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The first step of our analysis is to map the EU regions according to their economic structure. We exploit information conveyed by Eurostat data, which are available for a balanced panel of 241 regions and 86 economic branches in 2010 and 2015. In this way we are able to construct a space characterized by technological proximity of regions. The underlying assumption is that territories with similar production structures display similar production knowledge. The second step is the construction of the network space based on the correlation matrix. In order to obtain the clusters of regions based on the similarity of their economic structure, we apply a modularity algorithm to the network. Such measures define groups based on the degree of connectedness of the observations between them and allows to measure how such groups explain the network connections using as benchmark a case in which edges where assigned randomly.
Our findings suggest that regions, which are more dynamic in terms of structural change, are those with manufacturing capabilities located in Eastern European countries. Such regions were able to upgrade their competences towards more complex productions and this resulted also in a fast catch-up of their GDP per capita level with respect to other mid income regions in Western Europe. Most prosperous regions are found to be urban areas with developed creative service activities and in regions with advanced manufactures (machinery, automotive, electronics, etc.); whereas backwardness is detected in regions with a cumbersome weight of tourism related activities.

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Structural change and convergence across European regions

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Abstract

The aim of our paper is to analyze the structural diversity of the European regions assuming the complexity of production spaces approach (Hidalgo C.A., B. Klinger, A.L. Barabási, R. Hausmann 2007). This stream of economic literature is the natural companion of the evolutionary theory of economics, where development is seen as the endogenous learning process led by the initial knowledge basis, which tends to expand in its proximity (Boschma 2005).

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Our findings suggest that regions, which are more dynamic in terms of structural change, are those with manufacturing capabilities located in Eastern European countries. Such regions were able to upgrade their competences towards more complex productions and this resulted also in a fast catch-up of their GDP per capita level with respect to other mid income regions in Western Europe. Most prosperous regions are found to be urban areas with developed creative service activities and in regions with advanced manufactures (machinery, automotive, electronics, etc.); whereas backwardness is detected in regions with a cumbersome weight of tourism related activities.

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Introduction

The theory of economic complexity (Hidalgo C. A., B. Klinger, A.-L. Barabási, R.Hausmann 2007, Hausmann and Hidalgo 2010, Hausmann and Hidalgo *et al* 2011) has confirmed that the pool of competences within the economic fabric of territories is the key to open up trajectories of long run economic development. Convergence/divergence across nations and regions is deeply influenced by the quantity and quality of competences that are present on their territories; in this perspective the "convergence clubs" of Baumol (1986) can be intended as clusters of countries with similar within-group knowledge basis.

Operatively, the theory of economic complexity limits to productive knowledge the way to capture the knowledge basis and, therefore competences are intended as products. This stream of economic literature is the natural companion of the evolutionary theory of economics, where development is seen as the endogenous process led by the initial knowledge basis, which tends to expand in its proximity (Boschma 2005).

The structure of the economy in a given territory is therefore a key factor for explaining both the patterns of economic growth and the evolution of the knowledge basis. In this perspective, convergence and divergence across countries and regions has a twofold connotation, as it originates from the divide in productive competences and results in disparities in income and wealth. This somehow reconciles the neoclassic perspectives of endogenous growth with respect to knowledge (Romer 1986 and 1990) and learning by doing (Lucas 1988), with the patterns of technological change in the evolutionary economic theory (Nelson and Winter, 1982).

We represent the network of 241 European regions based on the distribution of wages paid across 86 economic branches (i.e. using structural similarity as the metric for distance) and identify six clusters of regions with peculiar sector characteristics. Our findings suggest that the regions, which are more dynamic in terms of structural change over the period 2010-2015, are those with manufacturing capabilities located in Eastern European countries. Such regions were able to upgrade their competences towards more complex productions and this resulted also in a fast catch up of their GDP per capita level with respect to other mid-income regions in Western Europe. Most prosperous regions are found to be in urban areas with developed creative service activities, whereas backwardness is detected in regions with a cumbersome weight of tourism related activities.

In the next section we briefly revisit the literature on economic complexity and explain how it represents an important link between the neoclassical and the new evolutionary economic theories; in the third section we outline the previous findings on convergence and divergence across European regions; section four introduces the methodology used for analyzing structural similarity of regions and illustrates our empirical findings; section five concludes.

Literature review

A general point of consensus in the economic literature is that knowledge is central to economic development. Different theories, often moving from contrasting assumptions and approaches, recognize knowledge, with its different semantic nuances, as the key factor explaining prosperity and poverty of nations and regions. In particular, *productive knowledge* or, said differently, *technology*, evolves with self-strengthening (or endogenous) trajectories, implying path dependency in the patterns of long-run economic growth. In this brief literature review we reconcile different theoretical frameworks to show that apparently contrasting interpretations entail very similar economic policy insight and recommendations.

Arrow (1962a) was first in exploring the concept of knowledge, intended as the capability of acquiring key information and managing it to gain advantages on the market. In this sense knowledge can be considered as a commodity that is used in any situation of uncertainty, which is the common ground where entrepreneurs tend to operate. Arrow's contribution is also to explore the way knowledge expands, i.e. through a process of learning by doing: knowledge is the resultant of practice and research (Arrow 1962b). Productive experience in Arrow's theory has therefore a central role in determining competitiveness of countries and in characterizing knowledge as a by-product of output or investment (for an exhaustive review on the theory of knowledge of Arrow's theory of knowledge, please refer to Vahabi 1997).

Among the neoclassical economists, Romer (1986) was the first explicitly encompassing *knowledge* in economic growth model; in such theoretical framework *knowledge* is allowed to grow without bound, even though with decreasing marginal returns with respect to research input invested to obtain it. Lucas (1988) identifies in *human capital*, intended as "an unobservable magnitude or force," the engine of long-run economic growth. In Lucas' theoretical framework human capital has similar characteristics to the concept of productive knowledge of evolutionary economics, as it evolves with experience gained in the production process, thanks to its *learning-by-doing component*. In addition to this, Lucas recognizes the importance of creative forces[1] as the resultant of the various individual professional efforts to emphasize "originality and uniqueness" of their products. The *endogenous* component of technological change is further expanded in Romer (1990), where *technology* is treated as "neither a conventional good nor a public good; it is a non-rival, partially excludable good." In this view economies endowed with larger stocks of *human capital* will attain faster growth.

Endogeneity in the patterns of technological change is central also in the evolutionary economic theory (Nelson and Winter,1982), which is in line with the new neoclassical framework of Romer and Lucas in that it recognizes the central role of knowledge to explain heterogeneous growth patterns across countries. However, the evolutionary economists take distance from the neoclassical production function as it does not capture changes in the evolution of knowledge, hence failing to account for the factor that at the same time is judged as the key of development within the neoclassical theory itself. Such dichotomy in economic theory has brought to a situation in which

[1] Lucas cite the work by The Economy of Cities by Jane Jacobs (1969).

evolutionary economics seemed better placed to illustrate the mechanics of change in knowledge, whereas the new neoclassical theory enjoyed a more pragmatic way to assess the impact of knowledge on economic growth through modeling and empirical analysis (Mulder, De Groot and Hofkes 2001).

Advances in data collection have gradually open the way to model in more sophisticated way technological change. Both research streams have in particular explored diversification (relevant to our discussion as diversification of products entails an enlargement of the pool of competences) as a key factor to enhance sophistication of products and economic growth. For instance, Koren and Tenreyro (2013) develop a model that reconciles the importance of having diversified economic fabrics with the idea of endogenous technological change of Romer (1990) by characterizing technological progress as an expansion in the number of input varieties. More in particular, by assuming that each product variety is prone to external shocks with a certain likelihood, the expansion in the number of varieties brings the direct benefit of stabilizing the economy. In this framework higher productivity resulting from deeper specialization in a given production, might have the undesirable outcome of excessively *technological concentration* and, hence, an exacerbated degree of volatility.

Boschma (2005) tackles the issue of interactive learning and innovation exploring five dimensions of proxitmity (cognitive, organizational, social, institutional and geographical). Such holistic approach has contributed to unravel the black box of endogeneity and explore further the determinants of growth and success of firms and regions. This streams of literature has widened the study of regional competitiveness from simply considering specialization (Marshallian externalities) to taking into account also regional diversification (Jacobs' externalities) as possible factors that affect patterns of economic growth (see also Frenken, Van Oort, Verburg, 2007 and Boshma and Iammarino 2007).

This approach has more recently developed into the study of economic complexity. The term complexity conveys a situation in which the change and impact of the single element is overcome by the simultaneous co-evolution of multiple elements adapting to the environment of which they are all inherent particles. Interaction may take place also across systems, as, when one of them evolves, it affects the landscape of the others (Kauffman 1993, 1995). The theory of economic complexity analyses the process of co-evolution in productive competences through the observation of changes in the bouquet of products made (or exported) in (by) a given territory. In this sense changes of sectors or products, reflecting the pool of competences within the economy, tend to take place simultaneously with continuous feedbacks across them. For instance the electronics and digital devices has brought innovations in numerous products and, at the same time, it has continuously received new inputs for further advances.

A coherent approach to analyze economic complexity has been developed starting since 2007 (Hidalgo et al. 2007, Hidalgo and Hausmann 2009, Hausmann et al. 2011). This theoretical framework is based on the two key concepts of diversification and ubiquity, where the former is simply the number of products exported by a country and the latter the number of countries exporting a given product. The idea underlying this approach is

that the pool of competences find direct expression in the range of products made in a given territory and that this two elements evolve together according to a mutual need of coexistence. Economic Complexity is also found to be a strong determinant of long-run growth. Countries exhibiting level of GDP per capita in excess with respect to the degree of diversification and sophistication of their bundle of exported products are destined to experience slowdowns in their growth path and *viceversa*. Additional methods have been proposed to measure economic complexity and assess its impact on economic development (see for example Tacchella et al. 2012, Albeik et al. 2017, Cristelli et al. 2013 e 2014).

Buccellato 2016 shows that the degree of economic complexity of territories arises from the strategies of diversification of individual firms. This adds a further dimension to economic complexity which, beside the interactions across competences synthesized in products and sectors, also calls the aspects of complexity arising at the micro-level from the strategies implemented within the single firm. The idea of considering the firms as a pool of competences stems from Penrose (1959) who recognizes the importance of diversification as a strategy of the firm to grow beyond the limits of the market, even though within the constraint of existing resources. As for countries, the knowledge of the firm evolves in proximity to acquire new competences close to the core ones originally present within the firm. This generates persistent competitive gaps across firms, because the initial pool of competences within the firm tend inevitably to affect the acquisition of new ones and therefore the expansion of the firm itself (Dosi, Grazzi, Moschella, 2015).

The theory of economic complexity has had the merit of stressing the importance of the structure of the economy, which is a trustful image of the overall pool of competences of countries and regions. It emerges the key role of sophisticated manufacturing activities as an engine for persistent and sustainable development. In this sense the theory of economic complexity is more in favour of the so-called *structuralist* approach, which is in contrast with the neoclassical view that market efficiency is the optimal way to promote structural change (see Gala, Rocha and Magacho, 2016).

Stylized facts on convergence/divergence across European regions

Starting in the second half of the 1990s and during the 2000s, the EU single market has gone through a period of fast political and economic integration, which found an important milestone in 2004 with ten new countries becoming member States. In parallel with EU integration, globalization accelerated worldwide, with a number of important economies, *in primis* China, entering the World Trade Organization; the strengthening of links across countries has brought to a boost in trade, capital and migration flows. While it has been beneficial to many people all over the world, the enhanced degree of competition and the continuous speeding up of innovation have also enlarged the economic divide between nations and regions. Highly competitive territories have acquired a key advantage from the enhanced level of export, which in turn implied higher returns of innovation, widening the gap with respect to weaker regions, in terms of both knowledge and prosperity.

This applies also to Europe, where the living standards have improved across all regions and, at the same time, the absolute gap between richer and poorer regions has widened. In 2000 the first percentile level of GDP per capita at purchasing power standards (PGDP) was 4,200 euros; in 2015 the same statistic was more than doubled to 9,600 euros; the growth pace in PGDP for regions at the bottom percentile of the distribution was faster with respect to those at the top (the top/bottom ratio passed from 10.3 to 6.2). Despite this, the absolute divide between the richer and the poorer regions has widened (the difference between the top percentile and the bottom percentile has passed from 39,200 to 49,900 euros) and the overall dispersion (standard deviation) has experienced an increase of 43.8%. Furthermore, the distance between the regions at the top of the distribution and those around the median has been more persistent (the top/median ratio has remained unchanged at 2.3) and the absolute gap between the two has increased of 38.8% (Table 1). At first glance, if any convergence took place over the period considered, this happened at the bottom part of the distribution (mainly due to the rapid growth in GDP per capita across regions in Central and Eastern Europe, see Cuaresma, Doppelhofer and Feldkircher, 2014).

Of particular interest in this sense is the analysis of groups of regions starting with similar and relatively low level of GDP per capita but experiencing contrasting path of growth and development. For instance, Boltho, Carlin and Scaramozzino (2018) compare the cases of the regions in Eastern Germany and those of the Italian Mezzogiorno, concluding that the former were more successful in catching up with the rest of the country, also thanks to the higher homogeneity in the degree of economic complexity, whereas national integration, *per se*, brings convergence in consumption rather than in GDP per capita.

The case of the reunification of the East with the West Germany is perhaps emblematic to explain the rapid catch-up of Eastern European regions with the remaining part of the EU. One could think that the reunification between the two German blocks has been the dress rehearsal for the integration of the Eastern economies in the Union. Germany has indeed played an important role, being far the largest foreign investor in the new countries, Poland has been the most attractive place for German firms. As in the case of the Ost-Länder after the fall of the Berlin wall, Central and Eastern European regions have enjoyed a quick political integration assisted by the EU institutions, great amount of resources to modernize the infrastructure thanks to the EU policy of cohesion, and the convergence of the private sector towards highly competitive standards thanks to the far reaching foreign direct investment of German corporations.

A clear example is provided by the quick development of German corporations active in the automotive sector that, following the fall of the reunification, have expanded in the Eastern Ländern. For instance the Eastern Region of Saxony at the beginning of the 1990s hosted the obsolete automotive industry inherited from the communist era and by the early 2000s already hosted a modern automotive cluster serving mainly the corporation of the Volks Wagen. A similar case study is the one of Berlin, but in this case thanks to the heavy investments of BMW and Mercedes. Already during the 1990s, in parallel to the wide flows of investment in its Eastern Ländern, Germany had already

started to redirect a great part of its foreign direct investment towards Eastern Europe, preparing the ground for the accession of such countries to the single market in 2004.

In general, the reasons of persistent gaps across regions are multifaceted and find their roots in historical, institutional, technological and geographical factors. Since the 1990s a large strand of the economic literature has been focusing on identifying the most meaningful determinants of convergence/divergence across countries and regions following the path initiated by Barro and Sala-i-Martin (1991) based on the theoretical implication of the Solow (1956) and Swan (1956). A wide range of hypothesis on the key factors for development and growth have been tested with such stream of models, leading sometimes to contrasting results depending upon the theoretical specification selected for conducting the study – the so called "open-endedness" of growth theories (Brock and Durlauf 2001). Despite this, key indicators such as human capital and the degree of technological stand (captured by total factor productivity) are recurrently found to be crucial determinant of long run development patterns.

The methodology: capturing structural relatedness across regions

In this section we illustrate the procedure followed to obtain the definition of clusters based on the degree of similarity in the structures of regions. The first step is the mapping of EU regions according to their economic structure. We exploit information conveyed by Eurostat data, which is available for a balanced panel of 241 regions and 86 economic branches in 2010 and 2015. The variable used is the amount of wages paid in each region and branch, normalized with the total amount per region. Based on this information we construct a symmetric matrix, in which each cell contains the pair-wise correlation between each region with all the others individually considered. We are therefore able to construct a space characterized by technological proximity of regions. The underlying assumption is that territories with similar production structures display similar production knowledge and, hence, degree of economic complexity.

The next step is the construction of the network space based on the correlation matrix. We consider two regions "close" if they exhibit a correlation of their respective production structure equal or above 0.75. As a result, for the year 2010, we construct a network of 241 nodes corresponding to the total number of regions and 3.587 edges equalizing the number of pair-wise correlations equal or above the 0.75 threshold (considering the same 241 regions in 2015 we obtain 3.807 edges). In order to obtain the clusters of regions based on the similarity of their economic structure, we apply a modularity algorithm to the network. Such measures defines groups based on the degree of connectedness of the observation between them and allows to measures how such groups explains the network connections using as benchmark a case in which edges where assigned randomly. In cases where modularity is positive, it implies that the groupings well explain the structure of the network. For both years modularity is above 0.5.

Thanks to this procedure and some qualitative considerations, we end up obtaining seven groups, one of which is composed by the regions that in each year do not match

the 0.75 correlation with any other region in the dataset. The structure of the network remained pretty much the same in 2010 and 2015, however, based on inspection of the groups both according to the regions part of them and the structure of their economy (Figure 1).

The description of the groups

Six out of the seven groups have peculiar characteristics attributable to their sector structure (one cannot be considered as such as it is composed by all the regions that are islands in the network). The six groups can be labelled as follows:

1. Urban areas characterized by a prominent presence of activities connected to services, with an important component of creative branches (publishing activities; computer programming, consultancy and related activities; activities of head offices, management consultancy activities; architectural and engineering activities). The regions that turn out to be more representative within this group (i.e. exhibiting highest degree or the greater number of connections both in 2010 and 2015) are Stockolm, the territories surrounding London and Utrecht.
2. Regions with a high weight of services more axed towards legal and accounting activities, real estate activities and employment activities. The most representative regions in this group are: Northern Ireland, Devon, Gelderland, and Noord Brabant.
3. Territories characterized by the presence of simple manufacture activities including mining of metal and ores, the manufacture of food products, textile products and manufacture of metals excluding machineries. This group includes mainly regions in Central and Eastern Europe that have the most evident evolution in the structure of their economy between 2010 and 2015. The group of most representative regions has changed completely over the five years considered, as the ones that exhibiting higher degree in 2010 have upgraded to more complex manufactures in 2015.
4. Areas with a relevant share of advanced manufacturing activities which include the manufacture of chemical products, manufacture of basic metals, computer and electronic equipments, machinery and motor vehicles. The three most representative regions within this group are Oberösterreich, Thüringen and País Vasco.
5. Regions with a cumbersome weight of tourism-related activities. These are mainly the peripheral areas of Europe, where the branches with prominent weights are accommodation and food and beverage services together with constructions. Among the most representative examples within this group appear Andalucía, Galicia, Alentejo and Communidad Valenciana.
6. Well-kept territories that are characterized by a well developed sector of specialized construction activities. These are mainly the rural areas of France, Germany and Scandinavian countries; the most representative regions are Alsace, Östra Mellansverige, Nordjylland, and Syddanmark.
7. Regions that cannot be associated in terms of similarity to any other regions and remains islands in the network space.

The distribution of regions per cluster is relatively persistent over the five years considered. Table 3 shows the distribution of regions per group and it appears clear that the majority of groups maintain the same size with the clear exception of the group of the regions characterized by a simple manufacture (it passes from 32 observations in 2010 to 6 observations in 2015). In the next section we analyse more specifically the mobility of regions across different groups.

Patterns of growth and structural change in the EU

In this section we study how the structural characteristics affected patterns of growth of the EU regions and how the structure itself has evolved over time. The starting point is the analysis of initial conditions, characterizing the groups according to different indicators, which include variables capturing prosperity, human capital, high tech penetration and institutional quality. Table 4 provides the description of groups according to these angles. Urban areas are the more virtuous economic environment, characterized by the highest level of GDP per capita at purchasing power parity (37.392 euros on average), enhanced levels of human capital (35.9% of the population has reached the tertiary level of education), the most elevated percentage of employees in high-tech sectors (6,6%) and a relatively good quality of institutions. Urban areas differ only slightly from regions with a high weight of services, which are characterized by a moderately lower level of human capital also reflected in a slightly inferior employment rate in high tech sectors, but a greater quality of the institutional environment.

It is interesting to compare the two different groups that are characterized by a strong weight of manufacturing activities. Regions specialized in high manufacture have a GDP per capita that on average is more than twice the one of the regions specialized in less complex manufacturing activities (in 2010, 25,804 and 12,650 euros, respectively). Regions with more developed manufacturing industries are also characterized by a higher share of people with tertiary education (22.3% and 19.8%) and a higher employment rate in high-tech industries (3.6% and 2.3%). Finally, the regions with less developed manufacturing systems tend to suffer poorer levels of institutional quality.

We can then analyse the two groups of regions characterized by rural environment. The areas with a cumbersome level of tourism-related activities have relatively high levels of GDP per capita (21,450 euros, greater than the one of the regions with less complex manufacturing activities) but the lowest employment rate (59.7%). This group of regions tend to suffer poor levels of institutional quality with average indexes that are negative for all the three components of corruption, rules of law and government effectiveness. The institutional environment is the greatest point of distinction with respect to the rural areas with more prosperous economies and living conditions and it is reflected also on the human capital (tertiary education in virtuous rural areas is 25,6% whereas it lagging ones is 21.6%) and high-tech employment (2,9% and 2,2% respectively).

We now move to the analysis of structural change looking at the mobility of regions across the groups. Table 5 displays the transition matrix of regions across the different groups over the period 2010-2015. First of all, it is important to remark that nearly all groups exhibit high persistency in the number of regions per group as structural change

naturally takes time (all values along the diagonal of the matrix are above 70% with the only exception of the less complex manufacturing regions). The only group that changed substantially its composition over the time span considered is the one of simple manufacturing regions, which, as noted above, passed from 32 to six regions inside it. The most of regions (65,6%) that in 2010 were part of this group have upgraded their manufacture converging towards the group of regions with manufacturing activities axed more towards machinery. Some of them have slipped towards a relative downgrade towards the rural areas with cumbersome weight of tourism activities and only a minor part towards more virtuous rural areas. This pattern of fast structural change has mainly concerned Eastern and Central European regions, which are also the ones who have caught up more in terms of GDP per capita levels.

The analysis is completed through a regression analysis of growth and convergence patterns in GDP per capita at purchasing power parity across EU regions. Table 6 shows the regression results obtained through general list squares of various model specifications. The first column introduces unconditional convergence results showing a significant convergence rate in the order of 1.2%. The convergence rate is rescaled downwards when considering the categorical variables for the different groups; more in particular the regions characterized by “simple manufacture” have outperformed on average the others, explaining a relevant part of the convergence process. Furthermore, the regions belonging to rural areas with cumbersome share of tourism activities have underperformed, exhibiting on average slower economic growth rate. The share of employees in high-tech industries is found to play a positive role on economic growth together with government effectiveness, although this last with a low level of statistical significance.

Conclusions and redirections for future research

In this study we have analysed the patterns of convergence in terms of structural change and GDP per capita across 241 regions part of the EU28. The analysis has been conducted adopting an original perspective of relatedness measured as the pairwise correlation between the distributions of wages paid in 86 economic branches in each region. This procedure has allowed to draw a network of the regions and categorize them into six clusters according to the similarity of their economic structures. Based on such classification we have studied the patterns of structural change in the network over the period 2010-2015.

Our results confirm that the patterns of convergence across EU regions are mainly driven by the rapid growth in terms of GDP per capita of Eastern European regions. In addition to this it shows that such patterns have been accompanied to a marked shift towards more complex manufacturing activities. One possible explanation of this success story experienced in Central and Eastern European regions could be represented by the great participation of FDI especially originating from Germany.

Future research should investigate further the drivers underlying the patterns of structural change in order to identify triggers and obstacles for the upgrade of economic

fabrics across territories. This should provide precious insight for bringing best practices in areas that result trapped into social and economic backwardness.

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Tables and graphs

Table 1 – Summary statistics of the distribution of income in 2000 and in 2015

2000					2015				
	Percentiles	Smallest				Percentiles	Smallest		
1%	4200	3600			1%	9600	8400		
5%	6700	4200			5%	13900	9500		
10%	8000	4200	Obs	260	10%	15600	9600	Obs	269
25%	14250	4200	Sum of Wgt.	260	25%	20900	9900	Sum of Wgt.	269
50%	19200		Mean	19225.38	50%	25900		Mean	27760.97
		Largest	Std. Dev.	9041.516			Largest	Std. Dev.	13003
75%	23300	36000			75%	32100	59200		
90%	28500	43400			90%	39400	59500		
95%	32300	48700	Skewness	2.77871	95%	46700	76200	Skewness	5.015799
99%	43400	99100	Kurtosis	25.3568	99%	59500	167500	Kurtosis	51.6107

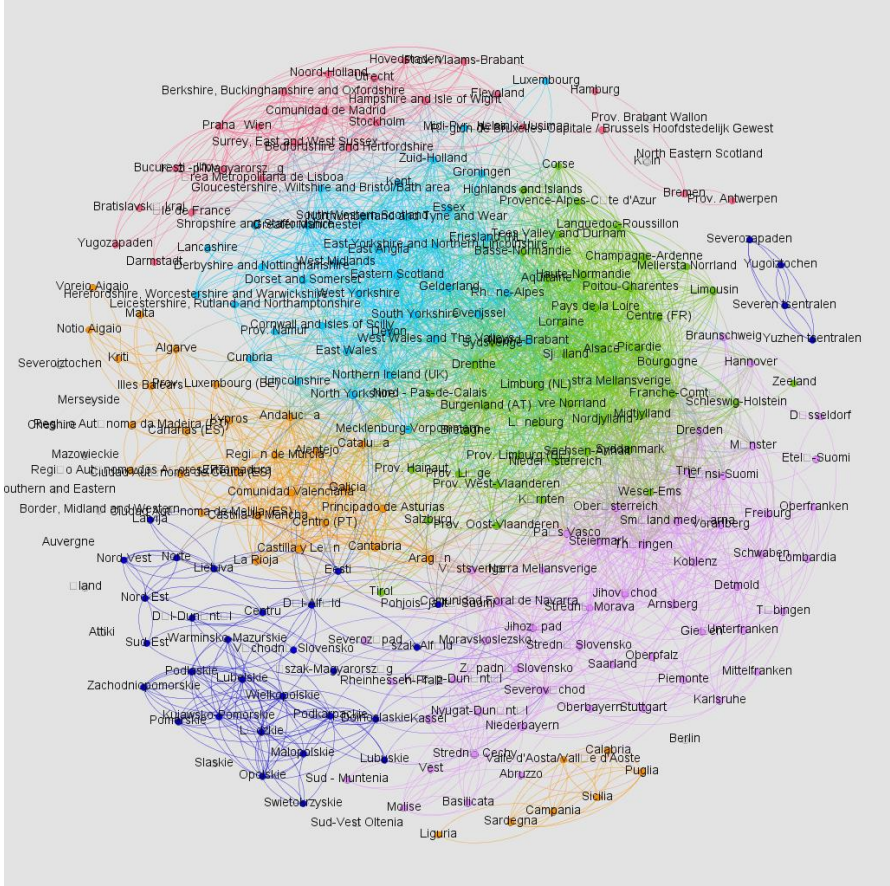
Table 2 – The 86 branches of the economy considered for the mapping of regions into clusters

nace	nace_label
B05	Mining of coal and lignite
B06	Extraction of crude petroleum and natural gas
B07	Mining of metal ores
B08	Other mining and quarrying
B09	Mining support service activities
C10	Manufacture of food products
C11	Manufacture of beverages
C12	Manufacture of tobacco products
C13	Manufacture of textiles
C14	Manufacture of wearing apparel
C15	Manufacture of leather and related products
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products

C24 Manufacture of basic metals
C25 Manufacture of fabricated metal products, except machinery and equipment
C26 Manufacture of computer, electronic and optical products
C27 Manufacture of electrical equipment
C28 Manufacture of machinery and equipment n.e.c.
C29 Manufacture of motor vehicles, trailers and semi-trailers
C30 Manufacture of other transport equipment
C31 Manufacture of furniture
C32 Other manufacturing
C33 Repair and installation of machinery and equipment
D35 Electricity, gas, steam and air conditioning supply
E36 Water collection, treatment and supply
E37 Sewerage
E38 Waste collection, treatment and disposal activities; materials recovery
E39 Remediation activities and other waste management services
F41 Construction of buildings
F42 Civil engineering
F43 Specialised construction activities
G45 1 Sale of motor vehicles
G45 2 Maintenance and repair of motor vehicles
G45 3 Sale of motor vehicle parts and accessories
G45 4 Sale, maintenance and repair of motorcycles and related parts and accessories
G46 1 Wholesale on a fee or contract basis
G46 2 Wholesale of agricultural raw materials and live animals
G46 3 Wholesale of food, beverages and tobacco
G46 4 Wholesale of household goods
G46 5 Wholesale of information and communication equipment
G46 6 Wholesale of other machinery, equipment and supplies
G46 7 Other specialised wholesale
G46 9 Non-specialised wholesale trade
G47 1 Retail sale in non-specialised stores
G47 2 Retail sale of food, beverages and tobacco in specialised stores
G47 3 Retail sale of automotive fuel in specialised stores
G47 4 Retail sale of information and communication equipment in specialised stores
G47 5 Retail sale of other household equipment in specialised stores
G47 6 Retail sale of cultural and recreation goods in specialised stores
G47 7 Retail sale of other goods in specialised stores
G47 8 Retail sale via stalls and markets

G47 9	Retail trade not in stores, stalls or markets
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I55	Accommodation
I56	Food and beverage service activities
J58	Publishing activities
J59	Motion picture, video and television programme production, sound recording and music publishing activities
J60	Programming and broadcasting activities
J61	Telecommunications
J62	Computer programming, consultancy and related activities
J63	Information service activities
L68	Real estate activities
M69	Legal and accounting activities
M70	Activities of head offices; management consultancy activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74	Other professional, scientific and technical activities
M75	Veterinary activities
N77	Rental and leasing activities
N78	Employment activities
N79	Travel agency, tour operator reservation service and related activities
N80	Security and investigation activities
N81	Services to buildings and landscape activities
N82	Office administrative, office support and other business support activities
S95	Repair of computers and personal and household goods

Figure 1-The 7 groups identified across European regions based on the structure of the economy in 2010 and 2015



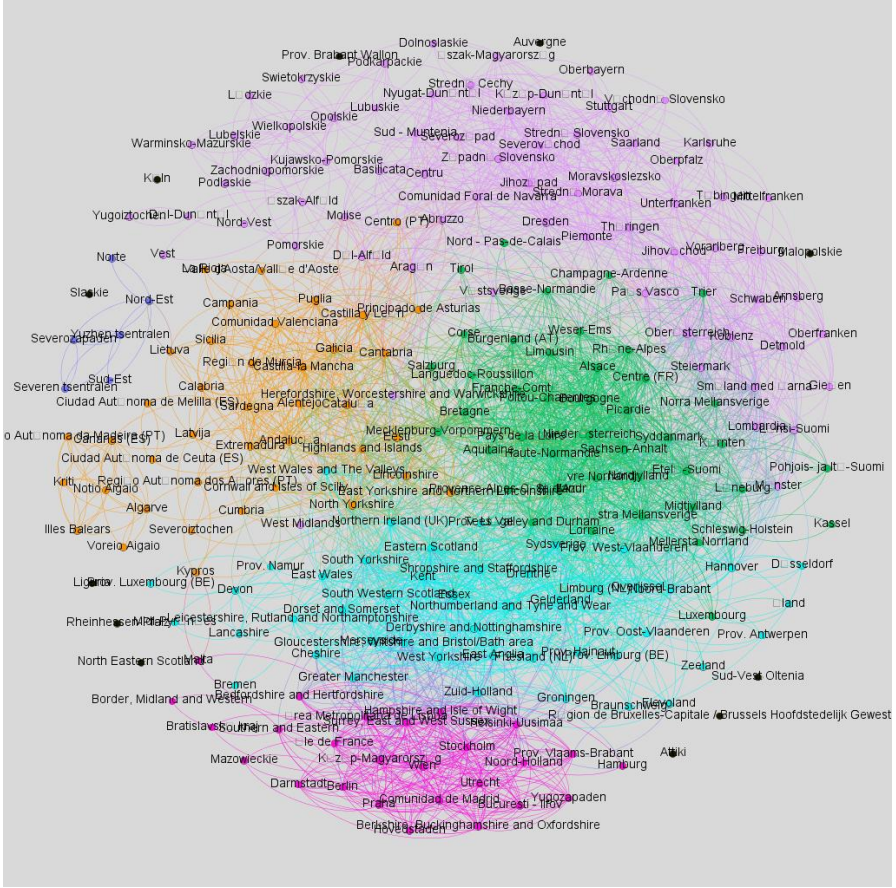


Table 3 – Distribution of the regions per group in 2010 and 2015.

	2010		2015	
	Freq.	Percent	Freq.	Percent
Urban areas	25	10.37	26	10.79
Activities connected with financial services	37	15.35	46	19.09
Simple manufacture	32	13.28	6	2.49
Advanced manufacturing	53	21.99	69	28.63
Rural areas with cumbersome weight of turism-related activities	34	14.11	40	16.6
Rural areas with well kept landscapes	45	18.67	43	17.84
Regions not associated to any cluster	15	6.22	11	4.56
Total	241	100	241	100

Table 4 – Characterization of the clusters based on various indicators

	Urban areas			High weight of services			Simple manufacture			Advanced manufacturing			Rural areas with cumbersome weight of turism-related activities			Rural areas with well kept landscapes			Regions not associated to any cluster		
	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.
GDP per capita at power purchasing parity	25	37392	8820	37	25314	8363	32	12650	3452	53	25804	6921	34	21450	4115	45	24811	3776	15	26493	9401
Tertiary education as percentage of active population	25	35.9	6.7	37	31.7	3.5	32	19.8	5.9	53	22.3	7.8	34	21.6	8.6	45	25.6	5.2	15	30.8	9.2
Employment rate	22	73.4	7.2	33	74.1	8.1	3	66.5	3.5	47	69.6	5.9	27	59.7	8.6	40	67.6	8.9	10	68.6	10.6
Employment in high tech industries	25	6.6	1.7	35	3.4	0.9	31	2.3	1.1	53	3.6	1.3	26	2.2	1.0	43	2.9	0.9	13	4.7	2.4
Corruption	24	0.4	1.2	37	1.0	0.3	31	-0.9	0.4	52	0.3	1.0	29	-0.2	0.9	45	0.9	0.5	12	0.3	1.0
Rule of law	24	0.3	1.1	37	1.0	0.3	31	-1.0	0.7	52	0.2	0.8	29	-0.1	0.7	45	0.9	0.5	12	0.2	1.1
Government effectiveness	24	0.3	1.0	37	0.9	0.3	31	-1.0	0.6	52	0.3	0.9	29	-0.3	0.8	45	0.9	0.5	12	0.1	1.0

Sources: Eurostat and EU RIC database

Table 5 – Transition matrix of regions across groups from 2010 to 2015.

	Urban areas	High weight of services	Simple manufacture	Advanced manufacturing	Rural areas with cumbersome weight of tourism-related activities	Rural areas with well kept landscapes	Regions not associated to any cluster
Urban areas	84.0	12.0	0.0	0.0	0.0	0.0	4.0
Activities connected with financial services	0.0	73.0	0.0	5.4	13.5	8.1	0.0
Simple manufacture	0.0	0.0	18.8	65.6	9.4	3.1	3.1
Advanced manufacturing	0.0	5.7	0.0	84.9	0.0	7.6	1.9
Rural areas with cumbersome weight of tourism-related activities	2.9	2.9	0.0	2.9	88.2	0.0	2.9
Rural areas with well kept landscapes	0.0	20.0	0.0	0.0	2.2	77.8	0.0
Regions not associated to any cluster	26.7	20.0	0.0	0.0	6.7	0.0	46.7
Total	10.8	19.1	2.5	28.6	16.6	17.8	4.6

Table 6 – GLS regression results (dependent variable GDP per capita growth 2010-2015)

VARIABLES	(1) gr1015	(2) gr1015	(3) gr1015	(4) gr1015	(5) gr1015	(6) gr1015
L5.pgdp	-0.0129***	-0.0204***	-0.0226***	-0.00715**	-0.0101***	-0.0108***
	(0.00223)	(0.00281)	(0.00362)	(0.00312)	(0.00371)	(0.00414)
Urban areas				0.000752	-0.00151	-0.00580
				(0.00503)	(0.00605)	(0.00565)
High share of services				-0.00168	-0.000838	-0.00689
				(0.00446)	(0.00535)	(0.00435)
Simple manufacture				0.0137***	0.0140**	0.0114**
				(0.00494)	(0.00587)	(0.00490)
Advanced manufacture				0.00665	0.00724	0.00244
				(0.00452)	(0.00535)	(0.00440)
Backward rural areas				-0.0189***	-0.0149**	-0.0179***
				(0.00466)	(0.00575)	(0.00472)
Virtuous rural areas				-0.00139	0.000378	-0.00553
				(0.00436)	(0.00533)	(0.00413)
Employment in high tech sectors		0.00247***	0.00269***		0.00132*	0.00140*
		(0.000621)	(0.000596)		(0.000752)	(0.000740)
Government effectiveness			0.00136			0.00153
			(0.00125)			(0.00143)
Constant	0.154***	0.222***	0.244***	0.0965***	0.121***	0.132***
	(0.0226)	(0.0269)	(0.0346)	(0.0309)	(0.0360)	(0.0401)
Observations	239	224	217	239	224	217
R-squared	0.113	0.207	0.234	0.508	0.484	0.527

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1