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# Cluster Analysis on Cohesion Policy Towards Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth

Ramona Camelia BERE (ramona.ber@gmail.com)

Ioana BUCERZAN (PRECUP)

Bucharest University of Academic Studies

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## ABSTRACT

*In the framework of Europe 2020 strategy for smart, sustainable and inclusive growth, economic, social and territorial cohesion plays an important role in (re)shaping Europe and recover from the financial crisis. In this context, and taking into account recent growth related theories, in this paper we intend to identify disparities among different European regions and countries. Thus, we analyse for the year 2010 the extent to which regional development of EU-27 member states measured through the cohesion policies indicators is similar to the development of EU-27 member states, as defined by the Europe 2020 strategy, in order to identify regional and inter-country disparities. The results show a disparate Europe, both within countries and among member states, highlighting the need of long-term reforms, such as the reformed Cohesion Policy for the programming period 2014-2020, with focus on growth and jobs, to be reflected at national level and in line with the vision and strategy of the European Union.*

**Keywords:** Europe 2020, cohesion policy, cluster

JEL Classification: R11

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## 1. INTRODUCTION

European Union policies, such as Europe 2020 strategy for smart, sustainable and inclusive growth and the regional policies, take into account economic, social and territorial cohesion-related aspects. Such policy endeavours have monitoring and evaluation components, including indicators which facilitate measuring of progress towards achieving policy objectives. Our interest in the current research is to identify disparities among different European regions and countries, taking into account the European policy framework set within the Europe 2020 strategy for smart, sustainable and inclusive growth and the regional policies, while also considering growth-related theories. Thus, after a brief

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presentation of the conceptual framework in which this analysis is conducted, we detail the methodology used in applying cluster analysis for the year 2010, the year in which the Europe 2020 strategy was adopted. The results of the analysis are discussed, both for EU-27 Member States from the perspective of Europe 2020 strategy and for the European regions from the perspective of cohesion policy. The analysis conducted enables us to conclude with regard to disparities among EU countries and regions.

## **2. BRIEF LITERATURE REVIEW**

When referring to theories on economic growth, there is no generally accepted theory on economic growth, without unified approach to its determinants, with different perspectives placing accent on different key determinants that contribute to economic growth. Of the different approaches, we shall refer to two major theories, one supported by Sollow in the neoclassical theories and the ones developed by Romer and Lucas, regarding endogenous growth theories. Thus, in Sollow's neoclassical theory (1956), capital and labor are taken into account, and technological progress being considered as exogenous factor, and highlighting the importance investment rates have in generating growth. When referring to Romer's endogenous theories (1986), knowledge is key endogenous factor taken into consideration, which includes technological progress; innovation and knowledge spillovers are considered in endogenous theories as leading to self-supported economic growth, with human capital and innovation as main determinants of economic growth.

EU regional policy is an investment policy that "aims to reduce the significant economic, social and territorial disparities that still exist between Europe's regions" (European Commission), supporting job creation, competitiveness, economic growth, improved quality of life and sustainable development. As cohesion policy, it encapsulates also EU's solidarity with less developed countries and regions, with the investments being focused towards areas and sectors in which they can contribute the most, as cohesion policy. This policy contributes to the implementation of the Europe 2020 strategy. The cohesion policy, which focused initially on regional development, over time acquired wider objectives, which make it too broad, all-encompassing, yet such vast coverage show significant limitations in measuring its impact, as pointed out by Begg (2010). The 2008 economic crisis, the development of the Europe 2020 strategy, together with several evaluation reports, and programming efforts for 2014-2020 refined this approach, going towards a reformed Cohesion Policy, as the main investment policy for growth and jobs.

The Europe 2020 strategy "emphasises smart, sustainable and inclusive growth as a way to overcome the structural weaknesses in Europe's economy,

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improve its competitiveness and productivity and underpin a sustainable social market economy”; it is an economic ten-year strategy that was adopted by the European Council in 2010. The advantage of this policy document resides in the fact that it has well-established indicators that enable measuring achievement, and thereby the possible success of the respective European policies, seemingly including lessons learnt from the critiques to the cohesion policy.

When looking at the Europe 2020 strategy headline indicators, this strategy seems to be based on endogenous theories.

### **3. METHODOLOGY**

Within this study, we continue previous research, presented at the 3<sup>rd</sup> World Conference on Business, Economics and Management, under the title “On growth poles from EU Countries in the framework of Europe 2020”, in which we conducted an analysis of the development of second-tier cities, considering employment related issues, from the countries with similar level of development as Romania. The Europe 2020 headline indicators (employment, research and development, climate change and energy sustainability, education, poverty and social exclusion), and resource productivity as lead indicator for resource efficiency, have been analyzed so as to highlight the different levels of development among EU countries. In order to ensure higher level of accuracy in clustering, we also included other indicators, such as GDP per capita and the index of economic freedom. The clustering resulted has been used to select the growth poles taken into account and perform the analysis of the growth poles.

Considering the objectives of the present research to identify disparities among different European regions and countries, and to determine whether, from the perspective of the cohesion policy indicators, the distribution of the European regions overlaps with the clusters of countries, we carry out our analysis based on the Europe 2020 headline indicators, GDP per head, as macro-economic indicator, and cohesion indicators.

While aware that regions may present different levels of development, we nevertheless took into account that including the regional level in the analysis would bring more in-depth information regarding the way Europe is divided from regional perspective and what disparities need to be overcome. Therefore, the clustering of regions would be subsequently grouped based on cluster membership and countries, with the possibility for a country to be present in more than one cluster.

Given that the Europe 2020 Strategy targets smart, sustainable and inclusive growth, the indicators included in our study so as to ascertain the different levels of development among EU-27 member states are the headline indicators provided by Eurostat, which focus on employment, gross domestic expenditure on R&D,

resource efficiency (greenhouse gas emissions, greenhouse gas emissions in non-ETS sectors, primary energy consumption, final energy consumption) and use of renewable energy, education and social inclusion, as shown in Table 1. In the case of indicators related to inclusive growth, the indicator taken into consideration was that of people at risk of poverty and social exclusion, since according to the methodology provided by Eurostat, it comprises the other 3 indicators available, in particular people living in households with very low work intensity, people at risk of poverty after social transfers and people severely materially deprived. In addition to the headline indicators, we added the GDP per head, expressed in Euro, as an additional indicator to highlight the countries' level of development.

The data used for our analysis have been collected for the EU-27 member states using the Eurostat databases for the year 2010, considered relevant for our analysis as it was the year in which the Europe 2020 strategy was adopted. For this reason we did not include Croatia in the analysis, as it acceded in 2013.

### Europe 2020 Headline Indicators

*Table 1*

Indicators	Description	Abbreviation
Employment rate - age group 20-64	% of population aged 20-64	EMPL
Gross domestic expenditure on R&D	% of GDP	GERD
Greenhouse gas emissions	Index 1990 = 100	GREEN 1990
Share of renewable energy in gross final energy consumption	%	RENEW
Greenhouse gas emissions in non-ETS sectors	million tonnes of CO2 equivalent	GREEN_NONETS
Primary energy consumption	million tonnes of oil equivalent (TOE)	PRIM_ENG
Final energy consumption	million tonnes of oil equivalent (TOE)	FINAL_ENG
Early leavers from education and training	% of population aged 18-24	EARLY_LEAVE
Tertiary educational attainment	% of population aged 30-34	EDU_TER
People at risk of poverty or social exclusion	Thousand	POV

Source: Eurostat, Europe 2020 Indicators

To determine how UE countries are grouped, given the Europe 2020 headline indicators, K-Means cluster analysis is performed, setting a number of 4 clusters, since in the previous study conducted we found 4 clusters to be a favorable fit. Furthermore, all data have been standardized before performing the cluster analysis.

At regional level, based on the cohesion indicators available on Eurostat, and taking into account that the cohesion policy contributes to achieving the Europe 2020 indicators, we further conduct a cluster analysis, based on the

same statistical method. Considering our empirical analysis to identify whether the cohesion at regional level subscribes to the country level of development at European level, classification methods, such as K-Means cluster, provide us with great insight and enable us to divide both EU-27 member states and EU regions in homogeneous clusters and to determine whether there is an overlap or if there are still disparities among regions both within each country and within Europe.

We need to take into account that the basic unit taken is that of countries, therefore the results are presented in the case of cohesion indicators taking into account the countries from which the regions are, which implicitly lead to the possibility of a country to be present in more than one cluster. This would further highlight the need for a stronger cohesion policy which aims to reduce disparities.

### Cohesion Policy Indicators

Table 2

Indicators	Description	Abbreviation
Employment rate of the age group 20-64 by NUTS 2 regions	Percentage of population aged 20-64	EMPL
Total intramural R&D expenditure (GERD) by NUTS 2 regions	Percentage of GDP	GERD
Patent applications to the EPO by priority year by NUTS 2 regions	Number of applications per million of inhabitants	PATENT
Tertiary educational attainment, age group 25-64 by sex and NUTS 2 regions %	Percentage of population aged 30-34	EDU_TER
Life expectancy at birth by sex and NUTS 2 regions Years	Thousand	LIFE_EXP
Regional gross domestic product by NUTS 2 regions	PPS per inhabitant	GDP

Source: Eurostat, Cohesion Indicators

The data regarding the cohesion indicators have been collected for the year 2010 from Eurostat for 270 regions (NUTS2) among all EU-27 member states, taking into account the availability of the data. The indicators, except for the life expectancy refer to SMART growth. For the other indicators no data have been available for 2010, or no data have been available for a significant number of regions.

According to Eurostat, the 'Nomenclature of territorial units for statistics (NUTS) which subdivides the economic territory of the European Union, NUTS 2 corresponds to regions. Regions are a key pillar in the economic development mechanisms in place within the EU cohesion policies, as regions represent the basis unit for allocating funds for part of the European structural and cohesion funds from within the investment policies, to reduce social-economic disparities in Europe. Using regions as key in cohesion policies is also accounted by the name of the policies – regional policies. Moreover, the cohesion reports have been made at NUTS2 level.

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## 4. RESULTS AND DISCUSSION

### 4.1. EU-27 Member States from the perspective of Europe 2020 strategy

At European level, for the year 2010 we can notice that countries with higher GDP per head invest more in R&D, have more people attaining tertiary education and have a higher employment rate and vice-versa. According to the Person correlation analysis, the level of development of a country (GDP per head) and employment rate, gross domestic expenditure on R&D, and tertiary education attainment are positively correlated. A positive, but moderately strong relationship is noticeable also between GDP per head and greenhouse gas emission. The nature of the relationship highlights that there is a link between the degree of economic growth and greenhouse gas emissions, as shown by previous studies of the European Environment Agency. However, considering the efforts and priorities of the European Commission to reduce greenhouse gas emission, and taking into account the positive correlation between R&D expenditure and the use of renewable energy, we may argue that shifting towards new energy sources might encourage overall research and development, along with further research in this field to ensure more efficient energy resources.

Employment rate is positively correlated with R&D expenditure and tertiary education, thus encouraging investments in R&D and education would serve as drivers for achieving the Europe 2020 target to engage people into work. In order to encourage entrepreneurship, hence employment, it is necessary to focus both on education, and innovation, thus contributing to long-term economic development and poverty reduction (Ács, Z.J., Virgill, N., 2009) and social exclusion. In the same context, and as shown by the results, there is a positive relationship between R&D expenditure and education. Stimulating research and development of economic sectors, by integrating new products and services on the market generates not only jobs creations, but also enrollment in tertiary education, as a high level of knowledge is needed for innovative and technology-based jobs. Thus, the key determinants of endogenous theories, human capital and innovation, taking into account that successful innovation requires highly skilled workforce able to use the developed technologies, which in turn require higher levels of education and training.

The correlation analysis underlines that there is no statistically significant linear relationship between the additional indicators referring to energy consumption (GREEN\_NONETS, PRIM\_ENG, FINAL\_ENG) and the rest of the headline indicators, except for the correlation among the 3 indicators mentioned before and the very strong correlation with the indicator for poverty. This shows that at least for 2010, countries who registered high number of people at risk of poverty and social exclusion also had high primary and final energy consumption.

The only headline indicator for which no correlation has resulted is the one referring to early leavers from education and training. This would require further analysis to be conducted at a later stage.

**Pearson correlation coefficients for the Europe 2020 Headline Indicators**  
*Table 3*

		GDP	EMPL	GERD	GREEN_1990	RENEW	GREEN_NONETS	PRIM_ENG	FINAL_ENG	EARLY_LEAVE	EDU_TER	POV
GDP	Pearson Corr	1	.550**	.596**	.403*	-.103	.172	.196	.211	-.142	.535**	-.003
	Sig.		.004	.001	.041	.616	.402	.338	.302	.488	.005	.987
EMPL	Pearson Corr	.550**	1	.679**	.220	.284	.102	.163	.167	-.323	.391*	-.117
	Sig.	.004		.000	.280	.160	.622	.426	.415	.108	.048	.568
GERD	Pearson Corr	.596**	.679**	1	.177	.450*	.194	.269	.277	-.210	.379	-.004
	Sig.	.001	.000		.386	.021	.342	.184	.171	.303	.056	.986
GREEN_1990	Pearson Corr	.403*	.220	.177	1	-.261	-.008	-.015	-.001	.352	.195	-.082
	Sig.	.041	.280	.386		.198	.968	.941	.995	.077	.340	.692
RENEW	Pearson Corr	-.103	.284	.450*	-.261	1	-.267	-.209	-.207	-.085	.020	-.224
	Sig.	.616	.160	.021	.198		.188	.306	.311	.681	.924	.271
GREEN_NONETS	Pearson Corr	.172	.102	.194	-.008	-.267	1	.991**	.991**	.177	.013	.926**
	Sig.	.402	.622	.342	.968	.188		.000	.000	.386	.948	.000
PRIM_ENG	Pearson Corr	.196	.163	.269	-.015	-.209	.991**	1	.997**	.145	.033	.888**
	Sig.	.338	.426	.184	.941	.306	.000		.000	.481	.873	.000
FINAL_ENG	Pearson Corr	.211	.167	.277	-.001	-.207	.991**	.997**	1	.160	.020	.896**
	Sig.	.302	.415	.171	.995	.311	.000	.000		.436	.924	.000
EARLY_LEAVE	Pearson Corr	-.142	-.323	-.210	.352	-.085	.177	.145	.160	1	-.225	.332
	Sig.	.488	.108	.303	.077	.681	.386	.481	.436		.270	.098
EDU_TER	Pearson Corr	.535**	.391*	.379	.195	.020	.013	.033	.020	-.225	1	-.132
	Sig.	.005	.048	.056	.340	.924	.948	.873	.924	.270		.519
POV	Pearson Corr	-.003	-.117	-.004	-.082	-.224	.926**	.888**	.896**	.332	-.132	1
	Sig.	.987	.568	.986	.692	.271	.000	.000	.000	.098	.519	

\*\* . Correlation is significant at the 0.01 level (2-tailed); \* . Correlation is significant at the 0.05 level (2-tailed).  
 Test of significance: two-tailed

Source: Authors' own computations



Based on the clustering results, using K-means cluster with standardized data, the EU-27 member states are grouped as shown in table 4.

### Clusters of countries

Table 4

Cluster	Countries
Cluster 1	France, Germany, Italy, Spain and United Kingdom
Cluster 2	Belgium, Ireland, Netherlands Luxembourg and Cyprus
Cluster 3	Austria, Denmark, Finland, Sweden and Slovenia
Cluster 4	Romania, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Greece, Malta, and Portugal

Source: Authors' own computations

From the Europe 2020 headline indicators perspective, there are high disparities both within cluster and among cluster. Based on the coefficient of variation computed for each variable for each cluster, we notice a great dispersion of final energy consumption, mostly for cluster 2 and 3, of greenhouse gas emission for all clusters except for cluster 1, people at risk of poverty excluding cluster 1 and cluster 4.

A high homogeneity within cluster resulted for the percentage of persons who attained tertiary education, expressed according to Eurostat as the share of the population that completed university or tertiary-level education with an education level ISCED 1997 of 5-6, and for employment rate.

The average GDP per head among the 4 clusters emphasizes the disparities which still exist between Central and Eastern Europe, considering the historical background, and more developed member states of the European Union.

Based on the Europe 2020 headline indicators, the 1<sup>st</sup> cluster highlights a homogeneous grouping of member states. The countries within this cluster can be considered as economic drivers of the European economy, as they have an average GDP per head accounting for 114% compared to the EU-27 average, high resource utilization both renewable energy and other sources, and invest considerable in R&D, however under the EU-27 average. The employment rate of 68.3% within this cluster almost equals the EU-27 average (68.6%) and the attainment of tertiary education of 35.6% among population aged 30 to 34 years is above de European average. Another characteristic of this cluster is the high number of people at risk of poverty and social exclusion (68958 thou.), significantly higher than within the other 3 groups of countries altogether (47821 thou.). We assume that one of the reasons might to some extent the impact of the financial crisis, but nevertheless the high level of migration into the all the member states that correspond to the cluster has also lead to social inequalities and imbalances. Moreover, the percentage of early



leavers from education and training among people aged 18-24 years is also considerable higher compared to the other cluster, and might be a result of the social imbalance.

### Country - Cluster 1 descriptive statistics

Table 5

Cluster 1	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max
EARLY_LEAVE	17.26	14.9	12.5	18.8	6.689768307	11.9	28.2
EMPL	68.32	69.2	62.8	73.6	6.215866794	61.1	74.9
FINAL_ENG	146.82	141.3	124.8	158.4	48.50203089	89.1	220.5
GREEN_NONETS	355.938	366.6	305.55	396.23	100.1113663	221.84	489.47
GREEN_1990	94.67	94.08	80.55	97.25	18.71469075	77.06	124.41
GERD	1.894	1.77	1.4	2.24	0.632834892	1.26	2.8
POV	13791.6	14211	12316	14757	1755.039971	11712	15962
PRIM_ENG	211.44	203.3	165	255	74.00941156	122.8	311.1
GDP	26220	27400	23500	29100	4092.309861	20600	30500
RENEW	10.22	10.7	10.6	12.7	4.09963413	3.3	13.8
EDU_Ter	35.6	42	29.8	43	10.48618138	19.8	43.4

Source: Authors' own computations

The countries within cluster 2 are the countries with the highest GDP per head, however the result is biased do to the membership of Luxembourg, which of all countries in Europe has the highest GDP per head, 279% higher than the EU-27 average. Considering the median and the 75<sup>th</sup> percentile we notice that 50% of countries within this cluster has a GDP per head higher than 33,100 Euro per inhabitant, and 25% higher than 35,900 Euro per inhabitant.

The member states from this group have in average a high employment rate (70.94%) and tertiary education attainment (45.46%) compared to the European average. There is also a low average final energy consumption, average primary energy consumption and average greenhouse gas emissions in non-ETS sectors compared to the other cluster, nevertheless there are great differences among countries. The situation is similar in the case of investments in R&D. However the greenhouse gas emissions, considering the base year 1990, are the highest compared to the other clusters. Also, the share of renewable energy is moderate.

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**Country - Cluster 2 descriptive statistics**

*Table 6*

<b>Cluster 2</b>	<b>Mean</b>	<b>Median</b>	<b>Percentile 25</b>	<b>Percentile 75</b>	<b>Std. Dev</b>	<b>Min</b>	<b>Max</b>
EARLY_LEAVE	10.64	11.5	10	11.9	2.208619478	7.1	12.7
EMPL	70.94	70.7	67.6	75	5.055492063	64.6	76.8
FINAL_ENG	21.92	11.9	4.3	37.5	22.82283944	1.9	54
GREEN_NONETS	52.936	44.48	10	80.47	50.3719409	4.9	124.83
GREEN_1990	113.644	101.86	101.43	114.04	26.31167479	92.26	158.63
GERD	1.532	1.69	1.51	1.86	0.616579273	0.5	2.1
POV	1244.6	1220	202	2235	1112.593951	83	2483
PRIM_ENG	29.24	14.9	4.6	53	30.98084892	2.6	71.1
GDP	36320	33100	29600	35900	17083.38374	18500	64500
RENEW	4.64	5	3.7	5.6	1.304990421	2.9	6
EDU_Ter	45.46	45.3	44.4	46.1	3.145313975	41.4	50.1

Source: Authors' own computations based on Eurostat data

Cluster 3 is formed by 3 Scandinavian countries, along with Austria and Slovenia. This cluster is characterized by countries with high GDP per head (129% compared to EU-27), high expenditure in R&D compared to the other clusters, high employment rate ranging from 70.3% to 78.1%, with low greenhouse gas emission and primary and final consumption, but a great share of renewable energy in gross final energy consumption, varying from 19.2% in Slovenia to 47.2% in Sweden. Also, the total number of people at risk for social exclusion is the lowest among the 4 clusters (5054 thou.). Moreover, a high level average of tertiary education attainment (38.1%) and low average rate of early leavers from education and training (8.22%) we can consider this cluster as the cluster perfectly aligned to the Europe 2020 strategy, ensuring sustainable, inclusive and smart growth.

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**Country - Cluster 3 descriptive statistics**

*Table 7*

Cluster 3	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max
EARLY_LEAVE	8.22	8.3	6.5	10.3	2.52	5	11
EMPL	74.42	74.9	73	75.8	2.94	70.3	78.1
FINAL_ENG	21.78	26.3	15.2	28.4	11.66	4.9	34.1
GREEN_NON ETS	35.188	35.98	32.86	41.93	15.60	11.28	53.89
GREEN_1990	100.68	105.37	90.74	106.62	9.26	90.67	110
GERD	3.038	3	2.8	3.39	0.67	2.1	3.9
POV	1010.8	1007	890	1373	426.43	366	1418
PRIM_ENG	28.78	32.7	19.9	35.6	15.91	7	48.7
GDP	29800	31300	30600	34500	8536.39	15300	37300
RENEW	30.44	30.8	22.6	32.4	10.87	19.2	47.2
EDU_TER	38.1	41.2	34.8	45.3	9.26	23.5	45.7

Source: Authors' own computations based on Eurostat data

The 4th cluster is formed mostly former communist countries of Central and Eastern Europe and Baltic States. Compared to the other member states, the CEE countries are still beyond the Europe and have a lot to recover so as to generate a shift in the structure of EU regional development distribution. The presence of Greece, Malta and Portugal, outlines the impact of the economic crisis on these member states.

Disparities can be noticed among these countries, although the similarities with regard to economic history up to the year 1989. The GDP per head varies from 3500 Euro per inhabitant, in Bulgaria, 4500 Euro per inhabitant in Romania to 11400 Euro per inhabitant in Czech Republic, followed by the other 3 Southern-European countries, despite the uniform distribution of employment rate, being around 64% in most of the member states, except Malta and Hungary where it reaches 60.1%, respectively 60.4% and Czech republic and Portugal where it is approximately 70.5%.

The average tertiary education attainment is the lowest among all clusters, the only one below the EU-27 average of 33.6%, and the percentage of early leavers from education and training is the second highest, but below the European average.

The share of renewable energy consumption within this group of cluster is the second highest among the 4 cluster, ranging 8.6% to 32.5 %, excluding Malta which has a share of 0.4%. These countries are developing countries or countries in distress, and given the low level of average R&D expenditure (under 0.8% in Latvia, Lithuania, Malta, Poland, Romania, and Slovakia), the share of renewable energy is not enough to support an increase of economic activity, the rising demand of the population and after all economic growth.

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**Country - Cluster 4 descriptive statistics**

*Table 8*

Cluster 4	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max
EARLY_LEAVE	12.9833	11.95	6.65	16.15	7.52	4.7	28.7
EMPL	64.8667	64.3	63.65	66.1	3.20	60.1	70.5
FINAL_ENG	16.7333	14.05	4.55	20.8	17.62	0.5	66.3
GREEN_NON ETS	47.1367	35.67	11.74	59.39	55.49	1.12	207.66
GREEN_1990	75.8892	65.86	47.97	99.65	34.24	43.29	150.5
GERD	0.93273	0.74	0.6	1.4	0.429	0.46	1.62
POV	3045.33	2094	933	3375	3308.45	86	10409
PRIM_ENG	24.85	19.95	6.1	31	25.69	0.9	96
GDP	9350	8600	6500	12400	4201.19	3500	17400
RENEW	15.425	12.1	9.15	23.7	9.31	0.4	32.5
EDU_Ter	28.1583	26.7	21.35	33.7	8.18	18.1	43.8

Source: Authors' own computations based on Eurostat data

#### **4.2. European regions from the perspective of Cohesion Policy**

As mentioned before, the cohesion policy contributes to achieving the targets set in the Europe 2020 strategy. Nevertheless, to achieve these targets, the efforts and policies should reflect themselves at regional level as well, so as each country could reduce disparities among regions within its borders, so in the long-run to achieve economic, social and territorial cohesion at European level.

To map how Europe is grouped at regional level in the year 2010, 270 European regions have been included in the analysis accounting for the EU-27 member states. As for the previous analysis, K-Means cluster has been computed, considering 4 clusters and taking into account the standardized z-scores of the cohesion indicators available on Eurostat.

Although the variables are structured based on the Europe 2020 strategy, in the context of cohesion policy, and subsequently at regional level, the indicators gathered by Eurostat for the NUTS2 do not perfectly match the headline indicators of the strategy, except for the employment rate of the age group, total intramural R&D expenditure and GDP. We did not take into account people at risk of poverty or social exclusion, as the coding of the regions did not match the coding of the other databases. Neither indicators for sustainable growth have been included due both to missing data and incongruity of datasets. Therefore, the variables to which we refer in this section refer to employment rate of the age group 20-64 by NUTS 2 regions expressed in percentage, total intramural R&D expenditure (GERD) by NUTS

2 regions, patent applications to the EPO by priority year by NUTS 2 regions, tertiary educational attainment, age group 25-64 by sex and NUTS 2 regions, life expectancy at birth by sex and NUTS 2 regions, regional gross domestic product by NUTS 2 regions.

Before going further with the analysis, the relationship among the variables included is discussed based on the indicators considered. All variables are positively correlated, and the correlation is significant at 1% level of significance, outlining the need to focus on all aspects of the cohesion policy so as to ensure a higher impact and growth within the regions. A weaker correlations can be observed between employment and life expectancy, also the latter one and R&D expenditure.

**Table 9: Pearson correlation coefficients for the Cohesion Indicators**

		GERD	PATENT	GDP	EMPL	EDU_TER	LIFE_EXP
GERD	Pearson Correlation	1	.675**	.443**	.428**	.566**	.372**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
PATENT	Pearson Correlation	.675**	1	.530**	.480**	.480**	.436**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
GDP	Pearson Correlation	.443**	.530**	1	.382**	.606**	.514**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
EMPL	Pearson Correlation	.428**	.480**	.382**	1	.513**	.252**
	Sig. (2-tailed)	.000	.000	.000		.000	.001
EDU_TER	Pearson Correlation	.566**	.480**	.606**	.513**	1	.367**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
LIFE_EXP	Pearson Correlation	.372**	.436**	.514**	.252**	.367**	1
	Sig. (2-tailed)	.000	.000	.000	.001	.000	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Test of significance = Two-tailed

Source: Authors' own computations based on Eurostat data

Based on the cluster analysis on NUTS2 regions, we reached the conclusion that considering the cohesion indicators, the NUTS2 regions of one country are not grouped in the same cluster, emphasizing disparities among regional development at country level.

### Region - Cluster 1 indicators value

Table 10

Regions	GERD	PATENT	GDP	EMPL	EDU_TER	LIFE_EXP
BE10:Rég. Bruxelles / Brussels Gewest	1.4	53.766	55100	59.2	42.1	80.2
LU00:Luxembourg	1.5	99.549	64000	70.7	:	80.8
UK11:Inner London	1.2	29.5	78800	68.4	53.1	80.8

Source: Authors' own computations based on Eurostat data

Three regions are included in cluster 1, one from United Kingdom (Inner London), which has defined 37 NUTS2 regions, one from Belgium (Brussels), which has a total of 11 regions, and Luxembourg. These regions have a high GDP per head, high employment rate, high life expectancy, investments in R&D, and the a significant share of the workforce with tertiary education. As shown in a recent ESPON-funded study (ESPO-FOCI, 2010), the metropolises of London and Brussels have a pace of growth that is clearly higher than the national average, proving the tendency of the capital region to mobilize and attract resources, including highly qualified workforce. In the case of London, besides being the capital city of UK and strong administrative center, its economic development that determine its inclusion in this cluster may be explained also by the fact that London is a service city that has a high share of business services, a strong financial center that acts as gatekeeper for internalization efforts of multinational companies, especially from USA and Asia, ensuring links between European cities and other cities worldwide, on main access routes, with easy access, and is also connected in innovative networks, all of these generating high levels of growth. Brussels on the other hand acts as the most important financial administrative center within the EU, also connected in innovative research networks, which generate high levels of growth.

### Region - Cluster 2 descriptive statistics

Table 11

	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max	Coef. of variation
GERD	4.2	3.9	3.0	5.1	1.3	2.5	7.1	32%
PATENT	162.8	143.1	105.0	186.8	90.9	52.6	472.2	56%
GDP	31551	30600	28100	34900	5613	22600	49500	18%
EMPL	75.8	76.9	73.7	78.1	3.3	68.2	81.1	4%
EDU_TER	31.0	30.1	25.9	36.0	8.4	15.5	49.5	27%
LIFE_EXP	81.1	81.1	80.5	81.8	.9	78.9	83.3	1%

Source: Authors' own computations based on Eurostat data

Cluster 2 is composed of 45 European regions, of which 21 are from Germany. Given this, we might consider this cluster of regions as an engine of economic growth, as the regions have a high GDP per head and over 2.5% of GDP allocation for expenditure in R&D, together with a high employment rate. The number of registered patents, varying from 52 to 472, is greater than compared to the other clusters, however the variation within cluster stands out. Attainment of tertiary education is dispersed, however this seems to be due to the low level of attainment in Austria (lower than 20% in all the 4 regions from the cluster).

### Region - Cluster 3 descriptive statistics

Table 12

	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max	Coef. of variation
GERD	1.4	1.3	1.0	1.7	.7	.2	3.9	48%
PATENT	42.4	35.3	19.7	63.5	29.7	.3	124.1	70%
GDP	24783	23500	20900	27400	5377	15100	43700	22%
EMPL	71.4	71.5	68.1	75.3	4.8	59.8	83.6	7%
EDU_TER	27.5	28.1	22.9	32.2	7.0	11.0	43.7	26%
LIFE_EXP	80.9	81.0	80.1	81.8	1.5	74.9	84.1	2%

Source: Authors' own computations based on Eurostat data

The 3rd cluster includes 142 regions from 22 member states, including 1 region from Romania (Bucuresti-Ilfov). The cluster is not homogeneous, due to the variation in R&D expenditure, GDP per head and tertiary education attainment. However the highest variation in data is for the number of patents registered. Within this cluster several capitals cities from Central and Eastern Europe, and South and south Eastern Europe are included: Bucharest (Bucharest-Ilfov region) - Romania, Budapest (Közép-Magyarország region) – Hungary, Prague (Praha region), Warsaw (Mazowieckie region) – Poland, Bratislava (Bratislavský kraj)– Slovakia, Wien (Wien region)–Austria, Madrid (Comunidad de Madrid) – Spain, Lisbon (Lisboa region) – Portugal, Rome (Lazio region) – Italy, Athens (Attiki region) – Greece, Nicosia (Kypros) - Cyprus. The strategic positions held in general by national capital cities within scientific networks, especially those focusing on converging technologies (nanotechnology, biotechnology, information technology and cognitive science), which could best illustrate a knowledge-based approach, could be considered as their “potential to control the circulation of knowledge spillovers that flow between European cities” (ESPON-FOCI 2010). Such potential and the tendency of capital cities to mobilize more resources could explain their inclusion in a different cluster, with higher levels than the other regions of the country.



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### Region - Cluster 4 descriptive statistics

Table 13

	Mean	Median	Percentile 25	Percentile 75	Std. Dev	Min	Max	Coef. of variation
GERD	.6	.6	.3	.9	.4	.1	1.7	65%
PATENT	5.7	4.1	2.3	6.6	5.9	.2	34.6	104%
GDP	15135	15900	11950	17400	4070	6500	25400	27%
EMPL	61.5	62.4	58.3	65.2	6.2	43.7	72.8	10%
EDU_TER	17.2	16.5	13.6	20.8	4.4	9.0	28.8	26%
LIFE_EXP	77.5	77.3	75.0	80.5	3.1	72.7	82.6	4%

Source: Authors' own computations based on Eurostat data

80 regions are included in cluster 4, out of which the 7 NUTS2 regions of Romania, except for Bucuresti-Ilfov. From country perspective, the result of the clustering shows that there are also disparities among Romanian regions, with the social-economic development of the capital city exceeding the regional development of the country. Such disparities have been also visible in other countries, with the capital region included in a different cluster than other regions of the country.

Moreover, within this cluster we notice that all the regions from cluster 4 computed for the Europe 2020 headline indicators at country level (which included the former communist countries, Greece, Malta and Portugal) have the same level of development also at regional level, as most of the regions at national level are included within this cluster. However, NUTS2 regions from Belgium, Spain, France, Italy and Slovenia are also comprised within this group of regions.

## 5. CONCLUSIONS

Cluster analysis provides great insights on structural changes at a given time, but also over time. The present analysis, although conducted for the year 2010, aims at providing an analysis of the EU member states status quo, and the regional disparities in the year the Europe 2020 strategy has been adopted, so as to see where Europe has been and towards what it is going.

From the Europe 2020 headline indicators perspective, there are high disparities both within cluster and among cluster. Based on the cluster analysis on NUTS2 regions, we reached the conclusion that considering the cohesion indicators, the NUTS2 regions of one country are not grouped in the same cluster, emphasizing disparities among regional development at country level and among regions in Europe.

The correlations among indicators taken into account in the cohesion policy and the Europe 2020 strategy reveal that at policy level there is awareness

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on the intrinsic links and influences among different areas that all contribute to economic growth, taking into account dimensions related to smart, sustainable and inclusive growth.

The research results should be taken into account with considering the methodology used and its possible limitations. Thus, in the case of the cluster analysis conducted on regions, the present research includes variables related to smart growth, because of limitations resulted from data availability; results may be different in case additional data is available for variables related to sustainable and inclusive growth and new variables are included. Moreover, changing the year of reference for the analysis may change the results of the cluster analysis - some countries or regions may be included in a different cluster than in the present research.

The study could be further expended by analyzing over time the cluster changes and what lead to the shifts of member states between clusters. Moreover, it will be extended considering a panel data approach for determining at both at European level and regional level the drivers of economic growth, considering the cohesion indicators.

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