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Article

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CES Working Papers

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Suggested Citation: Cojanu, Valentin; Stupariu, Ileana-Pătru; Dobre, Robert Răzvan (2011) : An Exploratory Study of the Regional Context of Competitive Development in Romania, CES Working Papers, ISSN 2067-7693, Alexandru Ioan Cuza University of Iasi, Centre for European Studies, Iasi, Vol. 3, Iss. 2, pp. 188-214

This Version is available at:

<https://hdl.handle.net/10419/198119>

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AN EXPLORATORY STUDY OF THE REGIONAL CONTEXT OF COMPETITIVE DEVELOPMENT IN ROMANIA

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Abstract: *A recent series of EU initiatives gradually have changed the meaning of growth initiatives whereby the options of economic policy became more closely linked to the needs of development at ever smaller territorial units. The present research attempts to contribute to the discussion about the competitive potential of economic growth at territorial level.*

We introduce a methodological model to evaluate the conditions under which economic growth may generate opportunities leading to self-sustained economic development. The hypothesis is discussed at both national and regional scale and tested with a set of socio-economic variables including indicators relative to economic growth, economic functionality and spatial networks.

Our findings suggest a huge potential in terms of capitalization of different types of capital (territorial, human, cultural), but also in terms of achieving mutual reinforcement of links between advanced and less advanced industries. Most of the national territory contributes insignificantly to the economic use of resources through exports and advanced manufacturing. All this means resources which do not currently contribute to economic growth. Integrating the new concepts of territorial planning is gradual, long term oriented, and with significant learning economies. The objectives to pursue can be suggested from such measures as mapping of business operations in the target area or establishing non-governmental institutions with observation and monitoring roles.

Keywords: competitiveness, spatial development, polycentrism, North-East Romania

JEL Classification: R11, O18

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INTRODUCTION

Competitiveness is intensely endorsed these days as one central issue on the political agenda of most advanced economies. The synchronizing of policy initiatives is remarkable: competitiveness councils in EU, Japan and the US announced a strategic policy vision almost simultaneously in mid-2010. Their convergent thematic focus is just as striking: from sector competition to support policies to regional prosperity. In the EU, an ample policy set including the *Stability and Growth Pact* in 1997, the *Lisbon Strategy* in 2000, and *Europe 2020* in 2010 has realigned growth objectives with the promotion of competitiveness and regional development. This experience left behind some important lessons, leading to a more careful formulation of the regional development policy. For example, the latest (2007-2013) funding package dedicated to economic and social cohesion marked the shift from generic to explicit objectives (i.e. Convergence, Regional competitiveness and employment, and European territorial cooperation), whereby the options of the EU economic policy became more closely linked to the needs of development at ever smaller territorial units.

Facing “competitive imbalances and conflicts”, the EU had to adapt its strategies to new challenges. Danuta Hubner (2010) stated that “the real success of Lisbon was the increased importance of regions in the architecture of the EU”. Given her previous capacity as the EU commissioner for regional development and current one as the president of the Regional Committee of the EU Parliament, her conclusion could be overshadowed by a tendency to serve her own interests if that would not be nevertheless one that happens to highlight the challenge of recent European policies to connect spatial cohesion to industrial competitiveness.

A rapprochement took place between various EU policies with a view to leading to a reinforced approach to competitive development. As a result, a continuous series of initiatives gradually have changed the meaning of growth initiatives. We may recall here projects like Regions of Economic Change (REC) for promoting networks of excellence regarding the sustainable development of regions and cities; European Groups for Territorial Cooperation (EGTC) to support cooperation and border networks, transnational and inter-regional; the European Spatial Planning Observation Network (ESPON) for analysis and measures addressing human settlements, or creation of European networks as alliances of groups of companies (clusters).

The present research attempts (1) to contribute to the discussion about the competitive potential of economic growth at territorial level, and (2) to identify policy guidelines of regional relevance for a

national economy. The estimated impact of this study rests on recommendations based on an interdisciplinary analytical process that explores the regional, industrial and institutional characteristics of developing competitive potential at territorial level.

The material is further structured in four sections. Section 2 provides a reference point for the inclusion of regional themes among current economic policy issues. We introduce a methodological model to evaluate the conditions under which economic growth generates or not opportunities leading to self-sustained economic development. The hypothesis is discussed in Section 3 on a methodology applied at the national scale and tested with a set of socio-economic variables including indicators relative to economic growth, economic functionality and spatial networks. The economic performance is estimated with the Competitive Potential Index (CPI) at NUTS 3 territorial level.

The option for a comprehensive approach at national level was limited by the scope of the present study. For this reason, we chose to narrow the research objectives to a case study dedicated to a development area. Consequently, Section 4 attempts to evaluate the development potential of the North-East region. Several characteristics, among them the abundance of contrasts (of development, of landscape etc.), recommend this region as a relevant case. Section 5 concludes with recommendations for policy guidance in light of present challenges of industrial competitive development, particularly in the context of correlating the national policies with the EU initiatives. The main implication for public policy consists in facilitating a more rapid transition towards building a competitive growth potential.

1. TERRITORY AND COMPETITIVE DEVELOPMENT: CONCEPT AND METHODOLOGY

The policies for regional development are implemented under a still incomplete understanding of what “regional” actually means. The “regional” development has no operational meaning, in the sense of being useful to policy-making, as long as there is no economic concept applicable to the “region” (Eurostat 2009; Council on competitiveness). The EU statistical arm, Eurostat, refers to a “region” as “a piece of land with boundaries more or less defined that often serves as an administrative unit at a level below that of the nation-state” and recognizes that “fuzzy” may characterize the degree of definition of boundaries (Eurostat 2009). As it happens, the local needs are not necessarily adequately met by the nomenclature of territorial classification (NUTS) which stands for the official territorial unit of analysis in the EU countries. For example, an assessment of the situation in Romania highlights that “the regional development of NUTS II allows only a limited understanding of development” and

should be completed with other factors such as district size, market access and proximity (MDLPL, 2007, p.16).

Interconnected territorial linkages representing contexts of regional/local economic development are almost impossible to be detected in the absence of an interdisciplinary exercise to evaluate the conditions that do or do not generate opportunities leading to self sustained economic development processes. Identifying them depends on an effort capable of deciding how large or small the regions under analysis need to be to form a competitive economic zone, that is, spatial configurations in which growth opportunities are self-sustainable. A welcome development consists in the effervescence of the patterns of economic territorial cooperation (cf. Spinach and Vara-Arribas, 2009; Commission et al., 2008, pp. 38-40). Pilot or network projects can be met in a wide range of activities starting from the identification of best practice examples to the developing of policy instruments or the establishment of consortia or public-private partnerships.

The conceptual support from economic geography captured by polycentric indicators (size of settlements, spatial dispersion and level of connectivity) and initiatives such as REC and EGTC help channel the funds towards the reduction of regional disparities and a more appropriate distribution of development funds within regions. Projects like ESPON enabled the entry into the current terminology of new concepts describing the geographic scale of development: Functional Urban Area (FUA), Metropolitan Economic Growth Areas (MEGA), Potential Urban Strategic Horizon (PUSH) or Polycentric Integration Area (PIA).

Polycentricism came to the fore since the 1980s, as a new concept in spatial planning policies, opposite to monocentricism (i.e. territorial management focusing on a single centre) and urban sprawl (secondary cities have a diffuse structure in a continuous space). The concept specifically aims at a balanced development (in regard to social cohesion), to promote competitiveness between cities and the equilibrium of the urban network for both the urban area and periphery (Richardson 1988).

Regardless of the geographical organization, polycentricism is based on *morphology* (the number of cities, hierarchy, and distribution) and the *relationship between urban areas* (the network of flows and cooperation). As defined by ESPON, the polycentric concept entails a spatial organization of cities, characterized by functional complementarities, institutional and economic integration and cooperation in common policies. The polycentricism degree of national systems in the EU was divided based on several criteria (ESPON 1.1.1): *size* (distribution and dimension of the locality network,

without the dominance of a big city), *location* (homogeneous distribution in the territory) and *connectivity* (high accessibility of FUA's lower levels compared to the main centre).

Based on these results, the existence of appropriate definitions of potentially funding beneficiary areas can be a step further as compared to previous approaches, although it is equally true that the relevance of some measures must exceed the rhetoric of the polycentricism related concepts. Polycentricism mainly results in a technical analysis of local development by devising an index based on the three criteria. The approach is deficient in indicating the degree or mapping of the optimal configuration of spatial development to be economically relevant. The coverage of development policies must be sufficiently large to allow, on one hand, spatial connections among cities and among cities and villages, and on the other hand, maximizing net economic benefits of specialization and diversification in a wider European context.

To address such needs, the analysis should take into account a growth model emphasizing the role of competitive interdependencies that might occur over a given territory. Location of production, because of its positive and negative externalities, leaves a problem unsolved: what is the optimal geographical scale at which benefits are maximized, and moreover, which is the actual territorial unit of analysis? An evaluation of the situation at the EU level ("Enlargement", p. 157) showed that there was no method to identify or to measure polycentrism at different geographical scales, as there was no way to estimate its impact over the objectives of cohesion, efficiency and sustainability. It is therefore suggested, within the same context ("Enlargement", p.157), to develop an operational concept of polycentrism and operational methods for identification and measurement.

A previous research (Cojanu, 2009) eventuated in mapping a typology of operational forms for the implementation of competitive development initiatives. The proposed theoretical framework consists of four coexisting territorial levels: (1) Urban field, (2) Correlated Industry Groups (GIC) (clusters), (3) Development Zone (DZ), and (4) Location-deficient areas. To find the geographical area of these self-sustained economic units is however an analytical exercise in its early phase. Even representations that may seem simple, such as the definition of a rural area (e.g. MMDD, 2007, p. 20) are subject to interpretations in progress. Convergent works (e.g. "Territorial atlas"; Gorj County Council, 2007) help much improve the investigative techniques and so lead to a narrower deficit of analytical instruments.

The starting point of this methodological exercise consists of a set of three mapping criteria – i.e. economic dynamics (described by general economic evolutions), economic functionality (described

by competitive analysis reports), and spatial network (described by territorial characteristics) – each of them analyzed against qualitative and quantitative benchmarks (Cojanu, 2009) folding over the role played by industrial agglomerations in economic development at territorial level. Both the scope of this study and the availability of regional statistics do not allow extending this research to a comprehensive cartography of development areas at national level, nor to a detailed discussion of the three criteria. What we do instead is to (1) create an image of the local development potential and economic performance at national level, and (2) select a regional sample resembling one component of the proposed typology and discuss its competitive potential following the same criteria.

In Romania, the EU concept of spatial development at different territorial levels (polycentricity) has been implemented according to the Government Directive (GD) 998/2008 by declaring *7 national growth poles* (Brasov, Cluj-Napoca, Constanta, Craiova, Iasi, Ploiesti, Timisoara) and *13 urban growth poles* (Arad, Baia Mare, Bacau, Braila, Galati, Deva, Oradea, Pitesti, Ramnicu Valcea, Satu-Mare, Sibiu, Suceava, Targu-Mures). We collected data at NUTS 3 level (counties) and selectively present our results by aggregations also for NUTS 2 level (regions of development).

The first two criteria – economic dynamics and functionality – were combined in a composite index at county level, the Competitive Potential Index (CPI). CPI is composed of values for GDP/capita, Exports/employed population, and a Technological Development Index (see Appendix 1 for methodology). This latter index is based on Eurostat's 'high-technology' aggregations of industries and conversion tables between the Harmonized System (HS) and the NACE rev.2 industrial classification⁸. Additional data on exports characteristics complete the perspective of the competitive potential.

As for the spatial network, we mapped the area covered in one hour on European and national roads starting from the growth poles. The map was realized by using variables like transport infrastructure type, network density and terrain configuration (see Appendix 2 for technical details). These three factors have defined the accessibility to Romania's national growth poles and center poles of urban development at both national and regional level. As regards this latter territorial level, the best approximation for a development area is by appealing to economic structures that already have a geographical and administrative representation. We selected the North Eastern area of Romania which corresponds at NUTS 2 level to the North East Development Region. Accordingly to Rey et al. (2006), *North-East* is the *largest region* (36,850 km²), the *most populous* (3,738 thousand inhabitants), the

⁸ Guidance is provided at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/htec_esms.htm.

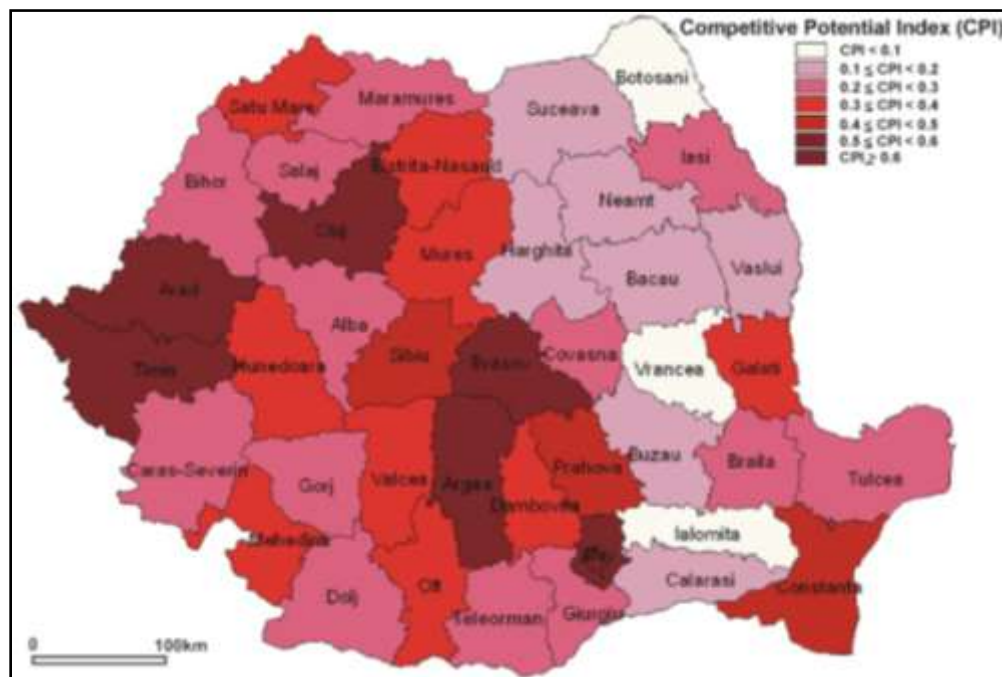
most rural (56% rural population, 46% of the population is active in agriculture and forestry) and the *poorest* of the Romanian regions, attributes that make this regional economy one of the most compelling cases for our discussion.

2. MAPPING COMPETITIVE DEVELOPMENT AT TERRITORIAL LEVEL

2.1. Economic dynamics and functionality at country level

Figure 1 graphically represents the values of the Competitive Potential Index (CPI) at country level. Compared to the country's average of 0.31, the distribution of values shows that: (1) *An axis of counties with high values of the Competitive Potential Index* crosses almost diagonally the country and nearly overlaps the most complete infrastructure in Romania (European roads, national railways, airports); (2) *An inlaid component of the index distribution* overlaps the western, central and southern parts. The Eastern part of the country is characterized by a homogeneous distribution of values, which translates into the economic performance landscape incapacity to exploit natural and human capital.

Figure 1 - Spatial Distribution of the Competitive Potential Index



The map is realized by georeferencing, digitization and processing in Open Source GIS software (Map Analyst).

According to the CPI hierarchy, Arges county ranks first with an index value of 0.78, reflecting a high volume of total exports (second at country level), the highest ratio of exports and employment (10,925 Euros per employee), as well as the largest share of medium-high technology exports (20.3% of the country's total and 24% of the county's total). Its exports are dominated by automobiles. In second place, with an index value of 0.68, ranks the city of Bucharest, with the highest export values, but also the largest employed population. Timis County ranks third, with the largest high-tech exports.

No county in the North-East region is ranked among top 20. Bacau, the 4th in terms of high-tech exports, ranks only the 34th of 42 because of the large share of low technology exports (ca. 70%) and a low value of exports / employed population at only 1,099 Euros. Only two counties in the South-East region - Constanta and Galati – are exceeding the CPI national average, with shipbuilding and metallurgy, respectively, as main industries. The situation is similar for most of the other regions, each with two or three counties with values above the national average. Overall, the best placed regions are Bucharest-Ilfov, South-Muntenia, with three counties ranking above the national average and Center, also with three counties.

Exports are largely based on medium- (MTE) and low-technology exports (LTE), with 68% and 30% of total exports, respectively. High technology (HTM) exports account for only 1.5% of total exports. If we further divide MTE into medium-high technology (MHTE) and medium-low technology (MLTE), their respective shares in Romania's total exports amount to 43% and 25%.

Table 1 presents the results of export values on the four technological levels for each of the 42 counties. Five counties (Bucharest, Arges, Timiș, Constanta, and Cluj) account for nearly 50% of total exports, while 20 counties have less than one percent. In terms of export volume/employed population (2009), Arges is positioned in the first place (10,925 Euros), while Bucharest is only on the eighth place, with 4,968 Euros, which is in part accounted by significant demographic differences between the two territorial units. 25 counties have values that are below the national average of 2,811 Euros, the last place being occupied by Gorj with only 280 euro.

Table 1 - Distribution of exports by level of technology and counties (2009)

	High Technology Sectors	Medium- High Technology Sectors	Medium- Low Technology Sectors	Low technology Sectors
Total Exports ('000 EUR)	435,992	12,400,230	7,241,337	8,736,974
Share of total national exports (%)	1,51	43,03	25,1	30,3
Alba	0,19	0,7	0,63	4,04
Arad	4,02	5,52	1,38	4,98
Argeş	3,3	20,3	1,5	2,25
Bacău	4,8	0,38	0,14	1,95
Bihor	1	2,35	0,43	6,16
Bistriţa-Năsăud	0,06	1,81	0,52	1,39
Botoşani	0,01	0,12	0,03	2,03
Brăila	0,03	0,1	1,93	1,11
Braşov	11,2	5,47	2,33	3,03
Buzău	0,01	0,4	1,06	2,93
Călăraşi	0	0,21	1,63	1,64
Caraş-Severin	0,5	0,19	0,48	0,48
Cluj	1,39	8,98	1,52	2,67
Constanţa	0,04	0,22	19,25	1,67
Covasna	0,04	0,4	0,1	1,7
Dambovita	0,04	1,19	1,2	0,47
Dolj	0,01	1,13	0,19	1,34
Galaţi	0,05	0,21	9,36	0,32
Giurgiu	0,02	0,38	0,33	0,34
Gorj	0,56	0,09	0,18	0,14
Harghita	0,05	0,09	0,21	1,98
Hunedoara	0,3	1,41	0,47	1,87
Ialomiţa	0	0,08	0,2	0,86
Iaşi	0,46	0,83	0,54	0,98
Ilfov	2,93	1,56	1,86	5,32
Maramureş	0,04	1,14	0,54	3,7
Mehedinţi	0	0,69	0,05	0,28
Mun. Bucureşti	18,02	18,4	20,79	16,16
Mureş	2,86	1,8	0,54	2,52
Neamţ	0	0,21	1,06	2,15
Olt	0	2,13	7,97	0,74
Prahova	0,67	4,19	4,92	2,8
Sălaj	3,41	0,11	1,21	0,86
Satu Mare	1,27	1,47	1,71	2,1
Sibiu	3,5	4,43	1,6	4,48
Suceava	0,08	0,28	0,08	1,41
Teleorman	0,01	0,38	0,03	0,49
Timiş	38,85	9,53	5,9	7,4
Tulcea	0	0,03	3,81	0,53
Vâlcea	0,01	0,76	2,26	0,7
Vaslui	0,27	0,26	0,02	0,91
Vrancea	0	0,09	0,04	1,1

Source: Centrul Român pentru Promovarea Comerţului şi Investiţiilor Străine (2010) and authors' calculation

In terms of high technology exports, the top five positions are occupied by Timis (38.85%), Bucharest (18.02%), Brasov (11.2%), Bacău (4.8%) and Arad (4.02%). In Timis, Bucharest, Arad and Brasov exports are represented by *Optical, photographic or cinema, measuring, checking or precision instruments and devices, surgical instruments and apparatus, clocks, musical instruments, parts and accessories* (HS Code XVIII), while Bacau also adds the aeronautics industry (HS Code XVII: *Vehicles, aircraft, vessels and associated transport equipment*). Calarasi, Ialomita, Mehedinti, Neamt, Olt and Vrancea have no high technology exports, and 29 out of 42 counties do not exceed 1% of the country total.

Medium-high technology exports are represented by Arges (20.3%), Bucharest (18.4%), Timiș (9.43%), Cluj (8.9%) and Arad (5.52%), while the least important contributors come from Gorj, Harghita, Vrancea, Tulcea, Ialomita, with less than 0.09%. Medium-low technology exports originate in Bucharest (20.7%), Constanta (19.2%), Galati (9.3%), Olt (7.9%) and Timis (5.9%) and the last places are occupied by Mehedinti, Vrancea, Teleorman, Botosani and Vaslui with less than 0.5%. Bucharest and Timis are also best performers in the low-tech category with 16.1% and 7.4%, respectively.

In summary, Timis, Arad and Bucharest rank first for each export category, while Vrancea, Vaslui, Teleorman, Mehedinti, Iasi, Ialomita, Gorj, Giurgiu and Caras-Severin do not exceed 1% for any category. The distribution of export categories in each county shows that for more than half of them, the share of medium-technology export exceeds 50% of the total, amounting to 96.13% for Galati. However, high-technology exports values do not exceed 10%, the highest share being recorded for Bacau with 8.45%. At regional level, from the least performing 20 counties, six are located in the N-E Development Region (Neamt, Bacau, Iasi, Botosani, Suceava, Vaslui), and other five counties (Calarasi, Dambovita, Giurgiu, Ialomita, Teleorman) also belong to just one Region (South-Muntenia). The latter region records the largest intra-regional disparities, with two counties (Arges and Prahova) in the first ten as share of total exports.

2.2. Spatial network at country level

The main interrogation of our mapping model is this: can there really be identified polycentric urban structures in Romania, following the oft cited European model of the Pentagon region

encompassing London, Hamburg, Vienna, Milan, Paris which produces 43% of the EU GDP (Rusu, 2009)? "Could it be that a part of the eastern cities of the country are neglected, in complete disagreement with the principles of territorial cohesion? Are public territorial actors not outlining the polarizing power of cities with the help of theoretical models?" (Rusu, 2009)

Our results are presented in Figure 2 and Table 2. Lack of infrastructure (motorways, express roads) leaves a clear dispersion gap between accessible zones. The only exceptions are Bucharest - Ploiesti and Timisoara - Arad, where the areas of accessibility are interwoven. The spatial distribution of temporal polygons highlights that the completion of the A2 (Bucharest – Constanta) and A3 (Bucharest - Brasov) motorways will lead to increased accessibility potential, which will boost economic transactions and give rise to a higher polarization. Difficult topography in some regions could be an obstacle to the temporal dynamics of accessibility. However, the construction of high speed roads may overcome this disadvantage. For example, the distance of 110 km between the growth poles Ploiesti and Brasov through the hardly accessible Posada defile will be covered in about an hour, which will lead to the interpenetration of temporal zones of the two poles. Geo-temporal development of concentric zones (radial accessibility from a central pole to several outer points) would lead to optimal solutions for accessibility.

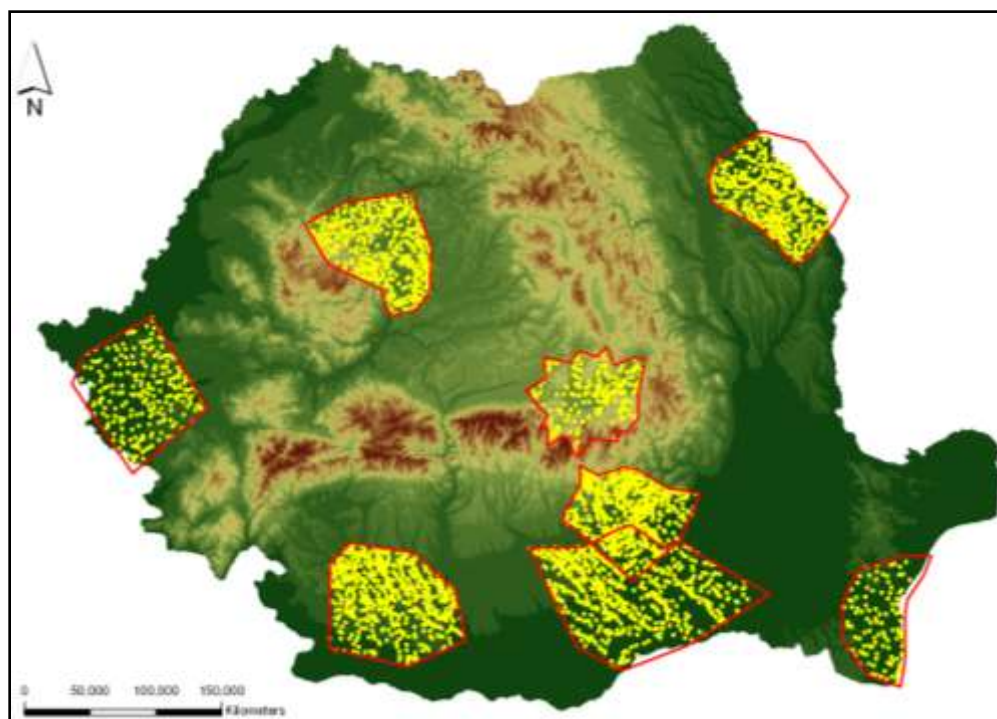
The spatial coverage of Bucharest is determined by the existing two highways A1 and A2 which yields an elongated form in direction east-west. This area is best developed because several divergent and radial roads start from Bucharest to Giurgiu (DN 5), Oltenita (DN 4), Urziceni (DN 2), Ploiesti (DN1), Targoviste (DN 7) or Alexandria (DN 6). The geographical landscape has no implications on the average speed of circulation and therefore on the coverage form.

The spatial coverage of Brasov resembles a "star" because the main roads are located on the valley corridors DN 1, DN 73, DN 1 A and therefore benefit from a higher average speed. Secondary roads, of regional or tourist interest, climb on the peak (Brasov - Poiana Brasov), lowering the average speed.

The influence of space topology is well evidenced by road distribution and speed variation of traffic in the spatial coverage of Cluj Napoca. The analysis points to a big development of roads in the directions east, west and north (DN 1, DN 1C) due to highly suitable ways of communication relative to local geography (Podisul Somesului, Campia Transilvaniei). To south and southwest, accessibility diminishes because of mountains and narrow valleys with steep high slopes. The elongated shape is also determined by the Plain Turda – Gilau of the new highway A3.

The national roads on four lanes (two per direction), close to express roads or highways, determine the form of spatial coverage for Ploiesti. This is the case of the elongation to north-west and south on Valea Prahovei.

Figure 2 - Potential and accessibility in Romania



The map is realized by georeferencing, digitization and processing in Open Source GIS software (Map Analyst).

Table 2 - Spatial coverage of growth poles in Romania

No.	1. Growth pole	2. Coverage area (CA)	3. Number of localities (NL)	4. Population (P)	5. Population density (P/CA)
1.	Timisoara	6,627 km ²	218	826,904	125
2.	Cluj Napoca	5,554 km ²	410	714,735	129
3.	Iasi	6,309 km ²	384	743,636	118
4.	Brasov	4,638 km ²	174	748,048	161
5.	Craiova	7,414 km ²	575	911,273	123
6.	Constanta	4,109 km ²	110	643,424	157
7.	Bucuresti	11,314 km ²	649	2,972,600	263
8.	Ploiesti	5,371 km ²	558	1,119,576	208
	TOTAL	51,336 km²	2,959	8,536,658	166

Source: Authors' calculation

3. THE DEVELOPMENT POTENTIAL OF THE AREA IN THE NORTH-EASTERN PART OF ROMANIA

North East's poor position among other regions is a result of a context of factors such as marginal geographical position, the Carpathians mountainous barrier (Eastern Carpathians) acting as a natural barrier to other parts of the country, lack of infrastructure and connection to the most important European corridors, lack of employment opportunities, considerable domestic and international migration, poor management of natural and human resources etc. Its six consisting counties (Bacau, Botosani, Neamt, Iasi, Suceava and Vaslui), with some notable exceptions, perform poor against almost all benchmarking criteria.

At the same time, the region is home to an apparently untapped potential. The mountainous, sub Carpathian and plateau disposal of the area, as well as favorable demographics and impressive cultural heritage, all confer this region a varied *territorial capital* potential, being characterized by a natural setting and diversification of the environmental components.

The *natural* territorial capital of this region is characterized by:

- *Mineral resources* associated in geological repositories, various in age and structure (Mesozoic crystal deposits, Neocene volcanic deposits, Miocene and Quaternary sedimentary deposits) that contain deposits of manganese, copper, poly-metallic sulphides, salt etc.;
- *Water resources* (springs, lakes, and surface water resources adducted in hydropower plants on Bistrita Valley); and
- *Landscape resources* in several protected areas of the region such as national parks, natural parks, reservations etc. The region has 126 protected areas which amount to 49,183 ha, almost 2% of the total area of the region. It is a high percentage, given that there are in all 949 Romanian protected areas (Primarck et al. 2008).

The *anthropogenic* territorial capital includes human and cultural resources. The region has important human resources (human capital), being the development region with the highest values of the birth index, which ranks second regarding the population density and includes almost 17% of Romanian population.

The region's *cultural* capital is defined by a series of historical monuments of national and international (UNESCO) importance. In the North East Region, there is the largest number of museums and collections open to the public. It also offers diverse cultural manifestations such as festivals,

theatrical events, customs and traditions, ethnographic and folklore heritage of great originality. The touristic offer is diverse, with eco and rural tourism specificities, with cultural centers, monasteries, and countless monuments.

3.1. Economic dynamics and functionality

3.1.1. Environmental quality: the landscape as a natural resource

To describe this feature, we use the Human pressure index and the Environmental transformation index.

Human pressure is a synthetic indicator for assessing the intensity of human activities' impact on the environment by different land uses (Pătroescu 2000): "The pressure on the environment through human land use is even greater as the share of agricultural area per capita is greater." ⁹

To account for various land categories (agricultural, forest and built areas), we refer to the FAO limits to maintain the environmental balance, namely 0.4 ha / capita for arable land and at least 0.3 ha / capita for forest. In the FAO/UNESCO publication *La Carte mondiale des sols* (1964), the *agricultural land use* is characterized by the following categories: (I) territories on the verge of keeping a relative balance between the natural landscape components (<0.40 ha/person); (II) rural landscapes very poorly balanced and moderate unbalanced (0.41 to 1.00 ha/person), characterized by an alternation of cultivated areas and areas with other uses (building area, patches of forest); (III) strongly unbalanced rural landscapes (1.01 to 2.00 ha/person), characterized by exclusive crops, patches of barely preserved forest; (IV) strongly unbalanced rural landscapes (> 2.00 ha/person) include areas with intensive agriculture.

For the N-E Development Region, the spatial distribution of the Human pressure index (2009) includes Botosani and Vaslui in the category III of arable area. The remaining counties are of type II, as storage areas *on the verge of the relative balance of the landscape's natural components*. This is explained by the fact that Suceava, Neamt, Bacau overlap the Subcarpathian and mountain regions where the degree of human intervention keeps itself within the limits of the mountain, most localities being situated at the contact between the Carpathians and the Subcarpathians.

⁹ The Index is calculated as follows: $P = S \text{ (ha)}/N$ where: P = human pressure; S= area (of different land uses); N= number of inhabitants.

In terms of the *use of forest area*, a pressure index is expressed as a degree of naturality¹⁰ that however refers to the actual forest area and not to the "natural state of forest", an ideal situation hard to find today. According to FAO standards, the share of forests helps to identify six types of territories, classified by reference to the degree of damage induced to the ecosystem's balance (Ionescu, Sahleanu, 1989 quoted in Necşuliu, 2007), as follows: ecologically balanced landscape near to the baseline (>60%), relatively ecologically balanced landscape (45-60%), slightly affected ecological landscape balance (30-45%), landscape with endangered ecological balance (30-20%), landscape with strongly affected ecological balance (10-20%), landscape with very strongly affected ecological balance (<10%).

For the N-E Development Region, the spatial dynamics of this index shows a high share of landscapes with very strongly affected ecological balance for Botosani, Iasi, Vaslui. Suceava is at the opposite, with relatively stable ecological balance, and Neamt, Bacau with slightly affected ecological balance. These latter counties enjoy better forested areas, compacted in Subcarpathian hills and mountainous peaks.

If we combine non-agricultural area land use (buildings, infrastructure) with arable and forest land use, we get a *synthetic index of environmental transformation degree*¹¹. Its spatial dynamics indicates that Iasi, Botosani and Vaslui cover the largest environmental changes, between 44% and 60%. Most stable counties, with changes less than 20% are the mountainous and Subcarpathian counties like Suceava, Neamt and Bacau.

The analysis of different values of the natural territorial capital leads us to the following conclusions:

- Human activities exert a strong pressure on the environment due to the exclusion of large forested areas from the natural circuit;
- Changes after 1990, related to land restitution, led to increased deforestation with visible effects on the increasing agricultural lands;
- The irrational land exploitation has determined the appearance of degraded terrains;
- Due to the economic crisis, agricultural land use in this region could be excessive, leading to deterioration and a negative environmental impact.

¹⁰ This index (I_N , naturality degree) expresses the proportion of forested area to total territorial unit area ($I_N = S_{\text{forest}} / S_{\text{total}} \times 100$).

¹¹ $I_{tr} = (S_{\text{forest}} + S_{\text{pasture}} + S_{\text{water}}) / (S_{\text{build}} + S_{\text{arable}} + S_{\text{ineyard}} + S_{\text{orchard}})$ (Dumitraşcu 2005)

3.1.2. Anthropogenic capital

In the analysis of human resources, the following demographic indicators are useful: population density, share of urban population and of rural population, and an ageing index. For the N-E Development Region, the values of birth rate are higher in relation to the rest of the country (birth rate in these counties ranges from 10 to 12 ‰) which is explained by the large share of rural population (60-90%). The ageing index, in comparison with the rest of the country, points to young dominant demographic structures. The analysis of different values of the anthropogenic territorial capital leads us to the following conclusions:

- Relative to the average population density per country (95 inhabitants/km² (Necşuliu, 2007)), the values vary greatly, mostly depending on the housing conditions. Thus, the lowest population density is 27 inhabitants/km² in Botosani and Bacau, and the highest in the largest urban counties (Iasi and Neamt), above the national average, with 96 inhabitants/km².
- The share of population in rural/urban areas is similarly varied: Suceava, Neamt, Botosani, Vaslui have values between 63 and 58% for the rural areas, while Iasi and Bacau have the largest urban shares (between 43-47%);
- The ageing index has the country's lowest values (1.02 compared to 1.59 for the southern regions): Suceava, Iasi, and Vaslui with values between 0.91-1.02 and Botosani and Neamt with the highest value of 1.26.

3.1.3. Economic performance

Table 3 describes exports by technology categories (HTE, MHTE, MLTE, and LTE). These data provides a first image as to the extent the area resources are capitalized both in the context of increasing competitiveness and in the sense of sustainable development.

Table 3 - Types of technology exports in the north-eastern counties (2009)

(value in thousands Euros and share of county's exports in county total)

County	High Technology Exports (HTE)		Medium-High Technology Exports (MHTE)		Medium-Low Technology Exports (MLTE)		Low Technology Exports (LTE)	
	Value	Share	Value	Share	Value	Share	Value	Share
Bacău	20914.74	8.45	46661.84	18.84	9797.72	3.96	170329.47	68.76
Botoșani	48.24	0.02	14283.33	7.35	2347.09	1.20	177491.30	91.41
Iași	2005.74	0.87	103384.04	44.87	39463.89	17.12	85618.56	37.14
Neamț	6.29	0.00	25969.26	8.94	76671.52	26.42	187556.60	64.63
Suceava	369.24	0.23	34856.86	21.25	5713.00	3.48	123078.37	75.05
Vaslui	1156.19	1.01	32707.85	28.52	1349.40	1.17	79458.98	69.30

Source: author's calculations

The low-technology exports are predominant. The differentiation of counties confirms the values derived from the analysis of natural and human resources. For example, Botosani and Suceava have the highest values of the degree of rurality and environmental change and the highest values of low technology exports. The high degree of rurality is transferred to products profile (food, processing, vegetable fiber, straw, etc.), but also to the intensity of resource exploitation and hence to the environmental transformation (wood and wood articles, cork).

Diversification of economic activities in this region should be oriented towards new dimensions related to sustainable development. Given the major role of agriculture and the massive migration flows to urban areas, it becomes evident that *alternative activities* should be encouraged in rural areas: craft activities/handicraft, rural tourism (including mountaineering, fishing, equestrian tourism, cycling) and agro-tourism; new investments and/or upgrading of storage, processing and marketing of forest fruits, medicinal and aromatic plants.

A re-orientation of the economical diversity starting with the European Natura 2000 network is needed as an opportunity to promote new development paths, built on the exploitation of natural resources (not on their degradation), respectively on nature and landscape conservation as a socio-economical imperative. The capitalization of this network doesn't involve blocking economic activities in these areas, but requires applied management of nature conservation and economic site productivity (WWF 2004). Precisely, these activities are found in the *management plan* of these sites (maintenance of environmental services, traditional activities regarding the use of natural resources developed by and

for the benefit of local communities), whereby both physical and legal persons are allowed to get custody of a Natura 2000 site. In addition, a series of other funds can be accessed for site management, such as ERDF (European Regional Development Fund), SOP ENV (Sectoral Operational Program Environment, Priority Axis 4), the EAFRD (European Agricultural Fund for Rural Development), NRDP (National Rural Development Program), SOP HRD (Human Resource Development), or LIFE +.

3.2. Spatial network

Starting from the general picture at national level, we attempt to discuss to what extent two or more cities can or should cooperate, and to what extent a polycentric network can emerge to help develop a balanced economical and social development.

The outcome of CEMAT Conference (2006 - 2010) (CEMAT 2010) points out that polycentric development can improve territorial functionality, without answering though a fundamental question: how to achieve a balance between a sustainable urban development based on economic performance and healthy living conditions. For our region, considering the number of cities (32), in relation to the region's area of 36,850 km², we can affirm *that a low potential in terms of making a polycentric network of human settlements and activities is present*, because these urban localities have been assigned a large area of polarization. This is also emphasized by the spatial analysis (Figure 3), which displays mostly a monocentric development. Most interactions are established between administrative centers and the other localities as most people travel to solve administrative problems. These cities may not be *labeled as most European cities are*, that is emerging as Functional urban areas (FUA), within which daily commuting is representative for a *polycentric system*.

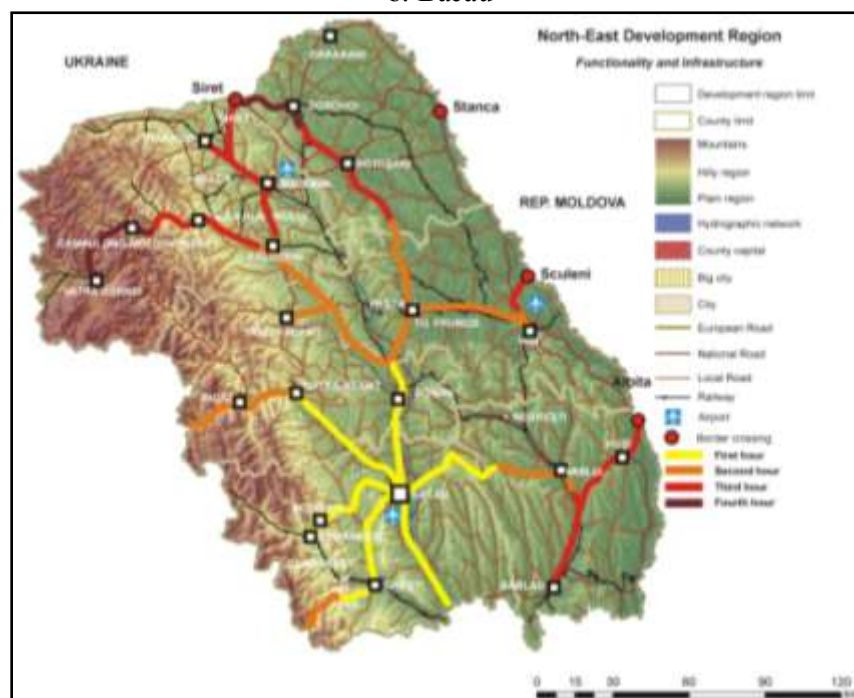
However the three county maps, on which the poles of growth and urban development are represented, make up a cartographic image of the intensity of main disparities, but also of the vectors of a possible polycentric development as the main means of balancing spatial development. We notice the possible polarization direction of Iasi and Bacau towards other centers, by the distance travelled in an hour or two (60 km-120 km on national roads), with an adequate infrastructure coverage for almost the entire region.

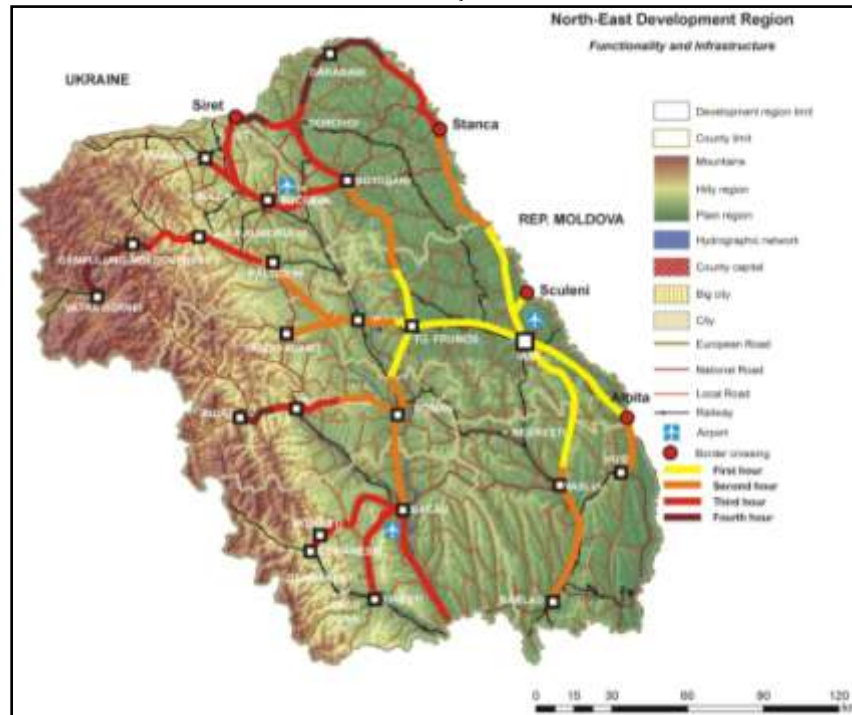
Figure 3 - The achievement potential of a polycentric network in the north - east

a. North-East Development Region



b. Bacău





The map is realized by georeferencing, digitization and processing in Open Source GIS software (Map Analyst). The database was created based on topographic and thematic maps introduced in digital format.

The region is still dependent on *agricultural resources*, with over 50% of population as "predominantly rural", according to the OECD urban-rural classification (OECD 2008). *The decline of small and medium-sized cities* (Roman, Bicz, Targu Neamt, Siret, Vatra Dornei), whose development was influenced by the industrial restructuring and lack of foreign investment resulted in the failure of these cities to fulfill their urban functions (Ianoș 2004).

The region has three international airports: Iasi, Suceava and Bacau, and is crossed by European corridors (E85 from north to south, E576, E574, E581, E583), and by the country's two main railroads (V-Bucharest-Suceava and VI-Bucharest-Iasi). There are few modernized public roads, their share being much lower than the national average (25.1%).

The lack of adequate infrastructure for enabling links to the northern corridors, the corridor III (Kiev-Dresden) and Corridor V (Venice-Bratislava) and the eastern ones, Corridor IX (Helsinki-Thessaloniki), isolates the region from the rest of Europe. Although roads have a higher density compared to the national average, especially alongside valleys (Siret and Prut), the infrastructure is inadequate and obsolete.

The Pan-European network density varies significantly, the western and southern regions having a higher density (IV, VII, X) than the northern and eastern ones. The biggest "blank spot" of the

European corridor network is located in the northern part of Romania, including a considerable part of the N-E Development Region. There is a point of interference with Corridor IX (east) in the southern part of the region. In addition, the position of the region on the eastern border of the European Union could be a strong point in view of the possibility of extending trade flows to the Eastern Europe. The highway project from Cluj to the Moldavian Republic, passing through a large area of the region, could ensure easy access to Moldavia and Ukraine.

In the case of the three poles of urban development (Iasi, Bacau, Suceava), covering a distance of 1 hour *does not* indicate access to important nodal points. The large share of small towns (II regional poles, sub-regional poles, local poles) indicates the existence of *cities with local attraction* serving a radius of 10-15 km. Iasi municipality, through the localities situated in the peripheral ring (Ungheni and Victoria) enables the link between Iasi metropolitan area further to Siret-Prut-Nistru Euroregion (Iașu 2006) and thus supports cross-border cooperation.

The temporal accessibility (expressed in hours) to other urban centers in the region indicates a poor accessibility, which is explicitly represented in cartographical models by coverage areas. For example, from Iasi to Vatra Dornei (a famous mountain resort), 226 km are travelled in over 4 hours. Poor and difficult *connectivity* from all localities to the three airports in Iasi, Bacau, Suceava (more than 4 hours) and daily accessibility to major cities from 1 hour to over 4 hours due to poor infrastructure, argues that the polycentric network can't have a clear contour due to low accessibility to major economic flows, a situation which is reflected in the poor attractiveness for foreign investors.

Identifying opportunities and directions for improving the quality of life should include due reconsideration of landscape as a *resource* for economical, environmental, recreational and social purposes. Thus, the phenomenon of polarization can be extended by the identification of some polarization axes: *natural development* (ecological corridors, protected areas), *agricultural development* (distribution of eco-products markets and centers), *economic development* (landscape as a resource), and *social development* (population movement in relation to the polarizing city).

Among the resources that could be most easily assessed, managed and organized in view to sustainable development is the territorial capital, especially through the abundance of *landscape* resources (natural, agricultural, and cultural). Equally important is the human capital, characterized by a high share of young population (over 30%), Nord East being the only development region with a positive natural balance (25%). This capital can be directed towards several professional reconversion perspectives (e.g. Natura 2000 landscape site management).

From an economic perspective, the key points of sustainable development are the reduction of environmental pollution and the increased productivity of natural resources, meaning more goods and services per unit of nature consumed. Simplification of rules which are too restrictive in accessing available funds (co-financing, eligibility, reporting, pre-funding of the project activities, additional funds from the budget allocation) is required. This would also facilitate the absorption rate and reduce the deficit created in recent years especially in LIFE+, Nature and Biodiversity Programme (see "National Strategy for Biodiversity").

CONCLUSIONS AND POLICY RECOMMENDATIONS

As has been suggested, policy recommendations are the result of an interdisciplinary process of assessing the potential competitive features of territorial activities and sectors. The assessment explores both the economic characteristics of competitive areas and the factors that could contribute to the development contexts as *independent units* of analysis. A corollary for future policies is that the necessary initiatives should provide support to achieve a self-sustaining competitive capacity as regards for example innovation, market share, or product differentiation.

The main implication for public policy initiatives is to facilitate an early transition to developing a competitive growth potential. The national evaluation of the competitive potential, even in the absence of delimitation of typologies of areas of development, suggests that the policy issues are defined by such topics as:

- Bacau, 4th place in terms of high-tech exports, is only the 34th of 42 because of the large share of total exports of low technology (almost 70%) and low value of exports / occupied population at just 1,099 euros. *Why spillover effects do not occur?*
- The top five ranking counties account for nearly 50% of total exports, while 20 counties have less than one percent of the total. *How the regional expansion of export potential can take place?*
- South-Muntenia exhibits considerable intra-regional disparities. *What is the optimal territorial coverage of the regional economy?*
- Relative to the volume of exports / occupied population, Arges county is positioned in the first place (10,925 euros), while Bucharest ranks only eighth with 4,968 euros. *What are the vulnerabilities of economic performance of large urban agglomerations?*

The regional evaluation of the competitive potential suggests further policy issues such as:

- In the case of the three poles of urban development (Iasi, Bacau, Suceava), covering a distance of 1 hour *does not* indicate access to important nodal points. *How interventions can improve accessibility in the territory?*
- Poor *connectivity* from all the localities to the three airports (Iasi, Bacau, Suceava) and difficult daily accessibility to major cities show that the polycentric network can't have a clear contour due to low accessibility to major economic flows, a situation which is reflected in the poor attractiveness for foreign investors. *What are the main priorities in terms of economic functionality for these regional economies?*
- The biggest "blank spot" of the European corridor network is located in the northern part of Romania, including a considerable part of the N-E Development Region. *What are the resources to strengthen transnational cooperation?*
- County differentiation confirms that the values derived from the analysis of natural and human resources are also reflected in the degree of economical capitalization. *How to find and use the territorial capital as a resource for economic, environmental, recreational and social purposes?*

Our recommendations focus on a selection of measures based on short-term priorities, namely (1) adjustment of policy interventions on a scale / area of intervention of variable geometry, and (2) gradual allocation of financial assistance according to the difficulties of integration of the development area, as these can be defined at local, regional, national or international level.

There remains a huge potential in terms of capitalization of different types of capital (territorial, human, cultural), but also in terms of achieving mutual reinforcement of links between advanced and less advanced industries. Most of the national territory contributes insignificantly to the economic exploitation of resources through exports and advanced manufacturing. All this means resources which do not currently contribute to economic growth.

Strengthening competitiveness is a process that requires continuous learning and real time action to adjust to changes in economic and technological development. Integrating the new concepts of territorial planning is gradual, long term oriented, and with significant learning economies. The objectives to pursue can be suggested from such measures as mapping of business operations in the target area or establishing non-governmental institution with *observation* and *monitoring* roles.

Recommendations of the ESPON program indicate that the new Member States focus the structural funds first on developing significant urban and other major agglomerations. The process will facilitate convergence at European level, but it is recognized at the same time that it may give rise to

economic disparities and therefore can not be sustained except for a limited period. In light of our findings, the next steps should include a national program of regional development with emphasis on territorial development.

REFERENCES

- „Atlas teritorial al României” available at http://www.mdpl.ro/_documente/atlas/atlas.htm
- Centrul Român pentru Promovarea Comerțului și Investițiilor Străine (2010) *Schimbările comerciale ale României pe județe, în anul 2008-2009*, București.
- Cojanu, Valentin (2009) Către un concept operațional al dezvoltării competitive în plan teritorial, *Revista Transilvană de Științe Administrative*, vol. 1, no. 23, 2009, pp. 19-38
- Conférence du Conseil de l'Europe des Ministres responsables de l'Aménagement du Territoire et Paysage (CEMAT) (2010) *Conclusions des séminaires et symposiums 2000-2010*, Document du Secrétariat Général, Division du patrimoine culturel, du paysage et de l'aménagement du territoire, Direction de la Culture et du patrimoine naturel et culturel, accessed at <http://eeea.fr/inscription.php>
- Consiliul Județean Gorj (2007) *Analiza socio-economică și spațială a județului Gorj*, May, 2007
- Eurostat (2009) *General presentation of regional statistics* accessed on August 2010 at http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics
- Government of Romania (Ministry of Environment and Sustainable Development, MMDD) (2007) *Sectoral Operational Programme Environment 2007-2013*, (Revised Official Proposal), May 2007, accessed on July 2010 at <http://posmediucraiova.uv.ro/files/SOP-ENV.doc>
- Government of Romania, Ministry of Development, Public works and Housing (MDLPL) (2007) *Regional Operational Programme 2007-2013*, Final version 2007, accessed on August 2010 at <http://www.inforegio.ro/user/file/ROP%20Final%20Version.doc>
- Hubner, D. (2010) Presentation to the international conference *The Cohesion Policy from Lisbon Agenda to Europa 2020 Strategy: New Perspectives*, The European Institute of Romania, Bucharest, Intercontinental Hotel, 30th April 2010.
- Ianoș, I. (2004) *Dinamica urbană*, București: Editura Tehnică.

- Iașu C. (2006) *Démographie et géographie du travail en Roumanie post – decembriste*, Iași: Editura Sedcom Libris.
- Necșuliu R. (2007) *Gestiunea socială a parcurilor naturale din Romania*, rezumatul tezei de doctorat, București: Editura Universității București.
- Organization for Economic Cooperation and Development (OECD) (2008) *Green Paper on territorial cohesion - Turning territorial diversity into strength*, Paris.
- Pătroescu, M. (2000). *Natural transborder parks. Biodiversity preserving direction in Romania*, în Laura Westra (ed.) (2000) *Ecological Integrity*, Kluwer Academic Press.
- Rey, Violette, Groza O., Ianoș, I., Pătroescu, M. (2006) *Atlasul României*, ediția a doua, București: Editura Rao.
- Richardson, H.W. (1988) Monocentric versus polycentric models: the future of urban economics in regional science, *Annals of Regional Science*, vol. 22, no. 2.
- Rusu Al. (2009) *Rețeaua orașelor mari din estul României – între tranziție și internaționalizare economică*, Teza de doctorat, Universitatea din Iași.
- Spinaci, Gianluca, and Gracia Vara-Arribas (2009) *The European Grouping of Territorial Cooperation (EGTC): New Spaces and Contracts for European Integration?*, EIPASCOPE 2009/2, available at www.eipa.eu
- Strategia națională pentru Biodiversitate și Planul de Acțiune* (2010), Proiect UNDP-GEF de asistență pentru Guvernul României, București.
- World Wide Fund (WWF) (2004). *Natura 2000 in the New EU Member States. Status Report and list of sites for selected habitats and species*, WWF Report, June 2004.

Appendix 1 Methodology for constructing a competitive potential index at county level

We select three indicators: I_1 GDP/capita; I_2 Exports/employed population; I_3 Technological development index, and define CPI the Competitive Potential Index: $CPI = (I_1 + I_2 + I_3) / 3$

Variables are normalized through the following formula: $I_j = (x_j - x_{\min}) / (x_{\max} - x_{\min})$

where x_j is the value of x characteristic in county j

x_{\min} is the minimum value of the characteristic

x_{\max} is the maximum value of the characteristic

The value of CPI ranges from 0 to 1, where 1 represents the maximum potential.

I_3 is a weighted score calculated for each county depending on the structure of exports taken from the EUROSTAT classification for the grouping of industries according to their technological development:

$$I_3 = (p_4 * 4 + p_3 * 3 + p_2 * 2 + p_1 * 1) / 100$$

Measurement scale:

4 – high technology exports ($p_4\%$ percentage from total exports per county)

3 – medium-high technology exports ($p_3\%$ percentage from total exports per county)

2 – medium-low technology exports ($p_2\%$ percentage from total exports per county)

1 – low technology exports ($p_1\%$ percentage from total exports per country)

Appendix 2 Measuring spatial coverage

The type of coverage areas is determined by *the type of road infrastructure and relief configuration*. The types of infrastructure analyzed are: highways, national roads, and county roads. Speed highway traffic is not influenced by the relief configuration, but speed restrictions may occur through engineering works (restriction of 100 km / h in tunnels or on viaducts).

Total actual localities covered: 2,959

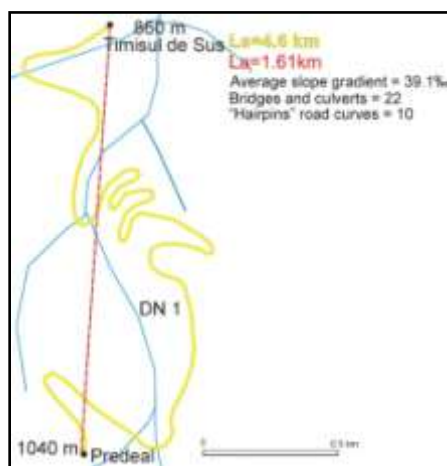
Total localities in all areas of coverage: 3,078

Localities in two areas of coverage (Bucharest and Ploiesti): 119

Total population covered: 8,536,658

	Maximum speed (km/h)	Km covered in one hour	Relief influence
Highway (A)	130	110	No
European Road (E)	100	80	Yes
National Road (DN)	90	70	Yes
County Road (DJ)	90	50	Yes

The relief comes in during the road trip by subtracting the average traffic speed to 50 km / h due to gradients and small radius curves. Example: a declivity of 10 to 15% or radii under 25m - "hairpins".



Example of relief influence for a national road (DN 1 between Brasov and Predeal, the sector Timisul de Sus - Predeal)

L_s = length of road (sinuous), L_a = length of air (ideal), C_s = coefficient of sinuosity due to high slopes, the average slope along the road ($H_{Predeal} - H_{Timisul\ de\ Sus} / L_s$), Hairpins = curve radius less than 25m, average speed = 40km / h.