per 20-29 years in 2000) + Population growth (Change 1995-2000 in percentages) +
Spatial concentration	Settlement structure (count of types with population=0) – Concentration of population (change of region’s share of EU 27+2 population in percentages)+ Concentration of GDP (change of region’s share of EU 27+2 population in percentages)+ Functional urban areas (share of population living in FUA) +

The description based on these synthetic indicators is then combined with a short description of the main trends in single indicators by means of primary source data from Eurostat, in particular for GDP, GDP growth, unemployment rate and population structure (ageing index and elderly dependency ratio).

Then, a more in-depth analysis is carried out on sectional specialisation, with a breakdown at sectorial level of added value and employment in NUTS2 regions. This analysis is functional to the regionalisation of the impacts of the investments estimated at the macro level (see chapter 3). As a result, only the relevant sectors in terms of elasticity to investments in infrastructures are considered (e.g. agriculture and fishing are excluded).

4.2. Economic performance

The following two indicators were used to analyse the economic performance of NUTS2 regions.

- Wealth: per capita GDP 2002 in purchasing power parity;
- Economic growth: change in per capita GDP between 1995 and 2002.

By combining wealth with the economic performance dynamics, these indicators can highlight economically successful regions.

In general the data provide a rather scattered European overview, with the South Eastern part of the Baltic Sea regions, as well as Ireland and large parts of North-West Europe, showing good combined figures for per capita GDP and GDP growth. Obviously, the reasons for any region to be considered "economically successful" vary. In the EU15 Member States high Per capita GDP is the main reason for success, while, on average, in the new EU Member States fast growth rates play a decisive role in the classification scoring.

Table 4.2. GDP-related figures for EU countries

	EU25	EU15	New EU10
Per capita GDP (PPP per inhabitant as a % of the EU25 average)	100	110	51
GDP growth (% p.a.)	1.1	1.0	2.4

Source: Eurostat, 2002.

In the old EU Member States, the highest Per capita GDP is found in the urban regions, mainly in the capital regions such as London, Brussels, Hamburg, Paris (Ile de France) and Vienna.

As shown in figure 4.1, the economic dynamism is well above average in the peripheral areas of the EU, in both the EU15 countries and the 10 New Member States. Among the EU15 countries, strong GDP growth is recorded in Greece, Spain, Southern Portugal, Ireland, Finland and in some regions of the United Kingdom (in particular the South East, London and Bedfordshire). Among the New EU regions, Mazowieckie (PL), Közèp-Magyarorszàg (HU), Bratislava (SK), Estonia and Latvia record the best performances in this respect. The growth rates of the new EU Member States are usually higher than those of the old EU countries.

The economic indicators show persistently slow growth in many regions, for example in Italian and German areas, in some French regions and in the Northern part of Sweden.

There are also substantial differences within some countries; in particular, this is the case of the UK and the Czech Republic. A substantial share of the economic wealth concentrates on the capital regions, particularly in the New Member States, but also in the EU15 countries. The data, in fact, show the prominent position of the regions of Brussels, Prague, Madrid, Paris and Lisbon, as well as London, Vienna, Budapest and Bratislava. Additionally, the capital regions of the New Member States also show significant economic dynamism, with the GDP of these areas growing systematically faster than the national averages.

4.3. Labour market efficiency

Regional labour market statistics play a key role in the measurement of the economic and social performance of European regions. The method developed by ESPON uses a set of seven indicators to compute a combined index:

- unemployment rate,
- development of unemployment,
- youth unemployment,
- labour force replacement ratio,
- employment density,
- employment in the tertiary sector,
- employment in the primary sector.

The combined ESPON index shows the highest values in the North Western European area, from Ireland to Northern Finland and down to Northern France and Benelux. In addition, the Alps area records high performances as well. In the new EU Member countries the index is lower, with the exceptions of Malta, Cyprus, Hungary and the Czech Republic, where the situation on the labour market is comparable to large parts of the core of Europe. Generally, compared to the central regions, many areas at the outer fringes of Europe seem to be disadvantaged (e.g. Portugal, Southern Italy, Greece, Poland, Latvia, Lithuania and Northern Finland), The urban and capital regions show greater labour market efficiency both in the EU15 and in the New EU countries as a whole.

As for unemployment rate, in 2004 it was above 20% in 13 regions of EU25, including three German regions, seven Polish regions, one Italian and two NUTS2 areas of Slovakia. The highest national figures were recorded in Slovakia (18.2%) and Poland (19%), while at a regional level the unemployment rate varied from 2.7% in the North-Eastern Italian region of Provincia Autonoma Bolzano to 25% in the South-Western Polish region of Dolnoślaskie.

An unemployment rate below 5% (almost the half of the UE25 average) was recorded in the United Kingdom, Northern Italy, Southern Sweden, Austria, the Netherlands, Denmark, Prague (Czech Republic), Western Hungary, two regions of Belgium, Luxembourg and the Centro region of Portugal.

Table 4.3. Unemployment-related figures for EU countries

	EU25	EU15	EU New10
Unemployment rate (mean 2004-2002)	9.2%	8.2%	14.3%
Average annual rate of change (2004-2000)	2.3%	3%	-0.2%

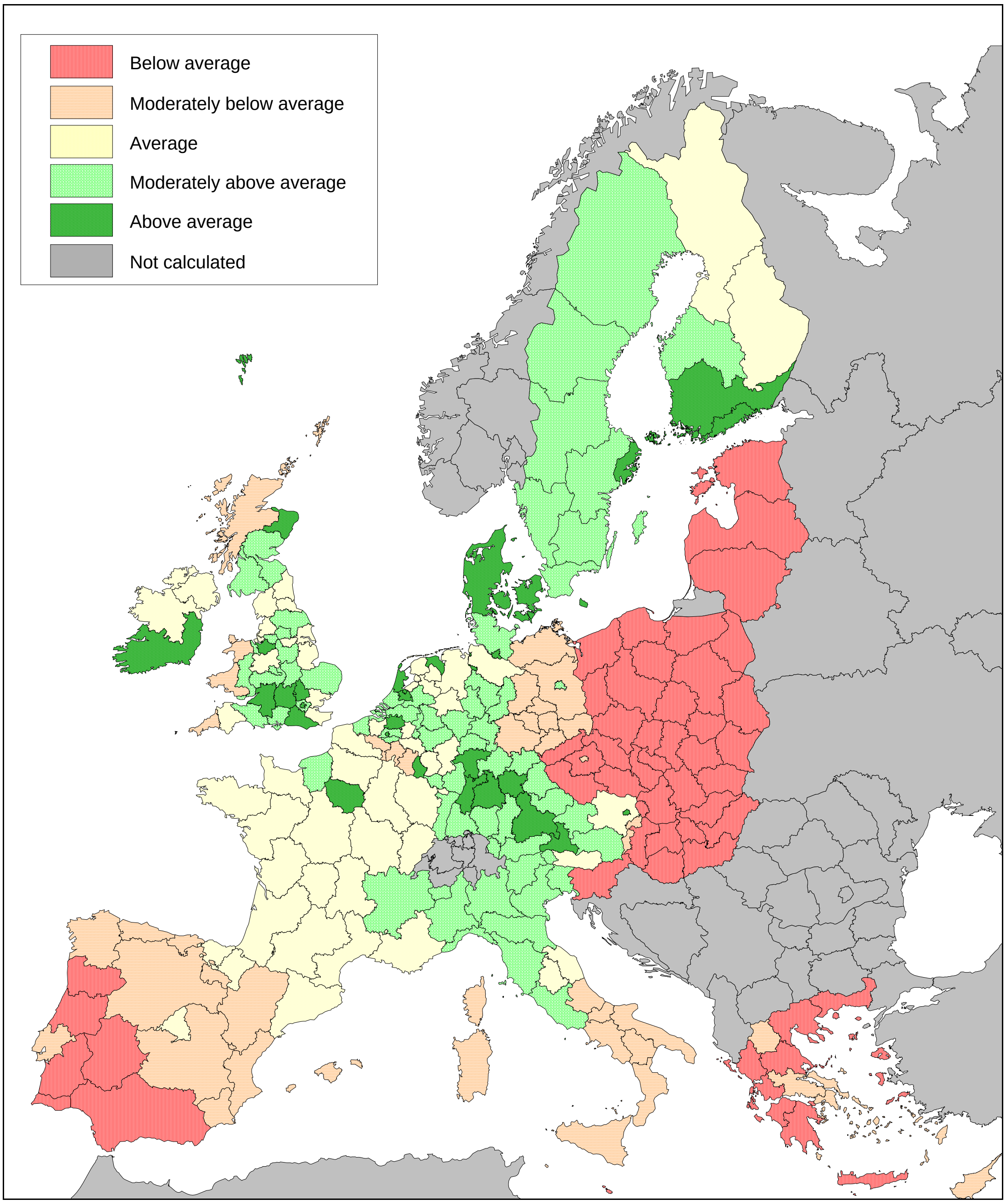
Source: Eurostat

From the dynamics viewpoint, in recent years (from 2000 to 2004) opposing patterns were apparent for the old EU countries and the new Member States: despite lower unemployment rates, the EU15 regions recorded positive and significant average annual rates of change (up to 3%), while the new Member States, showed an on-average downward trend (see figure 4.3).

Regionally, the most significant rise in recent years among the lower unemployment regions was recorded in the Netherlands, Luxembourg, some Austrian regions, Stockholm (Sweden) and Portugal (Centro).

The combination of high unemployment rates (well-above the EU25 average) and a large increase in unemployment is particularly significant for some regions of Poland, Germany, Belgium and Spain, and in the Greek region of Anatoliki Makedonia.

Figure 4.1. Per capita GDP by NUTS2 regions

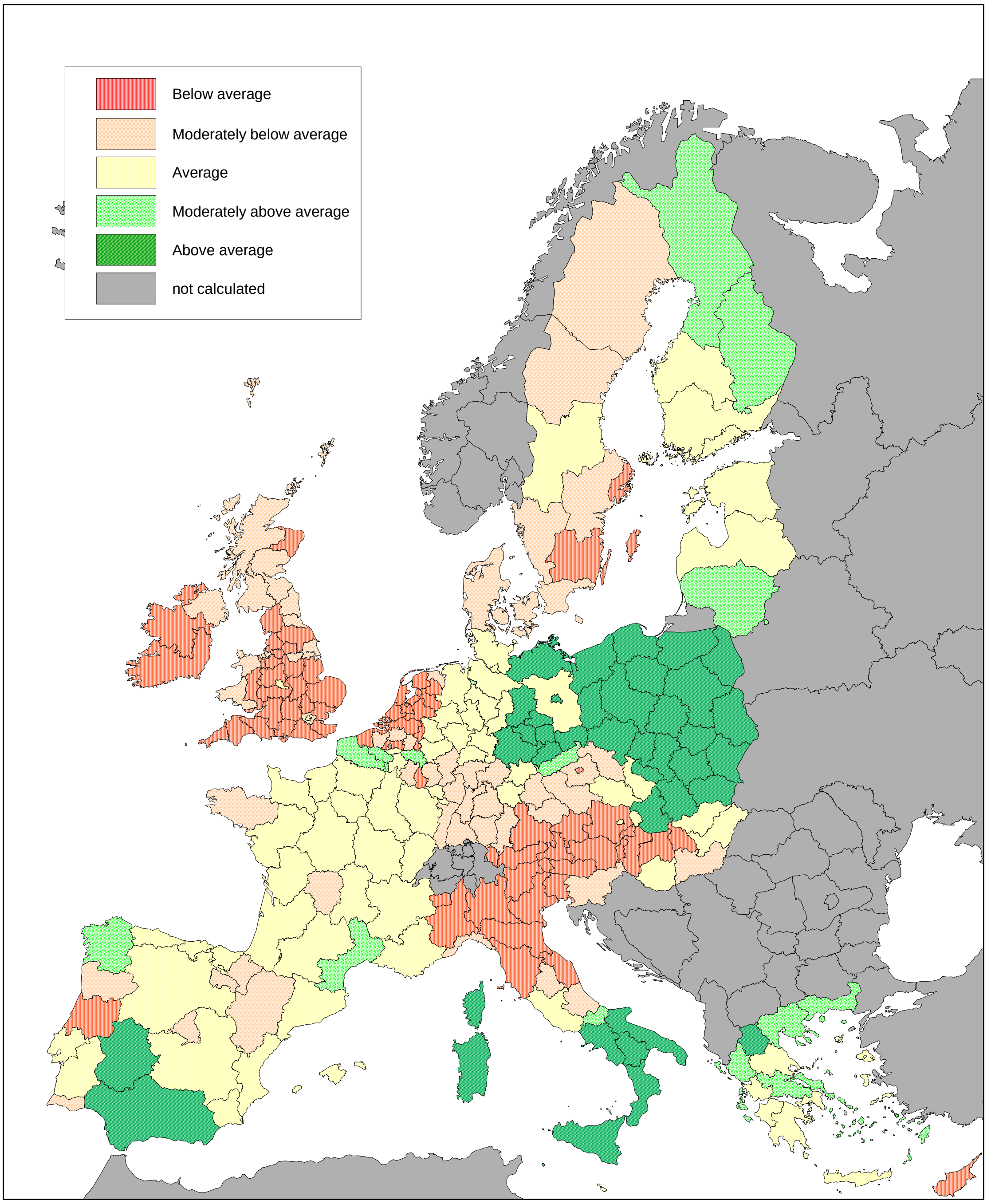


Deviation from the mean

<-40%	from +10% to +40%
from -40% to -10%	>+40%
from -10% to +10%	

Source: our estimates based on Eurostat data.

Figure 4.2. Unemployment rate by NUTS2 regions

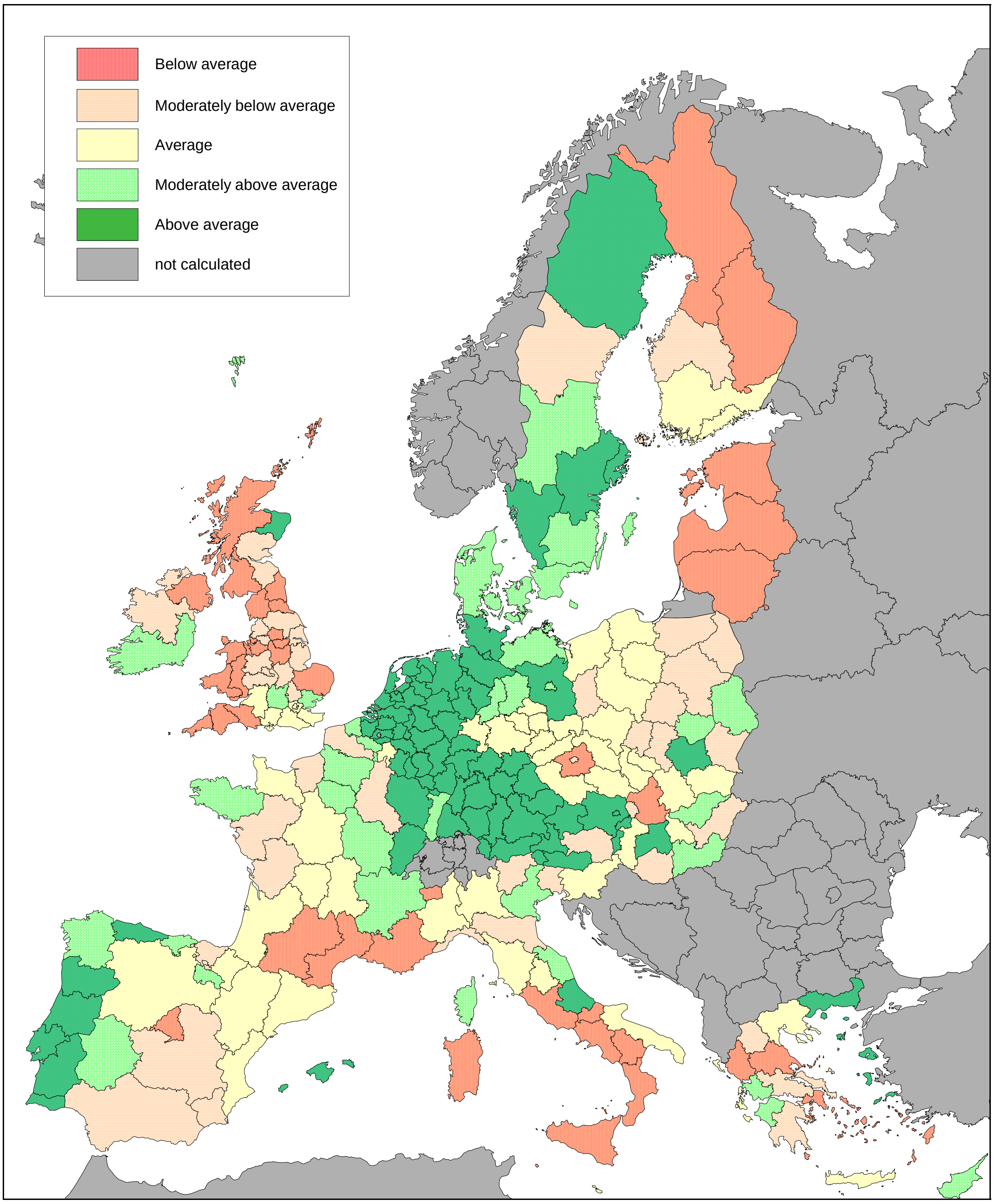


Deviation from the mean

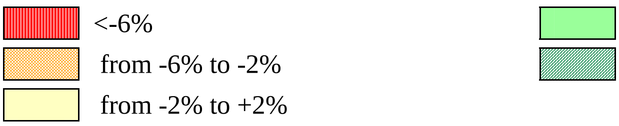
<-4%
from -4% to -2%
from -2% to +2%
from +2% to +4%
>+4%

Source: our estimates based on Eurostat data
Average values computed on 2002 – 2004 statistics for all countries.

Figure 4.3. Unemployment growth rate by NUTS2 regions



Deviation from the mean



Source: *our estimates based on Eurostat data*
Average values computed on 2002 – 2004 statistics for all countries

4.4. Trends in the population profile

In order to examine the current trends in the development of the European population, the ESPON analysis considers ageing and unbalanced population development in comparison with depopulation and regional concentration, combining the following four indicators:

- population density;
- share of population over 65 years of age;
- natural growth potential;
- population growth.

The combination of the four indicators provides an overview of the regional patterns. Demographic problems are associated with low population density, high level of ageing population, low regional reproduction potential and/or recent population losses. Most of the regions with a strong demographic problem are located in the EU15 regions, mainly in across some areas of Southern Portugal, Northern Spain, Central France, Eastern Germany, Northern Italy and in the Peloponnesus in Greece.

There are, however, some regions in Europe that, compared to the overall indicators, seem to be less affected by regional demographic challenges. Some large metropolitan areas (e.g. Paris and London) fall into this category together with a group of regions stretching from Ireland (where this favourable situation is particularly evident) and South East England, via the Netherlands to Northern Germany, some patches of Southern Germany and Alsace (France). Moreover, thanks to attractive landscapes and climate, some Mediterranean areas (Balearics, Algarve) show a positive scenario as a result of significant population gains (see figures 4.4 and 4.5).

Considering the overall ageing trend in Europe, the elderly dependency ratio (and the ageing index) shows, on average, a relatively younger population structure in the new EU regions than in the EU15 regions (except for some cases, such as Ireland and Flevoland in the Netherlands).

Table 4.4. Population-related figures for EU countries

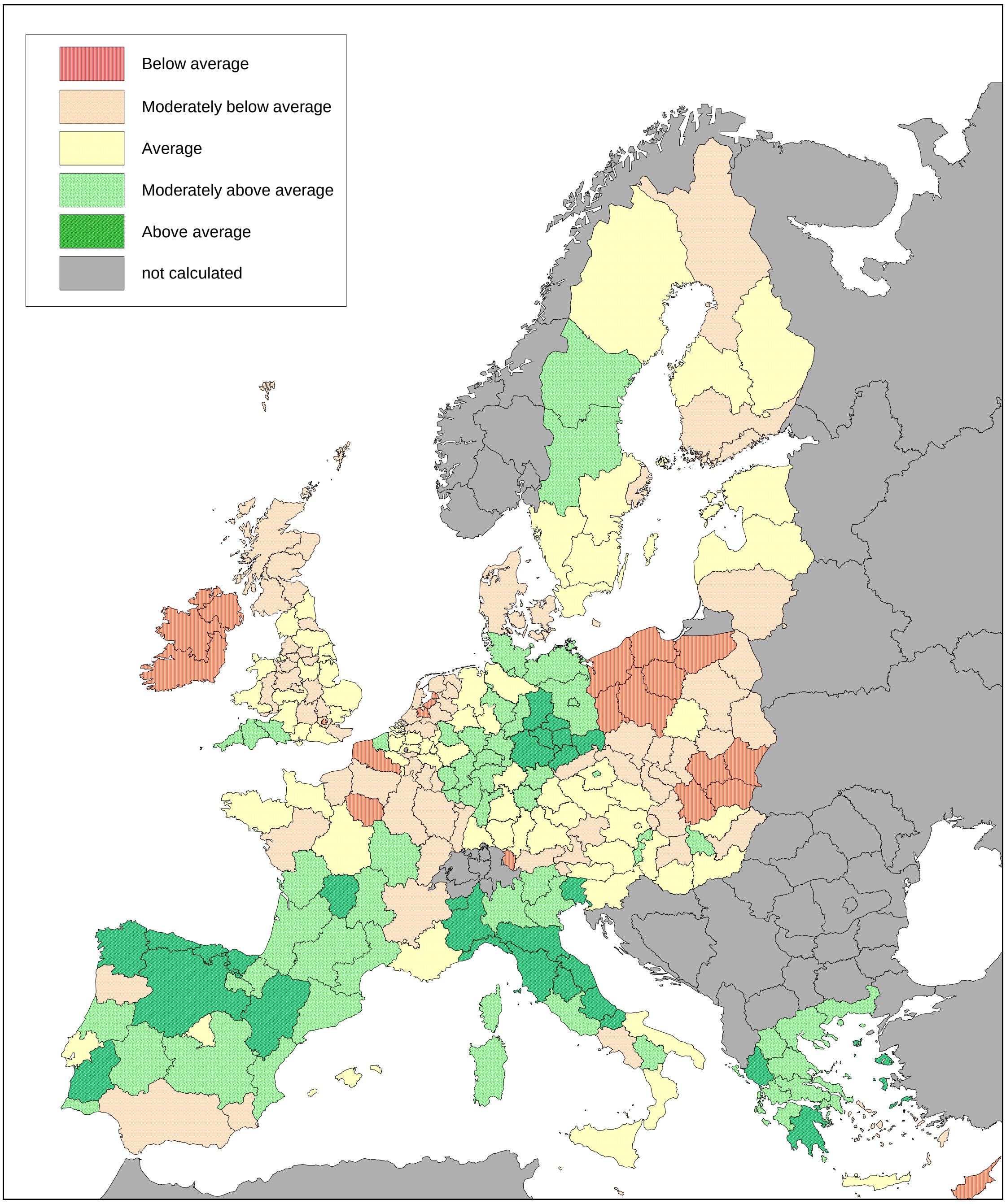
	EU25	**EU15**	**NewEU10**
Ageing index(1)	0.982	1.023	0.784
Elderly dependency ratio2	0.243	0.252	0.194

Source: Eurostat, years: average 2004-2002.
(1): The ageing index is the percentage ratio between the population over 65 years old and the population under 14 years old
(2): The elderly dependency ratio is the percentage ratio between the population over 65 years old and the working population (15-64 years old).

In the EU15 areas the ageing index and the elderly dependency ratio are particularly high in Greece, in many regions of Spain, Italy (especially in the centre and in the north), Portugal (Algarve, Centro, and Alentejo), the South Western part of France and North Eastern Germany.

We should point out, however, that in most of the new Member States the demographic trend of elderly people (over 65) has increased during recent years, especially in Slovenia, Lithuania, Estonia, Poland and Latvia.

Figure 4.4. Ageing index

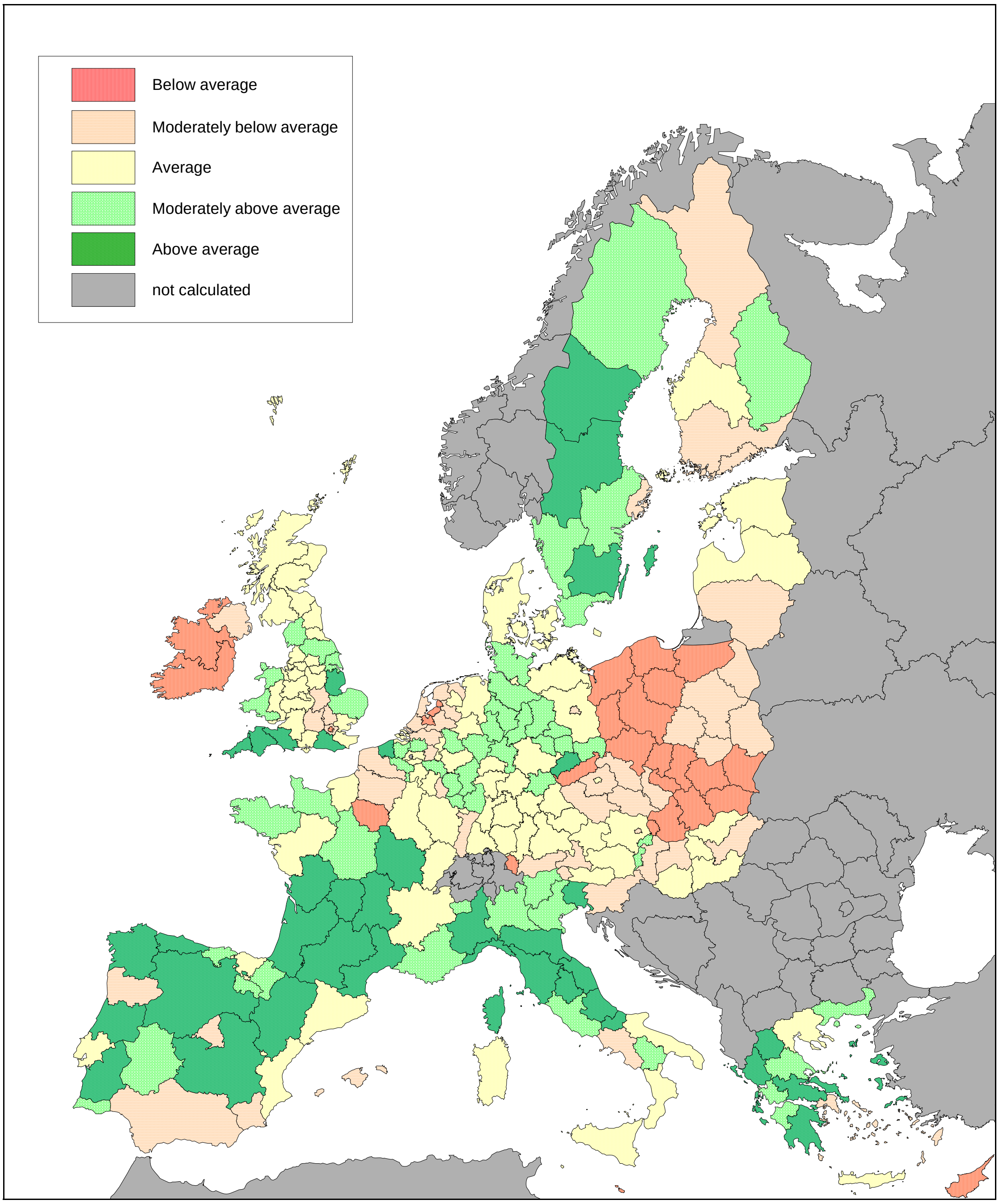


Deviation from the mean

<-0.2%	from +0.1% to +0.5%
from –0.2% to –0.1%	>+0.5%
from –0.1% to +0.1%	

Source: our estimates based on Eurostat data
Average values computed on 2002 – 2004 statistics for all countries except Slovenia: (2000) and Latvia (1998)

Figure 4.5. Elderly dependency ratio



Deviation from the mean

<-0.05%	from +0.02% to +0.05%
from –0.05% to –0.02%	>+0.05%
from –0.02% to +0.02%	

Source: our estimates based on Eurostat data
Average values computed on 2002 – 2004 statistics for all countries except: Slovenia (2000) and Latvia (1998).

4.5. Spatial concentration

The spatial concentration definition of the ESPON database includes two aspects relating to the spatial structure: one concerns the type of settlement (which differentiates the urban agglomerations according to relevant population density) and the role of the urban functional areas (FUA) on a regional scale; the other, instead, pertains to the process of spatial concentration of population and GDP, with a view to identifying the imbalances and opportunities as part of the spatial development across the EU. For this reason, ESPON's compound indicator divides the regions according to their (growing or reduced) importance in the EU. The above-average regions are those showing improvements in demographic and economic trends alike.

According to the ESPON classification, four larger territories can be identified as the main areas of spatial concentration. The first runs along the Mediterranean coast from the Algarve (P) via Spain, France and Italy to Sicily. The main concentration peaks are located in the Algarve (P), Valencia (E) and in large parts of Italy. A second belt runs from Ireland via England and parts of Scotland through Northern France, including Paris, along the channel coast to the Netherlands, Northern Germany, Denmark, Southern Sweden and up to Stockholm. The remaining two areas are more concentrated: one comprises Southern Benelux, Western and South Western Germany and Eastern France, the other is located in Poland, with hotspots in Warsaw, Southern Poland and Eastern Slovakia.

4.6. Sectorial specialisation

The analysis of the economic specialisation is particularly relevant for the identification of the regional effects of TENs investments, given that the analysis at the macro level presented in chapter 3 showed that the impact of infrastructures spending on economic sectors varies greatly.

Broadly speaking, there are significant differences between older and new Member States in the importance, in terms of number of employers, of the service, trade sector and industry. The statistics show clearly that, on average, the EU15 regions services are relatively more important than in the new EU countries. Yet, services predominate in Latvia and in the Mazopwieckie region of Poland.

In general, the regions being most active in services and trade are situated around the capitals, where trade and business services play an important role. This is the case in all the old and new Member States, except for Germany and Portugal. In Germany the most service-oriented regions are situated around ports, while in Portugal the Algarve region, a well-developed tourist area, is the country's most active area in the tertiary sector. Moreover, the service sector is also relatively important in the tourist regions of the Mediterranean area, while Belgium, the Netherlands and the North of Sweden have highly service-intensive regions, too. As to the Netherlands, commercial and transport activity are numerous around the ports of Amsterdam and Rotterdam.

Table 4.5. Employment share by macro-sector (2002 data)

	EU25	EU15	N10 (New EU Members)
Agriculture	5.4%	4%	13.2%
Industry	28.8%	28.2%	32.1%
Services	65.8%	67.7%	54.7%

Source: Third Cohesion Report on economic and social cohesion by the European Commission-DG Regional Policy.

When analysing regional specialisation in detail and focusing on those sectors mainly affected by transport investments[8], the difference between the old and new Member States is not so relevant. Figures 4.1 to 4.3 below provide a sample picture of the specialisation level of each NUTS2 region compared to the average computed for all EU NUTS2[9]. The main elements drawn from the figures are summarised below.

A share of employment in "mining and quarrying" well over 0.35% is recorded in the Czech Republic (Moravskoslezsko, Severozapad), Estonia, the Slovak Republic (Zapadne Slovensko) and many regions of Poland, but also in some EU15 countries such as Spain (Principado de Asturias), Greece, Northern Sweden, the UK (Cornwall and North-Eastern Scotland), Portugal and the Netherlands. In these regions the gross value added of the sector is above average too.As to the "construction" sector, we find a significantly higher number of employees than the reference benchmark (6.8%) mainly in four areas: Eastern Germany and the Czech Republic, the Mediterranean area (Greece, Italy, Spain and Portugal) and Ireland. There are also some peaks in Austria and North Eastern Italy, the Netherlands and England. Conversely, the sectorial contribution to employment is rather low in many regions of Poland, Sweden, Scotland and in Central Europe. However, considering the value added, the differences between the two groups is less noticeable.

In most of the New EU Member States the "electricity, gas and water supply" sector claims a sizeable share of employment compared to the European average (0.82%), along with two Italian and Greek regions and one region in the Netherlands. Considering the sectorial value added, other above-average regions emerge in Spain, Portugal, Sweden, Italy and Northern UK. By contrast, in some areas of Spain and England the sector slightly contributes to regional employment and value added. The employment share in the "transport, storage and communication" sector (figures 4.7 and 4.8) is particularly low in Portugal and some Greek and Italian regions, and well above the overall NUTS2 average (6%) in Estonia, Finland (Åland), the Greek islands, Trento/Bolzano, Luxembourg, and also in the capital regions of Sweden, Austria, Czech Republic, Slovak Republic, UK and Hungary. Finally, the "wholesale and retail trade" sector claims more than 25% of total employment (the European average is about 18%) in most UK regions, some Austrian and Italian regions, and in the tourist areas of Spain, Portugal and Greece. Conversely, the share of employment is particularly low in Germany and in some regions of Finland, Sweden and Poland. The disparities decrease slightly if we observe the sectorial value added.

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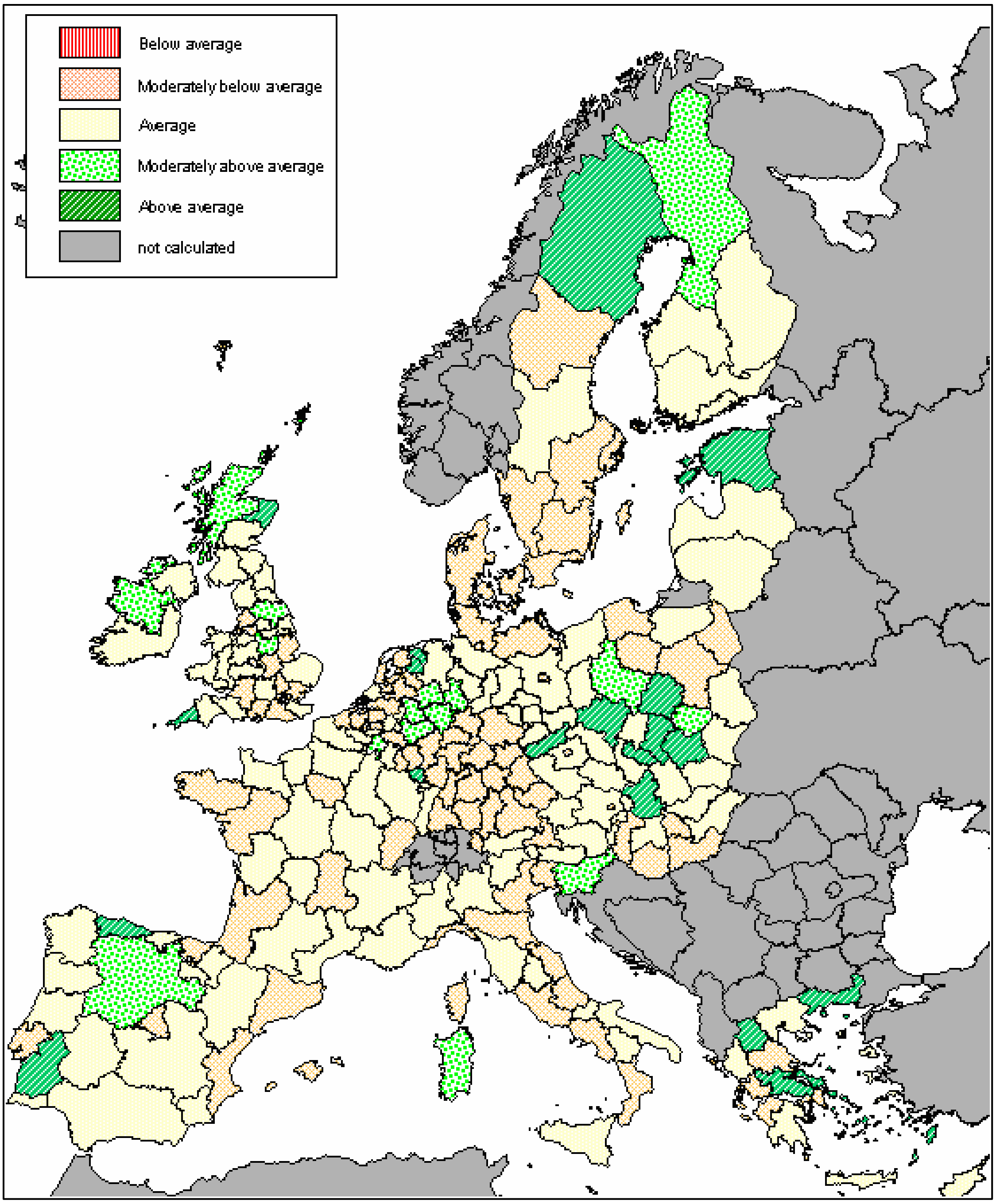
(8) According to the *Nomenclature Générale des Activités Economiques* (NACE), such sectors are: "mining and quarrying" (NACE C), "electricity, gas and water supply" (NACE E), "construction" (NACE F), "wholesale and retail trade" plus "hotels and restaurants" (NACE G and H), "transport, storage and communication" (NACE I). See chapter 3 for more details.

(9) The reference benchmark for sectorial specialisation was the average of all NUTS2 regions, and not the EU25 average, because the latter data depend heavily on the statistics of a limited number of major zones.

Figure 4.6. Specialisation of NUTS2 regions in terms of employment - Mining and quarrying

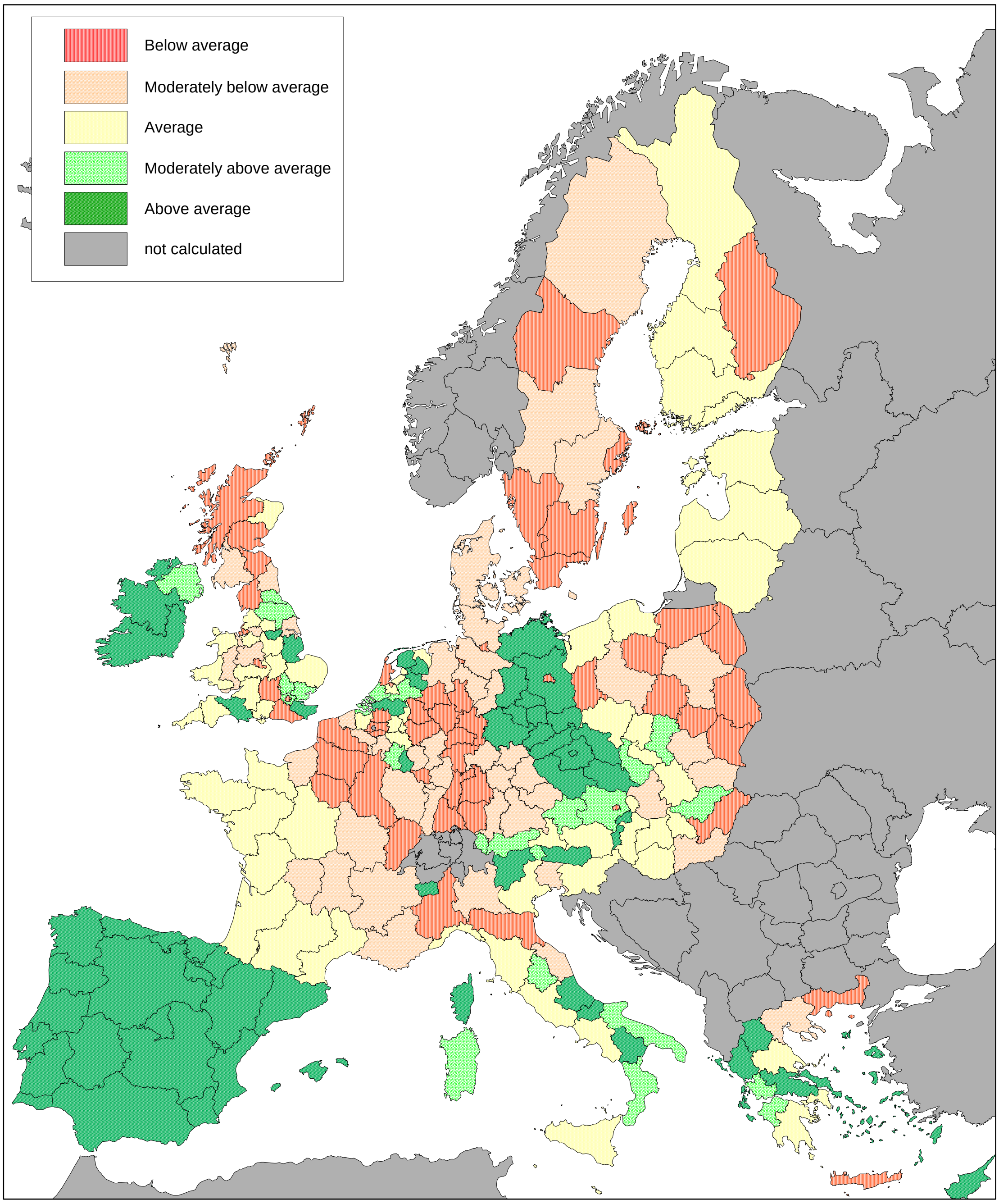


Deviation from the mean

<-0.5%	from +0.2% to +0.5%
from -0.5% to -0.2%	>+0.5%
from -0.2% to +0.2%	

Source: our estimates based on Eurostat data
Average values computed on 2001 – 2003 statistics for all countries except the Netherlands (mean 1995/98) and Greece (1999).

Figure 4.7. Specialisation of NUTS2 regions in terms of employment - Construction

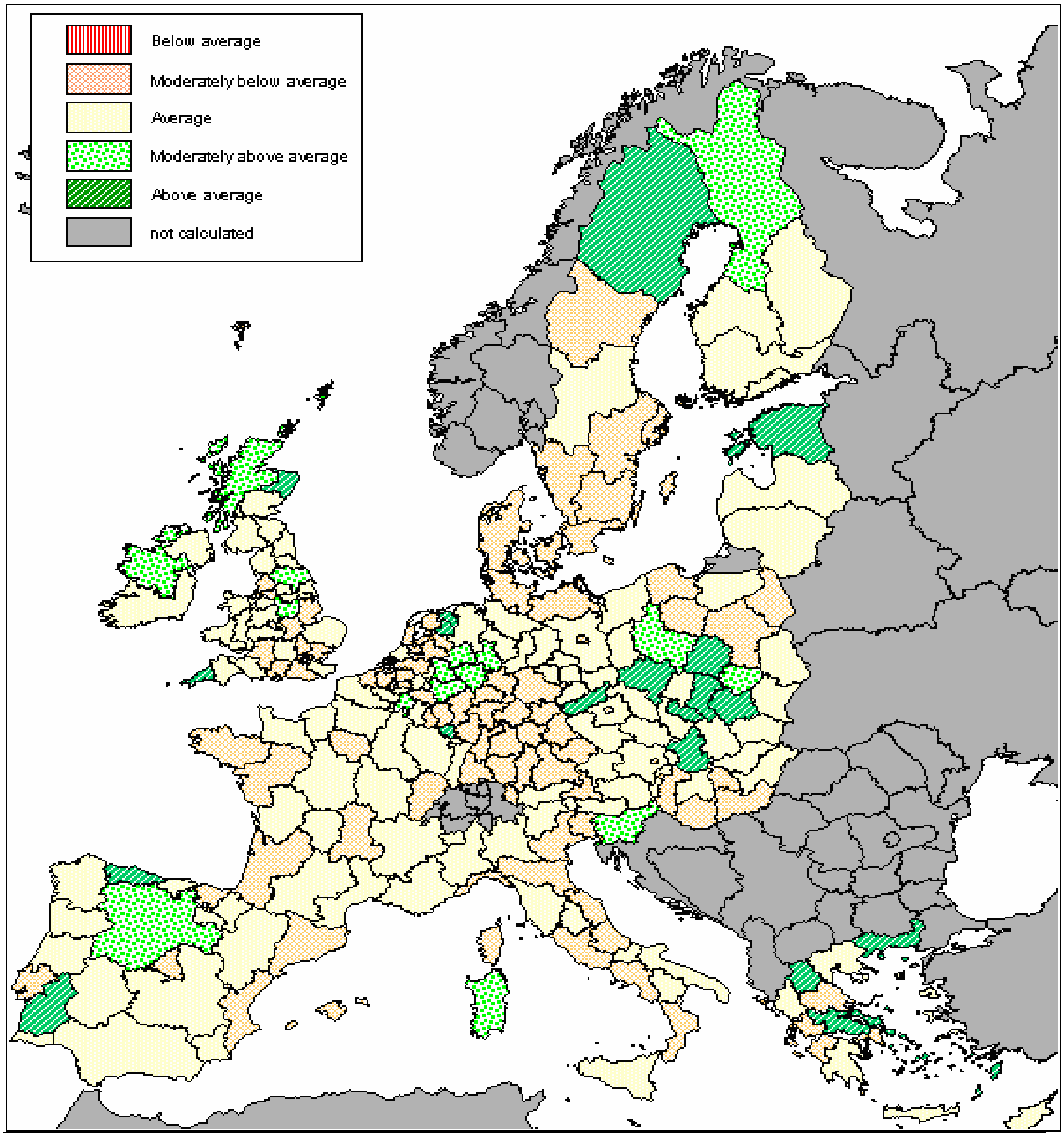


Deviation from the mean

- <-1%
- from -1% to -0.5%
- from -0.5% to +0.5%
- from +0.5% to +1%
- >+1%

Source: our estimates based on Eurostat data
Average values computed on 2001 – 2003 statistics for all countries.

Figure 4.8. Specialisation of NUTS2 regions in terms of employment - transport, storage and communication



Deviation from the mean

	<-2%		from +0.5% to +2%
	from -2% to -0.5%		>+2%
	from -0.5% to +0.5%		

Source: our estimates based on Eurostat data

Average values computed on 2001 – 2003 statistics for all countries except the Netherlands (mean 1995/98) and Greece (1999).

5. Micro level analysis

5.1. Introduction

In chapter 3, the analysis of the TENs networks impact was conducted at the macro level, i.e. examining the elasticity of national economies and sectors with respect to investments in transport infrastructures. Chapter 4 introduced the main features of the EU25 NUTS2 regions; such features were key to understanding the impacts at the local level. Chapter 5, instead, revolves around the methodologies and the results of the analysis of the impacts of TENs networks on the EU regions in 2015, 2030 and 2050.

The following paragraphs examine separately the impacts of the construction and operating phases of the TENs for 2015 and 2030. The combination of the two effects is then considered and the extension of such a combined effect until 2050 is investigated and discussed.

5.2. The impacts of TENs investments on EU regions: the construction phase

The aim of this paragraph is to estimate the regional economic effects of TENs spending in relation to GDP growth and employment for 2015 and 2030. The effects described in this report only relate to the effects of TENs projects in the investment phase, while the accessibility effects and the total impact will be discussed in later chapters.

5.2.1. The methodology for the estimation of the regional effects of transport investments

Two main elements were used to estimate the impacts of the construction phase of the TENs networks on the EU25 regions:

- the analysis of effects at the macro level (see chapter 3);
- the level of specialisation of the NUTS 2 EU regions.

In brief, the ASTRA model provided information on the TENs infrastructures impact by estimating the elasticity of added value and employment by sector and each of the EU25 countries. As a result, the regions with a higher share of TENs spending and stronger specialisation in those sectors particularly affected by infrastructure interventions, will produce a more favourable impact than the others, as a result of a multiplier effect on the regional economy of TENs spending in the investment phase.
However, the sectorial effect estimated at the macro level by ASTRA cannot be applied directly at the regional level, because the economic impact is not often aimed at the area attracting investments. For example, even if the industrial machinery sector is positively affected by infrastructure investments, it is reasonable to assume that the production of industrial machinery concentrates on some poles, whose location may correspond to the regions where investments occur.

To fully examine this aspect, the issue of defining whether the effect of an investment in one region is limited to such region was addressed technically, through interviews with engineers experienced in major civil works.

A number of activities are affected at a local level. First of all, the demand for many building materials (sand, cement, etc.) is only expected to be met locally (i.e. in the region where the investment is located) in order to minimize the transport costs. Again, when it comes to materials, it should be noted that not only many of the construction inputs are supplied locally, but also that the waste materials are generally cleared near the yard area. Therefore, it can be assumed that special waste (rubble, asbestos, etc.) is transported and disposed of in the region where the construction is made. The construction sites need to be supplied with numerous materials and services: energy, water, fuel, along with security, catering, cleaning and transport services, etc. The latter are generally supplied by local companies. Finally, offices and accommodation, furnishings, hardware etc. are mainly purchased locally too.

On the other hand, there are economic sectors receiving a positive input from transport infrastructure investments beyond the boundaries of the region where the investment is made. While cement and sand are generally produced locally, steel is purchased from one of the national manufacturers (if any) with no link to the construction sites location. Also specialist machinery (e.g. large diggers) is produced only by a limited number of companies and may be purchased from any region. Construction equipment can also be “second hand” from previous works and transported from one site to another. This is also true for the prefabricated structures used for offices and accommodation on the sites. Finally, specific equipment like signalling systems and security devices for rail networks are very specialised products that cannot necessarily be found in the same regions where the infrastructures are built.

The following table 5.1 summarises the analysis above. The matching between the items analysed, the ASTRA model sectors, and the NACE classification is also reported in the table. This correspondence is provided as only NACE sectors data is available to define regional specialisation.

Table 5.1. Localisation of the economic effects by sector

Inputs	ASTRA Sector	NACE Sector	Local effect	National effect
Sand, cement, ...	Mineral	Mining (C)	X	
Electric energy, gas, ...	Energy	Electricity (E)	X	
Water				
Fuels	Trade	Trade (G)	X	
Computer, electronic services	Computers	Trade (G)	X	
Offices/lodgings furnishing	Trade	Trade (G)	X	
Catering	Catering	Restaurant (H)	X	
Vigilance, cleaning,..	Other Market Services	Business activities (K)	X	
Transport services	Transport Inland	Transport (I)	X	
Services for construction	Construction	Construction (F)	X	X
Vehicles repair	Trade	Trade (G)	X	
Unskilled labour	All sectors	All sectors	X	
Skilled labour	All sectors	All sectors		X
Steel, ...	Metals	Mining (C)		X
Highly specialized machineries	Industrial Machines	Manufacturing (D)		X
Land movement machineries				
Safety devices, ...	Electronics	Manufacturing (D)		X
Prefabricated officed and lodgings	Trade	Trade (G)		X
Transport of special waste products	Transport Inland	Transport (I)		X

In order to get a quantitative estimation, the following data was used:

- the cost of the TENs interventions for countries and regions: as to multi-regional projects, an equal share of the total project cost is assigned to each region;
- the country's employment elasticity and added value to the transport projects, as estimated in chapter 4, adapted to the NACE sectors;
- the regional sectorial specialisation: this information, based on Eurostat data, is drawn from the analysis presented in chapter 4 and it is herein reported according to the regional variation on the EU average.

This data led to the evaluation of a simple relation, where the deviation of regional elasticity of added value (or employment) from the national average is given by the sum of a regional and a national effect. The result of the formula applied consists of a multiplier of the national elasticity as envisaged in chapter 4. It assumes below-one values for those regions where specialisation in the sectors mainly affected by TENs investments is below the national average and/or such investments with respect to regional GDP(10) are below the national average. As to above-average regions, the results of the model applied assume values higher than one.

Finally, in order to calculate the percentage regional variation of added value (and employment) due to TENs projects, the regional elasticity is multiplied by the ratio between the value of TENs investments and the whole national infrastructural expenditure.

(10) GDP and value added are the same entity in national accounts, therefore the two definitions will be used in the following as synonymous.

5.2.2. The estimated regional effects of transport investments until 2030

The results of the analysis are provided in the following pages by maps. This in order to easily view the regional impact of TENs investments on employment and added value (see figures from 5.1 to 5.4 below).

In general, the analysis shows a direct and local effect of TENs expenditure on regions involving the interventions needed. The effect highly depends on the extent of the intervention compared to the regional economy.

More specifically:
- the expected impact is significant in the regions with higher TENs expenditure as a ratio of regional GDP, while it is very slight or irrelevant in the others. This is because of the multiplier effect on the regional economy generated by the TENs intervention;
- it has a decreasing effect over time; consequently it will be virtually unimportant in most regions in 2030. Yet, this is consistent with the impact nature, which mostly relates to the investment phase. In fact, in 2030 all the projects should have been completed by at least ten years.

From a geographical viewpoint, the impacts are distributed along an “X”, stretching from North-East to South-West and from North-West to South-East.
The most affected areas include Portugal, the Central Spanish regions, the neighbouring Alpine regions of Austria and Italy, Eastern Germany and Southern Sweden on one side, and Northern Ireland, some English regions, the Netherlands, the Czech Republic and down to Greece on the other.

There is a systematically higher sensitivity to TENs investments for the EU15 countries than for the New Member States, both for employment and added value. This is due to the fact that, on average, the number and the levels of TENs investments are higher in EU15 countries.

In 2015, the regions where the estimated impact of the construction of TENs is above average can be found especially in Spain (especially central regions), continental Greece, United Kingdom, Netherlands, Czech Republic, Southern and Central Portugal, Northern Italy and Sweden. Later, in 2030, the overall impact of TENs constructions on the regional economies, as expected, is expected to drop, even though consistent variations in employment and added value persist in some areas, primarily in Greece, which is consistent with the large scale of the TENs expenditure characterising these regions.

Among the New Member States, it should be noted that some regions, while having a considerable investment share compared with GDP, seem not to be particularly affected by the TENs projects, such as those in Latvia, Slovenia, Poland and Slovakia. This is due to the following:
- the temporal investment concentration, which can seldom break the initial trend;
- a different structure of the intersectorial relationships linking the construction sector to the rest of the economy. When the other sectors providing services to construction (trade, market services, energy, industrial machines, etc.) are closely involved in input-output relations, the economic impact is significant. Conversely, if the construction sector uses investments to buy its own products (relations between firms in the same sector) or has relations mainly with building material manufacturers, the whole economic effect is lower.

Figure 5.1. Change in value added due to TENs projects (construction phase) in 2015

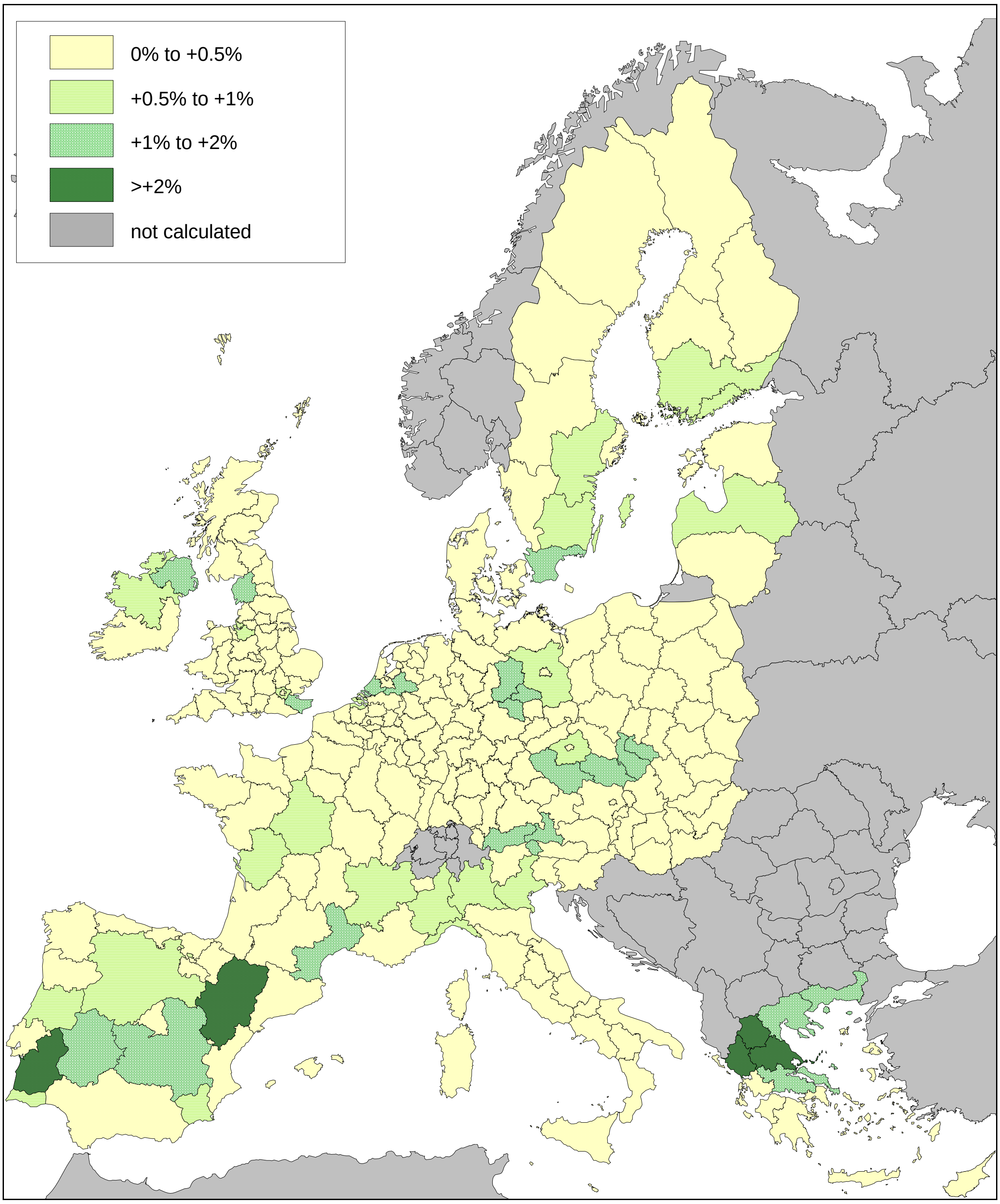


Figure 5.2. Change in employment due to TENs projects (construction phase) in 2015

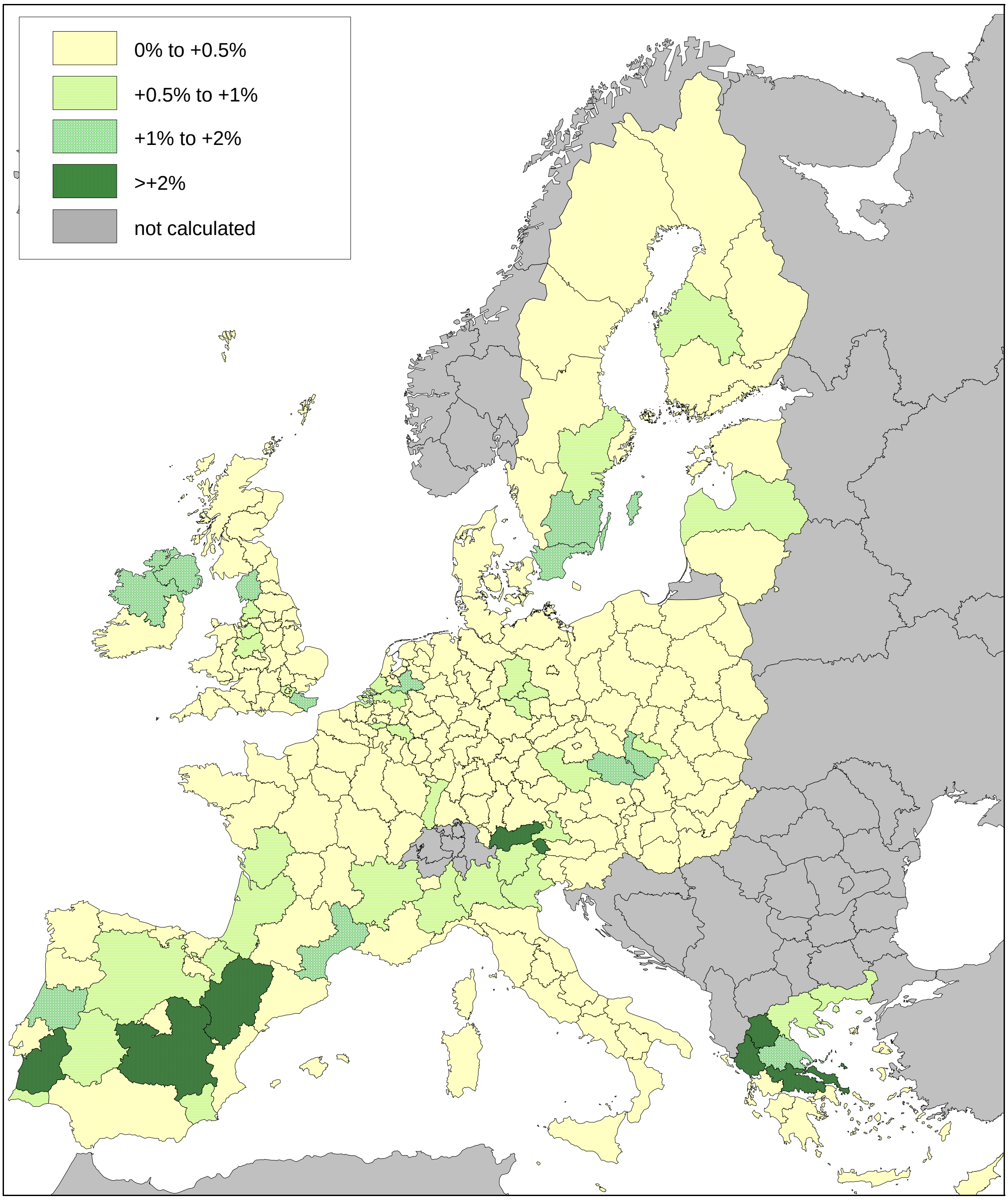


Figure 5.3. Change in value added due to TENs projects (construction phase) in 2030

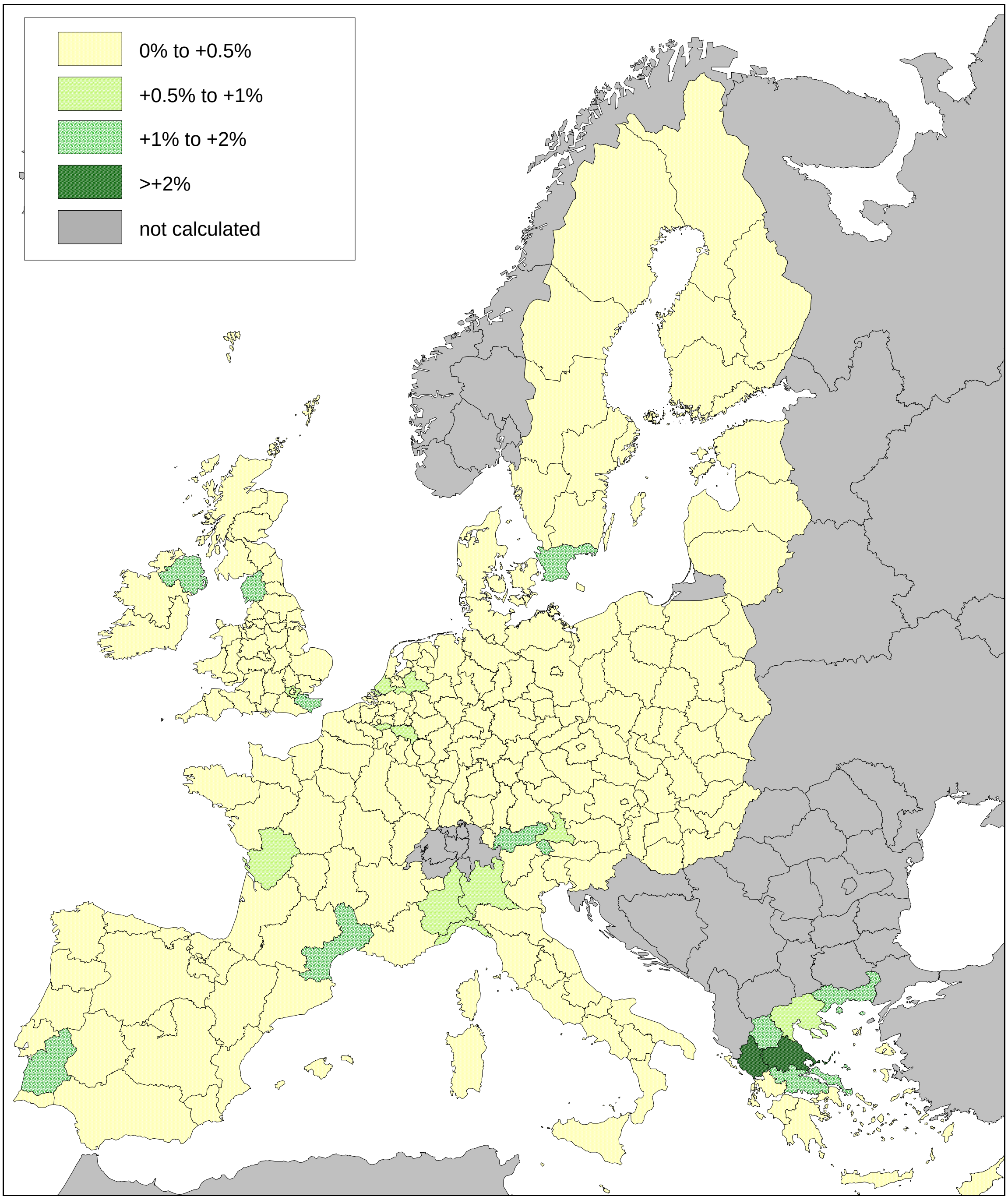
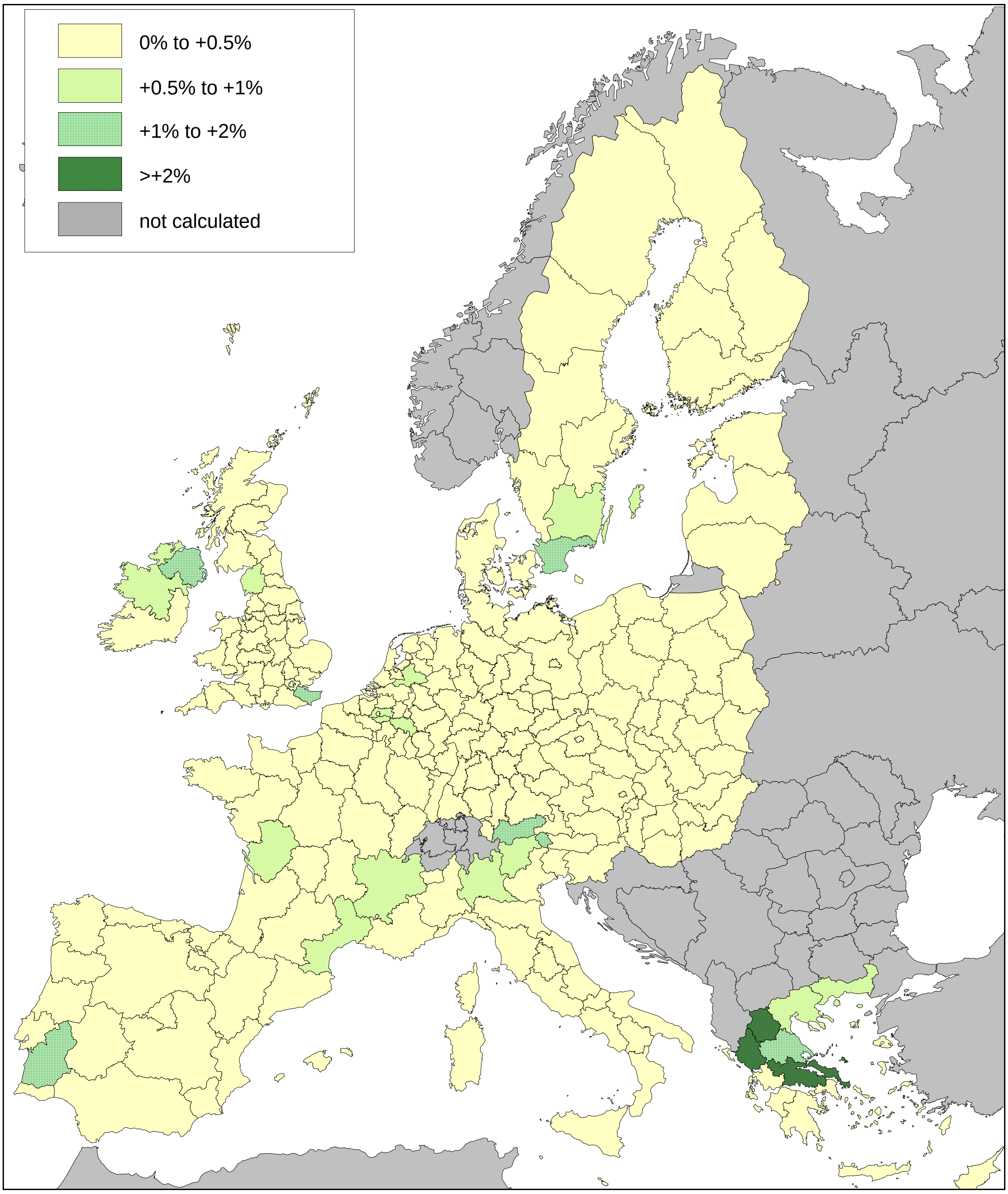


Figure 5.4. Change in employment due to TENs projects (construction phase) in 2030



5.2.3. The impacts on economic sectors

The regional impact on different sectors can be estimated thanks to the macro level analysis estimating elasticities of several economic sectors and given the amount of investments in each region,. Annex 2 of this report includes the full set of maps reporting the predictions of value added and employment changes as a result of TENs investments for different sectors in 2015 and 2030 (impacts in 2005 are irrelevant).

In the macro analysis, 25 different sectors were considered. On a regional scale, a less detailed segmentation is necessarily adopted for two main reasons. First of all, at the regional level, a given sector, for example “plastics products”, can represent a few industries specialised on a very specific production, for which the national parameters of the sector could be not representative. At the same time, detailed data of the economic structure of the NUTS2 regions as well as technical coefficients for specific industries are not available.
By working with a less detailed classification, the issues discussed above can be avoided. Obviously, the price to pay is that the estimated impacts are inherently more uncertain than those obtained at the national level. More precise responses about the regional impact of TENs investments on given sectors would require to carry out specific analysis on detailed local information.

Therefore, the analysis of the regional impact on different sectors was conducted on aggregate sectors. Basically, four groups of activities were considered: agriculture, manufacturing, market services and non-market services. The macro level analysis demonstrated that agriculture and non-market services are not significantly affected by transport investments; as a result, they were excluded from the regional level analysis. Instead, from manufacturing and market services, the most significant sectors for the impacts of transport investments were analysed separately. Finally, six sectors were considered: construction, building materials, industrial machines, trade and transport auxiliary services, other manufacturing and other market services.

As expected, larger impacts are recorded in the construction sector in 2015, when many infrastructures are due to be built (see figure 5.5). Employment and value added in construction could increase 6% more than in the non- TENs scenario across different areas (particularly, along TENs corridors) and employment growth could be higher than 2 % in many others zones. In 2030, when the construction phase of all TENs projects is due to end, most of the regional impacts in the construction sector fade out and only few regions would enjoy higher employment and value added in this sector.

Also in the building material sector, the impact of TENs investments on regional employment (see figure 5.6) and value added is significant. The areas where the impacts are more significant are often the same as for the construction sector; yet, there are some differences resulting from the different relevance of the two sectors in each country. Another difference compared to the construction sector is that the effects decline more slowly and in 2030 there will be more areas where employment and value added are higher than in the no-TENs case.

The impact of TENs investments on industrial machines is more limited both in terms of employment change (relative to the no-TENs scenario) and of regions with significant impact. Actually, the production of industrial machines concentrates more on specific areas and therefore this result is reasonable. It is worth noting that specific industrial machines to be used for major works are often produced on demand by a very limited number of producers.

However, it is hard to predict which of these producers will be chosen and in which location the production will take place. Also for this sector, the impact in 2030 is expected to be quite smoothed.

In several regions, mainly those located close to the new infrastructures, employment in trade and transport auxiliary services should benefit of the TENs investments, even though the overall impact is lower than construction or building materials. However, the 2030 impact (see figure 5.7) is very similar to the 2015 impact . This means that the positive effect of the TENs investments on this sector is more lasting than other sectors. This result seems reasonable as the increased availability of transport infrastructures is an enduring source of growth for trade and transport auxiliary services.

In the remaining sectors – ‘other manufacturing’ and ‘other market services’ – the effect of the TENs investments on employment is stronger near the new infrastructures. The impact on manufacturing activities is generally lower and declines faster than the impact on service activities.

An additional observation may help to form an opinion on the impacts described above. The changes of employment estimated for each sector relate to a no-TEN scenario and to the basic employment level in the same sector of each region. Some sectors, like construction or building materials, can show significant impacts in some regions, but if the basic employment level in such sectors and regions is low, the overall effect on regional employment will be modest. Likewise, if the basic employment trend is negative in certain sectors of a defined area, a positive impact of the TEN investments would mean that the existing negative growth rate is reduced, not that employment is growing in absolute terms.

Figure 5.5. Change in employment due to TENs projects (construction phase) in 2015 – construction

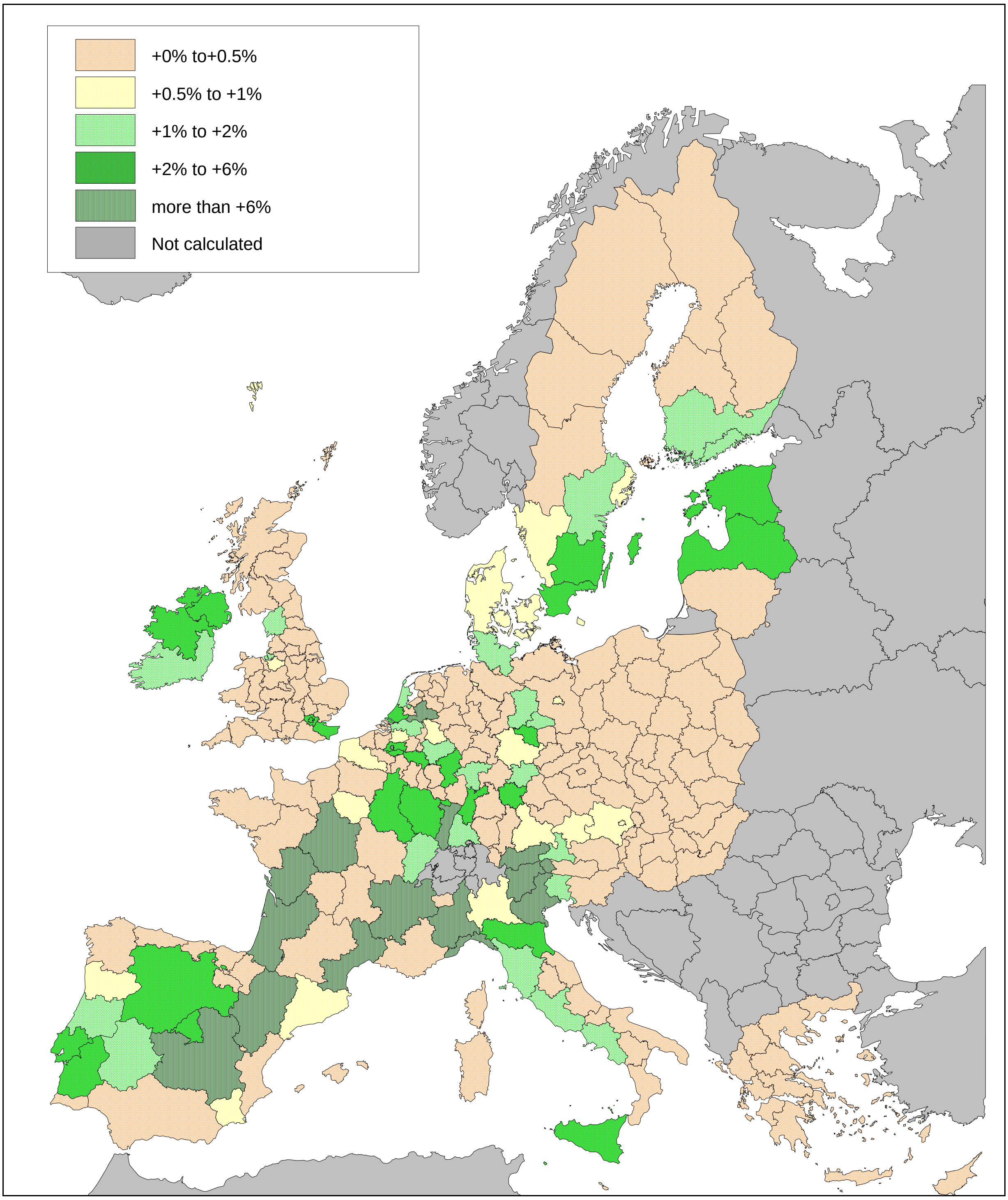


Figure 5.6. Change in employment due to TENs projects (construction phase) in 2015 – building materials

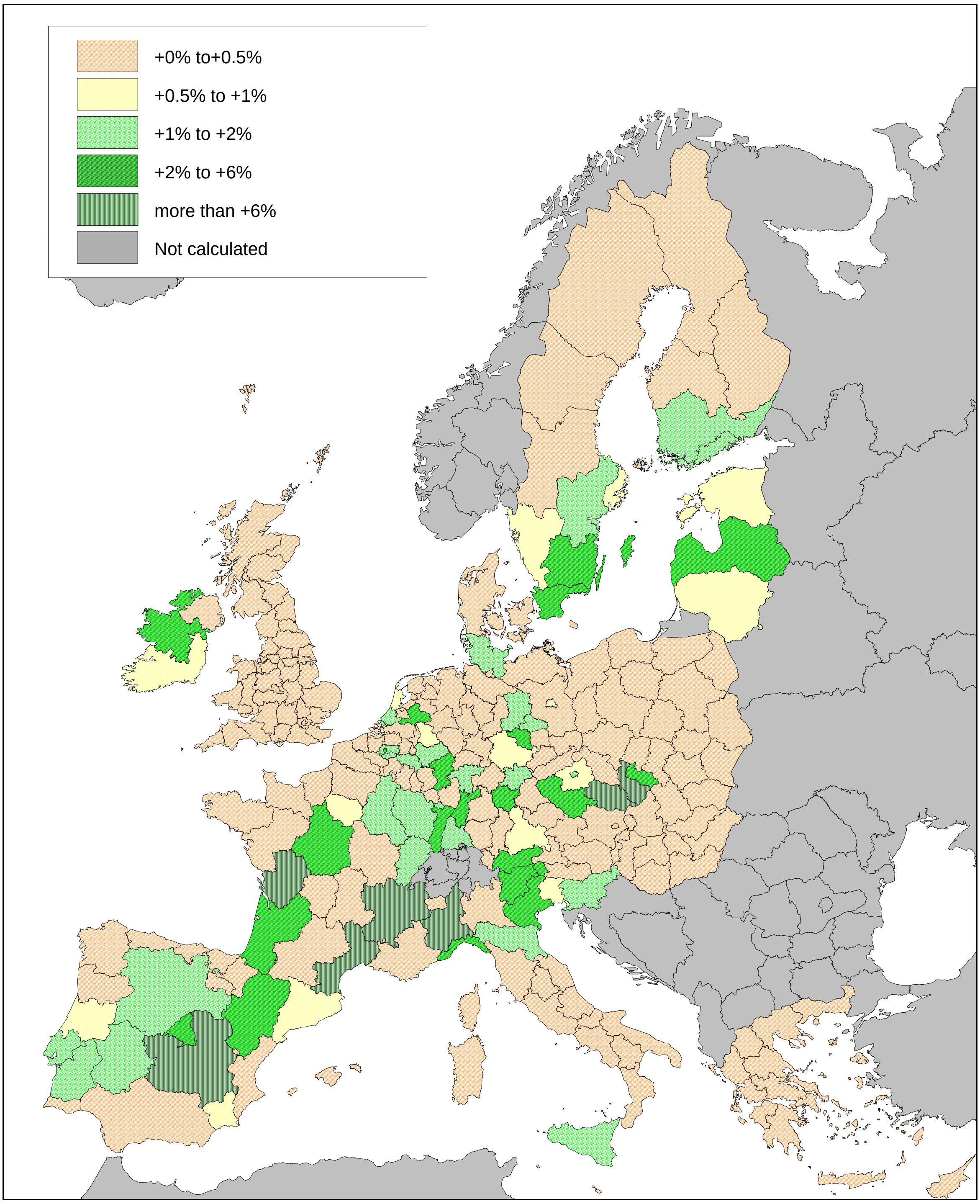
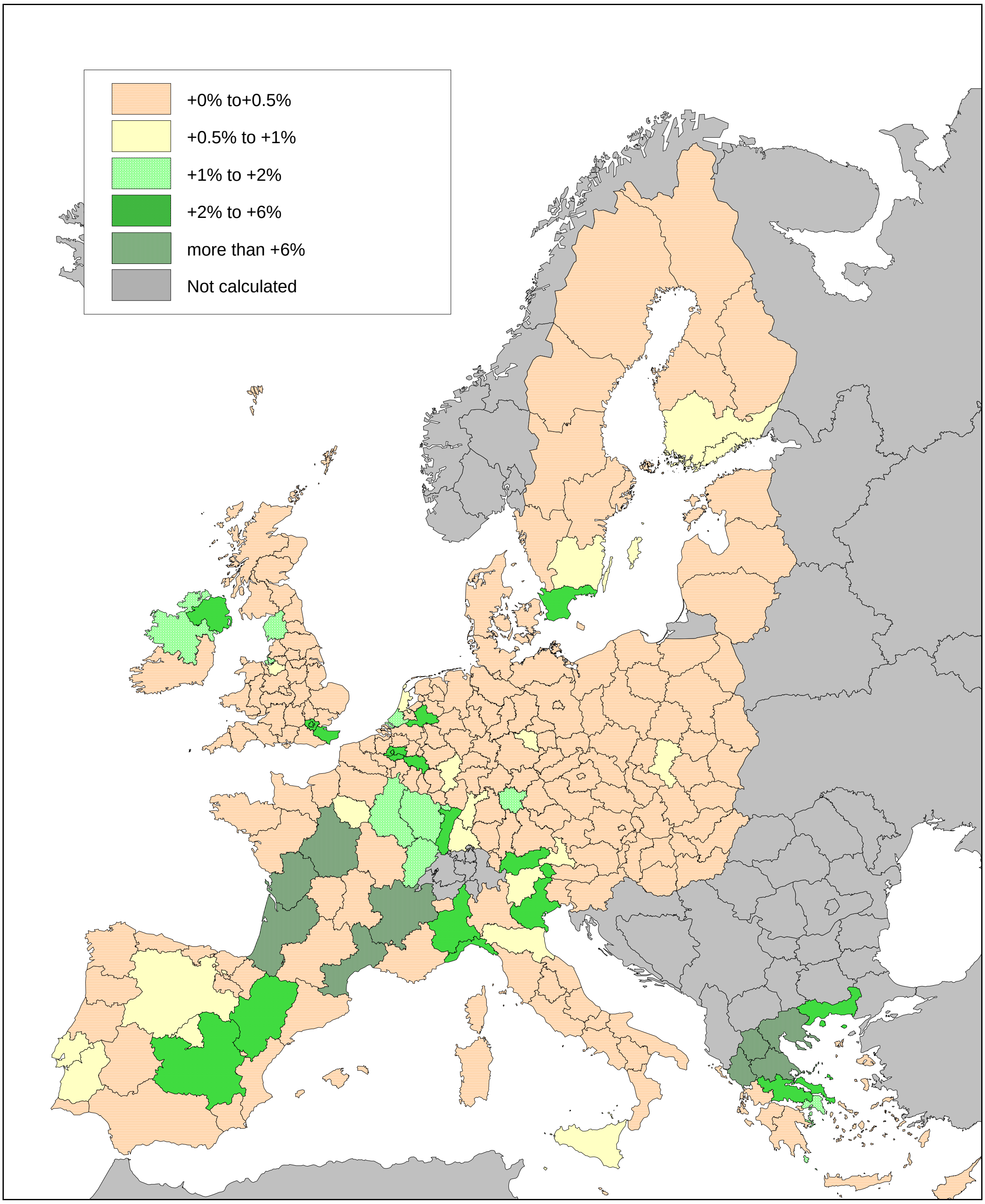


Figure 5.7. Change in employment due to TENs projects (construction phase) in 2030 – trade and auxiliary services



5.2.4. The impacts of different types of infrastructures

The investigation concerned the construction phase, only because the impacts of the operating phase can hardly be separated when it comes to the contribution of the various infrastructures types. Indeed, the impact of new infrastructures in terms of accessibility is the result of a complex “network effect” that depends on the whole set of the projects implemented. In other words, the analysis of the single or grouped projects would lead to very different results according to the assumptions on the implementation of the other projects. For instance, the effect of one new rail line connecting two regions will be different whether no other new infrastructures are assumed or new roads connecting the same regions to external zones are included in the analysis. Therefore, although investments are similar (e.g. only rail projects), in several regions, the estimation of the accessibility impact of specific types of infrastructures would require a dedicated modelling exercise.

As for the macro-level analysis , the impact resulting from the construction of different types of infrastructures was investigated. Annex 3 of this report includes the full set of maps reporting the predictions of value added and employment changes due to different infrastructures investments in 2015 and 2030 (impacts in 2050 are unimportant).

When examining the map in figure 5.8, the impacts of rail TENs construction are similar to the effects of all TENs infrastructures listed in the previous paragraphs. This was conceivable, as most of the TENs projects involve rail infrastructures. It should be noted that the analysis took into account ‘only rail’ and road-focused projects infrastructures. As for the latter, however, only the rail investments share was considered. Peripheral regions (Spain, Greece, Ireland, south of Sweden and France) show a larger employment growth as to the no-TENs scenario. In central Europe, the impact is minor and tends to fade in 2030. In fact, in the longer period, only a few regions still show a differential employment growth as a result of the rail TENs investments. However, in 2030, ten years after completion of all investments, in no area employment is expected to be more than 2% higher than in the no-TENs case (see figure 5.9).

When considering road projects, the impact on regional employment is more limited to specific areas (see figure 5.10). This mainly because of the more limited number of projects involving road infrastructures (once again, also road+rail projects were included in the analysis for only a share of the total investment). However, another factor can explain why impacts tend to concentrate on a small number of areas i.e. the lower complexity (on average) of road infrastructures compared to rail infrastructures. A rail track is made of several components produced by different industries (including electronic devices and fixed installations for monitoring traffic, etc.). Part of the inputs are produced by highly specialised companies located also far away from the region where the infrastructure is built. Therefore, a rail project, more likely than a road project, can produce its effects well beyond the regions where the infrastructure is located.

Finally, the small number of inland navigation projects give rise to a very limited number of slight effects in the areas where the infrastructure is placed. Actually, their contribution to value added and employment (figure 5.11) is virtually null.

Figure 5.8. Change in employment due to rail TENs projects only (construction phase) in 2015

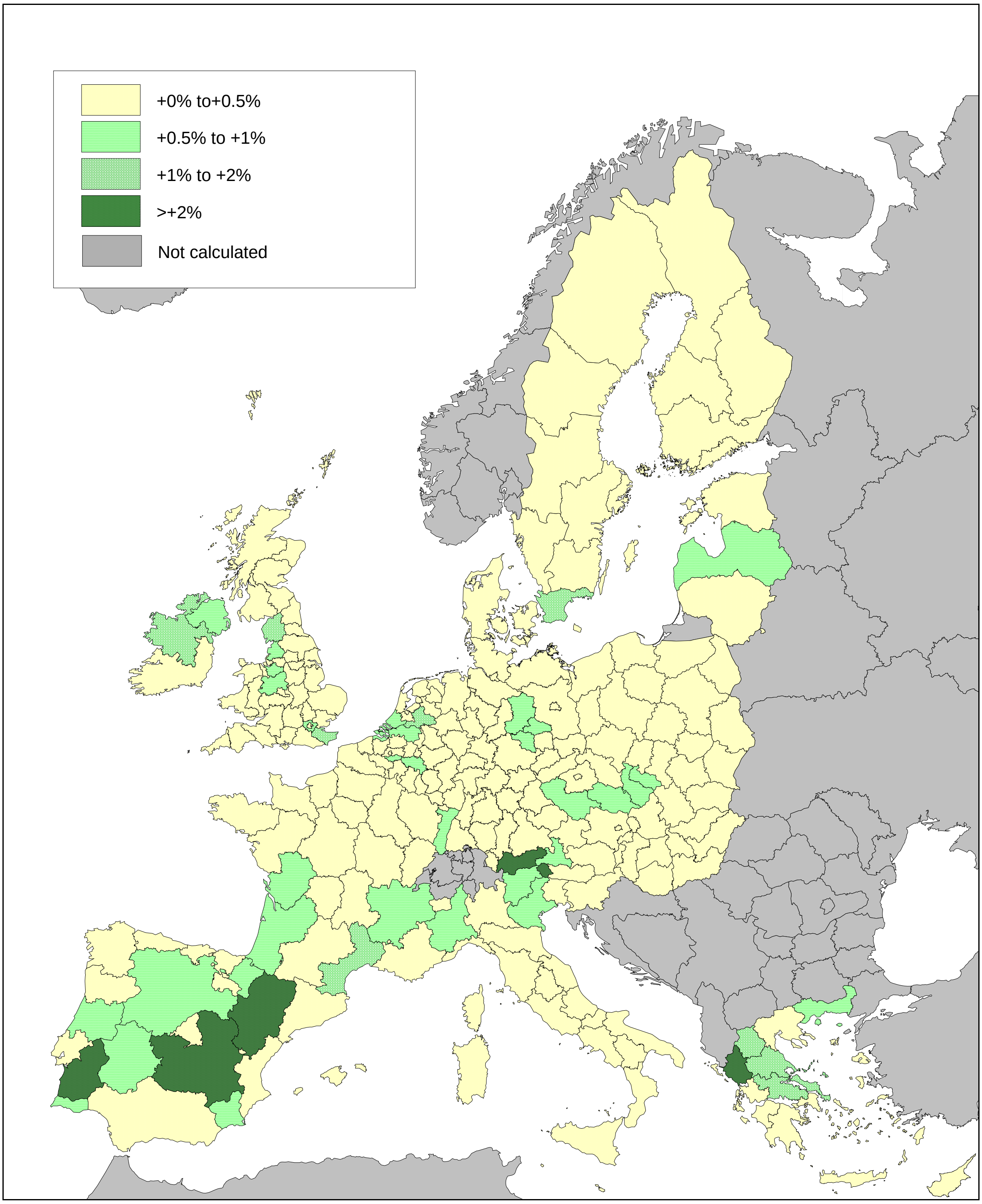


Figure 5.9. Change in employment due to rail TENs projects only (operational phase) in 2030

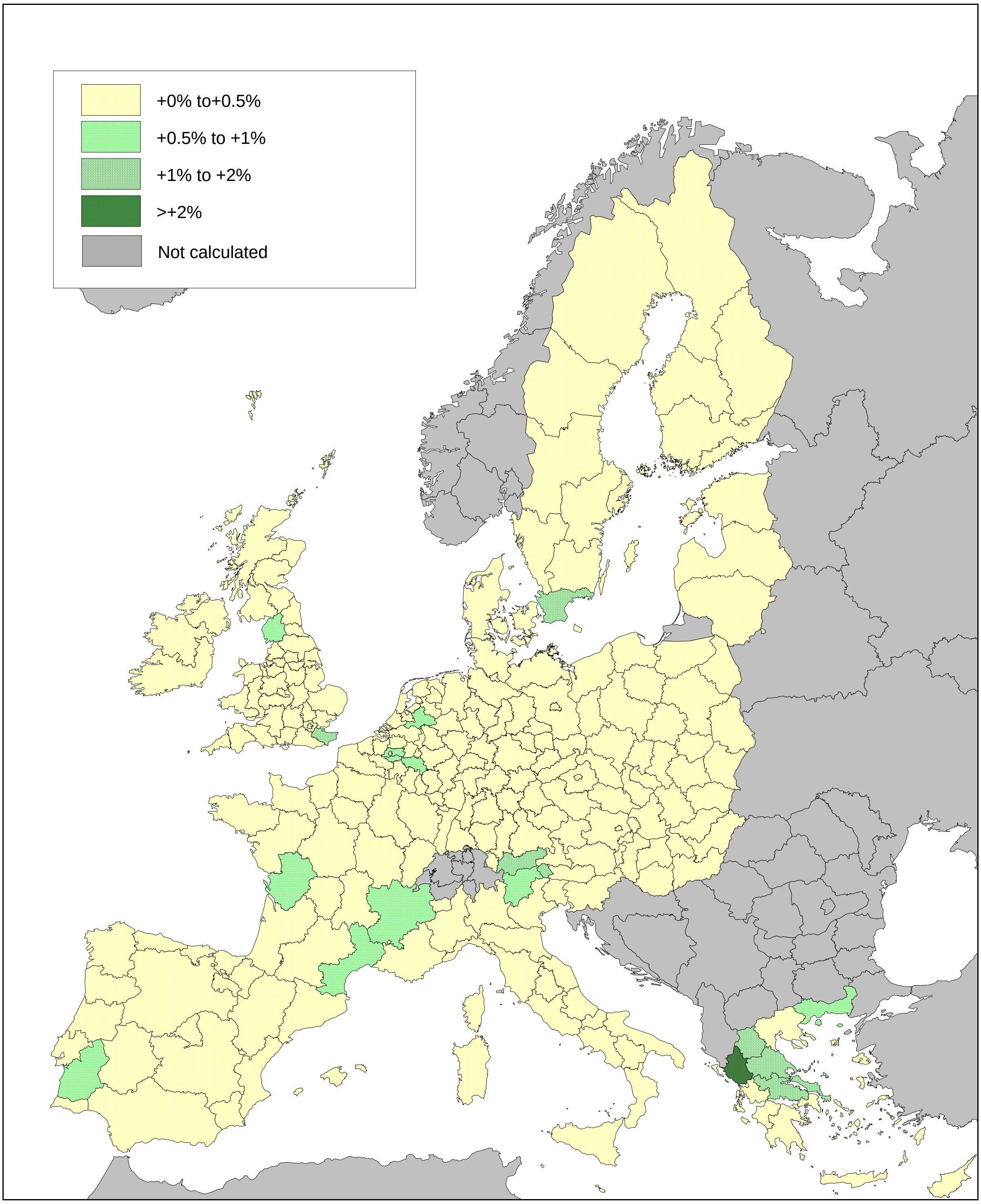


Figure 5.10. Change in employment due to road TENs projects only (operational phase) in 2015

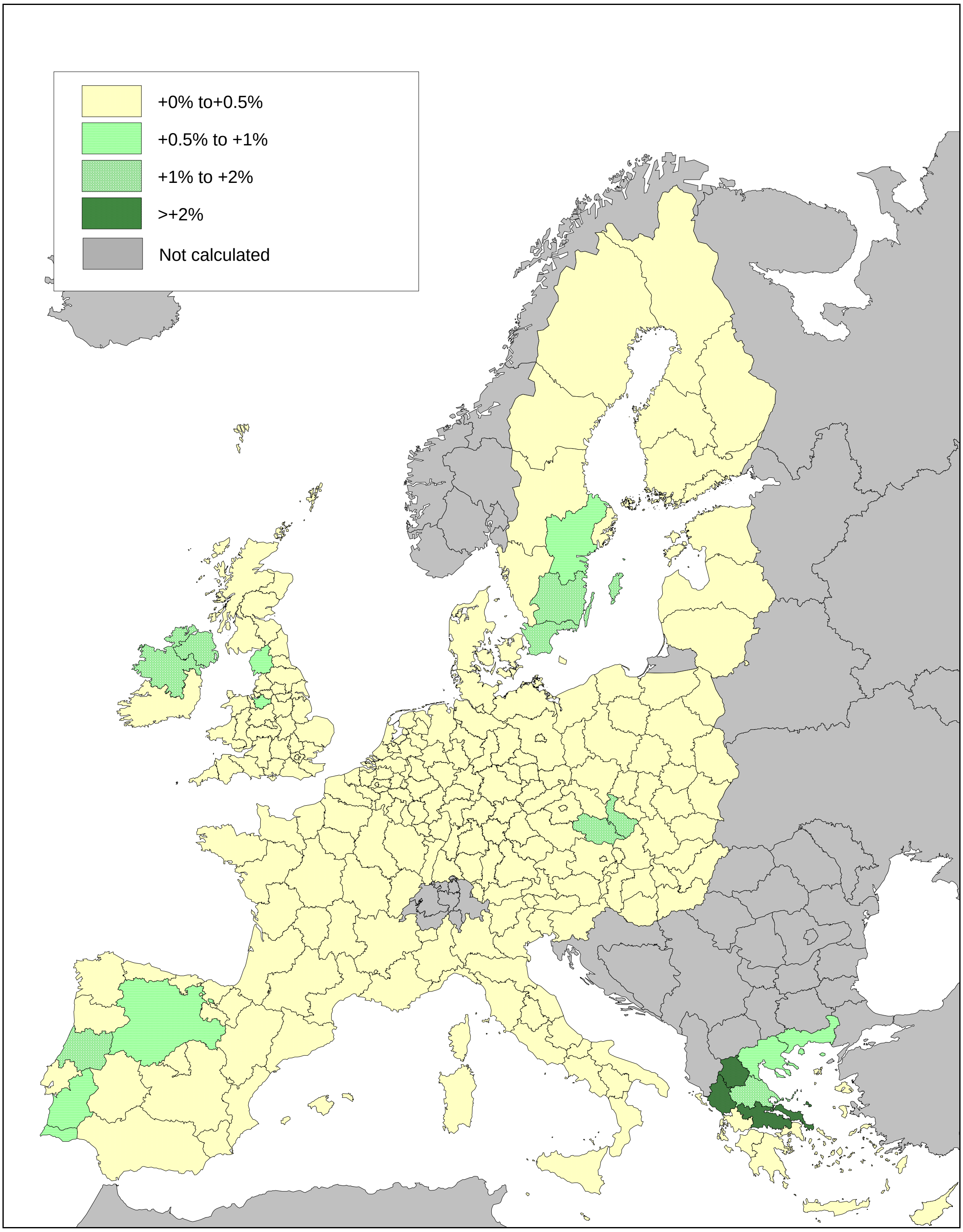
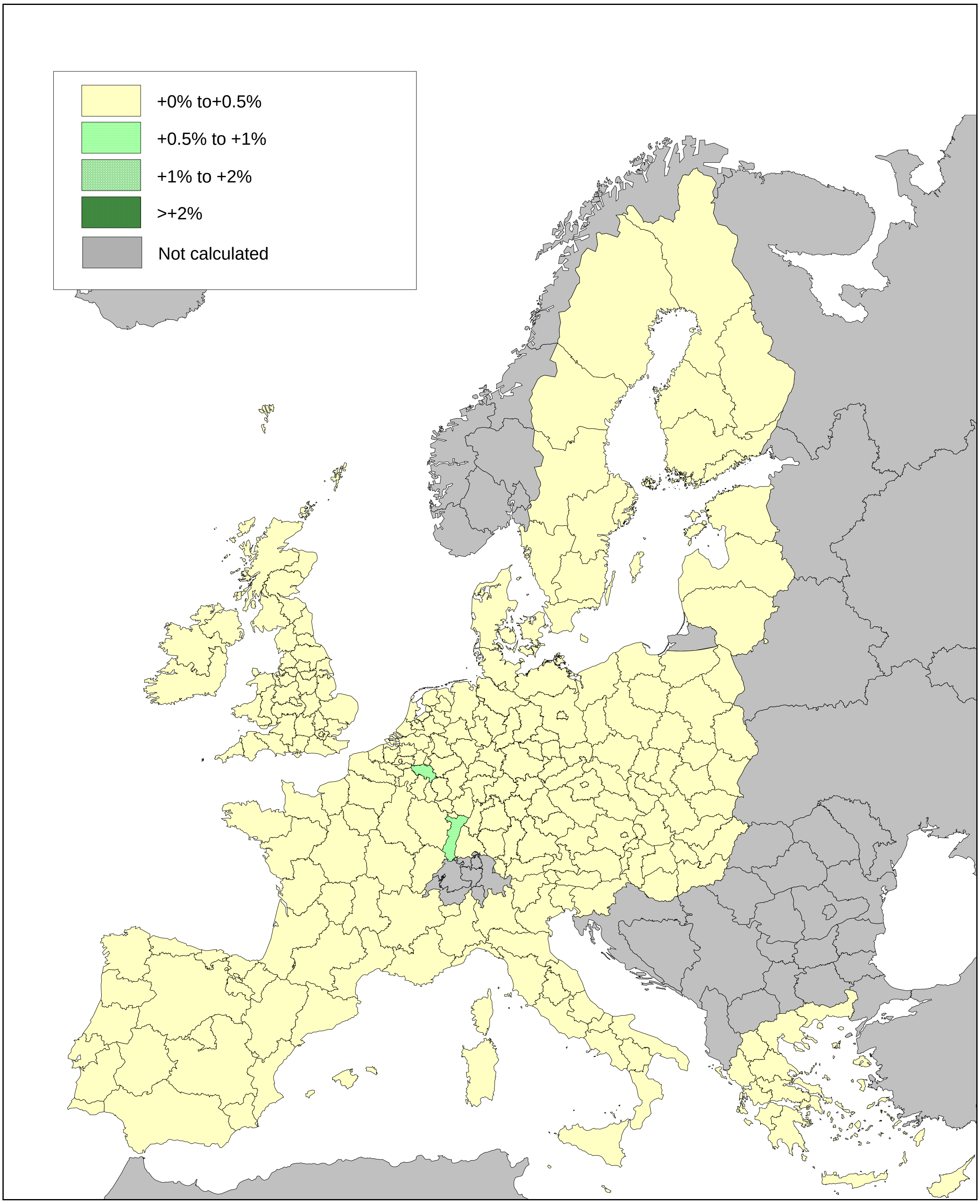


Figure 5.11. Change in employment due to inland waterways TENs projects only (operational phase) in 2015



5.3. The impacts of TENs investments on EU regions: the operational phase

Once a transport infrastructure is completed and becomes effective, there are additional effects on the regions other than the impacts due to the new construction investments. In order to assess the effect of the operational phase of TENs investments on the economy, the accessibility approach was used. As explained in chapter 2 (see paragraph 2.1.4), this approach introduces accessibility indicators into the regional production function, under the assumption that regions with better market access show higher levels of economic growth.
The initial elements for estimation were drawn from the ESPON database, the latter containing data on per capita GDP variations due to accessibility changes following the investments in TENs infrastructures. This data is the best starting point for the analysis because:

a) it is obtained from an established methodology and uses a sophisticated model (the SASI model, see paragraph 2.1.1);
b) it is computed for an infrastructure scenario similar to that herein analysed.

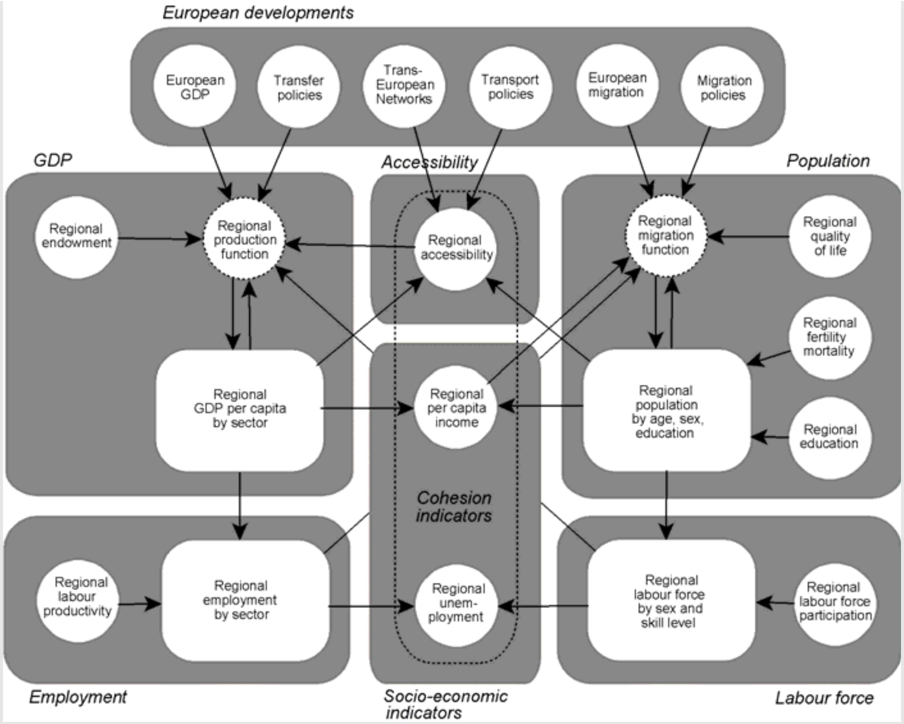
Nevertheless, as noted above, the economic indicator chosen for the analysis was the gross value added: instead, the use of the per capita GDP implies that we assume the population variation does not affect significantly the different regions and therefore per capita GDP variations is comparable to the GDP variations and, consequently, to the gross value added variations.

However, the ESPON data was used immediately, but only after additional processing, primarily with the aim of estimating the impacts of the operational phase of TENs investments at different time periods – 2015, 2030 – considering the investments timing. The procedure is explained below.

Figure 5.12. The SASI model

The **SASI model** is a recursive simulation model of the regional socio-economic development in Europe. This is subject to exogenous assumptions on the economic and demographic development of the European Union, transport infrastructure investments and transport system improvements, in particular the Trans-European Transport Networks. For each region, the model envisages the development of accessibility, per capita GDP and unemployment.

The SASI model includes six forecasting sub-models: *European Developments*, *Regional Accessibility*, *Regional GDP*, *Regional Employment*, *Regional Population* and *Regional Labour Force* (see figure below).



Regional accessibility indicators express the locational advantage of each region with respect to relevant destinations in that region and in other regions as a function of the travel time or travel cost (or both) needed to reach these destinations by strategic road, rail and air networks. The general travel costs consist of three elements, namely time, cost and barrier. As for the first element, time, rail and air timetable travel times and road travel times calculated from road-type specific travel speeds were converted into costs using a Europe-wide value of time. As to cost, mode-specific cost functions made available by the SCENES project were used. The barrier element consists of border waiting times (only for road traffic) and political and cultural barriers expressed as time penalties – all converted to costs, by using the same Europe-wide value of time. The political barriers are annually reduced to account for the effect of the European integration and, for the ten accession countries, the effect of their becoming members states of the European Union.

Gross Domestic Product (GDP) per capita is envisaged for six industrial sectors (agriculture, manufacturing, construction, transport and tourism, financial services and other services) generated in each region as a function of endowment indicators and accessibility. Endowment indicators measure the suitability or capacity of the region for economic activity: they include traditional location factors such as the availability of skilled labour and business services, capital stock (i.e. production facilities) and intraregional transport infrastructures, as well as 'soft' location factors such as the indicators describing the spatial organisation of the region, i.e. its settlement structure and internal transport system, institutions of higher education, cultural facilities and quality of life. In order to be independent from the size of the region, the regional production function used predicts annual regional per capita GDP.

The results of the regional per capita GDP forecasts are adjusted so that the total of all regional forecasts meets the exogenous forecast for economic development (GDP) of the European Union as a whole by the European Developments sub-model.

5.3.1. Methodology for the estimation of the effects of changed accessibility

The ESPON data refers to the per capita GDP changes in the NUTS3 regions as an effect of the economic impact of the accessibility changes produced by the TENs projects. Data is provided for different scenarios, each one reflecting an alternative level of the TENs networks completion. For this study, the scenario labelled as B2 in ESPON was used, where all TENs projects are supposed to be implemented in the reference year 2021.

As we tend to estimate the impact of TENs investments at different time thresholds, as for accessibility, we considered the completion year planned for each TENs project section in each NUTS2 region (see Chapter 1).

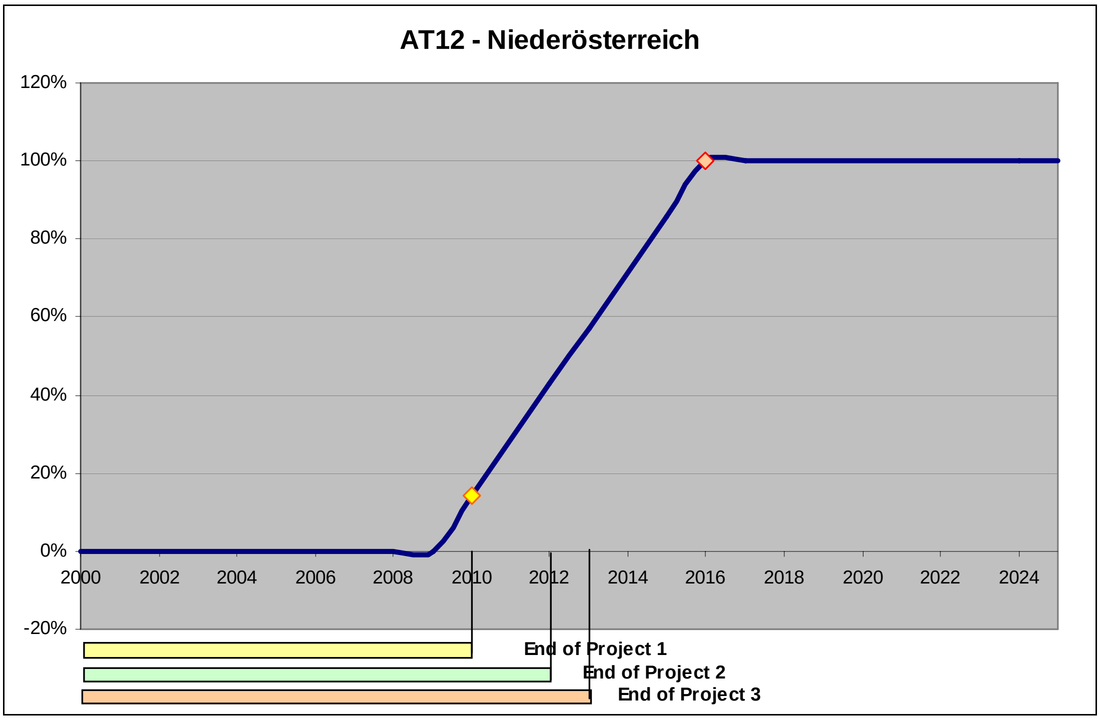
Obviously, before the completion of an infrastructure, its effect on accessibility, and therefore on the economy of the regions involved, is considered null. As a result, it was assumed that the effect on GDP reported in ESPON requires some years after the completion of the projects, because during the first years following the opening of a new infrastructure. a *ramp-up effect* usually occurs. This effect relates to the user's behaviour adaptation to the new transport alternative: initially, the number of users is generally lower than expected as they need time to become aware and make good use of the new integrated network. The analysis assumed for the ramp-up effect three years to exhaust. After that, the impact foreseen by SASI should be reached and retained until 2021.

As for those regions where different TENs project sections are planned -, each with a different expected completion year -, the analysis was slightly more complex. It can be assumed that each project section contributes to the accessibility change, so a growing impact was assumed to take place from the year of the first section completion. The overall impact, as foreseen in ESPON, was considered to be achieved in the third year after the last section completion.

Figure 5.13 provides an example of this case. It examines an Austrian region where three TENs sections are planned, each with a different year of completion: 2010, 2012 and 2013, respectively. The investments impact on the economy will start in 2010 (completion year of the first section) and will grow until 2016, i.e. three years after the completion of the third section.

In ESPON the accessibility impact on regional economies is also estimated for those regions where no project is carried out directly. Actually, one region without new major transport facilities can benefit from infrastructures built in neighbouring regions or, on the contrary, its economy can be dampened down as other regions, where new infrastructures are created, become more competitive. For these regions, the ramp-up mechanism was applied starting from the completion of the first national project until three years after the completion of the last national project.

Figure 5.13. Example of ramp-up for a region with three planned projects



The ESPON data provides information at the NUTS3 level, while the analysis, in this case, is conducted for the NUTS2 regions. The aggregation was carried out by applying a weighted average of the NUTS3 data and using as a weight the absolute value of per capita GDP for each NUTS3 region in 1999 (drawn again from the ESPON database).

ESPON fails to provide the results of the TENs investments impact on employment; thus, an alternative estimation was made for this purpose.

The accessibility effect on employment was evaluated by analysing the impacts of the construction phase on value added and employment on a regional scale. The estimation was based on the assumption that a change in employment can be observed for a given variation in value added, and such change is not up to the reasons for inclusion of the value added.

According to that, the ratio between the value added variation and that of employment was calculated for each region, in accordance with the results of the analysis of the investments impacts (see paragraph 5.2). Obviously, the ratio between the employment and value added variations vary for each region, according to its socio-economic structure.

The effect on employment due to accessibility was therefore estimated by applying the ratios computed above to the variation in per capita GDP[11] derived from ESPON.

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[11] As indicated in previous paragraphs, GDP and value added are the same entity in national accounts. Impacts on per capita GDP can therefore be interpreted as value added impacts. Furthermore, relative effects on GDP (valued added) and per capita GDP (value added) are equal provided that the reference population is the same as in the circumstances examined in this study.

5.3.2. Estimated effects of changed accessibility until 2030

Before presenting and discussing the estimated regional effects of the operational phase of TENs networks, it is worth noticing the significant difference with respect to the building phase impacts. As noted above, the building phase of transport infrastructures has mainly a local impact and it is strictly related to the amount of investments set aside for the region of interest. On the contrary, during the operational phase, the resulting accessibility changes can influence not only the regions where new infrastructures are built, but also neighbouring areas. In fact, accessibility concerns the relationships between regions, and many zones are crossing points to connect different regions so that, for instance, increased accessibility in a specific zone can be an advantage for all the regions whose goods transit through that zone.

The remark above can help to interpret the results provided in the following figures, showing the changes in value added and employment in the NUTS2 regions estimated for 2015 and 2030 according to the ESPON data processed as explained above. The effects on the two indicators are quite similar, as expected under the methodology applied.

In 2015 (see Figures 5.14 and 5.15), the effect of relative accessibility changes is relevant in several regions. A negative effect can be found in the peripheral regions: this is the case of Ireland, Southern Italy, Finland and Sweden. Spain and Portugal seem to have a similar behaviour, although these regions are involved in various TENs projects. Probably, in this case, the competitiveness of other regions more than offset the positive effect in terms of higher accessibility produced by the implementation of new TENs infrastructures.

On the other hand, Central Europe and, even more so, Eastern Europe show a significant increase in value added and employment in comparison to the case of no TENs. This is probably due to the current shortage of networks, so that even the implementation of a few projects can considerably increase the accessibility of these regions.

In 2030 the expected effects will not be so different from 2015 (see figure 5.16 and 5.17). As a matter of fact, the majority of the TENs projects will be virtually completed in 2015; therefore, the regions will continue recording the same trend found in previous years, increasing the positive effect on value added in Central Europe and, even more so, in Eastern Europe where the impact of the operational phase of the TENs projects shows an increase of up to 3%. When comparing the 2015 and 2030 results, a value added drop can be noticed, compared to the non-TENs scenario in the Paris region (Ile de France) while a decrease is not foreseeable across the other French regions. The reason for this result could be that the increased accessibility of neighbouring regions allows economic growth to be distributed across a wider region and the central function of the Paris zone tends to fade.

It is quite clear that the employment result directly from the value added impacts, even if the extent of the changes is smooth as a given variation in GDP does not generally give rise to a change in employment of the same size.

Figure 5.14. Change in value added due to TENs projects (operational phase) in 2015

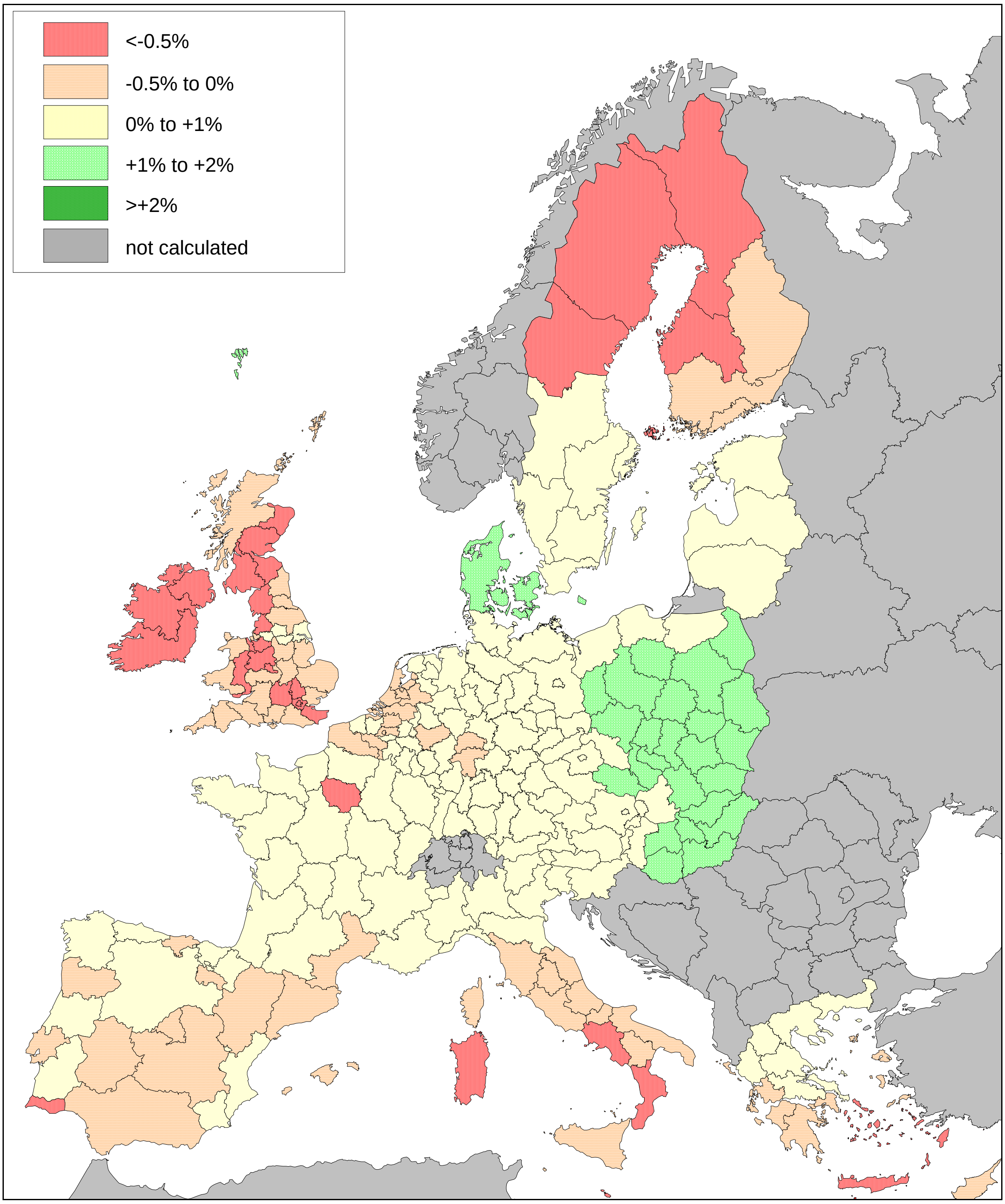


Figure 5.15. Change in employment due to TENs projects (operational phase) in 2015

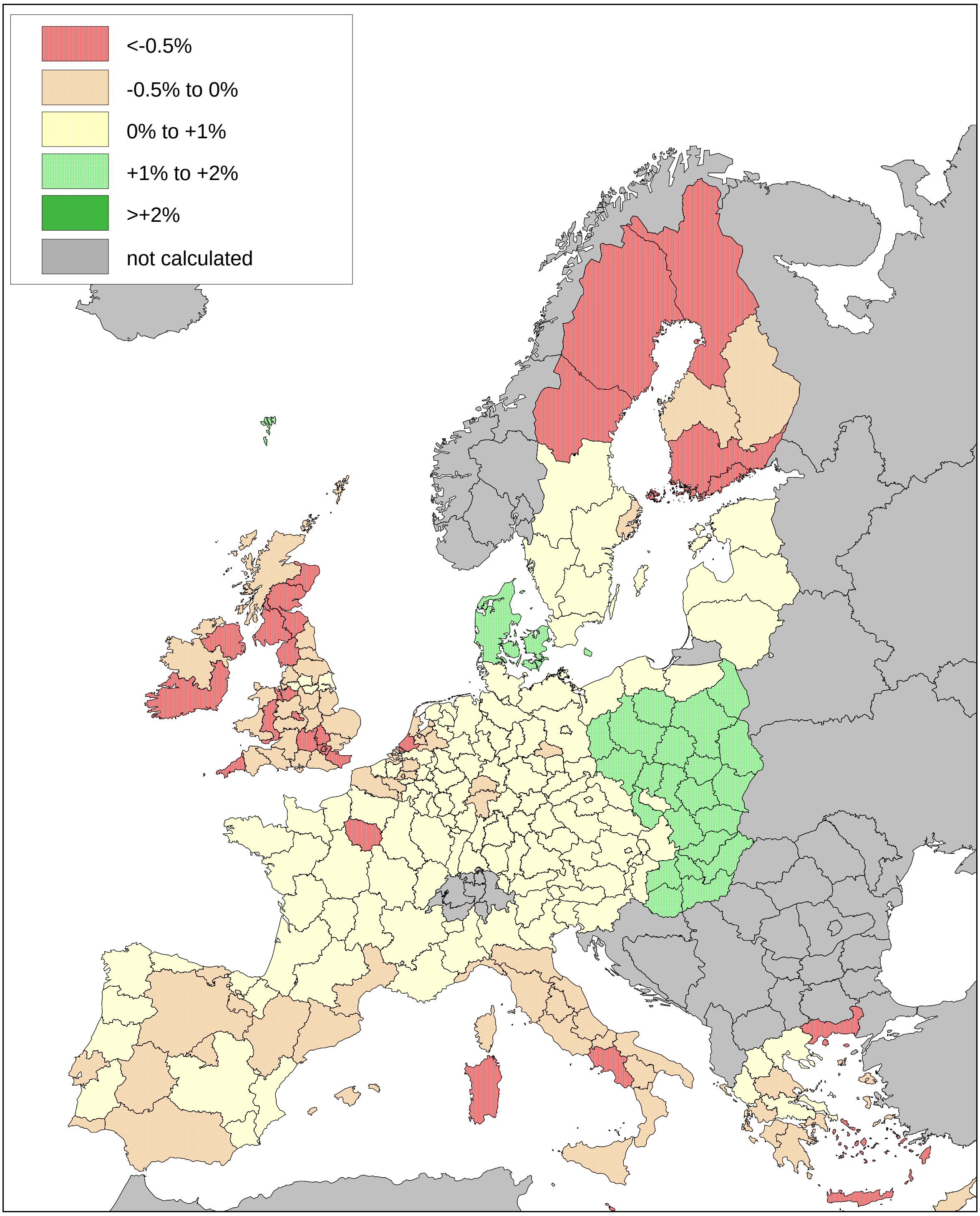


Figure 5.16. Change in value added due to TENs projects (operational phase) in 2030

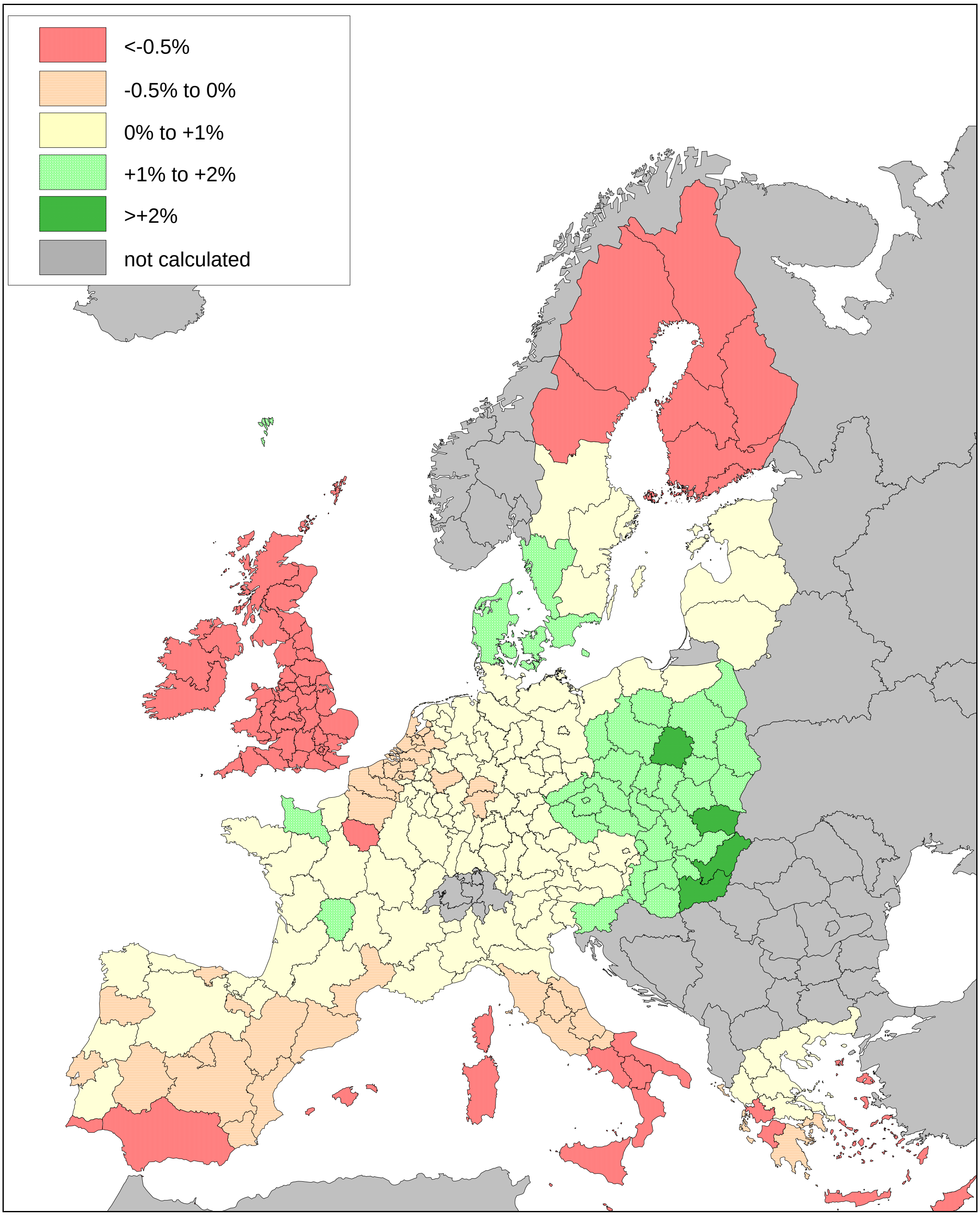
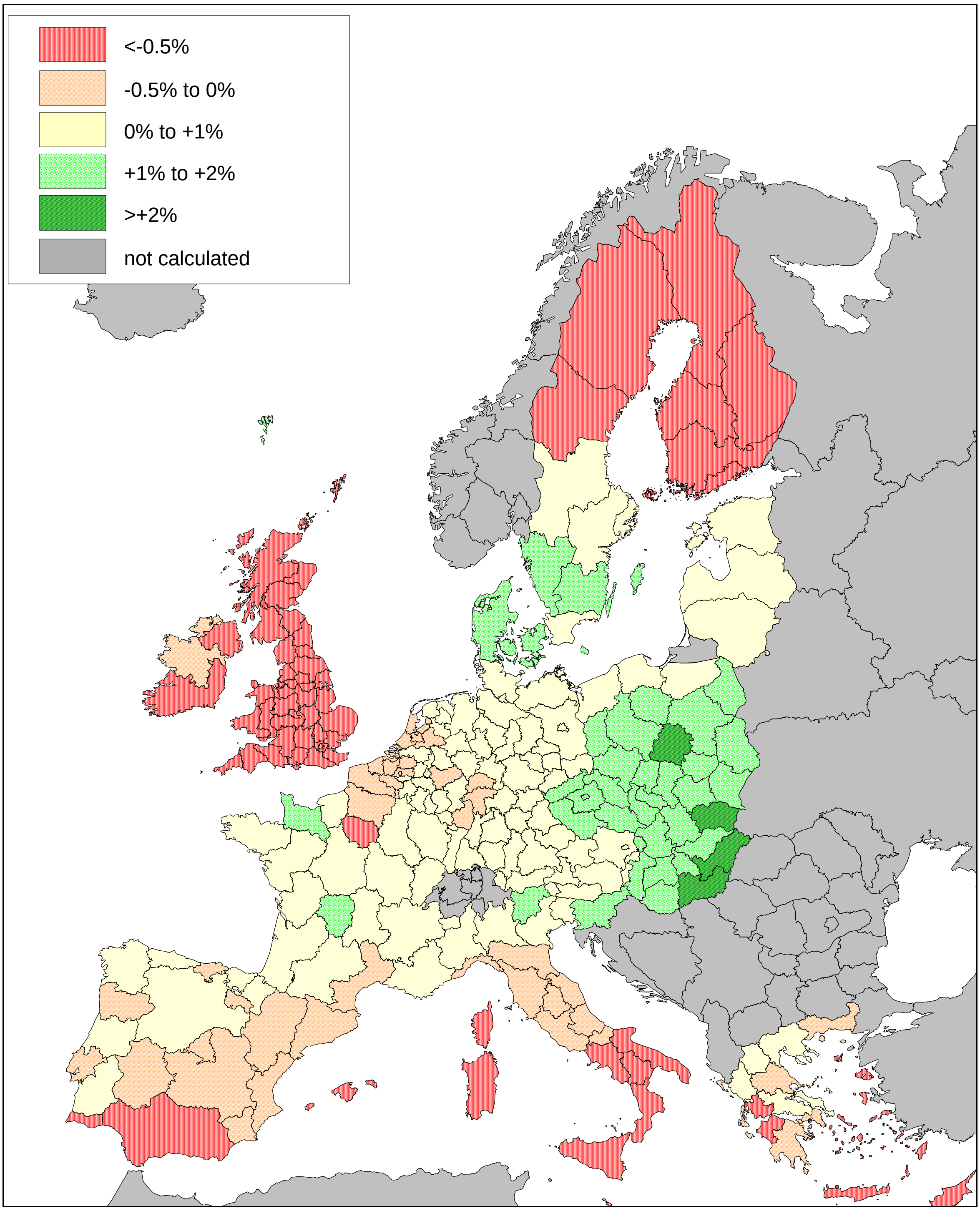


Figure 5.17. Change in employment due to TENs projects (operational phase) in 2030



5.4. The combined economic effect of the building and operating phase of infrastructure

The specific effects of the building and operational phases of the TENs projects were separately handled in previous paragraphs. In this paragraph, instead, the combined effect will be analysed by integrating the results obtained with the previous procedures.

The combined effect was estimated, assuming that the two effects - building and operational phases - are additive. The employment and value added variations estimated independently of the two elements, reflect different economic impacts that, to a certain extent, could interact with each other. However, the change drivers, in the two different aspects of the analysis, are sufficiently different that the simplifying assumption of linear additivity can be readily accepted.

The following figures show the combined impact of TENs networks on value added and employment in EU25 NUTS2 regions. The effects on the two variables are mostly similar and, therefore, are discussed jointly.

In 2015, the building phase and the operational phase effects will be more significant, as explained in the paragraphs above. The size of the combination of the two effects depends on the relative strength of the two in each region. For instance, the positive impact on the regions of Eastern European countries and Denmark as well as the slight reduction foreseen in Southern Italy, in the United Kingdom and in Sweden are mainly due to relative accessibility changes. Instead, the high values found in different regions of Spain, Northern Italy, France, Greece, Germany and the Czech Republic are linked to the construction phase of the investments planned in these countries.

In 2030, the contribution to accessibility change will be the most important determinant of the combined effects on regional economies because, as explained above, the economic effect of the construction phase is reduced once the investment is terminated. The regions still showing a positive impact lie across Eastern Europe, Denmark, Greece, Southern Sweden, France and Italy; all these regions are significantly influenced by the operational phase of the projects. The negative effect observed in Southern Italy, Spain, Finland, the United Kingdom and Northern Sweden is related to the accessibility changes too; yet it is slightly smoothed because of the compensation of the building phase.

Figure 5.18. Change in value added due to TENs projects (overall effect) in 2015

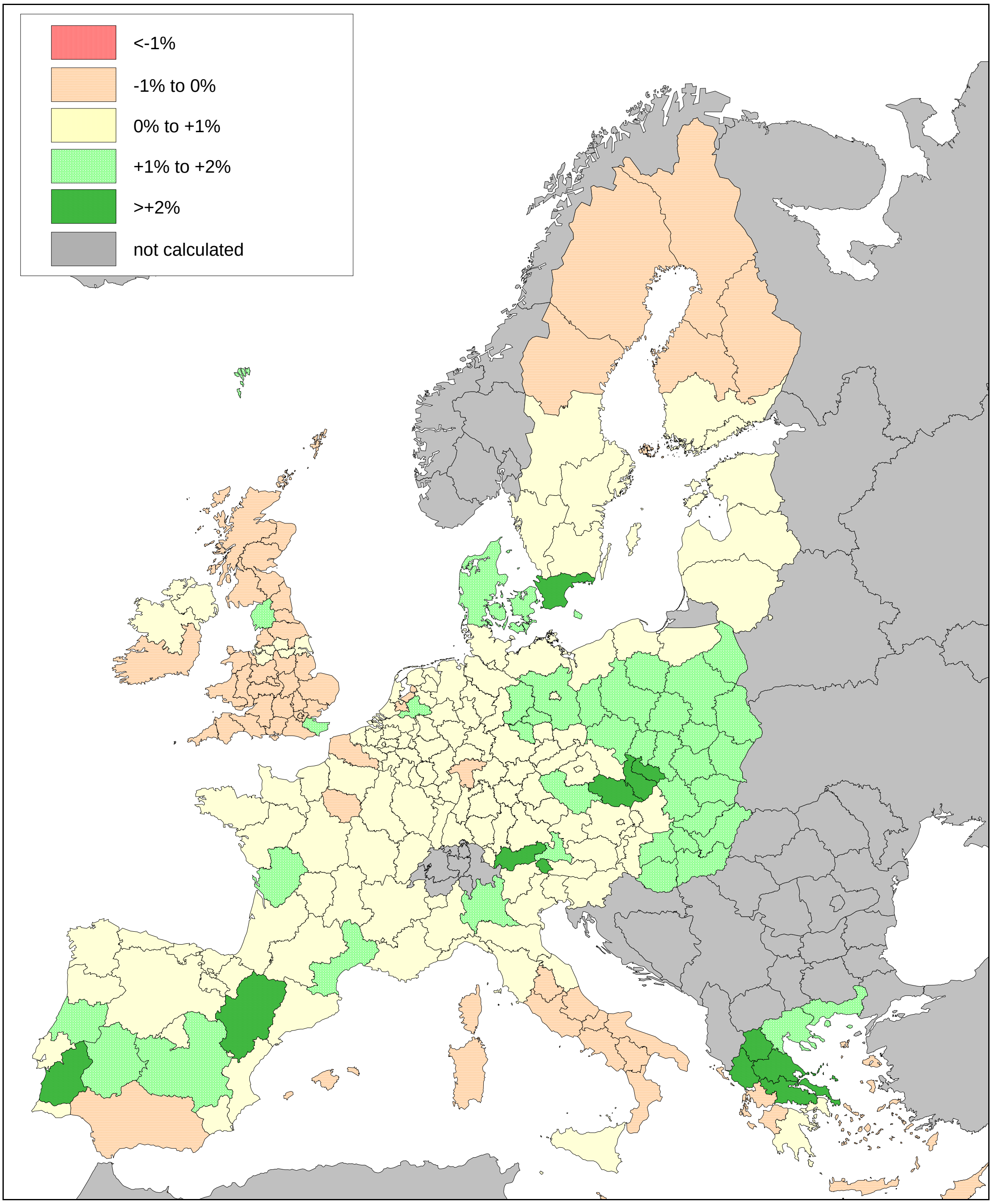


Figure 5.19. Change in employment due to TENs projects (overall effect) in 2015

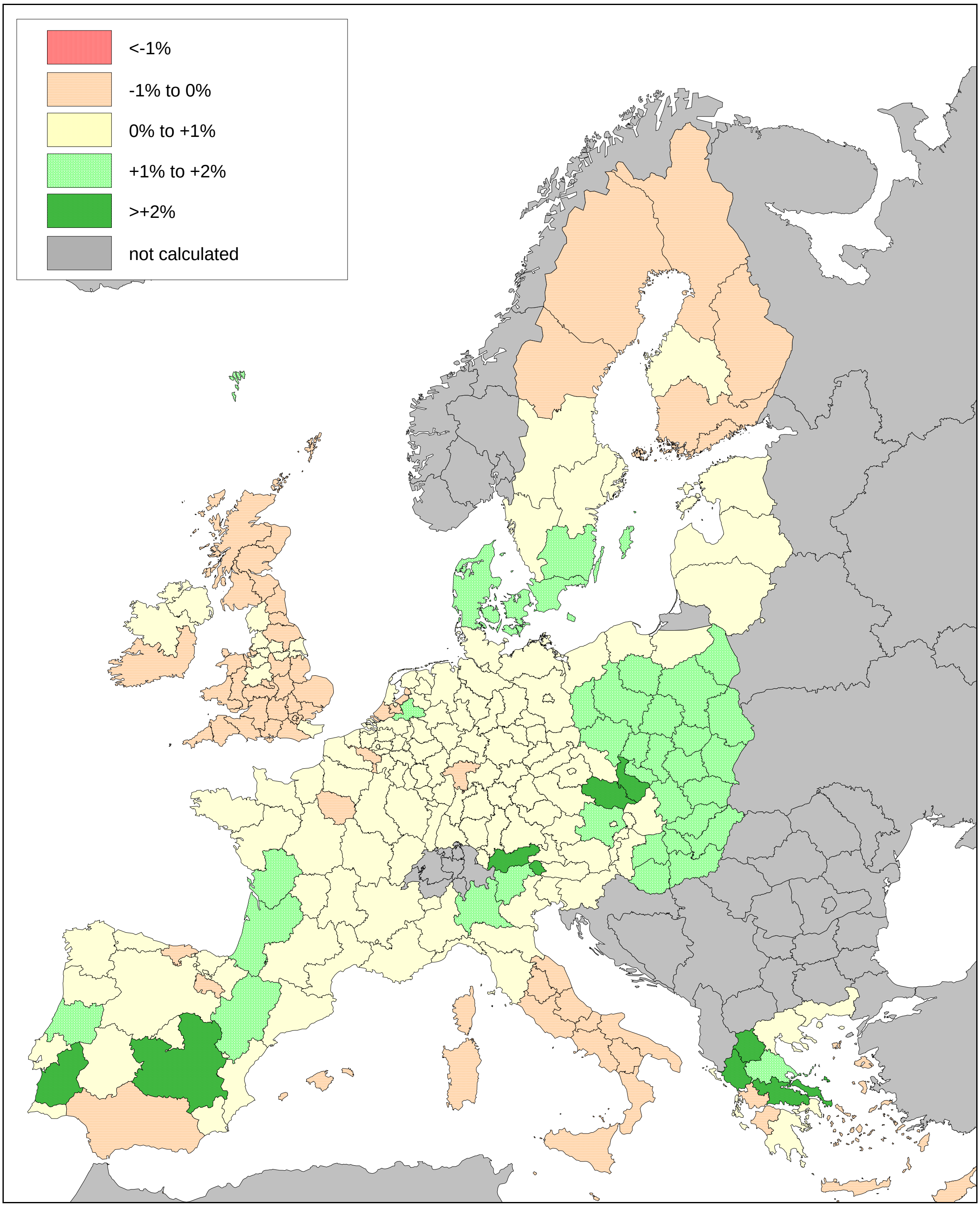


Figure 5.20. Change in value added due to TENs projects (overall effect) in 2030

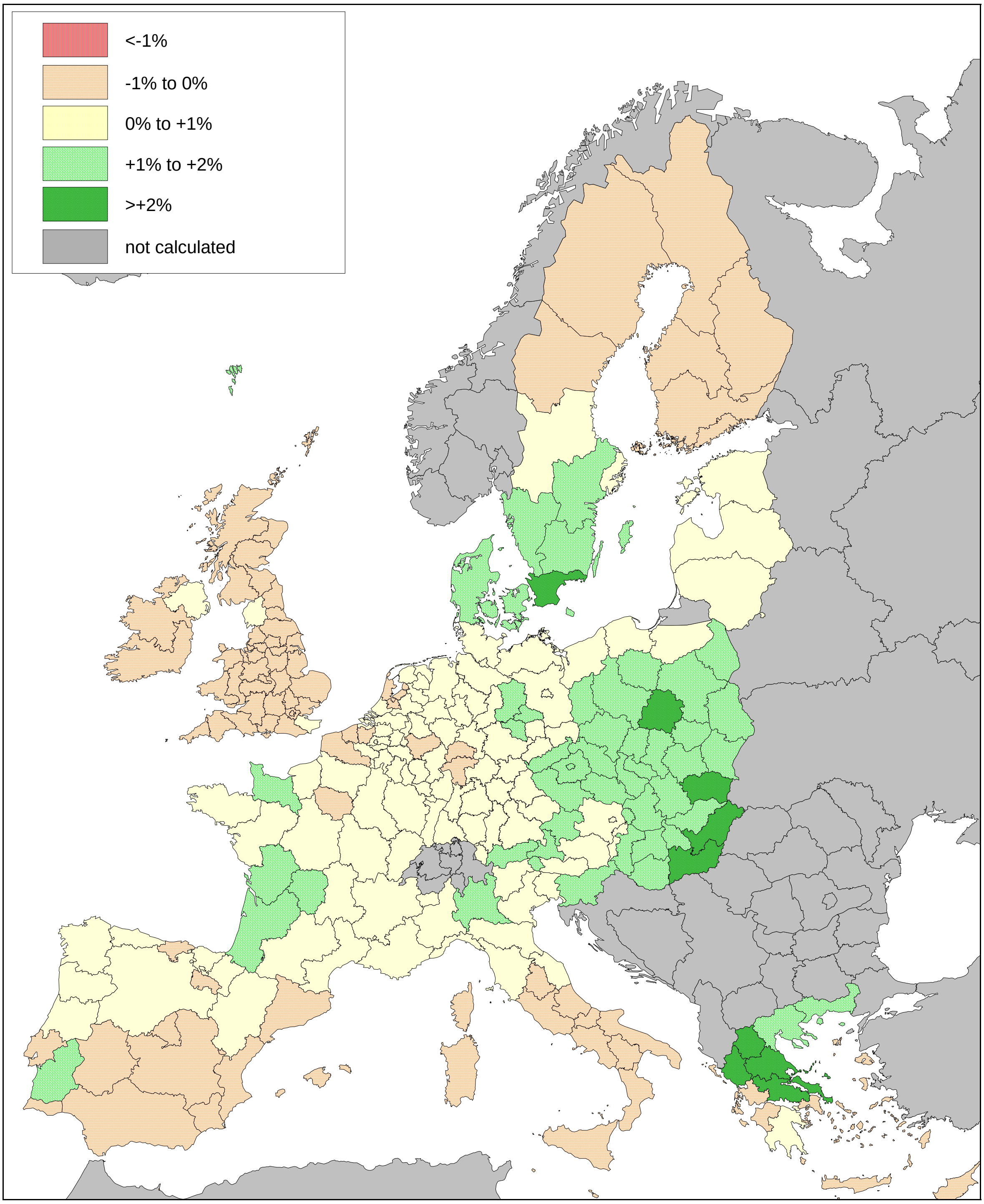
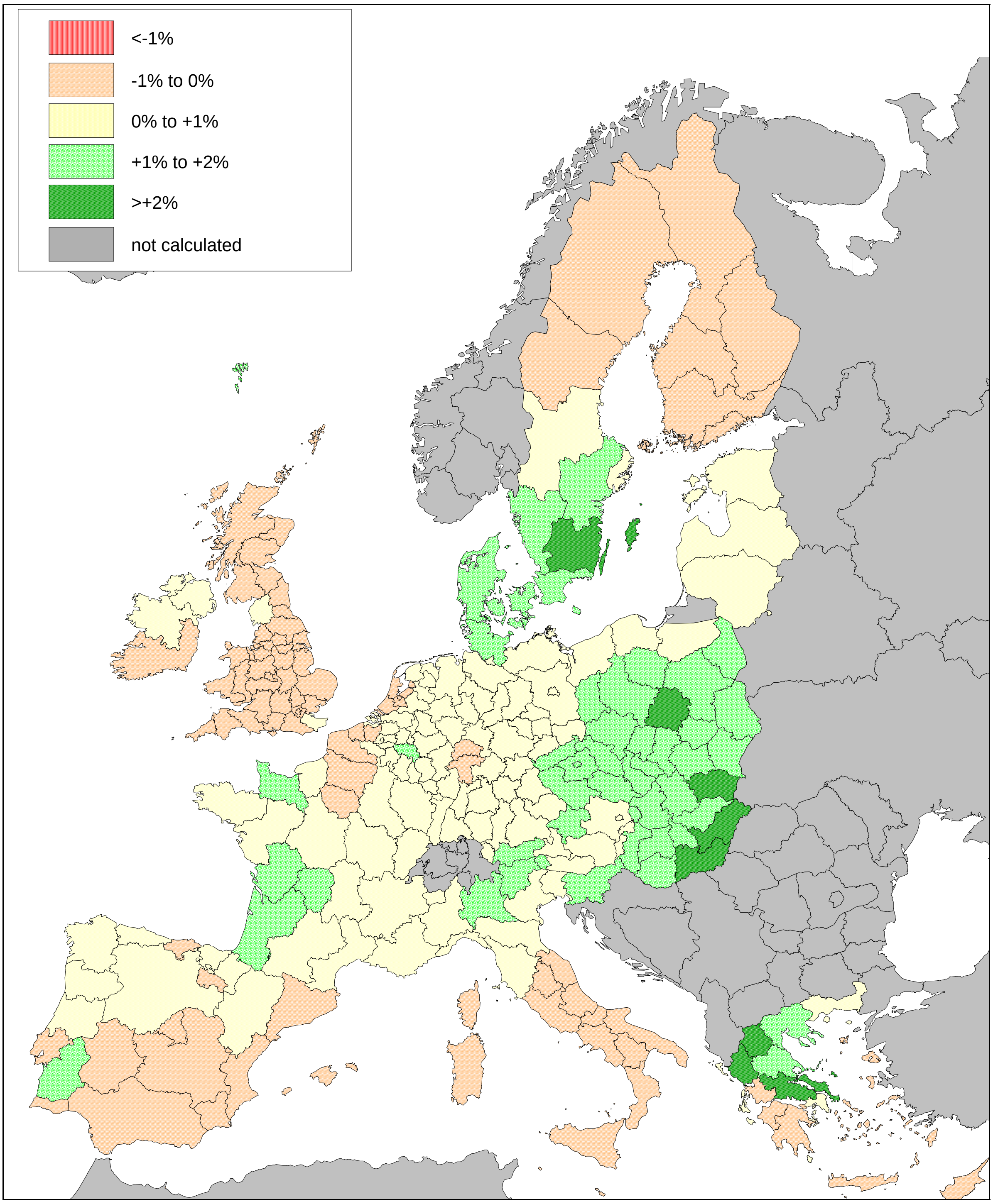


Figure 5.21. Change in employment due to TENs projects (overall effect) in 2030



5.5. Effects on tendency to internal migration

By linking the regional employment variations (including both investment and accessibility impacts) with the labour market and the population structure indicators, the effects of the TENs investments on the tendency to emigration or immigration across the EU regions can be estimated for the two time horizons (2015 and 2030).

Assuming that the whole demographic effect at EU25 level is neutral, and relating the global employment effects generated by TENs investments to the regional structural features (unemployment and ageing index), it is possible to calculate whether a region shows a higher tendency to emigrate or immigrate compared to the EU NUTS2 average. In fact, a region with an expected employment increase due to TENs projects and characterised by a lower unemployment rate and a relatively older population structure (high ageing index) than the EU25 benchmark, will probably attract population from areas with opposite structural indicators and trends. Furthermore, as far as regional structural features are concerned, it is also important to consider the dynamic process provided by the forecast for the population growth in 2015 and 2030. The latter, when used as a coefficient, can stress or soften the ageing population effect.

The final regional effect was then rated as “immigration”, “neutral” or “emigration” compared to the EU25 average (calculated as the average of all the region’s final effects). It should be stressed that the final regional effects estimated show the regional tendency to immigrate and emigrate as against a hypothetical no-TENs scenario. Therefore, the results should not be considered as forecasts of absolute migratory flows, but only as potential additional flows with respect to the existing ones. The results of the analysis are listed in figures 5.22 and 5.23 below.

In general, for both time horizons (2015 and 2030), the following main elements emerge:

- some peripheral regions show a tendency to emigrate towards the more central areas of the countries;
- a neutral effect of the investments in many of the New Member States.

In particular, in 2015, the regions estimated to undergo an emigration process are situated mainly in South and North Europe: Southern Spain and Southern Italy, some Greek islands, Finland, Northern Sweden and Scotland, along with some other English and Belgian regions. In 2030 the situation is similar, with additional regions in Portugal (Lisbon), England and France.

On the other hand, a significant tendency to attract population is recorded in continental Greece, in Central and Northern Italy and Spain, Austria, many German areas, Southern Sweden, together with some regions in Hungary, the Czech Republic and Portugal. In 2030 there is a potential immigration flow in some areas in the Central and Western part of France.
This scenario is quite consistent with the analysis described by the estimation of the total variation in employment, generated by the sum of the TENs investments and the accessibility impacts. In fact, the regions with negative employment variations in 2015 and 2030 show a higher tendency to emigrate compared to the EU average, and lie mainly across the peripheral areas of Europe. Unlike most of the regions with an expected relevant employment increase, the New Member States seem not to be affected by immigration flows. This is probably because they have a relatively younger population structure, higher unemployment rates and the distribution of economic effects due to TENs projects is quite homogeneous within the countries.

In general, the TENs projects seem to contribute to accessibility and growth, thus helping the most central regions, which are in a relatively good position. The quantity and quality of a region's infrastructure endowment, as well as the distance to population and/or economic centres, play an important role in exploiting the territorial potential; the impact, however, can be ambiguous. On the one hand, a new transport link can create new opportunities: for example it makes it easier for producers in peripheral regions to market their products in large conglomerations. On the other hand, it may also expose regional monopolies to the competition of more advanced producers from core regions.

Moreover, the results show that the economic impacts are stronger in the regions adjacent to the projects, which probably become more competitive. Changes should be expected in the relative competitive positions of regions and can prevail over the positive effect of greater accessibility in peripheral regions. Therefore a transport infrastructure in one region can draw industrial production and production factors (employment and people, in this case) away from other regions with weaker competitive positions.

This aspect is worth analysing in detail and could imply a series of additional socio-economic measures and secondary networks in order to spread the benefits of European infrastructure investments and to support a better balanced development on a national and regional scale.

Figure 5.22. Demographic effects due to TENs projects (overall effect) in 2015

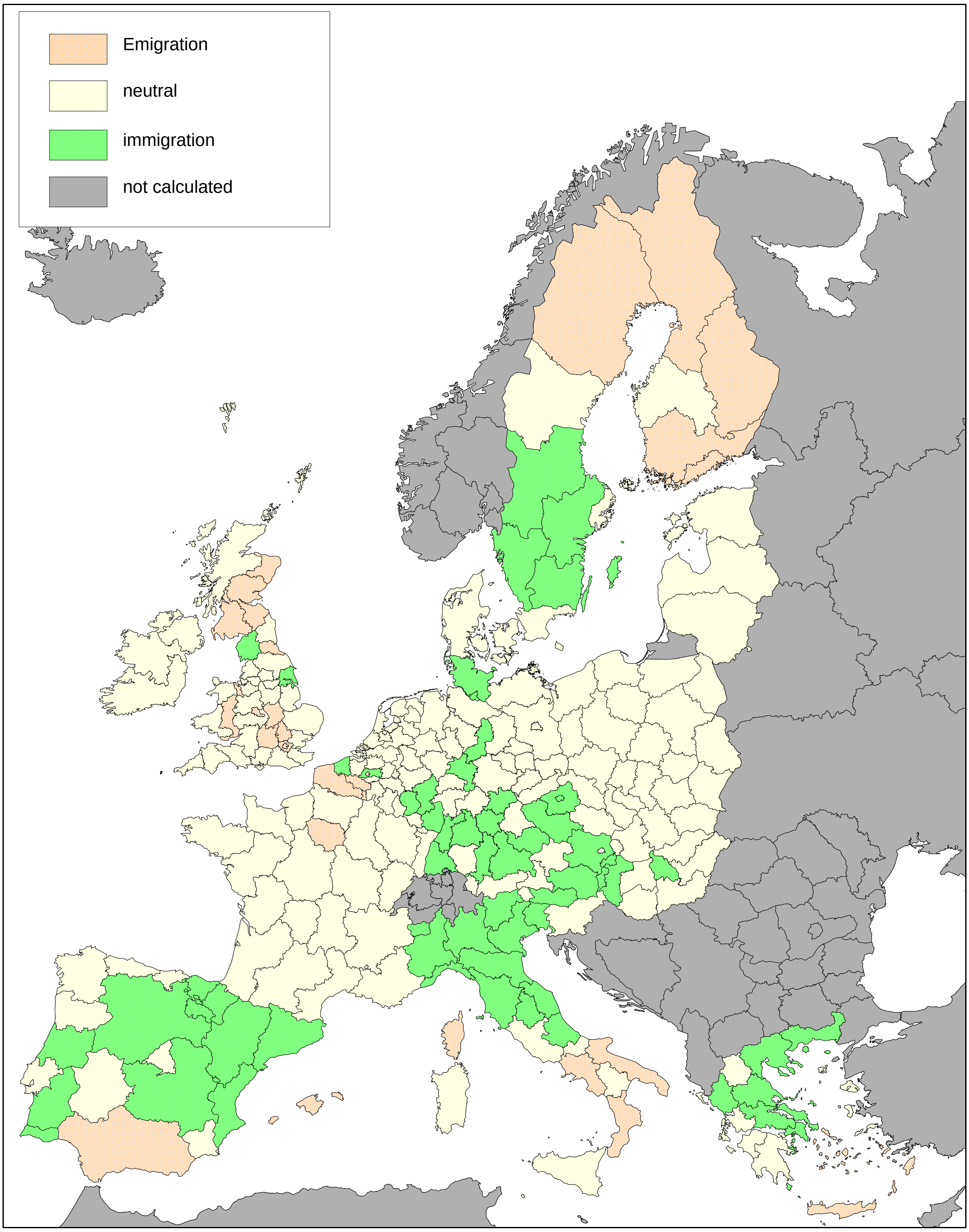
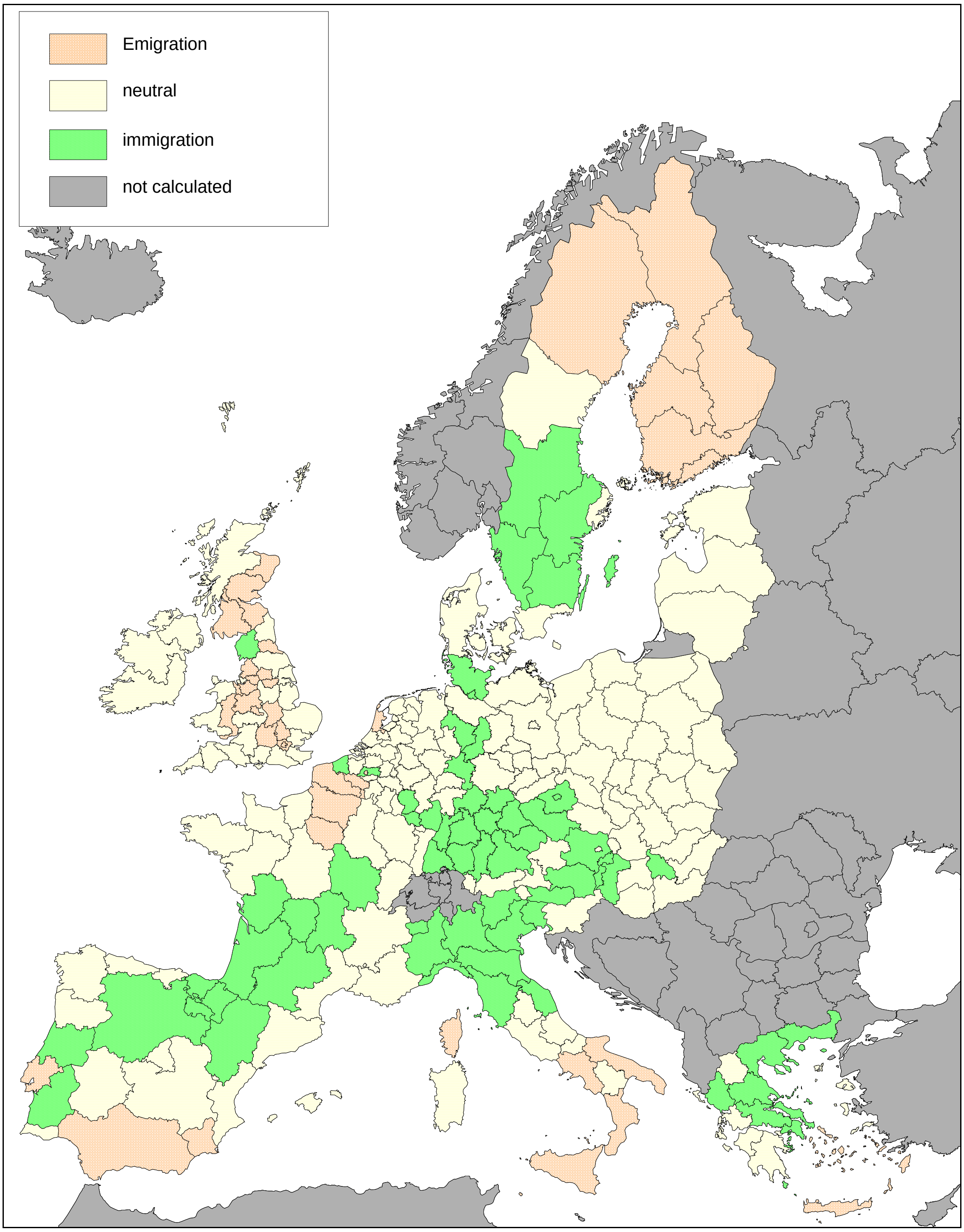


Figure 5.23. Demographic effects due to TENs projects (overall effect) in 2030



5.6. Impacts on different area types and on cohesion

5.6.1. Impacts on urban and rural areas

Rural areas and urban-rural relationships are key features for territorial cohesion, in particular at regional level.
ESPON provides a wide European classification of rural and urban areas at NUTS3 level(12). This classification is based on two main magnitudes reflecting the inter-dependence of rural and urban areas:

- the degree of urban influence is defined according to the population density and a European ranking of the urban centres based on their functional importance;
- the degree of human interventions as defined by the actual land use, i.e. the relative share of artificial surface and agricultural land in a region.

The classification includes 6 categories resulting from the matching of these two indicators(13).
According to ESPON data, the European regions with low urban influence and medium and low human intervention account for 53% of the total territory, including 20% of the total population and 16% of the total GDP. At the European level, urban areas with predominantly high population densities concentrate along a corridor running from Northern England through the Benelux countries and Western Germany to Northern Italy and partly along the Italian coasts. A second East-West corridor stretches through South-East Germany, along Southern Poland and the Northern areas of the Czech Republic into Hungary.
Starting from the ESPON classification, the previous results on the TENs projects effects during the construction and operational phases can be discussed in relation to the rural/urban typology of the affected regions.
We assessed the average employment variation and added value as a result of investment and accessibility impacts for 3 classes of European regions, drawn from the aggregation of the six ESPON categories at NUTS2 level(14) and characterised by (see figure 5.24):

- high urban influence and high human intervention or high urban influence and medium human intervention (urban regions);
- high urban influence and low human intervention or low urban influence and high human intervention (intermediate regions);
- low urban influence and medium human intervention or low urban influence and low human intervention (rural regions).

As regards the expected impacts of TENs investments in the construction phase (see figures 5.25 and 5.26), the expected variation in added value and employment in 2015 and 2030 is lower for the regions characterised by high urban influence or high human intervention, while it is more evident in rural areas, such as for example Alentejo in Portugal, Dytiki Makedonia in Greece or Aragòn and Castilla-La Mancha in Spain.

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(12) ESPON database, category “Land Use”, variable “Urban-Rural Typology”.

(13) The six ESPON categories are: (1) high urban influence and high human intervention, (2) high urban influence and medium human intervention, (3) high urban influence and low human intervention, (4) low urban influence and high human intervention, (5) low urban influence and medium human intervention, (6) low urban influence and low human intervention.

(14) We calculated the value for every NUTS2 region as the average value of its NUTS3 regions and then classified it according the following aggregation of the ESPON 6 classes: urban regions (classes 1 and 2), intermediate regions (classes 3 and 4), rural regions (classes 5 and 6).

This is due to the fact that the regions falling into the third category relate to the areas with higher TENs spending as a ratio of regional GDP. As observed in paragraph 5.2.2, the construction phase of transport investments has mainly a local impact because of the multiplier effect on the regional economy and it is strictly related to the relative amount of resources committed to the region of interest.

On the contrary, during the operational phase, the resulting changes of accessibility can not only affect the areas requiring the intervention, but also its neighbouring regions.

This may be the reason why, in the operational phase, a stronger effect on employment and added values occurs, on average, in the intermediate regions and not, as in the construction phase, in the rural regions (see figures 5.27 and 5.28). In fact, in this category, the presence of some peripheral regions may lower the overall average positive effect on the economies because of the changes in the relative competitive positions of the neighbouring regions.

The urban regions are, on average, the areas with lower TENs spending as a ratio of regional GDP and, as a consequence, with a minor economic impact in both the construction and operational phases.

Since the rural/urban patterns are consistent with core/periphery structure of regions and the relative incidence of TEN spending on GDP, this analysis confirms the previous overall results on impact of TENs.

Figure 5.24. Urban – rural classification of NUTS2 regions

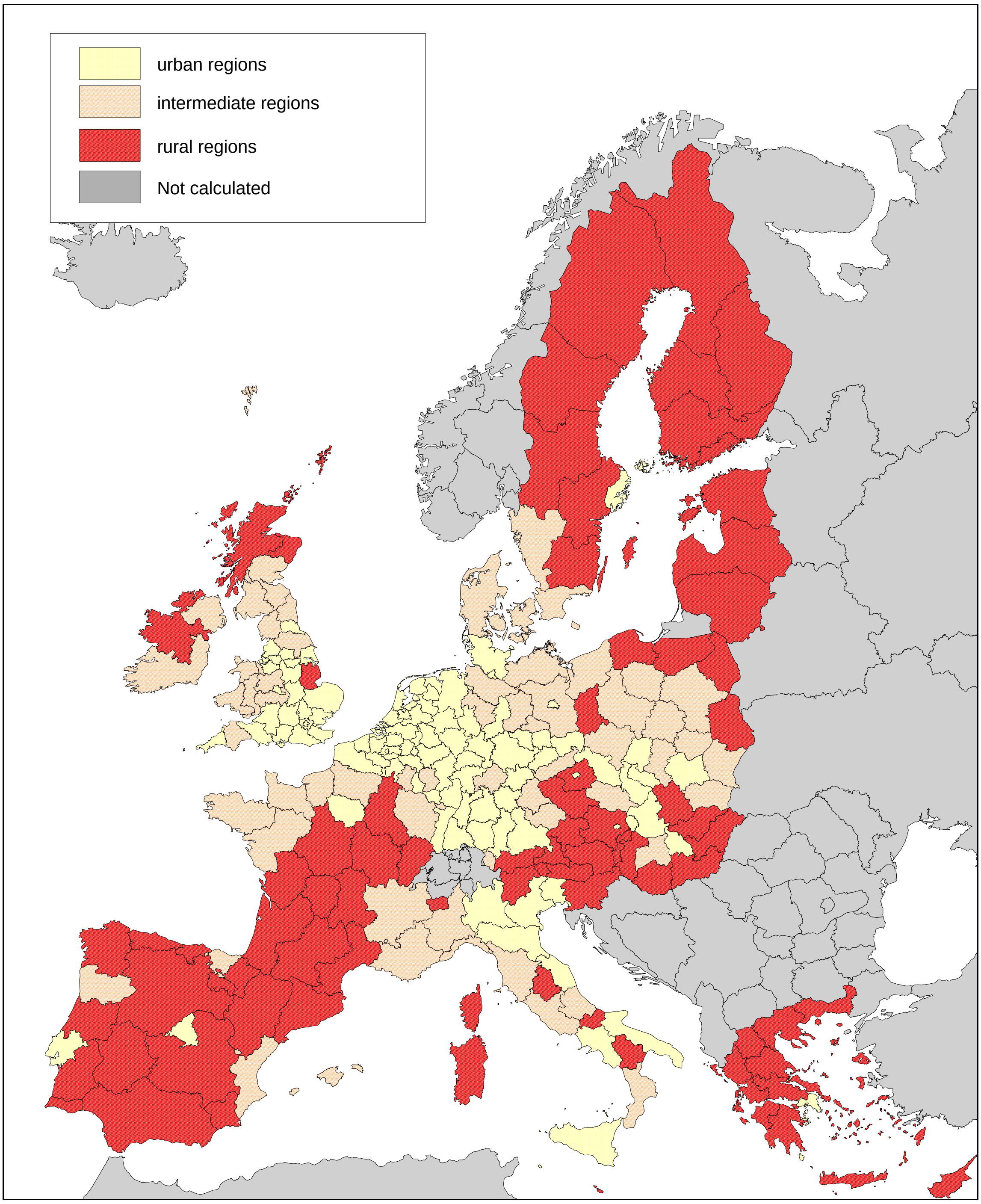


Figure 5.25. Construction phase: average change in added value and employment for the three urban/rural typologies. (100 = scenario without TENs)

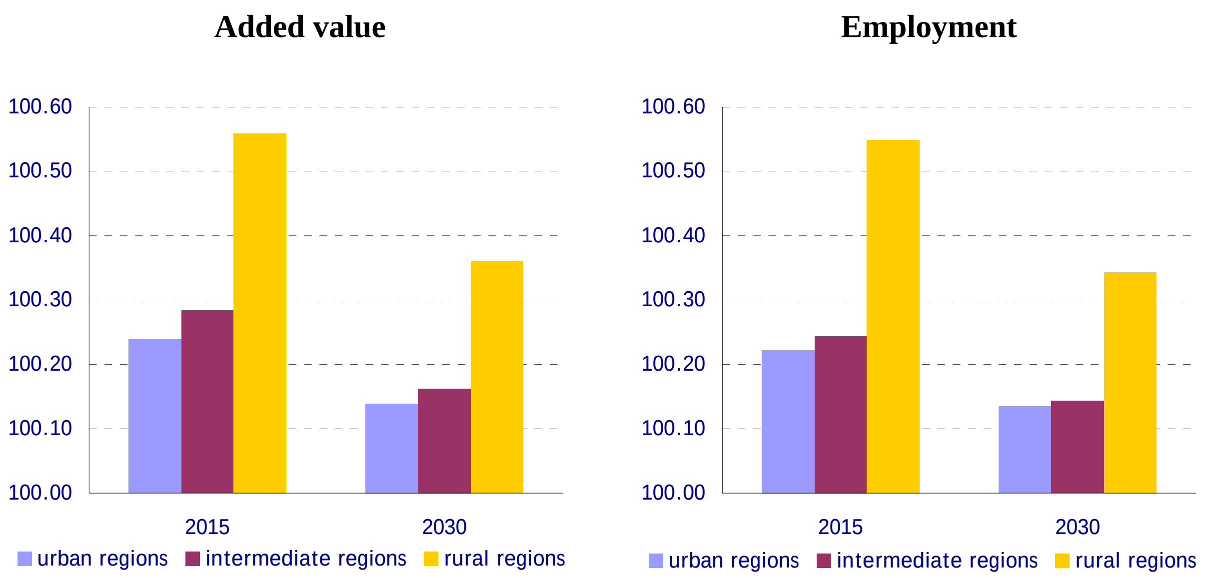
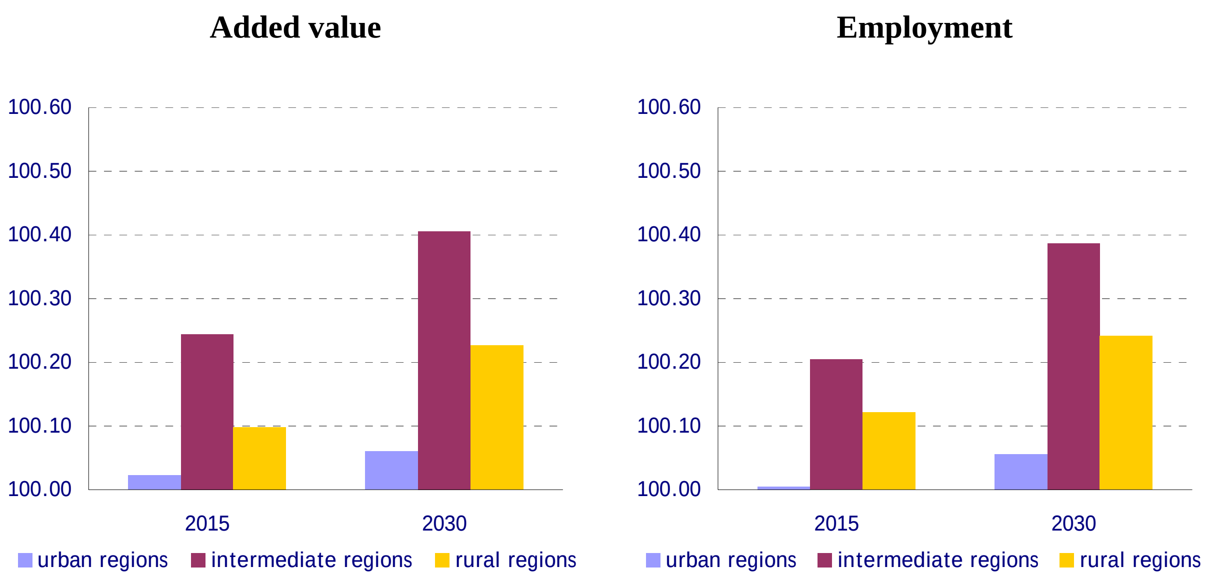


Figure 5.26. Operational phase: average change in added value and employment for the three urban/rural typologies. (100 = scenario without TENs)



5.6.2. Effects on cohesion

The analysis of the economic effects of the TENs forecasted leads to some observations on the consequent level of cohesion among the EU regions. A simple indicator of the cohesion level development due to the implementation of the TENs networks can be computed by comparing the direction and the extent of the economic effects on the regions whose economic performance is currently below and above the average of the EU25. In other words, if the regions currently under performance are the most positively affected by the TENs investments, then the level of cohesion among the EU regions is improved. Otherwise, the level of cohesion remains unchanged or is even reduced.

Such indicator assumes the 48.4% value in 2015 and the 50.0% value in 2030. Figures 5.27 and 5.18 show the regions being expected to converge towards the EU average and those expected to diverge. The simple indicator computed suggests that the investments in the TENs networks do not give rise to a large additional effects in terms of cohesion within the EU25 even if in 2015 the effect is more significant than in 2030, thus proving that the full impact of the new infrastructure is positive if compared to a partial implementation.

The reason for this result is mainly explained by the impacts of the operational phase of TENs, i.e. the induced changes in the relative accessibility levels. Indeed, the regions of the central part of EU25 (France, Benelux, Germany), which are already among the most developed EU regions, are generally favoured by the TENs networks while, at the same time, some peripheral areas in Finland, Sweden and Italy gain no real advantage from the implementation of TENs networks and most of them are currently among the less developed areas (at least within EU15). However, the positive impact of the TENs networks on other peripheral and currently not highly developed areas in Eastern Europe, Greece and Ireland improves the level of cohesion, so that more and less positive effects co-exist.

Figure 5.27. Regions converging towards EU average economic performance in 2015

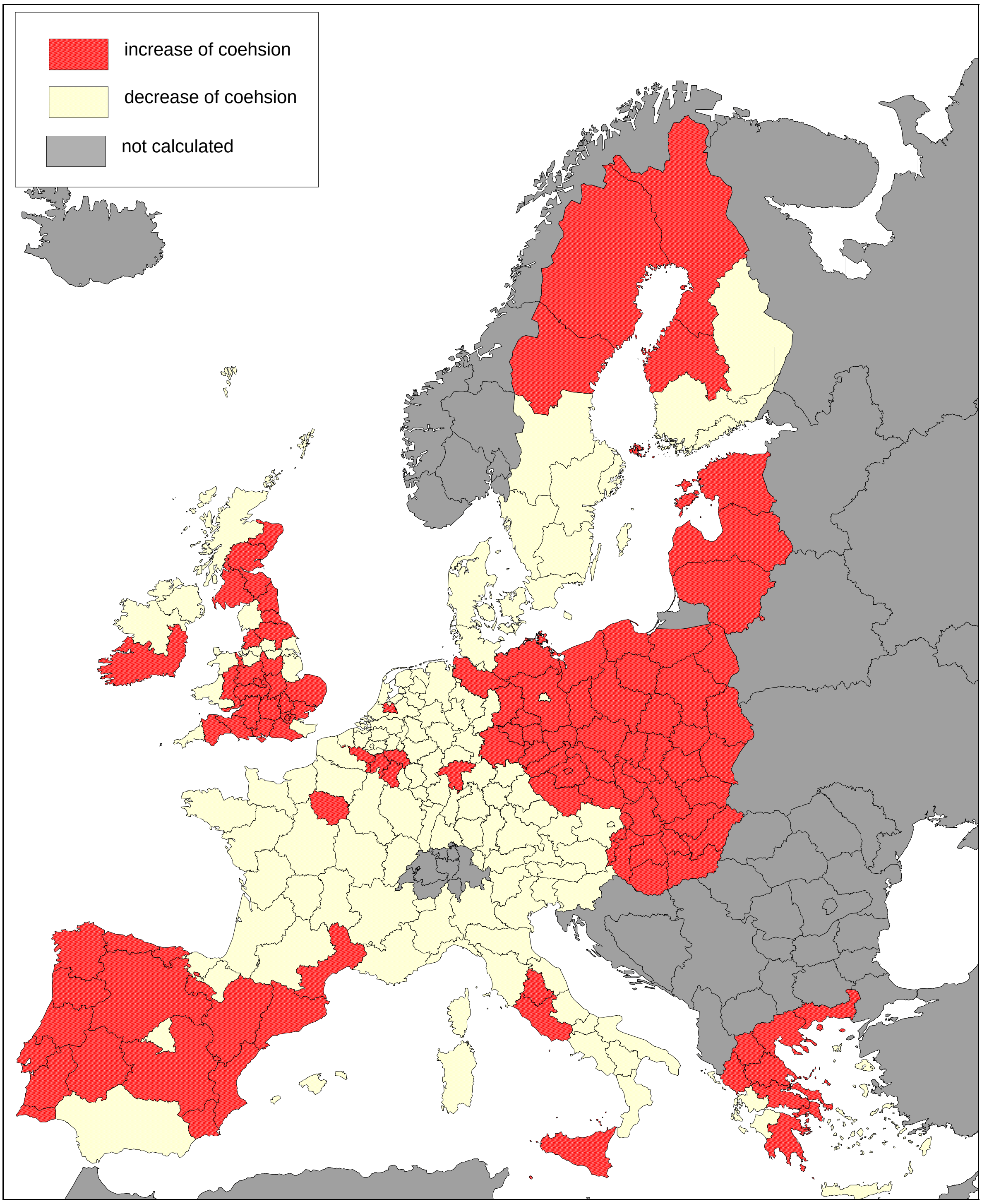
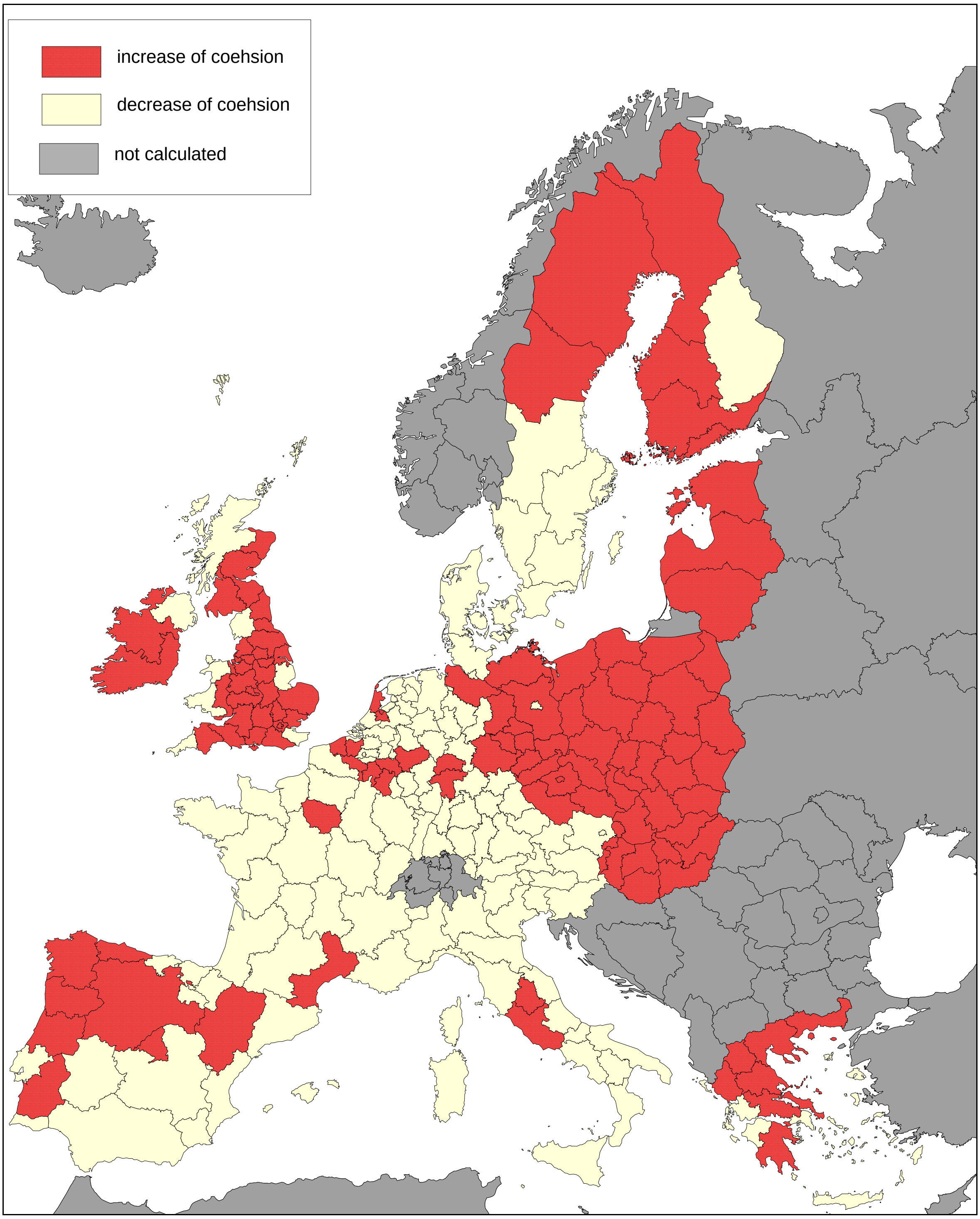


Figure 5.28. Regions converging towards EU average economic performance in 2030



5.7. Projections for the year 2050

The previous paragraphs highlight the different impacts of the TENs projects on EU25 regions at different time periods until 2030. The analysis was carried out with the support of modelling tools, integrated with additional procedures and data processing focusing on the rationalisation of the economic effects.

This study provides indications on the possible effects for 2050. The extension of projections until such term raises significant methodological issues. In fact, the application of the modelling tools used for estimating impacts until 2030 is unfeasible in this case, the models being unable to produce forecasts until that time. Even if their structures were forced to extend the modelling period until 2050, the results would not guarantee a reasonable degree of reliability.

The reason for this is the huge time gap, not only between now and 2050, but also between the forecasted completion year of the TENs projects and 2050. In these conditions, the models should recreate situations that are significantly different from the conditions used for their adjustment. In particular, the exogenous trends and assumptions involved in the projections, or simply used in the models, become unreliable. Foreseeing the development of the population is relatively simple, given that it essentially involves just three variables (births, deaths and migration). Therefore, the population projections until 2050 can be considered quite reliable. Exploring the state of the economy in the very long term is a completely different exercise. A simple indicator like the GDP growth summarises a number of different elements (e.g. technological development, productivity, national and international policies, globalisation, etc.) that can change dramatically over a 50-year term (e.g. in 1960 the technological revolution and the markets globalisation would hardly be considered in the economic forecasts for 2005).

Even when considering a shorter time period after the expected completion of the TENs investments, the issue of managing reliable assumptions and parameters is still relevant. After 25 or 30 years, the task of distinguishing the effect of a transport infrastructure from the probably profound changes in economic conditions is a very difficult one.

In these conditions, the estimation of the effects of TENs projects in 2050 was not made according to the same methodology described in the previous paragraphs and for all elements analysed above. Instead, a simpler approach based on the analysis of the trends and the generally accepted knowledge of links between transport and the economy was used to provide some indications about the possible economic impacts in the regions.

Firstly, the effects of the construction of the TENs projects (namely the investments by region), were considered to be completely worn out in 2050. In fact, the reaction of the economic sectors observed in the previous analysis show that once the investment ceases, the effect tend to wane in the following years. Thus, it is reasonable to assume that no effect resulting from the construction phase will be visible in 2050, many years after investments termination .

By contrast, the accessibility change effect is supposed to endure in time. Therefore, we may assume that the impacts will still be evident in 2050. In general, the accessibility effect of a completed project can be considered constant in time if the advantage given by the infrastructure is retained compared to competing regions. The region where the infrastructure is created will have the edge if the supply (other infrastructures, transport services, etc.) remains unchanged in all regions or develops at the same pace, and if the transport demand also grows at the same rate across all regions. For instance, if new infrastructures generate additional demand, congestion increases and the advantage in terms of accessibility is reduced or even null. Or, if some regions create advanced transport services or build new infrastructures, they can increase their accessibility by reducing the differential with other zones.

The development of transport infrastructures in the regions from 2030 onwards is obviously unknown and therefore we assumed in this report that, as for the supply, existing differences between regions in 2030 will be retained until 2050.

On the other hand, the assumption that the transport demand will remain unchanged over 20 years is unrealistic. So, several changes in accessibility effects are expected to take place in 2050, depending on the transport trends as well as the socio-economic development of each region. Given the lack of reliable long-term forecasts as mentioned above, simplifications were introduced to estimate the trend of the impact in 2050.

There is also significant uncertainty in the long-term projections for transport demand. One can think of the price of oil as a key variable whose development over the next 40 years is hardly predictable, as also are the technology and logistic changes. Thus, the analysis was based on a comparison between the transport demand trend in each country and the average trend for the EU25. The assumption is that, under the hypothesis of a fixed transport supply, the regions where demand grows faster than average will reduce their accessibility and this, consequently, will have a negative impact on their economic performance, while the reverse applies to regions where growth in demand is expected to be slower than average.

In other words, the forecasts on the accessibility effect on the economy in 2030 were minimised or maximised for 2050, according to the relative growth of demand in each country, assuming that the hierarchy of transport demand growth rates between regions will remain unchanged after 2030.

Figures 5.29 and 5.30 show the estimated change in value added and employment in 2050 compared to a scenario without the TENs projects.

Given the elements introduced above, the accessibility effects are not very different from the scenario described for 2030, but there are some differences that are worth mentioning.

- In 2030, the TENs investments are forecasted to have a negative impact on most regions of the United Kingdom, given the relatively small volume of investments in comparison to more central EU regions. The forecasts for 2050 show that this negative effect is reduced significantly in most of the UK regions, whose accessibility thus improves in relative terms;
- Another significant difference compared to the 2030 results is the positive impact over almost all NMS countries. This may result from the slower increase in transport demand in NMS regions (where population is deemed to decrease by about 20% at the horizon of 2050, see chapter 3) which, coupled with the TENs infrastructures, will allow such regions to increase their lead in terms of accessibility with respect to other parts of the EU25;
- Compared to 2030, the differences are slight, so the same observations and remarks for 2030 results still apply.

Figure 5.29. Change in value added due to TENs projects (overall effect) in 2050

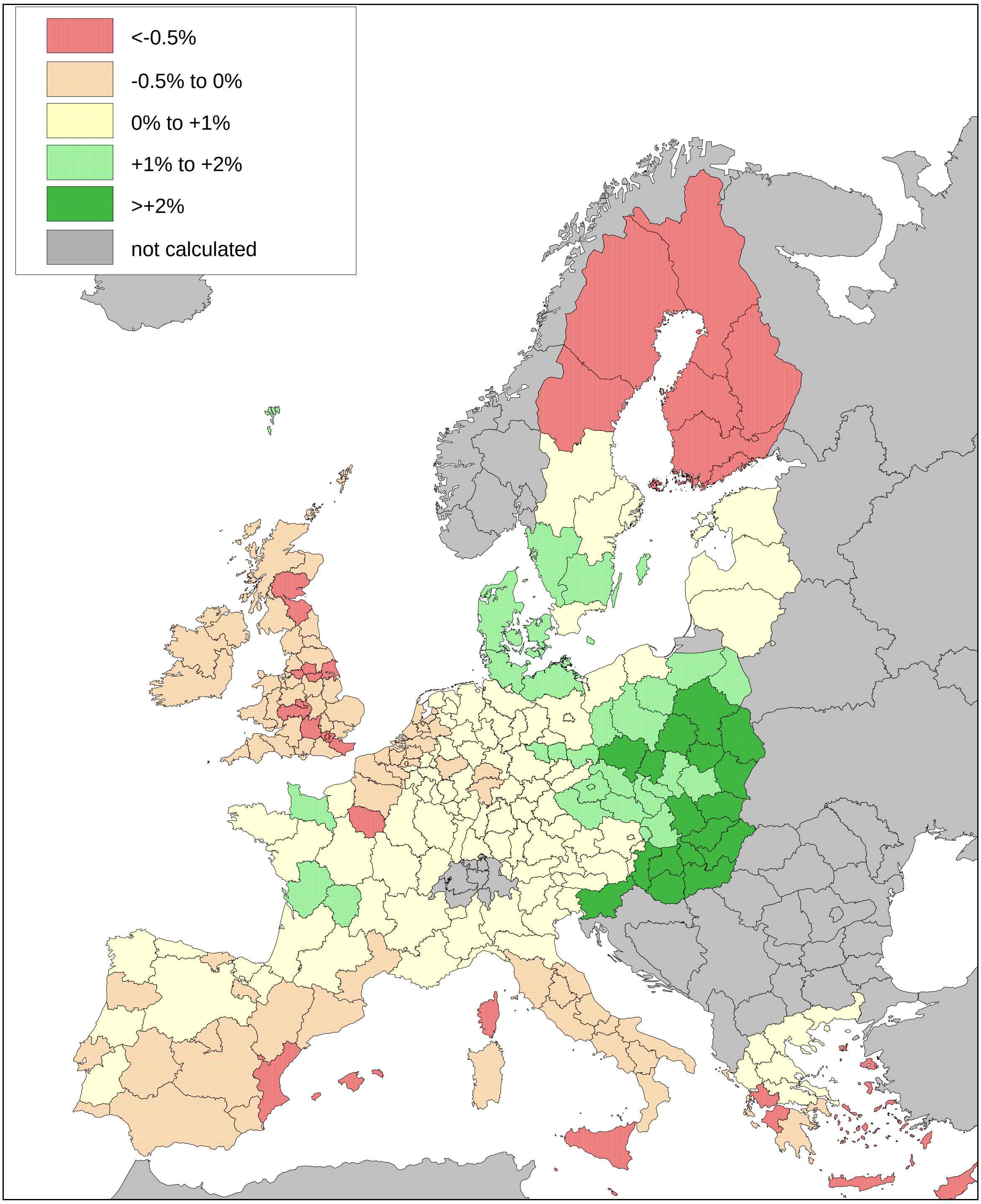
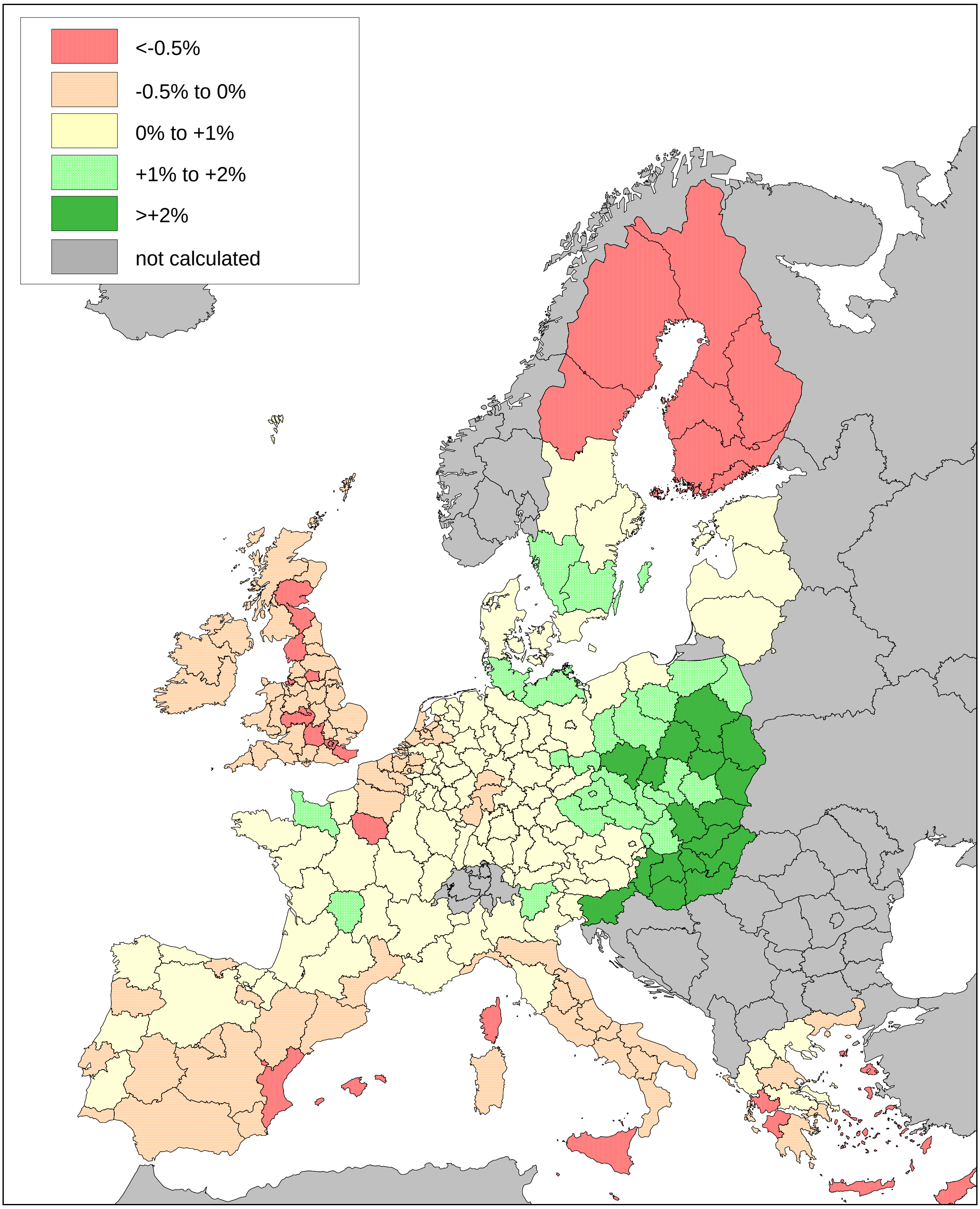


Figure 5.30. Change in employment due to TENs projects (overall effect) in 2030



6. Conclusions and recommendations

The paragraphs above provide the results of the analysis of the impact of Trans-European Networks on cohesion and employment. The analysis conducted in this study used different methodologies starting from the available data. The most important conclusions that can be drawn from this study concern the interpretation of the relationships between the regional conditions, the type of investments, the type and direction of the impacts predicted. In other words, the study allowed to highlight the most relevant elements that should be considered to predict the impact of TENs investments on the regional economies. The regional effects estimated in this study can be considered as a reference for additional in-depth analyses at the local level, which could be carried out on more detailed information (especially on the local economic specialisation side) and could help to refine and detail the predictions presented in this report.

Before introducing the main outcomes of the study, special attention shall be paid to some remarks. First, this study dealt with the impacts of TENs infrastructures in terms of difference compared to a ‘no-TENs’ case, all other things being equal. Indeed, it can be readily understood that the future economic performance of the European regions will depend on a number of local, national and international factors, and the evolution of such factors is unknown, especially over the longer period. Therefore, this study estimated the impacts that the TENs investments could have, in addition to a given economic trend not considered in this analysis. So, where this study shows that, for instance, the impact of TENs is negative in a given region, this does not mean that in such a region we should expect a reduction of either per capita value added or employment. Instead, this result mean that, in the region, value added would be lower and the unemployment rate would be higher in case of failed TENs implementation.

Secondly, from the consideration above, it follows that if the impact of the TENs networks is negative for a region whose underlying growth rate (due to all other factors affecting the economic performance) is highly positive, this impact consists of slowing down regional economic growth. Conversely, if the impact of the TENs networks is positive for a region whose underlying growth rate is poor, this impact consists of speeding up regional economic growth.

6.1. Main conclusions of the study

The main conclusions of the study can be summarised as follows:

a) The extent of the impacts generated by the investments in TENs infrastructures in their operational phase is generally low. The magnitude of the changes in per capita GDP and in employment is generally not much higher than 2% of the reference values, with only very few regions showing increases larger than 3%. This result suggests that, in general, the implementation of the TENs networks does not guarantee, in itself, that the economic performance of one EU region has dramatically improved.

b) The impacts of the construction and operational phases are similar, even if they tend to reach their peak at a different time lag: the multiplier effect of investments gives rise to positive effects in a relatively short term and tends to wane rapidly once the monetary flow of investments ceases. The effect of accessibility requires some time before it becomes visible, yet, it lasts for longer. This result suggests that if one region does not benefit from infrastructure investments to improve its accessibility, then occupational benefits may be transitory.

c) The local impacts of the construction phase depend heavily on the specialisation of the region. If the region where the investment is located lacks activities in some specific sectors, such as the production of industrial machines, steel, construction equipment, and cannot provide a skilled workforce, the positive incentive to investments and consumption may be limited to low-value services like security, cleaning, catering, etc. and some unskilled jobs. Conversely, the regions specialising in those sectors playing a significant role as providers of input for infrastructure building can improve their economic performance even if no infrastructures are planned in their territory.

d) As expected, the construction, the minerals and metals sectors are those where the positive effects of investments are more visible. It is also heralded that the production of industrial machines will significantly benefit from TENs investments. However, there are other sectors that should not be overlooked when anticipating the impacts of infrastructures, namely auxiliary transport services, trade and market services, whose development occurs later compared to other sectors, but is nevertheless relevant.

e) The effects of the operational phase of the TENs networks, at least when interpreted mainly in terms of the impacts of accessibility changes, depend on complex 'network effects', i.e. the impact of a given infrastructure can spread well beyond the regions where it is actually placed. Therefore, if several infrastructures are completed, the overall impact on a given region is the sum of direct and indirect effects, internal and external to the region.

f) The analysis produced different results, estimating both positive and negative impacts. The negative impacts of the TENs networks are essentially due to a lower economic performance in relative terms generated by different levels of accessibility. As the TENs networks fail to cover all regions and the impact of a new infrastructure on accessibility is highly different across regions and, finally, as the geographical position plays a significant role in explaining the accessibility level of a region, assuming that all TENs investments are implemented, <u>the relative accessibility</u> of each region changes compared to others. Some regions improve their position, while others worsen their conditions <u>even if in absolute terms, their accessibility has improved</u> compared to current conditions. Given the direct link between accessibility and economic performance, if the former is reduced, the latter suffers a negative impact.

g) In terms of cohesion, two distinct effects should be taken into account. On the one hand, the regions of the central part of EU25 (France, Benelux, Germany), which are already among the most developed EU regions, are generally boosted by the TENs networks while, at the same time, some peripheral areas in Finland, Sweden and Italy gain no real advantage from the implementation of the TENs networks and most of them are currently among the less developed areas (at least within EU15). Therefore, from this point of view, cohesion is not improved. On the other hand, however, in the longer term (2030), the positive impact of TENs networks on several other peripheral and currently not highly developed areas in Eastern Europe, Greece and Ireland improves the level of cohesion of the Union.

h) The EU25 inhabitants' propensity to migrate is not expected to change significantly with the implementation of TENs networks. Coherently with the economic effects, some peripheral areas increase their propensity to lose people, while many central regions could attract more immigrants than in the ‘no-TENs’ case. However, only a comprehensive knowledge of the local conditions would enable us to quantify these events.

6.2. Recommendations

Given the conclusions of the study summarised above, the following recommendations can be put forward.

1 Transport investments are key to improving the economic performance of regions, but they cannot be considered the sole or the major leverage of the economic policy. At least in the EU context, where the starting level of accessibility and economic development is generally acceptable, policy makers at any decisional level (local, national, etc.) should think of new infrastructures as one element of a policy mix rather than the key instrument to speed up economic development.

2 Given that transport infrastructures should be part of a more complex strategy aimed at developing regional economies, the choice of the elements to be included in the policy mix should be chosen carefully, according to their effectiveness and efficiency. It is therefore recommended that transport infrastructures projects are subject to assessment of their performance (e.g. economic, financial, environmental, etc.) in order to collect elements to take informed decisions about the payoff of financial investments. Of course, assessment is recommended also for non-transport projects and initiatives.

3 Transport infrastructure investments produce positive spin-off on regional economies thanks to a multiplier effect, but such effect highly relates to the economic structure of the region. Therefore, in order to take full advantage of the multiplier effect of infrastructure investments, regional economies should not be limited to the production of low value added goods and services (e.g. building materials) but pursuing to extend their specialisation in higher value added goods and services (e.g. high technology building machines, trade).

4 The most lasting positive impact of transport infrastructure investments is due to improved relative accessibility and, at the same time, the effects of new infrastructures on accessibility can be very complex, involving changes also for those regions lying far away from the location of the investments. Therefore investments in new infrastructures should be planned carefully, taking into account the current main flows of transport demand to and from one region, the impacts on crossing traffic, network effects and their potential effects on existing infrastructures, etc. Failing a careful planning, the overall impact might lead to reduced, and not increased cohesion.

5 New transport infrastructures improve the accessibility of regions and set up the conditions for higher regional competitiveness. However, if independent projects are conducted in different regions without an overall strategy, unexpected effects could arise from the economic viewpoint. Indeed, as the relevant accessibility variations are those in relative, and not in absolute terms, the infrastructures that contemporarily improve accessibility in different regions may leave their competitiveness level unchanged (other regions having improved their accessibility at the same time as well). Thus, infrastructures investments would have no practical effects on the regional economic performance or effects could be much less huge than expected. It is therefore recommended to analyse the foreseeable changes of relative accessibility when a number of different projects are planned in different regions and economic benefits are expected.

6 As the improvements of relative accessibility are a major determinant of positive spin-off of transport infrastructures, such improvements should be retained over time to profit by the advantages of transport investments. From this point of view, land use policies (e.g. limiting sprawling of metropolitan areas) and regulation of transport demand (e.g. boosting freight logistics to reduce empty trips and shorten consignment tours) can be adopted to counteract uncontrolled transport demand that can erode accessibility gains in a relatively short term.

Bibliography

Aschauer, D., *Is Public Expenditure Productive?*, Journal of Monetary Economics, n° 23, 1989, pp. 177-200.

ASTRA Project, *Assessment of Transport Strategies*, 4th EU RTD Framework Programme, 1997.

Bröcker, J., “Spatial Effects of European transport Policy: A CGE Approach”, Hewings, G., Sonis, M., Boyce, D. (Eds), *Trade, Networks and Hierarchies- Modelling Regional and Interregional Economies*, Springer, Berlin/Heidelberg/New York, 2002, pp. 11-28.

Bröcker, J., et al., *Territorial Impact of EU Transport and TEN Policies. Final Report of ESPON 2.1.1.*, Institut für Regionalforschung, Christian-Albrechts-Universität Kiel, Kiel, 2004.

Bröcker, J., et al., *Modelling the Socio-economic and Spatial Impacts of EU Transport Policy*, IASON Deliverable 6, Funded by 5th Framework RTD Programme. Kiel/Dortmund, 2004.

Bröcker, J., Peschel, K., “Trade“, Molle, W., Cappelin, R. (Eds), *Regional Impact of Community policies in Europe*, Aldershot Averbury, 1988.

Buhr, W., *Die Rolle der materiellen Infrastruktur im regionalen Wirtschaftswachstum,* Duncker & Humblot, Berlin, 1975.

CEBR (Centre for Economic and Business Research), *Roads and Jobs. The Economic Impact of Different Levels of Expenditure on the Roads Programme*. CEBR, London, 1994

De Ceuster, G., et al., *ASSESS Final Report*, European Commission DG TREN, Brussels, 2005.

ECOPAC project, *Final Summary Report: Socio-Economic and Spatial Impacts of Transport Infrastructure Investments and Transport System Improvements*, 1999.

European Commission-DG Regional Policy, *Third Cohesion Report on economic and social cohesion: A new partnership for cohesion, convergence, competitiveness, cooperation,* 2004.

Jochimsen, R., *Theorie der Infrastruktur. Grundlagen der marktwirtschaftlichen Entwicklung*, Mohr, Tübingen, 1996.

Keeble, D., Offord, J., Walker, S., *Peripheral Regions in a Community of Twelve Member State*, Office for Official publications of the European Communities, Luxembourg, 1988.

Keeble, D., Owen, P.L., Thompson, C., *Regional accessibility and economic potential in the European Community*. Regional study 16, 1982, pp. 419-432.

Leontief, W., *Input-Output Economics*, Oxford University Press, Oxford, 1966.

LOTSE Project, *Quantification of technological scenarios for long-term trends in transport*, JRC – IPTS, Seville, 2004.

Peschel, K. “On the impact of geographical distances on interregional patterns of production and trade”, *Environmental and Planning A*, n° 13, 1981, pp. 605-269.

Ponti, M., et al., *TIPMAC Project - Transport Infrastructure and Policy: a Macroeconomic Analysis for the EU*, 5th EU RTD Framework Programme, 2002

Rothengatter, W., “L’importanza della rete di trasporti transeuropea per l’integrazione e la crescita dell’Unione Europea allargata”, *Economia Pubblica* n° 4, Franco Angeli, Milan, 2005.

Schade, W., *Strategic Sustainability Analysis: Concept and application for the assessment of European Transport Policy*, Institut für Wirtschftspolitik und Wirtschftsdorschung der Univerität Karlsruhe, 2004.

Schürmann, C., Spiekermann, K., Wegener, M., *Accessibility Indicators. SASI Deliverable D5*, Berichte aus dem Institut für Raumplanung 39, Institute of Spatial Planning, Dortmund, 1997.

Simmonds D, Jenkinson N., *Regional Economic Impacts of the Channel Tunnel. Proceeding of Seminar E*, PTRC Summer Annual Meeting. PTRC, London, 1993.

Simmonds D, Jenkinson N., *The impact of changing transport service in Europe. Proceedings of Seminar A*, PTRC Summer Annual Meeting, PTRC, London, 1995.

Trans-European Transport Network. TEN-T priority axes and projects 2005, European Commission DG TREN, Brussels, 2005.

Van Miert, *High Level Group on the Trans-European Transport Network. Final report*, European Commission DG TREN, Brussels, 2003.

Venables, A. J., Gasiorek, M., *The Welfare Implications of Transport Improvements in the Presence of Market Failure*, SACTRA, 1998.

Wegener, M., Bökemann, D, *The SASI Model: Model Structure. SASI Deliverable D8.* Berichte aus dem Institut für Raumplanung 40, Institut für Raumplanung - Universität Dortmund, Dortmund, 1998.

Annex 1.

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P01	**Railways line Berlin-Verona/Milano-Bologna-Napoli-Messina**							
P01-1	Halle/Leipzig-Nuremberg	Rail (new/upgrade)	1996	2015	6959	1112.2	DE	DE24
								DE25
								DEE2
								DEE3
								DEG
P01-2	Nuremberg-Munich	Rail (new/upgrade)	2000	2006	3331	2746.3	DE	DE21
								DE25
P01-3	Munich-Kufstein	Rail (depending on completion of Brenner Tunnel)	2010	2015	1500	0	AT	AT33
							DE	DE21
P01-4	Kufstein-Innsbruck (2)	Rail (new)	1999	2012 (2009)	2900	320	AT	AT33
P01-5	Brenner Tunnel cross-border section	Rail (tunnel)	2007	2015	5400	26	AT	AT33
							IT	ITD1
								ITD2
P01-6	Verona-Naples	Rail (new)	1970	2007	14329	7292	IT	ITD3
								ITD5
								ITE1
								ITE4
								ITF3
P01-7	Milan-Bologna	Rail (new)	2000	2008 (2006)	6508	1735	IT	ITC4
								ITD5
P01-8	Rail/road bridge over the Strait of Messina-Palermo (3)	Rail/road bridge (new), rail upgrade	2005	2015	4684.3	0	IT	ITG1
P01-9	Berlin Lehrter Bahnhof/Berlin-Ludwigsfelde	Rail (new)	1994	2006	3348	2148.3	DE	DE3
								DE41
								DE42
								DEE1

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P01-10	Berlin-Halle/Leipzig	Rail (upgrade)	1991	2005	1594	1564	DE	DE3
								DE41
								DE42
								DEE2
								DEE3
P01-11	Fortezza-Verona	Rail (upgrade)	1992	2015	2500		IT	ITD3
P02	**High-speed train PBKAL (Paris–Brussels–Cologne–Amsterdam–London)**							
P02-1	Channel Tunnel–London	Rail (new)	1999	2007	8011	7080	UK	UKI1
								UKI2
								UKJ4
P02-2	Brussels–Liège–Cologne	Rail (new)	1996	2007	2734	2062	BE	BE10
								BE31
								BE33
							DE	DEA2
P02-3	Brussels–Rotterdam–Amsterdam	Rail (new)	1998	2007	6319	5635	BE	BE10
								BE21
								BE24
								BE33
							NL	NL41
								NL32
								NL33
P02-4	Amsterdam station		2008	2014	270	0	NL	NL32
P02-5	Rotterdam station		2006	2010	123	0	NL	NL33
P02-6	Lille–Brussels	Rail (new)	1992	2006	1423	1341	BE	BE10
								BE24
								BE32
							FR	FR3

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P02-7	Cologne–Frankfurt	Rail (new)	1990	2004	6015	6015	DE	DE71
								DEA2
								DEB1
P03	**High-speed railway axis of south-west europe**							
P03-1	Lisbon/Porto–Madrid	New line	2006	2011	11355	24	ES	ES30
								ES42
								ES43
							PT	PT11
								PT16
								PT17
								PT18
P03-2	Madrid–Barcelona–Figueras–Perpignan	New line, includingnew cross-border tunnel	1998	2008	10064	5853	ES	ES24
								ES30
								ES42
								ES51
							FR	FR81
P03-3	Perpignan–Montpellier	New line	2006	2009 (2015)	2200	0	FR	FR81
P03-4	Montpellier–Nîmes	New/upgraded	2006	2015 (2010)	1130	0	FR	FR81
								FR82
P03-5	Madrid–Vitoria–Irún/Hendaye	New line	2002	2010	8581	1475	ES	ES21
								ES30
								ES41
							FR	FR1
								FR24
								FR53
								FR61

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P03-6	Irún/Hendaye–Dax	Upgraded line	2006	2015 (2010)	100	0	ES	ES21
							FR	FR61
P03-7	Dax–Bordeaux	New line	2010	2020	2400	0	FR	FR24
								FR53
								FR61
P03-8	Bordeaux–Tours	New line	2008	2015	3900	0	FR	FR24
								FR53
								FR61
P04	**High-speed railway axis east**							
P04-1	Paris–Baudrecourt; Metz–Luxembourg	New line and upgrade	2002	2007	4034	1358	FR	FR1
								FR21
								FR41
								FR42
							LU	LU
P04-2	Saarbrücken–Mannheim	Upgrade	2003	2007	339	176	DE	DE12
P05	**Betuwe Line**							
P05-1	Betuwe line	Rail (upgrade)	1998	2006 (2007)	4685	4130	DE	DEA1
							NL	NL22
								NL33
P06	**Railway axis Lyon-Trieste-Divaca/Koper/Divaca-Ljubljana-Budapest-Ukrainian border**							
P06-1	Lyons–St-Jean-de-Maurienne	Rail (new)	2007	2015	6250	0	FR	FR71
P06-2	Mont Cenis Tunnel (including access)	Rail (new tunnel)	2004	2018 (2017)	6700	200	FR	FR71
							IT	ITC1
P06-3	Bussoleno–Turin	Rail (new)	2002	2011	2375	0	IT	ITC1
P06-4	Turin–Venice	Rail (new)	2002	2011 (2010)	14994	1700	IT	ITC1
								ITC4
								ITD3

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P06-5	Venice–Ronchi Sud-Trieste–Divaca	Rail (new)	2008	2015	6200	0	IT	ITD3
								ITD4
							SI	Sl00
P06-6	Koper–Divaca–Ljubljana	Rail (upgrade and new track)	2006	2012	376	5	SI	Sl00
P06-7	Ljubljana–Budapest	Rail (upgrade)	2000	2015	760	19	HU	HU10
								HU21
								HU22
							SI	Sl00
P07	**Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest**							
P07-1	Via Egnatia	New road	1996	2006	4600	3100	EL	GR11
								GR12
								GR13
								GR21
P07-2	Pathe	New road	1996	2008	8389	4654	EL	GR12
								GR14
								GR24
								GR30
P07-3	Sofia–Kulata–Greek–Bulgarian border	Upgrading motorway	2003	2010	675	0	BG	BG21
							EL	GR12
P07-4	Nadlac–Sibiu motorway (branch towards Bucharest and Constanta)	Upgrading/ new motorway	2004	2007	1879	0	RO	RO02
								RO03
								RO05
								RO07
								RO08

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P08	**Multimodal axis Portugal/Spain-rest of Europe**							
P08-1	La Coruña-Lisbon-Sines	Railway upagrade	2000	2009	2727	874	ES	ES11
							PT	PT11
								PT15
								PT16
								PT17
								PT18
P08-2	Lisbon-Valladolid	Railway upagrade	1999	2015 (2010)	1917	841	ES	ES41
							PT	PT16
								PT17
								PT18
P08-3	Lisbon-Faro	Railway upagrade	2000	2006 (2004)	1001	780	PT	PT15
								PT16
								PT17
								PT18
P08-4	Lisbon-Valladolid	New Motorway	1996	2010	1518	1336	ES	ES41
							PT	PT16
								PT17
								PT18
P08-5	La Coruña-Lisbon	New Motorway	2000	2005 (2003)	2365	2097	ES	ES11
							PT	PT11
								PT16
								PT17
								PT18

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P08-6	Seville-Lisbon	New Motorway	1998	2001	754	754	ES	ES61
							PT	PT15
								PT16
								PT17
								PT18
P08-7	Lisbon Airport	new	2006	2015	2550	0	PT	PT16
								PT17
								PT18
P09	**Railway axis Cork-Dublin-Belfast-Stranraer**							
P09-1	Cork–Dublin–Belfast–Stranraer	Rail (upgrade)	1989	2001	357		IE	IE01
								IE02
							UK	UKM3
								UKN
P10	**Malpensa Airport (Milan)**							
P10-1	Malpensa Airport (Milan, Italy)	Extension and new facilities	1995	2001	1344		IT	ITC4
P11	**Öresund fixed link**							
P11-1	Øresund fixed link	Tunnel, island and bridge		2000	2740		DK	DK
							SE	SE04
P11-2	Danish access routes	New motorway and railway		1999	946		DK	DK
P11-3	Swedish access routes	New motorway and railway		2001	472		SE	SE04
P12	**Nordic triangle railway-road axis**							
P12-1	Road and rail projects in Sweden	Road/rail (upgrade)	1996	2015	8102	2336	SE	SE01
								SE02
								SE04
								SE09
								SE0A

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P12-2	Helsinki–Turku motorway	Road (upgrade)	1995	2009 (2010)	618		FI	FI18
								FI19
P12-3	Kerava–Lahti	Rail (new)	2002	2006	331	222	FI	FI18
								FI19
P12-4	Helsinki–Vaalimaa motorway	Road (upgrade)	1995	2015	700	168	FI	FI18
								FI19
P12-5	Helsinki–Vainikkala	Rail (upgrade)	1996	2015 (2014)	1154	247	FI	FI18
								FI19
P13	**UK-Ireland/Benelux road axis**							
P13-1	Ireland section	road	1996	2010	3173	1441	IE	IE01
								IE02
							UK	UKN
P13-2	UK section	road	1986	2013 (2010)	1349	850	UK	UKD1
								UKD2
								UKD4
								UKD5
								UKF2
								UKG1
								UKG2
								UKG3
								UKH1
								UKH3
								UKL1
								UKM3

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P14	**West Coast Main Line**							
P14-1	West coast main line	Rail (upgrade)	1994	2008 (2007)	10866	9680	IE	IE01
								IE02
							UK	UKD1
								UKD2
								UKD4
								UKD5
								UKG2
								UKG3
								UKH2
								UKI1
								UKI2
								UKJ1
								UKM2
								UKM3
								UKN
P15	**Galileo**							
Galileo	Development and deployment	2001	2010 (2008)	3400				
P16	**Freight railway axis Sines-Madrid-Paris**							
P16-1	Trans-Pyrenean rail link	New line (including long-distance tunnel)	2013	2020	5000	0	ES	ES22
								ES24
								ES51
							FR	FR61
								FR62
								FR81

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P16-2	Sines–Badajoz rail link	New line	2006	2010	700	0	ES	ES43
							PT	PT18
P16-3	Algeciras–Bobadilla rail link	New line	2006	2010	360	0	ES	ES61
P17	**Railway axis Paris-Strasbourg-Stuttgart-Vienna-Bratislava**							
P17-1	Baudrecourt–Strasbourg–Baudrecourt–Strasbourg–Stuttgart, with the Kehl bridge as crossborder section	New line and upgrade	2010	2015	1450	0	DE	DE11
							FR	FR21
								FR41
								FR42
P17-2	Stuttgart–Ulm	New line	2006	2012	1266		DE	DE11
								DE12
P17-3	Munich–Salzburg cross-border section	Upgrade/electrification	2002	2015	461	46.2	AT	AT32
							DE	DE21
P17-4	Salzburg–Vienna	Upgrade	1990	2012	6600	2334	AT	AT12
								AT13
								AT31
								AT32
P17-5	Vienna–Bratislava cross-border section	Upgrade	2004	2012 (2010)	300	15.7	AT	AT12
								AT13
							SK	SK01
P18	**Rhine/Meuse-Main-Danube inland waterway axis**							
P18-1	Rhine–Meuse	Improve navigability	2005	2019	428	0	DE	DEB3
								DEC
							FR	FR41
								FR42
P18-2	Lanaken lock	New lock	2006	2011	76	1.1	BE	BE33
							NL	NL42

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P18-3	Vilshofen–Straubing	Improve navigability	2008	2013	128	0	DE	DE22
P18-4	Vienna–Bratislava	Improve navigability	2006	2015	180	2	AT	AT13
							SK	SK01
P18-5	Palkovicovo–Mohács	Improve navigability	2007	2014	300	0.6	HU	HU10
							SK	SK01
								SK02
P18-6	Bottlenecks in Romania and Bulgaria	Improve navigability	2002	2011	777	140	BG	BG11
								BG12
								BG13
							RO	RO02
								RO03
								RO04
P19	**High-speed rail interoperability on the Iberian peninsula**							
P19-1	Madrid–Andalusia	New line	2001	2020 (2010)	5115	1507	ES	ES30
								ES42
								ES61
P19-2	North-east corridor	New line	2001	2020 (2010)	3191	300	ES	ES24
								ES30
								ES41
P19-3	Madrid–Levante and Mediterranean	New line	2001	2020 (2010)	11183	542	ES	ES24
								ES42
								ES51
								ES52
								ES62
							FR	FR81

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P19-4	North/north-west corridor including Vigo–Porto	New line	2001	2020 (2010)	2824	136	ES PT	ES11 ES41 PT11 PT16 PT17 PT18
P19-5	Extremadura	New line	2001	2020 (2010)	0	0	ES PT	ES43 PT18
P20	**Fehmarn Belt railway axis**							
P20-1	Fehmarn Belt	Fixed rail–road link	2007	2015 (2014)	4000		DE DK	DEF DK
P20-2	Danish access railway from Øresund	Upgrade/electrification	2006	2015	675	4	DK	DK
P20-3	German access railway from Hamburg	Upgrade/electrification	2006	2014 (2014)	1092		DE	DE6 DE5 DE93
P20-4	Hannover–Hamburg/Bremen railway	Upgrade	2010	2015	1284	0	DE	DE5 DE6 DE92 DE93
P21	**Motorways of the sea**							
							BE BG CY	BE21 BE25 BG13 BG23 CY

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
							DE	DE5
								DE6
								DE94
							DK	DK
							EE	EE
							ES	ES51
								ES52
								ES61
							FI	FI18
								FI19
							FR	FR23
								FR3
								FR82
							EL	GR12
								GR14
								GR30
							IE	IE02
							IT	ITC3
								ITD4
								ITF4
							LT	LT00
							LV	LV
							MT	MT
							NL	NL32
								NL33
							PL	PL42
								PL63

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
							PT	PT11
								PT16
								PT17
								PT18
							RO	RO02
							SE	SE04
								SE0A
							SI	Sl00
							UK	UKC2
								UKF3
								UKH3
								UKI1
								UKI2
								UKJ4
P22	**Railway axis Athina-Sofia-Budapest-Vienna-Prague-Nürnberg/Dresden**							
P22-1	Greek/Bulgarian border–Kulata–Sofia–Vidin/Calafat	Rail (upgrade and new line)	2006	2015	4277	0	BG	BG11
								BG21
							EL	GR11
								GR12
								GR14
								GR24
								GR30
							RO	RO04
P22-2	Curtici–Brasov	Rail (new)	2006	2013 (2010)	2678	0	RO	RO03
								RO04
								RO05

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P22-3	Budapest–Vienna	Rail (upgrade)	2006	2010	300	0	AT	AT12
								AT13
							HU	HU10
								HU21
							SK	SK01
								SK02
P22-4	Breclav–Prague–Nuremberg	Rail (upgrade) and ERTMS	2005	2016 (2010)	2315	0	CZ	CZ01
								CZ02
								CZ03
								CZ06
							DE	DE23
								DE25
P22-5	Prague–Linz	Rail (upgrade)	2005	2017 (2016)	1555	0	AT	AT31
							CZ	CZ01
							CZ	CZ03
P23-1	Gdansk–Warsaw–Katowice	Rail (upgrade)	2005	2013 (2015)	2351	0	PL	PL11
								PL12
								PL22
								PL62
								PL63
P23-2	Katowice–Breclav	Rail (upgrade)	2007	2010	1581	850	CZ	CZ06
								CZ07
								CZ08
							PL	pl22

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P23-3	Katowice–Zilina–Nove Mesto n.V.	Rail (upgrade)	2006	2015 (2010)	1556	1.5	CZ	CZ08
							PL	pl22
							SK	SK01
								SK02
P24	**Railway axis Lyon/Genoa-Basel-Duisburg-Rotterdam/Antwerp**							
P24-1	Lyons–Mulhouse–Müllheim, with Mulhouse–Müllheim as cross-border section	New line/upgrading bridge	2006	2018	4580	1.5	DE	DE13
							FR	FR42
								FR43
								FR71
P24-2	Genoa–Milan/Novara–Swiss border	New line/upgrading	2005	2 013	10313	0	IT	ITC1
								ITC3
								ITC4
P24-3	Basle–Karlsruhe	Upgrading/new line	1987	2 015	4256	1448	CH	CH03
							DE	DE12
								DE13
P24-4	Frankfurt–Mannheim	New line	2010	2015 (2012)	1771	0	DE	DE12
								DE71
P24-5	Duisburg–Emmerich	Upgrading	1997	2015 (2009)	1254	61.4	DE	DEA1
							NL	NL22
P24-6	‘Iron Rhine’ (Rheidt–Antwerp)	Upgrading	2004	2 010	550	0	NL	NL34
								NL41
								NL42

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P25	**Motorway axis Gdansk-Brno/Bratislava-Vienna**							
P25-1	Gdansk–Katowice motorway	Road (new)	2005	2011 (2010)	2754	0	PL	PL11
								PL12
								PL22
								PL62
								PL63
P25-2	Katowice–Brno/Zilina motorway cross-border section	Road (upgrade and new)	2004	2010	4380	14	CZ	CZ06
								CZ07
							PL	pl22
							SK	SK02
P25-3	Brno–Vienna motorway crossborder section	Road (new)	2003	2013 (2009)	643	7	AT	AT12
								AT13
							CZ	CZ06
P26	**Railway-road axis Ireland/United Kingdom/continental Europe**							
P26-1	Ireland	Road/rail modernisation	1995	2010	2544	2075	IE	IE01
								IE02
							UK	UKN
P26-2	Hull–Liverpool	Rail modernisation	2003	2020 (2015)	1750	10	UK	UKD3
								UKD5
								UKE1
								UKE3
								UKE4
P26-3	Felixstowe–Nuneaton	Rail modernisation	2007	2014 (2011)	300	0	UK	UKF2
								UKF3
								UKG1
								UKH1

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P26-4	Crewe–Holyhead	Rail modernisation	2009	2012 (2008)	120	0	UK	UKD2
								UKL1
								UKL2
P27	**Rail Baltica axis Warsaw-Kaunas-Riga-Tallinn-Helsinki**							
P27-1	Warsaw–Kaunas	Reconstruction / new construction	2004	2010	300	0	LT	LT00
							PL	PL12
								PL34
P27-2	Kaunas–Riga	Modernisation /new construction	2010	2014	850	0	LT	LT00
							LV	LV
P27-3	Riga–Tallinn	Modernisation /new construction	2010	2018 (2016)	1500	0	EE	EE
							LV	LV
P28	**Eurocaprail on the Brussels-Luxembourg-Strasbourg railway axis**							
P28-1	Brussels–Luxembourg border	Rail (upgrade)	2007	2012	1245	0	BE	BE10
								BE24
								BE31
								BE34
								BE35
							LU	LU
P28-2	Luxembourg–French border	Rail (upgrade)	2009	2013 (2012)	164	0	FR	FR41
								FR42
							LU	LU

Section code	Project section	Project Type	Starting year	Completion Year	Total section cost	Section investments up to 2004	Country	NUTS 2 code
P29	**Railway axis if the Ionian/Adriatic intermodal corridor**							
P29-1	Kozani–Kalambaka–Igoumenitsa	New rail	2006	2012	1395	0	EL	GR13
								GR14
								GR21
P29-2	Ioannina–Antirío–Río–Kalamata	New rail	2009	2014	1094	0	EL	GR21
								GR23
								GR24
								GR25
P30	**Inland waterway Seine-Scheldt**							
P30-1	Deulemont–Ghent	Improve navigability	2001	2016	324	23	BE	BE23
								BE25
							FR	FR3
P30-2	Compiègne–Cambrai	New canal	2007	2016	2170	0	FR	FR22
								FR3

Annex 2.

Figure 1. Change in value added due to TENs projects(construction phase) in the year 2015 – construction

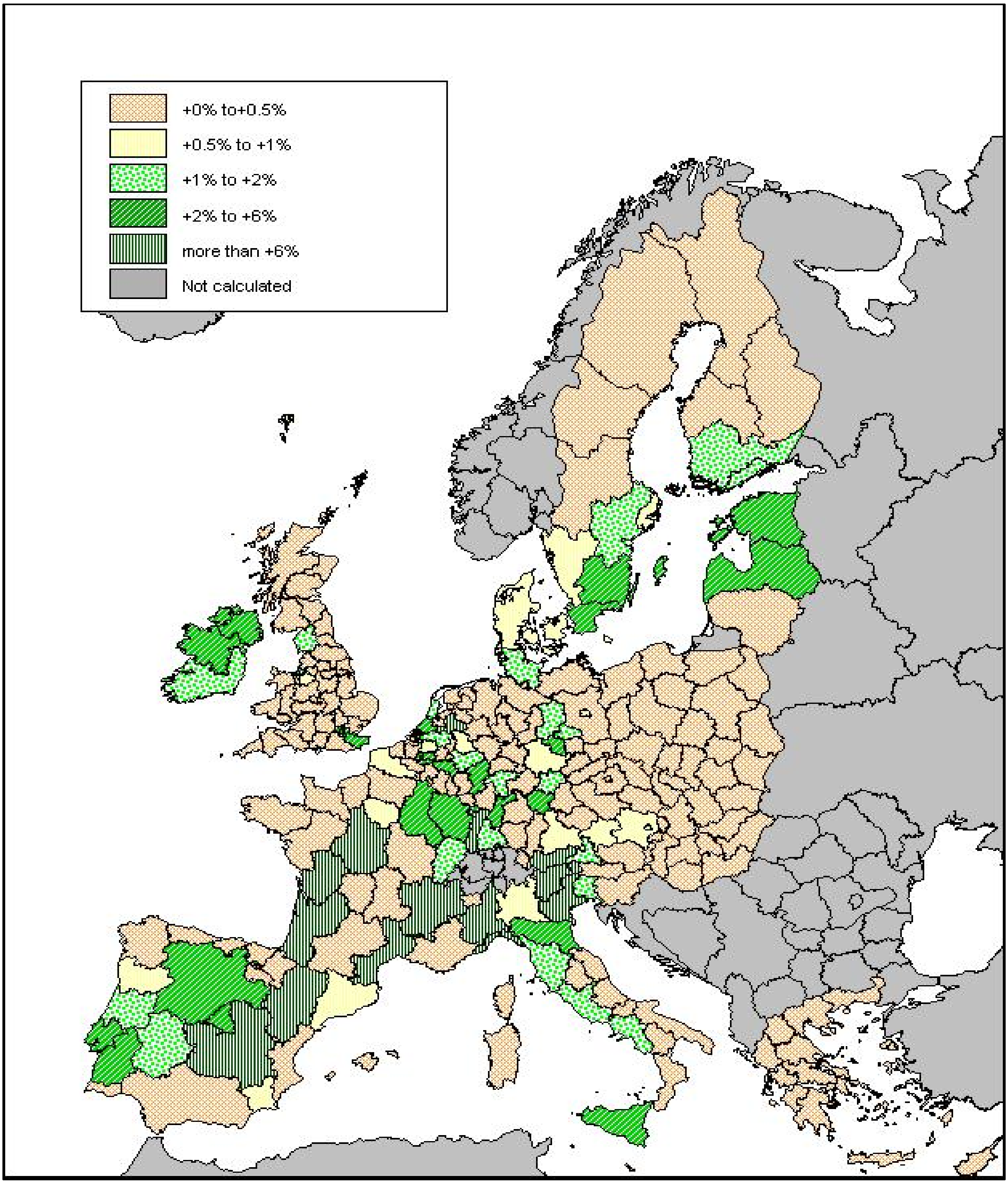


Figure 2. Change in value added due to TENs projects (construction phase) in the year 2030 – construction

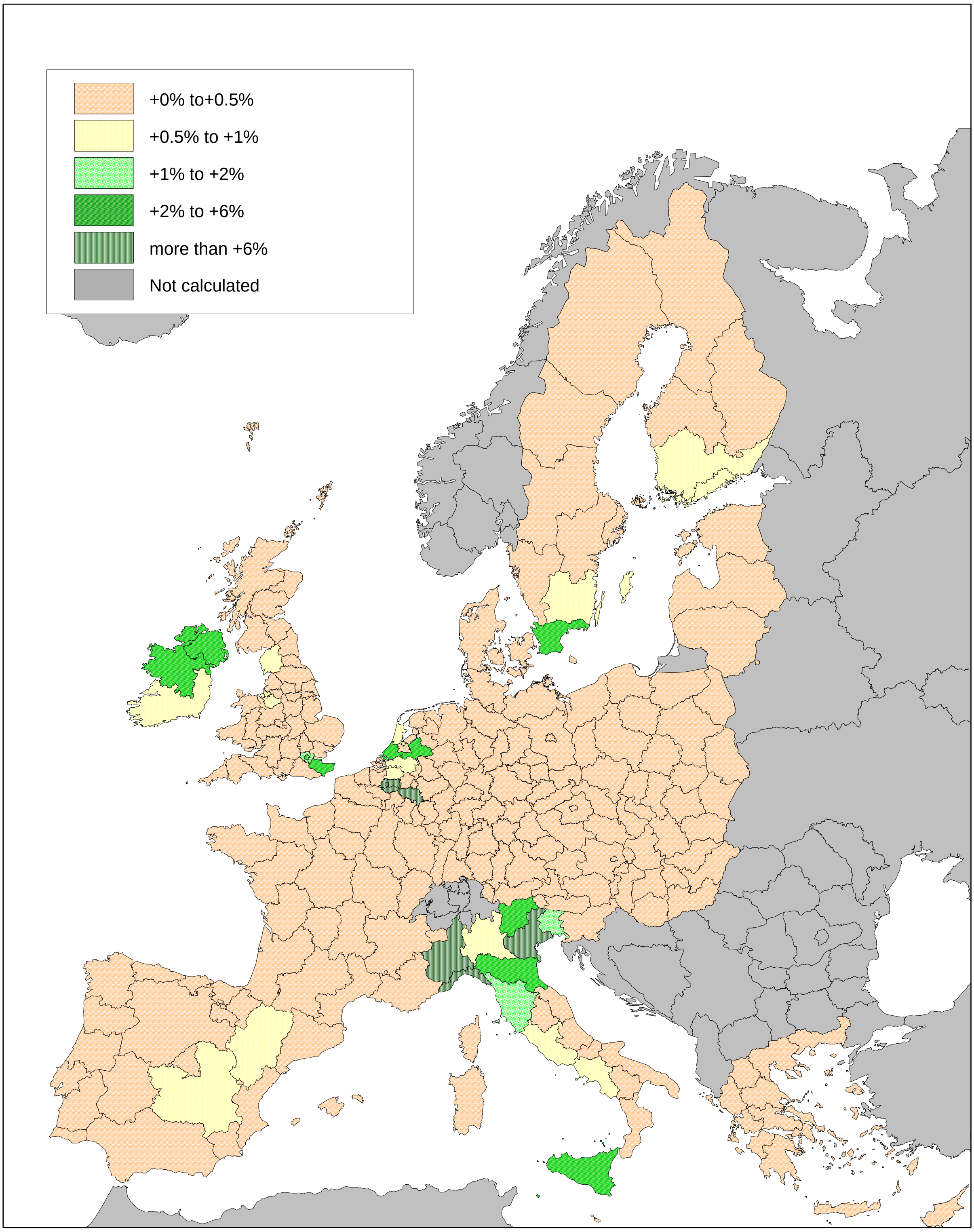


Figure 3. Change in employment due to TENs projects (construction phase) in the year 2015 – construction

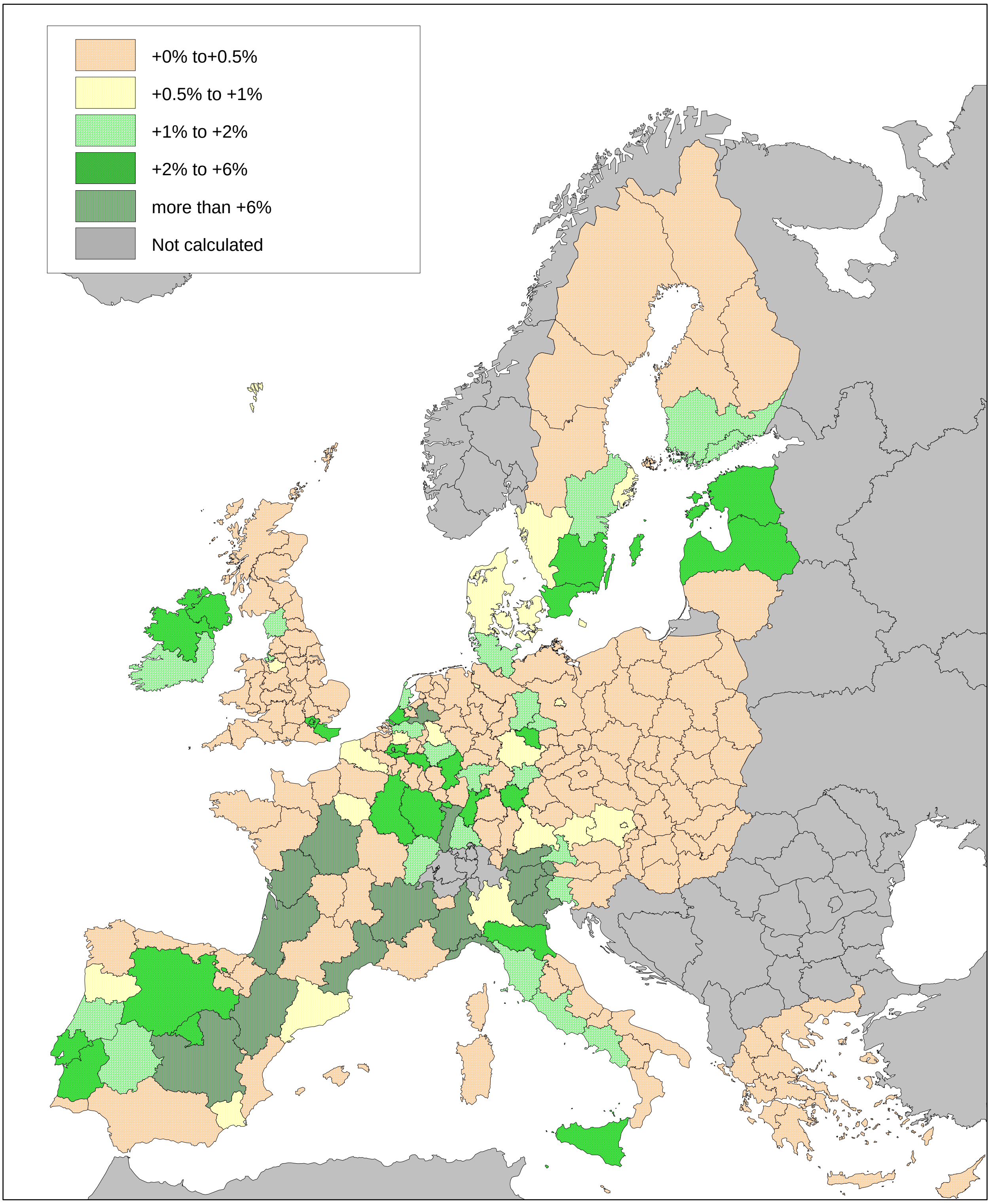


Figure 4. Change in employment due to TENs projects (construction phase) in the year 2030 – construction

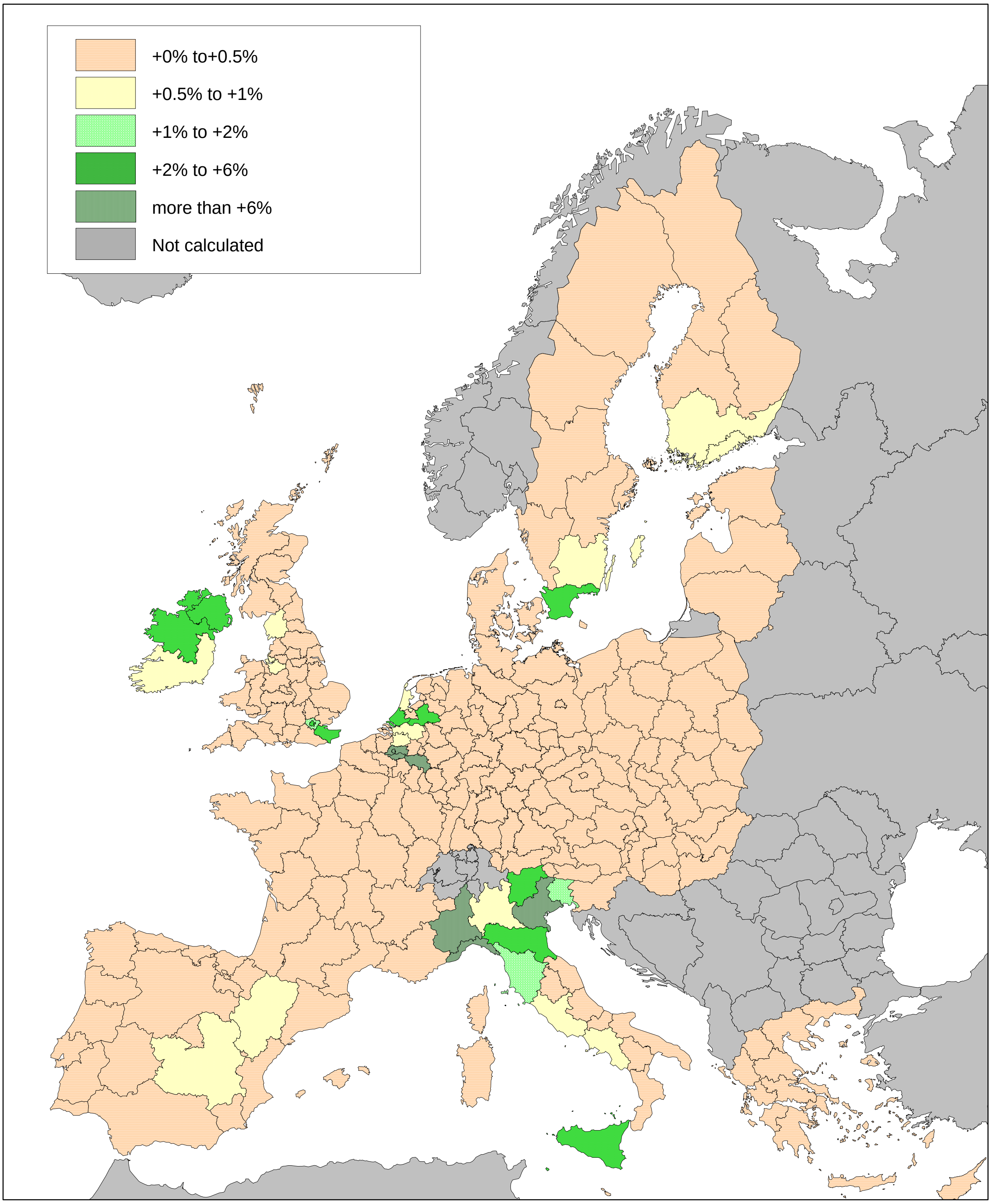


Figure 5. Change in value added due to TENs projects (construction phase) in the year 2015 – building materials

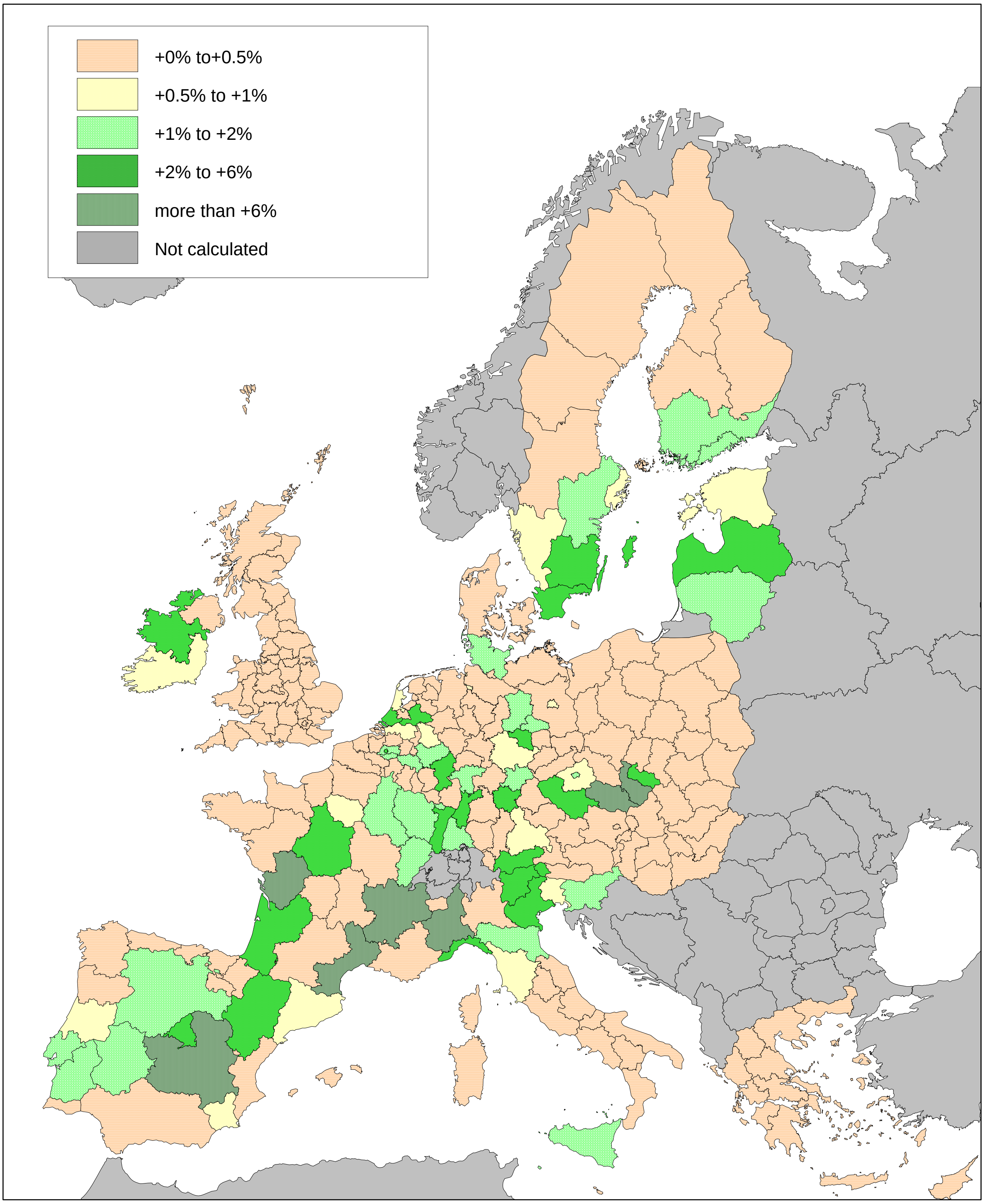


Figure 6. Change in value added due to TENs projects (construction phase) in the year 2030 – building materials

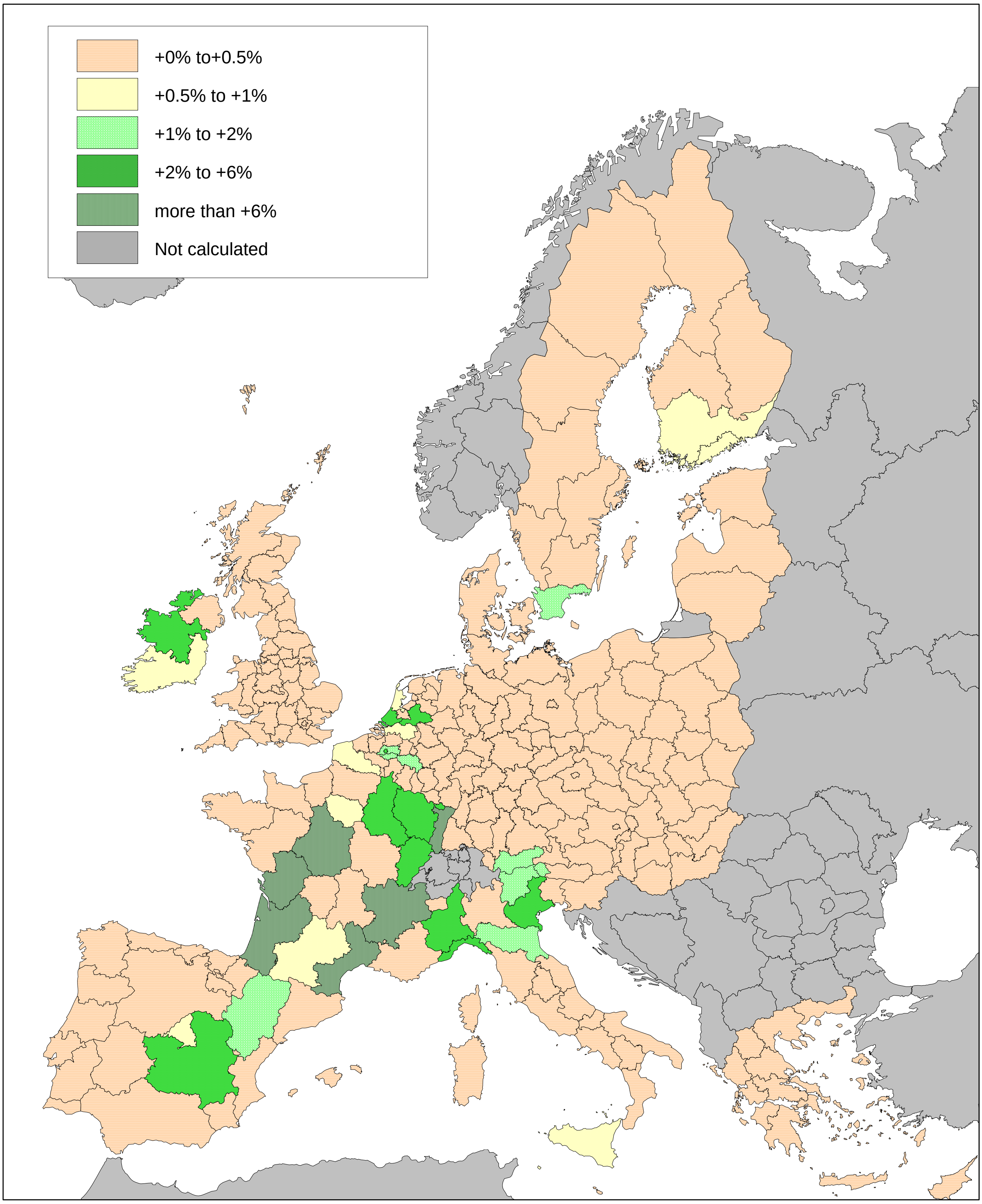


Figure 7. Change in employment due to TENs projects (construction phase) in the year 2015 – building materials

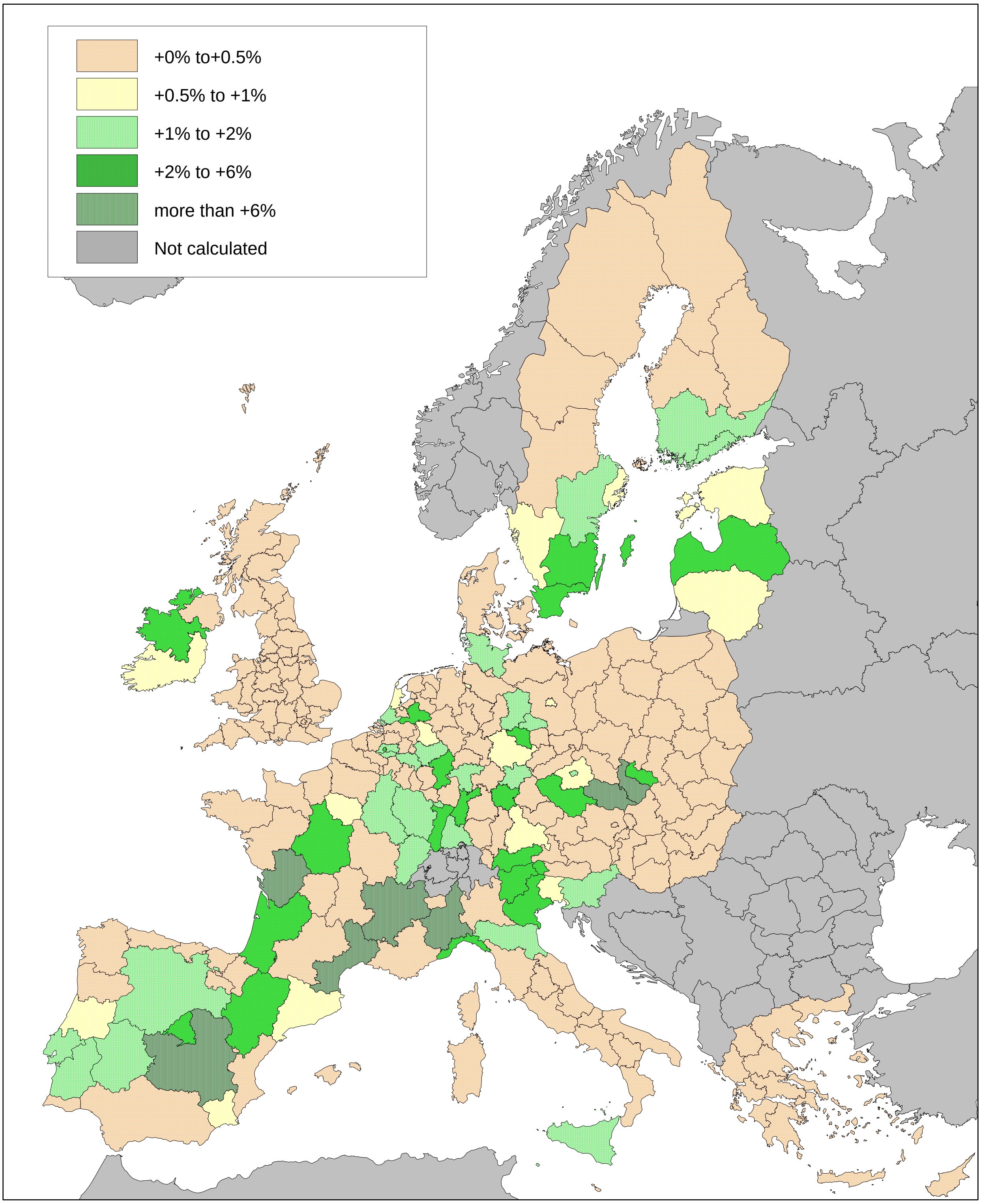


Figure 8. Change in employment due to TENs projects (construction phase) in the year 2030 – building materials

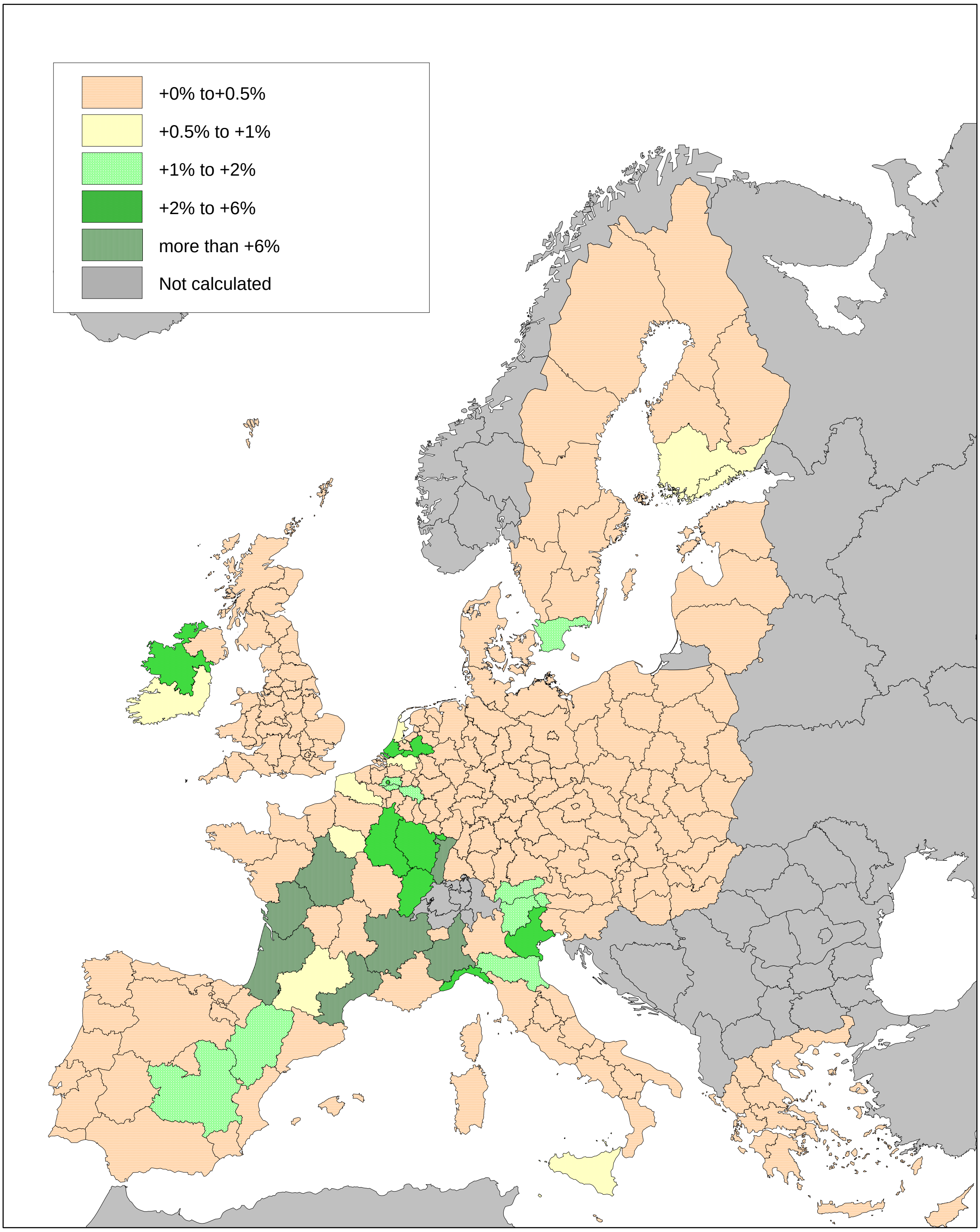


Figure 9. Change in value added due to TENs projects (construction phase) in the year 2015 – industrial machines

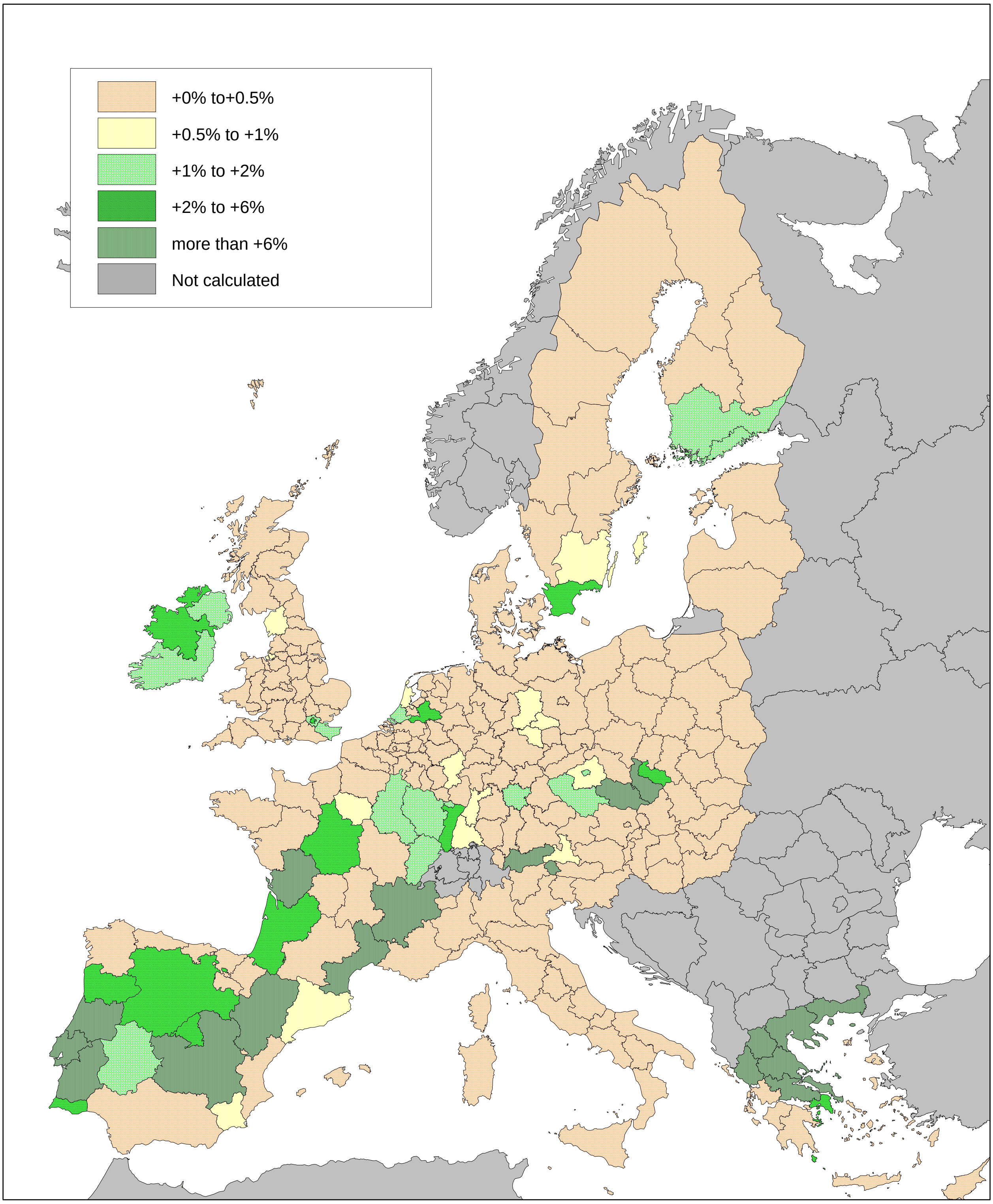


Figure 10. Change in value added due to TENs projects (construction phase) in the year 2030 – industrial machines

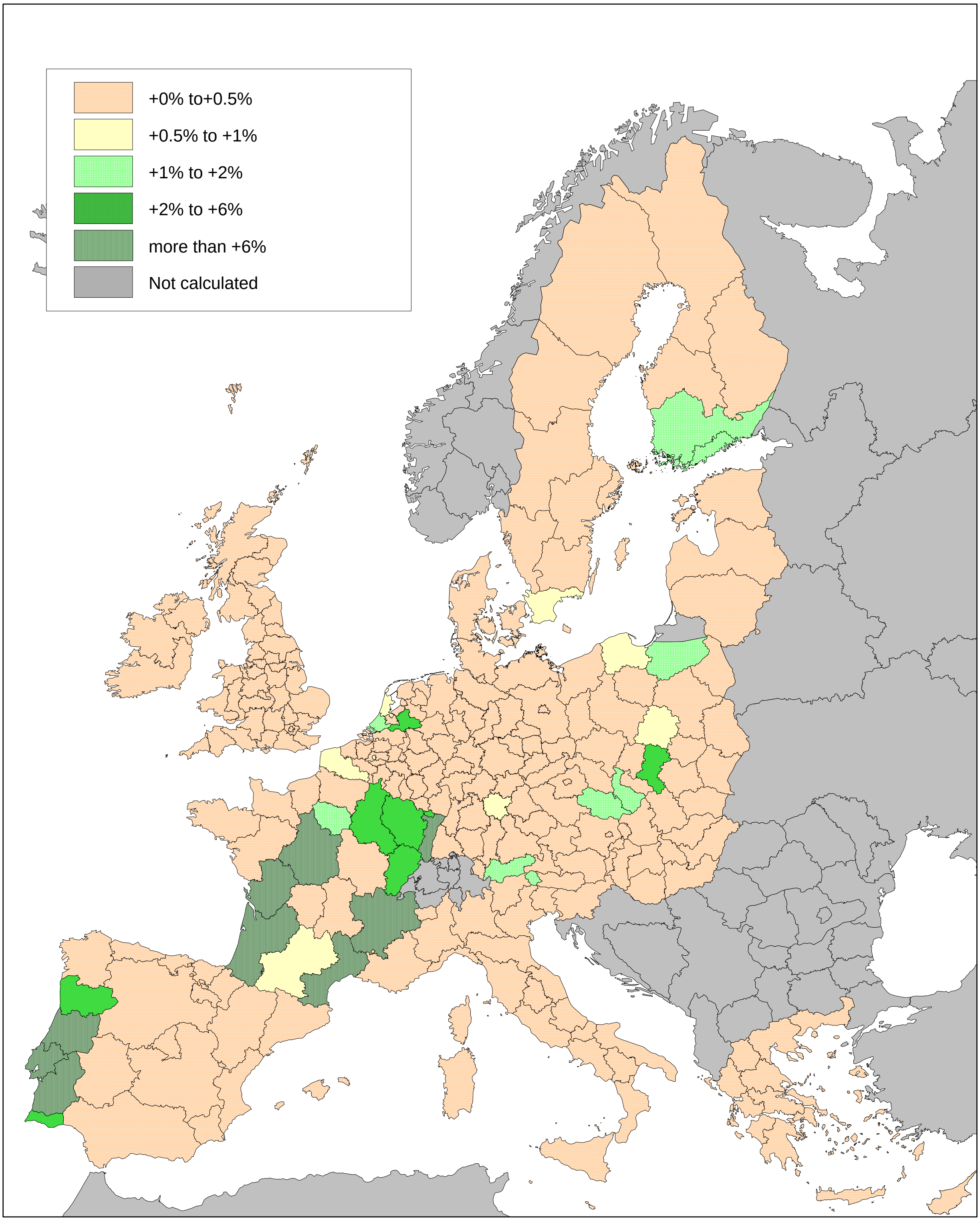


Figure 11. Change in employment due to TENs projects (construction phase) in the year 2015 – industrial machines

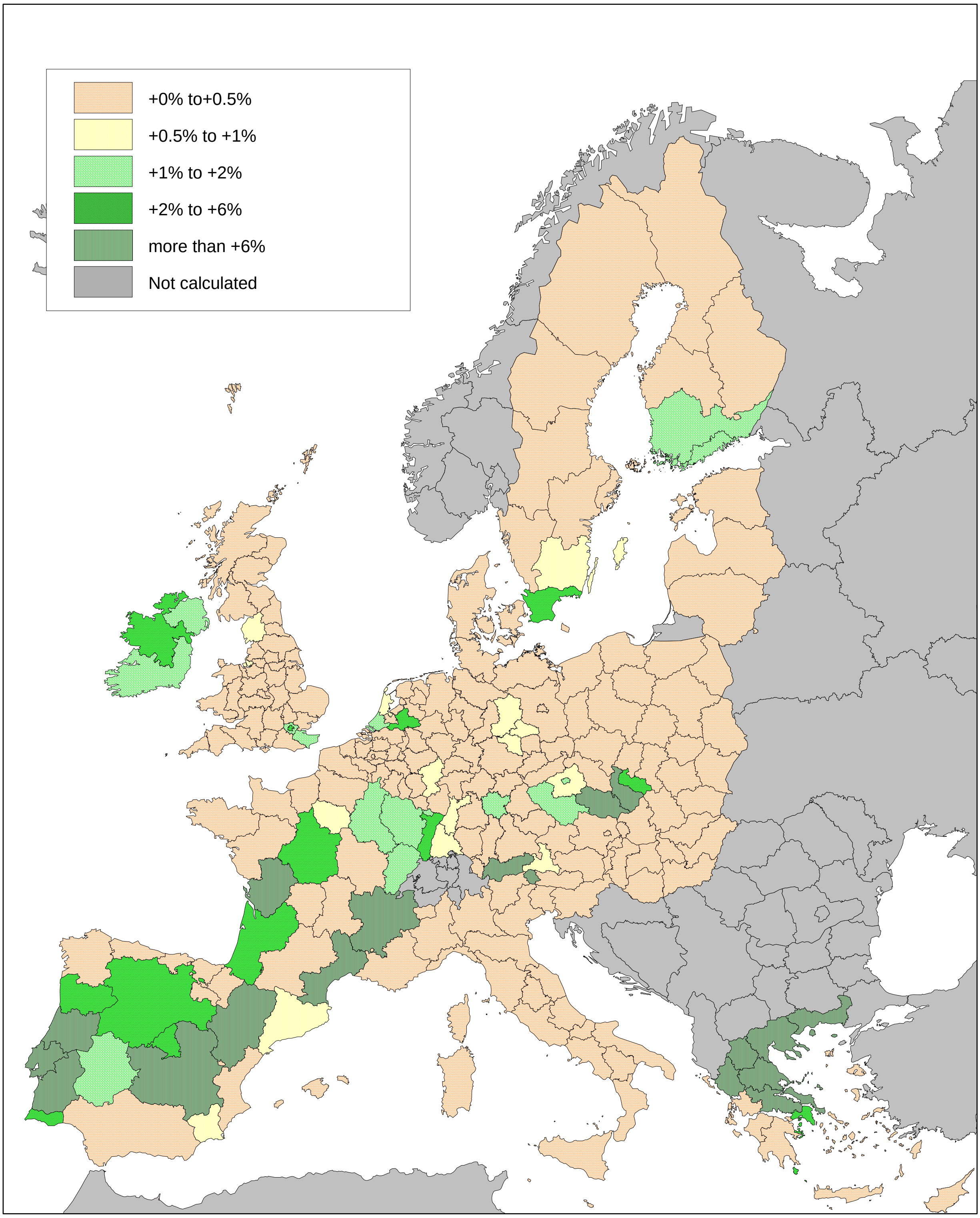


Figure 12. Change in employment due to TENs projects (construction phase) in the year 2030 – industrial machines

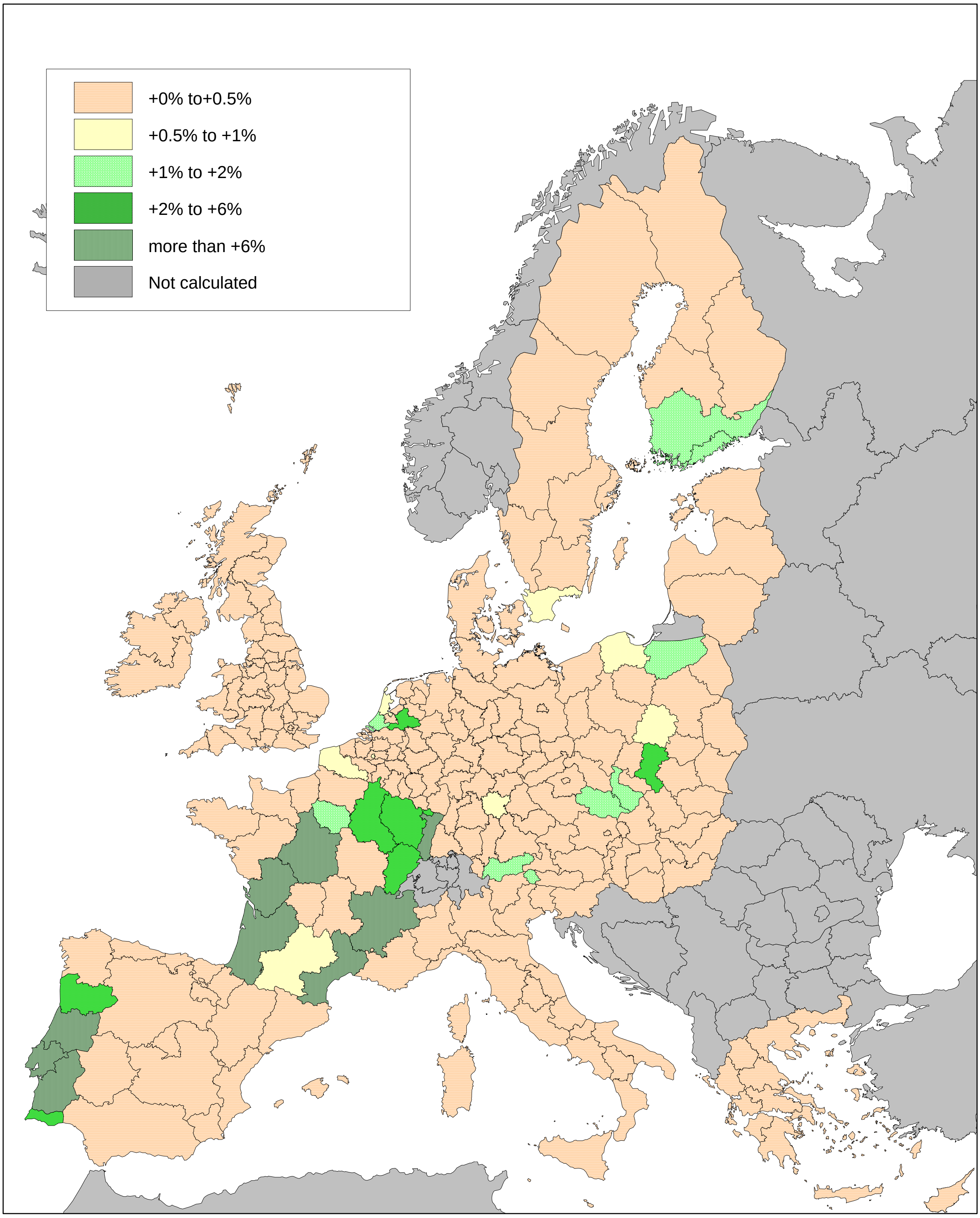


Figure 13. Change in value added due to TENs projects (construction phase) in the year 2015 – trade and auxiliary service

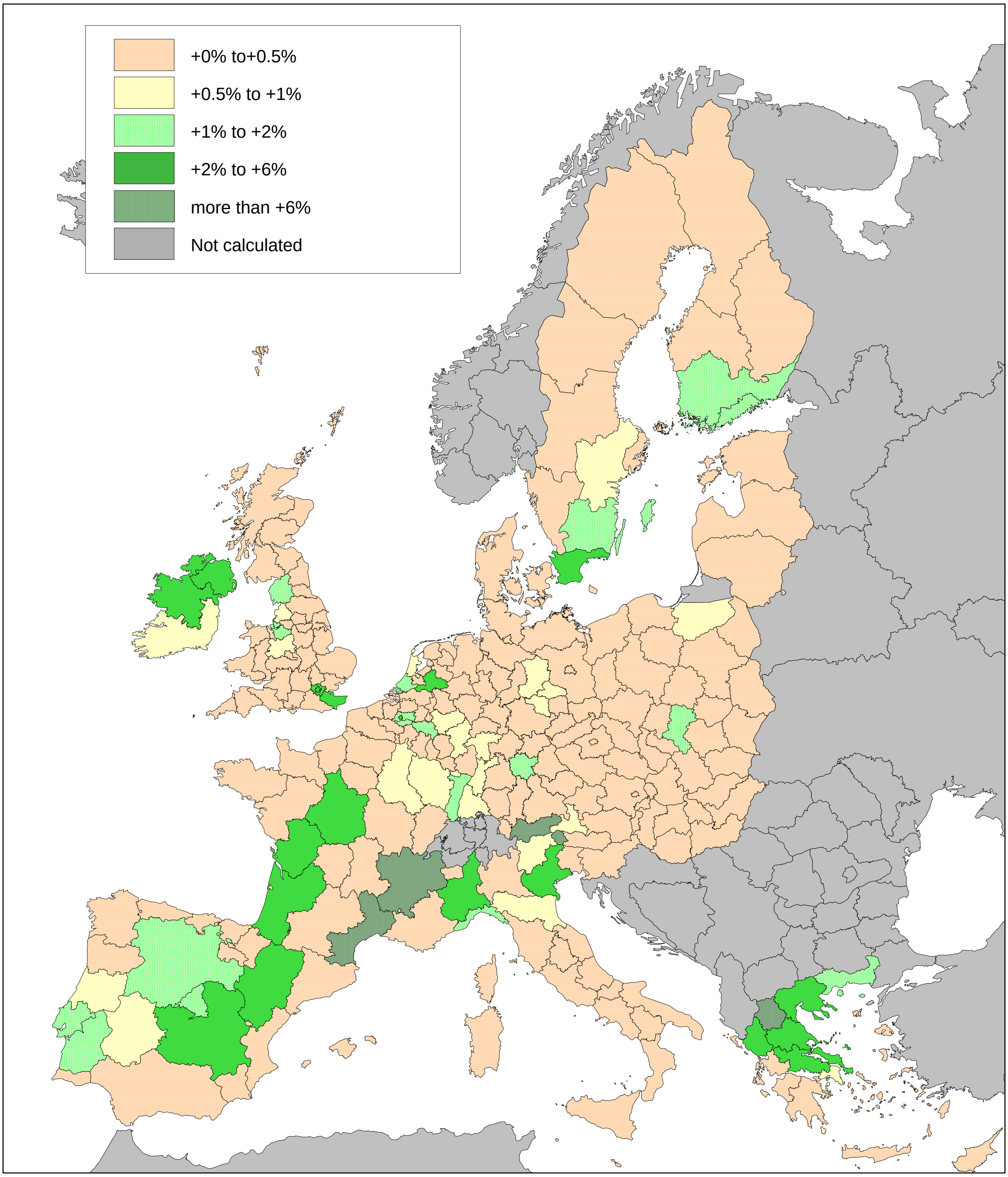


Figure 14. Change in value added due to TENs projects (construction phase) in the year 2030 – trade and auxiliary services

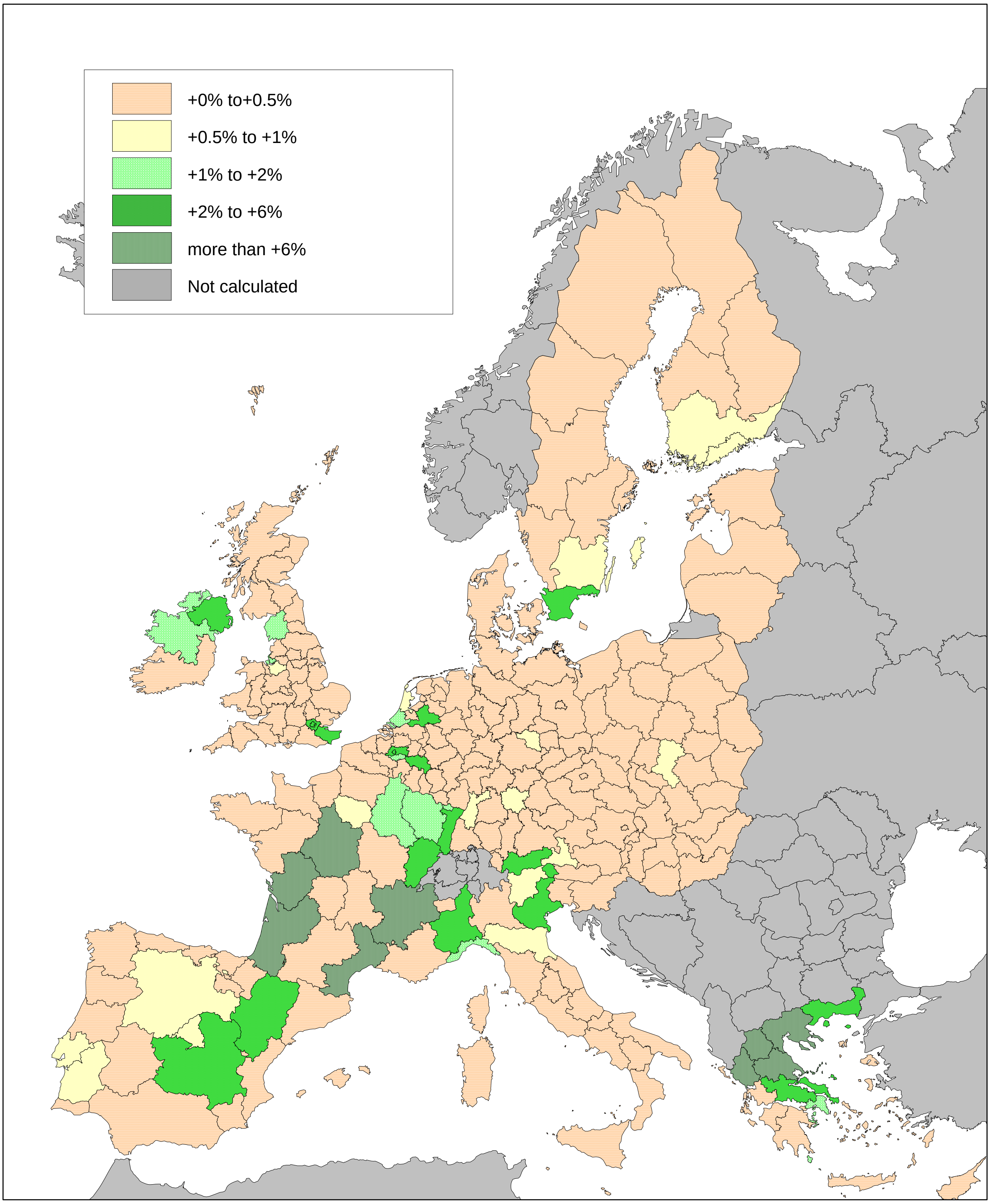


Figure 15. Change in employment due to TENs projects (construction phase) in the year 2015 – trade and auxiliary services

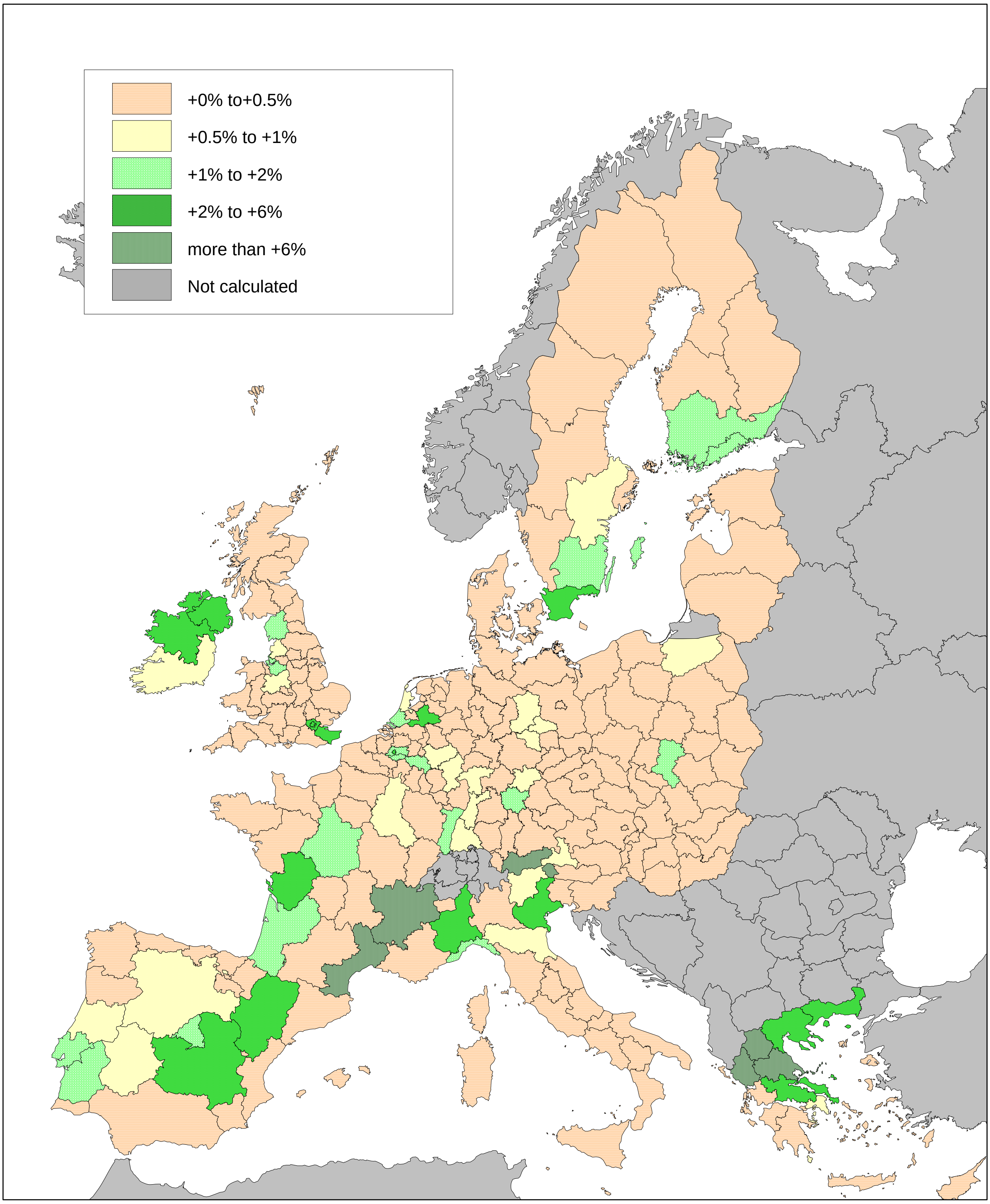


Figure 16. Change in employment due to TENs projects (construction phase) in the year 2030 – trade and auxiliary services

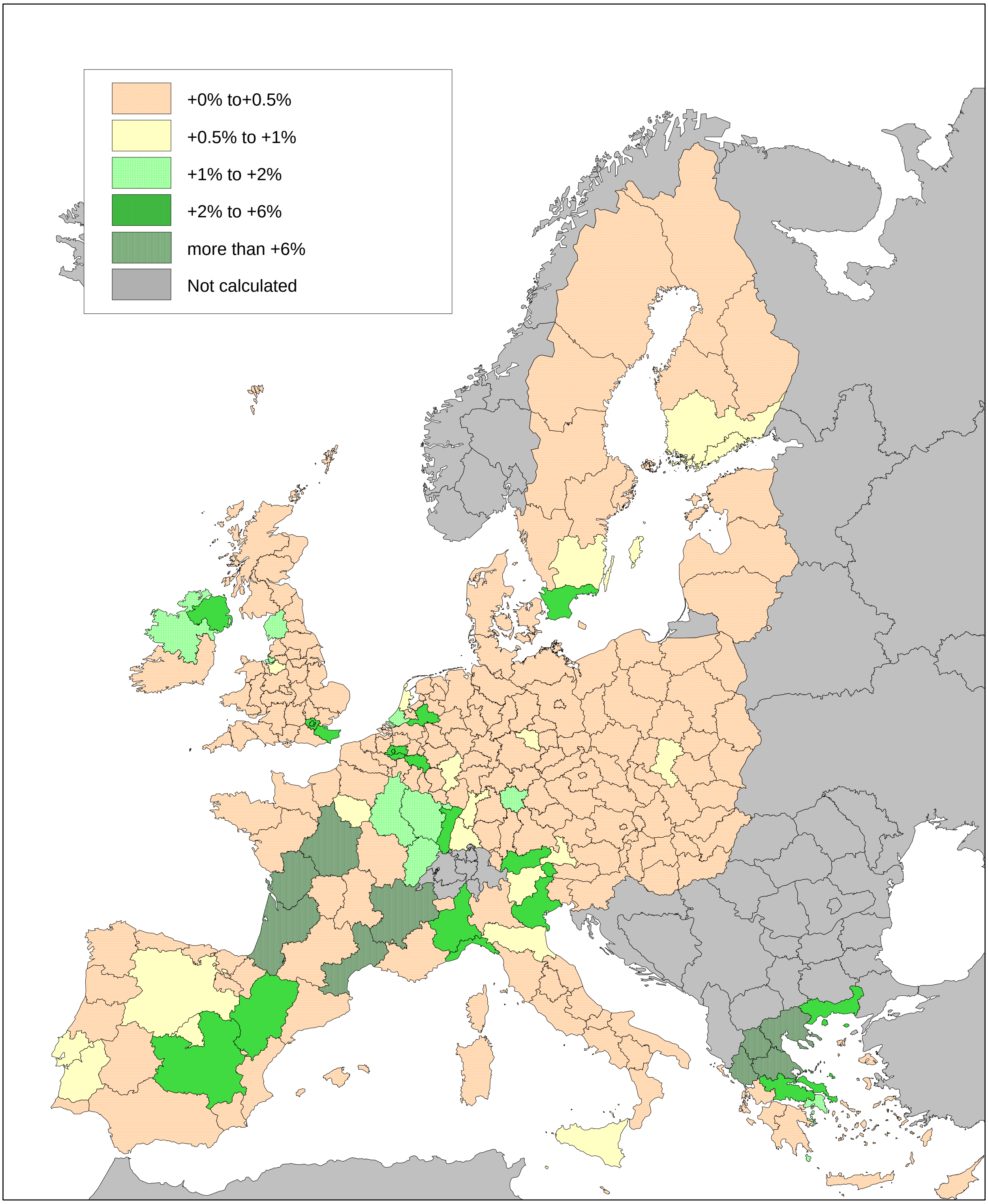


Figure 17. Change in value added due to TENs projects (construction phase) in the year 2015 – other manufacturing

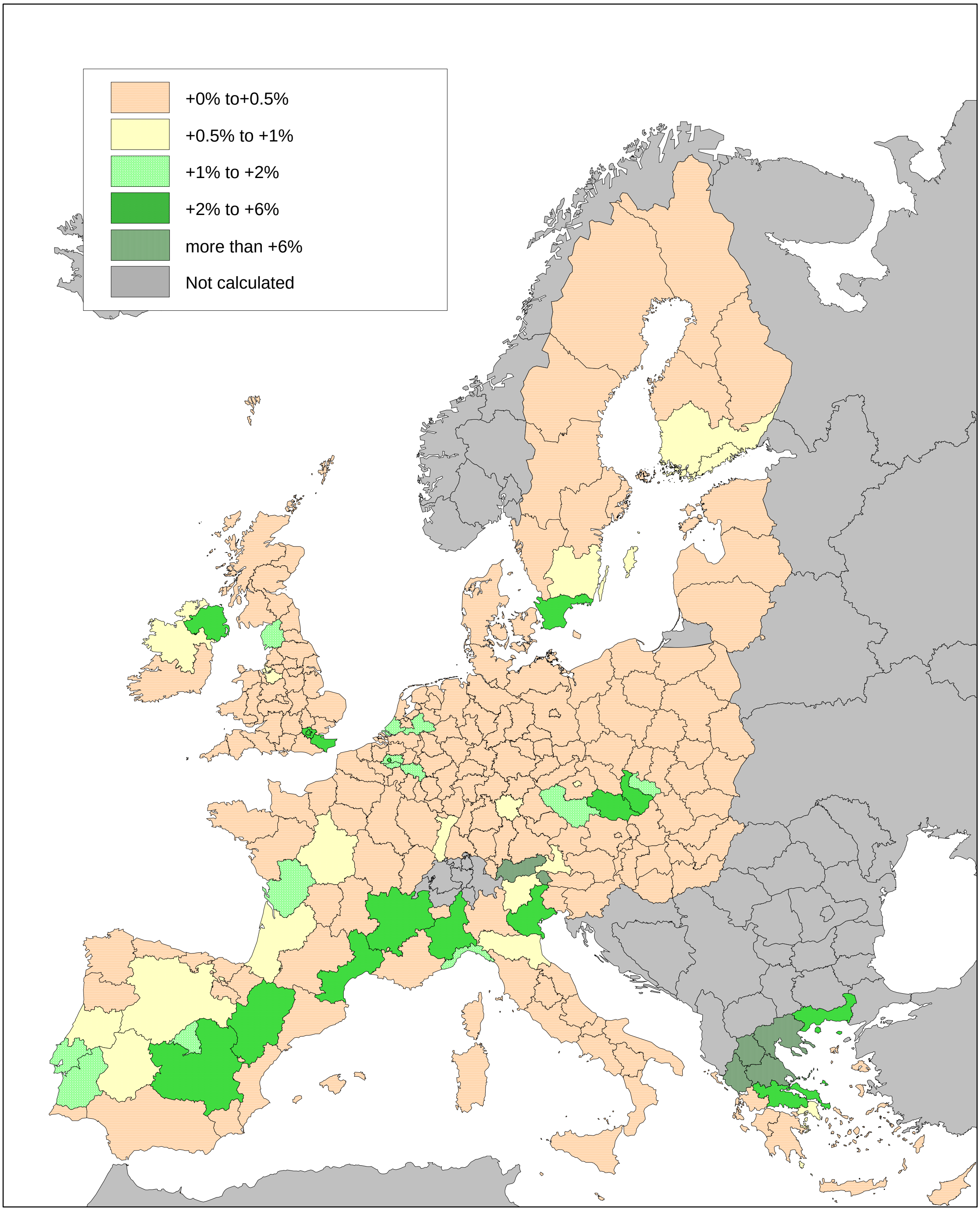


Figure 18. Change in value added due to TENs projects (construction phase) in the year 2030 – other manufacturing

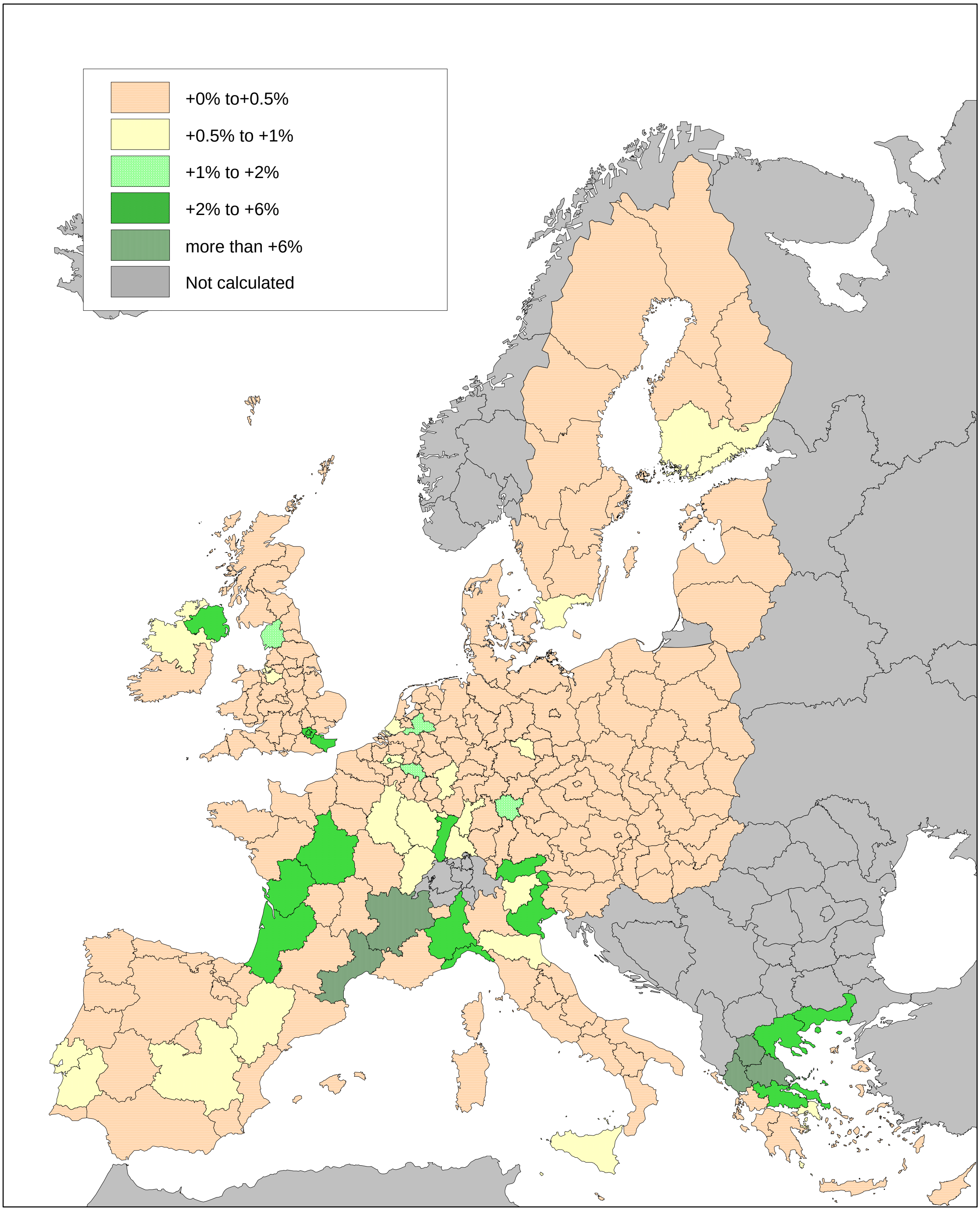


Figure 19. Change in employment due to TENs projects (construction phase) in the year 2015 – other manufacturing

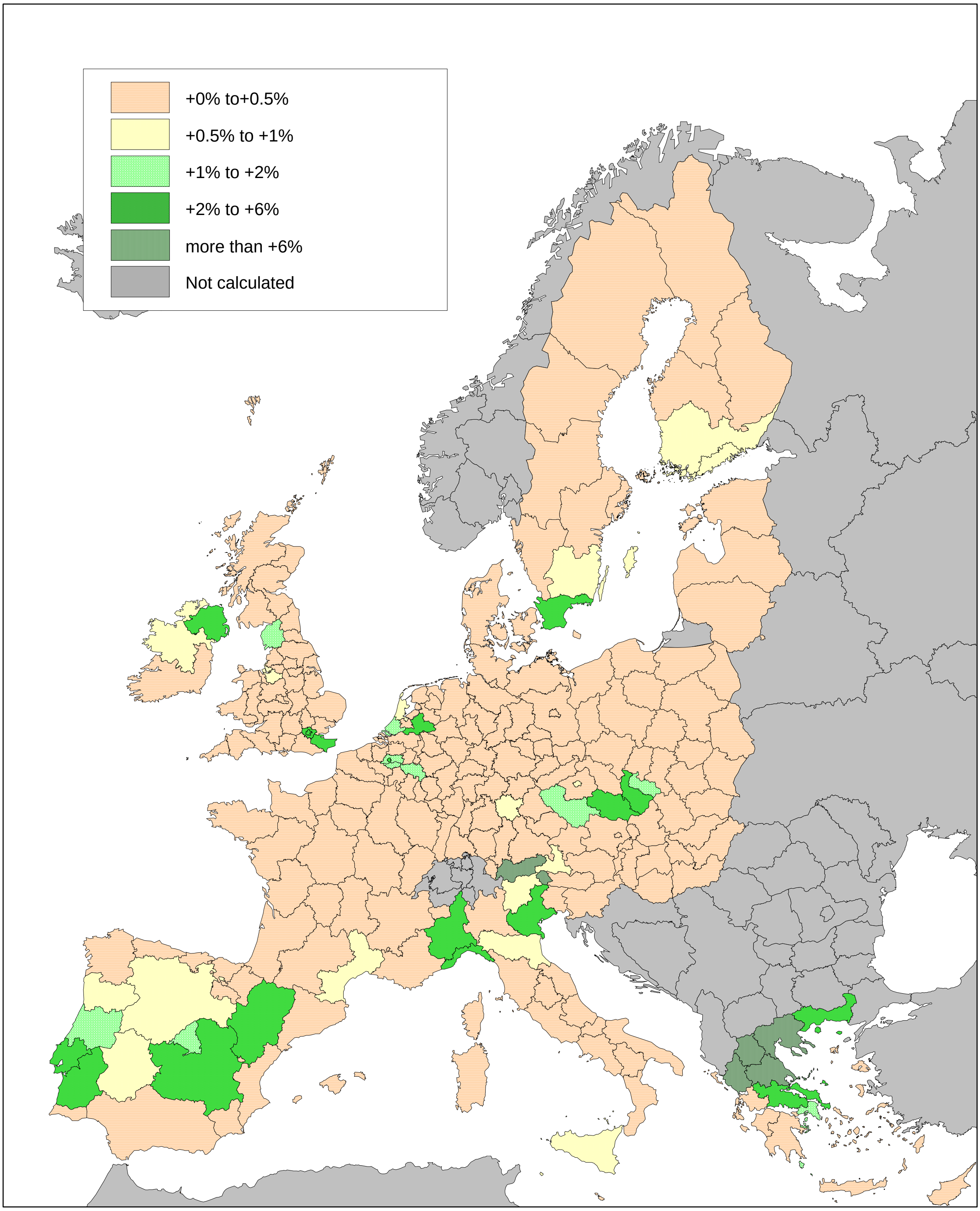


Figure 20. Change in employment due to TENs projects (construction phase) in the year 2030 – other manufacturing

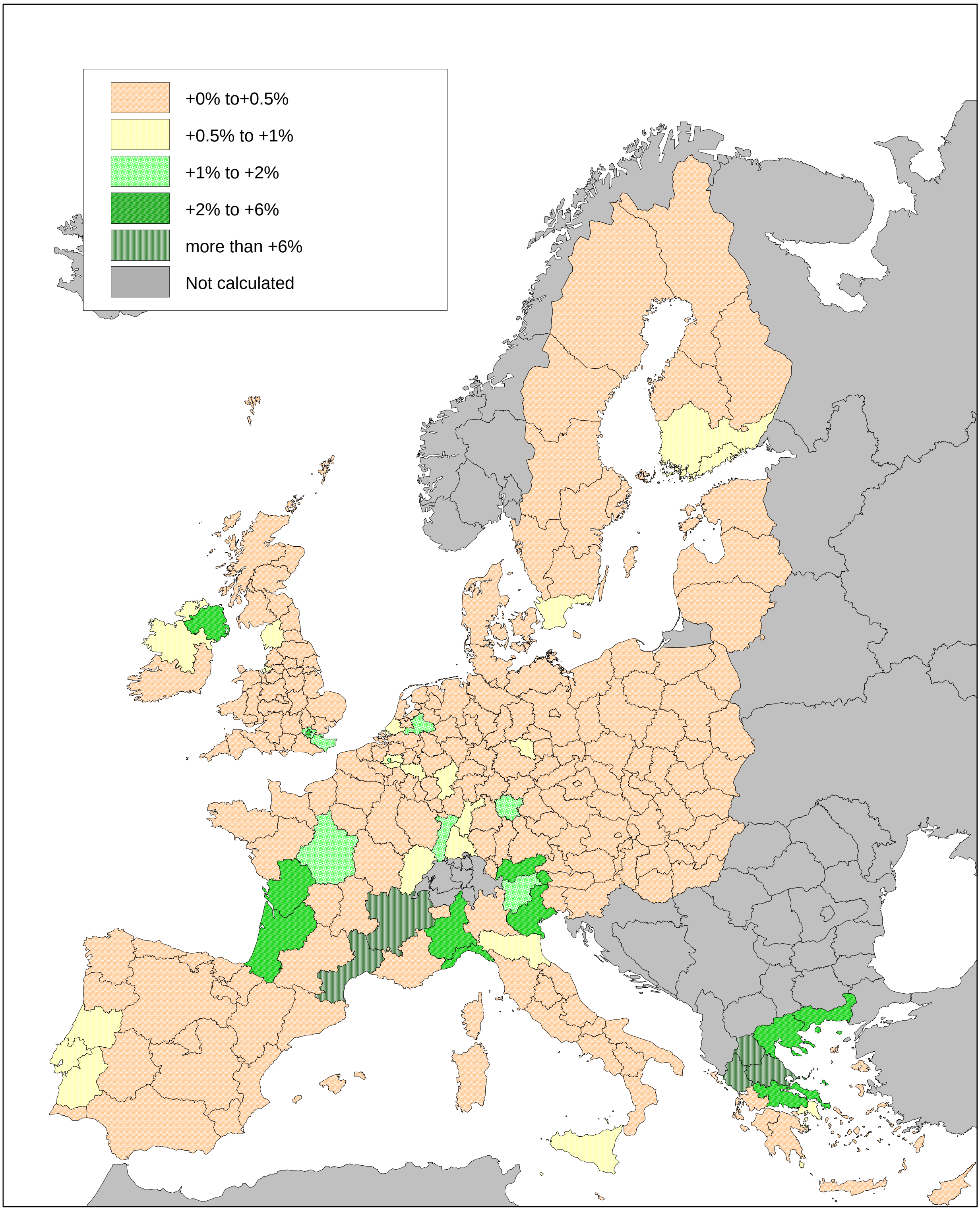


Figure 21. Change in value added due to TENs projects (construction phase) in the year 2015 – other services

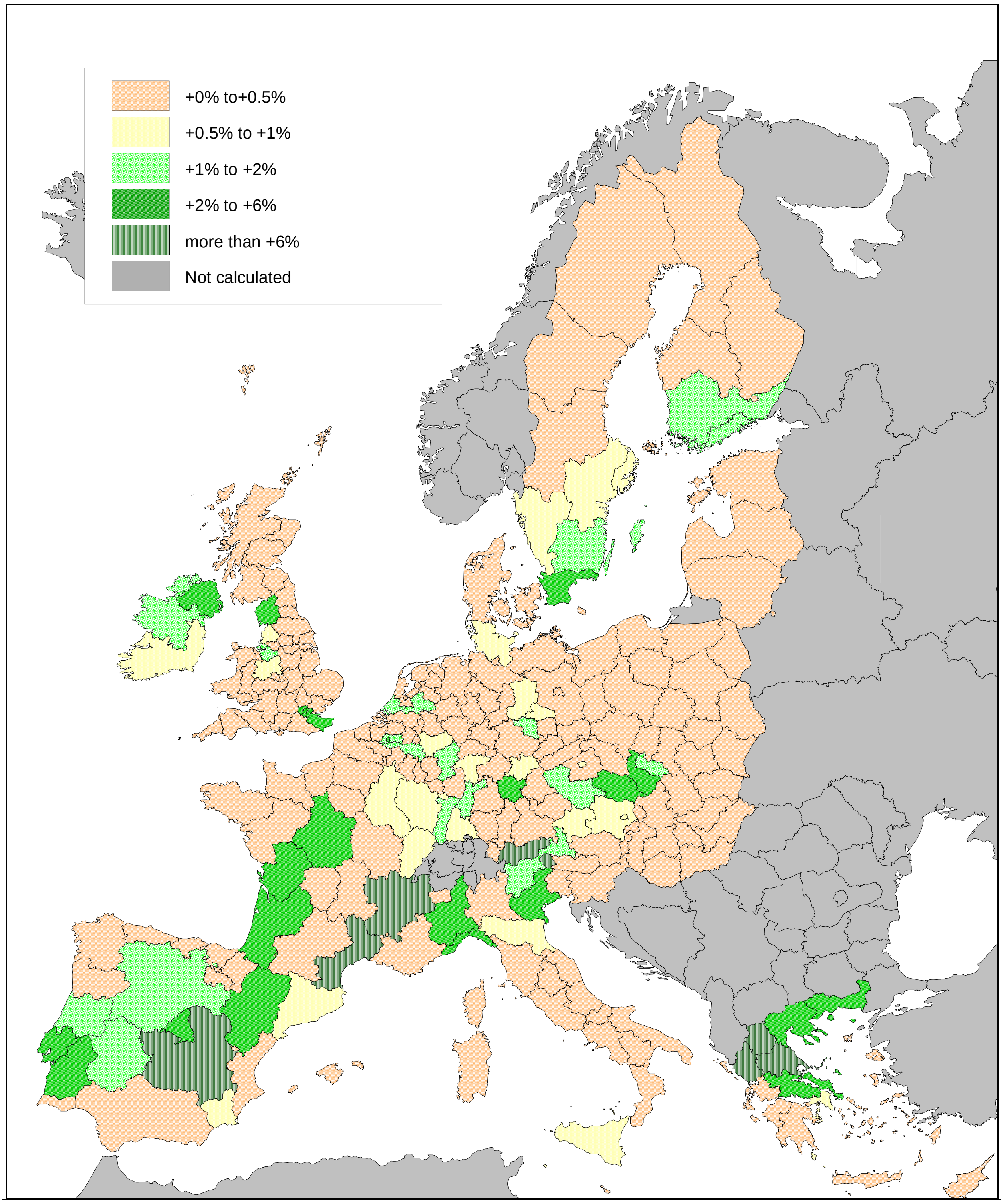


Figure 22. Change in value added due to TENs projects (construction phase) in the year 2030 – other services

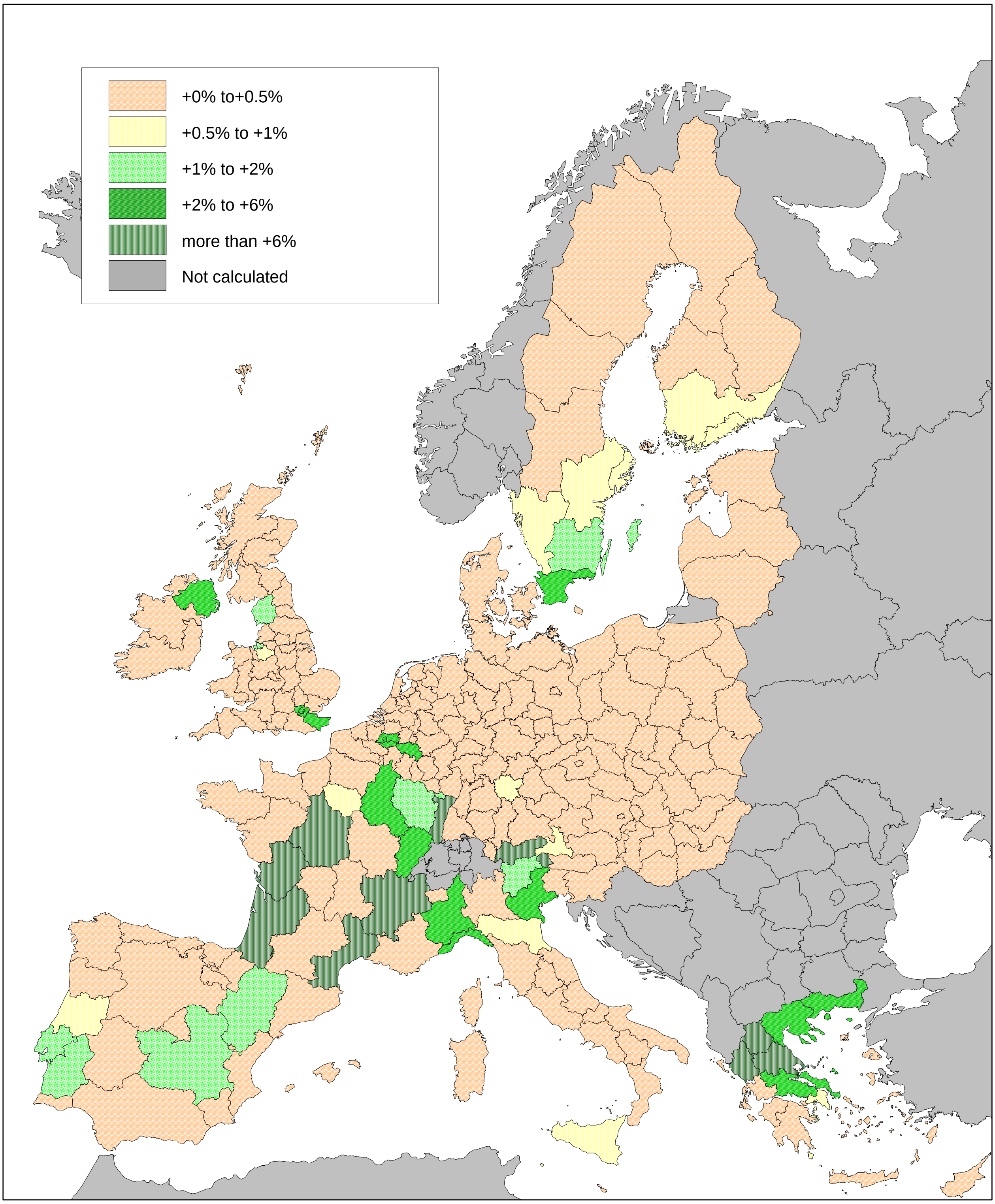


Figure 23. Change in employment due to TENs projects (construction phase) in the year 2015 – other services

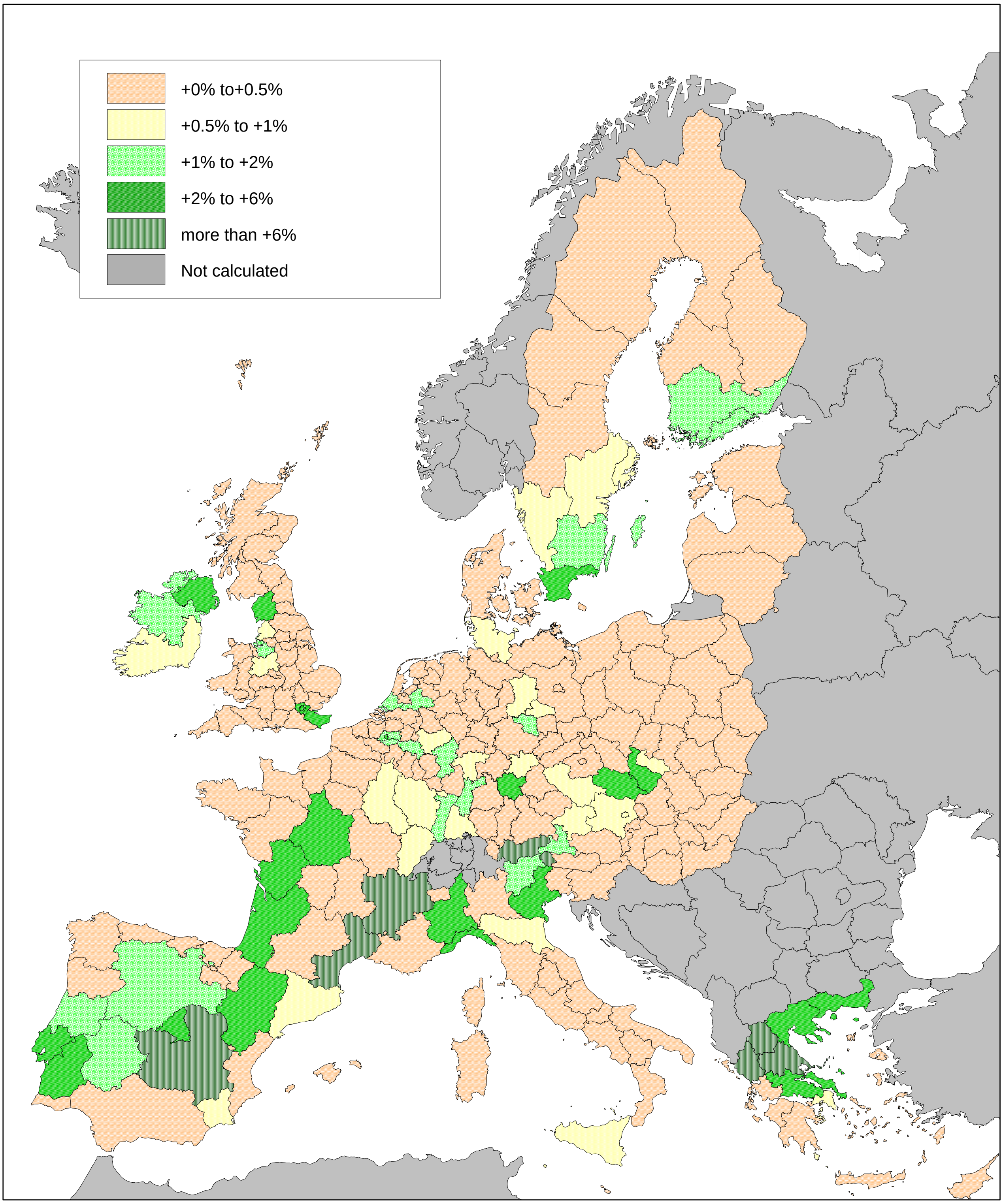
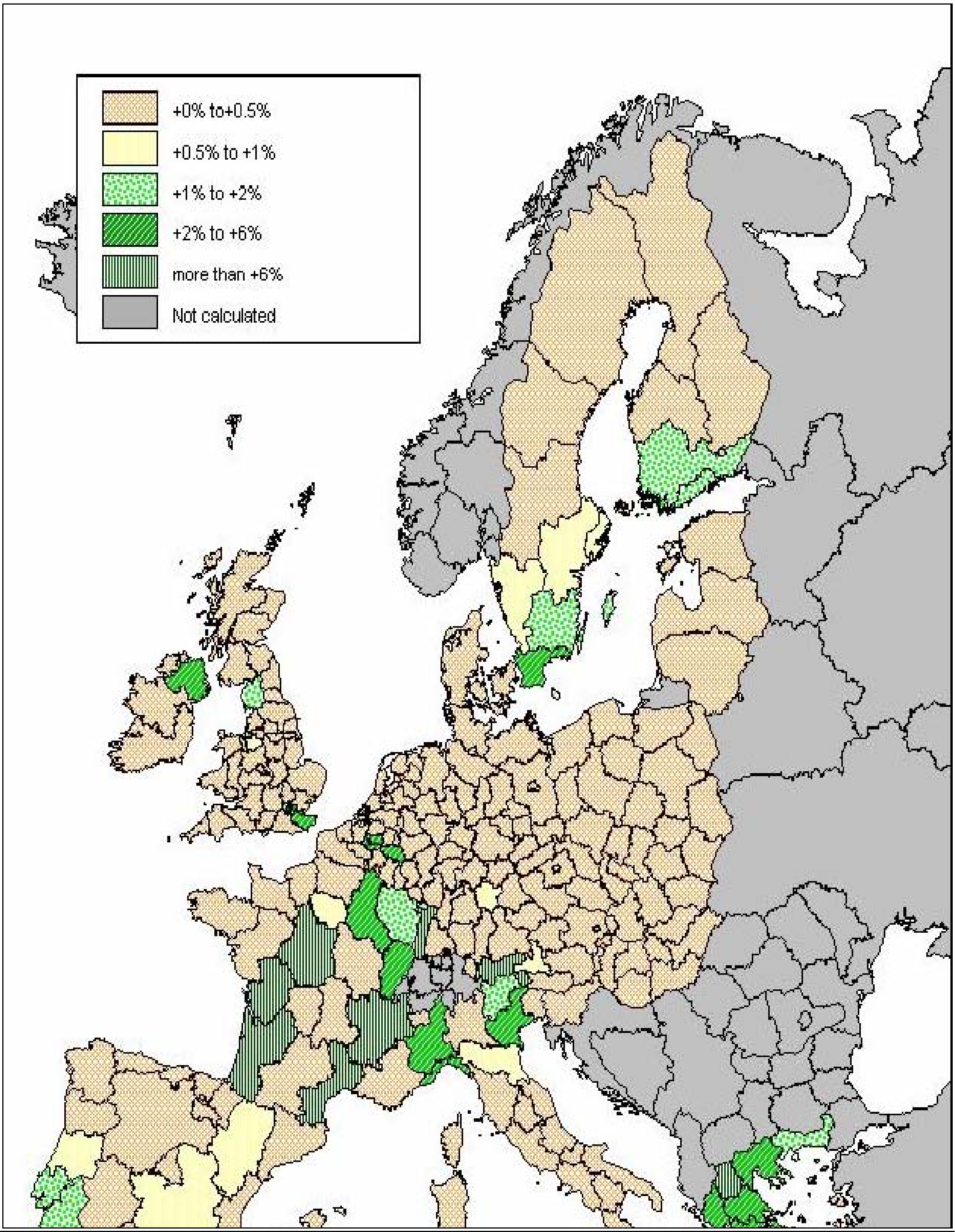


Figure 24. Change in employment due to TENs projects (construction phase) in the year 2030 – other services



Annex 3.

Figure 1. Change in value added due to rail TENs projects only (construction phase) in the year 2015

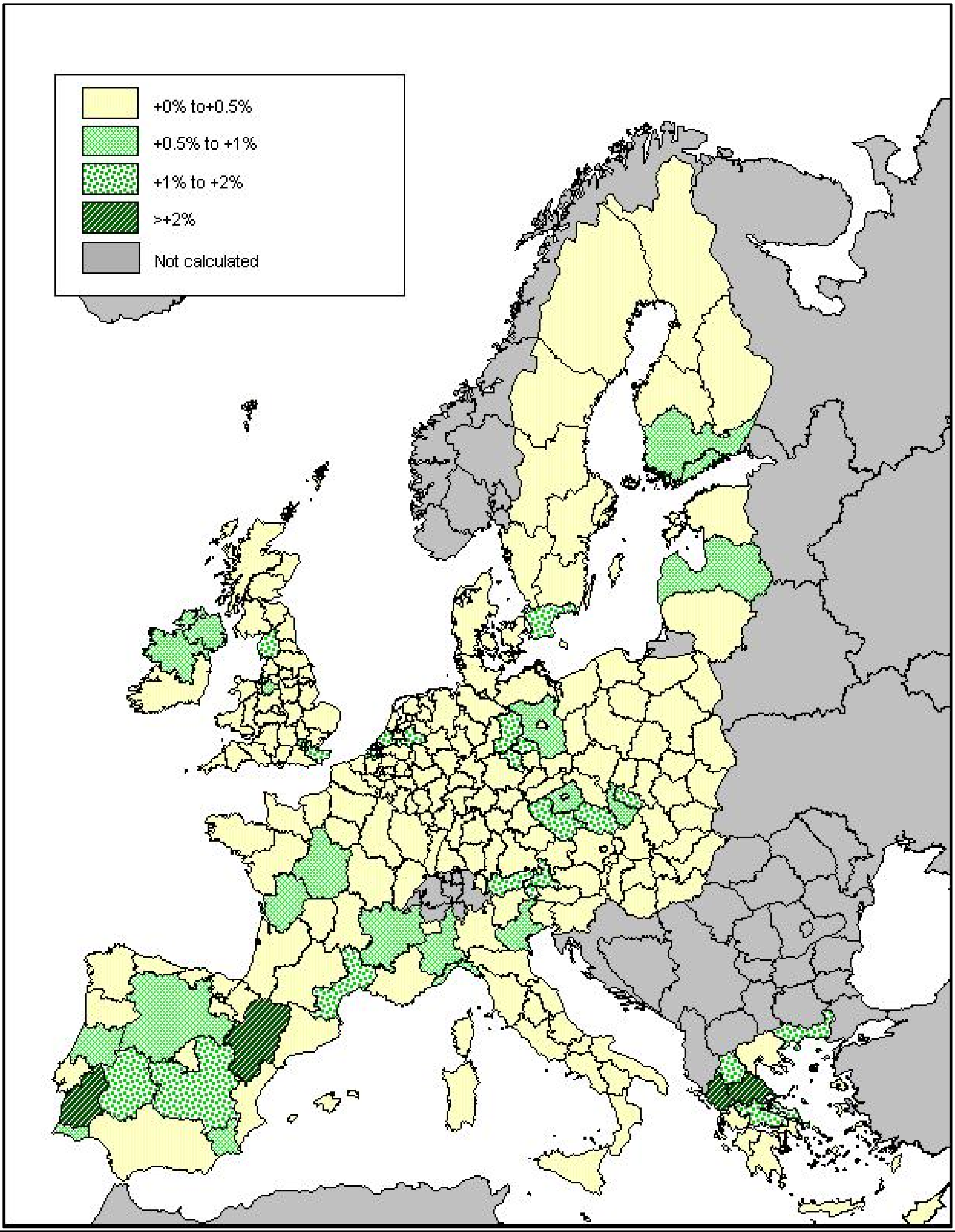


Figure 2. Change in value added due to rail TENs projects only (construction phase) in the year 2030

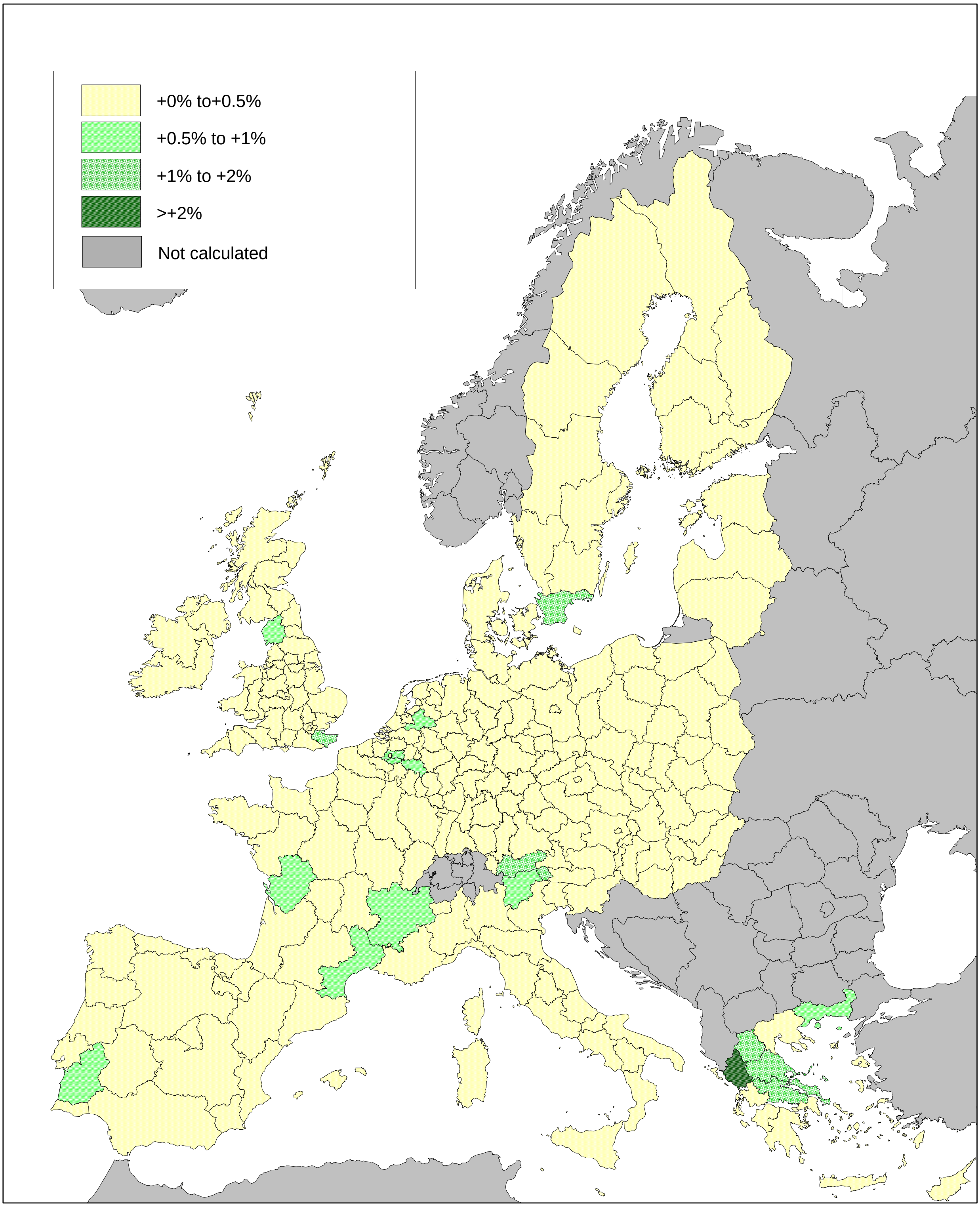


Figure 3. Change in employment due to rail TENs projects only (construction phase) in the year 2015

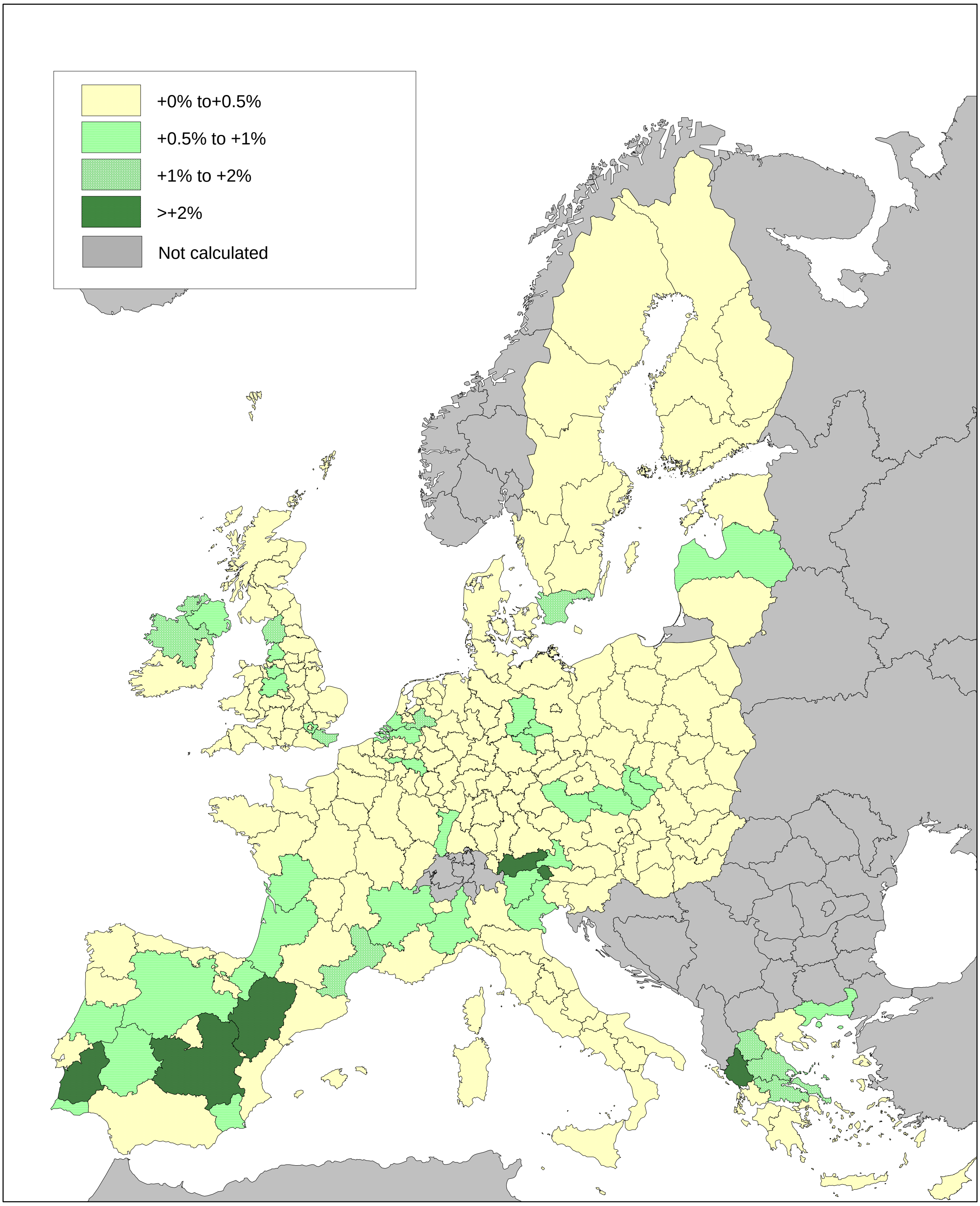


Figure 4. Change in employment due to rail TENs projects only (construction phase) in the year 2030

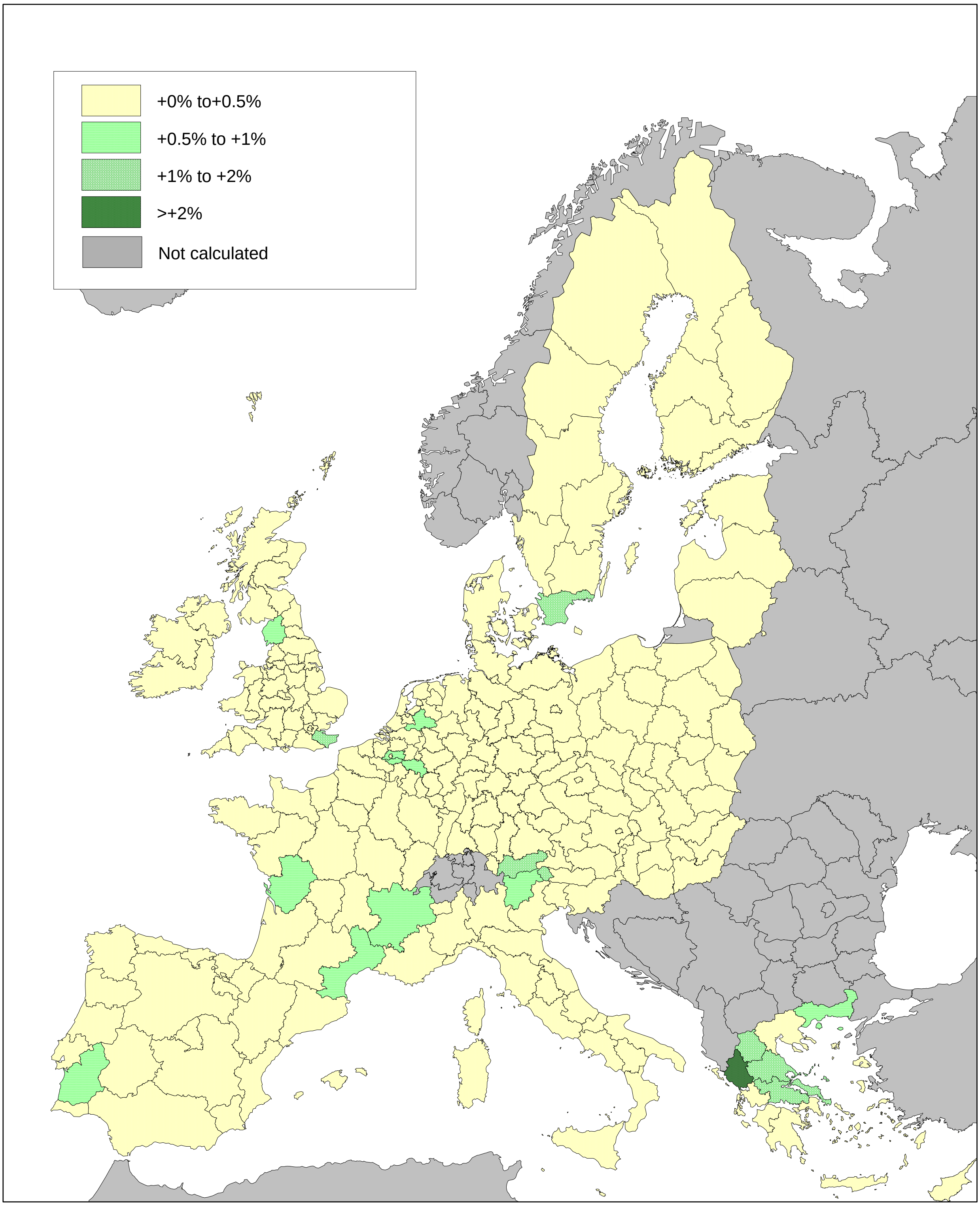


Figure 5. Change in value added due to road TENs projects only (construction phase) in the year 2015

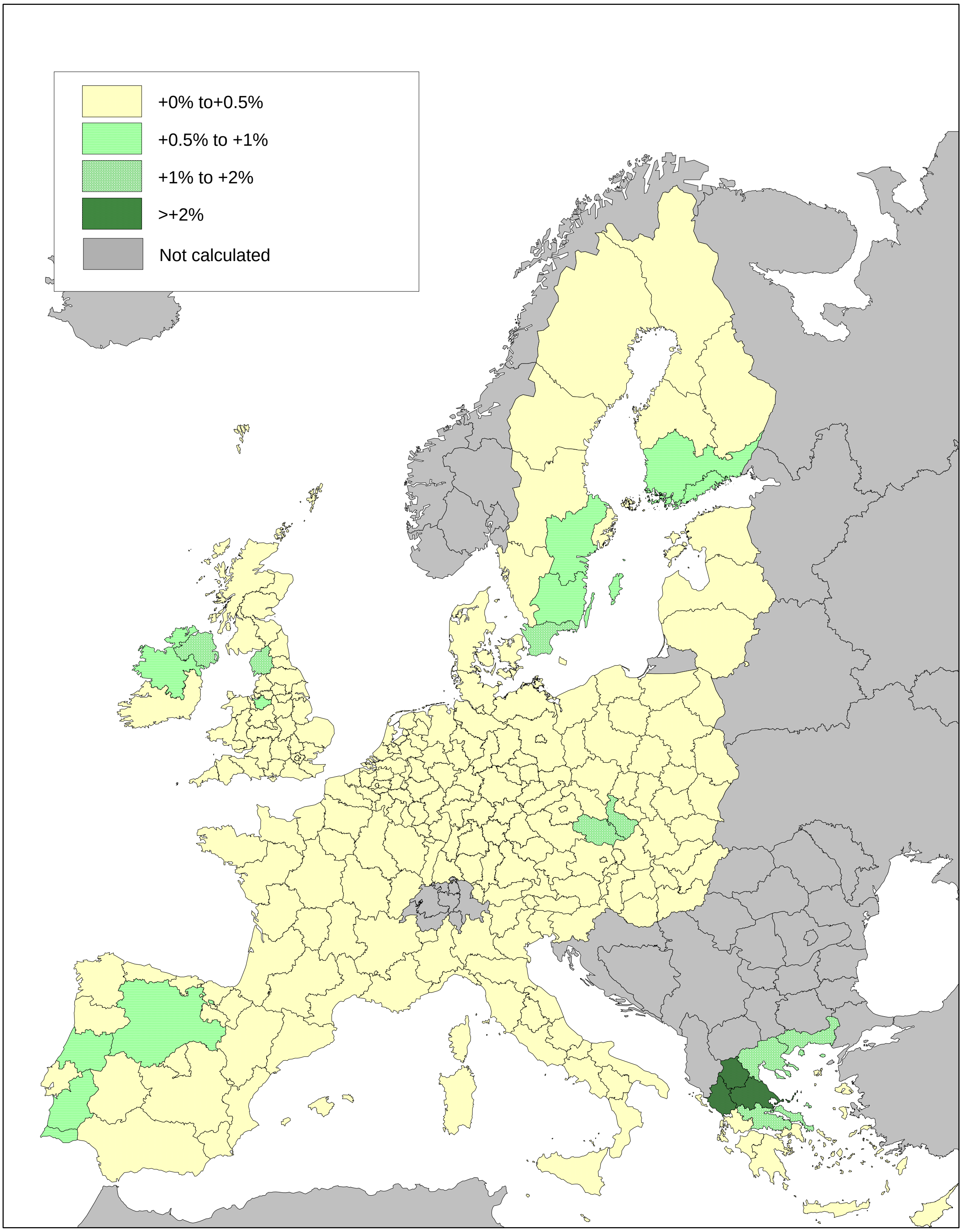


Figure 6. Change in value added due to road TENs projects only (construction phase) in the year 2030

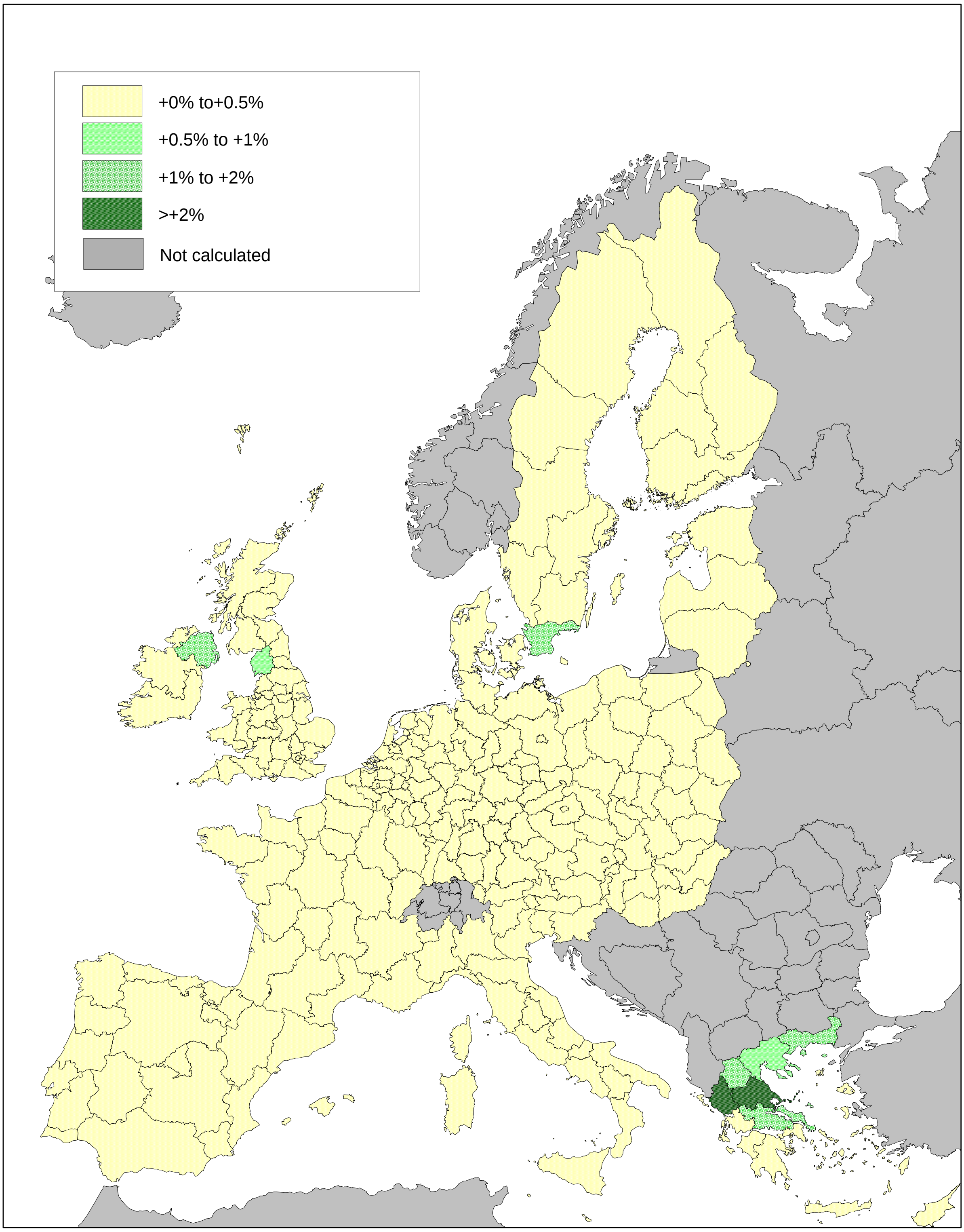


Figure 7. Change in employment due to road TENs projects only (construction phase) in the year 2015

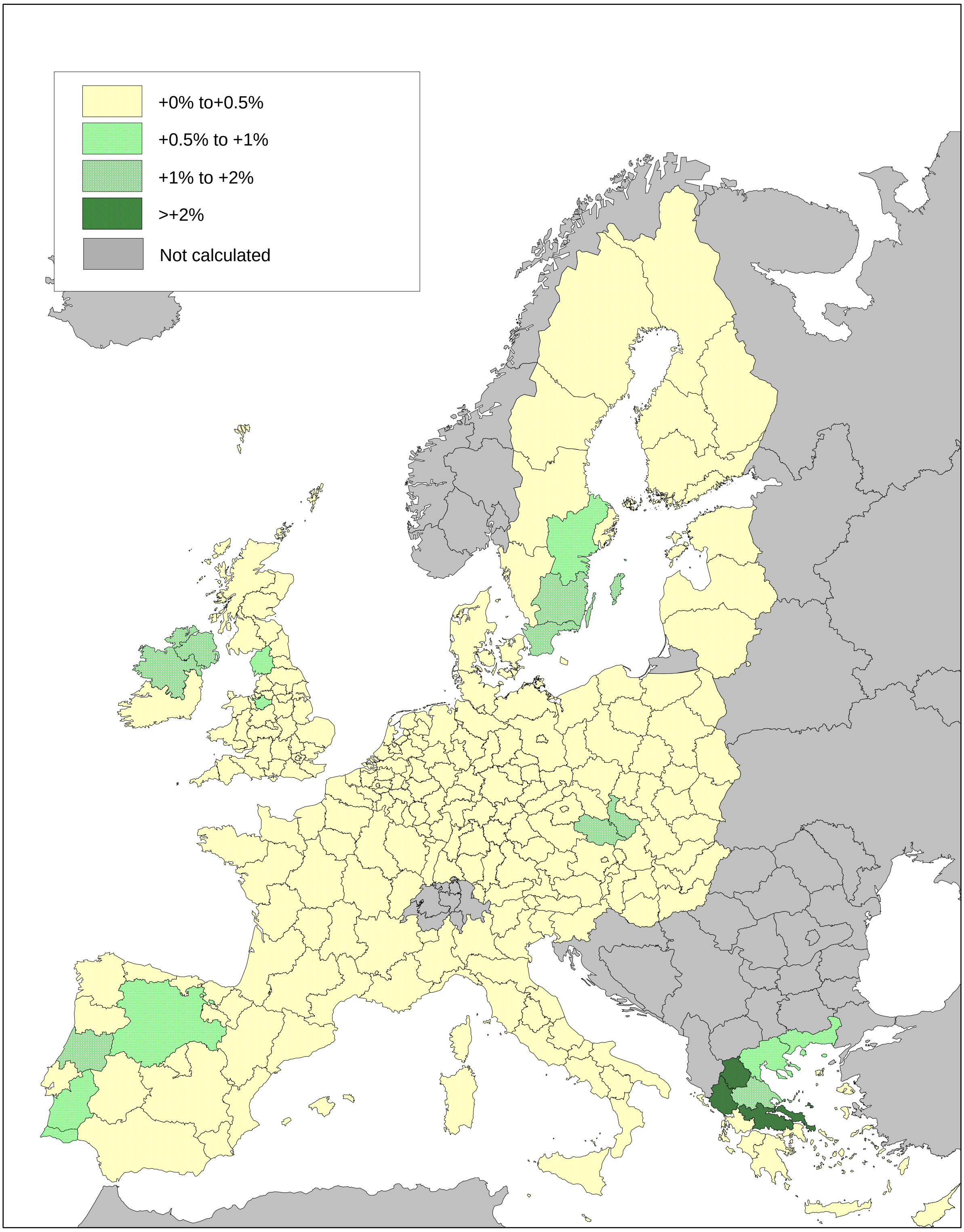


Figure 8. Change in employment due to road TENs projects only (construction phase) in the year 2030

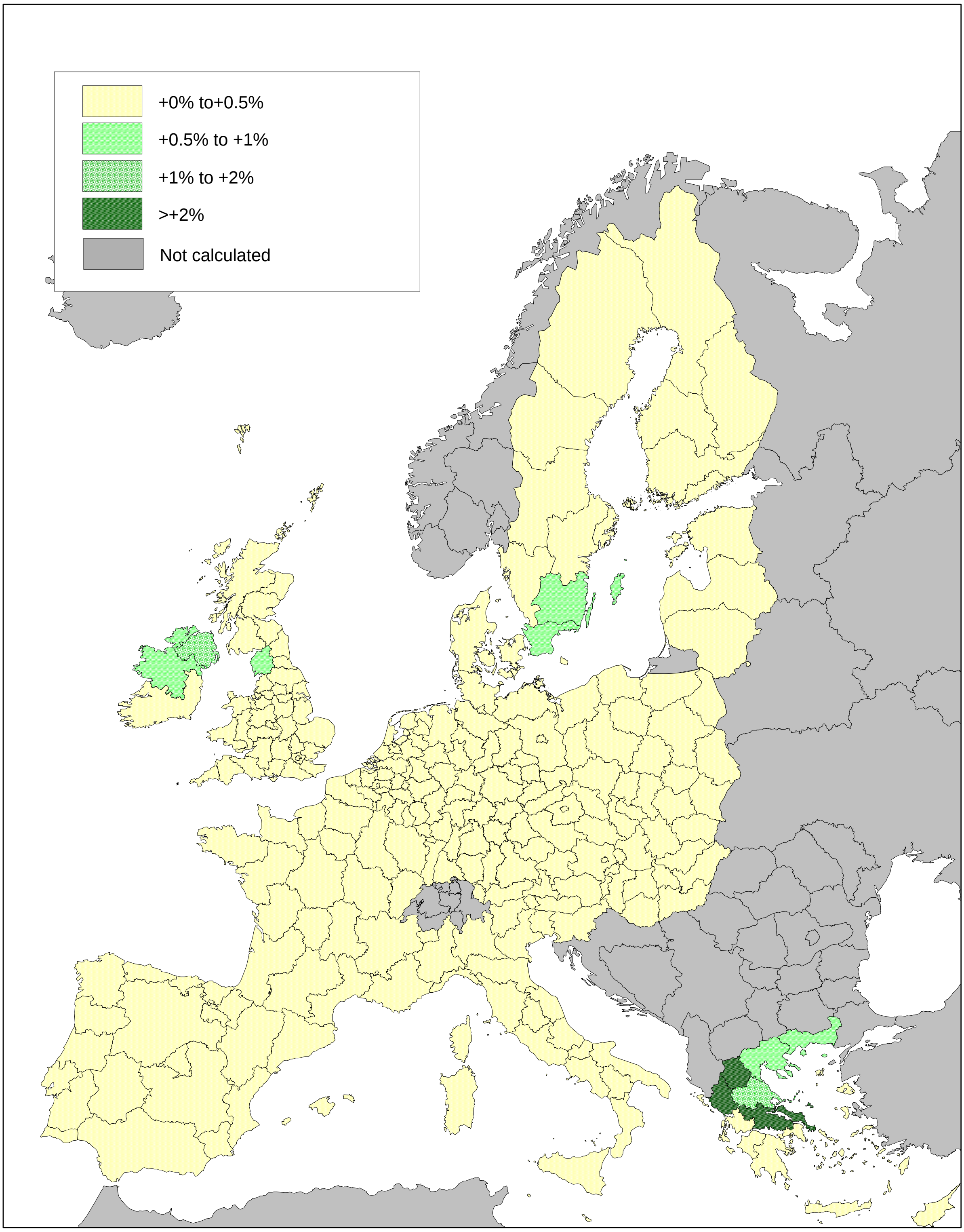


Figure 9. Change in value added due to inland waterways TENs projects only (construction phase) in the year 2015

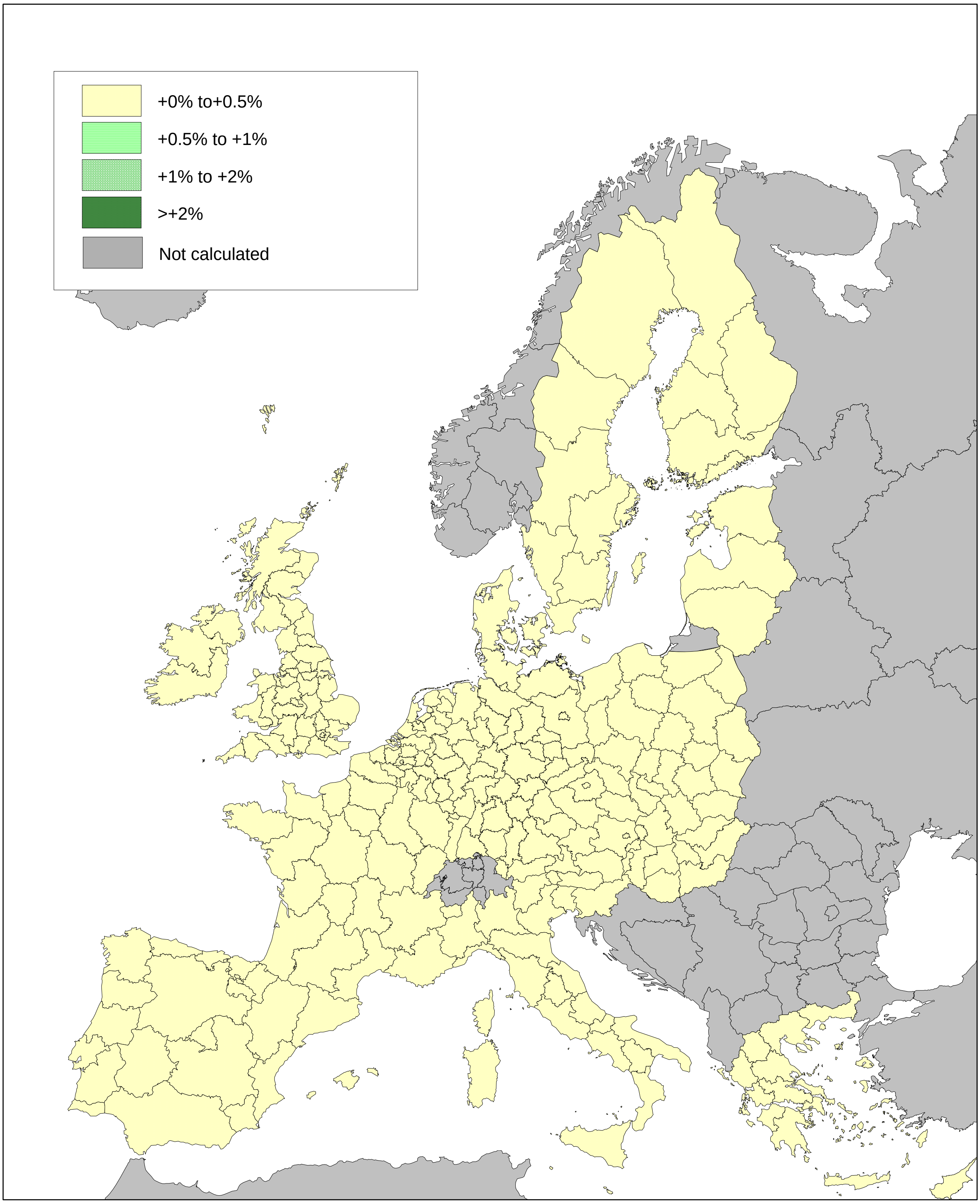


Figure 10. Change in value added due to inland waterways TENs projects only (construction phase) in the year 2030

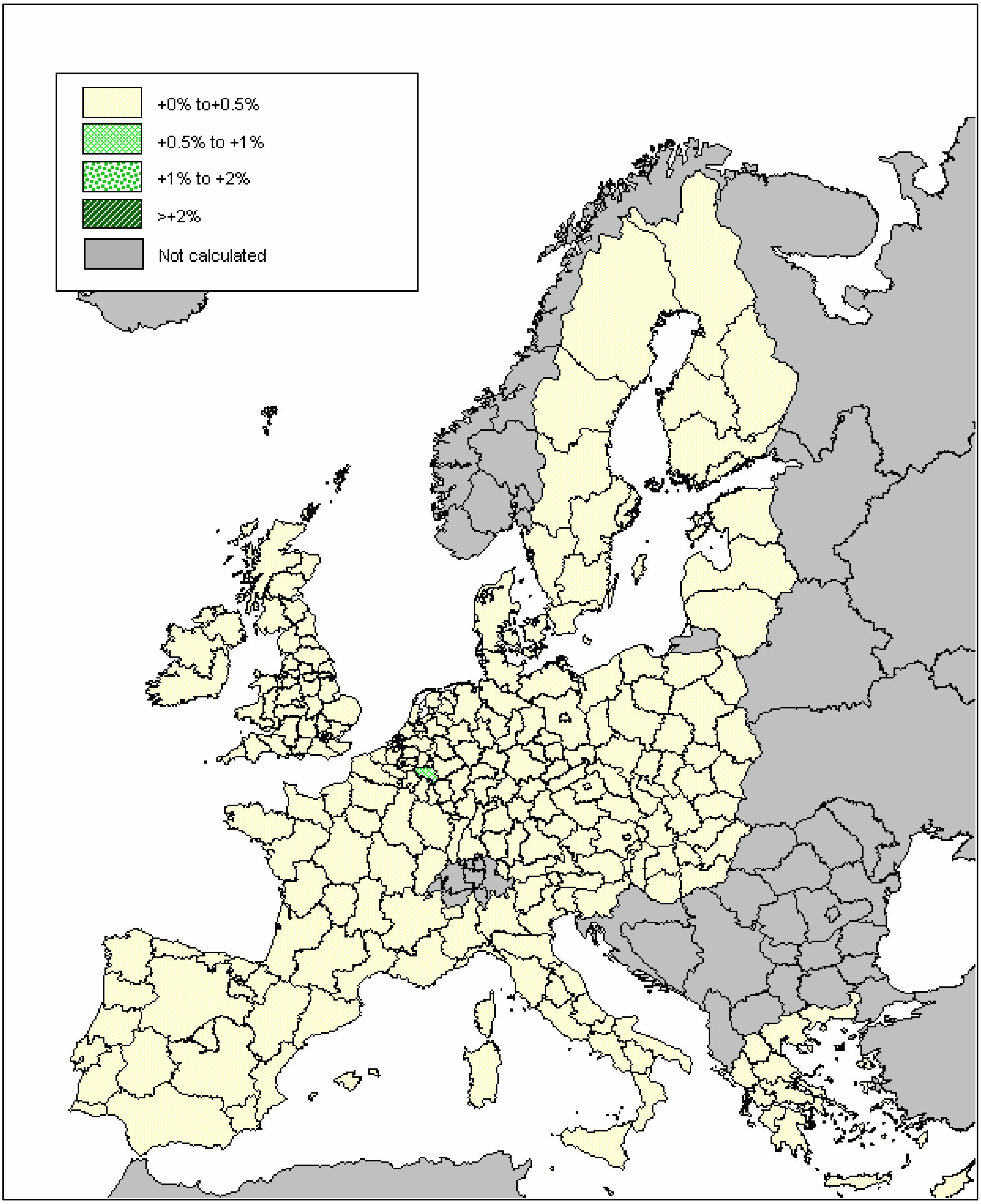


Figure 11. Change in employment due to inland waterways TENs projects only (construction phase) in the year 2015

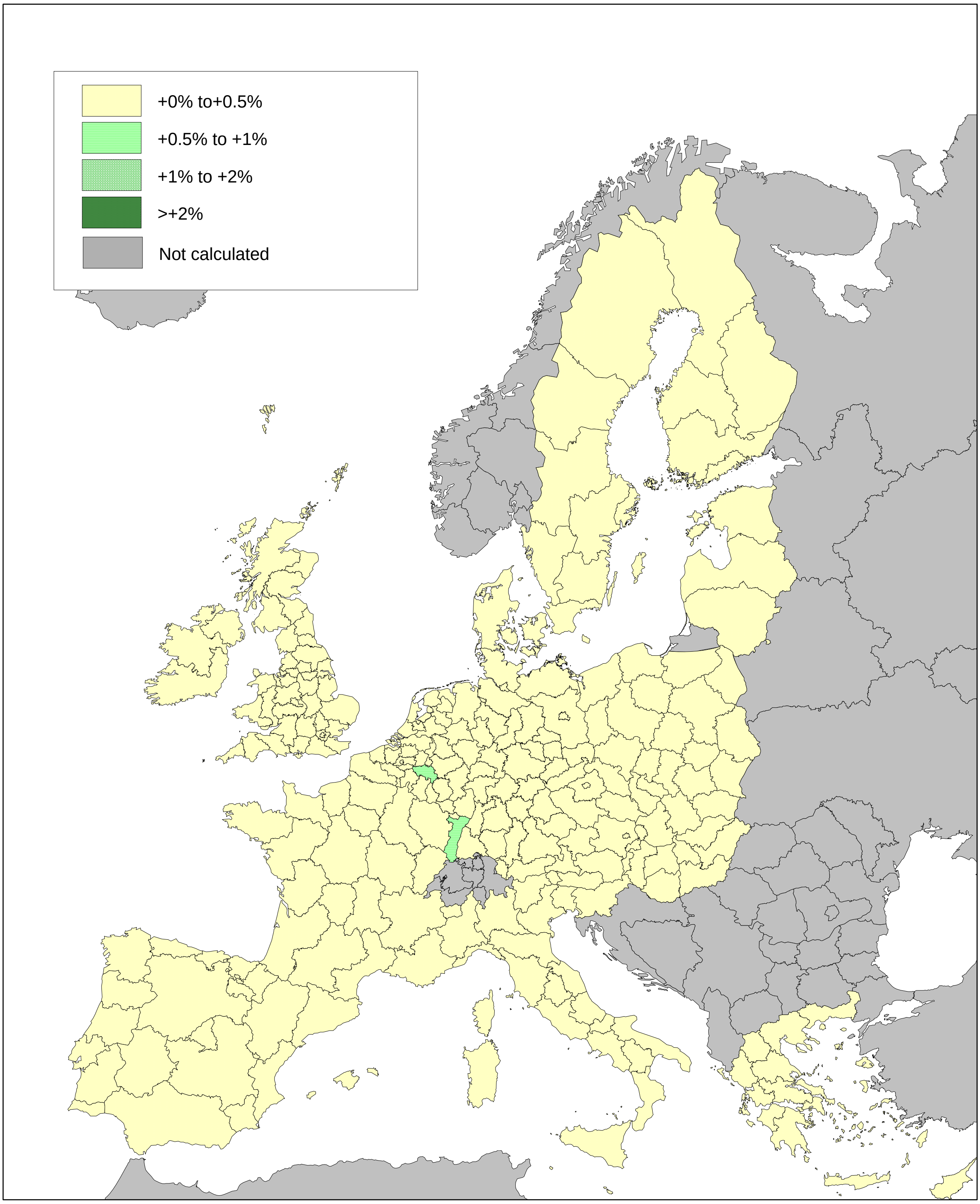


Figure 12. Change in employment due to inland waterways TENs projects only (construction phase) in the year 2030