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Examining Regional Research And Development Indicators for the Visegrad Countries

Testování ukazatelů výzkumu a vývoje v regionech Visegrádských zemí

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Annotation
The focus of the study is on the NUTS II regions in the Czech Republic, Slovakia, Hungary, and Poland. The objective is to analyze research and development expenditures, R&D personnel, employment in high technology sectors and labor force with tertiary education and employed in science and technology at NUTS II level. The use of trend analysis to observe the movement and the changes in performance over time for these variables from 2008 to 2020 is done to draw conclusions. Aside the regions around the capitals like Bratislavský kraj in Slovakia, for the Czech Republic at the least, seven of the eight regions rank in the top performers for the variables considered using the criteria determined in the methodology. Similar trends are observed in Hungary and Poland. Also, although Poland has the most number of NUTS II regions, the total number of regions that make it to the top performers compared to the other countries is low. Attention will need to put into these regions lagging behind to allow for a catching up with the other top performers. For instance, the Czech Republic had seven out of eight, and Slovakia had two to three out of the total for most variables. One of the key points in this study is to compare not only the main regions but also other non-capital regions and to show how interested countries are in regional development by observing changes over time.

Key words
research & development, NUTS II region, science and technology, Czech Republic, Hungary, Poland, Slovakia

Anotace
Studie se zaměřuje na regiony NUTS II v České republice, na Slovensku, v Maďarsku a Polsku. Cílem je analyzovat výdaje na výzkum a vývoj, zaměstnance ve VaV, zaměstnanost v high-tech sektoru a zaměstnance s terciárním vzděláním ve vědě a technice na úrovni regionů NUTS II. K vyvození závěrů je použita analýza trendů, aby bylo možné sledovat pohyb a změny výkonnosti v průběhu času pro tyto proměnné od roku 2008 do roku 2020. Kromě regionů v okolí hlavních měst, jako je Bratislavský kraj na Slovensku, se alespoň za Českou republiku sedm z osmi krajů umístilo na předních příčkách u proměnných posuzovaných podle kritérií stanovených v metodice. Podobné trendy jsou pozorovány v Maďarsku a Polsku. I když má Polsko nejvíce regionů NUTS II, celkový počet regionů, které se dostaly mezi nejvýkonnější ve srovnání s ostatními zeměmi, je nízký. Bude třeba věnovat pozornost těmto zaostávajícím regionům, aby bylo možné dohnat ostatní top aktéry. Například Česká republika jich měla sedm z osmi a Slovensko dva až tři z celkového počtu pro většinu proměnných. Jedním z klíčových bodů této studie je porovnat nejen hlavní regiony, ale i ostatní regiony mimo hlavní město, a ukázat, jak si sledované země vedou v oblasti regionálního rozvoje prostřednictvím sledování změn v čase.

Klíčová slova
výzkum a vývoj, region NUTS II, věda a technika, Česká republika, Maďarsko, Polsko, Slovensko

JEL Classification: *R59*

1. Introduction

There has been much attention on the relationship that exists between innovation, research and geography. Regional variation induces changes in innovation productivity and this has various important implications during public policy formulation. This has been further emphasized by research that seeks to discard the one size fits all framework for a more tailored-to-the-needs framework as determined by the specific conditions for the regions in question. There has been countless studies trying to explain the differences in knowledge spillover usage by firms. Research has proven that knowledge spillovers are highly localized. Cakin and Ozdemir (2015) mentioned that in recent years, R&D, innovation and knowledge-based activities have gained importance in eliminating regional development and regional development differences. Countries have also understood that the most important element of economic growth is innovation and they have started to allocate more resources to R&D investments. With globalization, countries have begun to compete with each other. Countries that want to achieve sustainable economic development and growth in this environment need to use all their resources effectively and efficiently. However, countries that want to gain competitive advantage have to produce different products and services, put forward different methods and develop new technologies rather than traditional products and methods. Realizing this, countries have begun to allocate more resources to R&D and innovation activities. As a result of this, today, regional development approaches have changed and one of the most important issues taken into consideration in the preparation of regional development policies has been innovation. Previous studies show that R&D spending positively influences patenting performance (Mudambi and Swift 2013).

2. Literature Review

Traditionally, investment in R&D has been seen as one of the key techniques to secure technological potential and, therefore, innovation and economic growth (Bilbao-Osorio and Rodríguez-Pose, 2004). R&D investment increases the opportunity of reaching a better standard of technology in firms and regions, which would allow them to introduce new and superior products and/processes, resulting in better levels of income and growth. Equally, Romer (1990) and Lichtenberg (1992) have shown the relationship between investment in technology and R&D expenditure and increases in productivity and growth. Yet R&D is not foreign to the service sector and like innovation, it certainly manifests itself in a different, non-technical form. Since the national economy consists of a large part of tertiary activities, we felt it was essential to measure R&D effort.

Equally, Evangelista et al. (2002) underline that the local innovative capability differs depending on “the density of and quality of systemic interactions as well as the presence of contextual factors favorable to innovation.” R&D intensity generates new thoughts and expands the technological possibility set; the increased know-how endowment in turn enhances the profitability of entrepreneurial activity by facilitating recognition and exploitation of new business opportunities. Hence, the industrial sectors with the largest shares of R&D employment have a tendency to include many new fast-growing companies, while companies with high "technological-competence-enhancing capabilities” can translate knowledge accumulation into sustained growth when knowledge is leveraged through the preliminary scale of such firms' technological endowments (Moutinho, Au-Yong-Oliveira, Coelho and Manso, 2015). Regions characterized by higher R&D investment additionally tend to experience more knowledge spillover, (Acs, Audretsch and Lehmann, 2013), and venture sustainability is influenced not only through traditional economic factors, such as market potential (Moutinho, Au-Yong-Oliveira, Coelho and Manso, 2015) or demand sophistication, however additionally by the possibility to access the knowledge and technology generated by surrounding universities (Acs, Audretsch and Lehmann, 2013). R&D intensity presumably provides an environment in which SMEs can grow through continuous investment in innovation and through attracting external capital (Moutinho, Au-Yong-Oliveira, Coelho and Manso, 2015).

3. Methodology

The focus of the study is on the NUTS II regions in the Czech Republic, Slovakia, Hungary and Poland. The objective is to analyze research and development expenditures, R&D personnel, employment in high technology sectors and labor force with tertiary education and employed in science and technology at NUTS II level. The use of trend analysis to observe the movement and the changes in performance over time for these variables from 2008 to 2020 is done to draw conclusions. According to Eurostat (Eurostat, 2022), Research and development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge. This includes the knowledge of humankind, culture and society and also, to devise new applications of available knowledge. According to the official documentation presented by the Eurostat, the main concepts and definitions used for the production of R&D statistics are given by the Frascati Manual "Guidelines for collecting and reporting data on research and experimental development", made available in (OECD, 2015). Unit of measurement for R&D expenditures for the study focuses on the percentage of gross domestic product for the purpose of ensuring uniformity in comparing the information across various regions in different countries. R&D personnel are collected

in Full time equivalent (FTE) data form. The rationale for using the FTE rather than head count is to allow for comparison and evaluation for all personnel employed in either part time or full time basis. Percentage of persons employed in technology and knowledge intensive sectors in total employed and the percentage of the labor force that have tertiary education and are employed in science and technology are also analyzed.

4. Findings

4.1 Gross domestic expenditure on R&D (GERD)

GERD values for all NUTS II regions from 2008 to 2020 are collected and the top 40% for the GERD values was calculated. In this case, the top 40% corresponds to regions with GERD score of 0.8 or more. Moreover, since there are thirteen years from 2008 to 2020, if a particular region has more than half of its years (seven out of thirteen total years) with GERD of 0.8 or more, it is included in the table. The Tab.1 shows regions with this value of 0.8 or more for majority of the years under study from 2008 to 2020. Regions with more values below the target than those within or above the target where not included. Regions like Západné Slovensko, Stredné Slovensko, Wielkopolskie and Dél-Dunántúl had just one year from the whole data set where they obtained values of 0.8 or more. Regions like Lubelskie, Podkarpackie, Dolnoslaskie, Lódzkie, Lubelskie, and Podkarpackie, had only two or three years in the whole data set where they scored values equal or above the 40% target. Since Közép-Magyarország is the same as Budapest and Pest after it was split, they are considered as one region. Pest however after the split had values below the target. In the same vein, Mazowieckie in Poland was split into Warszawski stołeczny and Mazowiecki regionalny and from 2016, Warszawski stołeczny falls within the top targets whiles Mazowiecki regionalny does not. Seven of all the NUTS II regions in the Czech Republic fall within the top 40% and the only Bratislavský kraj from Slovakia fall within the top 40%. Hungary had only one region (if counting Budapest and Pest after split or just Közép-Magyarország before split). Poland also had six regions (if counting Mazowieckie and Warszawski stołeczny as one), however, considering the fact that there are more NUTS II regions in Poland than the other countries, comparatively, this is not a large number for regions with majority years above GERD value of 0.8. More importantly aside the major NUTS II regions various other emerging regions performed well and were included in the top 40%. The table also lists the simple average for GERD (denoted as S.Av.). All the regions with the exception of Közép-Dunántúl (0.9125) and Pomorskie (0.9917) scored above 1% in simple average. Changes in GERD values over the period was determined for all the top regions and an average for all those changes were computed for each region and denoted as Av. C. Except for Dél-Alföld, all top regions had a positive value for the averages of changes over time.

Tab. 1: Top NUTS II regions for GERD (in percentage of GDP)

NUTS II	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	S.Av	Av. C
Praha	2.01	2.01	1.93	2.16	2.31	2.4	2.58	2.68	2.15	2.35	2.49	2.54	2.83	2.34	0.03
Střední Cechy	1.27	1.34	1.43	1.43	1.47	2.15	2.04	1.93	2.03	2.43	2.66	2.44	2.22	1.91	0.06
Jihozápad	0.95	0.93	1.11	1.32	1.57	1.61	1.67	1.6	1.34	1.3	1.48	1.58	1.49	1.38	0.04
Severovýchod	1.01	1.06	1.11	1.28	1.57	1.46	1.48	1.34	1.26	1.3	1.44	1.45	1.42	1.32	0.03
Jihovýchod	1.35	1.56	1.64	2.05	2.62	2.83	2.94	2.88	2.39	2.32	2.33	2.46	2.6	2.31	0.06
Střední Morava	0.83	0.88	0.93	1.13	1.56	1.39	1.51	1.29	1.23	1.41	1.55	1.6	1.5	1.29	0.06
Moravskoslezsko	0.67	0.81	0.81	1.24	1.14	1.15	1.24	1.19	1.14	1.05	1.12	1.09	1.2	1.07	0.06
Budapest	:	:	:	:	:	:	:	:	:	2.22	2.5	2.41	:	2.38	0.05
Közép-Magyarország (NUTS 2013)	1.32	1.48	1.52	1.6	1.62	1.76	1.83	1.87	1.77	:	:	:	:	1.64	0.04
Közép-Dunántúl	0.55	0.67	0.63	0.68	0.99	1.2	1.1	0.93	0.82	1.03	1.31	1.04	:	0.91	0.08
Észak-Alföld	1.02	1.16	1.05	0.98	1.12	1.27	1.11	1.06	0.88	0.93	0.95	0.94	:	1.04	0
Dél-Alföld	0.75	0.97	0.98	1.02	1.04	1.17	1.11	1.59	0.93	1.06	1.16	1.27	:	1.09	-0.07
Mazowieckie (NUTS 2013)	1.24	1.2	1.35	1.37	1.37	1.55	1.7	1.74	:	:	:	:	:	1.44	0.05
Warszawski stoleczny	:	:	:	:	:	:	:	:	2.08	2.23	2.45	2.56	:	2.33	0.07
Malopolskie	0.9	0.88	0.99	1	1.32	1.31	1.39	1.49	2.15	1.85	2.14	2.22	:	1.47	0.1
Pomorskie	0.56	0.51	0.6	0.7	1.07	0.99	1.06	1.11	1.14	1.08	1.4	1.68	:	0.99	0.12
Bratislavský kraj	0.86	0.85	1.07	1.2	1.56	1.63	1.45	1.79	1.37	1.58	1.41	1.42	1.5	1.36	0.06

Source: Authors' own calculation and Eurostat (2022)

4.2 Total R&D personnel in the total employment

NUTS II regions with percentage of total R&D personnel in the total employment value of 0.40 or higher are selected. Secondly, since there are thirteen total years (2008 to 2020) considered, regions with at least seven of the years (more than 50 percent of all years) out of the thirteen scoring values of 0.40 or higher are considered. The criterion for the selection into the table is that the region must have at least half of its years (seven out of thirteen) under study with 0.40 or more for the R&D indicator. The figures are inclusive of all total R&D personnel and researchers employed in government sector, business sector, higher education sector, and private non-profit organizations. The changes in percentage values for each of the regions from 2008 to 2020 are then tabulated and listed as Tab. 2. From the table, the Czech Republic has seven of NUTS II regions meeting the targets, Slovakia has just Bratislavsky kraj, and Hungary has two regions meeting the target since Közép-Magyarország is considered same as Budapest and Pest after split. Poland has Mazowieckie, Malopolskie and Dolnoslaskie meeting the targets and being included in the list. Taking the averages for the changes in the percentages (denoted as Av) shows that although obvious leaders are observed in the initial values for percentage of total R&D personnel, the changes during the periods shows the increase or decrease over time of approximately 0.075 for all regions and also major changes are not observed. This implies a similar trend in growth for all regions considered, although some regions may have higher initial percentage R&D values.

Tab. 2: Percentage changes in total R&D personnel in the total employment (in full-time equivalent (FTE))

NUTS II	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Av.
Praha	-0.04	-0.05	0.02	0.09	0.02	0.06	0.00	0.01	-0.08	0.07	0.06	0.05	0.04	0.02
Střední Cechy	0.00	0.04	-0.01	0.02	-0.02	0.02	-0.01	0.06	0.10	0.03	0.07	0.02	0.03	0.03
Jihozápad	-0.03	0.10	0.03	0.06	0.12	0.00	0.11	-0.05	-0.02	0.03	0.05	0.12	0.00	0.04
Severovýchod	0.00	0.01	0.04	0.15	0.05	0.04	-0.03	-0.02	-0.01	0.06	0.05	0.02	-0.02	0.02
Jihovýchod	0.20	0.04	0.04	0.02	0.18	0.00	0.10	0.06	-0.02	-0.01	0.05	0.08	0.09	0.07
Střední Morava	0.05	0.00	0.08	0.07	0.06	0.09	0.03	0.06	0.03	0.00	0.02	0.08	0.00	0.04
Moravskoslezsko	0.04	0.12	0.09	0.16	0.21	-0.22	0.14	0.00	-0.04	0.06	0.07	-0.02	0.04	0.05
Budapest	:	:	:	:	:	:	:	:	:	:	0.37	0.02	:	0.20
Pest	:	:	:	:	:	:	:	:	:	:	0.30	-0.03	:	0.14
Közép-Magyarország (NUTS 2013)	0.09	0.08	0.09	0.06	-0.01	0.06	-0.02	0.00	-0.09	:	:	:	:	0.03
Közép-Dunántúl	0.08	0.14	-0.01	0.25	0.40	0.03	-0.15	-0.06	-0.02	0.11	0.24	0.10	:	0.09
Mazowieckie (NUTS 2013)	-0.09	0.00	0.18	-0.05	0.02	0.09	0.01	0.00	:	:	:	:	:	0.02
Malopolskie	-0.15	0.00	0.26	0.14	0.09	0.01	0.17	0.10	-0.06	0.34	-0.01	0.05	:	0.08
Dolnoslaskie	0.02	0.01	-0.08	0.24	0.16	0.19	-0.01	-0.01	-0.10	0.35	0.14	0.04	:	0.08
Pomorskie	-0.15	0.14	0.03	0.16	0.05	0.00	0.06	-0.03	0.06	0.19	0.22	-0.01	:	0.06
Lódzkie	:	:	:	:	:	:	:	:	:	0.11	0.04	0.17	:	0.11
Warszawski stoleczny	:	:	:	:	:	:	:	:	:	0.39	:	:	:	0.39
Bratislavský kraj	-0.02	0.04	0.24	0.04	-0.03	-0.07	-0.07	-0.01	-0.02	0.02	0.05	0.04	0.09	0.02
Západné Slovensko	-0.02	0.03	0.14	-0.08	0.00	-0.05	0.21	-0.01	-0.12	0.28	0.01	0.01	0.02	0.03
Stredné Slovensko	0.11	0.08	0.13	0.01	-0.01	-0.05	0.14	-0.01	0.02	-0.03	0.11	0.07	0.00	0.04
Východné Slovensko	-0.08	0.05	0.05	0.01	0.03	0.03	-0.01	-0.07	0.05	-0.02	0.05	0.02	0.22	0.02
AVERAGE														0.075

Source: Authors' calculation with data from Eurostat (2022)

4.3 Employment in technology and knowledge-intensive sectors

Percentage of total employed persons in technology and knowledge intensive sectors (high-technology manufacturing and knowledge-intensive high-technology services) for all NUTS II regions are collected. Secondly, the top 40% value is determined to be 3.7 percent or more of persons employed in tech and knowledge intensive sectors. Since there are thirteen years (from 2008 to 2020) where values for percentage employed in these sectors are available, regions scoring 3.7% or more in at least seven years (thus more than 50 percent of all years considered) are then collected and tabulated in initial data. The changes in values for the percentage of employed

persons in technology and knowledge intensive sectors are then calculated and included in Tab.3. Data for 2007 on Employment in technology and knowledge-intensive sectors by NUTS II is unavailable and hence the change in percentage for 2008 was not calculated. Bratislavský kraj, Dolnoslaskie, Praha, Strední Cechy, and Közép-Magyarország (or Budapest or Pest) regions had all years under study meeting the 3.7% target. However, other not so major regions can also be found in the list showcasing the improved efforts made to increase performance in this indicator. The Tab. 3 shows the detailed list of regions with changes in their employment percentages over the period and the averages for the years (denoted as Av.).In this regard, it can be observed that, regions had similar performance in terms of increase/ decrease of approximately 0.024 in this employment changes when the obvious leader regions are accounted for. Only Nyugat-Dunántúl had a negative average for changes over the period value. Közép-Magyarország (or Budapest and Pest) and Warszawski stoleczny had their averages calculated for only years with data available which may account for the higher values.

Tab. 3: Changes in employment in tech and knowledge-intensive sectors in NUTS II (measured in percentage of total employed)

NUTS II	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Av.
Praha	0.07	-0.01	0.06	-0.11	0.12	0.12	-0.12	0.15	-0.05	0.05	0.06	0.01	0.03
Strední Cechy	0.11	0.00	0.20	-0.04	0.06	0.00	-0.06	-0.02	0.02	-0.06	0.02	0.07	0.02
Jihozápad	-0.03	-0.05	0.11	-0.15	-0.12	0.03	0.13	0.15	-0.03	0.05	-0.05	0.03	0.01
Severovýchod	-0.03	0.18	0.05	0.22	-0.10	-0.02	0.00	-0.05	0.17	-0.08	-0.07	0.00	0.02
Jihovýchod	0.06	0.21	0.04	-0.06	0.18	0.13	-0.12	-0.06	-0.08	0.15	-0.04	0.14	0.05
Strední Morava	0.11	0.03	0.10	0.18	-0.03	-0.10	0.06	0.16	-0.12	0.16	-0.11	-0.03	0.03
Moravskoslezsko	0.00	0.33	-0.08	-0.14	0.19	-0.11	-0.03	-0.03	0.16	0.11	-0.02	0.02	0.03
Budapest						-0.21	0.11	0.08	-0.13	0.21	0.07	0.18	0.05
Pest						0.09	-0.04	-0.01	-0.06	0.03	0.01	0.09	0.02
Közép-Magyarország (NUTS 2013)	-0.04	0.04	0.03	0.04									0.02
Közép-Dunántúl	0.00	0.02	-0.07	-0.08	-0.23	-0.22	-0.14	0.40	0.09	0.05	0.35	0.04	0.02
Nyugat-Dunántúl	-0.17	0.14	0.35	-0.24	-0.30	0.14	-0.08	0.14	-0.10	0.03	0.18	-0.17	-0.01
Észak-Magyarország	-0.03	0.29	0.13	0.02	0.06	-0.09	-0.10	0.09	0.06	0.02	-0.02	-0.02	0.03
Dolnoslaskie	0.00	-0.05	0.00	0.11	0.10	-0.02	0.05	-0.04	-0.07	0.15	0.06	-0.02	0.02
Pomorskie	-0.10	0.23	-0.05	0.00	0.07	-0.09	-0.18	0.12	0.19	0.05	-0.04	-0.11	0.01
Warszawski stoleczny						0.10	0.05	-0.13	0.04	0.06	0.01	-0.08	0.01
Bratislavský kraj	0.12	0.11	0.10	0.10	-0.06	0.07	0.06	-0.03	0.19	-0.04	-0.13	0.21	0.06
Západné Slovensko	0.00	0.14	0.07	-0.11	-0.05	-0.11	0.03	0.06	0.14	-0.10	0.05	0.00	0.01
Average													0.024

Source: Authors' calculation with data from Eurostat (2022)

4.4 Persons with tertiary education and employed in science and technology

For persons with tertiary education and employed in science and technology, the values for all NUTS II regions are collected and regions with above 15 percent or 0.15 are then determined. Moreover since there are thirteen total years from 2008 to 2020, regions with seven or more of their total years scoring this minimum of above 15 percent are tabulated. The changes in the percentage values over the period are calculated and the average for the period for each region is included in the Tab. 4. The table shows more details where the simple average (denoted as S.Av.) for percentage of labor force with tertiary education and employed in science and technology is compared to the average (denoted as Av.) of the changes over time for the same periods. Certain obvious leader regions like Praha and Jihovýchod in the Czech Republic, Bratislavský kraj in Slovakia, Budapest, Pest, (Közép-Magyarország), and Dél-Alföld in Hungary with higher percentage of their labor force having tertiary education and being employed in science and technology, is observed by the simple average calculation. The simple average highlights the disparity between the leader regions and the other regions, whiles the average of the changes in the percentage allows to observe a somewhat even performance existing among both leader and non-leader regions

with regards to changes over time. It should be noted that the split into Budapest and Pest for Közép-Magyarország (NUTS 2013), and Warszawski stoleczny, Mazowiecki regionalny means averages are done for only years with available data and may show higher than normal values.

Tab. 4: Changes in persons with tertiary education and employed in S&T in NUTS II (measured in percentage of labor force)

NUTS II	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Av.	S.Av.
Praha	0.11	0.00	0.17	0.01	0.00	0.02	0.03	-0.01	0.08	0.04	0.02	0.02	0.05	0.04	30.85
Strední Cechy	0.05	0.13	0.15	0.06	0.10	0.04	0.11	0.00	-0.03	0.07	0.10	-0.07	0.02	0.06	14.27
Jihovýchod	0.01	0.11	-0.01	0.04	0.06	0.09	0.05	-0.01	0.04	0.03	0.02	-0.01	0.10	0.04	16.52
Budapest	:	:	:	:	:	:	0.05	0.03	-0.07	0.01	0.11	0.04	0.06	0.03	35.89
Pest	:	:	:	:	:	:	0.05	0.03	0.05	0.00	-0.03	0.04	0.11	0.03	19.46
Közép-Magyarország (NUTS 2013)	0.06	0.00	0.00	0.11	0.02	:	:	:	:	:	:	:	:	0.04	23.68
Malopolskie	0.08	0.06	-0.01	0.08	0.08	-0.01	0.04	0.09	0.05	0.10	0.00	0.02	0.00	0.05	21.06
Slaskie	0.01	0.10	0.07	0.01	0.02	0.04	0.05	0.05	0.01	0.02	0.04	0.07	0.04	0.04	20.12
Wielkopolskie	0.07	0.03	0.15	-0.01	0.02	0.02	0.12	0.08	0.02	0.01	0.06	0.03	0.05	0.05	16.79
Zachodniopomorskie	0.03	0.03	-0.06	-0.02	0.07	0.07	0.03	0.06	0.01	0.02	0.06	0.02	-0.02	0.02	18.45
Lubuskie	0.06	0.01	0.04	0.01	-0.01	0.08	0.08	0.01	0.05	0.05	0.03	-0.03	0.08	0.04	16.32
Dolnoslaskie	-0.01	0.09	0.09	0.02	0.09	0.07	0.09	0.00	-0.01	0.04	0.06	0.06	0.06	0.05	20.85
Opolskie	0.25	-0.11	0.04	-0.02	0.09	0.10	0.10	0.05	-0.01	0.06	0.05	0.03	0.02	0.05	16.40
Kujawsko-Pomorskie	0.22	0.07	0.00	0.12	0.05	0.04	-0.05	0.06	0.12	0.08	-0.01	-0.03	0.10	0.06	15.52
Warminsko-Mazurskie	0.10	0.23	-0.02	0.01	-0.06	0.08	0.07	-0.03	-0.03	0.07	0.06	-0.02	-0.02	0.03	16.92
Pomorskie	0.04	0.08	0.03	0.09	0.05	0.02	-0.03	0.09	0.04	0.08	0.02	0.05	0.01	0.04	21.65
Lódzkie	0.02	0.05	0.03	-0.02	-0.01	0.01	0.17	0.08	-0.02	0.06	0.00	-0.04	0.10	0.03	17.82
Swietokrzyskie	0.28	0.16	-0.10	-0.05	0.09	0.16	0.03	-0.03	0.09	0.01	0.09	0.02	0.04	0.06	15.55
Lubelskie	0.10	0.07	0.01	0.01	0.08	0.07	0.07	0.02	-0.03	-0.03	0.14	0.12	0.00	0.05	17.66
Podkarpackie	0.08	0.06	0.07	-0.01	0.06	0.03	0.03	0.10	0.05	0.01	0.04	0.09	0.04	0.05	16.92
Podlaskie	-0.03	0.03	0.04	0.03	0.06	0.04	0.05	0.03	0.04	0.08	0.01	0.07	-0.02	0.03	18.40
Warszawski stoleczny	:	:	:	:	:	:	0.05	0.01	0.03	0.07	0.03	-0.02	0.00	0.02	41.34
Bratislavský kraj	0.05	0.12	0.07	0.04	0.00	-0.03	0.08	-0.08	0.01	0.13	0.00	0.07	-0.06	0.03	27.08

Source: Authors' calculation with data from Eurostat (2022)

5. Conclusion

In this study, R&D expenditures and R&D personnel distribution for the various NUTS II regions were observed. Examining the changes in the various indicators over the time period showed that, although obvious regional leaders can be seen, non-major regions can also be observed as in the case of Czech Republic which had majority (more than half of all NUTS II) regions in the top performers for GERD, total R&D personnel in total employment and percent of labor force employed in science and technology. Examining the change in values rather than the just the percentages also allows for comparison in the relative movement (increase/decrease) for the various indicators, which shows that although certain regions have higher percentage values, there is similar value increase and/or decrease for majority of the regions included in the tables regardless of being regional leader or not. Also, concentrations were observed within the major NUTS regions in Slovakia for percentage of labor force with tertiary education and employed in science and tech, and GERD. This phenomenon is observed in Hungary for total R&D personnel in total employment and employment in high tech sectors. This will imply that resources and facilities are not uniformly available in all the regions or that, conditions are not conducive to allow for a uniform use of resources and facilities. Attention will need to put into these regions lagging behind to allow for a catching up with the other top performers. Also, Poland has more NUTS II regions than the other countries under study, however, majority of the top performers in the various indicators were in the Czech Republic (three indicators had

seven Czech NUTS II regions in each from the total of regions). Conclusively, NUTS II regions in Czech Republic and Hungary occupy more places in the top list. As R&D is one of the key aspects of general and regional development, the future development of the regions of these countries is more expected. From another perspective, it is possible to look at the total R&D personnel in the total employment data to see how active the R&D sector is, and here the Czech Republic is the leading country, with 7 regions meeting the target. In general, the amount spent on the R&D sector, and its other indicators by regions, as well as the number of employees in the R&D sector, shows how active the sector is and how much the country is interested in this field. In addition, not only the data and analysis of the main regions, but also the analysis of other regions allows us to clarify the importance countries attach to regional development. Although some data were unavailable, it did not have a major impact on the overall analysis for these countries.

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