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# Metropolitan Regions as Centres of Knowledge and Innovation Creation

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## Abstract

Each region can be considered to be an individual regional innovation system. It is possible to distinguish various types of these systems. The approach based on assessment of deficiencies, which are organization thinness, lock-in effect and fragmentation, defines three types of imperfect regional innovation systems. The metropolitan regions are one of these types. These regions can be characterized by above-average research, innovation and patent activity and they are considered innovation centres. But this is not true absolutely; some of them typically have a fragmented innovation system and insufficient linking of its elements. On the basis of theoretical background it is possible to design a group of indicators that characterize this type of regions. The aim of this paper is to find relevant indicators that can be used as a basis for the definition of metropolitan regional innovation systems in the Czech Republic. Using the point method and cluster analysis, the Czech metropolitan regions on the NUTS3 level can be defined. Especially the Capital city Prague and the South-Moravian Region (encompassing the second biggest city Brno) can be defined as metropolitan regions. Other NUTS3 regions that can be considered metropolitan regions are the Pardubice, Central Bohemian, Pilsen and Liberec Regions.

**Keywords:** regional innovation system, knowledge, innovation, region, Czech Republic, metropolitan region

**JEL classification:** R11, O31

## Introduction

Innovation represents an important competitive advantage of regions in advanced countries. However, individual regions differ considerably in their ability to use innovation as a source of their development. On a theoretical level, the territorial significance of innovation is dealt with by national and regional innovation systems. Concepts of national and regional innovation systems also serve as an analytical framework creating an empirical base for innovation policy creation (Doloreux, Parto, 2005). A. B. Lundvall (2010), P. Cooke (1992), C. Edquist (Edquist, Hommen, 1999), F. Tödtling (Tödtling, Trippl, 2005), C. Freeman (2002) and others can be classified as the main representatives of these concepts. Generally, we can define the innovation system as a group of players in the private and public spheres whose activities and interactions influence development and diffusion of innovations in a particular territory (state, region).

It is of considerable importance to distinguish between different types of regional innovation systems (RIS), from the perspective of the methodology of economic sciences as well as the economic policy. One of the approaches is to distinguish the roles of regional and innovation actors in innovation processes (Asheim, Isaksen, 2002); in this, territorially embedded, regional networked and regionalised national RIS are defined. Another way to classify the RIS (Cooke, 2004) is by the dimension of management (grassroots, networked, dirigiste) and the dimension of the innovation

business (localist, interactive, globalised). A different approach is to classify the regions based on their innovation potential, including the creation and dissemination of knowledge, the ability to gain European funds to promote innovation, and the application and use of knowledge (Cooke et al., 2000; Doloreux, 2002). There are regions with strong, medium, and low RIS development potentials. A different political approach divides regions into those undergoing transformation, institutionally thin, those with dualized and interactive RIS (Cooke et al., 2000).

The concept based on the identification of various RIS deficiencies, such as organizational thinness, negative lock-in and fragmentation was established by Tödting and Trippl (2005). They defined three types of RIS: peripheral, metropolitan and old industrial. They based their classification on system failures, defined by Isaksen (2001) as failures inhibiting innovation activities (see Table 1).

Table 1

Classification of barriers to regional innovation systems

The problem of the regional innovation system	The main problem	A typical problem region
Organizational thinness	Lack of relevant local actors	Peripheral areas
Fragmentation	Lack of regional cooperation and mutual trust	Metropolitan regions, some regional clusters
Lock-in	Regional industry specializes in obsolete technologies	Old industrial regions and peripheral areas built on the acquisition of raw materials

Source: Isaksen (2001), adapted

Metropolitan regions, which are the subject of this paper, are characterized by above-average research, innovation, and patent activity and are considered the centres of innovation. These regions have an adequate representation of all types of organizations, for example top research institutions and universities, innovative enterprises, the headquarters of multinational companies and trading services, and the regions thus benefit from the knowledge externalities and agglomeration economies. However, we cannot definitely say that all of the metropolitan regions are centres of innovation. (Tödting, Trippl, 2005) Their problems may be fragmentation of the innovation system and insufficient linking of the different RIS elements. A low level of networking and knowledge exchange leads to an insufficiently developed collective and interactive learning and lower systemic innovation activities. (Trippl, Asheim, Miorner, 2015). Some metropolitan regions may lack dynamic clusters, even though there are individual high-tech companies and knowledge organizations in the region. However, a low level of cooperation represents their innovation barrier, which results in the innovation activities being at a lower level than could be expected. The two main RIS subsystems, the subsystem of creation and the subsystem of knowledge application, operate separately and the links between them are weak. Also the innovation networks among local companies are insufficient, although they cooperate commercially. (Tödting, Trippl, 2005) Examples of fragmented metropolitan regions mentioned in literature are the Vienna agglomeration, Frankfurt am Main, South-East Brabant with Eindhoven in the Netherlands (Tödting, Trippl, 2005), Scania in Sweden, Prague, the South-Moravian Region, Helsinki, Amsterdam or Oslo (Adámek, Csank, Žížalová, 2007).

Based on the theories described above, we can now define the metropolitan regional innovation systems at the level of Czech regions. The aim of this paper is to find relevant indicators that can be used as a basis for the definition of metropolitan regional innovation systems. The structure of our paper goes as follows: The next

chapter deals with methodology and introduces the indicators which have been chosen as the characteristics or features of metropolitan region. In the follow-up part we present results and discuss them. All Czech regions were divided into six clusters and it was decided which ones are metropolitan. Achieved results are summarized in the conclusion.

## Methodology

In this paper we define the metropolitan regional innovation systems in the Czech Republic. All other steps are based on the approach presented by Tödfling and Tripl (2005). The point method seems to be appropriate for identification of the metropolitan regions; this method makes the ranking of the regions based on the cumulative score, in combination with the cluster analysis, thanks to which it is possible to define groups of similar regions, or to classify as metropolitan also those regions where the result of the point method is not clear.

The following eight indicators have been chosen as the characteristics or features of metropolitan regions:

- the number of faculties of public universities (NPF),
- the number of research and development centres per 100,000 inhabitants (RDC),
- the share (%) of employees with university degrees in all the employed in the national economy (UDE),
- the share (%) of businesses in high-tech industrial sectors (NACE 21 and 26) in the total number of businesses in the manufacturing industry (HTI),
- the share (%) of businesses in high-tech service sectors (NACE 59-63 and 72) in the total number of businesses in services (HTS),
- the share (%) of businesses that have implemented a technical innovation in all businesses with 10 and more employees (TIS),
- the business expenditures on research and development as a share (%) of GDP (BRD),
- the share (%) of external costs (purchase of R&D services, purchase of other external knowledge) of businesses in the total expenditures on technical innovation (ECS).

All the indicators, excluding ECS, are assumed to reach high values ("more is better" principle) in terms of the characteristics of metropolitan regions; by contrast, ECS is assumed to reach a low value ("less is better"). All data are as of the end of 2012. The values of these indicators are presented in Table 2.

With regard to the aim and nature of indicators, which are expressed in different units and gain different values, it seems appropriate to use the point method. However, since its results are to a large extent affected by potential major differences in the values of one or more indicators, it can be further combined with the cluster analysis.

The point method (the author is M. K. Bennet) is based on finding the region which in the case of the analyzed indicator reaches the maximum or the minimum value. The minimum value is relevant if the indicator decline is considered positive (the less, the better); the maximum value in the opposite case, an increase in the indicator value is positive. (Melecký, Staníčková, 2011)

The point value of the specific indicator is set:

- in the case of the maximum using equation  $B_{ij} = \frac{x_{ij}}{x_{i \max}}$ ,
- in the case of the minimum using equation  $B_{ij} = \frac{x_{i \min}}{x_{ij}}$ ,

where  $B_{ij}$  is the point value of the  $i$ -th indicator for the  $j$ -th region,  $x_{ij}$  is the value of the  $i$ -th indicator for the  $j$ -th region,  $x_{i \max}$  represents the maximum value of the  $i$ -th indicator and  $x_{i \min}$  is the minimum value of the  $i$ -th indicator.

Table 2

Indicators of RIS typology evaluation – metropolitan regions

Code	Region	NPF	RDC	UDE	HTI	HTS	TIS	BRD	ECS
CZ010	Prague	41	5.47	39.09	5.87	7.33	34.84	1.01	16.78
CZ020	Central Bohemia	1	1.94	19.79	2.97	4.02	34.10	1.10	53.57
CZ031	South Bohemian	10	1.76	17.55	2.85	4.11	35.41	0.64	10.65
CZ032	Pilsen	10	2.08	19.12	3.13	4.56	36.44	1.31	22.42
CZ041	Karlovy Vary	0	0.73	13.23	0.74	1.36	24.75	0.23	15.15
CZ042	Usti	8	1.24	13.76	2.27	2.93	33.54	0.28	6.98
CZ051	Liberec	6	2.05	16.41	2.95	4.47	45.30	0.96	17.30
CZ052	Hradec Kralove	6	2.42	17.43	5.81	4.03	28.67	0.60	14.91
CZ053	Pardubice	7	2.77	14.99	4.61	5.25	36.04	1.27	5.26
CZ063	Vysocina	1	1.72	15.78	1.53	3.35	40.76	0.47	5.38
CZ064	South Moravian	27	3.99	24.78	3.58	6.82	36.31	1.26	7.86
CZ071	Olomouc	8	2.10	17.68	2.05	6.34	32.73	0.56	19.15
CZ072	Zlin	6	2.92	16.64	3.11	6.36	44.43	0.83	14.02
CZ080	Moravian-Silesian	17	2.16	18.14	2.42	5.73	33.76	0.56	13.43

Source: CZSO (2013a, 2013b, 2014), Albertina database (2014), recalculated, the authors.

The region with the maximum (minimum) value of the indicator is assigned with a certain number of points within the point evaluation of each (100 in the calculations carried out here); other regions are rated according to their indicator values (0–100). The main advantage of this method is the possible establishment of integrated indicators - a group of indicators expressed in different units is summarized in one characteristic, a dimensionless quantity (Kutscherauer et al., 2010).

The point values of the individual parameters can further be used as data for the cluster analysis. By means of this analysis, regions can be grouped into clusters based on their resemblances (e.g. Poledníková, Leiková, 2013). Non-hierarchical clustering is used; specifically, for this purpose, the method of k-means with Euclidean distances is appropriate.

## Results and Discussion

The values of the indicators are converted using the point method so that the maximum value of 100 points corresponds to the minimum or the maximum value, depending on the expected interpretation (whether less or more is the better) of the indicator for the metropolitan RIS. When the regions are ranked based on the point score (see Table 3), some results stand out.

Capital city Prague and the South-Moravian Region achieve the highest values. There is a difference in the rate of achievement of the maximum values - Capital city Prague reaches the maximum in five out of the eight cases, the South-Moravian Region not once. However, this is not surprising. Prague is one of the most advanced European regions, and the South-Moravian Region, mainly due to the presence of Brno, is a region with a developed innovation infrastructure and a considerable concentration of knowledge and innovation activities. Further, the Pardubice Region can be classified as metropolitan. In other regions within the ranking, we have to consider their similarities.

Table 3

RIS typology evaluation – metropolitan regions – point method

Code	Region	NPF	RDC	UDE	HTI	HTS	TIS	BRD	ECS	Total
<b>CZ010</b>	<b>Prague</b>	100	100	100	100	100	77	77	31	<b>685</b>
<b>CZ064</b>	<b>South Moravian</b>	66	73	63	61	93	80	96	67	<b>600</b>
<b>CZ053</b>	<b>Pardubice</b>	17	51	38	78	72	80	97	100	<b>533</b>
<b>CZ072</b>	<b>Zlin</b>	15	53	43	53	87	98	63	38	<b>449</b>
<b>CZ032</b>	<b>Pilsen</b>	24	38	49	53	62	80	100	23	<b>431</b>
<b>CZ051</b>	<b>Liberec</b>	15	38	42	50	61	100	73	30	<b>409</b>
<b>CZ080</b>	<b>Moravian-Silesian</b>	41	39	46	41	78	75	43	39	<b>403</b>
<b>CZ052</b>	<b>Hradec Kralove</b>	15	44	45	99	55	63	46	35	<b>402</b>
<b>CZ031</b>	<b>South Bohemian</b>	24	32	45	49	56	78	49	49	<b>383</b>
<b>CZ063</b>	<b>Vysocina</b>	2	31	40	26	46	90	36	98	<b>369</b>
<b>CZ071</b>	<b>Olomouc</b>	20	38	45	35	86	72	43	27	<b>367</b>
<b>CZ020</b>	<b>Central Bohemia</b>	2	36	51	51	55	75	84	10	<b>363</b>
<b>CZ042</b>	<b>Usti</b>	20	23	35	39	40	74	21	75	<b>327</b>
<b>CZ041</b>	<b>Karlovy Vary</b>	0	13	34	13	19	55	18	35	<b>185</b>

Source: authors

To decide which regions are metropolitan, it is necessary to conduct another analysis. For this purpose, the cluster analysis seems to be suitable. It relatively reliably distributes regions into clusters based on their similarities. The hierarchical method of k-means will be used. In the case of distribution into six clusters, the situation is as follows (the order of the clusters is subjected to the mean values of the point score of the sub-indicators in the individual clusters):

- 1st cluster – Capital city Prague,
- 2nd cluster -- the South-Moravian and Pardubice Regions,
- 3rd cluster -- the Pilsen, Liberec, and Central-Bohemian Regions,
- 4th cluster – the Zlín, Hradec Králové, Olomouc, Moravian-Silesian and South-Bohemian Regions,
- 5th cluster – the Ústí nad Labem and Vysočina Regions,
- 6th cluster – the Karlovy Vary Region.

The results of the cluster analysis show that the regions in the first, second and third clusters can be definitely considered metropolitan. On the surface, the ranking of the Central-Bohemian Region can be surprising; however, we have to consider its specific structure, in which the natural centre and regional capital, Prague, is at the same time a separate region. The fourth cluster consists of the regions that have some features of metropolitan regions but cannot be considered as "clear" types.

## Conclusion

Three types of incomplete RIS can be defined by means of the theoretical concept of the regional innovation system typology based on the evaluation of their deficiencies, which are the organizational thinness, the lock-in effect and the fragmentation, whose authors are Tödtling and Trippl. One of these types is metropolitan regions. They are characterized by above-average research, innovation, and patent activity and are considered the centres of innovation. However, this is not of an absolute validity. Some of them have a fragmented innovation system and insufficient linking of the individual RIS elements. Applying the mentioned approach in the environment of the regions of the Czech Republic, first, a system of indicators characterizing this type of regions had to be established. These indicators can be generally described as indicators of research and development,



knowledge creation, and high-tech industries. Metropolitan regions have been identified based on the results of the point method and the cluster analysis. They are mainly the Capital city Prague, the South-Moravian Region (including the second largest city of the Czech Republic - Brno) and the Pardubice Region. The other NUTS3 which can be considered metropolitan are the Central-Bohemian, Pilsen and Liberec Regions. Particularly, the classification of the Central-Bohemian Region is of interest - this region creates the natural background for the capital, which is at the same time its natural centre, but a different region.

Although our research study has certain limitations (e.g. availability of statistical data or testing only one-year data), the designed methodology have strong research potential. The future research can be aimed at verification of results for longer time or comparison with regions of other countries, especially the Visegrad Group countries (Slovakia, Poland, Hungary).

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