# European cities - territorial assessment of change

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## Abstract

Cities are the cores of economic activity and innovation in Europe. They host majority of the population, but they are confronted with serious environmental, social and economic problems. Today, Europe needs to have well-grounded policies for the sustainable development of its cities and urban areas, and the evaluation of the potential implication of such policies is becoming increasingly important. This study aims to contribute to this evaluation efforts by introducing a set of spatial indicators in various thematic fields to assess the current state of European cities and their possible future development. It follows a common reference scenario for the future that has been developed within the LUISA Territorial Modelling Platform. In particular, it focuses on the analysis of changes and trends in urban demographics, economic activity, productivity and resilience as well as accessibility. It confirms the prevalence of metropolitan regions, in particular the capitals, above non-metropolitan regions across all indicators and points towards a further widening of the gap that separates them.

## 1. Introduction

Today, the cities of Europe are more productive than they were in the past. They lead economic growth and innovation and host the majority of the population providing it with better opportunities for employment. Most of the specialized services, social and cultural activities also take place in cities. At the same time, cities are confronted with serious environmental, social and economic problems. Air pollution, flooding, congestion, poverty, unemployment, unaffordable housing, inadequate social services and infrastructure are among the most important. Parts of the population in cities are more exposed to these problems than others are and hence more vulnerable. This issue is increasingly being raised and the real inclusivity of cities is now the object of numerous discussions.

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The new urban agenda for the EU set policies towards creating inclusive cities and achieving inclusive economic growth. It includes several objectives under key thematic fields such as urban poverty, housing, circular economy and inclusion of migrants and refugees. Together with the policies that support the sustainable development of cities and urban areas, these policies aim at maintaining economic productivity and innovation in cities, improving the quality of life, addressing the main environmental challenges and providing solutions to social and physical problems of citizens. Therefore, ex-ante or ex-post evaluation of the potential implication of such policies at the level of cities is becoming increasingly important in Europe. How cities are likely to evolve in a longer perspective with the implementation of some specific policies is one of the main questions many policy analysists want answered.

This study aims to contribute to this evaluation efforts by introducing a set of spatial indicators in various thematic fields to assess the current state of European cities and their possible future development. In particular, it focuses on the changes and trends in urbanisation, urban demographics, economic activity and productivity, and provision of urban services and accessibility. It explores the territorial dimension of likely changes in urban areas and help establishing clear links with productivity and inclusiveness of European cities. It follows a common reference scenario for the future that has been developed within the LUISA Territorial Modelling Platform.

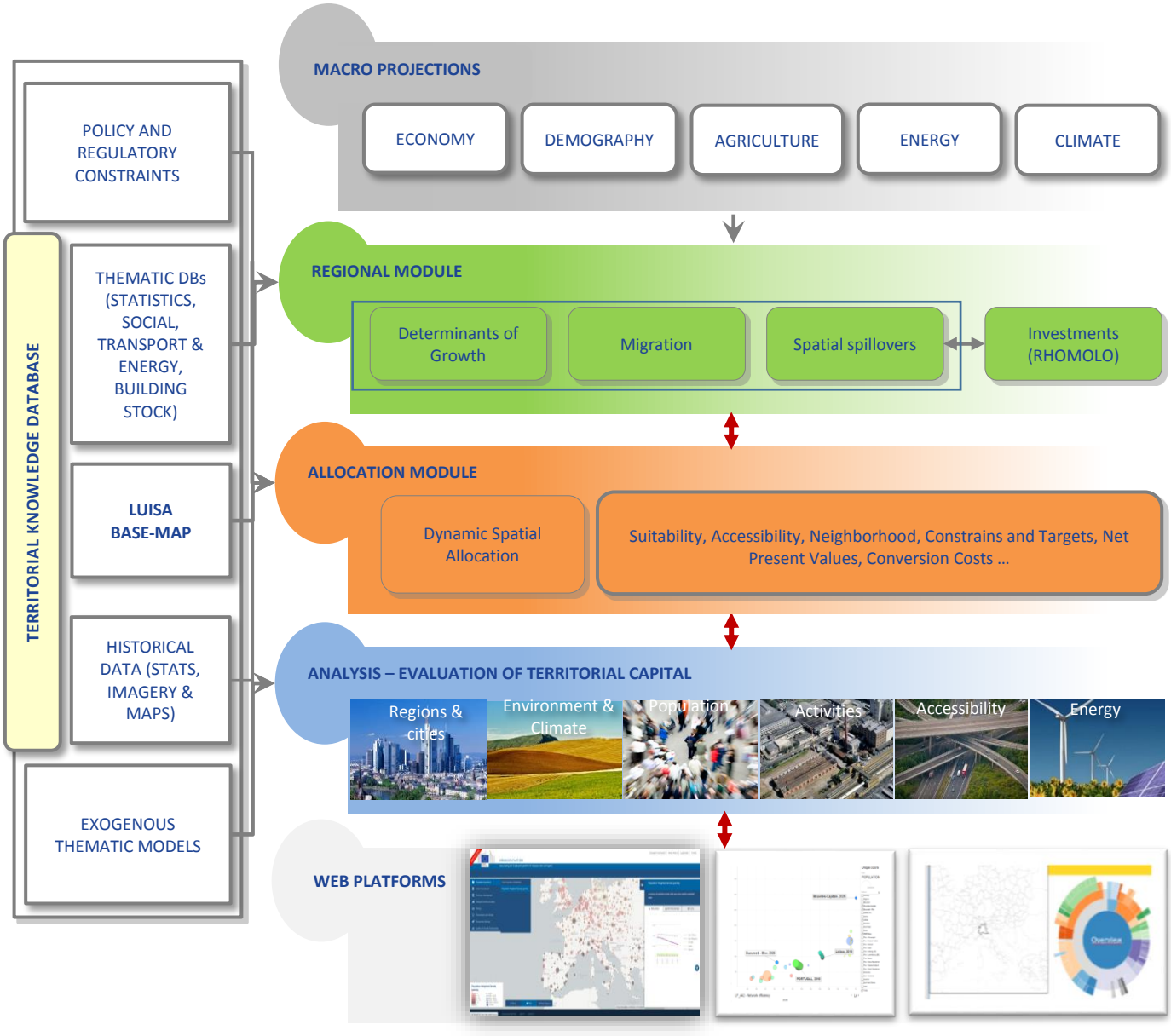
## 2. The LUISA Territorial Modelling Platform

The LUISA Territorial Modelling Platform is designed for the evaluation of European Commission policies with direct or indirect territorial impacts (Lavalle et al., 2011; 2013). It provides a comprehensive, harmonised and consistent spatial analysis of environmental and socio-economic changes in Europe. The overall structure of LUISA is illustrated in Figure 1. It is based on the concept of 'land functions' for cross-sector integration with an endogenous dynamic process of population, services and activities allocation.

LUISA has coherent linkages with the other Europe-wide macroeconomic and biophysical models (e.g., RHOMOLO and CAPRI models) and projections (e.g., EUROSTAT and ECFIN projections) which derives information from several other European databases and scenarios. LUISA produces territorial assessment indicators that can be grouped together according to the 'function' of interest and/or the sector under assessment (LUISA, 2017).

The core of LUISA is a computationally dynamic spatial model that allocates population and activities based on biophysical and socio-economic drivers (Figure 1). It generates three primary outputs at 100 meters spatial resolution: (1) land use/cover, (2) population and (3) accessibility. Several other spatial indicators are derived from these three main outputs to assess policy effects on various themes such as resource efficiency, environmental impact assessment or urban and regional development.

**Figure 1: The structure of LUISA Territorial Modelling Platform**




Given its approach developed for territorial modelling, and its high-resolution land use and population outputs, LUISA provides the means to measure the performance of European cities and explore key spatial parameters that shape urban areas. Other existing territorial impact assessment practices had difficulties in measuring the EU-wide performance of cities and urban areas against specific policies. Europe-wide spatial models are generally designed to produce projections at the country level and/or for NUTS2 and NUTS3 regions. Moreover, other more fine-resolution spatial analyses cover only a limited number of cities or urban regions, implying intrinsic difficulties in making comparisons between different regions and in monitoring EU-wide impacts of urban policies.

At this point, the approach developed by LUISA creates an important opportunity to fill this gap in territorial impact assessment practice. The high-resolution land use and population data and resulting spatial functions of LUISA provide useful complementary indicators to measure the performance of European cities and to explore the key spatial parameters that shape urban areas and regions in Europe. Further information on the LUISA model can be seen at Batista et al. (2013), Baranzelli et al. (2014), Kompil et al. (2015) and Jacobs-Crisioni et al. (2017).

## 3. The Urban Data Platform

Lately, LUISA explored the present and future state of European cities and regions to contribute to the 'The State of European Cities 2016' report of the European Commission (2016). It developed several urban indicators that analyse the main dynamics of urbanization and urban development through changes in land use / land cover, population growth, recreation potential, green infrastructure, air quality, flood risk and accessibility in Europe. The results were presented in detail for a number of thematic fields at the spatial extent of the entire EU (Kompil et al., 2015) and constituted the base for the Urban Data Platform[3] – an EU-wide data sharing and visualization platform for urban areas and cities – jointly developed by DG JRC and DG REGIO in 2016. It includes 60 indicators in seven thematic fields: demography, urban development, economic development, transport and accessibility, environment and climate, resource efficiency, and social issues. It provides data and visuals at the level of cities /greater cities, functional urban areas, metropolitan regions and by degree of urbanisation. The most of the spatial indicators elaborated in this proceeding to analyse European cities and urban areas can be retrieved from the Urban Data Platform. Further information on methodological issues can also be obtained from the platform.

## 4. European cities – past and future trends

The current study will focus on the changes and trends in urbanisation, urban demographics, economic activity and productivity, and provision of urban services and accessibility. It will demonstrate results of the analyses based on the LUISA reference scenario 2016 and 2017, which have been set up by DG JRC and DG REGIO primarily for the production of thematic information for the previous cities' report and for the upcoming 7th cohesion report. Within this study, territorial and temporal dimensions of future changes in urban areas will be explored and linked to the discussions on the productivity and inclusiveness of European cities. The results cover past decades and the period from 2010 to 2050 for the entire EU; they include analyses at various spatial levels such as metropolitan and non-metropolitan regions and degree of urbanisation, etc.

[3] The Urban Data Platform (http://urban.jrc.ec.europa.eu) is a joint initiative of the Directorate General Joint Research Centre (DG JRC) and the Directorate General for Regional and Urban Policy (DG REGIO) of the European Commission. It aims to provide access to information on the status and trends of European cities and their surrounding regions. The design and implementation of the Urban Data Platform has been maintained by the LUISA Territorial Modelling Platform (https://ec.europa.eu/jrc/en/luisa).

## 4.1. Urbanisation and urban demographics

Europe is highly urbanised in comparison to other parts of the World. As of 2015, 78% of the population in Europe live in urban areas[45]. The World average for urban population proportion is below the EU28 average with only 54%. As indicated in Figure 2, the proportion of urban population in Europe was 60% in the 1950s and it is estimated to reach 80% in 2020 and 85% in 2050. It is obvious that this urbanisation trend in Europe will slow down, but continue.

**Figure 2: Change in urban population proportion within the European Union (EU-28) and the World**

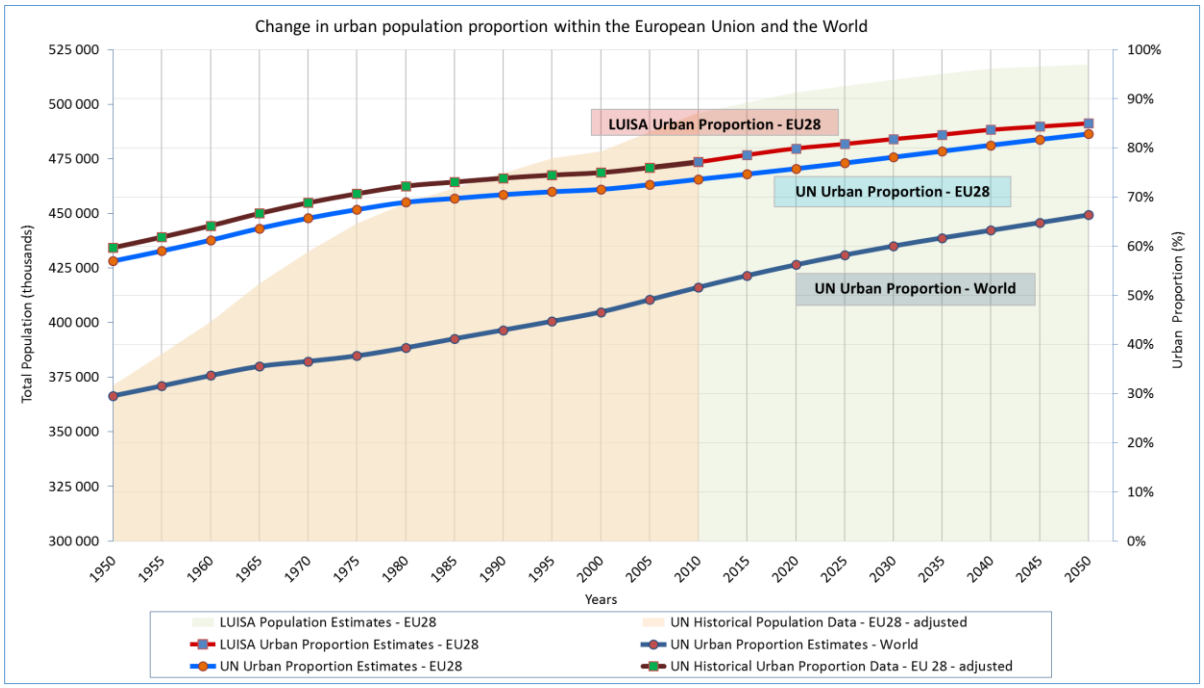
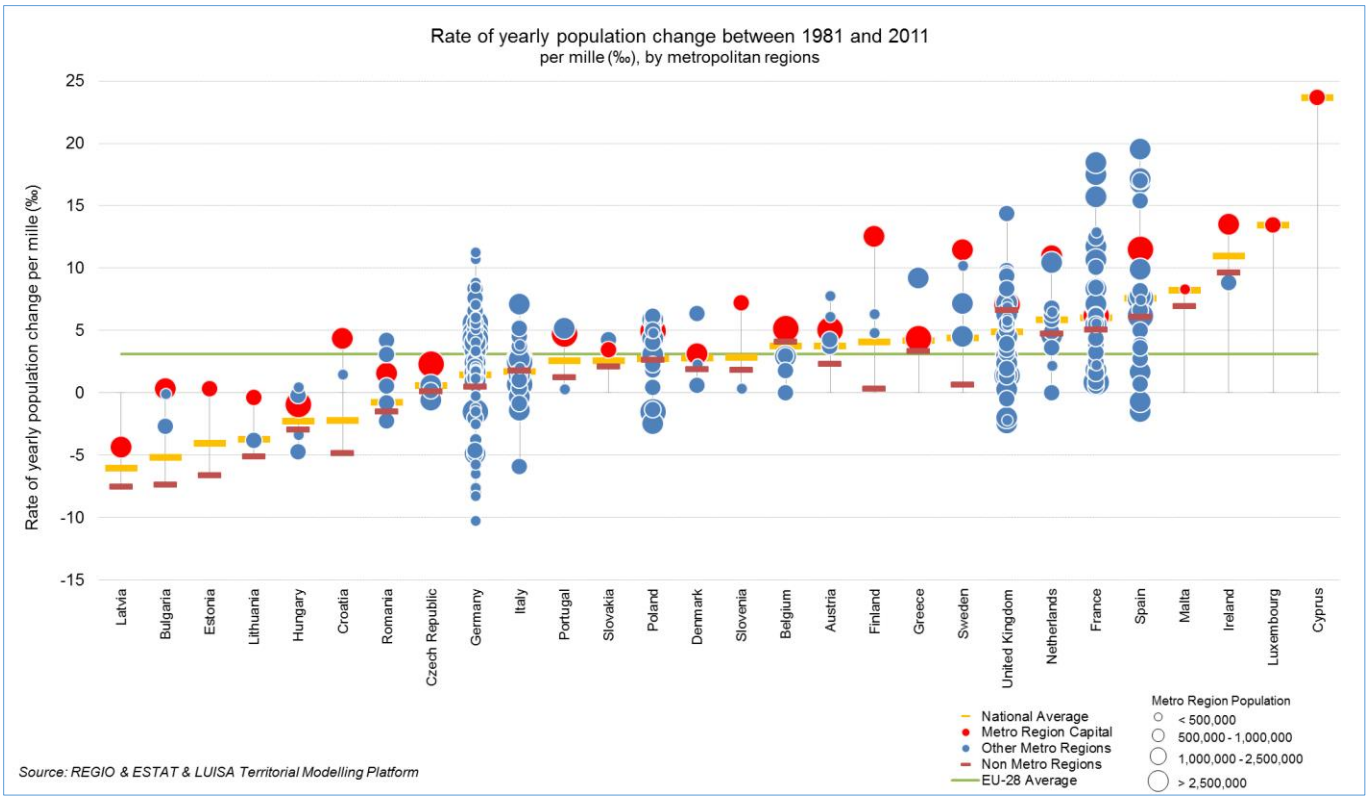



Figure 3 and Figure 5 show the rate of yearly population change per mille (‰), by metropolitan regions and from 1981 to 2011. The EU-wide population within this period has increased by 3‰ yearly. Although it has a non-uniform distribution among countries, the yearly rate of population growth in metropolitan regions (4‰) has always been greater than the non-metropolitan regions of Europe (1‰). The same population trends in overall Europe will not continue any more, overall increase will become only 0.4‰ yearly. Almost half of the metropolitan regions will lose population. However, the other half of the metropolitan regions, in particular the capital regions, will be the locomotives of the population growth in Europe, while several non-metropolitan regions in Europe will lose population (Figure 4 and Figure 6).

[4] Based on the EC-OECD description for urban and rural areas and degree of urbanisation. Urban population covers the population within cities, towns and suburbs identified at the level of communes (LAU2). For further information, see Kompil et al. (2015), Dijkstra and Poelman (2014).

[5] The data before 2010 and the UN urban proportion data for the World and EU28 is derived from the report entitled 'World Urbanization Prospects: The 2014 Revision' (UN, 2014). The values before 2010 were adjusted to ensure continuity with the LUISA projections.

## Figure 3: Rate of yearly population change between 1981 and 2011, by metropolitan regions




## Figure 4: Projected rate of yearly population change between 2010 and 2050, by metropolitan regions

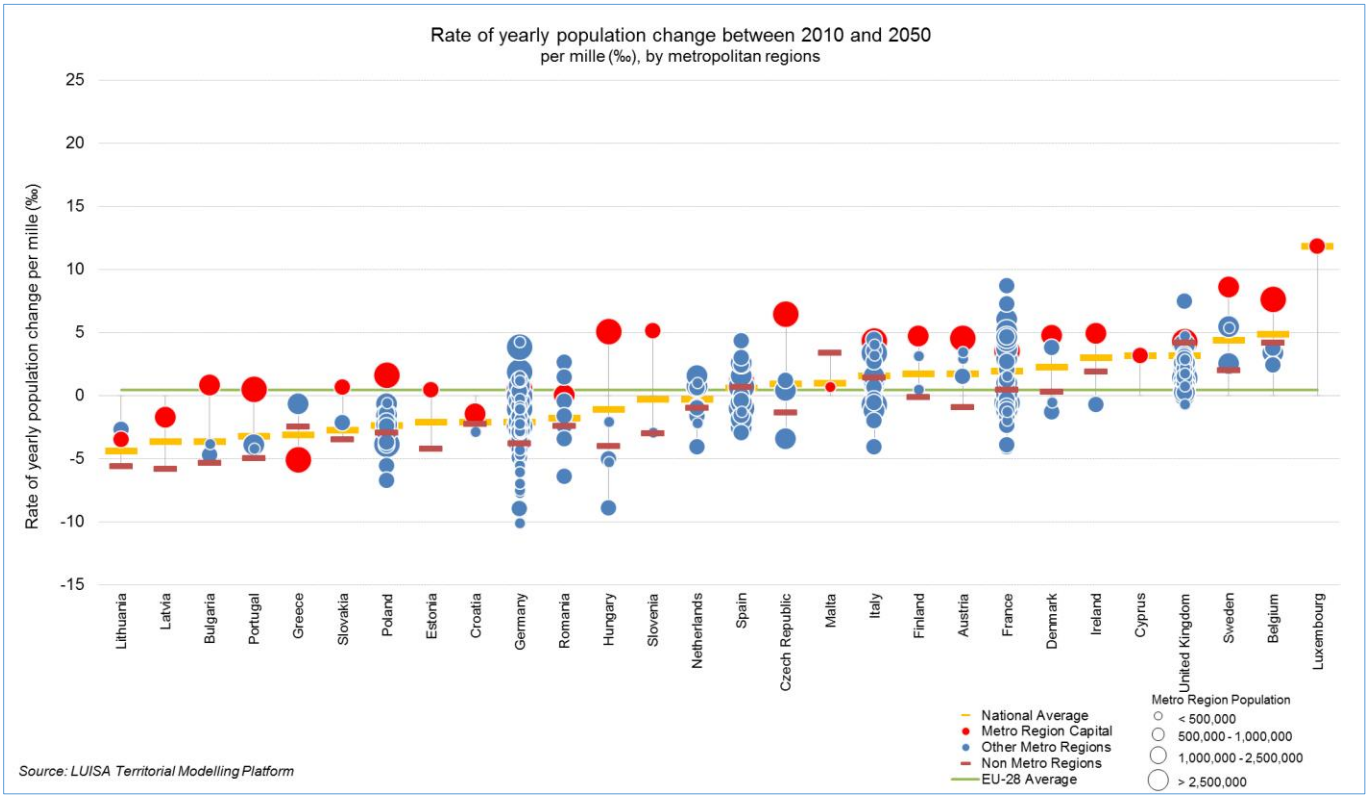
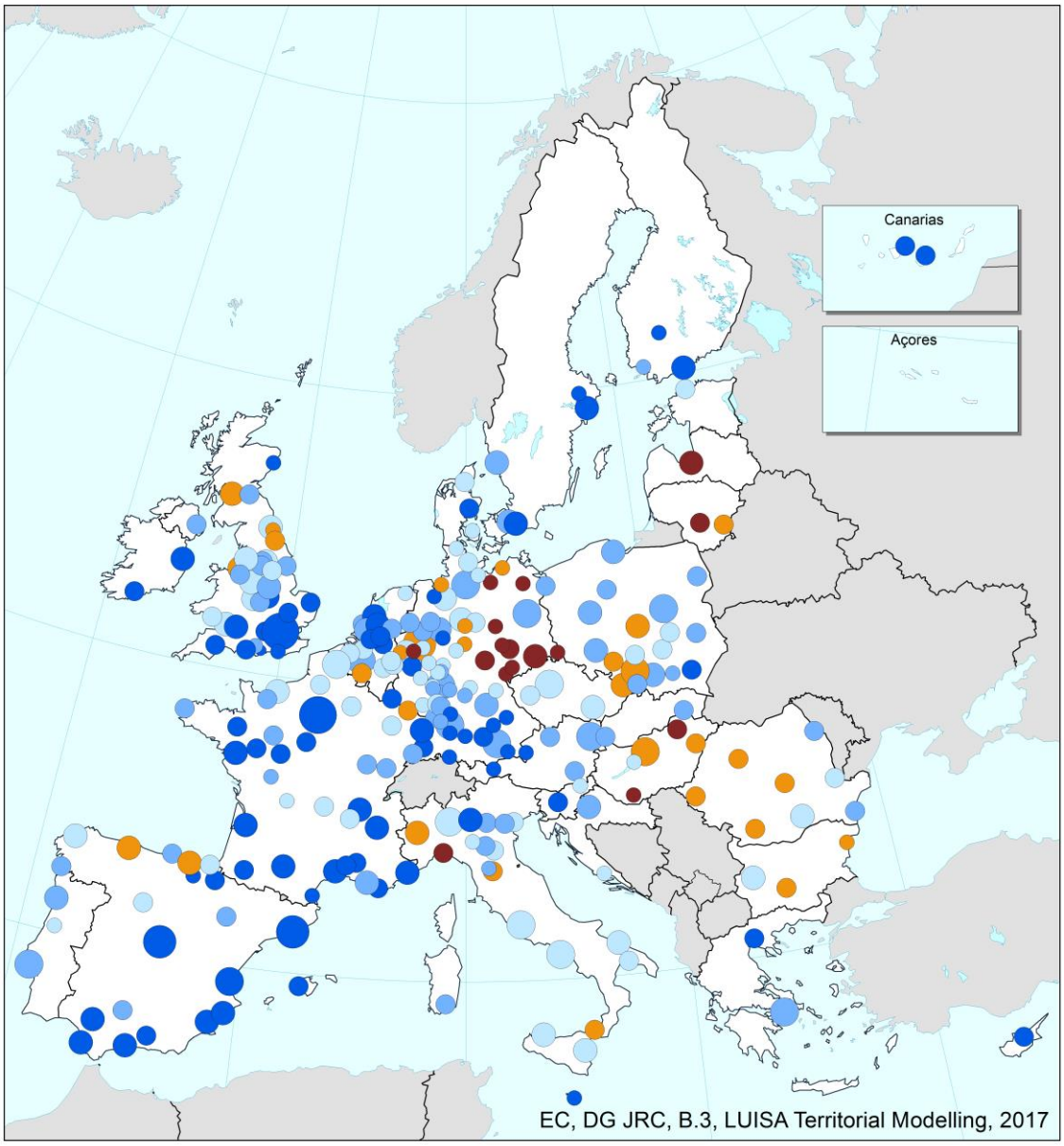


**Figure 5: Rate of yearly population change between 1981 and 2011, by metropolitan regions**




Rate of yearly population change between 1981 and 2011, by metropolitan regions

Rate of yearly population change between 1981 and 2011, by metropolitan regions (‰)

- High Decrease (< -3‰)
- Decrease (-3‰ - 0‰)
- Increase (0‰ - 3‰)
- Moderate Increase (3‰ - 6‰)
- High increase (> 6‰)

Population 2011

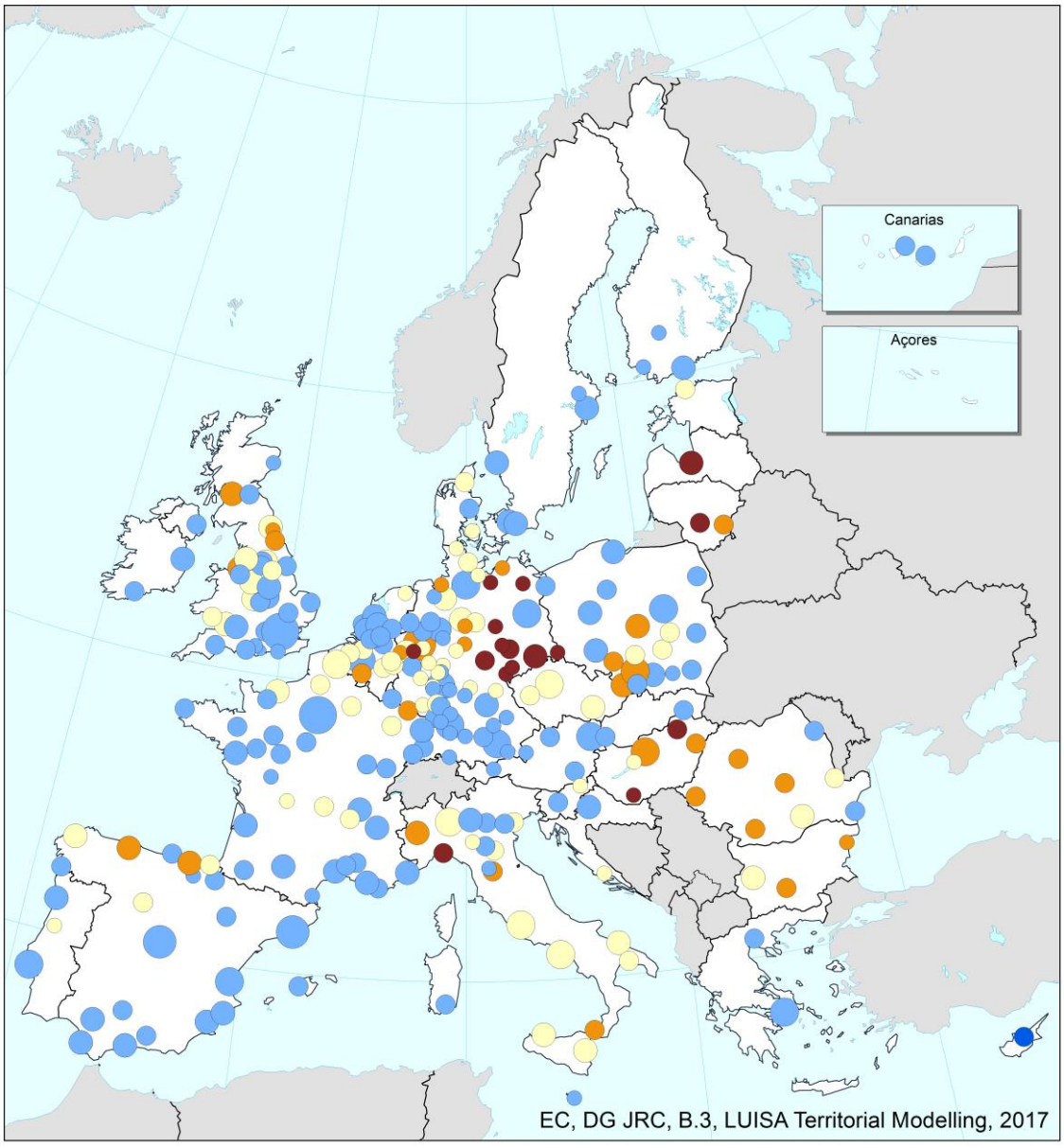
- < 500000
- 500000 - 1000000
- 1000000 - 2500000
- 2500000 - 5000000
- 5000000 - 7500000
- > 7500000

0 250 500 1,000 Km

EC, DG JRC, B.3,
LUISA Territorial Modelling, 2017

Based on REGIO & EUROSTAT data

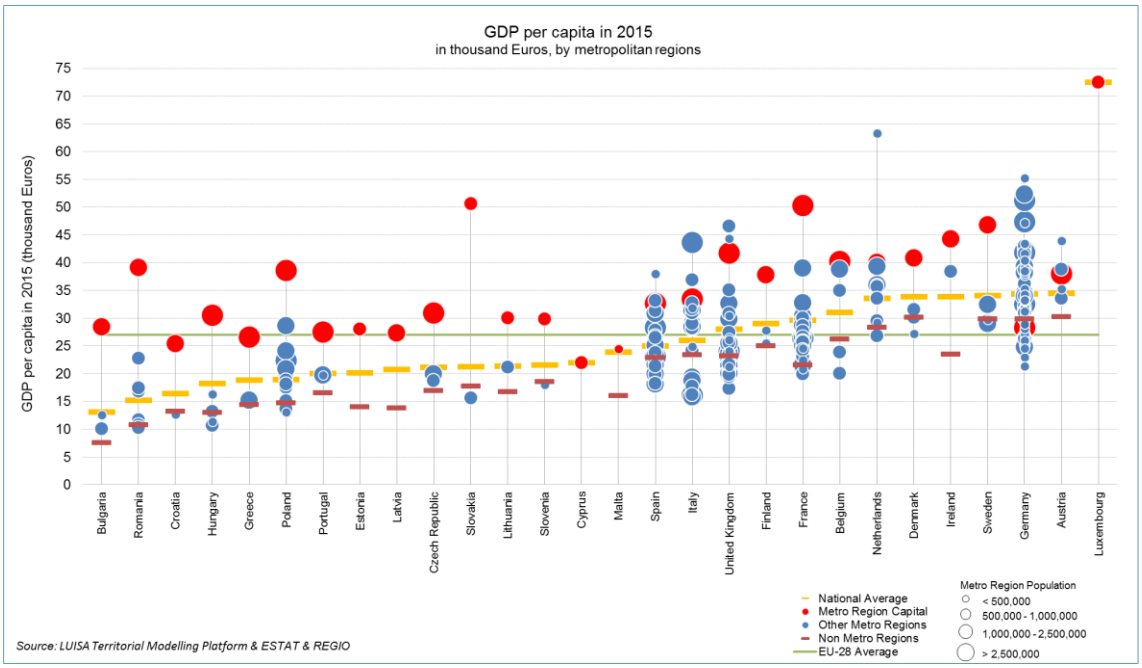
**Figure 6: Projected rate of yearly population change between 2010 and 2050, by metropolitan regions**



## 4.2. Economic development

GDP per capita (in PPS) shows large disparities across European metropolitan regions (Figure 7) [6]. While the average GDP per capita is roughly 30.000 Euros, the GDP of people in the metro region of Luxembourg reaches above 70.000 Euros while that of people in the metro region of Plovdiv, Bulgaria is just around 10.000 Euros. People living in metro regions usually have a higher GDP than people living in the rest of the country (non-metro regions). This does not appear to be the case in a large number of metro regions of low to medium population in Spain, Italy, the UK, Belgium and Germany. However, smaller metro regions may also be associated with high GDP per capita as illustrated by Groningen in the Netherlands and Salzburg in Austria. For most EU28 countries, metro region capitals show higher GDP per capita than other cities or non-metro regions.

**Figure 7: GDP per capita in 2015, by metropolitan regions**



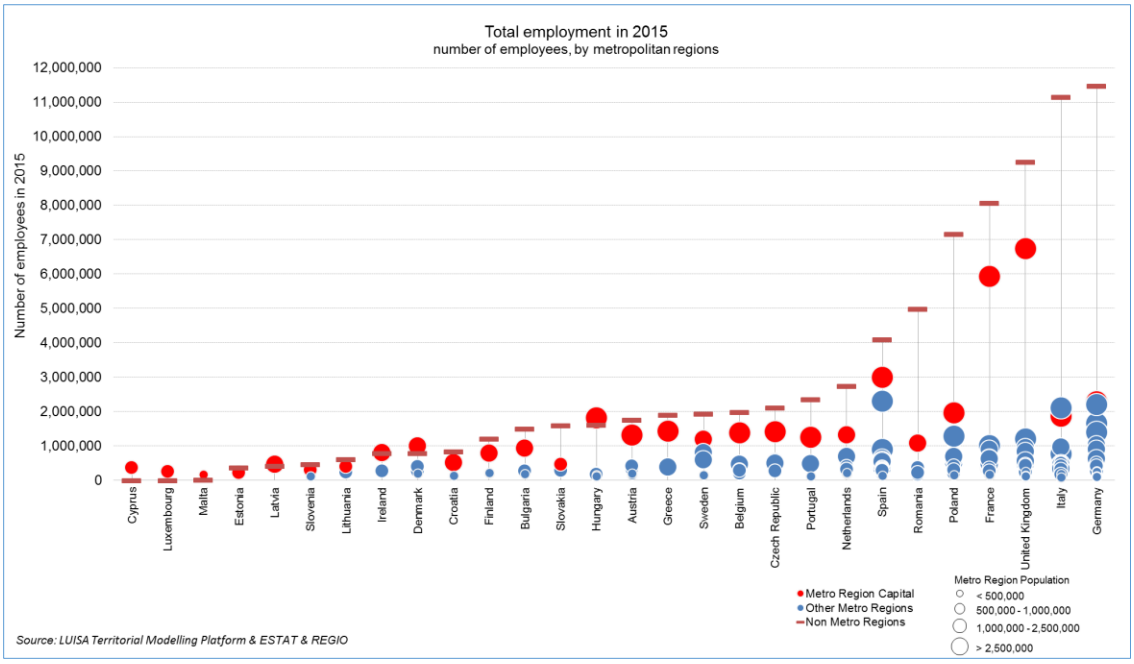

The occurrence of higher GDP per capita in capital metro regions is particularly pronounced in Slovakia, Romania, Poland and France where it exceeds the national average by more than 20.000 Euros. The only major exception is the metro region capital of Berlin, Germany where the GDP per capita (28.000 Euros) is inferior to that of most other German metro regions, well below the national average of 34.000 Euros. However, the observed low performance of the Berlin capital metro region is likely related to the fact that it covers a large number of heterogeneous territorial units. Projected rates of changes in GDP per capita between 2015 and 2050 (Figure 9) indicate that most growth in

[6] For the methodology and data behind the economic development indicators, see Batista et al. (2016).

Europe will occur in Eastern Europe and in Romania, Hungary and Poland where annual growth rates will exceed 6%. Within these countries, capital metro regions will see the highest growth rates, which is likely to further increase the existing gap with other non-capital metro regions, leading potentially to more inequalities. Most metro regions in Spain and Portugal will show annual growth rates exceeding 4% while the rest of Europe will see less growth and even a decrease in GDP per capita for a few metro regions in the UK, Germany and the Czech Republic.

Employment figures for 2015 (Figure 8) indicate that 62.5% of people employed are in metro regions. Capital metro regions consistently provide the highest or near highest employment opportunities across all EU countries with the metro regions of Paris and London clearly dominating the rest of European metro regions. Finally, while a few non-capital metro regions such as Barcelona, Ruhrgebiet, Hamburg have a number of employees exceeding 2 million, the vast majority of metro regions hosts less than a million employees.

**Figure 8: Total Employment in 2015, by metropolitan regions**




Employment projections indicate that overall, at the EU28 scale non-metro regions will lose more than 10% of their employees while metro regions will remain relatively stable. However, across Europe, as indicated in Figure 10, metro regions in Germany, Poland, Lithuania, Latvia, Estonia, Portugal and Romania will see strong decreases in employment while other metro regions in Belgium, France, the UK, Sweden Denmark and Cyprus will see strong increases. Spain is likely to have the most spatially heterogeneous response with metro regions in the centre south and north losing employment while the metro regions of Madrid and Malaga will see a strong increase, followed by Barcelona, A Coruña and Valladolid. This above-described trend in employment change should also be put into perspective with broader population trends and in particular population aging and within EU migration.

**Figure 9: Projected rate of change in GDP per capita between 2015 and 2050, by metropolitan regions**

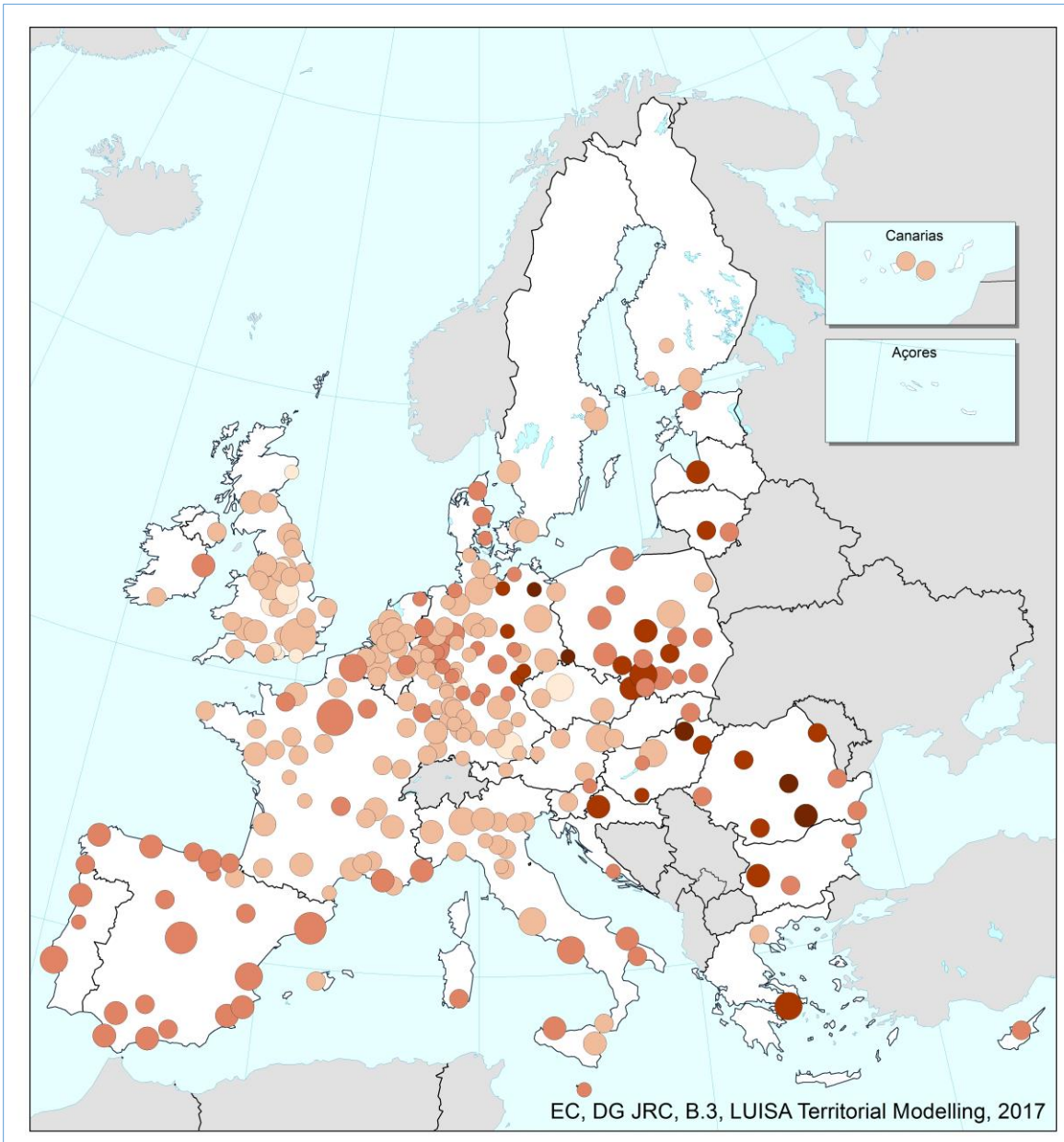
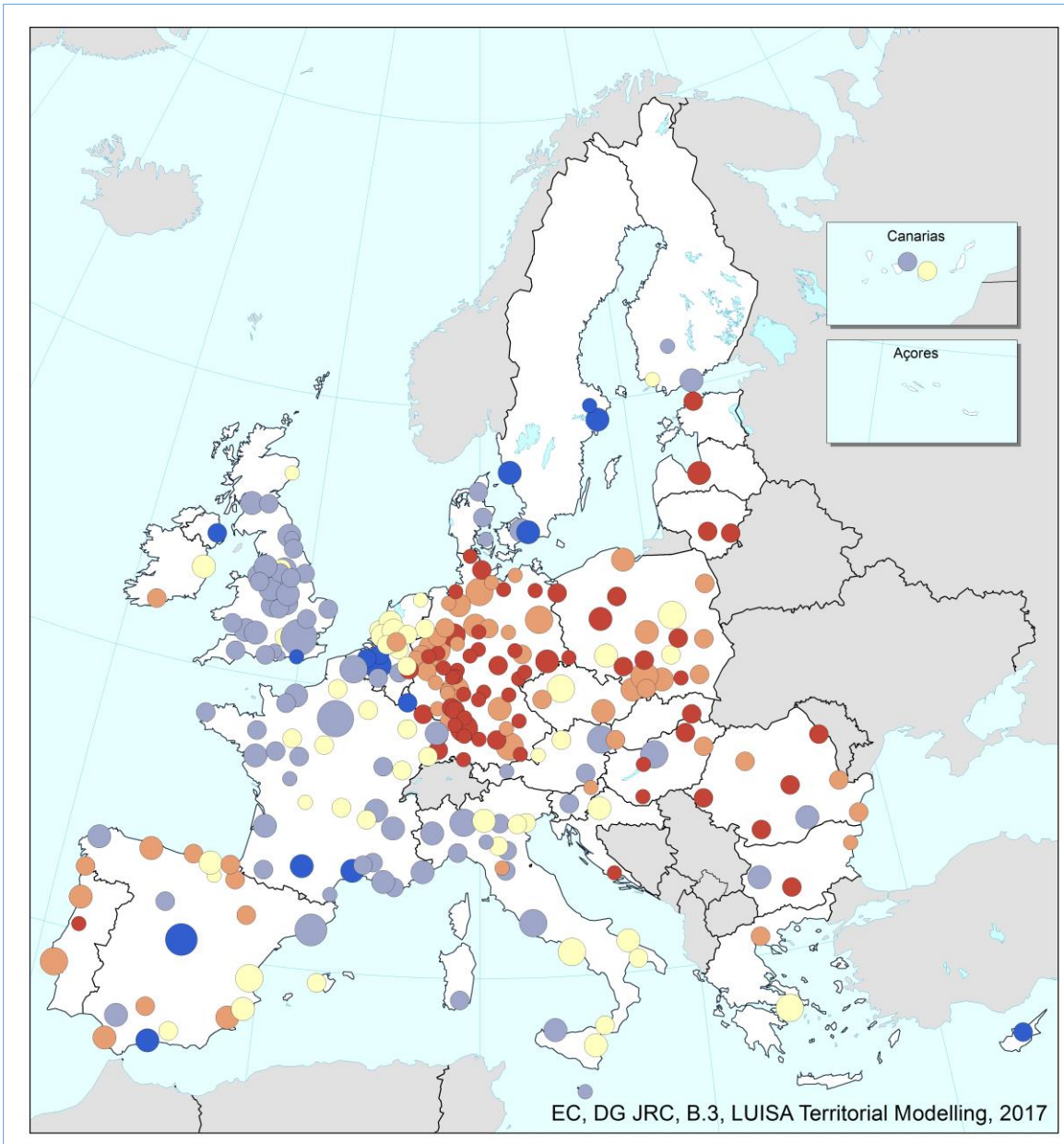


**Figure 10: Change in total employment between 2015 and 2050, by metropolitan regions**




Change in total employment between 2015 and 2050

Change in total employment between 2015 and 2050, by metropolitan regions (%)

- High decrease (< -20%)
- Decrease (-20% - -5%)
- No siginficant change (-5% - 5%)
- Increase (5% - 20%)
- High Increase (> 20%)

Population 2011

- < 500000
- 500000 - 1000000
- 1000000 - 2500000
- 2500000 - 5000000
- 5000000 - 7500000
- > 7500000

0 250 500 1,000 Km

EC, DG JRC, B.3,
LUISA Territorial Modelling, 2017

Based on EUROSTAT demographic projections

GDP per person employed, a combination of the two important economic indicators, provides useful insights on how productive a region is. Figure 11 presents GDP per person employed by metropolitan and non-metropolitan regions in 2015. It does not follow a uniform pattern because there are many factors that affect this ratio; it is higher in non-metropolitan regions of Italy, France and Poland; then higher in metropolitan regions of Germany, Spain and Bulgaria. One thing is clear that capital metro regions have higher GDP per person employed compared to other metro regions. If the change in GDP per person employed between 2015 and 2050 is considered (Figure 12): the average GDP per person employed increases by 4.4% overall, the majority of the metropolitan regions outperform non-metropolitan regions with an average of 4.6% change. GDP per person employed increases average 4% in non-metropolitan regions.

**Figure 11: GDP per person employed in 2015, by metropolitan regions**

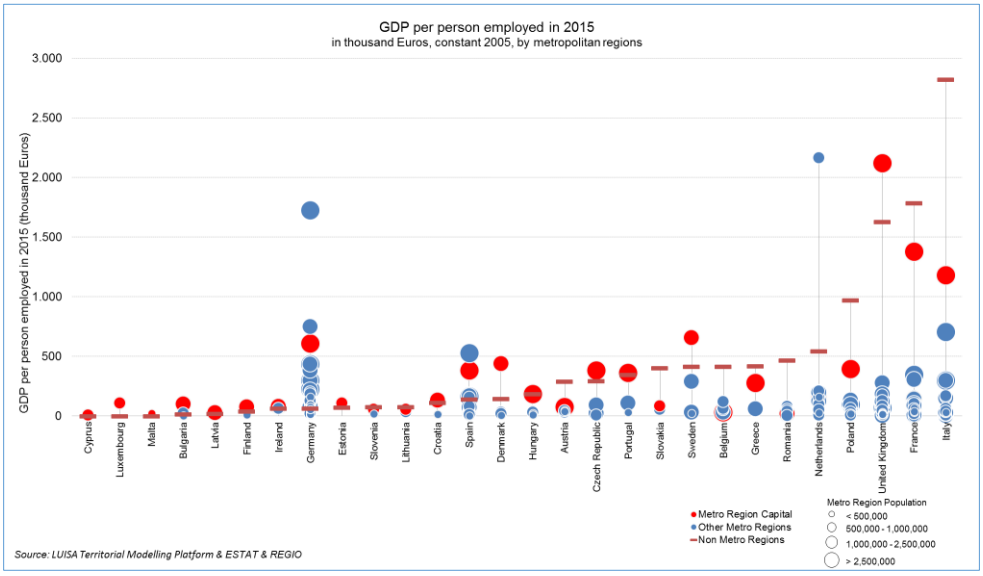



**Figure 12: Change in GDP per person employed between 2015 and 2050, by metropolitan regions**

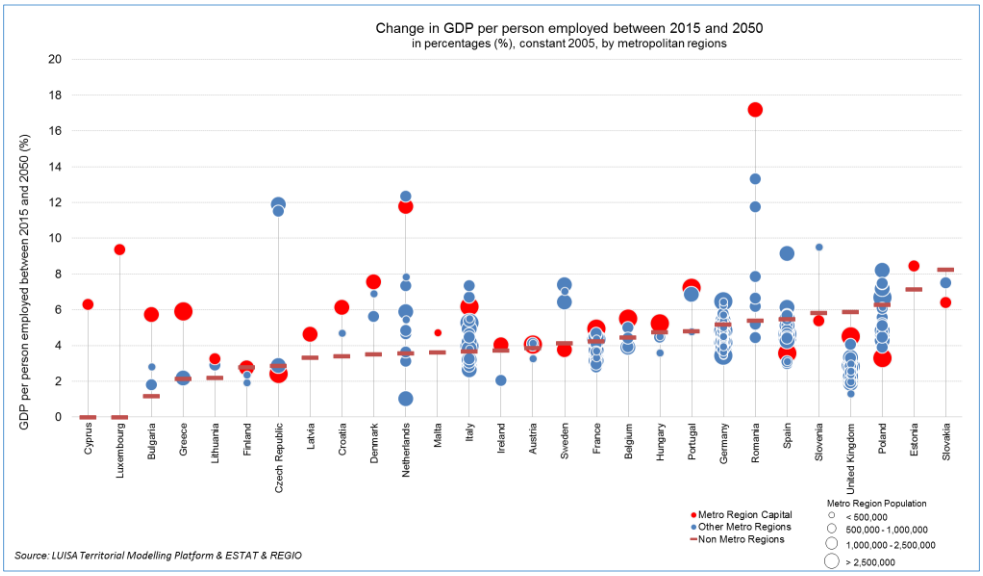
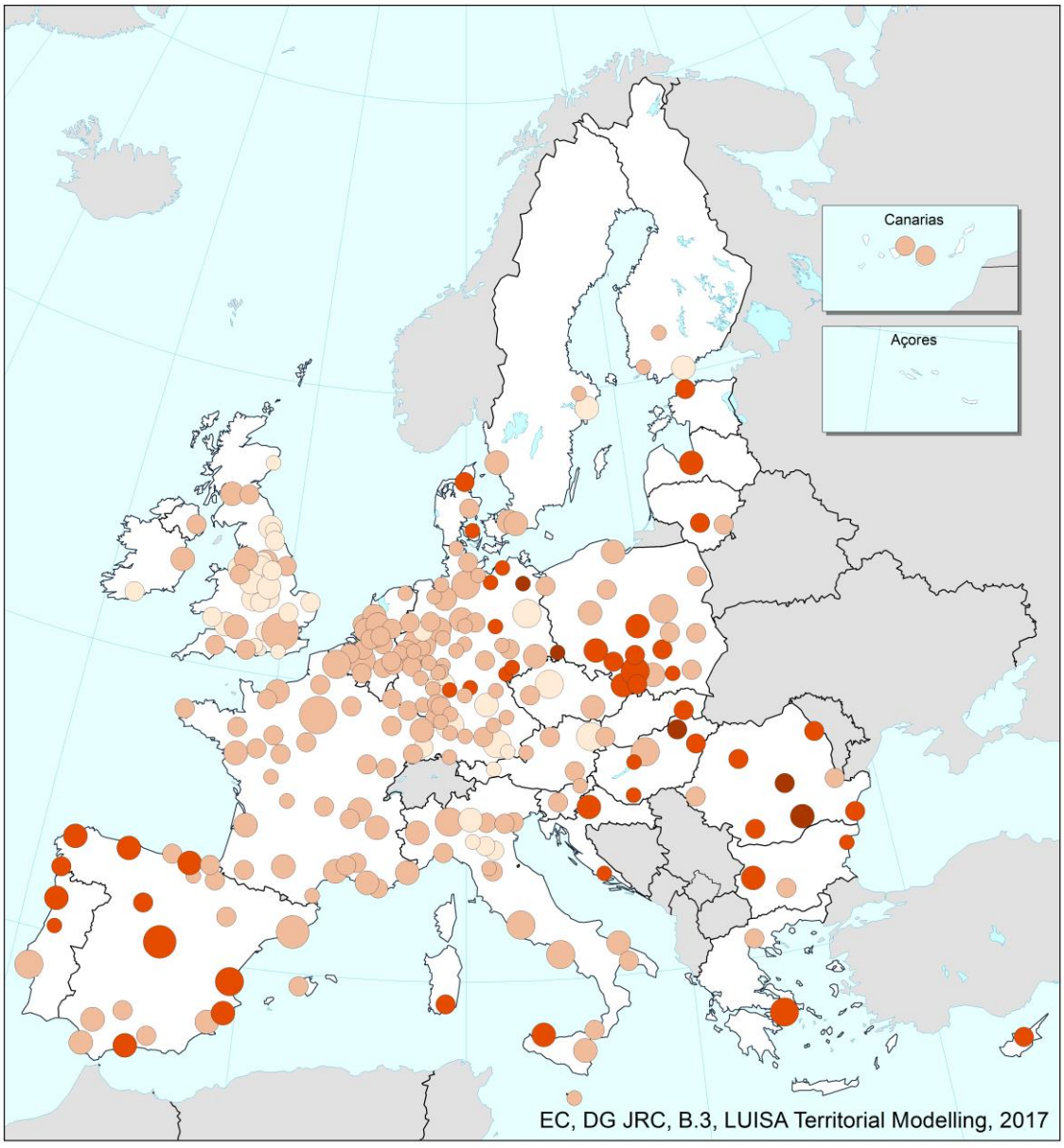


**Figure 13: Change in GDP per person employed between 2015 and 2050, by metropolitan regions**




Change in GDP per person employed between 2015 and 2050

Change in GDP per person employed between 2015 and 2050, constant 2005, by metropolitan regions (%)

- < 2.5 %
- 2.5% - 5 %
- 5% - 7.5 %
- 7.5% - 10 %
- > 10%

Population 2011

- < 500000
- 500000 - 1000000
- 1000000 - 2500000
- 2500000 - 5000000
- 5000000 - 7500000
- > 7500000

0 250 500 1,000 Km

EC, DG JRC, B.3,
LUISA Territorial Modelling, 2017

Based on EUROSTAT demographic projections

## 4.3. Economic resilience and inequality

### 4.3.1. Convergence groups - the core and periphery

By dividing the European Union into two spatial clusters or convergence groups, a map of core and periphery regions can be obtained as in Figure 14. Following the approach in Le Gallo (2008), these convergence groups are identified using the Getis and Ord (1992) Gi spatial statistics. The basic idea is that a positive value of Gi for a region indicates that it is surrounded by regions with high GDP per capita and consequently – belongs to a spatial cluster of regions with high GDP per capita, defined as core regions. Conversely, a negative value indicates that a region is surrounded by regions with low GDP per capita, and hence, belongs to a spatial cluster of regions with low per capita GDP, i.e. periphery regions.

**Figure 14: Convergence groups based on GDP per capita in 2000, by NUTS 3 regions**

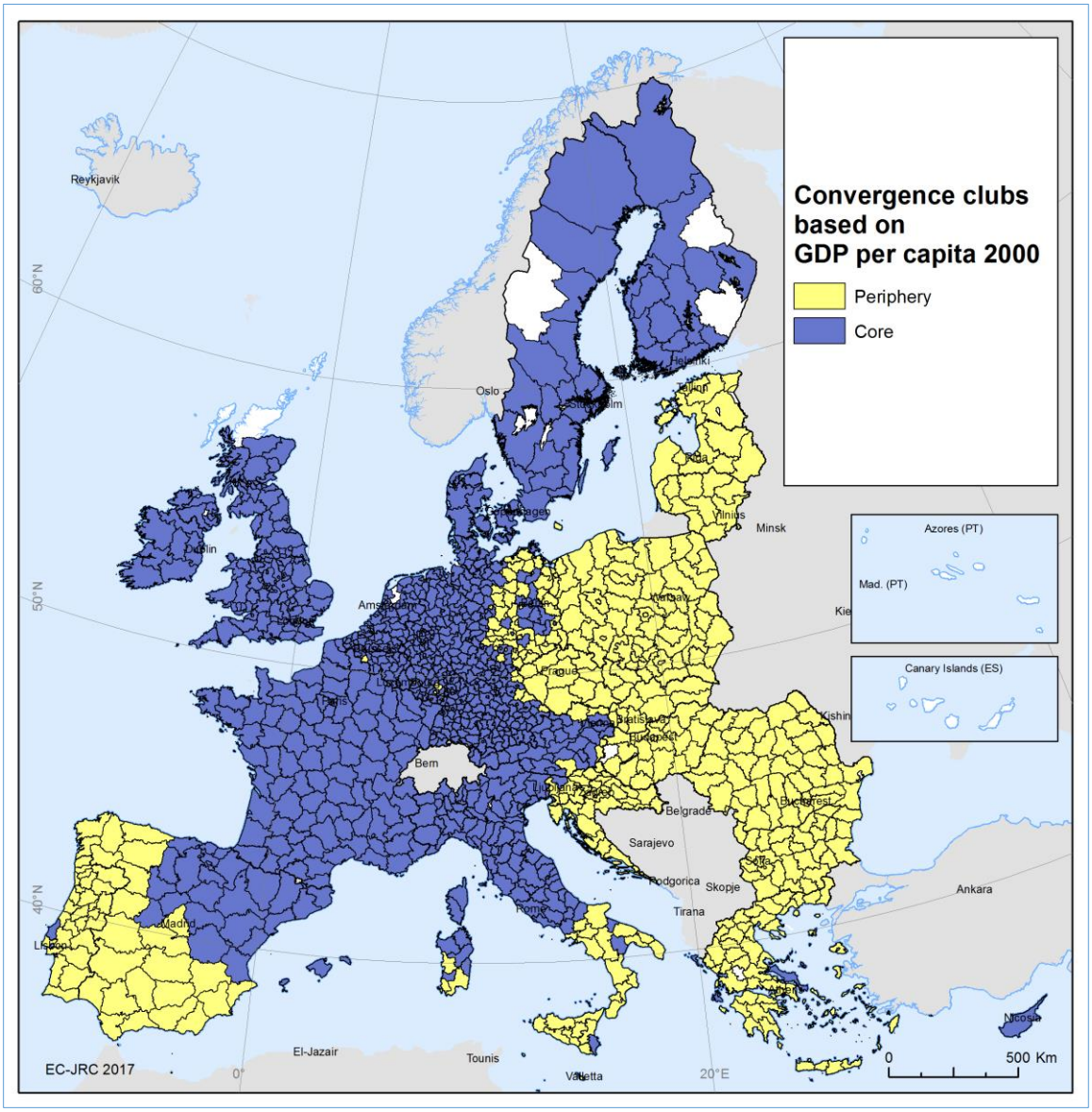
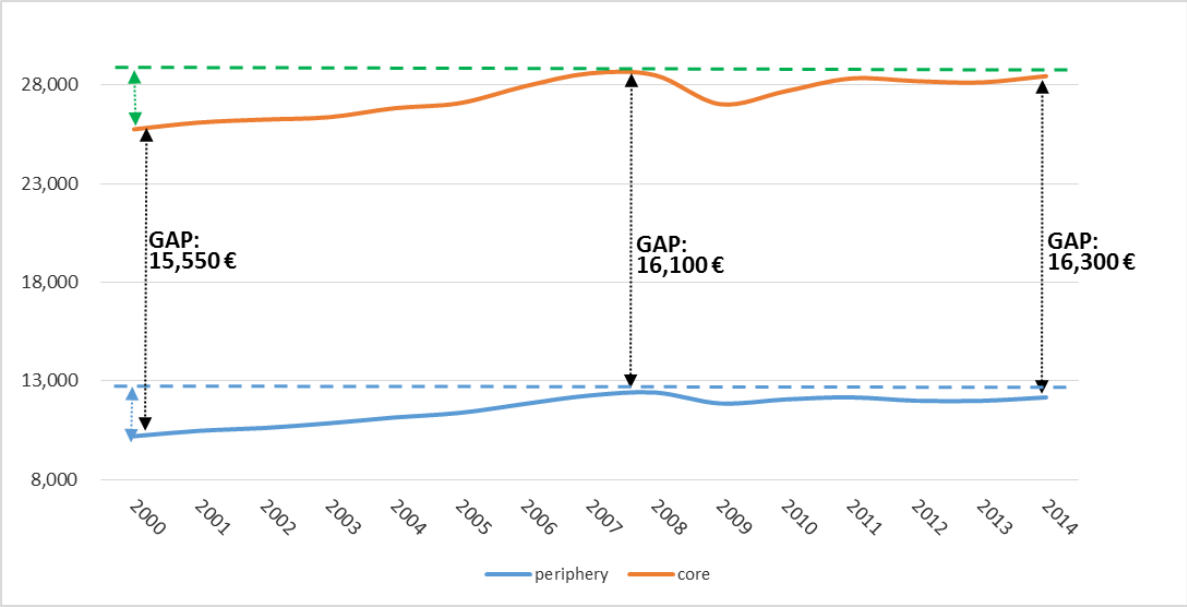


Figure 15 shows the evolution of GDP per capita in core and periphery European regions between 2000 and 2014 based on the data from Cambridge Econometrics, European Regional Database. Between 2000 and 2008, GDP per capita of the core and periphery regions has increased more than in periphery regions. As a result, the gap between these two groups increased by around 500 €. The global financial crisis interrupted the growth paths of the two groups of regions. In 2009, the GDP per capita of both came back to the level of 2005. The main difference has been the capacity of recuperation, i.e. the resilience. The core regions in 2011 went back to their pre-crisis GDP per capita (dotted green line), and remained quite stable until 2014. Peripheral regions were not able to recover to the pre-crisis levels. Consequently, in 2014 the gap between the two groups became even wider than in 2008.

**Figure 15: GDP per capita in core and periphery European regions between 2000 and 2014**




Inequality across regions is another important issue, besides the GDP growth. Figure 16 and Figure 17 show the evolution of GDP per capita and the corresponding degree of inequality across regions (measured by the Gini index, which ranges between 0 and 1, where 0 means perfect equality and 1 perfect inequality) in core and peripheral regions respectively. Comparing the two figures, it can be observed that core regions tend to be less unequal than periphery regions, as well as the inequality trends are quite different in the two types of regions. The 2008 crisis led to a reduction in GDP per capita, but also in territorial disparities, probably because wealthier areas were hit more dramatically in the beginning. Later on, after 2009, inequality was on the rise especially in core regions, which phenomenon was gone in parallel with recovery of the GDP per capital to the pre-crisis levels, thereby enlarging the gap with periphery regions. In periphery regions, the inequality slightly increased between 2009 and 2012, but then it declined, in parallel with the recovery of the GDP per capita. The two observations, taken together, indicate a more balanced territorial development in the peripheral regions than in the core regions.

**Figure 16: GDP per capita and inequality (Gini) in the core European regions**

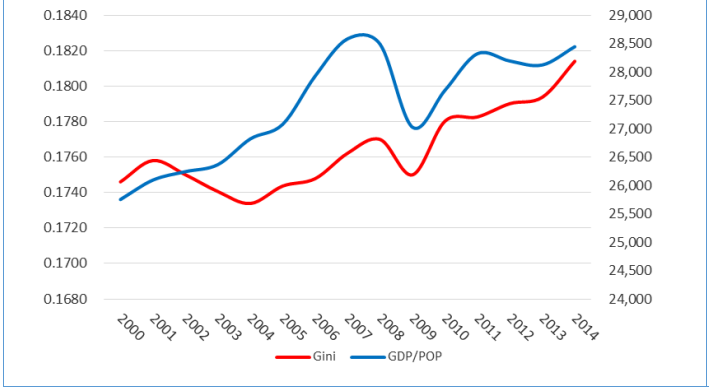
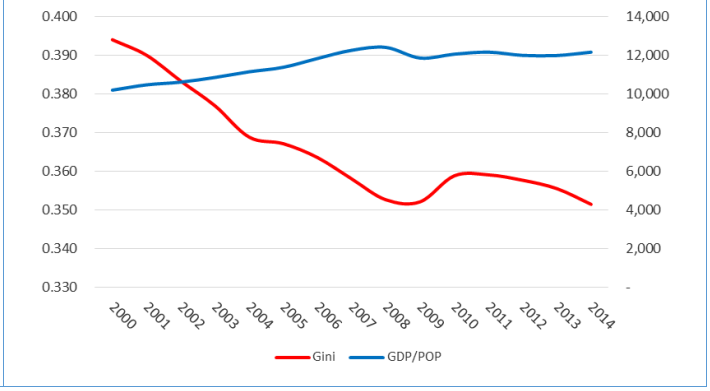



**Figure 17: GDP per capita and inequality (Gini) in the periphery European**




Large cities or highly urbanized areas are believed to significantly contribute to regional economic growth owing to higher investment returns. Figure 18 and Figure 19, for core and periphery regions, respectively, show the effect of smaller, capital and second-tier metro regions on growth with respect to non-metro regions taken as a benchmark. Figure 18 indicates that in the cluster of core regions only smaller metro regions have a positive impact on growth, (the shaded area does not cross the dotted line that represents the benchmark value). In the rest of the groups of metro and non-metro regions, there is no significant difference in GDP growth.

**Figure 18: Relation between metro region typology and GDP per capita growth in core regions**

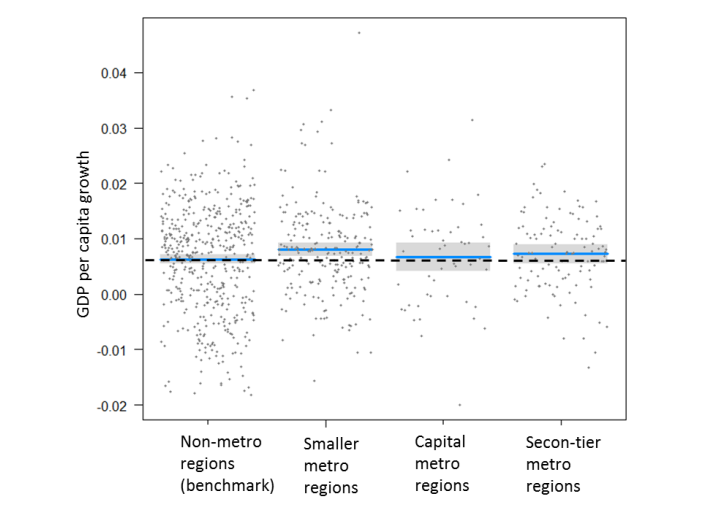
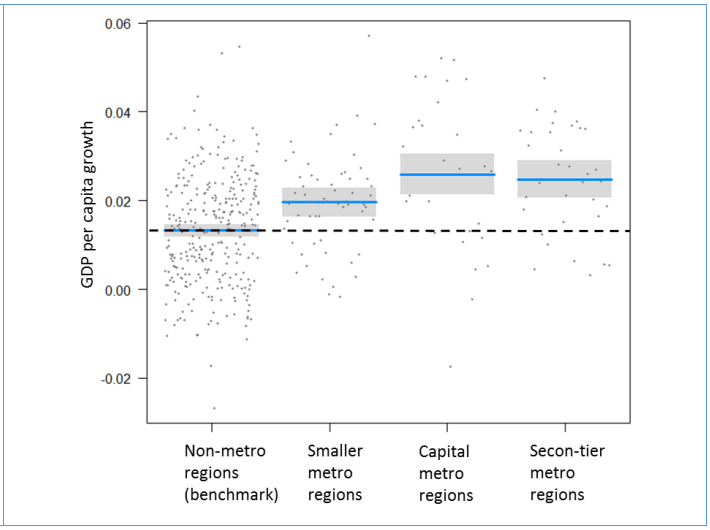



**Figure 19: Relation between metro region typology and GDP per capita growth in periphery regions**



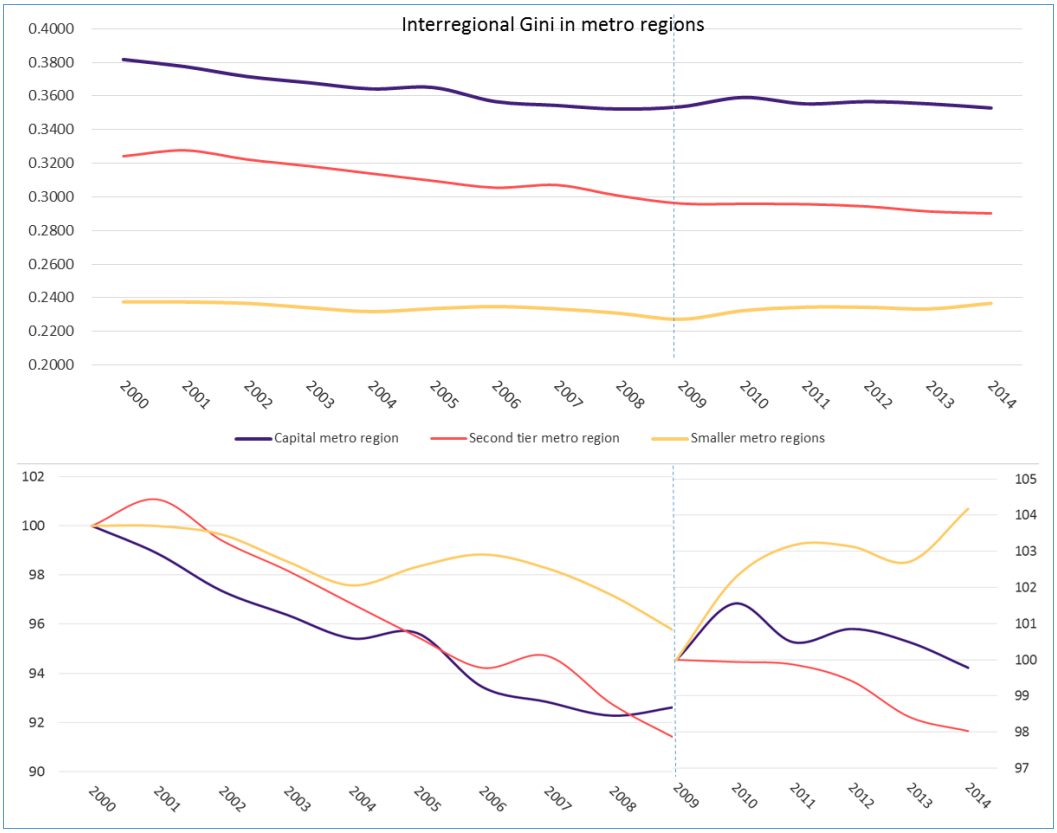

In the case of periphery regions (Figure 19), all types of metro regions have a positive effect on the GDP per capita growth. The second-tier and capital metro regions have similar, quite high impact on regional development, followed by the smaller metro regions. Being a non-metropolitan region in the periphery has no significant impact on the GDP per capita growth.

As a result, the economic growth tends to be observed not only in the capital metro regions, but also in smaller and second-tier metro regions, which observation indicates a strengthened resilience of less developed European regions. They stop the decline of GDP per capita and avoid the increase of inequality as indicated previously in Figure 17. In addition to this, the convergence groups analysis shows: I) the group of core regions is resilient in terms of GDP growth per capita at the expense of a raising territorial inequality; II) the group of periphery regions is not resilient in terms of GDP growth per capita but inequality across regions is at least not rising; III) all types of metro regions are driving growth in periphery regions, while only smaller metro regions have a positive impact in core regions.

### 4.3.2. Resilience and inequality of metropolitan regions

This section investigates the past economic trends in metropolitan regions, focusing on their resilience and inequality, i.e. the recovery after the Global Recession of 2008. Figure 20 shows the evolution of inequality among regions, based on GDP per capita, measured with the so-called Gini index. The Gini index measures the degree of inequality across regions within the same club and ranges between zero and one, where zero means perfect equality and one perfect inequality. The upper part of the figure shows the trend and the size of interregional inequality, while in the lower part interregional inequality is standardized to 100 index points for 2000 and then for 2009. This allows reader to compare the growth of interregional inequality in the different classes of metro regions before and after the economic crisis.

**Figure 20: Inequality among metro regions of the same class between 2000 and 2014**



The high interregional inequality is in capital metro regions. This is due to the strong differences in GDP per capita between the capital regions and in their surroundings. The Gini index is around 6% higher than in second-tier and 14%higher than in smaller metro regions, with capitals that show the stronger decline. After 2009, smaller metro regions show the stronger increase of inequality.

Figure 21 shows the evolution of GDP per capita in each class of metro regions. It is constructed following the reasoning of Figure 20. In absolute terms, the capital metro regions are the best performing with regard to GDP per capita, followed by the smaller metro regions, while second-tier ones end last. Before the crisis, the capital metro regions were slightly better performing than the second-tier and smaller metro regions. After the crisis, the situation drastically changed. Smaller metro regions and second tier metro regions recovered to the pre-crisis levels of GDP per capita in 2011, while capital metro regions could not manage to return to the pre-crisis GDP per capita levels yet.

**Figure 21: GDP per capita in metro regions between 2000 and 2014**

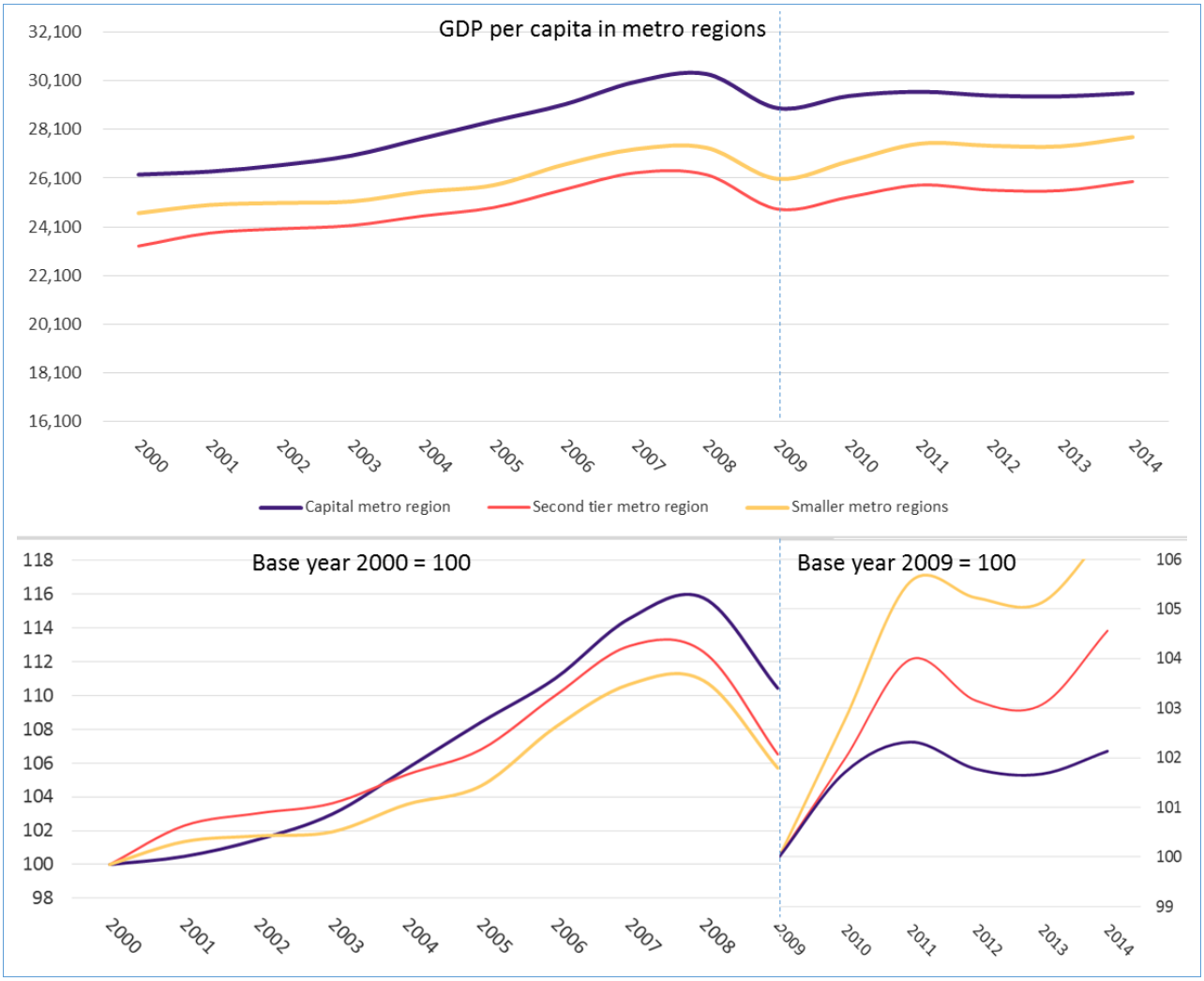
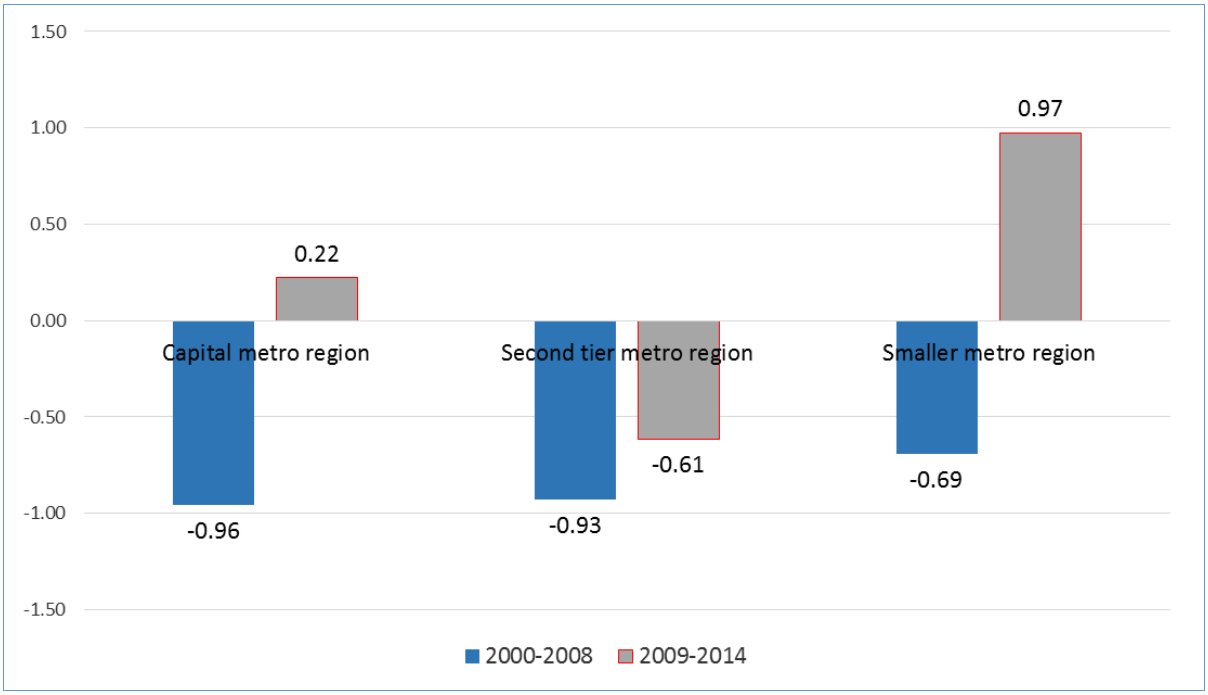


Figure 22 presents the correlation between the inequality growth and the average GDP growth per capita per type of metro region. The correlation coefficient varies between minus one and one. A positive correlation means that the two indicators go in the same direction (one indicates perfect synchronization); while a negative correlation means that they go in opposite directions (minus one indicates totally opposite trends).

As indicated in Figure 22, before the crisis of 2008 all three types of metro regions experienced relatively strong decline in inequality, in a situation of a robust GDP growth. This evolution was the strongest in capital regions, followed by second-tier and smaller regions. After 2008, the trend changed and the inequality started to rise in parallel to the (weaker) GDP growth. Again, this negative outcome was softer in capital regions, followed by the smaller regions. In the second tier metro regions, the GDP growth leaded to a decrease in the level of inequality.

**Figure 22: Correlation between growth in GDP per capita and inequality between 2000 and 2014, by metropolitan regions**




Analysis of past trends in GDP per capita by metropolitan regions highlights that there are strong differences in GDP per capita among various types of metro regions. Between 2000 and 2014, capital metro regions experienced greater inequality combined with higher GDP per capita. They were also the least resilient in terms of average GDP growth per capita, but the most resilient in terms of interregional inequality, because inequality was declining, although the GDP per capita did not fully recover to the pre-crisis levels. In the second tier metro regions inequality continues to decline, while in the smaller metro regions after the crisis it increased along with the GDP per capita. Thus, both were resilient in terms of GDP growth per capita growth, but only second tier metro regions in terms of inequality.

### 4.4. Potential accessibility

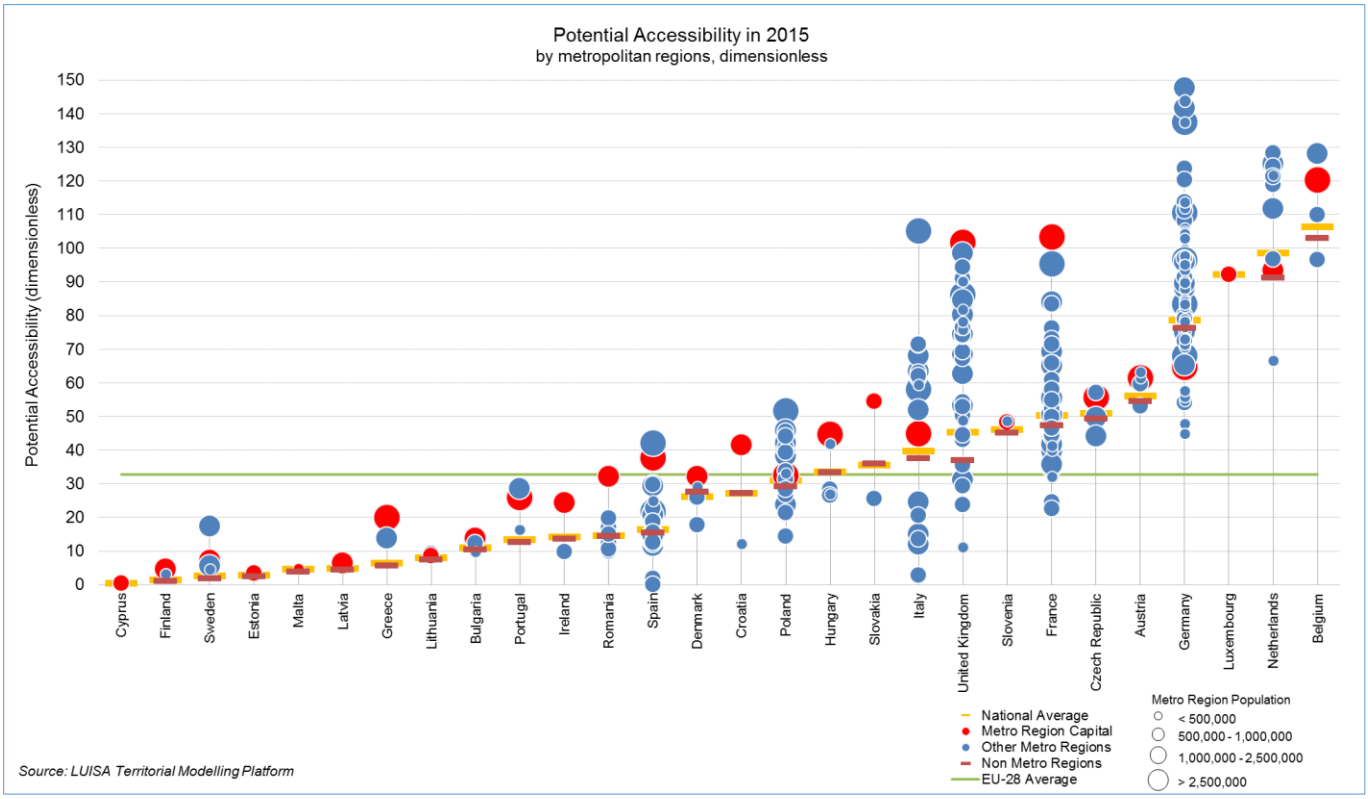
The functioning of transport infrastructure is considered to be of key importance for economic activity. Potential accessibility measures take into account the spatial distribution of markets and the services supplied by the transport infrastructure. It is one of many measures available in the literature, repeatedly noted as particularly useful to describe the economic usefulness of transport infrastructure provisions (Keeble et al. 1982; Gutiérrez 2001; Vickerman et al. 1999).

This section gives an overview of potential accessibility trends in Europe. The results presented here include changes in road transport networks that have been used as external input to the LUISA framework, and changes in population distribution that are modelled by the LUISA platform. The road transport network used here is based on data from the TRANSTOOLS model, with additional modifications to take into account expected regional investments. The network improvements accounted for are in all cases based on the assumed effects of TEN-T policies and other EU funding; in particular, the newest member states receive network improvements. Population distributions modelled here are based on Eurostat NUTS3-level population projections, further aggregated to the 100m grid level by an additional spatial modelling exercise in the LUISA platform for the LUISA reference scenario 2017. Further information on its method can be obtained from a previous study by Jacobs-Crisioni et al. (2016).

As indicated in Kompil (2016) existing accessibility pattern in Europe follows a core-periphery pattern and it is highly correlated with the level of urbanisation. For road transport, accessibility the distinction is particularly evident. As indicated for 2015 in Figure 23 and Figure 25, the average potential accessibility is the higher at large metropolitan regions that are in central Europe such as Belgium, the Netherlands and Germany. The countries at the periphery together with the non-metropolitan regions have lower potential accessibility compared to them. Apart from this, capital metro regions presents the highest accessibility levels for the majority of EU countries apart from Poland, Italy, Germany, the Netherlands and Belgium. However, the discrepancies for these five countries can mainly be explained by their geographical location in relation to major pan-European transport infrastructure.

Projections of potential accessibility with transport infrastructure and population changes (Figure 24 and Figure 26) indicate that metropolitan regions will unevenly benefit from accessibility improvements with capital metro regions benefiting the most in Romania, Denmark and the UK, while smaller and intermediate metro regions should see the largest increase in Germany, Poland the Netherlands and Belgium. Again, the non-metropolitan regions will have the least gain in terms of potential accessibility between 2015 and 2025. Finally, the results show that potential accessibility levels will increase mostly in those member states where population numbers are expected to increase. On the other hand, it will decrease in some other member states even though they receive investments for transport network improvements.

## Figure 23: Potential accessibility in 2015 per metropolitan regions




## Figure 24: Changes in potential accessibility between 2015 and 2025 per metropolitan regions

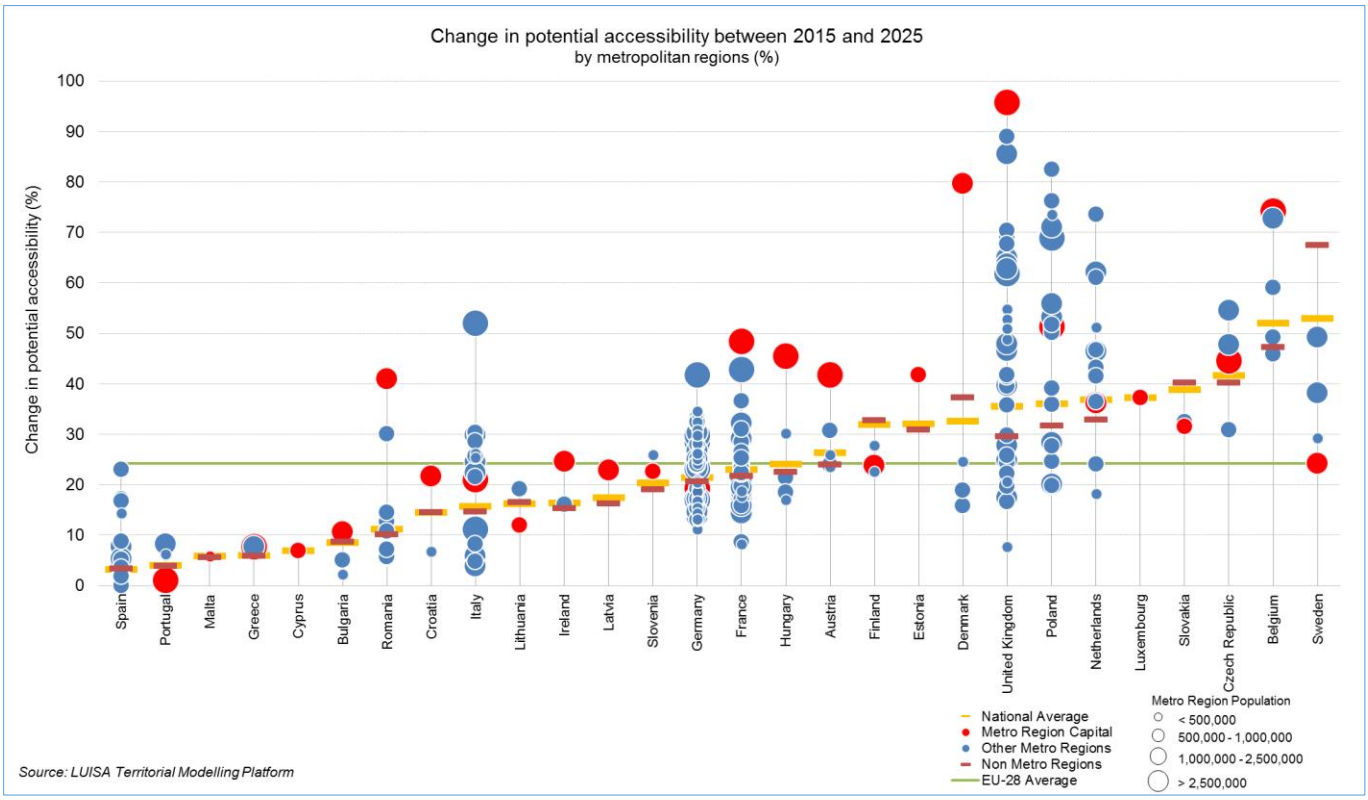
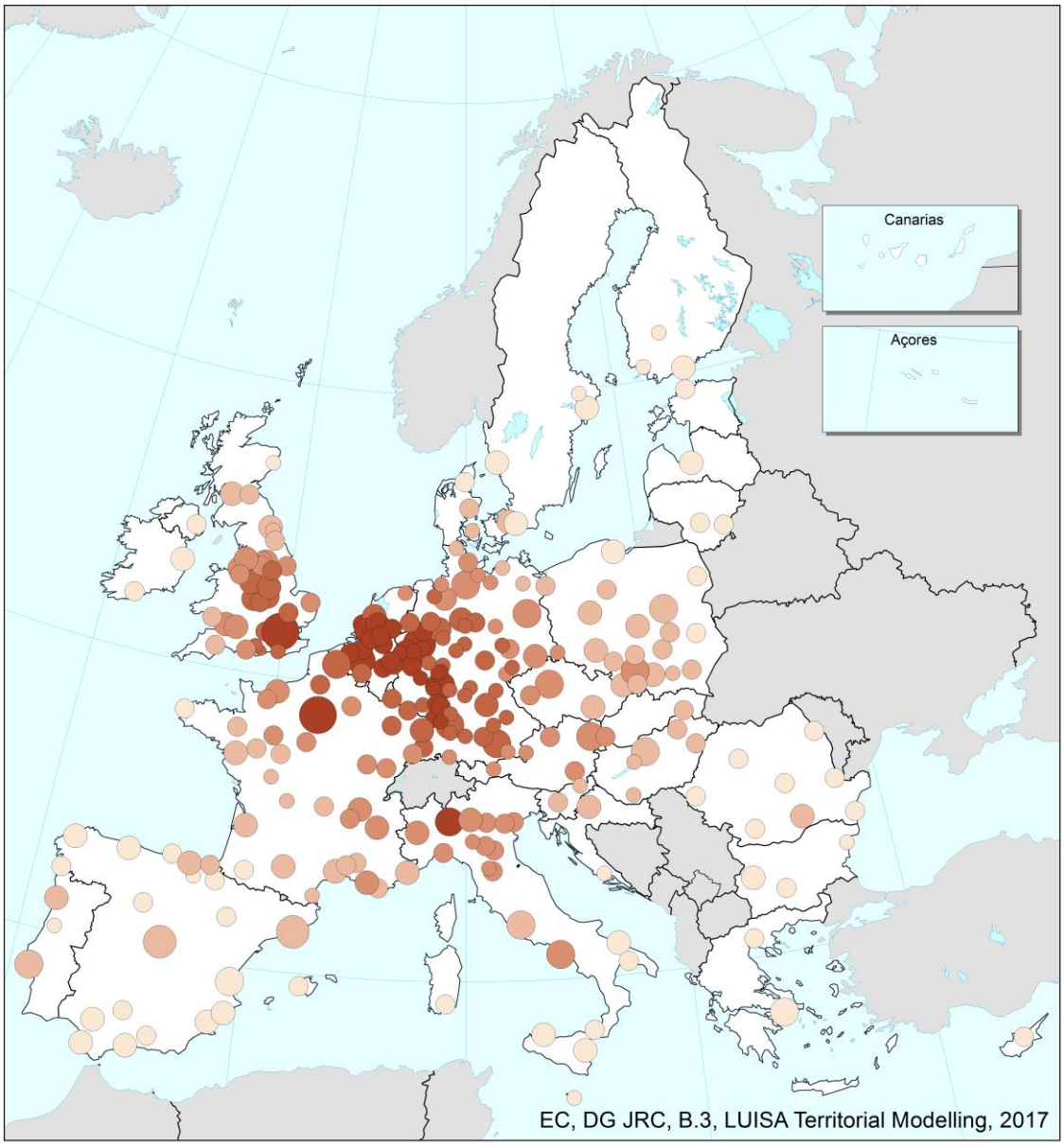


**Figure 25: Potential accessibility in 2015, by metropolitan regions**




Potential accessibility in 2015

Potential accessibility in 2015 by metropolitan regions (dimensionless)
< 25
25 - 50
50 - 75
75 - 100
> 100

Population 2011
< 500000
500000 - 1000000
1000000 - 2500000
2500000 - 5000000
5000000 - 7500000
> 7500000

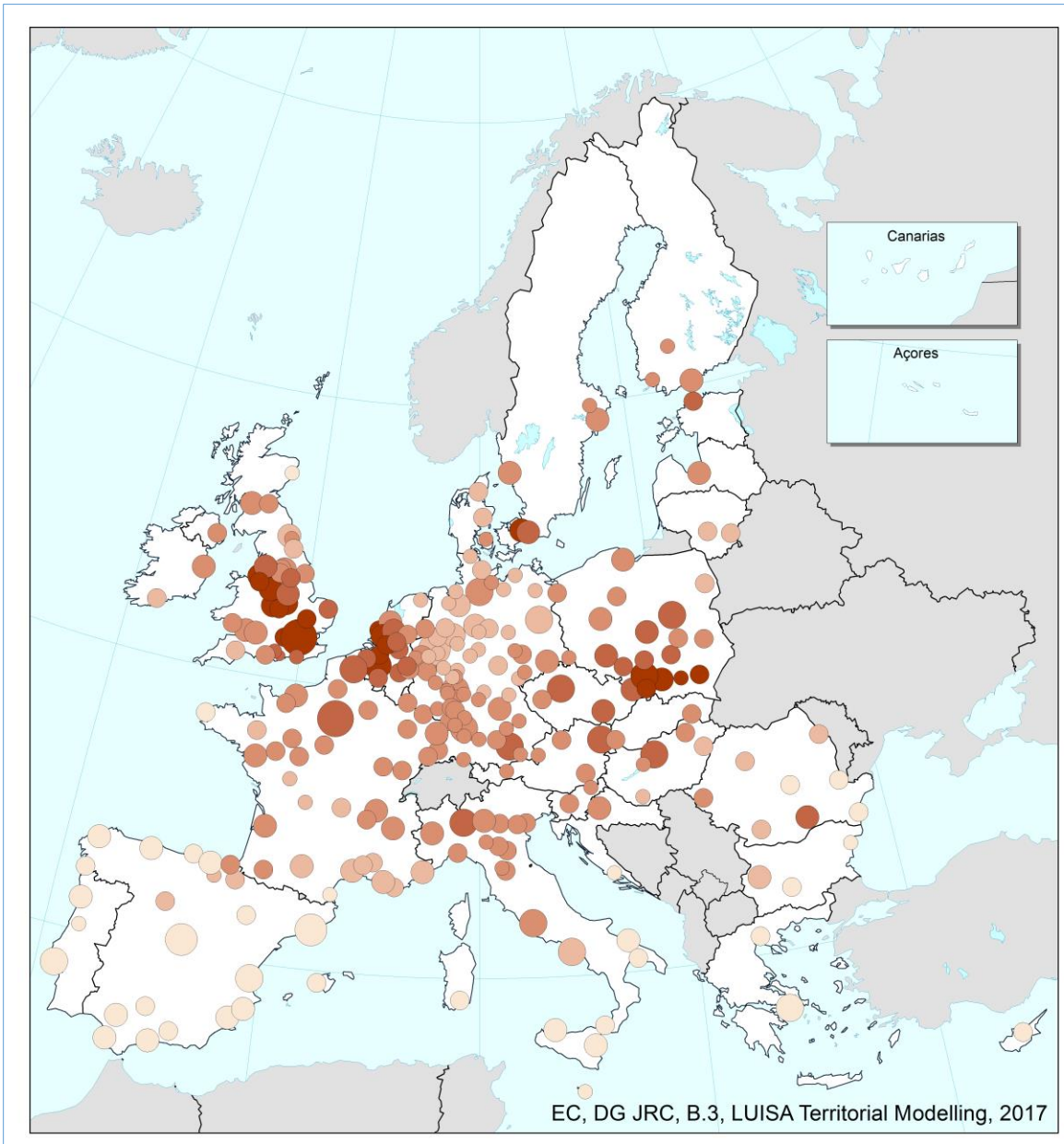
0 250 500 1,000 Km

EC, DG JRC, B.3,
LUISA Territorial Modelling, 2017

Based on the road network of TRANSTOOLS

© EuroGeographics Association for the administrative boundaries

**Figure 26: Changes in potential accessibility between 2015 and 2025 per metropolitan regions**



## 5. Concluding remarks

This study illustrates how the LUISA Territorial Modelling Platform brought together various data sources, including its own downscaled projections, to provide an exhaustive spatial and temporal coverage of European metro regions across various thematic fields. The data analysed in this exercise indicate that metropolitan regions will continue to lead economic activities in Europe and they keep attracting more people in the next decades.

Other than this, capital metro regions across Europe have grown and are likely to continue growing more than other metro regions. While countries such as Germany, France, the UK, Spain and Italy will see the population growth rate of some metro regions exceed that of the capital metro region; capital metro regions remain and will continue to remain at the first position in relation to economic performance and potential accessibility. Increasing at a higher rate than other metro regions, capital metro regions are likely to further widen the gap with most other metro regions particularly in Eastern European countries. However, the past response of capital metro regions to the global financial crisis has also shown that they were slower to recover after a shock than smaller metro regions. Besides, other metro regions will follow the capitals and non-metro regions will follow the other metro regions in terms of economic performance and potential accessibility gains.

Finally, it is worth pointing out that the presented results (mostly) can be retrieved from the Urban Data Platform (http://urban.jrc.ec.europa.eu). Apart from the demographic and economic indicators partly presented in this study, it also includes several other indicators under different thematic fields such as urban development, transport and accessibility, environment and climate, resource efficiency, and social issues. They are provided at the level of cities / greater cities, functional urban areas, metro regions and by degree of urbanisation.

## References

Baranzelli, C., Jacobs, C., Batista e Silva, F., Perpiña Castillo, C., Lopes Barbosa, A., Arevalo Torres, J. and Lavalle, C., 2014, "The reference scenario in the LUISA platform – updated configuration 2014 - towards a common baseline scenario for EC impact assessment procedures", EUR 27019, Luxembourg: Publications Office of the European Union, JRC94069, doi: 10.2788/85104.

Batista e Silva, F., Dijkstra, L., Vizcaino Martinez, P. and Lavalle, C., 2016, Regionalisation of demographic and economic projections –Trend and convergence scenarios from 2015 to 2060, ‚JRC Science for policy report. EUR27924 EN; doi: 10.2788/458769

Batista e Silva, F., Lavalle, C., Jacobs-Crisioni, C., Barranco, R., Zulian, G., Maes, J., Baranzelli, C., Perpiña, C., Vandecasteele, I., Ustaoglu, E., Barbosa, A. and Mubareka S., 2013, Direct and indirect land use impacts of the EU cohesion policy - assessment with the Land Use Modelling Platform, EUR 26460, Luxembourg: Publications office of the European Union, JRC87823, doi: 10.2788/60631.

Dijkstra, L. and Poelman, H., 2014, A harmonised definition of cities and rural areas: the new degree of urbanization, Regional Working Papers, WP 01/2014. European Commission, http://ec.europa.eu/regional_policy/sources/docgener/work/2014_01_new_urban.pdf - access May, 2017.

European Commission, 2016, The State of European Cities 2016, Luxembourg, Publications office of the European Union, JRC80684, doi:10.2776/643506.

Getis, A., Ord, J.K., (1992), The analysis of spatial association by use of distance statistics, Geographical Analysis, 24: 189-206.

Gutiérrez, J., 2001, Location, economic potential and daily accesibility: an analysis of the accessibility impact of the high-speed line Madrid-Barcelona-French border, Journal of Transport Geography, 9(4), pp.229–242.

Jacobs-Crisioni, C., Batista e Silva, F., Lavalle, C., and Baranzelli, C., 2016, Accessibility and territorial cohesion in a case of transport infrastructure improvements with changing population distributions, European Transport Research Review, 8(9), pp.1–16.

Jacobs-Crisioni, C., Diogo, V. and Baranzelli, C., 2017, Bridging the gap between function and cover in spatially explicit land-use models: The LUISA approach, AGILE 2017 – Wageningen, May 9-12, 2017.

Keeble, D., Owens, P.L., and Thompson, C., 1982, Regional accessibility and economic potential in the European Community, Regional Studies, 16(6), pp.419–432.

Kompil, M., Aurambout J., Ribeiro Barranco, R., Barbosa, A., Jacobs-Crisioni C., Pisoni E., Zulian, G., Vandecasteele, I., Trombetti, M., Vizcaino, M., Vallecillo Rodriguez, S., Batista e Silva, F., Baranzelli, C., Mari Rivero, I., Perpiña Castillo, C., Polce C., Maes, J., Lavalle, C., 2015, European cities: territorial analysis of characteristics and trends - An application of the LUISA Modelling Platform (EU Reference Scenario 2013 - Updated Configuration 2014), EUR 27709 EN, doi:10.2788/737963.

Kompil, M., Demirel, H. and Christidis, P., 2016, Transport accessibility measure for europe : ex-post analysis of cohesion fund infrastructure projects", in Geurs, K. T., Patuelli, R., and Dentinho, T. P. (eds) *Accessibility, Equity and Efficiency*. Cheltenham, UK: Edward Elgar Publishing, pp. 210–242. doi: 10.4337/9781784717896.00021.

Lavalle, C., Baranzelli, C., Batista e Silva, F., Mubareka, S., Rocha Gomes, C., Koomen, E. and Hilferink, M., 2011, A high resolution land use/cover modelling framework for Europe: introducing the EU-ClueScanner100 model, In *Computational Science and Its Applications - ICCSA 2011, Part I, Lecture Notes in Computer Science vol. 6782*, edited by Murgante, B., Gervasi, O., Iglesias, A., Taniar, D. and Apduhan, B.O., Berlin: Springer-Verlag.

Lavalle, C., Mubareka, S., Perpiña, C., Jacobs-Crisioni, C., Baranzelli, C., Batista e Silva, F., and Vandecasteele, I., 2013, Configuration of a reference scenario for the land use modelling platform, EUR 26050, Luxembourg, Publications office of the European Union, JRC80684, doi:10.2788/58826.

Le Gallo, J., Dall'erba S., 2008, Spatial and sectoral productivity convergence between European regions: 1975-2000, Papers in Regional Science, 87, 4: 505-524.

LUISA, 2017, "LUISA Territorial Modelling Platform", official webpage, https://ec.europa.eu/jrc/en/luisa - access May, 2017.

UN, 2014, World Urbanization Prospects: The 2014 Revision, United Nations Department of Economic and Social Affairs, Population Division, CD-ROM Edition.

Vickerman, R., Spiekermann, K., and Wegener, M., 1999. Accessibility and Economic Development in Europe, Regional Studies, 33(1), pp.1–15.