The impact of urban concentration on countries' competitiveness and entrepreneurial performance

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Abstract

This paper aims to elaborate the role of Jacobs-type of agglomeration effects on countries' competitiveness and entrepreneurial performance. Our research allows for a better understanding of the relationship that exists between a country's urban system, characterized by spatial agglomeration (concentration) or deglomeration (deconcentration) processes, and its competitiveness and entrepreneurial performance.

Urbanization economies refer to considerable cost savings generated through the locating together of people, firms and organizations across different industries. It has recently become an axiom that the better performance of global cities (as they are important nodes of innovation and creativity) is derived from agglomeration effects. This general assumption follows that the more concentrated an urban system of a country, the more competitive and better its entrepreneurial performance. Even though this notion has gained quick and ardent acceptance from practitioners, the related literature shows contradictory results;this has induced a heated debate in academic circles, because it has raised serious doubts about the "bigger is better" theory. We hope to contribute to this debate with our detailed analysis.

To understand the impact of urban concentration, we selected 70 countries and calculated the so-called ROXY Index measuring the degree of agglomeration or deglomeration in their urban systems. To exemplify country-level competitiveness, we applied the Global Competitiveness Index (GCI) while the Global Entrepreneurship and Development Index (GEDI) was used to demonstrate country level entrepreneurial performance. Using these indexes correlation and cluster analysis were designed to obtain understanding of the relationship between them.

Our analysis indicates that as urban concentration initially increases competitiveness, entrepreneurial performance also increases, but at a decreasing rate. Both of them eventually reaches a maximum, and then after a certain point decrease with further concentration. Therefore, the curve for this relationship is non-linear and folds back. This indicates that over- or under-concentration of the population within an urban system does not necessarily result in a better outcome. However, we should consider that a high concentration of population is only one important factor for competitiveness and entrepreneurial performance while other effects may exist.

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Introduction

It was the classical economist, Alfred Marshall (1920), who first identified the main characteristics and sources of location-specific economies of scale labelled in economic literature as *agglomeration* or *external economies*. Since that time, other researchers have actively been contributing to the further development of his theory. Today it is widely accepted that agglomeration economies refer to an increasing return of scale derived from the clustering of different or, on the contrary, similar and specific economic activities. Co-locating near other firms, organizations and people can result in an increased benefit from greater diversity and/or specialization. Some often mentioned reasons for these advantages are the following: (1) market size effect (demand side), (2) local skilled labour pool effect (supply side), (3) local non-traded inputs (e.g. special business services), as well as (4) tacit knowledge and spillover effects. Clustering of firms together at a location implies frequent personal contacts and social ties among local actors that facilitate the circulation of information among them. Hence, intense knowledge spillovers are fostered by the proximity of firms, thereby promoting their innovation activity, and ultimately resulting in higher profit. Local non-traded inputs refer to peculiar products or services whose provision can be very expensive. However, if there are many firms located together, the cost of such special products or services can be dispersed among them. Co-locating of many firms also goes hand in hand with the accumulation of a skilled workforce. In many sectors, the cost of searching and (re)training people can be extremely high and time-consuming, particularly in a rapidly changing environment. Therefore, easy access to a pool of skilled labour also benefits firms (Duranton–Puga 2004, Rosenthal–Strange 2004, Puga 2010, McCann 2013). Even though agglomeration economies can be classified in several ways, typically three major categories are distinguished: (1) benefits of *localization economies (Marshall – Arrow – Romer externalities)* are derived from the agglomeration of specialized firms across the same industrial sector, (2) *urbanization economies* (*Jacobs' externalities*) refer to cost savings generated through the locating together of people and firms across different industries, and (3) *internal economies of scale* results in a significant return because of the size of the firms (Parr 2002, McCann 2013). In this paper, we solely study the impact of urbanization economies on countries' competitiveness and entrepreneurial performance.

Nowadays, there is a widely held view that global cities and large urban areas perform better and grow faster than the others. First of all, the appearance of globalization, new information and communication technologies have given rise to the recognition that metropolis are the '*space of flows*' as they are important nodes of innovation and creativity (Castells 1996). According to a large extent of the literature, the better performance of big cities can be explained by the advantages of agglomeration economies. Several theoretical and empirical studies have affirmed that agglomerations associated with a high density of economic activity does matter for productivity and economic growth (e.g., Chinitz 1961, Glaeser et al. 1992, Ellison and Glaeser 1997, Ciccone and Hall 1996, Ciccone 2002, Henderson 2003a, Rosenthal–Strange 2003). Studies dealing with urbanization economies

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

ascertain that a doubling of city size results in a productivity gain of between 2 and 8 percent (see overview from Vreeker et al. 2009).

This general assumption follows that the more concentrated an urban system of a country, the more competitive and better its entrepreneurial performance. For instance, in his well-known theoretical general equilibrium model, Krugman explained the initial spatial concentration processes of economic activities by identifying the main reasons, and introduced a new stream in spatial economic science, the New Economic Geography (NEG). NEG interprets agglomeration economies as the outcome of three reasons: (1) increasing returns, (2) trade costs and (3) the demand for manufacturing products. Krugman's theory implies that production is prone to concentrate in a few regions, which will become populous and competitive (Krugman 1991, 2009). Despite the remarkable novelty of Krugman's theory, it does not give any satisfying answer about divergent regional growth (Acs–Varga 2002). Also, findings from empirical studies indicate the positive effect of urban concentration on entrepreneurial performance mainly measured by new firm formation rates. Highly populated urban areas offer more opportunity for entrepreneurial success, because they can provide firms with a large consumer base, relatively cheap physical infrastructure, tacit knowledge, special services or a skilled workforce., therefore new firms prefer highly urbanized areas (Reynolds et al. 1994, Acs–Armington 2004, Van Stel–Suddle 2008, Knoben et al. 2011).

The 'bigger is better' notion has gained quick and ardent acceptance from practitioners, particularly from policymakers. Consequently, many EU territorial strategic concepts support the same view, viz. metropolitan areas are the most important drivers of European competitiveness, even if only a few studies *unambiguously* prove a positive contribution from agglomeration effects on economic growth. In fact, the majority of studies have highlighted contradictory results. *De facto*; there are some papers that support the view that urbanization economies tend to increase with the size of the city and they have a positive impact on economic growth; on the other hand, other studies have found no clear evidence that urbanization economies would generate growth (David et al. 2013). Then, there are some other studies that may explain these contradictory results. Findings of these papers refer to the negative effects of urban concentration, such as higher costs of skilled labour or higher rent for land, environmental contamination and severe congestion. Recent studies suggest that spatial competition (for qualified labour and other inputs), as a centrifugal force, can restrain the above-mentioned positive effect of urban concentration, possibly leading to a decrease in start-up rates and productivity growth (Rizov et al. 2012). Henderson (2003b) has estimated the impact of urbanization and urban concentration on productivity growth at the country level for the period between 1960 and 1990. According to his results, productivity growth is not strongly affected by urbanization, because *"urbanization is not a growth stimulus per se, is it a by-product"*, but there is a "*best degree of urban concentration in terms of maximizing productivity growth that varies with the level of development and country size*" (Henderson 2003b, p. 50). Consequently, both over- and under-concentration have negative effects on growth: "*City size affects positively the degree of local information spillovers, which interactively affects local knowledge accumulation, promoting productivity growth. However, cities of extensive size draw resources away from investment and innovation in productive activity to try to maintain the quality of life in a congested local environment.*" (Henderson 2003b, p. 67). According

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

to Duranton and Puga (2001, p. 1454) cities can be conceived as areas "*facilitating search and experimentation in innovation*". They also found evidence that under-sized cities have too little experimentation affecting productivity nationally, while over-sized cities waste excessive amounts of resources on other activities, which, drawing resources away from experimental activities, accordingly also inhibiting growth (Henderson 2003b). *David et al.* (2013) have systematically tested the relationship between city size (urban concentration) and the economic performance of cities in the European context. Their analysis also confirmed that the comparative advantage of cities also depends on the country in which they are located: *"In highly developed and densely urbanized areas, congestion effects might counteract the advantages of agglomeration. ... Hence, it may be that, in the dense Western part of Europe more than in the rest of Europe, the performances of the cities are more linked to their economic structures, their heritage, and the quality of their governance than to their size and centrality"* (David et al. 2013, p. 249). Castells-Quintana and Royuela (2014), in their study, explain that agglomeration (as urban concentration) fosters growth particularly in low-income developing countries, while urbanization has a positive effect on high-income developed countries. Since the large cities in Europe are highly urbanized areas, the positive link between urbanization and economic growth has already vanished. At the same time, dis-economies as congestion, pollution or high housing prices may have a negative effect. Consequently, economic growth in developed countries has been observed in small- and medium-sized cities, because of their intense urbanization: *"among the rich countries, twelve out of fifteen most entrepreneurial cities are small to medium-sized cities…"* (McCann–Acs 2012, p. 23).

In our study, we focus on the understanding of the relationship between a country's urban system characterized by spatial agglomeration (concentration) or deglomeration (deconcentration) processes and its competitiveness, as well as its entrepreneurial performance. The innovative component of our paper is that we demonstrate the impact of urbanization economies classified by the four stages of the spatial-cycle path on economic performance; and using a large sample of countries, a long time span and a method that has never been used for such purpose. Our results are consistent with other studies' findings related to the emerging literature on the limits of agglomeration.

We selected 70 countries and calculated the "ROXY Index", measuring the degree of agglomeration or deglomeration in their urban system. To exemplify country-level competitiveness, we applied the Global Competitiveness Index (GCI) while the Global Entrepreneurship and Development Index (GEDI) was used to demonstrate country level entrepreneurial performance.

The remainder of this paper is organized in the following fashion. First, the descriptions of the employed indexes (GEDI, GCI and ROXY) are reviewed (Section 2.1). We then describe the data and analysis methodology in Section 2.2. Our results are reported in Section 3. Finally, a concluding summary and discussion is provided in Section 4.

Data and methodology

In this section, we summarize the applied indexes and methodology. We employed three indexes for the analyses: (1) the *Global Competitiveness Index* (GCI) as a comprehensive tool to characterize country-level competitiveness, (2) the *Global Entrepreneurship and*

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Development Index (GEDI) as a composite indicator of entrepreneurship performance, and (3) as a third index the *ROXY Index,* which indicates the direction and size of population changes (concentration or deconcentration processes) within an urban system. We conducted correlation and cluster analysis to understand the relationship between urban concentration/deconcentration trends and economic performance.

Measuring country-level competitiveness and entrepreneurship

Since 2004, the yearly published Global Competitiveness Report – developed by the World Economic Forum (WEF) – ranks countries according to their competitiveness based on a composite indicator, the "*Global Competitiveness Index"* (GCI). According to the WEF, competitiveness can be defined *"as the set of institutions, policies, and factors that determine the level of productivity of a country"* (Schwab 2013, p. 4). Therefore, GCI builds up from many different indicators that characterize the institutions, productivity or policies of countries. Altogether 12 pillars are created from the identified set of indicators, which can be divided into three sub-indexes[1]: "basic requirements"(4 pillars), "efficiency enhancers" (6 pillars) and "innovation and sophistication factors" (2 pillars). The three sub-indexes are calculated by using weights that express the development level of a country's economy. Three development categories are used by WEF: factor-driven, efficiency-driven and innovation-driven economies. The involved countries are grouped into five groups, which are determined by the three development levels and two transition stages. Finally, the GCI Index is composed of the weighted average of the three sub-indexes. In our research, we used data derived from several GCI reports over the period 2006–2014.

The Global Entrepreneurship Development Institute lead by Zoltan J. Acs and László Szerb developed the *Global Entrepreneurship Index* (GEDI). The GEDI Index is a composite index that measures productive entrepreneurship in a multidimensional way. It examines the connection between entrepreneurship and economic development and provides policy recommendations regarding economic policies (Szerb et al. 2013). The basic idea of the GEDI Index is based on the theory of the National System of Entrepreneurship that "(…) *is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures*" (Acs et al. 2014, p. 479). The index builds on individual data derived from the Global Entrepreneurship Monitor (GEM) Adult Population Survey. It focuses not only on the process of business creation but also captures the qualitative aspects, the 'institutional context' of the country. The index consists of three sub-indexes (attitudes, abilities, aspirations), and each sub-index has four or five pillars. The GEDI pillars are determined by a complex method and indicate the combined effect of individual and institutional data.[2]

1 The whole descriptions of GCI sub-indexes and pillars are available in the 2013–14 edition of the Global Competitiveness Report: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf

2 The whole description of GEDI sub-indexes and pillars are available in the latest GEDI book: Zoltan J. Acs et al. (2013): *Global Entrepreneurship and Development Index*. Edward Elgar Publishing.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

To express urbanization economies, we calculated the ROXY Index[3], which is *"an indicative instrument to quantitatively identify the major stages of the spatial cycles. This index can be used in conducting both of the intra- and inter-city analysis to study the spatial agglomeration and deglomeration processes"* (Fukatsu – Kawashima et al. 1999, p. 395). The ROXY Index captures the effect of migration through the periodic change of the population. It measures the change in population by a weighted average growth ratio and by a simple average growth ratio (see the formula below).

$$ROXY\ Index = \left(\frac{WAGR_{t,t+1}}{SAGR_{t,t+1}} - 1{,}0\right) * 10^4 = \left\{\frac{\sum_{i+1}^{n}(x_i^t * r_i^{t,t+1})}{\sum_{i=1}^{n} x_i^t} * \frac{n}{\sum_{i=1}^{n} r_i^{t,t+1}} - 1{,}0\right\} * 10^4 \qquad (1)$$

where: x^t_i = population of city "i" in year "t", $r^{t,\,t+1}_i$ = annual growth ratio of population in city "i" for the period between years "t" and "t+1", which is defined as the "k"th root of x_i^{t+k}/x_i^t, n = number of cities, $WAGR_{t,\,t+1}$ = weighted average of annual growth ratios of population "n" cities for the period between years "t" and "t+1", which is equal, in the case where population level of each city is used as a weighting factor, to $\sum(x_i^t * r_i^{t,t+1})/\sum x_i^t$, $SAGR_{t,\,t+1}$ = simple average of annual growth ratios of population in "n" cities for the period between years "t" and "t+1", which is equal to

$$\sum r_i^{t,t+1}/n$$

Marginal value of the ROXY Index (ΔROXY)

$$\Delta ROXY = \frac{ROXY\ Index_{(t+1,t)} - ROXY\ Index_{(t,t-1)}}{Cf} \qquad (2)$$

where: ROXY $Index_{(t+1,t)}$ = the value of ROXY Index for period "t", ROXY $Index_{(t,\,t-1)}$ = the value of ROXY Index for period "t-1", Cf = the difference between the mid-point time for "t" period and the mid-point time for "t-1" period (*Source*: Kawashima et al. 1997, p. 221 and Fukastu – Kawashima 1999, p.407.).

The index is based on the spatial-cycle hypothesis originally conceptualized by *Klaassen* (1979, 1981). Klaassen differentiated four stages of the spatial-cycle path: Stage 1 – Accelerating concentration, Stage 2 – Decelerating concentration, Stage 3 – Accelerating deconcentration and Stage 4 – Decelerating deconcentration (Kawashima et al. 1997). The first version of the ROXY Index was published in an empirical study written by Kawashima (1978). Since then, the index has been developed further and used in numerous empirical studies to identify the spatial agglomeration – deglomeration phenomena associated with the changes in population or other social and economic variables (see Kawashima 1982, 1985, 1986, Hirvonen et al. 1997, Fukatsu–Kawashima 1999).

According to the size and direction of the ROXY Index, four hypothetical stages of the spatial-cycle process can be distinguished. The positive value of the ROXY Index indicates concentration while the negative value shows deconcentration. The direction of change depends on the value of ΔROXY: if it is positive, there is an accelerating concentration or decelerating deconcentration; if it is negative, it indicates an accelerating deconcentration or decelerating concentration (Table 1).

3 ROXY means "**R**atio **o**f *Weighted Average Growth Ratio* (abbreviated as **X**) to *Simple Average Growth Ratio* (abbreviated as **Y**)" (*Kawashima* 1985)

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table 1

The characteristics of different stages of urbanization

Stages of urbanization	The size and direction of change
AC (accelerating concentration)	positive ROXY value, ΔROXY positive
DC (decelerating concentration)	positive or negative ROXY value, ΔROXY negative
DD (decelerating deconcentration)	negative or positive ROXY value, ΔROXY positive
AD (accelerating deconcentration)	negative ROXY value, ΔROXY negative

Source: own compilation based on Kawashima et al. 1997.

There are two crucial points in the computation of the ROXY Index: (1) the length of the examined period and (2) the number of cities that are involved in the examination. Therefore, we tried to find a rule or concept that could help us identify the most important cities of each examined country. However, data like GDP, which could represent the most important cities in a country, are available for only a few countries at the city level. After reviewing some of the relevant literature (see Gabaix 1999; Eeckhout 2004; Tabuchi et al. 2005; Czaller 2012), we realized that although the problem of determining the adequate number of cities is known, no clear solution exists. Therefore, we decided to analyse three cases and conducted the analysis for the first 20, 30 and 40 most populated cities of the 70 countries. It was important to be aware that the sample contained very different countries with regard to their size. Thus, examining an urban system with less than 20 cities was considered too small; on the other hand, in the case of some countries, it was not possible to examine their urban systems with more than 40 cities, because data were not available. The three mentioned cases may also serve as a robustness check of the results.

The other important factor to calculate the ROXY Index is the time period in which the index indicates the agglomeration or deglomeration trends. Therefore, we used the three latest available data of city populations. Thus, we created two periods ($ROXY_t$ and $ROXY_{t-1}$) and calculated the ΔROXY that shows the direction and scale of the change. Our original idea was that the time periods used by the GEDI/GCI Index would be considered by the calculation of the $ROXY_t$ and $ROXY_{t-1}$ indexes. However, because of data availability, the first or last years, and also the lengths of the periods were not the same for the different countries (see Appendix Table A1).

Originally, we planned to carry out analyses for all the countries involved in the GEDI research during the examined period. It was altogether 76 countries, but we excluded some of them due to the lack of city population data. Thus, we could involve 70 countries. Our country set contains both developed and developing nations. Because of the lack of former city population data, it was not possible to calculate $ROXY_{t-1}$ for some countries (Jordan, Malaysia, Portugal and South Africa), hence we had to exclude them from the later examinations. In the case of the United Arab Emirates, city population data are available only for its nine biggest cities; therefore, only the ROXY20 was calculated for the available cities of the United Arab Emirates (UAE).

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Method

To examine the intensity and direction of the relationships among the indexes, we conducted correlation analysis. We carried out the correlation analyses separately for the two indexes – GCI and GEDI – using the three versions of the ROXY Index (ROXY20, ROXY30 and ROXY40). The analyses were not limited to the main indexes alone. We also analysed the relationships between the ROXY Index and the different sub-indexes of GCI and GEDI. Furthermore, those sub-indexes of GCI and GEDI that showed the highest correlation with the ROXY Index were also examined.

As a first step, we checked the characteristics of our descriptive statistics. GCI and GEDI did not require any data transformations, but a relatively high skewness was discovered considering the ROXY Index. We managed this problem with a transformation process. Many data transformation processes were checked that might solve the problem of skewness. The results of the correlation analysis with different transformation processes did not show significant differences. Hence, we decided to apply the Box-Cox transformation method, in the same way as Annoni–Kozovska (2010). Finally, the transformed ROXY Index data were rescaled to a scale from 0 to 10.

We endeavour to use not only the annual values of GEDI and GCI but also to represent the changes in their values during a given period as well. Therefore, we calculated the average value of both indexes for the whole period (GCI_AVE and GEDI_AVE). To catch the changes within the examined period, the changes from year to year were calculated and averaged for each country as well (GCI_CH and GEDI_CH). Finally, we multiplied the 'average values' with the 'change values' in the case of both indexes (GCI_AVG_CH and GEDI_AVG_CH). Then we rescaled both modified indexes to a scale from 0 to 10.

As a next step, K-means cluster analysis was conducted. First, the observed outliers were excluded from the analysis. The examination started with 66 countries in the case of ROXY20 (no available / t-1 / data for Jordan, Malaysia, Portugal and South Africa) and 65 countries in the case of ROXY30 and ROXY40 (no available / t-1 / data for Jordan, Malaysia, Portugal and South Africa and UAE). We used the original and transformed ROXY indexes in the cluster analysis as well. We tested different numbers of clusters (2, 3, 4, 5 and 6 groups). However, the results of the ANOVA test (the optimal F- and significance-values) indicated the need to create 3 clusters in the case of GCI with the original ROXY Index and 4 clusters with the transformed ROXY values, while countries were classified into 4 groups in the case of the GEDI Index using the transformed ROXY values. The tests proved that the groups are significantly different from each other at every significance level.

Results

Results of the examination: ROXY and GCI indexes

In this sub-section, we examine the intensity and direction of the relation between the GCI Index and the three version of ROXY Index. Table 2 contains both the original ROXY indexes for different pools of cities (ROXY20, ROXY30 and ROXY40) and also the three Box-Cox transformed and rescaled ROXY indexes (ROXY_BOXCOX_10).

According to the correlation analysis, there is a positive relationship between the ROXY and the GCI Index, but the intensity of this relationship is quite moderate, and it is significant only with the Box-Cox transformed ROXY indexes. The ROXY40_BOXCOC_10 variable and the GCI Index show the strongest correlation coefficient (r = 0.321). If we analyse the relationship between the ROXY Index and the three sub-indexes of GCI (BASIC – GCI Basic sub-index, EFF – Efficiency sub-index, INN – Innovation sub-index), the strongest correlation can be observed between the ROXY Index and the GCI Efficiency sub-index, but only a loose connection can be confirmed among them (r = 0.350). We can assume that concentration or deconcentration of the population within an urban system has a moderate effect on efficiency (Table 2). To investigate this presumption, we detach the relationship between the transformed ROXY Index and the different pillars of the GCI Efficiency sub-index (Table 3).

Besides the intensity of the connection, the direction is also very important. A positive correlation coefficient between the ROXY Index, the GCI Index and its sub-indexes means that *the more concentrated the population within a country's urban system, the higher the value of the GCI Index. Higher GCI value refers to the higher competitiveness of the country.*

Table 2

The correlation coefficients between the GCI Index, its sub-indexes and ROXY Index

ROXY INDEX *(original and transformed)*	GCI_(AVG_CH)	BASIC_(AVG_CH)	EFF_(AVG_CH)	INN_(AVG_CH)
ROXY20	0.187	0.187	0.220	0.139
ROXY30	0.216	0.211	0.242[a)]	0.154
ROXY40	0.218	0.210	0.241[a)]	0.153
ROXY20_BOXCOX_10	0.221	0.223	0.267[a)]	0.183
ROXY30_BOXCOX_10	0.295[a)]	0.279[a)]	0.347[b)]	0.261[a)]
ROXY40_BOXCOX_10	0.321[b)]	0.305[a)]	**0.350**[b)]	0.292[a)]

Note: BASIC = GCI "Basic" sub-index, EFF = GCI "Efficiency" sub-index, INN = GCI "Innovation" sub-index.
a) Correlation is significant at the 0.05 level (2-tailed). b) Correlation is significant at the 0.01 level (2-tailed).
Source: own calculations.

Table 3

The correlation coefficients between the pillars of GCI Efficiency sub-index and ROXY Index

Pillars of GCI Efficiency sub-index	ROXY20_BOXCOX_10	ROXY30_BOXCOX_10	ROXY40_BOXCOX_10
HT_(AVG_CH)	0.284[a)]	**0.362**[b)]	**0.363**[b)]
MEFF_(AVG_CH)	0.148	0.255[a)]	0.283[a)]
LEFF_(AVG_CH)	0.298	**0.404**[b)]	**0.382**[b)]
FIN_(AVG_CH)	0.112	0.192	0.206
TECH_(AVG_CH)	0.295[a)]	**0.385**[b)]	**0.396**[b)]
MSIZE_(AVG_CH)	0.143	0.108	0.095

Note: HT = Human capital pillar, MEFF = Market efficiency pillar, LEFF = Labour efficiency pillar, FIN = Financing pillar, TECH = Technological readiness pillar, MSIZE = Market size pillar, AVG = average, CH = change.
a) Correlation is significant at the 0.05 level (2-tailed). b) Correlation is significant at the 0.01 level (2-tailed).
Source: own calculations.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Efficiency sub-index group's pillars related to human capital, market efficiency, labour productivity, financing, technology readiness and market size. Three of the pillars – Human capital, Labour efficiency and Technology readiness – show positive medium-strength correlation coefficients with the transformed and rescaled ROXY Index (Table 3). The strongest connection is shown between the GCI Labour efficiency pillar and the transformed ROXY30 (r = 0.404). The positive coefficient means that *the higher the concentration in a country's urban system in a given period, the higher the labour efficiency, the technological readiness and the quantity of skilled human capital of the country.*

As a next step, we conducted cluster analysis for each county's urban system consisting of the first most populous 20, 30 and 40 cities, respectively. Determining the direction of change, we calculated the ROXY values for the previous period (t-1) to receive the ΔROXY. We carried out the cluster analysis with different cluster numbers (2, 3, 4, 5 and 6 groups). Using original ROXY values, the ANOVA analysis showed the best F-test values with 3 clusters (the interpretation of the clusters below or over 3 clusters was problematic). However, using the Box-Cox transformed ROXY values, the interpretation of 4 clusters seemed to be more appropriate (ANOVA analysis showed appropriate F-test values for both 3 and 4 clusters). Consequently, we present here the results of the cluster analysis for 3 and 4 clusters. According to the ANOVA test, the significance was lower than 0.05, proving that the clusters in terms of the variables differ from each other. Here, we only show the results of the cluster analysis conducted between the ROXY30 and GCI index (cluster analyses with ROXY20 and ROXY40 are available in the Appendix and serve as robustness checks).

As mentioned above, using the original ROXY Index, we could distinguish three clusters (Table 4). *Cluster 1* contains those countries whose urban system is characterized by a strong concentration trend represented with a high ROXY value (final cluster centre = 5.21). The results show that the competitiveness of those countries in which the urban system is highly concentrated is high (GCI final cluster centre = 5.33). It contains 11 countries characterized by the acceleration of concentration (AC), and 29 countries characterized by the deceleration of deconcentration (DD). *Cluster 2* consists of 12 countries, among them 9 characterized by the deceleration of deconcentration, but they are still in the deconcentration stage. This cluster generally contains countries in which the urban system is heading to a concentration from the deconcentration stage. This cluster is a transitional category. *Cluster 3* contains those countries in which the deconcentration of the urban system is accelerating (AD, ROXY final cluster centre = -168.86). According to the results of the analysis, *if deconcentration is strengthening, competitiveness will drop* (GCI final cluster centre = 2.63).

On the other hand, using the Box-Cox transformed ROXY Index, we could identify 4 clusters of countries (*Table 4*). An important difference compared to the 3 cluster case is that here, if a country's urban system is characterized *either by a strong concentration trend* (Cluster 1) *or by a strong deconcentration trend* (Cluster 4), *competitiveness will fall* (Cluster 1 – GCI final cluster centre = 2.77, Cluster 4 – GCI final cluster centre = 2.82). While if the county's urban system is in a transition stage – meaning it is not so concentrated, or not so deconcentrated – competitiveness will be more outstanding (Cluster 2 – GCI final cluster centre = 8.33, Cluster 3 – GCI final cluster centre = 4.57).

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table 4

Results of the cluster analysis: ROXY30 – GCI index

Final Cluster Centres	Cluster 1 *Concentration with generally high GCI values*	Cluster 2 *Deceleration of deconcentration with GCI values higher than the average*	Cluster 3 *Deconcentration with generally low GCI values*
Number of cases	45	12	5
ROXY 30	5.21	–55.51	–168.86
GCI	5.33	3.49	2.63
AC	*11*	-	-
DC	2 *(conc)*	-	1 *(deconc)*
DD	*29 (16 deconc, 13 conc)*	*9 (deconc)*	1 *(deconc)*
AD	3	3	*3*

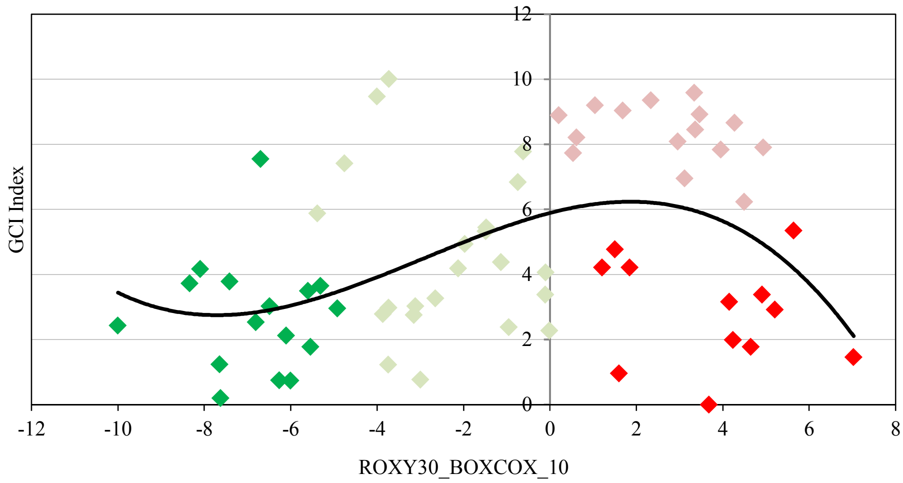
Final Cluster Centres	Cluster 1 *Concentration with generally low GCI value*	Cluster 2 *Acceleration of concentration with high GCI value*	Cluster 3 *Deceleration of deconcentration with high GCI value*	Cluster 4 *Deconcent-ration with generally low GCI value*
Number of cases	13	15	22	15
ROXY 30_BOXCOX	5.04	4.30	–2.02	–6.85
GCI	2.77	8.33	4.57	2.82
AC	*5*	*6*	–	–
DC	–	*2 (conc)*	–	1 *(deconc)*
DD	*7(conc)*	*7 (conc)*	*18 (deconc)*	*8 (deconc)*
AD	1	–	4	*6*

Notes: same as in Table 3.
Source: own calculation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Figure 1

Connection between GCI scores and ROXY30_BOXCOX



Note: green colour refers to countries where deconcentration is accelerating, light green colour refers to countries where deconcentration is decelerating while red and pink colours represent counties where concentration is accelerating or decelerating, respectively.

Source: own calculation.

The results of ROXY and GEDI examination

For the analysis, we used both the original index values (ROXY) and the Box-Cox transformed values (ROXY_BOXCOX_10). The original values represented a relatively high level of skewness; hence, the results of their examination should be taken into account with care. The analysis shows that there are positive relationships between the GEDI Index and the different ROXY indexes, but the intensity is moderate. We examined the relationships for the three sub-indexes of GEDI as well (ATT – Entrepreneurial Attitudes, ABT – Entrepreneurial Abilities, ASP – Entrepreneurial Aspirations). The Attitudes sub-index has the weakest while the Aspiration has the strongest relationship with ROXY indexes among the sub-indexes (Table 5).

Table 5

The correlation coefficients between the GEDI Index, its sub-indexes and ROXY Index

ROXY INDEX *(original and transformed)*	GEDI (AVGCH)	ATT (AVGCH)	ABT (AVGCH)	ASP (AVGCH)
ROXY20	0.309 [b)]	0.252 [a)]	0.278 [a)]	0.334 [b)]
ROXY20_BOXCOX_10	0.277 [a)]	0.198	0.264 [a)]	0.305 [a)]
ROXY30	0.328 [b)]	0.279 [a)]	0.297 [a)]	0.343 [b)]
ROXY30_BOXCOX_10	**0.355** [b)]	0.281 [a)]	**0.353** [b)]	0.358 [b)]
ROXY40	0.310 [b)]	0.246 [a)]	0.284 [a)]	0.335 [b)]
ROXY40_BOXCOX_10	0.335 [b)]	0.254 [a)]	0.316 [b)]	**0.360** [b)]

Notes: ATT = "attitudes", ABT = "abilities, ASP = "aspirations", AVG = average, CH = change
a) Correlation is significant at the 0.05 level (2-tailed). b) Correlation is significant at the 0.01 level (2-tailed).
Source: own calculation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

The analysis indicates the strongest correlation between the ROXY Index and GEDI in the case of ROXY30_BOXCOX_10 (r = 0.355). The lowest results were measured in the case of ROXY20 while the other two ROXY cases have almost the same scores. We can see almost the same results at the sub-indexes. The positive correlation coefficient between the ROXY indexes and GEDI means that *the more concentrated the population in a given country's urban system, the better the entrepreneurial performance there*. To discover more about the attributes of entrepreneurial aspirations, we analysed the pillars of this sub-index as well (Table 6).

Table 6

The correlation coefficients between the pillars of GEDI Aspiration sub-index and ROXY Index

Pillars of GEDI Aspirations sub-index	ROXY20_BOXCOX_10	ROXY30_BOXCOX_10	ROXY40_BOXCOX_10
ProdInnov_AVG_CH	0.191	0.230*	0.271*
ProcInnov_AVG_CH	0.257*	0.270*	0.317**
HGrowth_AVG_CH	0.307**	0.382**	0.346**
Internation_AVG_CH	0.268*	0.345**	0.326**
RiskCap_AVG_CH	0.246*	0.261*	0.261*

Notes: ProdInnov = "product innovation", ProcInnov = "process innovation", HGrowth = "high growth", Internation = "internationalization", RiskCap = "risk capital", AVG = average, CH = change

a) Correlation is significant at the 0.05 level (2-tailed). b) Correlation is significant at the 0.01 level (2-tailed).

Source: own calculation.

Almost all of the pillars of the Aspiration sub-index have a significant relationship with the different ROXY indexes, but two pillars are outstanding among them: High growth and Internationalization have the strongest correlation coefficients with the ROXY Index. It means that *the high growth (of firm size) and internationalization of firms are relatively dependent on the concentration or deconcentration of a country's population*.

The cluster analysis was carried out for each ROXY Index case (cluster analyses with ROXY20 and ROXY40 see the Appendix) with the GEDI Index. We applied the original ROXY Index for this examination. The ROXY30 cases showed the best correlation values with the GEDI Index and its sub-indexes. In this case, we used the data of 65 countries because it was not possible to involve the United Arab Emirates. The first results of cluster analysis helped us to filter the extreme values. There were altogether 7 countries that had extreme positive or negative values (Costa Rica, Dominican Republic, Ecuador, Guatemala, India, Panama and Zambia). Thus, 58 countries have been involved in this cluster analysis (Table 7).

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table 7

Results of cluster analysis: ROXY30 and GEDI Index

Final Cluster Centres	Cluster 1 *Concentration with generally low GEDI value*	Cluster 2 *Acceleration of concentration with high GEDI value*	Cluster 3 *Deceleration of deconcent-ration with high GEDI value*	Cluster 4 *Deconcent-ration with generally low GEDI value*
Number of cases	10	18	21	9
ROXY 30_BOXCOX	27.76	4.24	–10.31	–62.66
GEDI	39.35	69.40	41.07	31.78
AC	*5*	*5*	2	–
DC	–	*2 (conc)*	–	–
DD	*5(conc)*	*6 (conc)* *3 (deconc)*	*16 (deconc)* *2 (conc)*	*6 (deconc)*
AD	–	2	1	*3*

Source: own calculation.

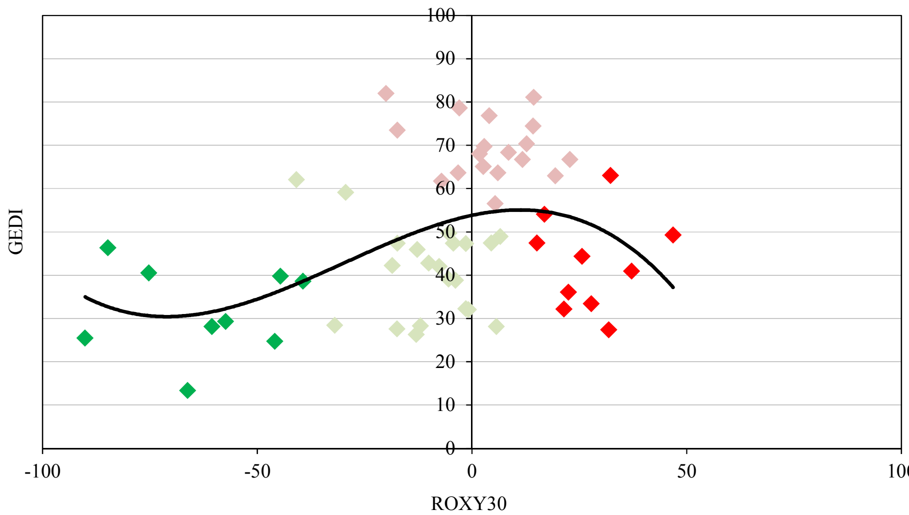
Cluster 4 contains those countries whose urban system is characterized by the acceleration of deconcentration or deceleration of deconcentration (but the cases typically remain in the deconcentration stage) represented with a relatively low ROXY30 and GEDI values (GEDI final cluster centre = 31.78). *Cluster 3* contains those countries where deconcentration is decelerating, but these countries are mostly still in the deconcentration stage. In this cluster, the GEDI Index is a bit higher than in Cluster 4 (GEDI final cluster centre = 41.07). Those countries have the highest GEDI values that belong to *Cluster 2* (GEDI final cluster centre = 69.4). This cluster can be characterized by the acceleration of concentration trends. This cluster contains countries in which the urban system is heading to a concentration from the deconcentration stage. This cluster is a transitional category: it shows the deceleration of deconcentration in counties that have already changed into the concentration stage (DD) or are still in the deconcentration stage (DC). The countries in *Cluster 1* have the highest ROXY30 values (final cluster centre = 27.76), but their GEDI values (final cluster centre = 39.35) are lower than countries in Cluster 2.

These results mean that those countries that show deconcentration trends have lower GEDI values than other countries characterized by concentration. However, this does not mean an obvious nexus between concentration and high entrepreneurial performance. It seems that concentration of the population has a positive effect on entrepreneurship, but on the other hand, *there is a threshold and after that, further concentration of the population may not improve the entrepreneurial performance, but has a negative effect on it* (Figure 2).

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Figure 2

The connection between the GEDI scores and ROXY30



Note: green colour refers to countries where deconcentration is accelerating, light green colour refers to countries where deconcentration is decelerating while red and pink colours refer to counties where concentration is accelerating or decelerating, respectively.

Source: own calculation.

Conclusions

The correlation analyses confirmed that *the more concentrated the population within a country's urban system, the higher its competitiveness and entrepreneurial performance*. This result seemingly supports the "bigger is better" concept. The correlation analysis has shown that the concentration or deconcentration of the population is *only one important factor* in the explanation of countries' entrepreneurial performance and competitiveness. This has been proven by the moderate correlation coefficients between the GCI/GEDI and ROXY indexes (both original and transferred). Consequently, we should consider that other effects may exist (e.g. differences in institutional settings, creativity and openness of human resources, culture).

However, in-depth analysis (conducting cluster analyses) confirmed that *relatively high-levels of concentration or deconcentration within an urban system are coupled with lower GCI/GEDI values*. Those countries have the highest GCI/GEDI values that have a ROXY Index value close to zero. It means that they have a moderate level of concentration (positive ROXY values) or moderate level of deconcentration (negative ROXY values). Our analysis indicates that, initially, as concentration increases (or deconcentration decreases) competitiveness and entrepreneurial performance also increase, but at a decreasing rate. Both of them eventually reaches a maximum and then after a certain point decrease with further concentration. Therefore, the curve that apprehends this relationship is non-linear and folding back. As follows, our results support the view that concentration is useful until a certain threshold, but excessive concentration could not help to improve

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

competitiveness or entrepreneurial performance. In other words, this indicates that *under- or over-concentration of the population within an urban system is not a useful phenomenon considering competitiveness or entrepreneurial performance*.

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REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

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REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Appendix

Table A1

The length of examined periods

Country	Period (t)	Period (t–1)	Country	Period (t)	Period (t–1)
Algeria	2008/1998	1998/1987	Jordan	2004/1994	no results
Argentina	2010/2001	2001/1991	Kazakhstan	2012/1999	1999/1989
Australia	2011/2006	2006/2001	Korea	2012/2002	2002/1997
Austria	2013/2001	2001/1991	Latvia	2013/2000	2000/1989
Bangladesh	2011/2001	2001/1991	Macedonia	2010/2002	2002/1994
Belgium	2013/2000	2000/1990	Malaysia	2000/1991	no results
Bolivia	2010/2001	2001/1992	Mexico	2010/2005	2005/2000
Bosnia Herzegovina	2013/1991	1991/1981	Montenegro	2011/2003	2003/1991
Brazil	2010/2000	2000/1991	Morocco	2004/1994	1994/1982
Canada	2011/2006	2001/1996	The Netherlands	2013/2000	2000/1990
Chile	2012/2002	2002/1992	Norway	2013/2000	2000/1990
China	2010/2000	2000/1990	Panama	2010/2000	2000/1990
Colombia	2010/2005	2005/1993	Peru	2007/1993	1993/1981
Costa Rica	2011/2000	2000/1984	Philippines	2010/2000	2000/1990
Croatia	2011/2001	2001/1991	Poland	2012/2002	2002/1992
Czech Rep	2011/2001	2001/1991	Portugal	2011/2001	no results
Denmark	2013/2000	2000/1990	Puerto Rico	2010/2000	2000/1990
Dominican Rep	2010/2002	2002/1993	Romania	2011/2002	2002/1992
Ecuador	2010/2001	2001/1990	Russia	2013/2002	2002/1989
Egypt	2006/1996	1996/1986	Saudi Arabia	2010/2004	2004/1992
Finland	2012/2000	2000/1990	Serbia	2011/2002	2002/1991
France	2011/2006	2006/1999	Slovakia	2012/2001	2001/1991
Germany	2012/2001	2001/1995	Slovenia	2013/2002	2002/1991
Ghana	2010/2000	2000/1996	South Africa	2011/2001	no results
Greece	2011/2001	2001/1991	Spain	2013/2001	2001/1991
Guatemala	2008/2002	2002/1994	Sweden	2012/2005	2005/2000
Hungary	2013/2001	2001/1990	Switzerland	2012/2000	2000/1990
Iceland	2013/2005	2005/2000	Taiwan	2012/2006	2006/2001
India	2011/2001	2001/1991	Uganda	2011/2002	2002/1991
Iran	2011/2006	2006/1996	UAE	2005/1995	1995/1985
Ireland	2011/2006	2006/2002	United Kingdom	2011/2001	2001/1991
Israel	2012/2008	2008/1995	United States	2012/2000	2000/1990
Italy	2012/2001	2001/1991	Uruguay	2011/2004	2004/1996
Jamaica	2011/2001	2001/1991	Venezuela	2011/2001	2001/1990
Japan	2010/2005	2005/2000	Zambia	2010/2000	2000/1990

Source: edited by the authors.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table A2

Results of the cluster analysis: ROXY20 – GCI index

Final Cluster Centres	Cluster 1 *Concentration with generally high GCI value*	Cluster 2 *Deceleration of deconcentration, with GCI values higher than the average*	Cluster 3 *Deconcentration, with generally low GCI values*
Number of cases	33	20	10
ROXY 20	15.10	–17.43	–82.13
GCI	5.58	4.60	2.61
AC	*9*	–	–
DC	2 *(conc/deconc)*	1 *(deconc)*	2 *(deconc)*
DD	*22 (conc)*	*18 (deconc)*	3
AD	–	1	*5 (deconc)*

Final Cluster Centres	Cluster 1 *Concentration with generally low GCI value*	Cluster 2 *Acceleration of concentration with high GCI value*	Cluster 3 *Deceleration of deconcentration with high GCI value*	Cluster 4 *Deconcent-ration with generally low GCI value*
Number of cases	18	18	8	22
ROXY 20_BOXCOX	4.35	4.69	4.35	–5.81
GCI	2.78	7.62	7.94	2.49
AC	*6*	*4*	–	–
DC	*1 (deconc)*	*2 (conc)*	–	*2 (deconc)*
DD	*11(conc)*	*12 (conc)*	*7 (deconc)*	*13 (deconc)*
AD	–	–	1	*7*

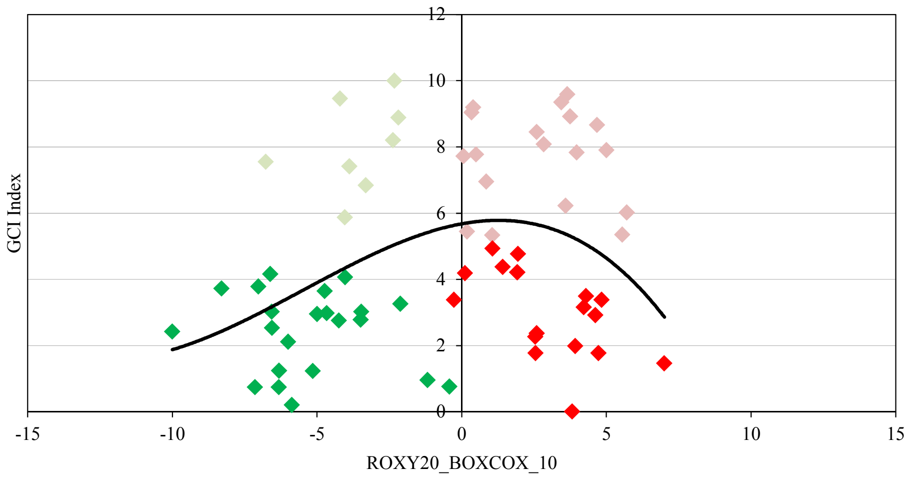
Notes: **AC** = Acceleration of concentration. **DC (deconc)** = Deceleration of concentration and it has already changed to deconcentration stage. **DC (conc)** = Deceleration of concentration, but it is still in concentration stage. **DD (deconc)** = Deceleration of deconcentration, but it is still in deconcentration stage. **DD (conc)** = Deceleration of deconcentration and it has already changed to concentration stage. **AD** = Acceleration of deconcentration.

Source: own calculation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Figure A1

The connection between GCI scores and ROXY20_BOXCOX



Note: green colour refers to countries where deconcentration is accelerating, light green colour refers to countries where deconcentration is decelerating while red and pink colours refer to counties where concentration is accelerating or decelerating, respectively.

Source: own calculation.

Table A3

Results of the cluster analysis: ROXY40 – GCI index

Final Cluster Centres	Cluster 1 *Concentration with generally high GCI value*	Cluster 2 *Deceleration of deconcentration, with GCI values higher than the average*	Cluster 3 *Deconcentration, with generally low GCI values*
Number of cases	26	28	8
ROXY 40	16.38	–21.28	–96.10
GCI	6.12	4.03	3.03
AC	*10*	–	–
DC	4 *(conc)*	–	1 *(deconc)*
DD	*12 (conc)*	*24 (deconc)*	*1 (deconc)*
AD	–	4	6

(Table continues on next page.)

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

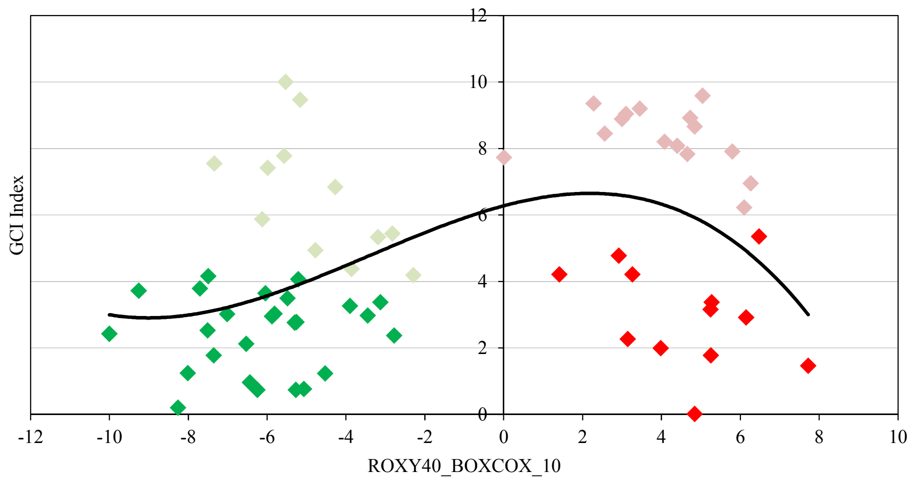
(Continued)

Final Cluster Centres	Cluster 1 *Concentration with generally low GCI value*	Cluster 2 *Acceleration of concentration with high GCI value*	Cluster 3 *Deceleration of deconcentration with high GCI value*	Cluster 4 *Deconcent-ration with generally low GCI value*
Number of cases	12	15	12	26
ROXY 40_BOXCOX	4.64	4.02	–4.74	–6.11
GCI	2.96	8.33	6.60	2.47
AC	*5*	*5*	–	–
DC	*1 (conc)*	*3 (conc)*	1 *(deconc)*	–
DD	*6 (conc)*	*7 (conc)*	*8 (deconc)*	*17 (deconc)*
AD	–	–	3	*9*

Notes: same as in Table 3 and Table 4.
Source: own calculation.

Figure A2

The connection between GCI scores and ROXY40_BOXCOX



Note: green colour refers to countries where deconcentration is accelerating, light green colour refers to countries where deconcentration is decelerating while red and pink colours refer to counties where concentration is accelerating or decelerating, respectively.
Source: own calculation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table A4

Results of cluster analysis: ROXY20 – GEDI Index

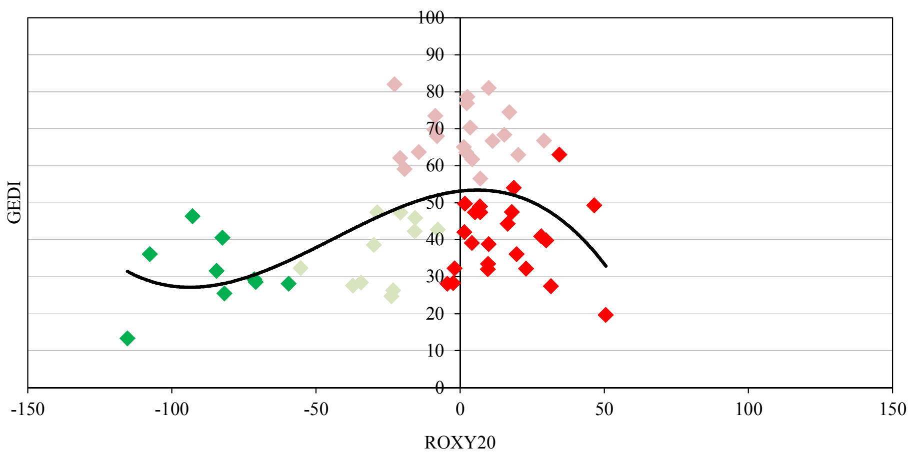
Final Cluster Centres	Cluster 1 *Concentration with generally lower GCI value*	Cluster 2 *Acceleration of concentration with high GCI value*	Cluster 3 *Deceleration of deconcent-ration, with high GCI value*	Cluster 4 *Deconcent-ration, with generally low GCI value*
Number of cases	23	20	11	9
ROXY 40_BOXCOX	15.8	1.16	–26.58	–85.12
GEDI	40.04	68.52	36.66	31.01
AC	*6*	*3*	–	–
DC	–	*2 (conc)*	*1 (deconc)*	*2 (deconc)*
DD	*14 (conc), 3 (deconc)*	*8 (conc), 7 (deconc)*	*8 (deconc)*	*3 (deconc)*
AD		–	2	*4*

Notes: **AC** = Acceleration of concentration. **DC (deconc)** = Deceleration of concentration and it has already changed to deconcentration stage. **DC (conc)** = Deceleration of concentration, but it is still in concentration stage. **DD (deconc)** = Deceleration of deconcentration, but it is still in deconcentration stage. **DD (conc)** = Deceleration of deconcentration and it has already changed to concentration stage. **AD** = Acceleration of deconcentration.

Source: own calculation.

Figure A3

The connection between the GEDI scores and ROXY20



Note: green colour refers to countries where deconcentration is accelerating, light green colour refers to countries where deconcentration is decelerating while red and pink colours refer to counties where concentration is accelerating or decelerating, respectively.

Source: own calculation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Table 12

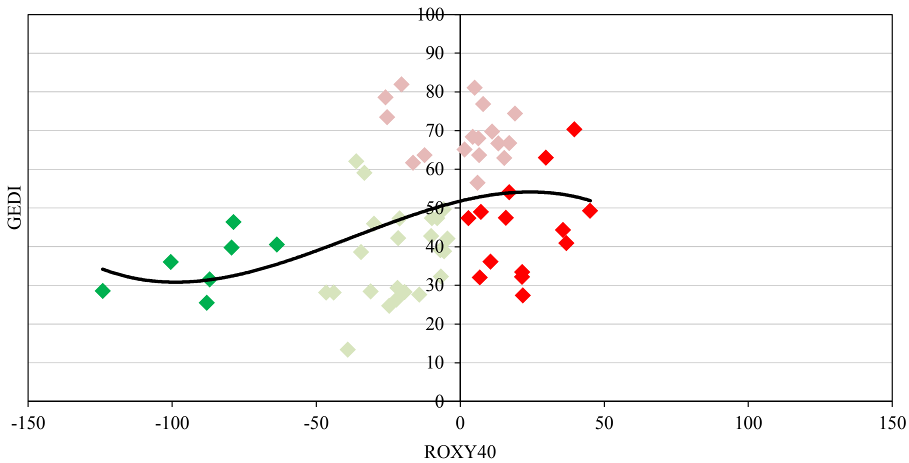
Results of cluster analysis: ROXY40 and GEDI Index

Final Cluster Centres	Cluster 1 *Concentration with generally lower GCI value*	Cluster 2 *Acceleration of concentration with high GCI value*	Cluster 3 *Deceleration of deconcentration, with high GCI value*	Cluster 4 *Deconcentration, with generally low GCI value*
Number of cases	14	18	22	7
ROXY 40_BOXCOX	22.31	0.43	–22.27	–88.71
GEDI	42.29	68.26	37.21	35.45
AC	6	*4*	–	-
DC	2 *(deconc)*	2 *(conc)*	–	1 *(conc)*
DD	6 *(conc)*	*6 (conc),* 3 *(deconc)*	*21 (deconc)*	1 *(conc)*
AD	–	3	–	*5*

Source: own calculation.

Figure 6

The connection between the GEDI scores and ROXY40



Source: own computation.

REGIONAL STATISTICS, 2015, VOL 5, No1: 97–120; DOI: 10.15196/RS05106

Appendix 3

Table 13

The results of cluster analysis between ROXY Indexes and GCI Index

ANOVA	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
ROXY_20	36945,376	2	181,007	60	204,110	,000
GCI_AVE_CH_10	34,468	2	7,247	60	4,756	,012
ROXY_20_BOXCOX_10	523,973	3	3,277	62	159,916	,000
GCI_AVE_CH_10	136,622	3	1,772	62	77,086	,000
ROXY_30_BOXCOX_10	465,608	3	1,431	61	325,341	,000
GCI_AVE_CH_10	100,020	3	3,593	61	27,841	,000
ROXY_40	39659,711	2	220,599	59	179,782	,000
GCI_AVE_CH_10	43,303	2	7,044	59	6,147	,004
ROXY_40_BOXCOX_10	529,564	3	2,936	61	180,339	,000
GCI_AVE_CH_10	135,866	3	1,830	61	74,261	,000

Table 14

The results of cluster analysis between ROXY Indexes and GEDI Index

ANOVA	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
ROXY20	23860,079	3	223,237	59	106,882	,000
GEDI_AVGCH	4616,308	3	81,006	59	56,987	,000
ROXY30	14152,718	3	162,240	54	87,233	,000
GEDI_AVGCH	4123,310	3	96,702	54	42,639	,000
ROXY40	20903,343	3	205,731	57	101,605	,000
GEDI_AVGCH	3827,858	3	120,616	57	31,736	,000