POLYCENTRICITY FUNCTIONAL ANALYSIS OF THE ROMANIAN COUNTIES

Main researcher 3 Antonio TACHE
Main researcher Monica Tache
”*URBAN-INCERC*” National Institute for Research and Development in Constructions, Town Planning and Sustainable Territorial Development
PhD. Associate Professor Sorin Daniel MANOLE
”Constantin Brâncoveanu” University of Piteşti

Abstract

The development of polycentricity at the national level involves the balanced development of network of settlements and the achievement of a harmonious relationship between settlement and territory based on principles of sustainable development, internal balance, the opening towards the exterior, and the exploitation of the exiting potential, functional complementarity and the growth of local autonomy. For this reason, the assessment of polycentricity at the county level is extremely important. The methodology in assessing the degree of polycentricity at NUTS 3 level consists in identifying certain domains significant for the characterization of polycentricity and some relevant indicators within such domains and then, after transformation indicators' values into scores, it consists in calculating some composite indicators corresponding to the domains and polycentricity. The analysis of these findings leads to some interesting conclusions, necessary for the formulation of some local, regional and national development policies.

Keywords: *polycentricity; index; county; domain; indicator; Romania.*

JEL: R11, R12, R15, R23, R42, R58

Introduction

The promotion of the balanced polycentric urban system is one of the most frequently cited politic objectives of the spatial policy of the European Union (ESDP, 1999). However, due to the multi-dimensional and multi-scalar nature of polycentricity, there is an ambiguity in how that concept is defined (Veneri and Burgalassi, 2012; Kloosterman and Musterd, 2001; Davoudi, 2003). Moreover, there is not any universally accepted method of measuring polycentrism at different spatial scales or any method for assessing the impact of polycentrism on the policy objectives: efficiency (competitiveness), equity (cohesion) and durability. Consequently it is impossible to decide upon an optimal degree of polycentrism between centralization and decentralization, or, in other words, between the extremes monocentricity (all activities are concentrated in one center) and dispersion (all activities are equally distributed over space). Wegener (2013) argues that both extremes monocentricity and dispersion, perform poorly with respect to the policy goals: efficiency, equity and sustainability. The polycentric urban system can be defined as a functionally integrated socio-spatial entity, which consists in more urban nodes which can be different in size but which play an important role in the system; they are bound by intensive reciprocal and multidirectional relationships, with a development influenced by government strategies which admit, consider and support the further strengthening of interests, complementarities, synergies and opportunities of mutual cooperation. ESPON 1.1.1 program details aspects related to the concept of polycentricity and shows the operational methods of measuring the polycentrism of the urban system in Europe. It is also analyzed the European urban polycentric system (consisting of the Member States of the European Union plus Norway and Switzerland), based on the current model of polycentrism, at three spatial levels: regional and local level, national level and European level, including the trans-national urban levels. As analysis units in each countries, there were established the functional urban areas (FUAs). At the European level, functional urban areas do not have a common definition. Mainly, functional urban areas consisted in a core municipality plus adjacent commuting areas. Lacking a comprehensive definition, to establish functional urban areas we need to identify their core (location of the center) and the share of the total population that lives in the neighboring which make up the FUA. This paper aims at studying polycentricity at NUTS 3 level (counties), and the methodology used is based on the methodology used in ESPON 1.1.1 for the analysis of polycentricity of functional urban areas.

According to ESPON 1.1.1, two structural aspects are of particular importance for polycentricity:

- morphological, concerning the distribution of urban areas in a given territory;
- relational – concerning the networks of flows and the cooperation between urban areas at different scales.

Polycentricity is currently considered a useful spatial planning tool to enhance the competitiveness of cities, social cohesion and environmental sustainability (Davoudi, 2003). There are two key approaches in the conceptualization of polycentric areas. The first approach is purely morphological, and according to this one, polycentric areas can be seen as a model of spatial organization which is a middle way between the traditional compact cities and urban expansion, while maintaining the advantages associated with compact cities, observing dispersion spontaneous trends (Camagni et al., 2002). The other approach is both functional and morphological, and according to it, polycentric areas represent the alternative for monocentric areas (Meijers and Sandberg, 2008), consisting in a progressive integration of urban centers into a single metropolitan area.

Methodology of assessing the polycentric system at the level of counties (NUTS 3) in Romania

The indicators present in the spatial database at the county level were chosen according in compliance with the indicators of functions of urban areas from the ESPON 1.1.1 study and the national characteristics specific to the Romanian territory. In order to characterize polycentricity there were considered more domains (which correspond to the functions of urban areas in the ESPON 1.1.1 study) and their corresponding indices were calculated, as well as a general polycentricity index using the original methodology. Thus, we considered the following domains and indicators, for which the mentioned encodings were used:

Population domain – A:
- Dynamic index of population $I_{2011/2001}$ – *A*1;
- Population in 2011 – *A*2;
- Gross domestic product (in million lei) in 2010 – *A*3;

Economic domain – B:
- The location of top 100 companies (in terms of turnover) – *B*1;
- Gross domestic product per capita at current prices (in euro) in 2010 – *B*2;
- Dynamic index of gross domestic product $I_{2010/2008}$ – *B*3;

Tourism domain – C:
- Number of tourist units in 2011 – *C*1;
- Number of overnight stays in tourist units in 2011 – *C*2;
- Dynamic index of number of overnight stays in tourist units $I_{2011/2008}$ – *C*3;
- Number of tourists in 2011 – *C*4;

Transport domain – D:
- Number of passengers transited through the airports in 2012 – *D*1;
- The volume of goods in transit through the ports in 2012 – *D*1;
- The railway density in 2012 – *D*3;
- The density of national roads in 2012 – *D*4;
- The density of public roads in 2012 – *D*5;

Education domain – E:
- Number of universities in 2011 – *E*1;
- Number of students in 2011 – *E*2;
- Dynamic index of number of students $I_{2011/2008}$ – *E*3.

For every indicator there has been achieved a grouping of values registered at the level of counties on 10 equal intervals, thus obtaining 10 groups, which, in the ascending order of values, were awarded scores from 1 to 10. When an indicator registered a value of 0 at a county, the score given to that county at this indicator was also 0. Consequently, all the values of selected indicators were transformed into scores of groups to which they belong (1,2,…,10, even 0), and this was achieved with the statistical assistance of the program ArcGIS 10.2. Within every domain, more specialists in local development established coefficients of importance (weights) for all indicators. For each domain, the index corresponding to a county was calculated as the average of scores given indicators weighted by coefficients of importance. Similarly, the coefficients of importance (weights) were provided to every domain of interest and the polycentricity index was calculated at NUTS 3 level as average of indices corresponding to these domains weighted by coefficients of importance.

Thus, the following formulas were used:

- the index of the population domain: $A = 0.15 \cdot A1 + 0.5 \cdot A2 + 0.35 \cdot A3$;
- the index of the economic domain: $B = 0.2 \cdot B1 + 0.7 \cdot B2 + 0.1 \cdot B3$
- the index of tourism domain: $C = 0.2 \cdot C1 + 0.35 \cdot C2 + 0.1 \cdot C3 + 0.35 \cdot C4$
- the index of transport domain: $D = 0.3 \cdot D1 + 0.3 \cdot D2 + 0.15 \cdot D3 + 0.15 \cdot D4 + 0.1 \cdot D5$
- the index of education domain: $E = 0.35 \cdot E1 + 0.55 \cdot E2 + 0.1 \cdot E3$;
- the polycentricity index: $IP = 0.2 \cdot A + 0.35 \cdot B + 0.1 \cdot C + 0.2 \cdot D + 0.15 \cdot E$.

Also, in order to analyze how much the values of indices differ from one county to another, Gini coefficient of inequality was calculated. Thus, if we have the observed values arranged in ascending order $x_1, x_2, \ldots, x_n$ with the average $\bar{x}$, Gini coefficient of inequality (G) is calculated as follows (Buchan, 2002):

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

The Gini coefficient ranges between zero for perfect equality ($x_1 = x_2 = \ldots = x_n$) and $(n-1)/n$ for perfect inequality ($x_1 = x_2 = \ldots = x_{n-1} = 0,\ x_n \neq 0$), approaching one for large n (Halffman and Leydesdorff, 2010).

Results and analyses

Scores and indices

By transforming the values of indicators into scores with the statistic assistance of ArcGIS 10.2 program, we obtained the following information as included in Table 1.

Scores corresponding to the relevant indicators given to counties in Romania

Table 1

The name of the county	Code of the county	*A1*	*A2*	*A3*	*B1*	*B2*	*B3*	*C1*	*C2*	*C3*	*C4*	*D1*	*D2*	*D3*	*D4*	*D5*	*E1*	*E2*	*E3*
Vaslui	VS	7	5	1	0	1	2	1	2	8	2	0	0	6	6	8	0	0	0
Valcea	VL	5	4	3	1	3	2	8	7	3	6	0	0	3	8	7	0	1	8
Teleorman	TR	1	4	2	0	2	3	1	1	3	1	0	1	5	5	3	0	1	5
Timis	TM	9	8	9	5	9	8	7	5	3	7	7	0	8	5	6	7	7	5
Tulcea	TL	4	1	1	0	1	7	4	3	2	4	1	3	1	1	1	0	0	0
Suceava	SV	9	8	5	0	4	5	7	5	5	6	2	0	7	6	6	2	2	7
Satu Mare	SM	4	4	3	0	3	4	3	3	4	4	1	0	6	4	7	2	1	8
Salaj	SJ	5	1	1	1	1	5	2	2	9	1	0	0	6	6	9	0	1	8
Sibiu	SB	6	4	5	4	5	5	6	5	5	7	4	0	2	2	5	4	5	5
Prahova	PH	5	9	7	2	7	1	8	6	3	7	0	0	4	5	9	2	2	7
Olt	OT	2	5	3	3	3	7	1	1	7	1	0	1	5	3	8	0	1	6
Neamt	NT	6	6	3	1	3	2	5	4	2	5	0	0	3	6	5	2	1	6
Mures	MS	7	6	5	2	5	3	7	5	5	7	5	0	5	4	5	4	3	7
Maramures	MM	7	6	4	0	4	6	5	4	4	5	1	0	3	3	4	2	2	7
Mehedinti	MH	2	2	1	0	1	4	2	3	4	3	0	0	2	8	7	0	1	2
Iasi	IS	8	9	7	1	7	7	3	4	4	6	4	0	6	4	8	7	8	7
Ialomita	IL	5	2	1	0	1	6	3	4	2	2	0	0	7	6	3	0	1	0
Ilfov	IF	10	3	6	7	6	3	2	3	1	4	0	0	9	9	10	2	1	6
Harghita	HR	6	3	2	0	2	3	6	4	5	5	0	0	3	5	5	0	1	4
Hunedoara	HD	1	5	4	1	4	3	4	4	3	4	0	0	5	3	9	3	1	3
Giurgiu	GR	6	2	2	0	2	10	1	2	5	1	0	2	1	7	5	0	0	0
Galati	GL	5	7	5	3	5	6	2	3	2	3	0	3	7	6	6	3	4	6
Gorj	GJ	6	4	4	0	4	9	3	3	7	3	0	0	5	6	8	2	1	4
Dolj	DJ	5	8	6	1	6	5	3	3	3	3	2	1	3	4	5	3	6	3
Dambovita	DB	6	6	5	2	5	8	3	4	3	3	0	0	2	7	9	2	2	6
Covasna	CV	7	1	1	0	1	2	4	5	6	4	0	0	3	6	2	0	1	3
Constanta	CT	8	8	8	3	8	8	10	10	2	9	3	10	9	6	6	5	6	5
Caras-Severin	CS	2	3	3	0	3	8	6	5	2	5	0	0	5	5	2	2	1	3
Calarasi	CL	4	3	2	1	2	9	1	1	1	1	0	3	4	8	3	0	1	6
Cluj	CJ	7	8	8	2	8	6	7	5	1	7	7	0	4	7	8	7	8	7
Buzau	BZ	5	5	4	2	4	5	3	3	2	2	0	0	5	2	8	0	1	9
Brasov	BV	6	7	7	3	7	8	9	8	5	8	0	0	7	7	4	3	6	2
Botosani	BT	7	5	2	0	2	4	1	2	8	2	0	0	3	7	8	0	1	5
Braila	BR	3	4	3	1	3	2	3	4	2	3	0	3	4	3	3	0	1	3
Bistrita-Nasaud	BN	8	3	2	0	2	2	3	3	1	3	0	0	7	3	4	0	1	8
Bihor	BH	6	7	6	1	6	4	8	7	3	6	2	0	7	5	7	4	4	5
Bacau	BC	5	8	6	0	5	5	3	4	2	4	5	0	4	5	6	3	2	6
Arad	AR	6	5	5	2	5	6	5	4	5	6	1	0	7	3	4	3	5	7
Arges	AG	6	7	7	4	7	4	6	4	1	5	0	0	4	7	10	3	3	4
Alba	AB	4	4	4	2	4	7	3	3	10	4	0	0	4	6	9	3	1	6
Vrancea	VN	9	4	2	0	2	6	2	2	4	2	0	0	4	8	6	0	1	10
Bucharest	B	8	10	10	10	10	4	9	9	5	10	10	0	10	10	7	10	10	2

Source: The data in the table were determined by the authors based on the information from the National Institute of Statistics by their own calculations and by using the statistic support of the program ArcGIS 10.2

Using the above-mentioned formulas, the values of the indices were calculated (Table 2).

The values of the indices corresponding to domains and of the polycentricity index for the counties in Romania

Table 2

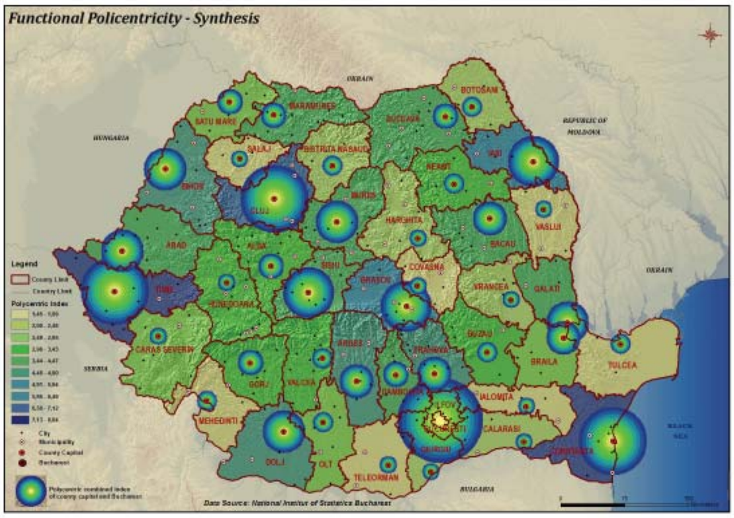
Name of the county	Code of the county	*A*	*B*	*C*	*D*	*E*	Polycentricity index
Vaslui	VS	3.90	0.90	2.40	2.60	0.00	1.86
Valcea	VL	3.80	2.50	6.45	2.35	1.35	2.95
Teleorman	TR	2.85	1.70	1.20	2.10	1.05	1.86
Timis	TM	8.50	8.10	5.90	4.65	6.80	7.07
Tulcea	TL	1.45	1.40	3.45	1.60	0.00	1.45
Suceava	SV	7.10	3.30	5.75	3.15	2.50	4.15
Satu Mare	SM	3.65	2.50	3.45	2.50	2.05	2.76
Salaj	SJ	1.60	1.40	2.35	2.70	1.35	1.79
Sibiu	SB	4.65	4.80	5.90	2.30	4.65	4.36
Prahova	PH	7.70	5.40	6.45	2.25	2.50	4.90
Olt	OT	3.85	3.40	1.60	2.30	1.15	2.75
Neamt	NT	4.95	2.50	4.35	1.85	1.85	2.95
Mures	MS	5.80	4.20	6.10	3.35	3.75	4.47
Maramures	MM	5.45	3.40	4.55	1.60	2.50	3.43
Mehedinti	MH	1.65	1.10	2.90	2.20	0.75	1.56
Iasi	IS	8.15	5.80	4.50	3.50	7.55	5.94
Ialomita	IL	2.10	1.30	2.90	2.25	0.55	1.70
Ilfov	IF	5.10	5.90	2.95	3.70	1.85	4.40
Harghita	HR	3.10	1.70	4.85	1.70	0.95	2.18
Hunedoara	HD	4.05	3.30	3.90	2.10	1.90	3.06
Giurgiu	GR	2.60	2.40	1.75	2.30	0.00	1.99
Galati	GL	6.00	4.70	2.70	3.45	3.85	4.38
Gorj	GJ	4.30	3.70	3.40	2.45	1.65	3.23
Dolj	DJ	6.85	4.90	3.00	2.45	4.65	4.57
Dambovita	DB	5.65	4.70	3.35	2.25	2.40	3.92
Covasna	CV	1.90	0.90	4.55	1.55	0.85	1.59
Constanta	CT	8.00	7.00	8.85	6.75	5.55	7.12
Caras-Severin	CS	2.85	2.90	4.90	1.70	1.55	2.65
Calarasi	CL	2.80	2.50	1.00	3.00	1.15	2.31
Cluj	CJ	7.85	6.60	5.70	4.55	7.55	6.49
Buzau	BZ	4.65	3.70	2.55	1.85	1.45	3.07
Brasov	BV	6.85	6.30	7.90	2.50	4.55	5.55
Botosani	BT	4.25	1.80	2.40	2.30	1.05	2.34
Braila	BR	3.50	2.50	3.25	2.25	0.85	2.48
Bistrita-Nasaud	BN	3.40	1.60	2.80	1.90	1.35	2.10
Bihor	BH	6.50	4.80	6.45	3.10	4.10	4.86
Bacau	BC	6.85	4.00	3.60	3.45	2.75	4.23
Arad	AR	5.15	4.50	5.00	2.20	4.50	4.22
Arges	AG	6.85	6.10	4.45	2.65	3.10	4.95
Alba	AB	4.00	3.90	4.05	2.40	2.20	3.38
Vrancea	VN	4.05	2.00	2.20	2.40	1.55	2.44
Bucharest	B	9.70	9.40	8.95	6.70	9.20	8.84

Source: The data in the table were determined by the authors based on the information from Table 1 by their own calculations

Based on our own methodology above mentioned and with the assistance of the program ArcGIS 10.2 we obtained the cartogram of the polycentricity index (Map 1).

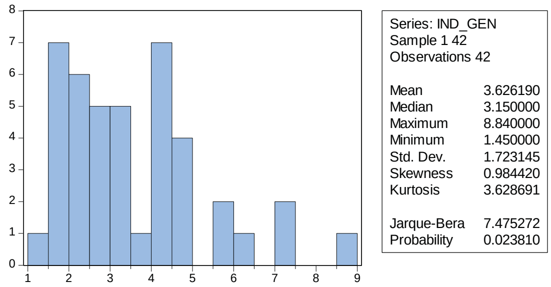
The polycentricity index of counties in Romania

Map 1



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

Analyzing the results obtained (Map 1 and Table 2), we find that there are little territorial units NUTS 3 which have a higher polycentricity index (including the indices corresponding to more domains): Bucharest (8.84), Constanta (7.12) and Timis (7.07). In this ranking, follows three counties, spaced between each other and from the other three in terms of index values in the following order Cluj, Iasi and Brasov. Further, we find a group of counties with polycentricity indices ranging between 4.5 and 5: Arges, Prahova, Dolj, Bihor. At the same time, we note that there are several counties with low values of indices corresponding to domains and with a very low polycentricity index, less than 2: Giurgiu, Vaslui, Teleorman, Ialomita, Salaj. Last in the ranking of polycentricity are Covasna (1.59), Mehedinti (1.56) and Tulcea (1.45). All these counties with small polycentricity index will have difficulties in the future socio-economic development, which will be a disadvantage for Romania in achieving the objective of territorial cohesion. As we stated earlier, the Gini coefficient ranges between zero for perfect equality and $(n-1)/n = (42-1)/42 = 0.9762$ for perfect inequality. The Gini coefficient of the polycentricity index of counties has the value of 0.2562, meaning that this index does not differ too much from one county to another. Concerning the distribution of the polycentricity index series, we have the following information, provided by the soft EViews 9.0:



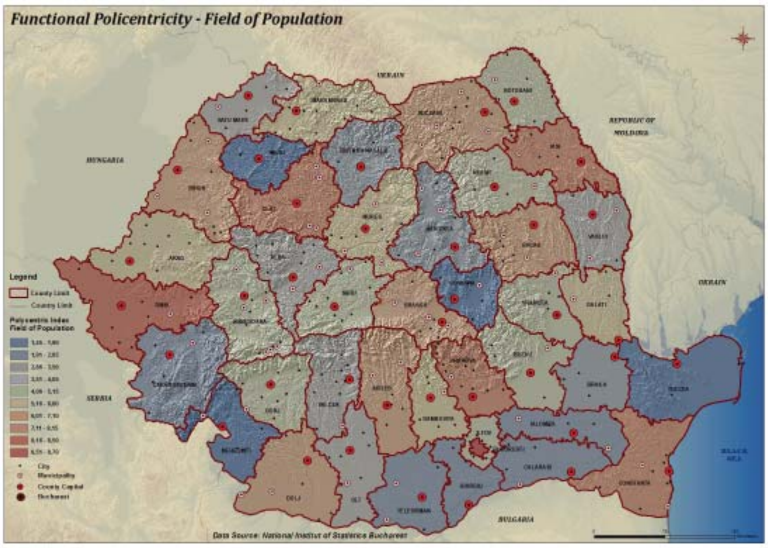
Among the elements provided by the output, only a few are of interest for our study. Thus, the mean polycentricity index is of 3.63, and the skewness has the value of 0.98 (between 0.5 and 1), which means that the distribution is moderately skewed to the right (more values are concentrated on left of the mean, with extreme values to the right). Therewith, the probability value associated with the Jarque-Bera statistic is 0.0238, less than 0.05 which means that we reject the null hypothesis of normal distribution.

Population domain

For the population index we performed the following cartogram with the assistance of the program ArcGIS 10.2

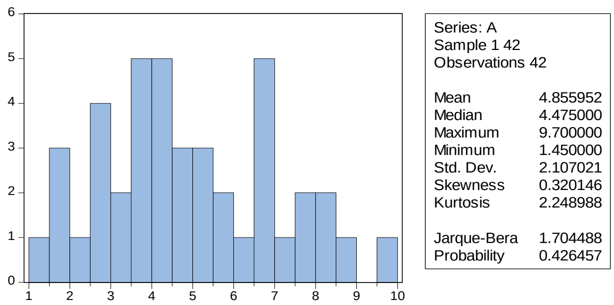
The population index at the level of counties in Romania

Map 2



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

By analyzing the above cartogram we note that Bucharest and most counties in which big cities are located: Timis, Iasi, Constanta, Cluj and even Prahova (due to the high degree of urbanization of the county) have an increased index of population, in line with the values expressed at European level for Metropolitan European Growth Area. The counties with a relatively high population index are: Suceava County, Brasov, Bacau and Arges. Also, a significant population index belongs to the counties of Bihor, Galati (in particular, due to the volume of population), Mures (especially due to GDP). In contrast, with an low index of population, are the counties of Caras-Severin, Teleorman (especially because of GDP), Calarasi, Giurgiu, Ialomita, the last being Covasna County, Mehedinti, Salaj and Tulcea counties with populations lower than the national average. Gini coefficient of the population index has the value of 0.2442, which shows that in the distribution of population there are not too big differences from one county to another. **Descriptive Statistics** shows us the following information on the distribution of the population index series:



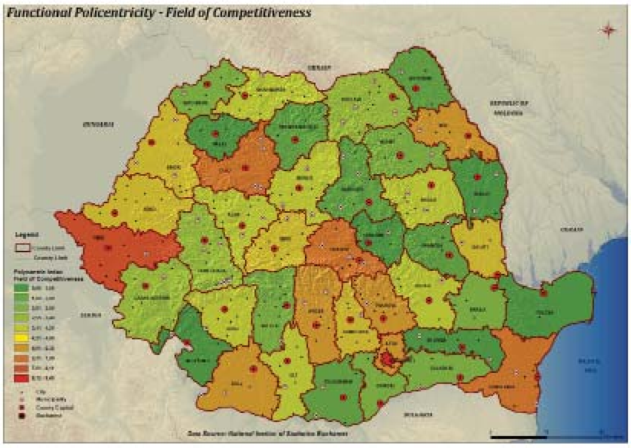
Thus, the mean population index is 4.86, much higher than the mean polycentricity index (3.63). The value of skewness is 0.32 (between 0 and 0.5) which means that the distribution is approximately symmetric. Hence many population index values are concentrated around the average index. We also note that the average variation of the index value against the mean population index, expressed as standard deviation (Std. Dev.), is high enough (2.11).

Economic domain

For the economy index we have the following cartogram:

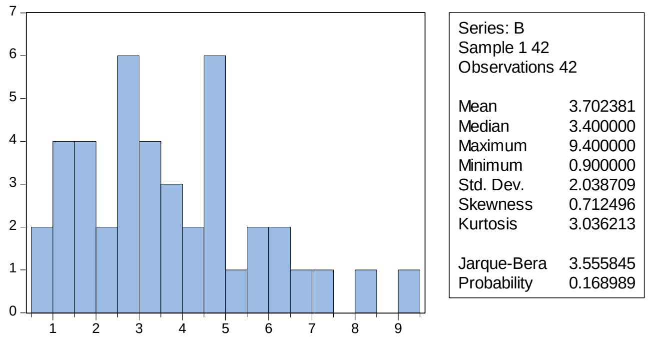
The economy index at the level of counties in Romania

Map 3



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

By analyzing the above map there are highlighted the economic disparities between counties. In the economic domain hierarchy the Municipality of Bucharest emerges with a very high index, both because of the GDP per capita and because of the localization of most companies in the top 100 companies in Romania. Timis County follows Bucharest in the ranking, with such advantages as the GDP per capita, the ascending evolution of the GDP and the existence of numerous companies in the top 100 companies in Romania in the county. Further, it is Constanta, Cluj and Brasov, with such advantages as the GDP per capita above the average for the country and an ascending evolution of the GDP in recent years. On the other steps below we find Arges, Ilfov, Iasi, Prahova, Dolj Counties, with a high industrial potential and the presence of companies in the top 100, but with a sinuous evolution of GDP in recent years (except in Iasi County). The ranking continues with counties that are rising in terms of the competitiveness level, such as the counties of Bihor and Sibiu and with industrialized counties in stagnation or even declining as Dambovita and Galati. At the opposite end, we find southeastern counties, counties of Moldova and Transylvania, such as Bistrita-Nasaud, Salaj, Covasna Counties. Also, it appears that the industrialized counties in a forced manner under the communism will have difficulties, depending economically on large industrial facilities, such as the case of Valcea, Galati, Hunedoara, Ialomita and even Mehedinti. Gini coefficient of the economy index has the value of 0.3036, which shows that nor in the distribution of economic development are there very big differences from one county to the other. Concerning the distribution of the economy index series we have the following results:



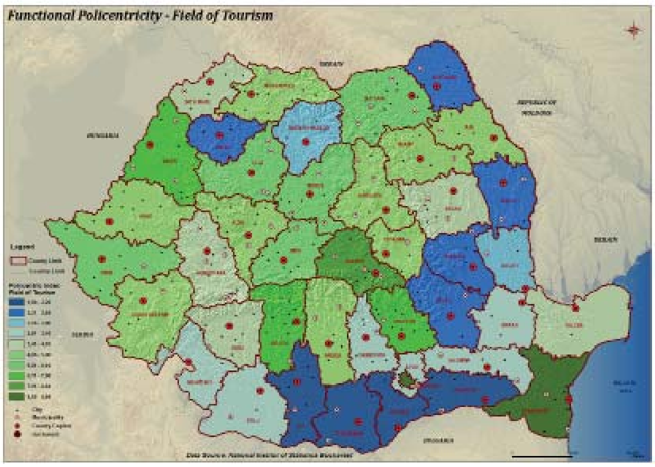
The mean economy index is 3.70, close in value to the mean polycentricity index (3.63). The value of skewness being 0.71 (between 0.5 and 1), the distribution is moderately skewed to the right (more values are concentrated on left of the mean, with extreme values to the right). At the same time, the values of the economy index vary in average enough consistently from the mean economy index, as the standard deviation (Std. Dev.) is of 2.04.

Tourism domain

For the tourism index, we performed the following cartogram.

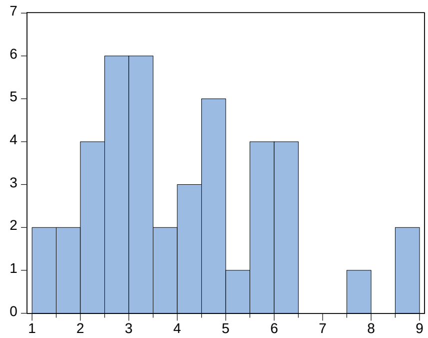
The tourism index at the level of counties in Romania

Map 4



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

Tourism index values clearly shows counties with high tourism potential and counties with low resources for tourism development. From the study of the map above, it appears that, at present, the greatest tourism potential belongs to Bucharest and Constanta county, followed by Brasov, which is ahead of Prahova, Bihor and Valcea. At the same time, we notice a group of counties that have a high tourism potential and an increasing trend of promoting it, which includes Mures, Timis, Sibiu, Suceava, Cluj and another group of counties that have a significant tourism potential, yet insufficiently exploited, consisting of Arad, Caras-Severin, Harghita, Maramures, Covasna, Iasi, Arges, Neamt and Alba. On one level below are the counties with high tourism potential, but unexploited, the most important being Tulcea, Gorj, Hunedoara and Bacau counties. The counties with low tourism potential are those in southeast Romania, which have significant problems in terms of competitiveness. Gini coefficient of the tourism index at the level of counties has the value of 0.2544, close to that of the Gini coefficient of the polycentricity index. In order to characterize the distribution of the tourism index series, we have the following data:



Series: C01	
Sample 1 42	
Observations 42	
Mean	4.159524
Median	3.750000
Maximum	8.950000
Minimum	1.000000
Std. Dev.	1.926017
Skewness	0.678083
Kurtosis	3.010368
Jarque-Bera	3.218761
Probability	0.200011

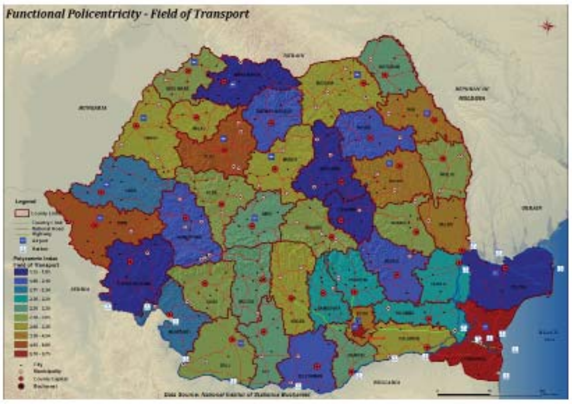
The mean tourism index is 4.16, higher than the mean polycentricity index (3.63). The distribution is moderately skewed to the right, because skewness has the value 0.68 (between 0.5 and 1). Therefore, the series has several values close to average but lower than the average and large extreme values. At the same time, because standard deviation (Std. Dev.) is 1.93, the series values are spread enough against the mean tourism index.

Transport domain

The soft ArcGIS 10.2 generated the cartogram of the transport index at the level of counties in Romania (Map 5).

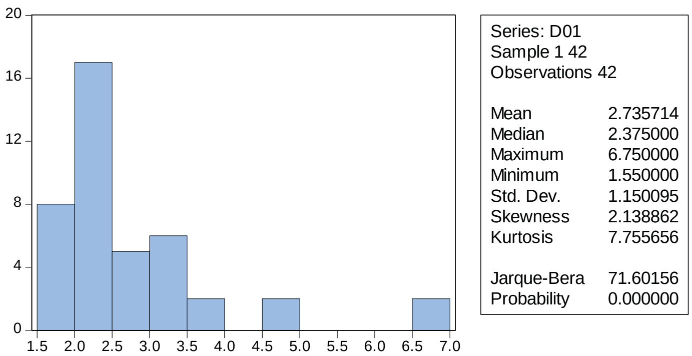
Transport index at the level of counties in Romania

Map 5



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

As seen from the analysis of the transport index map, a very good position in the ranking of this index have the county of Constanta, Municipality of Bucharest, Timis County, Cluj county, due to the relatively high densities of national roads and railways, and the presence of international airports with a flow of passengers of over 1 million - for Bucharest, Cluj and Timis counties and the presence of the port with European goods transit - for Constanta County. The following places of the hierarchy are held by counties with a high density of roads and railways and international airports with an average flow of passengers at national level in their territory, namely Ilfov, Iasi, Galati (which has the advantage of the port of Galati) and Bacau. Other counties with a high transport domain index are: Mures, Suceava, Bihor (which also have international airports) and Calarasi (due to the flow of goods from the port of Calarasi) Salaj (with high density of public roads and railroads), Arges. Counties with low transport index are: Caras-Severin, Harghita, Covasna and even Tulcea and Maramures, where there are international airports Gini coefficient of the transport index at the level of counties has the value 0.1957, the least of the values of the Gini coefficient of these indices. The distribution of the transport index series is characterized by the following elements:



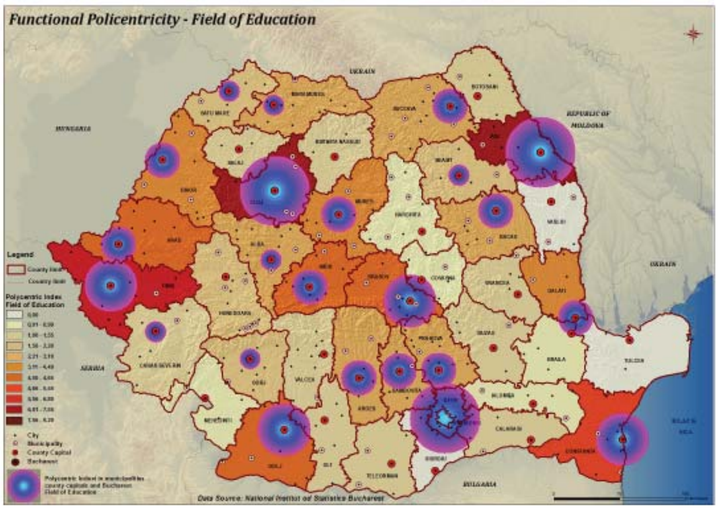
The mean transport index is 2.74, much less than the mean polycentricity index (3.63). Moreover, this index ranges from 1.55 to 6.75, and the size of this interval is less than the intervals size of other indices. Because skewness has the value 2.14 (greater than 1), the distribution is highly skewed to the right i.e. a lot of values are concentrated on left of the mean, with extreme values to the right. Therewith, the probability value associated with the Jarque-Bera statistic is less than 0.05 which means that we reject the null hypothesis of normal distribution.

Education domain

For the education domain we performed the following cartogram.

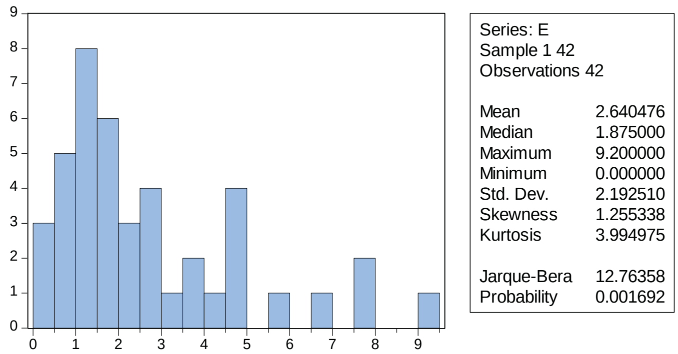
The education index at the level of counties in Romania

Map 6



Source: Performed by the authors based on the data from Table 2 by using ArcGIS 10.2

Analyzing the cartogram of the education index it results that Bucharest tops the hierarchy of the index, due to the large number of universities and number of students and that the counties below are Iasi and Cluj for the same reasons. Next, we find the counties whose homes are large university centers, namely Timis, Constanta, Sibiu, Dolj and Brasov. A relatively high education index have the counties of Arad, Bihor, Galati, Mures, Arges, Bacau, Prahova, Suceava and Maramures. The counties with the lowest education index are Harghita, Braila (even if Braila is a city with historical resonance), Covasna Mehedinti and Ialomita. At the bottom of the ranking is included Tulcea, Vaslui and Giurgiu, where the national statistics registers no student. Gini coefficient of the education index has the value 0.4317, which shows that the differentiation between counties in this domain is bigger. Concerning the distribution of the education index series we have the following information:



The mean education index has the value 2.64, the least of the mean indices values. The distribution is highly skewed to the right because the skewness has the value 1.26 (greater than 1). Standard deviation (Std. Dev.) being 2.19, the values of the education index vary in average much enough in comparison with the mean education index. Since the *p*-values (Probability) for the Jarque-Bera test is less than 0.05 we reject the null hypothesis of normal distribution.

Conclusions

The polycentricity of locations systems is considered to be a factor supportive of territorial sustainability as well as of decreasing territorial disequilibrium. The territorial units NUTS 3 can be assimilated to a certain extent to functional urban areas. For such reasons, the study of counties polycentricity acquires a great importance. For all indices calculated prevail low values which means that most of the counties have a low development level concerning polycentricity and each of the domains. Taking this into account, the long-term development strategy in the field of spatial and urban planning in Romania must develop integrated projects for those areas facing difficulties. All the same, central and local authorities must work together in order to create conditions for direct investments and implicitly a higher capital contribution, so as to achieve the objectives of the European Union Strategy, for the period 2014-2020 on the policy of territorial cohesion. The results obtained related to the degree of polycentricity at the level of territorial units NUTS 3 in Romania are not exhaustive but they rather represent a useful exercise to reach some conclusions about the current situation and a possible evolution of counties and to highlight their typology through the areas studied. More accurate evaluations of the domains indices and thus of the polycentricity index might get by converting the results for indicators into utilities using linear functions (Manole *et al*., 2011). Also, the differentiation of counties could be achieved by determining intensity of preference for each county with the help of PROMETHEE methods (Brans and Mareschal, 2005) or by establishing some out-rating relations between counties with the help of ELECTRE methods (Milani *et al*., 2006).

References

1. Brans, J. P., Mareschal, B. (2005) PROMETHEE methods, *Multiple criteria decision analysis: state of the art surveys*, 78, pp.163-186

2. Buchan, I. (2002) *Calculating the Gini coefficient of inequality*, Northwest Institute for BioHealth Informatics, available at https://www.nibhi.org.uk/Training/Forms/AllItems.aspx?RootFolder=%2FTraining%2FStatistics&FolderCTID=&View={4223A4850-B4790-4965-4285DBD4220A4841A5430B}. (accessed on 20 July 2015)

3. Camagni, R., Gibelli, M. C., Rigamonti, P. (2002) Urban mobility and urban form: the social and environmental costs of different patterns of urban expansion, *Ecological economics*, 40(2), pp. 199-216

4. Comisia Europeană (2010) *Europa 2020. O strategie europeană pentru o creştere inteligentă, ecologică şi favorabilă incluziunii*, Bruxelles, available at http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=COM:2010:2020:FIN:RO:PDF. (accessed on 25 July 2015)

5. Davoudi, S. (2003) Polycentricity in European Spatial Planning: From an Analytical Tool to a Normative Agenda, *European Planning Studies*, 11(8), pp. 979-999

6. European Spatial Development Perspective (ESDP) (1999) *Towards Balanced and Sustainable Development of the Territory of the European Union*, Luxembourg, Office for Official Publications of the European Communities, available at http://ec.europa.eu/regional_policy/sources/docoffic/official/ reports/pdf/sum_en.pdf. (accessed on 2 August 2015)

7. ESPON (2004) *ESPON 1.1.1. Potentials for polycentric development in Europe*, Luxembourg, ESPON Monitoring Committee, available at http://www.espon.eu/mmp/online/website/content/ projects/259/648/file_1174/fr-1.1.1_revised-full.

pdf. (accessed on 26 July 2015)
8. Kloosterman, R. C., Musterd, S. (2001) The Polycentric Urban Region: Towards a Research Agenda, *Urban Studies*, 38(4), pp. 623-633
9. Halffman, W., Leydesdorff, L. (2010) Is inequality among universities increasing? Gini coefficients and the elusive rise of elite universities, *Minerva*, 48(1), pp. 55-72
10. Manole, S. D., Petrişor, A. I., Tache, A., Pârvu, E. (2011) GIS Assessment of Development Gaps Among Romanian Administrative Units, *Theoretical and Empirical Researches in Urban Management*, 6(4), pp. 5-19
11. Meijers, E., Sandberg, K. (2008) Reducing regional disparities by means of polycentric development: panacea or placebo?, *Scienze Regionali*, 2008(Suppl. 2), pp. 71-96
12. Milani, A. S., Shanian, A., El-Lahham, C. (2006) Using Different ELECTRE Methods in Strategic Planning in the Presence of Human Behavioral Resistance, *Journal of Applied Mathematics and Decision Sciences*, 2006, 1–19, pp. 12-31
13. Ministerul Dezvoltării, Lucrărilor Publice şi Locuinţelor (2008) *Conceptul Strategic de Dezvoltare Teritorială – România 2030*, available at http://www.mdrl.ro/_documente/publicatii/2008/ Brosura%20Conc_strat_dezv_teritoriala.pdf. (accessed on 29 July 2015)
14. Veneri, P., Burgalassi, D. (2012) Questioning polycentric development and its effects. Issues of definition and measurement for the Italian NUTS-2 regions, *European Planning Studies*, 20(6), pp. 1017-1037
15. Wegener, M. (2013) Polycentric Europe: More efficient, more equitable and more sustainable?, *International Seminar on Welfare and competitiveness in the European polycentric urban structure, Florence* (Vol. 7)