ANALYSIS OF POLYCENTRICITY OF THE SOUTH-EAST REGION OF ROMANIA

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Abstract. Although its content is not clear enough, "polycentricity" has become, since the 1990s, an important concept that was at the core of discussions on territorial and economic development of Europe. This paper includes the presentation of a methodology for estimating the polycentricity degree of regions. Thus, first the functional urban areas must be identified; these are the basic elements in the analysis of polycentricity. Next, the three dimensions of polycentricity are assessed, i.e. size, location and connectivity, based on indicators. By aggregating the size index, location index and connectivity index, the polycentricity index is obtained. Finally, the methodology presented is used to assess the polycentricity of South-East Region of Romania. A comparison of the four indices of the South-East Region with the corresponding indices of ESPON Space shows significant differences favoring either of them.

Key words: spatial development, regional policies, balanced development, GIS, geo-spatial methods.

1. Introduction

According to the European Spatial Development Perspective (CSD, 1999:11), promoting balanced urban polycentric system is one of the most important policy objectives of the EU programs. This concept goes beyond the different interests of Member States and meets the objectives of economic and social cohesion of ESDP, in particular the need to encourage a more balanced competitive structure throughout Europe (Dobrin *et al*., 2010a, b; Manole *et al*., 2011, 2012; Ianoş *et al*., 2013). From a programmatic perspective, one can say that polycentric development is the territorial dimension of European cohesion policy. Polycentric development now represents a strategic tool which can promote economic competitiveness (Hague and Kirk, 2003:7; Tache *et al*., 2017), social cohesion (Meijers *et al*., 2007; Meijers and Sandberg, 2008; ESPON and Vienna University of Technology, 2012) and environmental sustainability (CSD, 1999). Polycentrism (polycentric development) is one of the dominant themes of the ESPON program.

Accordingly, ESPON countries are best integrated at a territorial level in Europe and therefore best suited analyzing the degree of polycentrism.

The term "polycentrism" describes a system of cities which are interlinked and mutually encourage themselves (Schubert and Martina, 2006:23). In polycentric regions, the cities are located in economic cooperation network (Stan, 2014) with no leading city, and evenly distributed as independent political entities, historically distinct (Kloosterman and Mustered, 2001). Also, a polycentric urban system is a spatial organization of cities characterized by a functional division of labor, economic and institutional integration, and political co-operation (Tatzberger, 2004). Polycentric development calls for closer cooperation at the EU level in response to the challenges of globalization and the increasing transnational impact of spatial development policies in Europe (Krätke, 2001). In this regard, the territorial cohesion of E.U. calls for greater flexibility of Member States on territorial sovereignty, taking account of the emergent transnational cooperation networks (Faludi and Waterhout, 2005). Polycentricity played and plays a central role in the planning and economic geography literature since the European Spatial Development Perspective (ESDP) was released.

One of the main problems, appearing when performing analyses of polycentric regions and proposed regional development policies (Stan, 2014), is that there are no widely used standards to identify polycentricity (Davoudi, 2003). This is due to the different types of existing territories in the European Union, from very small countries to countries with large areas, diverse typology of cities and national statistical data used. It is therefore necessary to assess polycentricity both nationally and internationally (Waterhout *et al.*, 2005).

Functional urban areas are the building blocks of a polycentric region (Tache and Tache, 2016; Manole *et al.*, 2018). Polycentric regions are formed by two or more mutually reinforcing functional urban areas. Using a traditional morphologic approach, an urban area can be defined as polycentric if its employment is not concentrated in a single center, but it is distributed in two or more centers (Riguelle *et al.*, 2007).

A perfect polycentric system would offer two major economic advantages: the presence of agglomeration economies, which results in increasing returns for companies, and a potential reduction of transport costs (including time) (Tresserra and Cladera, 2012). In a polycentric system the development of every city (as an element of the urban system) depends on its territorial capital and relevant assets providing locations based on advantages regarding its competitiveness at different spatial levels (Giffinger and Suitner, 2010).

The Territorial Agenda (2011) introduced the notion of territorial cohesion, which complements the solidarity mechanisms with a qualitative approach and ensures that development opportunities are best adapted to the peculiarities of an area. The new spatial development perspective is a dynamic concept in which cities are regarded not only as centers of supply, but also as engines of development (Schindegger and Tatzberger, 2002:27). Sassen (2001) and Castells (1996) emphasise the relevance of flows between the nodes of the network drawn by the global economy. The expression "flow" means the exchange of goods, capital, persons and information. Thus, polycentricity is emerging as an archetypal model of spatial organization of cities or metropolitan areas, appropriate challenges of globalization (Anas *et al.*, 1998; Tache *et al.*, 2018a). Despite the prominent role it holds polycentricity in the most important documents on European spatial planning, the state of knowledge about the contribution of polycentricity towards the achievement of the major goals of the European Union is still limited (Wegener, 2008).

From a polycentricity perspective, there are several types of region: regions dominated by a large metropolis, polycentric regions with high urban and rural densities, polycentric regions with high urban densities in a less dense rural area, rural areas under metropolitan influence, rural areas with networks of medium and small sized towns, and remote rural areas (Strubelt *et al.*, 2001:5).

Parr (2004) highlights a set of conditions which must be met in order for an urban region to be polycentric, and presents different forms of the polycentric urban region and economic advantages of the polycentric urban region. Champion (2001) examines the nature of changes in demographic regimes, attempting to identify the features of polycentric urban regions in comparison with traditional monocentric structures and seeking for links between the changes in demographic regime and those in the urban structure. Also, van Houtum and Lagendijk (2001) analyze and assess the concept of polycentric urban region, showing that this notion constitutes a strategic rather than an analytical concept, and present two examples: the Ruhr area in Germany and the Basque country. Starting from the premise that polycentric urban regions, or urban networks, are often associated with the notion of synergy, Meijers (2005) analyzes the presence of synergy in the Randstad region in the Netherlands focusing on the synergy mechanisms of cooperation and in particular complementarity.

Veneri and Burgalassi (2011), investigating how the spatial structure affects labor productivity in the Italian NUTS 3 regions, found that both polycentricity and dispersion have a negative impact and size has a positive one. Likewise, Veneri and Burgalassi (2012) analyzed the Italian NUTS 2 regions and showed that the two dimensions (functional and morphological) are highly correlated. Also, they proved that there is a correlation between polycentricity and a higher level of productivity and a more uneven income distribution. Kloosterman and Lambregts (2001) explore at what level of spatial aggregation the tendencies of clustering of economic activities articulate themselves within the Randstad region by analyzing the profiles of business start-ups in the individual *cities* of this region. Their results show that the process is taking place at the level of the polycentric urban region homogenization, with respect to new economic activities. Bailey and Turok (2001) explore the extent to which Central Scotland region, which has two separate cities reasonably close to each other with neither dominant (Edinburgh and Glasgow), operate as polycentric urban regions. Meijers and Romein (2003) by analyzing four polycentric urban regions in North West Europe (the Randstad, the Rhein-Ruhr, the Flemish Diamond and the Central Scotland) found that the building of regional organizing capacity is conditioned by a number of institutional, political, spatial-functional and cultural factors.

Benini and Czyzewski (2007) performed an analysis of the regional urban system polycentricity of Central-Eastern Europe and showed that at the European level a balance must be sought for between cohesion policies (where polycentric development focuses on small and medium-sized towns) and competitiveness policies (which allocate the central role of the large metropolitan areas and capitals). Pessoa (2009) presents the Brazilian urban systems and classify them based on three aspects of polycentrism (morphology, inter- and intra-relations, and governance) into three structures: medium-size city region, metropolitan region and inter-metropolitan region. Egnatia Odos Observatory (2001) shows that the changes resulting from the Egnatia Motorway – Vertical Axes system in the area of regions crossed by the highway, are minor in terms of morphological polycentricity, but significantly positive in terms of functional polycentricity.

Brezzi and Veneri (2015) provide measures of polycentricity at different spatial structures (national, regional and metropolitan scale) and show that relatively more monocentric regions have higher GDPs per capita than more polycentric regions and that a higher degree of policentricity determines a larger GDP per capita at the national level.

Many articles are devoted to the study of specific issues related to polycentric metropolitan areas. Anderson and Bogart (2001) identify and characterize employment centers in four comparably sized metropolitan areas (Cleveland, Indianapolis, Portland, and St. Louis). McDonald and McMillen (1990) present some prior research and new results on the identification of employment sub-centers in Chicago. Redfearn (2007) introduces a nonparametric method for identifying employment sub-centers in Los Angeles metropolitan area. Aguilera (2005) investigates the development of population and employment location and its consequences in terms of commuting distance between 1990 and 1999 in the three biggest French metropolitan areas (Paris, Lyon and Marseille). Goebel *et al.* (2007) examine functional polycentricity aspects, namely, the spatial patterns and firm connectivity of the knowledge based economy in the Mega-City Region of Munich.

Cook *et al*. (2007), using methodologies developed by GaWC for global urban research, analyze the polycentricity of Mega-city Regions of Western Europe. Hoyler, Kloosterman and Sokol (2008) deal with key elements of global city-regions, underline some unresolved gaps, and present a research agenda for future work on emerging mega-city regions.

Heikkila *et al*. (1989) use hedonic regression methods to assess the impact of dwelling and structure characteristics, neighborhood effects, and multiple locations on the residential property sales in Los Angeles County, and conclude that the largest US metropolitan areas are increasingly polycentric in shape.

McMillen and McDonald (1997) have shown that Chicago is a polycentric city because employment density rises near an array of sub-centers, using empirical research nonparametric estimation procedures (locally weighted regressions).

Richardson and Jensen (2000) make a critical analysis of the European Spatial Development Perspective (ESDP), focusing on the twin core themes of spatial mobility and polycentricity. Copus (2001) shows off the need to supplement conventional (spatial) models of peripherality by more appropriate non-spatial concepts in order to produce coherent models and operational indicators. Andersson and Ostrom (2008) studied decentralized natural resource governance in the new light of applying institutional theories of polycentricity (the relationships among multiple authorities with overlapping jurisdictions).

Anas and Kim (1996) propose a general equilibrium model of polycentric urban land use (allocated to houses, production, and roads) that tests the stability of balance and identifies perturbations, presenting numerical solutions for the case of a bounded linear city where only one commodity is produced.

Starting from here, the present study aims to present a new methodology for assessing the polycentricity of functional urban areas and apply it to the South-Eastren region of development in Romania.

2. Methodology

The approach proposed here to measure polycentricity is very similar to the one used in the ESPON Project 1.1.1 (Norderegio *et al.*, 2005). To assess polycentricity, we must look at its three dimensions: size, location and connectivity, measured by indices (size index, location index and connectivity index). With these three indices a comprehensive Polycentricity Index can be built up.

In the ESPON approach (Norderegio *et al.*, 2005), the size of the functional urban areas is expressed by their GDP and population. Since no data about GDP localities, the present study uses turnover instead. For the turnover and the population, a linear regression between the value of the size of each functional urban area and the corresponding location in the size rating is computed. The functional urban area ranked first in the size rating is excluded from this linear regression. The regression slope constitutes an indicator of the even distribution of variable considered (the population or the turnover). The smaller the slope of the regression is, the better the even distribution of variable considered. We are also interested in the degree by which the size of the largest functional urban area deviates from this regression line, which is called primacy. This is computed by dividing the size of the functional urban area that is first in the rating by its hypothetical size which would acquire if it followed the linear regression. Therefore, we use the same methodology for the population, which is a demographic indicator of the size and for turnover, which is an indicator of economic power.

The second dimension of polycentricity is location. The polycentricity of an urban system is a function of the location of settlements in space. Therefore, a prerequisite of a polycentric urban system is that “its centers are equally spaced from each other – this prerequisite is derived from the optimal size of the service or market area of centrally provided goods and services” (Norderegio *et al.*, 2005:60).

Therefore, it is necessary to analyze the distribution of functional urban areas centers over the territory. In this regard the area of a region is divided into service areas such that each point is associated with the nearest centre. Such areas are called Thiessen polygons and can be constructed by dividing the territory into raster cells of equal size and to allocate each cell to the nearest centre of a functional urban area (Nordregio *et al.*, 2005:59-60). In this study, the national road network distance was used to allocate raster cells to centers.

To measure the disproportion between the sizes of service areas, the Gini coefficient of inequality was used. The Gini coefficient of inequality (G) has the following definition:

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{2n^2\bar{x}}$$

where:
n=the number of observed values;
x_i = observed value, x_i, $i = 1,2, k, n$;
$\bar{x}$= mean of values x_i, $i = 1,2, k, n$;

If $x_1^{'}, x_2^{'}, K, x_n^{'}$ are observed values arranged in ascending order we can use the following formula to compute faster Gini coefficient (Buchan 2002):

$$G = \frac{2}{n^2\bar{x}}\sum_{i=1}^{n} i(x_i' - \bar{x})$$

The Gini coefficient can take values in the interval $[0,(n-1)/n]$, zero – for perfect equality $(x_1^{'} = x_2^{'} = K = x_n^{'})$, and $(n-1)/n$ which tends to one with large n – for perfect inequality $(x_1^{'} = x_2^{'} = K = x_{n-1}^{'} = 0,\ x_n^{'} \neq 0)$ (Halffman and Leydesdorff, 2010).

The third dimension of polycentricity is connectivity that "implies that the channels of interaction between cities of equal size and rank, but in particular between lower-level and higher-level cities, it must be short and efficient" (Nordregio *et al.*, 2005:61).

For the assessment of connectivity, in this paper the potential accessibility of functional urban areas centers is used. Thus, population is an activity function, travel time is an impedance function, and the two functions are combined in a multiplicative fashion by the potential accessibility formula (Shürmann *et al.*, 1997):

$$A_r = \sum_s W_s^a \exp(-\beta c_{rs})$$

where
A_r= the accessibility of a city r;
W_s = the population of a city s in the urban network considered;
c_{rs} = the travel time between the city r and the city s, that is measured in minutes;
α, β = parameters

In general, it takes $a = 1$, but in order to take into account the agglomeration effects, term W_s is weighted by an exponent $a > 1$. Other parameter is positive and takes small values commonly $\beta = 0.005$ (Wegener *et al.*, 2002).

Once the accessibility of functional urban areas centers is determined, this raises the question of how far the accessibility of these centers is from an even distribution. In this respect, the Gini coefficient is used. Another indicator of the connectivity index is the slope of the regression line between the accessibility of functional urban areas centers and its population.

The size index, location index and connectivity index are used to produce a composite index for measuring polycentricity. First, the values of the seven sub-indicators are transformed into utilities. Thus, we denote by x the value of a sub-indicator, by u the corresponding utility, and define two thresholds:
x_{min} = the sub-indicator value at which polycentricity is zero;
x_{max} = the sub-indicator value at which polycentricity is one hundred.

If the greater the values of the indicator, the more favorable are, we have:

$$u = \begin{cases} 0, \text{if } x < x_{\min} \\ \dfrac{x - x_{\min}}{x_{\max} - x_{\min}} \cdot 100, \text{if } x_{\min} \le x \le x_{\max} \\ 100, \text{if } x > x_{\max} \end{cases}$$

If the smaller the values of the sub-indicator, the more favorable are, we have:

$$u = \begin{cases} 100, \text{if } x < x_{\min} \\ \frac{x_{\max} - x}{x_{\max} - x_{\min}} \cdot 100, \text{if } x_{\min} \le x \le x_{\max} \\ 0, \text{if } x > x_{\max} \end{cases}$$

The threshold values for the seven indicators used in this paper (Table 1) are those proposed in the ESPON Project 1.1.1 (Nordregio *et al.*, 2005:72).

The utilities determined this way are aggregated into a Polycentricity Index by weighted aggregation. The aggregation is made with the same weights as in ESPON Project 1.1.1 (Nordregio *et al.*, 2005:72):
Size Index (33.33%)
Population (50%)
- Slope of regression line (20%)
- Primacy (80%)
- Turnover (50%)
- Slope of regression line (20%)
- Primacy (80%)

Location Index (33.33%)
Gini coefficient of size of service areas
Connectivity Index (33.33%)
Correlation between population and accessibility
- Slope of regression line (50%)
- Gini coefficient of accessibility (50%)

Multiplicative aggregation for the three component indices and additive aggregation at the other levels were used.

The Gini coefficient of accessibility of the functional urban areas centers in the South-East Region is 5.88%, which means that the accessibility of these centers does not differ much between them.

The slope of the regression line between the accessibility of functional urban areas centers and the corresponding functional urban areas population is very small, 0.0004, which shows that the accessibility of these cities does not depend on the population size of belonging functional urban areas, as confirmed by the small value of the coefficient of determination, 0.12 (Fig. 4).

After transforming the values of indicators into utilities and aggregating these utilities into the three component indices measuring the different dimensions of polycentricity and then merging them into a polycentricity index, according to the methodology described above, the following results were obtained:
Size Index = 62.66
Location Index = 73.85
Connectivity Index = 88.24
Index of Polycentricity = 74.19

We compared the Index of Polycentricity of the South-East Region with the Index of Polycentricity of the ESPON Space. Even if the two indices are computed based on data from different period and measure the polycentricity at different levels (the first at a regional level and the second at a continental one), their computation methodology is the same. For this reason, this comparison makes sense and is also of interest. Thus, the polycentricity index of the South-East Region (74.19) is greater than the one of the ESPON Space (56.20) by 18, according to the data from ESPON Project 1.1.1. (Nordregio *et al.*, 2005:73).

By comparing the partial polycentricity indices of South-East Region with those of the ESPON Space even greater differences are obtained (Fig. 5). Specifically, for the location index and connectivity index, differences of about 39 and 30 are obtained in favor of the South-East Region respectively, and about 26 for the size index, to the detriment of the region.

Table 1. The threshold values for sub-indicators. *Source:* ESPON Project 1.1.1 (Nordregio *et al*., 2005:72, Table 3.3).

	Rank-size distribution of population		Rank-size distribution of turnover		Size of service areas	Population and accessibility	
	Slope	*Primacy*	*Slope*	*Primacy*	*Gini coefficient*	*Slope*	*Gini coefficient*
Sub-indicator value at which polycentricity is 0	–1.75	7.5	–1.75	10	70	75	25
Sub-indicator value at which polycentricity is 100	–0.5	0	–0.5	0	10	0	0

Table 2. Rating of the functional urban areas in South-East Region based on population and turnover. *Source:* The data in table have been generated by the authors according to the information provided by National Institute of Statistics (http://statistici.insse.ro/shop/index.jsp?page=tempo3&lang=ro&ind=POP102D) and The National Bank of Romania (http://www.bnr.ro/ Cursul-de-schimb-3544.aspx).

Functional Urban Area	**Population** (in thousands)	**Rank**	**Turnover** (in lei)	**Turnover** (in million euros)	**Rank**
Constanta	453.266	1	25,593,566,151	5743.618975	1
Galati	336.565	2	19,072,174,161	4280.110898	2
Focsani	247.071	3	4,263,203,578	956.733298	5
Braila	239.918	4	6,577,267,893	1476.047552	4
Buzau	239.387	5	10,012,341,807	2246.934876	3
Tecuci	163.708	6	1,032,553,515	231.722064	9
Tulcea	129.406	7	3,870,236,711	868.545043	6
Ramnicu Sarat	97.478	8	1,150,184,226	258.120338	8
Medgidia	89.277	9	856,521,081	192.217478	10
Adjud	72.874	10	488,292,388	109.580877	11
Mangalia	60.768	11	1,497,326,107	336.024710	7
Ianca	46.378	12	335,476,466	75.286460	13
Macin	35.729	13	260,099,346	58.370589	14
Nehoiu	34.503	14	225,181,444	50.534435	15
Harsova	26.188	15	359,904,015	80.768406	12

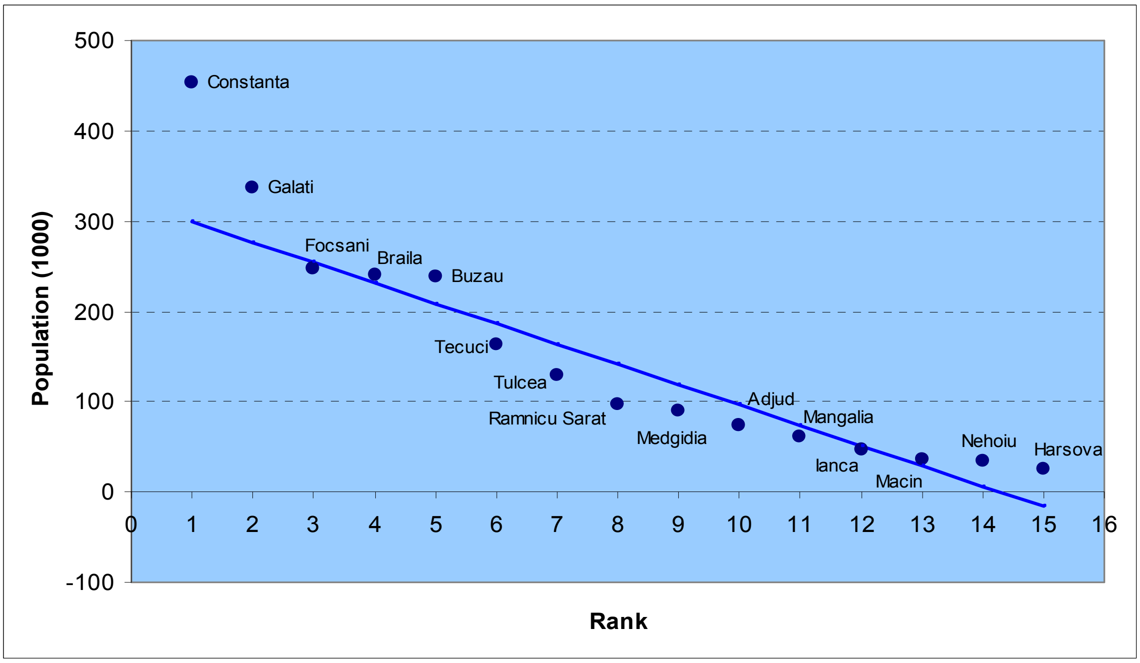

Fig. 1. Linear regression between population and position in the rating. *Source:* prepared by the authors based on the data in Table 1.

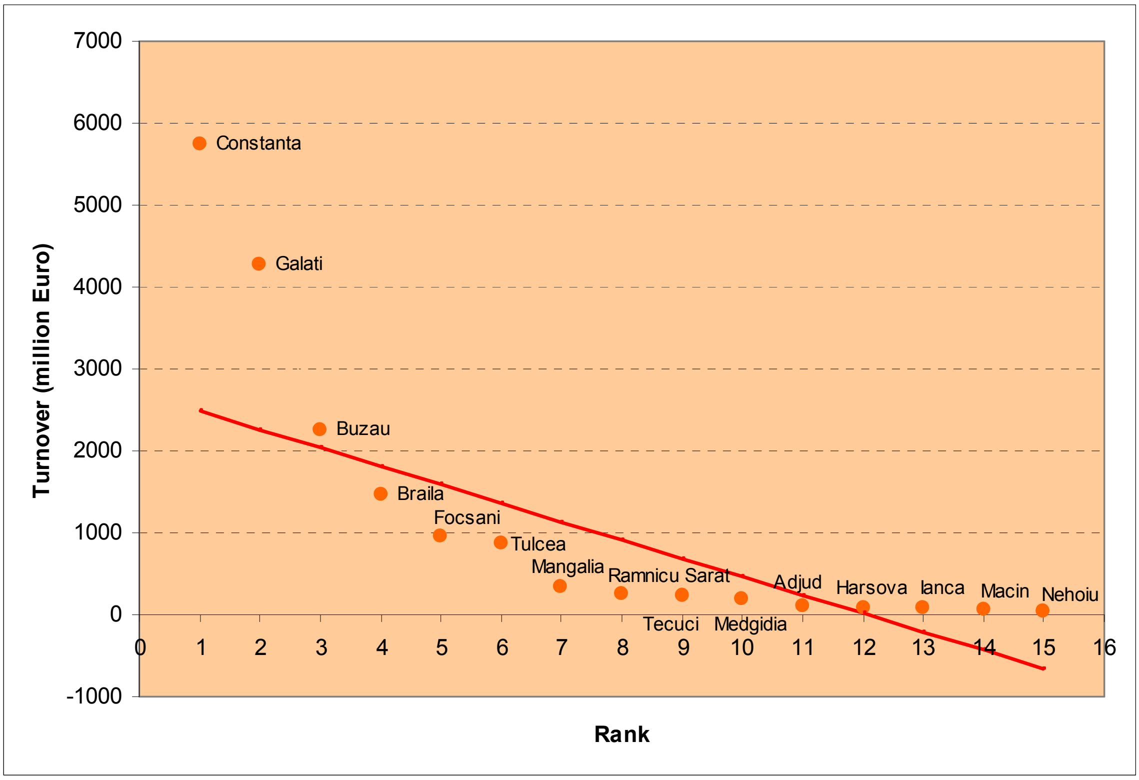

Fig. 2. Linear regression between turnover and position in the rating. *Source:* prepared by the authors based on the data in Table 1.

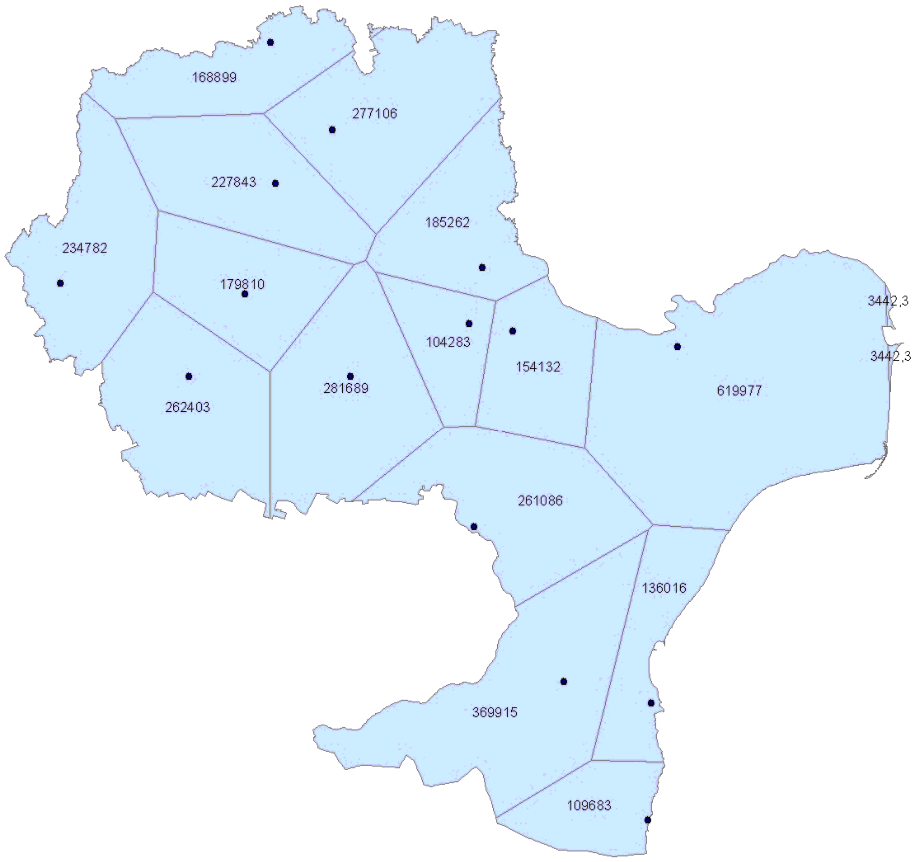

Fig. 3. Service areas in South-East Region. *Source:* prepared by the authors Thiessen polygons for each city using ARCGIS 10.2.2.

Table 3. Travel times between functional urban areas centers (in minutes). *Source:* prepared by the authors with the help of the website http://www.viamichelin.com/.

	Constanta	*Mangalia*	*Medgidia*	*Harsova*	*Galati*	*Tecuci*	*Tulcea*	*Macin*	*Braila*	*Ianca*	*Buzau*	*Ramnicu Sarat*	*Nehoiu*	*Focsani*	*Adjud*
Constanta	0	41	35	68	163	210	100	120	140	131	156	172	229	203	235
Mangalia	41	0	65	96	168	234	168	151	165	157	181	198	254	229	260
Medgidia	35	65	0	57	150	196	107	124	128	119	143	157	216	191	222
Harsova	68	96	57	0	105	151	78	81	82	74	117	115	190	146	177
Galati	163	168	150	105	0	70	107	58	23	59	108	91	182	78	108
Tecuci	210	234	196	151	70	0	169	116	76	86	86	61	155	31	38
Tulcea	100	168	107	78	107	169	0	67	108	145	191	180	264	176	206
Macin	120	151	124	81	58	116	67	0	47	83	133	119	206	118	149
Braila	140	165	128	82	23	76	108	47	0	37	86	74	160	77	107
Ianca	131	157	119	74	59	86	145	83	37	0	49	42	123	73	105
Buzau	156	181	143	117	108	86	191	133	86	49	0	28	76	60	91
Ramnicu Sarat	172	198	157	115	91	61	180	119	74	42	28	0	99	36	67
Nehoiu	229	254	216	190	182	155	264	206	160	123	76	99	0	130	162
Focsani	203	229	191	146	78	31	176	118	77	73	60	36	130	0	37
Adjud	235	260	222	177	108	38	206	149	107	105	91	67	162	37	0

4. Results and Discussion

The source of population and turnover data for the settlements in South-East Region was the National Institute of Statistics. For this study we used the 2014 population and 2012 turnover, and the conversion Leu to Euro was made using the annual average rate of exchange for 2012, 1 Euro=4.4560 Lei. The functional urban areas were classified according to their population and turnover (Table 2).

Analyzing the data in Table 2, we find that, in terms of population, two groups of functional urban areas stand out, differing greatly in size. One contains larger functional urban areas, consisting of Constanta, Galati, Focsani, Braila, Buzau, and the other smaller functional urban areas, consisting of Ianca, Macin, Nehoiu, Harsova. This aspect shows a low polycentricity of the analyzed urban system, also confirmed through the slope of the regression line of the rank-size distribution of functional urban areas population that has a small negative value, -22.5372 (Fig. 1). The same is also indicated by the coefficient of determination that has a large value (0.9020), which means that population depends on rank, and the rank-size distribution is not flat, condition which would have been necessary for a polycentric structure. At the same time, the degree by which the size of the largest functional urban area deviates from that regression line is small, the primacy having a value of 1.5161. Because a polycentric urban system should not be dominated by a large city, the previous result demonstrates that this polycentricity condition is accomplished.

The results related to turnover are very similar to those obtained for population. As the data in Table 1 suggest, in terms of turnover, two very different functional urban areas groups are found; on the one hand, the group consisting of Constanta, Galati, Buzau, and on the other hand, the group made up of Harsova, Ianca, Macin, Nehoiu. For this reason, it can be said that the urban system of the South-East Region is more polarized. The slope of the regression line of the rank-size distribution of functional urban areas turnover is negative and very small, -224.2856, which also shows a low-polycentricity (Fig. 2).

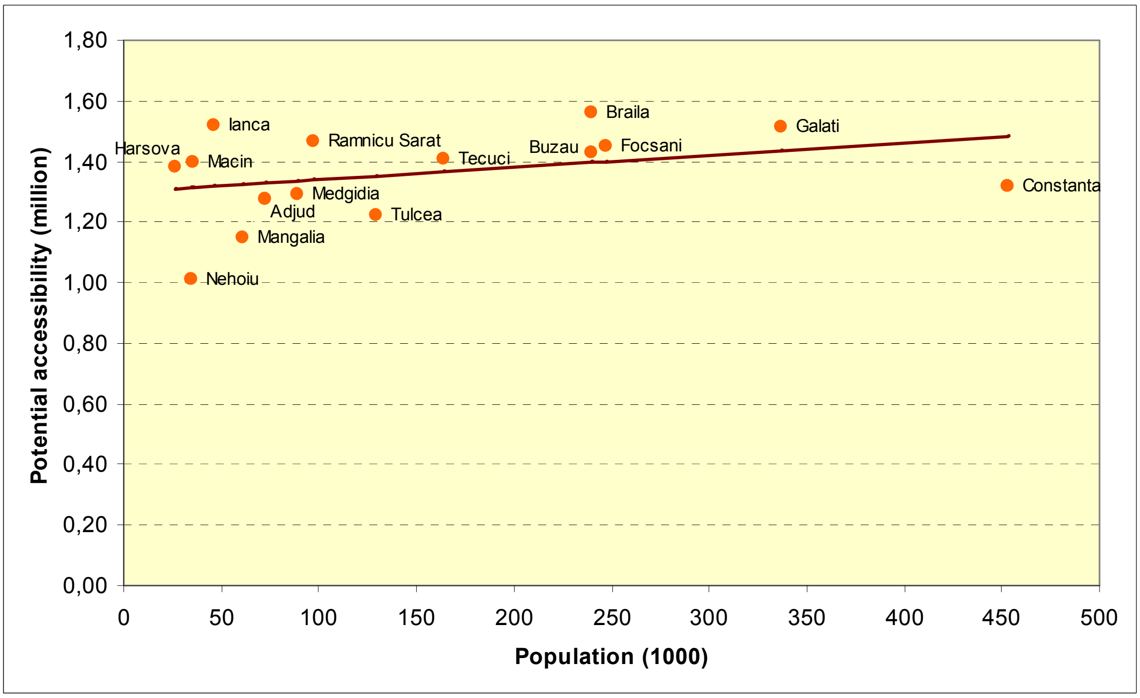

Fig. 4. Linear regression between the accessibility of functional urban areas centers and the corresponding functional urban areas population. *Source:* prepared by the authors based on the data in Table 2 and Table 4.

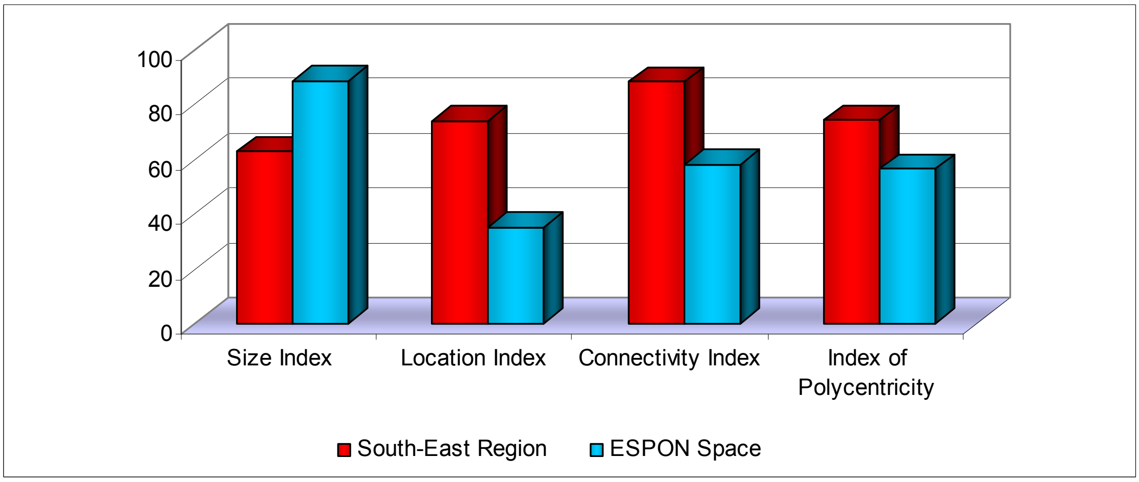

Fig. 5. South-East Region of Romania vs. ESPON Space. *Source:* prepared by the authors based on results previously obtained and data from ESPON (Norderegio *et al.*, 2005:73).

Furthermore, the primacy that expresses the degree by which the size of the functional urban area with the highest turnover deviates from that regression line, is quite large, 2.3126. This also shows a low polycentricity of the urban system analyzed.

Following the methodology described previously, the service areas in South-East Region were built up (Fig. 3), the values within representing their sizes, expressed in hectares. The Gini coefficient of the size of service areas in the South-East Region is 25.69%.

The potential accessibility of the centers of functional urban areas has been determined based on the travel times between those centers obtained by moving on the national road (Table 3), taking $a = 1$ and $\beta = 0.005$ (Table 4).

Table 4. Potential accessibility of functional urban areas centers. *Source:* The data in the table were determined by the authors based on the information from the National Institute of Statistics (http://statistici.insse.ro/shop/index.jsp?page=tempo3&lang=ro&ind=POP102D) and the data from Table 3 by own computations.

Centers of functional urban areas	Potential accessibility
Constanta	1,317,956
Galati	1,512,351
Focsani	1,451,994
Braila	1,559,605
Buzau	1,430,788
Tecuci	1,409,335
Tulcea	1,225,312
Ramnicu Sarat	1,464,804
Medgidia	1,293,272
Adjud	1,274,562
Mangalia	1,147,028
Ianca	1,519,275
Macin	1,395,654
Nehoiu	1,011,880
Harsova	1,382,993

This paper attempted to provide a better understanding of polycentrism by presenting some aspects related to this topic and the methodology for determining the degree of polycentrism of the South-East Region of Romania. To conceptualize polycentricity three dimensions of its, size, location and connectivity were highlighted, and assessed using indicators to build up indices of size, location and connectivity, and merge them into a polycentricity index, using functional urban areas as building blocks (Tache *et al.*, 2018b). Establishing functional urban areas is not easy, because it requires the knowledge of several aspects of the territory, especially economic and social, given that there is no universally accepted definition for functional urban areas.

The four indices take values between 0 and 100, 0 representing no polycentricity and 100 being awarded for perfect polycentricity. The Index of Polycentricity, the Location Index and Connectivity Index of South-East Region are greater by 18, 39, 30, respectively, than the corresponding indices of the ESPON Space. Regarding the location index, large difference were found is because in the ESPON space there are countries that have a low density, in which many service areas are great (Norway, Finland, Sweden), and countries with high density, in which many service areas are small (Germany, Netherlands, France, United Kingdom). This means that the sizes of the service areas differ greatly among themselves, while the sizes of service areas in the South-East Region differ lesser between them. In the cases of the connectivity index, the big difference between the two index values is explained by the fact that the potential accessibility of centers of functional urban areas in the South-East Region differs little from one center to another (Tache and Petrişor, 2017), which determines a high value of the index (for comparison, among countries from the ESPON space only Cyprus has a higher value of the index, 89.1). Instead, the size index of the South-East Region is less than the size index of the ESPON space with about 26. The reasons are the large differences between the sizes of functional urban areas, which determine a high value of the slope of linear regression between size and rank, and the largest functional urban area (Constanta) is considerably higher than the other (which determines a large value of primacy), implying a lower value of the size index of the South-East Region. At the European level, there are no huge differences between the sizes of functional urban areas, and the largest functional urban area (Paris) has a size smaller than the size it would have had if it had followed linear regression, which makes the Size Index of ESPON space have a higher value.

A fuller picture of polycentricity would have benefited upon adding some aspects of functional polycentricity. For this purpose, special functional polycentricity and general functional polycentricity to commuting networks can be used, as well as the analysis of graph associated localities network (Green, 2005 and 2007). Likewise, for computing the potential accessibility of functional urban areas centers travel times between these centers obtained by moving on the national road were used. It would have been more accurate to compute the travel time obtained by rail between any two centers and choose the lowest between the times determined by the two modes of transport. These items are the potential directions for the future research.

5. Conclusion

Polycentric development and territorial integration of peripheral areas with low connectivity are among the priorities of European regional policy aimed at reducing regional disparities and ensuring territorial cohesion. Network planning is essential for spatial planning. Cities have a catalytic effect on the economic development and the establishment of functional territorial network. The European concept of smart cities focuses on different global challenges (technological innovation, socio-demographic processes and economic restructuring), that cities must face.

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