Metropolitan Areas in European Countries: Measuring Morphological Polycentricity

P. Nikolopoulos[1,2*], A. Gkouzos[1,2], and A. Papadaskalopoulos[1,2]
[1]Department of Economic and Regional Development, Panteion University, 17671, Athens, Greece
[2]Regional Development Institute, 130 Syngrou Ave., 11745, Athens, Greece

*Corresponding author: E-mail: p.g.nikolopoulos@panteion.gr

Abstract
Globally, the location patterns of individuals and firms can be still interpreted as urbanisation-driven, and in Europe in particular, the population living in urban areas is estimated to have surpassed 70% of the total population. In this context, the importance of metropolitan configurations is corroborated, as they constitute cradles of economic growth, provide agglomeration benefits to firms, and attract dynamic companies and rapidly developing economic industries. In order to canalise such benefits to the continental space in total, the European Union has adopted the notion of polycentricity as a guiding principle in its spatial policy documents, where polycentric development appears to be able to balance the European territory spatially and make it more efficient, equitable and sustainable. The aim of this paper is to examine the degree of national polycentricity in the European context, by utilising population data, in order to define the trajectory of the EU space regarding morphological polycentricity at the national level, as well as the relation of polycentricity with the development level of a country (GDP per capita), as, among others, it is considered to be a means of achieving efficiency. The national polycentricity degree in the examined countries is calculated with the measure of the rank-size coefficient, while in order to define how the degree of national polycentricity relates to the development level of a country (Gross Domestic Product per capita), the correlation of the GDP per capita natural logarithm and the calculated polycentricity beta is illustrated, for the group of the examined European countries.
Keywords: polycentricity; functional urban areas; metropolitan areas; rank-size distribution.

1. Introduction

Globally, the location patterns of individuals and firms can be still interpreted as urbanisation-driven, with the population living in urban areas estimated to have surpassed 50% of the world population.In Europe, in particular, the urbanisation percentage makes up the 70% of total population, andin the EU28 it even reaches the 72%, although its urban areas account for the 17% of the territory only [1]. Moreover, in the EU metropolitan regions (urban cores together with their commuting zones of 250.000< inhabitants) concentrates the 59% of the population, the 62% of the jobs, and the 68% of the GDP. However, Europe seems to be less polarised than other continents, as there exists a significant number of metropolitan areas spread across its territory [2], with several major cities in relative close proximity, which, though, are in a greater distance with each other [3], since the urban

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

fabric is completed with the in-between location of small and medium-sized urban areas. Nonetheless, it cannot be claimed that the European urban system is balanced.

The illustration of the European urban space leads to three main urban spatial patterns [4]. Firstly, there is a dense grid of urban configurations concentrated along the European dorsal axis -also found in bibliography as the "blue banana"- which covers the area from the Northern England to the Southern Italy. Secondly, in Eastern Europe there are regularly spaced cities, while on the west of the dorsal, specific pattern of urban concentration seems to be the case. The first pattern draws its roots from the small sized political territories, the decentralised political and administrative background of the past, and the multitude of manufacturing centres from the nineteenth century, while the two latter patterns emerged from the late and institutionalised colonisation of the eastern region, and the centralised kingdoms of Western Europe with large colonial era centres, respectively [4,5]. Thus, the Northwestern European territory is characterised by large, and densely located, urban configurations.

In the globalised development context, the importance of metropolitan configurations is corroborated, as they constitute cradles of economic growth, which provide agglomeration benefits to firms, and attract dynamic companies and rapidly developing economic industries. In order to canalise such benefits to the continental space in total, the European Union has adopted the notion of polycentricity as a guiding principle in its main spatial policy documents, namely the European Spatial Development Perspective (1999), the Territorial Agenda 2020 (2011), and the EU Urban Agenda (2016) [6,7,8], where polycentric development appears to be able to balance the European territory spatially and make it more efficient, equitable and sustainable.

Polycentricity is quite a complicated and relative notion, with different dimensions, elements, and scales of application. These factors explain in the main part why the European Spatial Development Perspective (ESDP) defines it simply as an opposite to the notions of monocentricity, dispersal and sprawl [9]. The analytical dimension of polycentricity interprets a particular polycentric system, and the normative one, refers to polycentricity as the guiding principle that policy goals are focused on [10].The elements of the notion are morphological, in the sense that they are endogenous to the centres of the urban system (size, spatial distribution, etc), or exogenous, such as the networks of flows and co-operation between the centres [11]. Last but not least, polycentricity can be applied to the continental, the national and interregional, and the intraregional level [9]. In the continental and the national scales particularly, the term of polycentricity describes an urban field comprised of several agglomerations characterised by a relative balance, regarding the contribution of population and economic activity, as well as the spatial location.

Aim of this paper is to examine the degree of national polycentricity in the European context, by utilising population data, in order to define whether in the period following the ESDP, the European Union space has become more morphologically polycentric. In this respect, the current study considers a more polycentric urban system as an urban system comprised of relatively more equally populated urban areas. Moreover, the relation of polycentricity with the development level of a country (GDP per capita) will be assessed, as, among others, the polycentric structure is considered

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

to be a means of achieving efficiency.The paper structures as follows. The second section discusses the methodology and data employed for the quantification of morphological polycentricity in the present paper, as well as specific issues that have to be taken into account during the process. In the third section, the results of the analysis are presented and commented. The last section consists of the conclusions on the carried-out analysis.

2. METHODOLOGY AND DATA

In Europe, for mainly a decade after the publication of the European Spatial Development Perspective (ESDP), there has been great relevant research work in the regional context [12,13,14,15], as well as in the national one [9,16,17,18,19]. However, the majority of the empirical bibliography focuses on the morphological aspects of the notion [17,18,19,20,21], since the addition of functional elements in the research, although it makes for a more consistent measuring of polycentricity, it makes also for a more complex quantification [22]. After all, the morphological characteristics are not second-class factors for the assessment of urban networks, as they constitute long-term consequences of functional relations between urban centres [23].

The comparison of cities, and urban systems, using demographic and economic data is not simple, since -among others- there is not a common definition of the "European city" [23]. However, based on population size and density, OECD and Eurostat have jointly created a methodology for the designation of a Functional Urban Area (FUA), which consists of an urban configuration and its corresponding commuting zone, in four steps. Firstly, by utilising geographically referenced population data, dense areas of more than 1,500 inhabitants per km^2 are selected; subsequently adjacent and non-adjacent dense urban cores -that belong, though, to the same city- are subjoined, and finally, the hinterland of the Functional Urban Area is identified [24]. Since, this is a harmonised definition of a city, it is more appropriate for international comparisons, and thus it is widely used in urban analyses.

2.1 The Quantification of Polycentricity and its Efficiency

In order to calculate the national polycentricity degree, the national urban hierarchy is utilised, as it has been the case in the vast majority of the polycentricity applied bibliography [17,18,19,20,21]. By employing the measure of the rank-size coefficient, it is defined whether the national urban system is monopolised by a small number of urban centres (less polycentric), or it is more balanced - deconcentrated (more polycentric). This method takes into account the size distribution of the national cities, measuring polycentricity through the beta coefficient of the following equation [20]:

$$\ln(\text{size}) = a + b \ln(\text{rank}) \quad (1)$$

Where size is the population of a Functional Urban Area, and rank is the size ranking of the corresponding FUA. The estimated beta, and the slope of the regression line, indicate the level of hierarchy among FUAs, and thus the level of national polycentricity. The slope is always negative,

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

since, the city size and the city rank are negatively related. Regarding the graphic illustration of the equation, the population is placed on axis y and the rank on axis x, and consequently the national urban system becomes more polycentric when the slope decreases in absolute value (flattens), and vice versa [9,17,20].

Moreover, in order to define how the degree of national polycentricity relates to the development level of a country (Gross Domestic Product per capita), the correlation of the GDP per capita natural logarithm and the polycentricity beta is calculated and illustrated, for the group of the examined European countries. By employing the Pearson correlation coefficient, it is attempted a rudimentary recording of the efficiency level of a national urban system being polycentric, as attempted in past papers [19].

2.2 Employed Data and Special Issues

For the current analysis are examined the larger urban areas for each country, while as an urban area is considered the Functional Urban Area (FUA), which is widely utilised as an urban unit in the polycentricity research bibliography [9,17,18,19]. The data employed concern the population of FUAs and the country GDP per capita, and come from the Eurostat database for the years 2000 and 2011 [25, 26]. Since 2011 population data for Austria and Norway are not available in the Eurostat database, counterpart data -of population and GDP per capita- of the years 2013 and 2012 are employed for these countries, respectively.

The number of urban areas taken into account in such a type of analysis differs in the various previous attempts. There are cases where it is utilised a large number of urban areas per country [9,27], while others utilise a fixed and limited number of urban areas [17,19,28], as a more reliable practice for international comparisons, since a low population threshold, and the consequent use of a large number of small provincial cities may have an influence on the results [17]. The number of the largest national FUAs examined in this paper is 4, as is the case in previous studies [19]. Thus, the countries included in the analysis are the EU28 countries that have at least four FUAs, plus Norway and Switzerland (22 countries in total). Last but not least, it must be pointed out that the morphologically polycentric nature of an urban system is not an equivalent to a territorially balanced urban system. This is an issue that needs special methodologies in order to define whether each region of a country has a large urban centre that serves as a growth pole [18]. However, this is not a question to answer for the current analysis.

3. THE RESULTS OF THE ANALYSIS

In order to assess the degree of polycentricity in the examined urban systems the rank-size coefficient for each and every country has been calculated, as described already. Table 1 shows the results of the calculations for the two years of the analysis, in descending order of the polycentricity degree of the year 2000 (in absolute value). It is emphasised that a lower rank-size beta in absolute value is interpreted as a higher degree of polycentricity, since it shows a more equal distribution of the variable

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

in question among the cities taken into account. Moreover, Table 1 captures the direction of change of the polycentricity level between 2000 and 2011.

Table 1. Rank-size betas of the examined countries for 2000 and 2011 (in absolute value)

	Country	2000	2011	Change of polycentricity
More polycentric	Italy	0.496	0.650	▼
▲	Belgium	0.500	1.071	▼
▮	Germany	0.515	0.481	▲
▮	Netherlands	0.633	0.931	▼
▮	Poland	0.696	0.749	▼
▮	Switzerland	0.728	0.830	▼
▮	Slovakia	0.744	1.034	▼
▮	Czech Republic	1.051	1.185	▼
▮	Norway	1.120	1.141	▼
▮	Spain	1.132	1.197	▼
▮	Sweden	1.239	1.387	▼
▮	Bulgaria	1.260	1.197	▲
▮	Finland	1.276	1.263	▲
▮	Romania	1.320	1.317	▲
▮	Denmark	1.380	0.999	▲
▮	Hungary	1.483	1.715	▼
▮	United Kingdom	1.509	1.322	▲
▮	France	1.626	1.667	▼
▮	Austria	1.721	1.405	▲
▮	Ireland	2.032	1.818	▲
▼	Portugal	2.323	1.902	▲
More monocentric	Greece	2.449	2.257	▲
	Average	**1.238**	**1.251**	▼
	Standard Deviation	**0.550**	**0.418**	
	Coefficient of Variation (%)	**44.456**	**33.438**	

To begin with, Italy and Belgium constitute the most polycentric urban systems in 2000, however polycentricity decreases in both countries -particularly in Belgium- in 2011. Furthermore, Germany is quite polycentric in 2000, while its urban system becomes more polycentric in the next year of the analysis. The German urban system is the only one among the top-half most polycentric urban systems that follows an increasing trajectory regarding the polycentricity level. The rest of the countries in this group, namely Netherlands, Poland, Switzerland, Slovakia, Czech Republic,

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

Norway, Spain and Sweden drop their level of polycentricity between the years of the analysis. In the next group of urban systems (lower-half), all countries show an increase of the polycentricity degree, with the exception of Hungary and France (Bulgaria, Finland, Romania, Denmark, United Kingdom, Austria, Ireland Portugal and Greece). The less polycentric urban systems (or the most monocentric, alternatively) in 2000 are these of Ireland, Portugal, and Greece in particular.

In 2011, the most polycentric urban system according to the beta coefficient is that of Germany. Italy drops to the second place, while the Polish and Swiss urban systems -although dropping their polycentricity level- they ascend in the classification. Belgium drops from the 2nd to 8th place. Denmark and Bulgaria enter the top-half of the classification, while Sweden and Spain drop to the lower-half of it. Netherlands drop a place, while the Czech Republic drops two places. Slovakia, Norway, Finland, Romania and France retain their position in both the years of the analysis, while the United Kingdom and Austria ascend in the classification, and Hungary drops. Finally, Ireland, Portugal and Greece are still the less polycentric countries in 2011, which in the main part results from the significant concentration of population and economic activity in their capital city (high urban primacy).

During the examined period, polycentricity shows on average only a marginal decrease in the countries of the analysis as a whole (Table 1). However, the employment of appropriate inequality measures shows that the European space tends to become more coherent in terms of polycentricity - although it is still characterised by significantly heterogeneous levels of national polycentricity, since the standard deviation of the distribution drops, as well as the coefficient of variation presents a significant decrease.

Table 2. Rank-size beta and GDP per capita (thous. €) of the examined countries (2000, 2011)

2000				2011			
Country	**beta**	**GDP pc**	**GDP pc class.**	**Country**	**beta**	**GDP pc**	**GDP pc class.**
1. Italy	-0.496	21.80	13	1. Germany	-0.481	33.70	10
2. Belgium	-0.500	25.20	11	2. Italy	-0.650	27.30	13
3. Germany	-0.515	26.00	10	3. Poland	-0.749	9.90	20
4. Netherlands	-0.633	28.10	7	4. Switzerland	-0.830	63.70	2
5. Poland	-0.696	4.90	19	5. Netherlands	-0.931	38.50	5
6. Switzerland	-0.728	40.70	2	6. Denmark	-0.999	44.50	3
7. Slovakia	-0.744	4.10	20	7. Slovakia	-1.034	13.10	18
8. CzechRepublic	-1.051	6.50	17	8. Belgium	-1.071	34.50	9
9. Norway	-1.120	41.40	1	9. Norway	-1.141	79.10	1
10. Spain	-1.132	15.90	14	10. Czech Republic	-1.185	15.60	17
11. Sweden	-1.239	31.80	4	11. Bulgaria	-1.197	5.60	22
12. Bulgaria	-1.260	1.80	22	12. Spain	-1.197	22.90	14
13. Finland	-1.276	26.30	9	13. Finland	-1.263	36.50	8
14. Romania	-1.320	2.30	21	14. Romania	-1.317	6.60	21

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

15. Denmark	-1.380	33.30	3	15. United Kingdom	-1.322	29.80	12
16. Hungary	-1.483	5.00	18	16. Sweden	-1.387	42.90	4
17. United Kingdom	-1.509	30.30	5	17. Austria	-1.405	38.20	6
18. France	-1.626	24.40	12	18. France	-1.667	31.50	11
19. Austria	-1.721	26.70	8	19. Hungary	-1.715	10.20	19
20. Ireland	-2.032	28.50	6	20. Ireland	-1.818	37.60	7
21. Portugal	-2.323	12.50	16	21. Portugal	-1.902	16.70	16
22. Greece	-2.449	13.20	15	22. Greece	-2.257	18.60	15

Table 2 presents the beta coefficient of polycentricity for each national urban system in descending order, for both the years of the analysis. Additionally, the gross domestic product per capita is included, as well as the classification of each country regarding the GDP per capita level. A cursory look at Table 2 makes it clear that if there is any relation at all between the two variables, it is not an obvious one. For example, Italy, the most polycentric urban system in Europe in 2000, shows the 13th highest GDP per capita, the least polycentric system, that of Greece, is associated with the 15th higher GDP per capita, while the country with the highest GDP per capita, Norway, has an urban system in the middle of the distribution regarding polycentricity (9th place). Thus, it is necessary to employ statistic measures in order to conclude about this relation.

In order to test the claimed association between polycentricity and efficiency, it is carried-out a correlation between the variables of polycentricity beta coefficient and the natural logarithm of the gross domestic product per capita. Figure 1 and Figure 2 illustrate the results of the examination for the given set of countries, in both years 2000 and 2011.

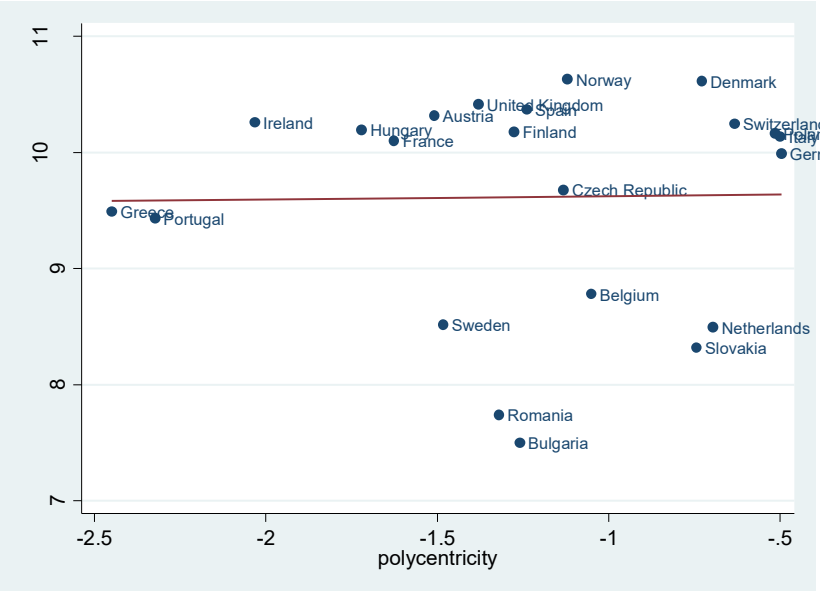

Figure 1. Correlation of polycentricity and GDP per capita in the European Union (2000)

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

The results of the correlation are not significantly different for the two years of the analysis. As it can be seen in Figure 1, in the first year (2000), the correlation coefficient seems to be rather neutral, with the degree of national polycentricity being irrelevant to gross domestic product per capita, or alternatively to the level of national development (r = 0.0003). Furthermore, in Figure 2 the illustration of the correlation between the degree of polycentricity of the group of countries under analysis and their corresponding development level for 2011, is narrowly different than that of 2000, and shows no correlation between the two variables also (r = 0.0253).

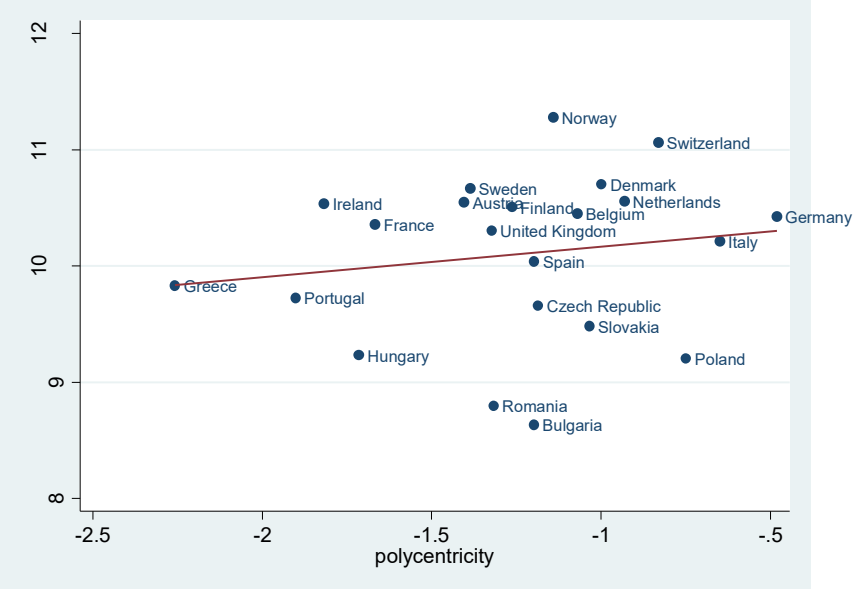

Figure 2. Correlation of polycentricity and GDP per capita in the European Union (2011).

Thus, it is not ascertained a significant relation between gross domestic product and polycentricity at the national level, implying that more polycentric countries are not characterised by a higher level of development, although previous studies concluded to the affirmation of this hypothesis, with a different set of countries instead [19]. However, the examination of the relation is rather rudimentary and further testing of empirical methods is necessary for a more thorough perspective on this matter.

4. CONCLUSIONS

Compliant with its research questions this paper examines the morphological polycentricity in the national urban systems of the European Union member-states in 2000 and 2011. The polycentricity degree is calculated with the measure of the rank-size coefficient, with the overall polycentricity level presenting a confined decrease. In this period there are not observed major changes as far as the general state of the polycentricity distribution. Furthermore, it is deduced that the European space during the period 2000-2011 becomes more coherent in terms of polycentricity, since the inequality among the examined urban systems decrease. Concerning the examination of the research question, whether there is a relation between polycentricity and the development level of a country, it was carried out a correlation analysis employing the GDP per capita natural logarithm and the calculated

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

polycentricity beta for the group of the examined European countries. The results show no tangible proof that national polycentric urban systems relate directly to a higher development level. However, the failure to corroborate the relation between these two variables does not weaken the role of polycentricity as a goal-vision for an efficient, equitable and sustainable European territory. In Europe, there are traditionally deconcentrated urban systems, while others can much less be characterised so, which face great challenges, as for instance a high urban primacy degree. The carried-out analysis makes it obvious that some countries, more than others, are in great need of more efficient national policies in order to be reinforced this positive trajectory of decreasing inequalities in the European space.

Acknowledgement

This article is implemented through the Operational Program "Human Resources Development, Education and Lifelong Learning", and is co-financed by the European Union (European Social Fund) and Greek national funds.

References

1. Böhme, K., Lüer, C., & Toptsidou, M. (2019). Towards a European Geography of Future Perspectives: A Story of Urban Concentration. In Eduardo Medeiros (ed.) Territorial Cohesion: The Urban Dimension, Springer, Cham, 173-191.
2. ESPON, 2014. *Polycentric Territorial Structures and Territorial Cooperation*, ESPON Policy Brief.
3. European Commission and UN-HABITAT, 2016. The state of European Cities 2016. *Cities leading the way to a better future*, Publications Office of the European Union, Luxembourg.
4. Rozenblat, C., 2009. European urban polycentrism: A multiscale typology. *Geographica Helvetica.***64**, 175-185.
5. Dieleman, F.M., Faludi, A., 1998. Polynucleated Metropolitan Regions in Northwest Europe: Theme of the Special Issue. *European Planning Studies*, **6 (4)**, 365-377.
6. European Commission. (1999). *European Spatial Development Perspective (ESDP): Towards Balanced and Sustainable Development of the Territory of the European Union*. Brussels: European Commission.
7. EU Ministers responsible for Urban Matters., 2016. *Urban Agenda for the EU*. Agreed on 30 May 2016, Amsterdam, The Netherlands.
8. EU Ministers responsible for Spatial Planning and Territorial Development., 2011. *Territorial Agenda of the European Union 2020*. Agreed on 19 May 2011, Gödöllő, Hungary.
9. Nordregio (Lead partner) (Ed), 2005. *ESPON 1.1.1: Potentials for polycentric development in Europe. Final Report*. Stockholm/Luxembourg: Nordregio/ESPON Monitoring Committee. https://www.espon.eu/sites/default/files/attachments/fr1.1.1_revised-full_0.pdf (Accessed March 12 2017)
10. Davoudi, S., 2003. Polycentricity in European Spatial Planning: From an Analytical Tool to a Normative Agenda. *European Planning Studies*, **11 (8)**, 979-999.

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

11. Green, N., 2007. Functional Polycentricity: A Formal Definition in Terms of Social Network Analysis. *Urban Studies*, **44 (11)**, 2077–2103.
12. Bailey, N., & Turok, I., 2001. Central Scotland as a polycentric urban region: useful planning concept or chimera?. *Urban studies,* **38(4)**, 697-715.
13. Kloosterman, R. C., Lambregts, B., 2001. Clustering of economic activities in polycentric urban regions: the case of the Randstad. *Urban studies,* **38 (4)**, 717-732.
14. Parr, J., 2004. The polycentric urban region: a closer inspection. *Regional studies,* **38 (3)**, 231-240.
15. Carmo, R. M., 2013. Polycentrism as a multi-scalar relationship between urban and rural areas: The case of Portugal. *European Planning Studies,* **21 (2)**, 149-166.
16. Institut de Gestion de l' Environnement et d' Amenagement du Territoire, ULB (Lead partner) (Ed), 2007. *ESPON 1.4.3: Study on Urban Functions, Final report*, Brussels/Luxembourg : ULB/ ESPON Monitoring Committee. https://www.espon.eu/export/sites/default/Documents/Projects/ESPON2006Projects/StudiesScientificSupportProjects/UrbanFunctions/fr-1.4.3_April2007-final.pdf (Accessed April 22 2017)
17. Meijers, E., Waterhout, B., Zonneveld, W.A.M., 2007. Closing the gap: Territorial cohesion through polycentric development. *European Journal of Spatial Development*, **24**, 1-25.
18. Meijers, E., Sandberg, S., 2008. Reducing regional disparities by means of polycentric development: Panacea or Placebo. *Scienze Regionali*, **7 (2)**, 71–96.
19. Brezzi, M., Veneri, P., 2015. Assessing Polycentric Urban Systems in the OECD: Country, Regional and Metropolitan Perspectives. *European Planning Studies*, **23 (6)**, 1128-1145.
20. Meijers, E., 2008. Measuring polycentricity and its promises. *European Planning Studies*, **16 (9)**, 1313-1323.
21. Bačić, K., Šišinački, J., 2014. Croatia's potential for polycentric development. *Društvenaistraživanja,* **23 (2)**, 327-347.
22. Wegener, M., 2013. *Polycentric Europe: More efficient, more equitable and more sustainable?* Paper presented at the Seminar *Welfare and Competitiveness in the European Polycentric Urban Structure: Which Role for Metropolitan, Medium and Small Cities?*June, Florence, Italy.
23. Rozenblat C., Pumain D. (2018) Metropolization and Polycentrism in the European Urban System. *International and Transnational Perspectives on Urban Systems,* (eds C. Rozenblat, D. Pumain, E. Velasquez), Springer, Singapore, 117-141.
24. Brezzi, M., 2012. Redefining" urban": A New Way to Measure Metropolitan Areas, OECD.
25. Eurostat. (2018a). *Population on 1 January by age groups and sex - functional urban areas.* Eurostat, http://ec.europa.eu/eurostat/web/products-datasets/-/urb_lpop1(Accessed February 19 2018)
26. Eurostat. (2018b). *Main GDP aggregates per capita.* https://ec.europa.eu/eurostat/web/products-datasets/product?code=namq_10_pc Accessed February 20 2018)
27. Pavleas, S., Petrakos, G., 2006. The urban system of South-Eastern Europe: evolution, structure and hierarchy. *New Members-New Challenges for the European Regional Development Policy* (eds T. Markowski and M. Turala), Warsaw: Polish Academy of Science, 29-40.

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2

28. Nikolopoulos, P., Gkouzos, A., Papadaskalopoulos, A., 2018. Morphological Polycentricity in Southern Europe: Evidence at the National Level. *Theoretical and Empirical Researches in Urban Management,* **13 (4)**, 73-93.

Proceedings
of the International Conference on ***Changing Cities IV****:*
Spatial, Design, Landscape & Socio-economic Dimensions
Chania, Crete Island, Greece ● June 24-29, 2019
ISSN: 2654-0479
ISBN: 978-960-99226-9-2