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Identification of Czech Metropolitan Regions: How to improve targeting of innovation policy

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Abstract

Concepts of national and regional innovation systems can serve as an analytical framework forming the empirical base for innovation policy creation. It is possible to distinguish various types of these systems. One of these typologies is based on the assessment of innovation deficiencies. There are three types of regions: metropolitan, peripheral, and old industrial. Metropolitan regions can be characterized by a high level of research, innovation, and patent activity. The aims of this paper are to find relevant indicators that can be used as the basis for defining metropolitan regional innovation systems and using them for the identification of Czech metropolitan regions. The results of the point method combined with the cluster analysis showed that the capital city, Prague, as well as the South Moravian, Pardubice, Central Bohemian, Pilsen, and Liberec Regions can be defined as metropolitan regions.

Key words: regional innovation system, knowledge, innovation, region, Czech Republic, metropolitan region

1 Introduction

Innovation is an essential prerequisite for economic prosperity and wealth creation, because it has a significant influence on socio-economic development and its long-term sustainability. We can say that 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, forming an empirical basis for innovation policy creation (Doloreux & Parto, 2005). Lundvall (2010), Cooke (1992), Edquist and Hommen (1999), Tödtling and Trippel (2005), Freeman (2002), and other researchers can be classified as the main representatives of these concepts. Generally, we can define innovation system as a group of players in the private and public spheres whose activities and interactions influence the development and diffusion of innovations in a particular territory (state, region).

The innovation system concept emerged in the 1980s, and its purpose is to explain the disparities in innovation performance of industrial countries. Its proponents have claimed that the differences in economic and technological performance of individual states are given by the combination of institutions present and their interactions. Innovation performance depends on the institutional differences in the introduction, development, and diffusion of new technologies, products, and processes (Metcalfe & Ramlogan, 2008). In recent years, the innovation systems concept has become the primary approach in research into innovations (Kaufmann, 2007).

Initially, the innovation systems concept focused exclusively on the national level (see Tödtling & Kaufmann, 1999); within a short period, it started to be applied to the transnational and especially regional levels. It was affected by the idea that industrial branches are concentrated in some geographical areas, and the existing decentralized policy can be applied at the regional level (Buesa, Heijs, Pellitero, & Baumert, 2006). The innovation systems concept (together with the endogenous growth theory and the cluster-based theory of the national industrial competitive advantage) was also used for the construction of the concept of national innovative capacity. This concept explains the innovation ability using three building blocks: common innovation infrastructure (including science and technology policy), country's industrial clusters, and linkages between them (Furman, Porter, & Stern, 2002).

The innovation systems concept is characterized by an emphasis on cooperation (networking) and interactive learning. Interactive learning is a process whereby its participants cooperate on the creation and application of new and economically useful knowledge (Lundvall, 2007). This learning arises in a specific institutional context—namely, in a systematic environment influenced by (among other things) by regulations, laws, political culture and “game rules” of economics institutions (Mytelka & Smith, 2002). The innovation network is a network of various actors that helps introduce and diffuse innovations (Powell & Grodal, 2005). Activities practiced in these networks include

creation, combination, exchange, transformation, absorption, and utilization of resources through a wide range of formal and informal relations (Fischer, 2001; Tijssen, 1998). Innovation networks can significantly contribute to the improvement of companies' innovation capabilities. Through such cooperation, companies can determine tasks in the innovation process and reach targets that would not be reached without others (Bučar, Jaklič, & Stare, 2010; Powell & Grodal, 2005).

We should distinguish between different types of regional innovation systems (RIS) because it can help further the development of economic theory and the better implementation of 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 way, territorially embedded, regional networked, and regionalized national RIS are defined. Another way to classify the RIS (Cooke, 2004) is through 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, Boekholt & Tödtling, 2000; Doloreux, 2002).

The concepts influencing the identification of various RIS deficiencies, such as organizational thinness, negative lock-in, and fragmentation, were identified by Tödtling and Trippl (2005), who 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).

Organizational thinness is the main deficiency of regional innovation systems in peripheral regions. It means that the key elements of RIS are missing or present only to a small extent. In particular, there is an insufficient presence of innovative companies, universities, research institutes, supporting organizations, and clusters. (Trippl, Asheim &

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

Miorner, 2015) Peripheral regions are also characterized by a low level of research and development, innovation, and patenting activities (Tödting & Trippel, 2005). At the same time, these regions are not able to gain the offered resources (Klímová & Žitek, 2015).

Old industrial regions are characterized by a strong representation of industry that is declining or out of date (e.g., mining industry, metallurgy, heavy engineering) and the emergence of the lock-in effect. This innovation system is considered too embedded or specialized (Trippel et al., 2015; Tödting, Skokan, Höglinger, Rumpel, & Grillitsch, 2013).

Metropolitan regions, which are the subject of this paper, are characterized by a high level of research, innovation, and patent activity and are considered to be the centres of innovation. These regions have sufficient representation of all types of organizations, such as top research institutions and universities, innovative enterprises, the headquarters of multinational companies, and trading services; they thus benefit from the knowledge externalities and agglomeration economies (Tödting & Trippel, 2005). The innovation importance of metropolitan regions is strengthened by the fact that cities are becoming generators of economic development and a source of growth for the whole national economy (Mavrič, Tominc, & Bobek, 2014). However, we cannot definitively say that all metropolitan regions are centres of innovation. They may have experienced fragmentation of the innovation system and poor linkages among the different RIS elements. A low level of networking and knowledge exchange leads to insufficiently developed collective and interactive learning and lower systemic innovation activities (Trippel et al., 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 (weak innovation networks) represents an innovation barrier, which results in the innovation activities being at a lower level than could be expected (Tödting & Trippel, 2005).

Based on the theories described thus far, we can 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 the basis for the definition of metropolitan regional innovation systems and to use these indicators for the identification of metropolitan regions in the Czech Republic. The next chapter deals with the methodology and introduces the indicators that have been chosen as the characteristics or features of metropolitan regions. In the following sections, we present and discuss the results. All Czech regions were divided into six clusters, and it was determined which ones are metropolitan. The results achieved are summarized in the conclusion.

2 Methodology

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

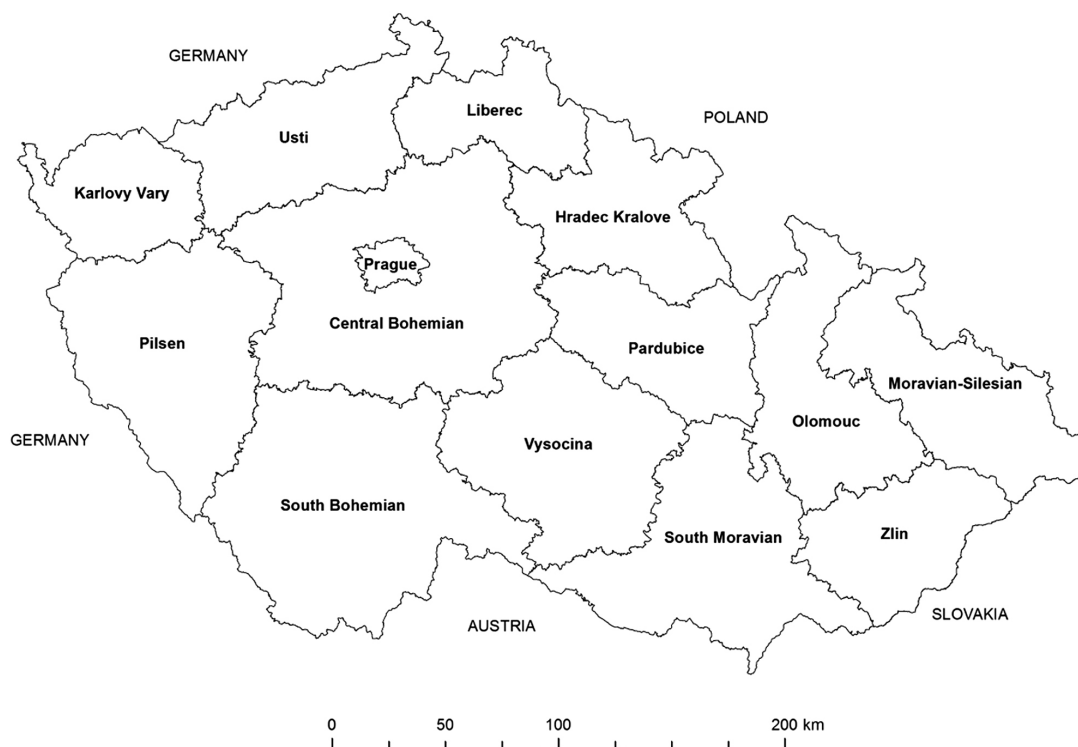
The Czech Republic is divided into 14 regions (NUTS3 regions,) which also represent administrative units within their own regional governments. The capital city of Prague (1.2 million inhabitants) is a self-governing region that is among the most developed regions in Europe based on the gross domestic product and other indicators. Brno (380,000 inhabitants) is the second biggest city in the Czech Republic and the capital of the South Moravian Region. These two cities are considered innovation centres of supranational significance. These regions include many universities, research institutes, innovative companies, and central government bodies. The position of the Central Bohemian Region is very specific, because it surrounds Prague and represents its natural centre. The most important Czech company, Škoda Auto, is located in this region. The economic structure of the Czech regions is affected by natural conditions, the quality of infrastructure, industrial structures, and also continuing structural problems in some cases (especially in the Moravian-Silesian, Karlovy Vary, and Usti Regions). Figure 1 shows all the Czech regions.

When selecting the indicators, we followed the theoretical knowledge provided in scientific literature (Tödting & Trippel, 2005). We searched for indicators that express the presence of knowledge organizations (see NPF, RDC) and well-educated people (UDE). We also needed to evaluate the presence of innovative companies (TIS) and their research activity (BRD). In addition, it was necessary to find out whether the knowledge-intensive branches with high value added (HTI, HTS) are available. We wanted to know whether the knowledge organizations and innovative companies cooperate with each other (ECS). At the same time, all the indicators have to be accessible at the regional level.

The following eight indicators were 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 among all those employed in the national economy (UDE)

Figure 1: Czech NUTS3 regions



Source: Authors

- the share (%) of businesses in high-tech industrial sectors (NACE 21 and 26) in all businesses in the manufacturing industry (HTI)
- the share (%) of businesses in high-tech service sectors (NACE 59-63 and 72) among all businesses in services (HTS)
- the share (%) of businesses that have implemented a technical innovation among all businesses with 10 or 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 of 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, as

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 is based on finding the region that, in the analysed indicator, reaches the maximum or minimum value. The minimum value is relevant if the indicator’s decline is considered positive (the less, the better); the maximum value is the opposite case—namely, an increase in the indicator value is positive (Melecký & Staníčková, 2011).

The point value of the specific indicator is set as follows:

- in the case of the maximum:
- in the case of the minimum:

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.

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

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 Bohemian	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: Albertina Database (2014) and CZSO (2013a, 2013b, 2014), recalculated by authors

expressed in different units that 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 the cluster analysis, regions can be grouped into clusters based on their resemblances (e.g., Poledníková & Lelková, 2012). Non-hierarchical clustering is used; specifically, the method of *k*-means with Euclidean distances is appropriate for this purpose.

3 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.

Prague and the South Moravian Region achieved the highest values. Several differences are evident in the rate of achievement of the maximum values: Prague reaches the maximum in five out of eight cases, whereas the South Moravian Region does not a single time. 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. Furthermore, the Pardubice Region can be classified as metropolitan. In other regions within the ranking, we have to consider their similarities. The situation in the individual regions can be graphically presented using the icon graph (see Figure 2).

To decide which regions are metropolitan, it is necessary to conduct another analysis. For this purpose, the cluster analysis seems to be appropriate. It relatively reliably distributes regions into clusters based on their similarities. The hierarchical method of *k*-means was used. After distributing the regions 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 of Prague
- 2nd cluster: South Moravian and Pardubice Regions
- 3rd cluster: Pilsen, Liberec, and Central Bohemian Regions
- 4th cluster: Zlín, Hradec Králové, Olomouc, Moravian-Silesian, and South Bohemian Regions
- 5th cluster: Ústí nad Labem and Vysočina Regions
- 6th cluster: Karlovy Vary Region

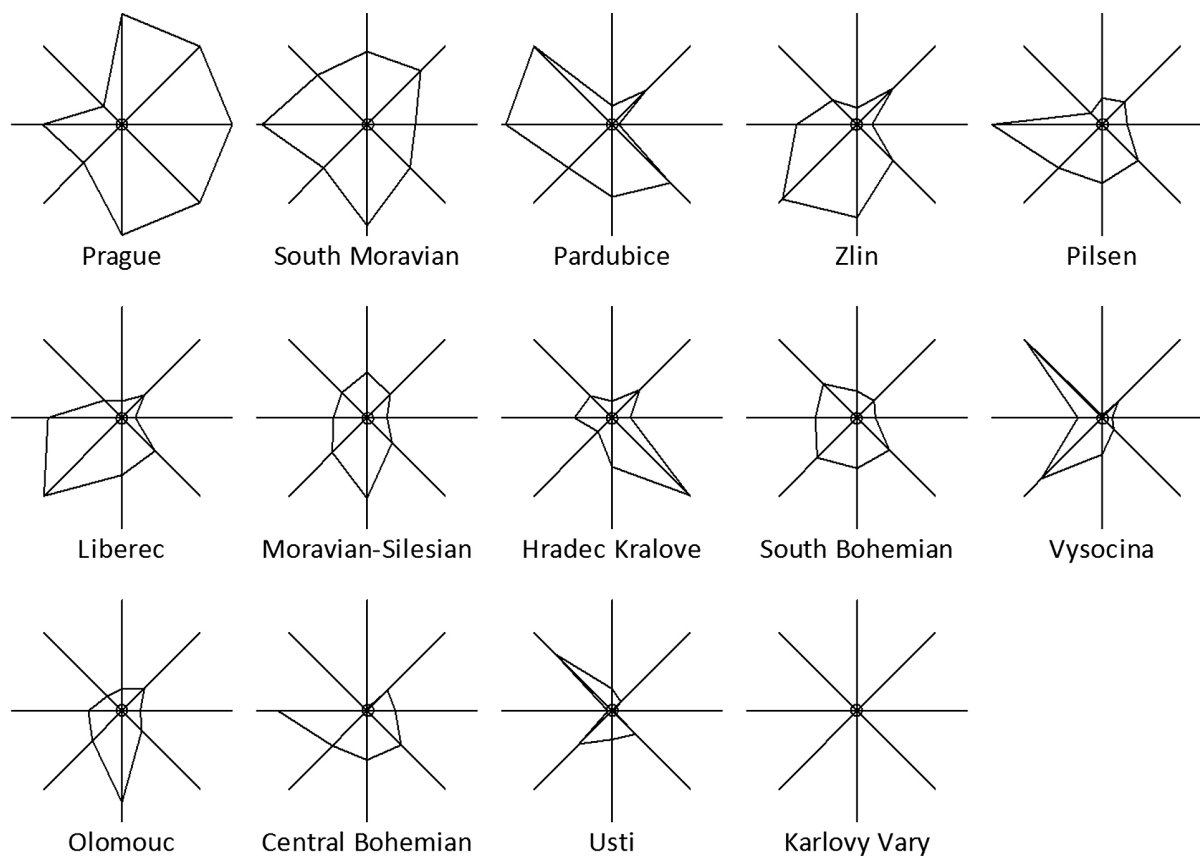
The results of the cluster analysis show that the regions in the first, second, and third clusters can be definitely considered metropolitan (see Figure 3). On the surface, the ranking of the Central Bohemian Region might be surprising; however, we have to consider its specific structure, in which the natural centre and regional capital, Prague, is at the same time a separate region. The fourth cluster consists of

Table 3. RIS Typology Evaluation: Metropolitan regions (point method)

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

Source: Authors

Figure 2: Icon graph of metropolitan region indicators



Note: The eight rays represent the individual indicators. The 12 o'clock position is occupied by NPF, the other indicators (RDC, UDE, HTI, HTS, TIS, BRD and ECS) are ordered clockwise.

Source: Authors

the regions that have some features of metropolitan regions, but cannot be considered as “clear” types. The Czech metropolitan regions lie on the three main developmental axes of national significance: Prague–Brno; Prague–Pardubice, and Liberec–Mlada Boleslav–Prague–Pilsen (Viturka, Halámek, Klímová, Tonev, & Žitek, 2010).

4 Conclusion

A higher level of innovation activity is typical characteristic of metropolitan regions due to two main factors: they have more resources for innovation and they have a more appropriate density of potential innovation partners (Kaufmann, 2007). This density brings various types of externalities, which can enhance innovation opportunities (Dautel & Walther, 2013).

This article identified the Czech metropolitan regions: the capital city of Prague, the South Moravian Region (including Brno, the second largest city of the Czech Republic), and the Pardubice Region. The other NUTS3 that can be

considered metropolitan are the Central Bohemian, Pilsen, and Liberec Regions.

Prague’s economic performance highly exceeds that of the other Czech regions. Prague is home to many multinational companies, research institutes, and universities. Innovation activity in the South Moravian Region is concentrated in Brno, which is a city often referred to as “university city”. In addition to universities, it is home to numerous innovative companies, research institutes, and supporting organizations. In recent years, it has become a research leader, especially due to the large investments financed from the EU cohesion policy. Prague and Brno are considered innovation centres of supranational significance. The advantages of the Pardubice Region are well connected to Prague and the Central Bohemian Region, presence of an international airport, and the tradition of chemical research.

As previously stated, the identification of a regional type enables better targeting of the innovation policy. Metropolitan regions should strive for greater cooperation among regional actors (through the formation of innovation

Figure 3: Czech metropolitan regions



Source: Authors

networks and clusters) and connections to global networks. These regions have the potential to introduce radical innovations that they must develop permanently. They have to support the establishment and development of start-up and spin-off companies in knowledge-based fields. They also have to build high-quality universities and research institutes in order to support specialized qualifications and skills in relevant fields (Tödtling & Trippl, 2005).

We are of the opinion that the capital city of Prague should cooperate closely with the Central Bohemian Region. Both regions have strong mutual linkages, and the border between them is only formal. A very good transportation connection already exists between them, and a lot of people from the Central Bohemian Region commute to work and school in Prague. In turn, Prague's research organizations build their research facilities in Central Bohemia, where real estate is available and cheaper and the organizations can get more support from the EU's structural funds (in terms of the EU cohesion policy, Prague is a more developed region and Central Bohemia is a less developed region). Innovations do not represent the priority for regional governments there, so the political support for innovation is very low in both regions. Until 2015, none of them had their own regional innovation strategy. Furthermore, there is no special agency for innovation support. Therefore, we would recommend paying more attention to the regional innovation policy and establishing a special intermediary organization (innovation centre). To the contrary, the development of innovations in the South Moravian Region has strong political support. The first innovation strategy was approved in 2003 and has continued to be updated. It managed to build two renowned intermediary organizations: the South Moravian

Innovation Centre and the South Moravian Centre for International Mobility. Yet the South Moravian Region needs a better air connection to other countries and a better road connection to Vienna. We do not recommend establishing new public research centres in the three regions mentioned, but it is necessary to develop the existing ones and attract foreign scientists and doctoral students. These three regions have the necessary prerequisites to participate in the Horizon2020 programme. The universities in the Pardubice, Pilsen, and Liberec Regions do not have as good of a tradition as those in Prague and the South Moravian Region, and such tradition cannot be built in the foreseeable future. Therefore, these latter regions have to cooperate more with universities in Prague and Brno and focus on the embeddedness of big innovative companies in their territories. In addition, they need stronger political support for innovation, and it is recommended that they establish intermediary organizations. The Pilsen Region should aim to cooperate with Germany (Bavaria). Poor cooperation represents a weakness of all metropolitan regions. Therefore, we recommend supporting collaborative research projects, innovation vouchers, pre-commercial public procurements projects, participation in international projects, and the like. It is suitable to focus on proof-of-concept projects to support radical innovations; these innovations can be supported through private equity as well (e.g., public venture capital funds).

Although our research study has certain limitations (e.g., availability of statistical data), the designed methodology has a strong research potential. Future research should verify these results over a longer period or compare them with regions in other countries.

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Opredelitev čeških metropolitanskih regij: kako izboljšati ciljanje inovacijske politike

Izvleček

Koncepti nacionalnih in regionalnih inovacijskih sistemov lahko služijo kot analitični okvir, ki tvori empirično osnovo za oblikovanje inovacijske politike. Razlikovati je mogoče več tipov teh sistemov. Ena izmed teh tipologij temelji na oceni inovacijskih primanjkljajev. Obstajajo trije tipi regij: metropolitanski, obrobni in staroindustrijski. Metropolitanske regije je mogoče označiti z visoko raziskovalno, inovacijsko in patentno dejavnostjo. Cilj tega članka je najti ustrezne indikatorje, ki jih je mogoče uporabiti kot osnovo za definicijo metropolitanskih regionalnih inovacijskih sistemov in jih uporabiti za opredelitev čeških metropolitanskih regij. Rezultati točkovne metode v kombinaciji s klustersko analizo so pokazali, da je mogoče regijo Praga ter Južnomoravsko, Pardubiško, Osrednječeško, Plzensko in Libereško regijo definirati kot metropolitanske.

Ključne besede: regionalni inovacijski sistemi, znanje, inovacija, regija, Republika Češka, metropolitanska regija