REGIONAL COMPETITIVENESS DYNAMICS: A COMPARATIVE ANALYSIS USING RCI 2.0 METHODOLOGY

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Abstract

This paper employs the Regional Competitiveness Index (RCI) 2.0 methodology and sigma convergence analysis to examine the dynamics of regional competitiveness. The data used in this study were published by the European Commission in the 2016, 2019 and 2022 editions, and have been adjusted to align with the RCI 2.0 methodology. A portion of the data is derived from the WEF database. The methodology section elucidates the construction of the RCI 2.0 composite indicator and provides a concise overview of the advantages and disadvantages of the selected methodology. In the practical section of the paper, the sigma convergence method is employed to contrast the regional competitiveness of the two original EU member states, Germany and Austria, and the Visegrad Four countries. The primary objective of this paper is to assess whether there is regional convergence in economic performance (GDP per capita in purchasing power standards (PPS)) in the NUTS2 regions over the period under review. A related objective is to determine whether differences in economic performance between the capital city and the other regions persist in the new member states. The second objective is to map the convergence process in the sub-indices of regional competitiveness (Basic, Efficiency, Innovation) and to identify the competitiveness pillars where the differences between regions are most significant. By providing insights into the dynamics of regional competitiveness, this paper can contribute valuable insights for policymakers and stakeholders who strive to promote balanced development and increased competitiveness in each region.

Keywords: key composite index, regional competitiveness, regional disparities, sigma-convergence

JEL Code: O11, O18, O47

Introduction

A significant aspect of EU economic policy is the promotion of regional growth and the reduction of wealth disparities between EU regions. The degree of achievement of these goals can be observed in the evolution of the basic indicator of economic performance and living

standards (GDP per capita). The composite indicators of competitiveness provide evidence of the preconditions for higher economic performance at the country and regional levels. Using the concept of sigma convergence, we aim to assess whether national and regional differences in a selected group of countries (our sample consists of the Visegrad Four countries, Germany and Austria) are decreasing or persisting. The performance of countries (and regions) in the composite Regional Competitiveness Index (RCI 2.0), its sub-indices and pillars allows the identification of both convergence and persistence of any differences in key aspects of competitiveness. It also makes it possible to assess the success and effectiveness of European regional policy instruments.

1   Literature review and methodology

1.1   Some selected aspects of regional convergence in the EU - a brief literature review

The convergence process at the national and regional levels is closely linked to the deepening economic integration of EU countries. For instance, Baldwin and Wyplosz (2022) highlight the following effects of deepening EU economic integration: 1) reducing trade costs tends to reduce the importance of local competition and reinforce the benefits of economies of scale. 2) Consequently, economic integration leads to a greater concentration of economic activity in specific locations, and the forces driving this concentration are self-reinforcing. 3) These forces are driven by the mobility of physical and human capital, as well as technology spillovers.

The empirical literature focusing on the geographical determinants of the convergence process (e.g. Krugman, 1999; Alcidi, 2019; Babecký, Komárek, 2020) is concentrated on the impact of agglomeration and dispersion forces on firm decision-making. Agglomeration forces demonstrate that firms wish to operate in a large market for the following reasons: 1) Large quantities of their products can be sold in these markets (demand linkages), 2) In areas with high firm concentration, there is easy access to cheaper intermediate goods and services needed to finalise the product (cost linkages). These demand and cost linkages lead to a concentration of economic activity. Conversely, increasing local competition, higher costs of establishing a competitive position, and infrastructure congestion in agglomerations may reinforce dispersion forces in firm decision-making.

Puga (1999) tried to explore the relationship between the degree of regional integration and regional differences in production structures and income levels. His main conclusion is that when workers migrate to places with more firms and higher real wages, this intensifies agglomeration (Puga, 1999, p.303). As Alcidi (219) points out, the acceptance of Puga's

argument (in the EU context) is based on the fact that greater labour mobility within countries has strengthened agglomeration in metropolitan areas. Crescenzi and Guia (2019) investigated the impact of cohesion policy on regional growth and employment with the results: 1) cohesion policy has a positive impact on economic growth in the EU Member States, and 2) the benefits of this growth are concentrated mainly in Germany. Alcidi (2019) demonstrates that the distance between the richest and the poorest Member States before the pandemic crisis was greater than when the euro was introduced.

Pina and Sicari (2021) show that progress in regional convergence in the EU has been uneven over the last two decades, at the same time disparities between large cities and rural areas have widened in most countries. According to these and other authors, worldwide factors hindering convergence include globalisation, digitalisation, and global warming, but also the effects of the pandemic and energy crises. On the other hand, incomplete financial integration, less effective fiscal governance and insufficient innovation performance are usually considered Europe-specific factors hindering convergence. Alcidi (2019) demonstrates that the present distance between the richest and the poorest EU Member States is greater than when the euro was introduced, despite the high growth period before the crisis. Using the concept of beta-convergence, Alcidi´s analysis shows that Central and Eastern European (CEE) countries (with a lower-than-average initial relative GDP per capita) have experienced the largest growth rates and the highest speed of convergence towards the EU average. By contrast, the position of most Southern EU Member States (with an initially higher-than-average GDP per capita) has deteriorated concerning the EU average. (Alcidi, 2019, p. 6)

1.2   Measuring convergence between regions - methodology

The concepts of beta- and sigma-convergence are used to assess the development and degree of real convergence across regions. These concepts are based on the neoclassical theory of economic growth.

Beta-convergence refers to the tendency for less developed countries (or regions) to grow at a faster rate than more developed ones, thus narrowing the economic gap over time (Barro & Sala-i-Martin, 1992; Quah, 1996; Sala-i-Martin, 1996). This phenomenon is often attributed to factors such as capital accumulation, technology diffusion, and policy interventions targeted at promoting growth in lagging regions. Sigma convergence, on the other hand, pertains to the reduction in the dispersion or variance of economic indicators across regions or countries within the EU (Barro & Sala-i-Martin, 1992; Quah, 1996; Sala-i-Martin, 1996). It signifies a trend where regional economic disparities diminish over time. While the

concept of beta-convergence allows assessing whether poorer regions are catching up with richer regions, sigma-convergence is used to assess the degree of convergence across regions and over time. Thus, if the standard deviation (s.d.) between regions is decreasing, then the degree of convergence is higher and vice versa. The reference indicator for EU regional policy is GDP per capita in PPP[1]. Our approach to the measurement of sigma-convergence is traditional: the sigma coefficient = the standard deviation of regional GDP per capita in PPP (results in RCI 2.0 or BASIC, EFFICIENCY and INNOVATION sub-indices) relative to the country's average at the NUTS 2 level. Lower values mean a higher degree of convergence.

1.3   Methodology of RCI 2.0 – a brief description

According to the World Economic Forum (WEF), competitiveness at the national level is "the set of institutions, policies, and factors that determine a country's level of productivity" (Schwab, 2019). The definition of regional competitiveness formulated by the European Commission emphasises the interests of both businesses and residents (Dijkstra et al., 2023). This definition balances the goals of firm competitiveness with those of societal well-being. The concept of sustainability refers to the ability of a region to provide an attractive environment in the short and long term (the designers of the composite index methodology assume that variables assessing human capital and the quality of institutions should predict the long-term competitive potential of a region).

The RCI 2.0 is based on the framework developed by the WEF for its Global Competitiveness Index (GCI). Designers of the RCI 2.0 adapted the WEF framework to the EU regional context to capture the underlying factors that support a region's long-term economic development[2]. The RCI consists of three sub-indices - "Basic", "Efficiency" and "Innovation"

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[1] As e.g. Babecký and Komárek (2020) highlight, the use of GDP in PPP leads to some distortion of the results. An impact of this methodological choice is an overvaluation of the results for the newer EU member states (with generally lower price levels compared to the EU average) and undervaluation of the results for traditional EU countries. It is given by the PPP calculation mechanism, which takes into account, for example, income and expenditure of the population that are de facto not taken into account in the currency's market exchange rate, such as the size of subsidies provided, the breadth of the administered price segment and differences in the rate of taxation and the level of social transfers. Conversely, the exchange rate based on PPP does not reflect current demand for the currency on the foreign exchange market, including, for example, global sentiment. (Babecký and Komárek, 2020)

[2] The fifth edition of the RCI does not capture the impact of short-term shocks such as the COVID-19 pandemic or the invasion of Ukraine. To avoid the pandemic distorting the underlying drivers of competitiveness, 2019 data has been used for some indicators - see the description of the RCI 2.0 methodology (Dijkstra et al., 2023). The last (the fifth) edition of the RCI maintains the structure of the previous editions but uses an improved framework to facilitate comparisons over time. To point out the change in methodology, this new edition is named RCI 2.0.

- and 11 pillars that describe different aspects of competitiveness. The structure of the framework is illustrated in Table 1.

Tab. 1: RCI 2.0 pillars

RCI 2.0 Sub -indices	Pillars	s.d.	The best value (2022)	The worst value (2022)
A. Basic (2/29), s.d. 23.9 Nominal weight of the pillar: *6 %; 5 %; 4 %** *The best value: Netherlands* *The worst value: Romania*	1. Institutions (2/12)	41.2	Finland	Bulgaria
	2. Macroeconomic stability (5/0)	29.6	Denmark	Greece
	3. Infrastructures (3/0)	27.0	Netherlands	Romania
	4. Health (6/0)	21.5	Sweden	Lithuania
	5. Basic education (3/0)	37.8	Estonia	Bulgaria
B. Efficiency (17/0), s.d. 17.0 Nominal weight of the pillar: 16.6 %; 16.6 %; 16.6 %* *The best value: Netherlands* The worst value: Romania	6. Higher education, training and LLL (5/0)	18.4	Sweden	Romania
	7. Labour market efficiency (9/0)	13.8	Germany	Greece
	8. Market size (3/0)	46.4	Netherlands	Malta
C. Innovation (19/0), s.d. 31.0 Nominal weight of the pillar: 6.6 %; 8.3 %; 10 %* *The best value: Luxembourg* The worst value: Romania	9. Technological readiness (6/0)	34.8	Denmark	Bulgaria
	10. Business sophistication (3/0)	37.4	Luxembourg	Romania
	11. Innovation (10/0)	29.5	Luxembourg	Romania
Composite indicator	**RCI 2.0 _2016**	27.3	Netherlands	Romania
	RCI 2.0 _2019	22.0	Luxembourg	Romania
	RCI 2.0_2022	19.9	Netherlands	Romania

Source: Dijkstra et al., 2023, author's processing. Note: The quantities of the two types of variables used in sub-indices and pillars (hard data/soft data) are mentioned in the 1st and 2nd column (in brackets). *Nominal weights of pillars for three stages of development (stage 1, stage 2, stage 3) are listed in the first column.

The "Basic" sub-index identifies the main issues that are essential for the development. The "Institutions" pillar captures the quality and efficiency of institutions, the level of perceived corruption and the general regulatory framework in each country. "Macroeconomic stability" (Pillar 2) is essential to ensure confidence in markets, both for consumers and for producers of goods and services. Stable macroeconomic conditions should lead to higher levels of long-term investment and be an essential ingredient for maintaining competitiveness. Quality of infrastructure (Pillar 3) ensures easy access to other regions and countries, contributing to better integration of peripheral and lagging regions. Good population health (Pillar 4) leads to greater labour market participation, longer working careers, higher productivity and lower health and

social care costs. The indicators of pillar "Basic education" (5) focus on the outcomes of compulsory education as an indicator of the efficiency and quality of the education system. A high level of basic skills and competencies increases the ability of individuals to achieve good subsequent employment outcomes and to continue in tertiary education.

The sub-index "Efficiency" comprises three pillars: (6) "Higher education, training and lifelong learning", (7) "Labour market efficiency" and (8) "Market size". The 'Higher education and LLL' pillar captures the contribution of education to productivity and economic growth. The "Labour Market Efficiency" emphasises the importance of efficient and flexible labour markets for the efficient allocation of resources. The choice of variables in the 'Market size' pillar (disposable income per capita, potential market size expressed in GDP, potential market size expressed in population) predicts that larger markets allow firms to develop and exploit economies of scale and can potentially stimulate entrepreneurship and innovation.

The "Innovation" sub-index includes three pillars that drive improvements at the most advanced stage of economic development. The 'Technology Readiness' pillar measures the extent to which households and businesses use and adopt existing technologies. The Business Maturity Pillar (10) assesses the level of maturity of enterprises[3]. The variables entered in the 'Innovation' pillar assess the ability to maintain a competitive advantage through the introduction of new technologies and the production of cutting-edge products. The level of regional innovation capacity influences how technology diffuses within the region. (Dijkstra et al., 2023)

The explanatory power of a composite indicator always depends on the choice of sub-steps leading to the final composite indicator. The compilers of the RCI 2.0 have opted for min-max normalisation[4] and the same weights (linear aggregation) from the particular indicators up to the level of the sub-indicators. Non-identical weights (different weights for different stages of development) were used from the sub-indicators up to the overall RCI. It is necessary to take into account that linear aggregation is considered questionable by many authors. E.g. El Gibari et al. (2018) point out that this attitude to aggregation enables total compensation among the

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[3] The potential for specialisation and diversification can help regions respond to competition. Specialisation in high value-added sectors also contributes to competitiveness.

[4] This normalization is reflected on a scale from 0 to 100, where 0 represents the lowest performance and 100 represents the best. At the same time, the indicators that have a negative direction are reversed. The formula used is the following: $y = 100 \times (x - min) / (max - min)$, where *min* and *max* are the minimum and maximum values in the set of observed values. (Dijkstra et al., 2023)

different criteria[5]. Table 2 shows the criteria for dividing countries into development stages and provides an overview of which countries belong to each stage.

Tab. 2: Development stage_weighting scheme and countries

Stage of development	Sub-index weights			Countries
	Basic	Efficiency	Innovation	
Stage 1: GDP index < 75	30 %	50 %	20 %	BG, EL, HR, RO, LV, SK, HU, POL
Stage 2: GDP index [75-100]	25 %	50 %	25 %	PT, EE, LT, ES, SI, CY, CZ, IT
Stage 3: GDP index > 100	20 %	50 %	30 %	MT, FR, FI, BE, SE, DE, AT, NL, DK, IE, LUX

Source: Dijkstra et al., 2023, author's processing.

Our countries are included in all three stages (Stage 1 - Hungary, Poland and Slovakia, Stage 2 - Czechia, Stage 3 - Austria and Germany). In terms of compensability, it is important whether a country (region) is successful in a pillar (variable) with high importance in the composite index (i.e. with a high nominal weight). Column 1 of Table 1 shows both the weights of the sub-indexes and the weights of the pillars by level of development. The third column of this table shows the variation across countries in each pillar, and the fourth and fifth columns show the countries with the best and worst performance in each pillar. The setting of the nominal weights shows that the competitive advantage in the pillars of the Efficiency sub-index has the highest offsetting potential. The most influential variables in this sense are the Market Size pillar variables. The variability makes it possible to assess the impact of competitive advantage (disadvantage) on the overall rating (ranking) of a country (region). A competitive advantage in a pillar with high variability and high nominal weight then positively affects the final ranking of the country (region).

2   Measuring sigma-convergence

### 2.1   Convergence of real GDP per capita

When evaluating convergence, it is useful to take a more detailed view and look at the wealth of individual regions (Babecký and Komárek, 2020). The evolution of GDP per capita in purchasing power parity (PPP) for the NUTS 2 regions of selected EU countries reveals that in all chosen countries (except Germany), the capital cities are significantly wealthier than the

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[5] This type of the aggregation presupposes that the weights attached to the different variables 1) add up to one and 2) reflect the importance of the variables. As e.g.Kuc-Czarnecka et al. (2020) emphasise, both assumptions are highly questionable.

national average of the country (see Figure 1). This gap is more than double and persistent in the newer EU Member States. In Austria, on the other hand, the gap between the capital city and the other regions is significantly smaller and decreasing. Despite the widening gap between the capital cities and other regions in Czechia, Hungary, Poland and Slovakia, the wealth of most regions in these countries (and hence the economies as a whole) grew faster than the EU-27 average (see Figure 2).

Fig. 1: Ratio of real GDP p.c. in PPP in the capital city to the nationwide average

Fig. 2: Real GDP p. c. in PPP, nationwide average (index, EU-27 = 100)
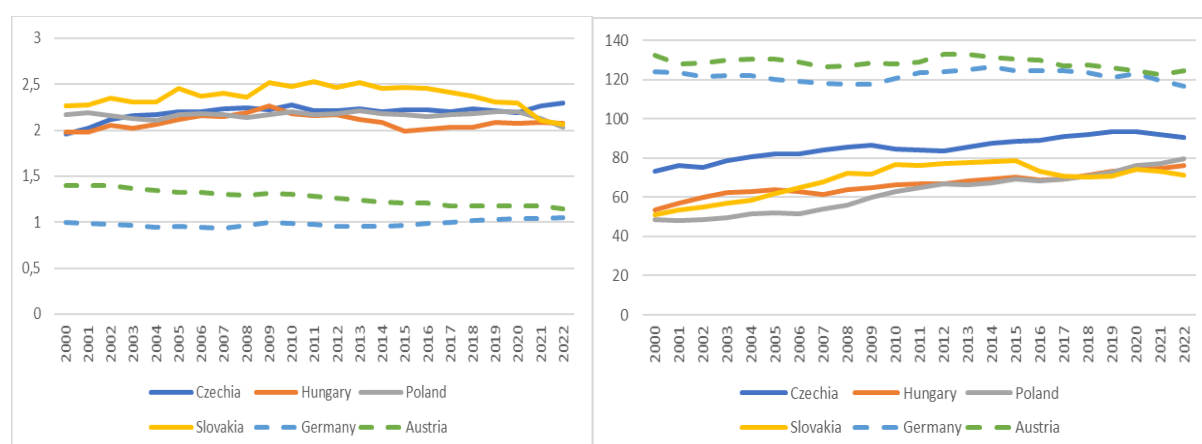
Source: Eurostat, author's processing.

Babecký and Komárek's (2020) analysis, conducted on a larger sample of EU countries, shows a clear relationship between country wealth and regional disparities (capital versus regions). The poorer the country, the more visible the disparities between capital cities and regions. The highest differences in GDP per capita were observed for Romania, followed by roughly similar differences for Hungary and Slovakia. In contrast, for Germany and Austria, the disparities between the capital (largest) city and the other regions are negligible.

The evolution of the sigma coefficient (Figure 3) demonstrates that the sigma convergence between regions (including the capital city) is more likely to have occurred in the traditional countries, i.e. Austria and Germany, while the differences between the capital city and the other regions persist in the new Member States. Austria has the highest degree of sigma convergence between regions at the country level, while the degree of inter-regional convergence of German regions is only slightly lower.

Fig. 3: sigma convergence of real GDP per capita at the regional level

Fig. 4: sigma convergence of real GDP per capita at the regional level (excluding "capital city" region)
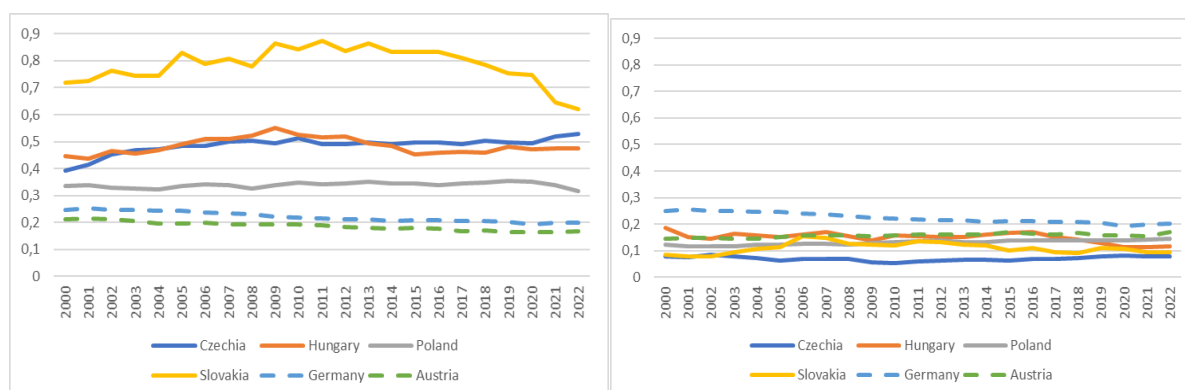
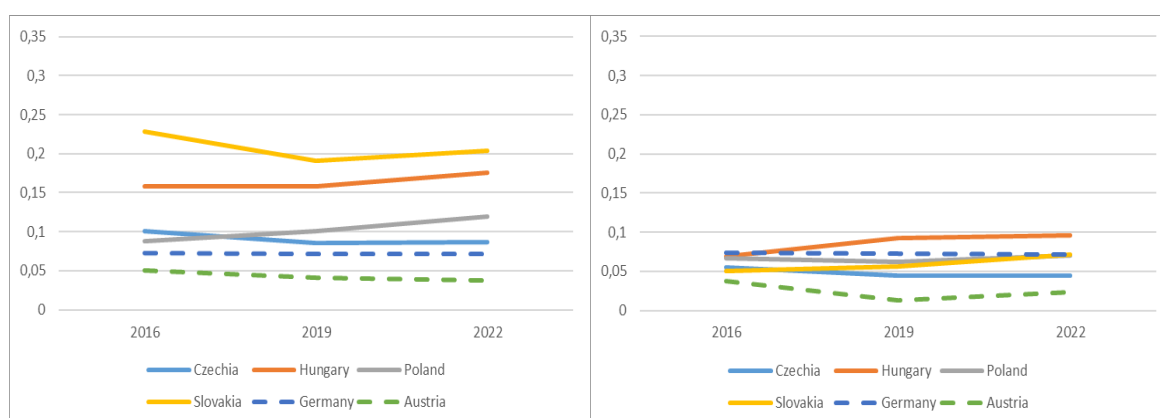Source: Eurostat, author's processing.

After 2009, there has been some inter-regional convergence in Hungary and Slovakia, while a slight divergence can be observed in Czechia, especially after 2020. However, the gap with the above-mentioned traditional EU economies is still significant. If we exclude the capital region (see Figure 4), the differences within the newer Member States are comparable to the traditional EU Member States (the lowest differences in Czechia illustrate the exclusive position of Prague among the Czech regions).

2.2   Convergence of RCI 2.0 and sub-indices

The values and evolution of the sigma coefficient for RCI 2.0 (see Figures 5 and 6) and its sub-indices (see Figures 7-12) confirm the trends observed in the previous section (2.1.).

Fig. 5: RCI 2.0_sigma convergence at the regional level

Fig. 6: RCI 2.0_sigma convergence at the regional level (excluding "capital region")

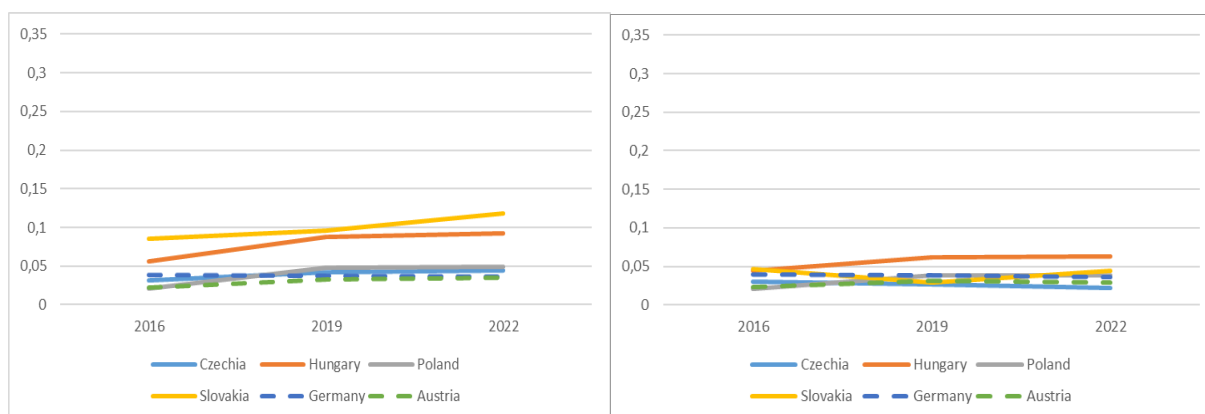
Source Dijkstra et al., 2023, author's processing

The most converging regions are in Austria, while the largest differences between the capital city and other regions were found in Slovakia. Out of consideration for the availability

of data (only data from three yearbooks were adjusted according to the new methodology, and some partial variables in a given yearbook are available for different previous years), it is not meaningful to use regression analysis to identify the relationships between the sigma convergence of living standards (GDP per capita) and the sub-indices of regional competitiveness. Consequently, our sub-conclusions on convergence can only be seen as a tendency with limited explanatory power.

The values of the sigma coefficient in the BASIC sub-index (see Figures 7 and 8) indicate the smallest regional differences in the basic assumptions of regional competitiveness. These differences are mainly conditioned by the ranking in the infrastructure pillar (the pillar with the highest regional variability in the sub-index). The largest regional differences in Slovakia indicate Bratislava's regional competitive advantage in the assessment of infrastructure quality.

Fig. 7: RCI 2.0_sigma convergence of BASIC sub-index at the regional level

Fig. 8: RCI 2.0_sigma convergence of BASIC sub-index at the regional level (excluding "capital region")
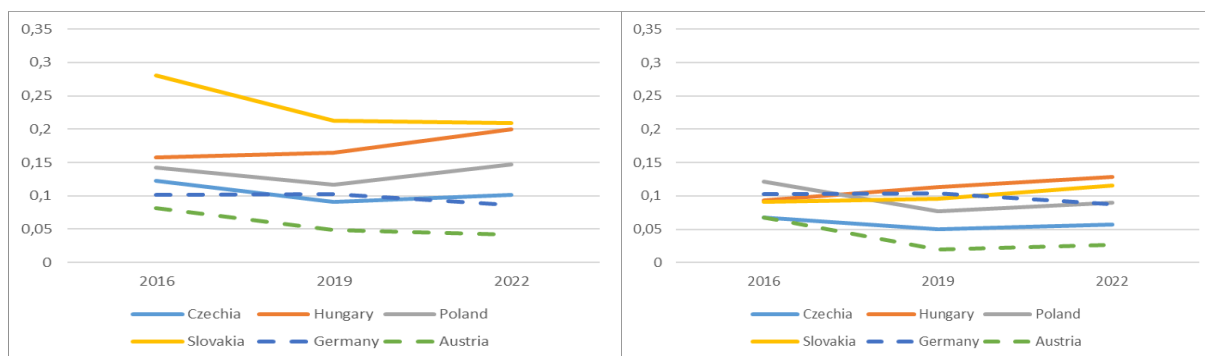

Source: Dijkstra et al., 2023, author's processing

The ranking of countries in the EFFICIENCY sub-index indicates (except for Slovakia in RCI 2.0 2022) their competitive advantage in this area (see Dijkstra et al. 2023). Figures 9 and 10 show the largest regional differences in Slovakia and Hungary, with Hungary and Poland showing a widening gap in both graphs (all regions and regions excluding the capital city) in 2022. The country with the smallest regional differences is Austria, followed by the Czech

Republic. The balanced values of the sigma coefficient for Germany in both graphs confirm Germany's distinctiveness compared to the other original Member States[6].

Fig. 9: RCI 2.0_sigma convergence of EFFICIENCY sub-index at the regional level

Fig. 10: RCI 2.0_sigma convergence of EFFICIENCY sub-index at the regional level (excluding "capital region")
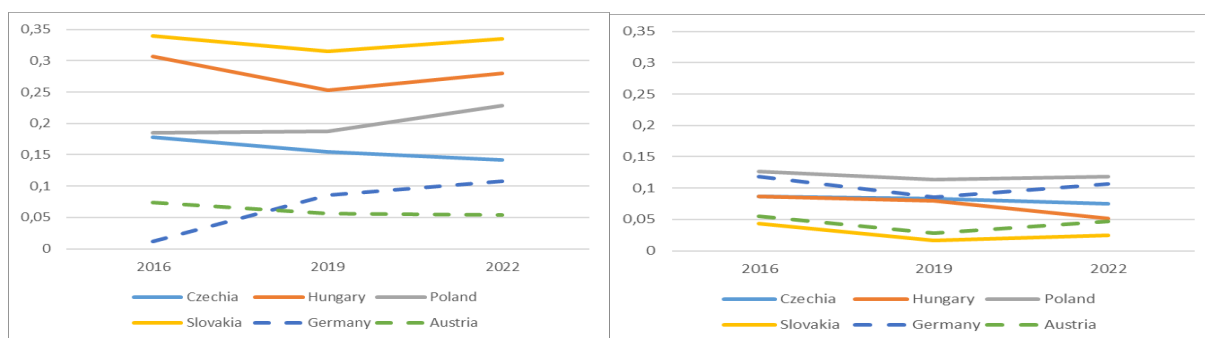

Source: Dijkstra et al., 2023, author's processing

Regional differences are mainly due to the size of the market in individual regions (the greatest variability was found in the Market size pillar), so these differences are caused by the predominance of agglomeration forces, especially in the new Member States.

Fig. 11: RCI 2.0_sigma convergence of INNOVATION sub-index at the regional level

Fig. 12: RCI 2.0_sigma convergence of INNOVATION sub-index at the regional level (excluding "capital region")

Source: Dijkstra et al., 2023, author's processing

In the innovation sub-index, there are the largest regional differences (especially between the capital region and other regions), which tend to widen in the new Member States (except the Czech Republic) (see Figures 11 and 12). The reason for the regional differences is

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[6] In Germany, the capital region is not the most competitive region. The region with the best ranking according to the RCI 2.0 methodology was Hamburg in the 2022 yearbook, and Oberbayern in the 2019 and 2016 yearbooks.

the regional variation in the Innovation index and the Business Sophistication index. Agglomeration forces (concentration of innovation activities in certain regions) are the cause of diverging tendencies not only in the new Member States but also in Germany (see the evolution of the sigma coefficient for Slovakia, Hungary, and Poland in Figure 11 and the sigma coefficient for Germany in Figures 11 and 12).

Conclusion

The evolution of the sigma coefficient in both parts of our analysis (GDP per capita in the countries studied between 2000 and 2022, regional competitiveness results according to the RCI 2.0 and its sub-indices in the 2016, 2019 and 2022 Yearbooks) confirms the privileged position of the capital city regions in the assessment of regional competitiveness (the exception in our sample of countries is Germany). More competitive countries (Austria and Germany as representatives of the original member countries, Czechia of the Visegrad Four countries) tend to have a smaller gap between their capital city region and its other regions. Those more developed countries also have smaller differences between all their regions. These findings show that regional performance is directly related to a country's competitiveness and underline the importance of appropriate public regional policy settings at national and EU level.

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References

Alcidi, C. (2019). Economic Integration and Income Convergence in the EU. *Intereconomics*, *54*(1), 5–11. https://doi.org/10.1007/s10272-019-0783-6

Babecký, J., Komárek, L. ((2020). Regional disparities in selected EU countries. Global Economic Outlook 2/2020, Czech National Bank. https://www.cnb.cz/export/sites/cnb/en/monetary-policy/.galleries/geo/geo_2020/gev_2020_02_en.pdf

Baldwin, R., & Wyplosz, C. (2022). *EBOOK The Economics of European Integration 7e*. McGraw Hill.

Barro, R. J., & Sala-i-Martin, X. (1992). Convergence. *Journal of Political Economy*, *100*(2), 223-251.

Crescenzi, R., & Giua, M. (2020). One or many Cohesion Policies of the European Union? On the differential economic impacts of Cohesion Policy across member states. *Regional Studies*, *54*(1), 10–20. https://doi.org/10.1080/00343404.2019.1665174

Dijkstra, L., Papadimitriou, E., Martinez, B. C., Dominicis, L., & Kovacic, M. (2023). EU regional competitiveness index 2.0. *Luxembourg: Publications Office of the European Union*. https://doi.org/doi:10.2776/46106

El Gibari, S., Gómez, T., & Ruiz, F. (2019). Building composite indicators using multicriteria methods: A review. *Journal of Business Economics*, *89*(1), 1–24. https://doi.org/10.1007/s11573-018-0902-z

Krugman, P. (1999). The Role of Geography in Development. *International Regional Science Review*, *22*(2), 142–161. https://doi.org/10.1177/016001799761012307

Kuc-Czarnecka, M., Lo Piano, S., & Saltelli, A. (2020). Quantitative Storytelling in the Making of a Composite Indicator. *Social Indicators Research*, *149*(3), 775–802. https://doi.org/10.1007/s11205-020-02276-0

Pina, Á., & Sicari, P. (2021). Enhancing regional convergence in the European Union. *OECD Economics Department Working Papers*, No. 1696; OECD Publishing, Paris, https://doi.org/10.1787/253dd6ee-en.

Puga, D. (1999). The rise and fall of regional inequalities. *European economic review*, *43*(2), 303-334.

Quah, D. T. (1996). Convergence empirics across economies with (some) capital mobility. *Journal of Economic Growth*, *1*, 95-124.

Sala-i-Martin, X. X. (1996). Regional cohesion: evidence and theories of regional growth and convergence. *European economic review*, *40*(6), 1325-1352.

Schwab, K. (2019). *The Global Competitiveness Report 2019*.World Economic Forum. https://www.weforum.org/publications/global-competitiveness-report-2019/

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