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FROM TRANSITION TO TRANSFORMATION: DECOMPOSING REGIONAL PRODUCTIVITY GROWTH IN CENTRAL AND EASTERN EUROPE, 2000-2019

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Abstract

This study investigates the structural drivers of regional productivity change across 156 NUTS-3 regions in six Central and Eastern European countries – Czechia, Poland, Hungary, Slovakia, Slovenia, and Romania – between 2000 and 2019. Employing a refined shift-share decomposition-based simulation, the research disaggregates total productivity change into three components: the composition effect, the competition effect, and the reallocation effect. The analysis reveals significant spatial disparities and temporal shifts in regional productivity dynamics. During the pre-crisis period (2000-2007), rapid productivity growth across the area, especially in Romania, was largely driven by sectoral reallocation and labour reallocation. In contrast, the post-crisis period (2012-2019) witnessed more spatially fragmented patterns, with competition-based productivity gains increasingly concentrated in urban centres and industrial hubs – especially those integrated into global automotive value chains. The findings underscore the importance of sectoral specialization and the differentiated impact of labour productivity. The study concludes that while structural convergence is evident in some lagging regions, spatial inequality persists.

Keywords: Central and Eastern Europe, NUTS-3 regions, shift-share analysis, spatial competition effect

INTRODUCTION

Over the past three decades, Central and Eastern Europe (CEE) has undergone a profound metamorphosis, transitioning from centrally planned economies to market-oriented systems embedded within the institutional and regulatory framework of the European Union. These processes have been characterized by robust, albeit uneven economic growth (Smętkowski, 2015, Psycharis et al., 2020), extensive industrial restructuring (Nagy et al., 2021; Megyeri et al., 2023), and significant sectoral realignments (Szakálné Kanó et al., 2025).

However, alongside these transformations, the region has witnessed the entrenchment of new spatial asymmetries and the persistence of territorial inequalities. These changes were undoubtedly influenced by the phenomena highlighted by Dobrzanski et al. (2024), namely that periods of economic prosperity and growth in labor productivity over the past decades have been undermined by a series of unprecedented events, such as the global financial crisis, the

COVID-19 pandemic, and the war in Ukraine. These dynamics have reignited critical debates concerning the effectiveness of convergence mechanisms and the capacity of EU cohesion policies to foster inclusive and territorially balanced development trajectories (Zezza & Guarascio, 2024).

Currently, the strategic significance of the CEE region has been rearticulated. The ongoing Russia-Ukraine conflict has repositioned the region as both a geopolitical buffer and a vital node in safeguarding the EU's eastern frontier. Simultaneously, the reconfiguration of global value chains – catalysed by pandemic-induced supply disruptions, the resurgence of economic nationalism (Clausing & Obstfeld, 2024), and escalating transatlantic trade frictions – has foregrounded the CEE as potential pivot spaces in Europe's evolving industrial geography. These intersecting pressures underscore the imperative of a more nuanced and spatially sensitive understanding of how structural change, territorial resilience, and regional development trajectories intersect within the CEE context.

As a diverse and strategically important area, the Central and Eastern Europe area provides a unique context for studying the relationship between economic restructuring and spatial inequality. While capital cities and selected metropolitan regions have emerged as powerful growth poles (Parkinson et al., 2015; Smętkowski, 2018; Psycharis et al., 2020), many rural and peripheral areas remain vulnerable to economic shocks and sectoral stagnation (Nagy et al. 2024). This phenomenon raises critical questions about the spatial distribution of productivity gains and the effectiveness of cohesion-oriented development strategies (Butkus et al., 2020). The main research questions addressed in this paper are as follows:

- What patterns of regional productivity change can be identified at the NUTS-3 level across Central and Eastern Europe between 2000 and 2019?
- How do the key components of structural change – namely the composition effect, competition effect, and reallocation effect – contribute to the observed differences in regional productivity dynamics within and between countries?

Taking this into account, the main aim of this paper is to analyse the dynamics of productivity growth at the NUTS-3 level in six Central and Eastern European countries (Czechia, Poland, Hungary, Slovakia, Slovenia, Romania) between 2000 and 2019, using a refined shift–share framework. By applying this method, we are able to explain regional productivity change (how the composition effect, competition effect, and reallocation effect contribute to regional disparities).

Our contribution to the literature is threefold. First, we provide a long-term comparative perspective on regional productivity dynamics across multiple CEE countries at a granular

(NUTS-3) level, which remains underexplored in the literature. Second, we adapt the shift–share methodology by comparing regions to the average of the selected countries rather than to the EU average, thereby offering a more meaningful benchmark for semi-peripheral economies. Third, we highlight how regional productivity trajectories reflect broader patterns of development traps and structural transformation, with implications for EU cohesion policy. In doing so, the paper aims not only to identify the drivers of uneven productivity growth but also to provide a framework that can support alternative interpretations and policy conclusions.

The article is structured as follows. We first provide a theoretical overview of structural change and its role in regional development, with special attention to the legacy of post-socialist transition and the region's current geopolitical context. Subsequently, we present the main characteristics of the selected Central and Eastern European countries and justify our focus on the NUTS-3 level as a more granular spatial scale. We then outline the methodological framework, applying a refined shift-share decomposition to capture the structural components of productivity change. Finally, we present and interpret the spatial patterns revealed by the empirical results and discuss their relevance for regional policy and future research.

THEORETICAL BACKGROUND

Economic development is accompanied by a gradual reallocation of employment and resources across sectors with differing productivity levels, thereby inducing structural change (Andergassen et al., 2018). In post-socialist Central and Eastern Europe, this process has been deeply intertwined with EU accession, market reintegration, and exposure to global production systems supported by FDI (Bilenko, 2022; Gál & Lux, 2022). While aggregate productivity levels have been increasing over the past two decades, the underlying transformation has been highly uneven in both sectoral and spatial terms (Gál & Singh, 2024). To better understand the territorial unevenness of these transformations – and in light of increasing policy emphasis on reindustrialization (EC 2012) as a strategic tool for regional development– recent theoretical frameworks have sought to capture how structural change unfolds across space through distinct reindustrialization patterns.

Recent theoretical advances have refined our understanding of how this unevenness emerges. In particular, Capello and Cerisola (2023) conceptualize structural change through the lens of reindustrialization, offering a typology of regional trajectories that helps explain differential productivity outcomes. Their framework distinguishes four patterns of regional reindustrialization: upgrading of existing industrial specializations, diversification into new but

related activities, reorientation toward unfamiliar sectors, and the creation of entirely new industrial systems. These patterns differ in terms of continuity with the past, knowledge intensity, and institutional requirements – and, crucially, in their potential to enhance regional productivity (Capello & Cerisola, 2023).

The literature suggests that upgrading-based reindustrialization, which reinforces established industrial paths, is the only pattern consistently associated with significant productivity gains (Christopherson et al., 2014). In contrast, diversification and creation strategies may lack the depth and coherence needed to generate broad-based improvements in the short to medium term. This distinction is especially relevant in the CEE context, where historical legacies and narratives (Balogh et al., 2022), post-socialist restructuring, and path-dependent institutional capacities have led to highly differentiated regional growth paths (Barta et al., 2008; Shkolnykova & Wedemeier, 2025). In western border zones – such as Bratislava, Western Hungary, or Southern Poland – FDI-driven manufacturing concentrations have enabled upgrading processes, often in the automotive or electronics sectors. In contrast, rural or eastern regions and settlements have faced the dual challenge of economic stagnation and weak innovation ecosystems, making diversification or creation strategies far more uncertain and policy-dependent (Egri & Táncos, 2018; Pénzes & Demeter, 2021; Egri & Lengyel, 2024; Caravella et al., 2023). Moreover, there are obvious demographic implications in terms of population migration from rural and some border regions and concentration in urban areas (Boros et al., 2022; Lados et al., 2024).

These spatial asymmetries reflect deeper centre–periphery dynamics in the European economic space, wherein CEE countries occupy semi-peripheral positions. Within these countries, capital cities and second-tier urban centres increasingly function as national cores, while peripheral rural regions struggle with limited access to knowledge networks, investment, and institutional resources (Vas et al., 2024). The persistent urban–rural divide and the east–west productivity gradient are not merely statistical patterns – they are structural outcomes of differentiated reindustrialization and digitalization capacities across space (Kiss & Páger, 2024). This perspective implies that structural change is not only about sectoral shifts, but also about the nature and quality of those shifts: which sectors grow (for instance: the tourism sector in rural areas), where, and how they interact with local capabilities (Bagdi & Mondok, 2024).

To capture the spatial complexity of these types of transformations, the literature increasingly recommends the use of shift-share decomposition approaches (Capello & Cerisola, 2023). By distinguishing between the composition effect, the competition effect, and the reallocation effect, such models make it possible to identify whether regional productivity

changes are primarily driven by favourable sectoral structures, superior sector-specific performance, or dynamic shifts in employment. These analytical components correspond closely to the categories introduced by Capello and Cerisola: strong composition effects may reflect upgrading processes within existing specializations; competition effects signal internal efficiency or innovation; and reallocation effects may be indicative of transitions toward new structural configurations. For our purposes, this framework allows researchers not only to assess patterns of productivity convergence or divergence, but also to infer the types of structural dynamics that underpin them.

Sectoral aggregation, typically into a manageable number of broad groups, is also considered appropriate in this context, both for reasons of data availability and theoretical coherence. In particular, the use of aggregated sector categories facilitates comparability across regions and countries – especially where detailed NUTS-3 level data is scarce – and reflects the meso-level at which industrial transformation and reindustrialization processes tend to occur. Moreover, analyses conducted at the NUTS-3 level, rather than at broader territorial scales, are better suited to detecting spatial nuances, such as urban–rural divides, regional upgrading centres, or persistently stagnating peripheries (López-Villuendas & Campo, 2022). Such granularity is essential for accurately interpreting how structural change interacts with territorial development paths, particularly in the heterogeneous economic geography of Central and Eastern Europe.

In summary, the literature emphasizes that structural change goes hand in hand with economic development, but its regional outcomes depend heavily on how economies are embedded in global production systems and how spatial structures shape the distribution of gains. In Central and Eastern Europe, structural transformation has been closely linked to integration into global value chains, particularly through the automotive industry (Pelle & Tabajdi, 2023; Sass & Tabajdi, 2023). While this has brought about notable productivity growth and export performance, it has also led to selective regional upgrading and persistent territorial inequalities. The centre-periphery dynamic, the hierarchical structure of supply chains, and the limited autonomy of peripheral regions all contribute to uneven development paths. Moreover, while EU cohesion policy has aimed to mitigate these disparities, its success has varied by region and institutional context (Zezza & Guarascio, 2024). Building on these theoretical foundations, the present study empirically investigates how structural change – captured through composition, competition, and reallocation effects – has shaped regional productivity trajectories across NUTS-3 regions in CEE between 2000 and 2019.

DATA AND RESEARCH DESIGN

First of all, we choose six countries – Hungary, the Czech Republic, Poland, Romania, Slovakia, and Slovenia – to test and analyze the special peculiarities of structural changes that these regions have undergone. These countries share a similar historical and economic background, shaped by their socialist past and EU accession in the 2000s. Their reintegration into the common market and access to EU funding have had a significant impact on their development paths. In addition, they occupy more or less similar positions in the global value chain, where the automotive industry plays a key role to varying degrees (Megyeri et al., 2023; Pelle & Tabajdi, 2023). As semi-peripheral economies, they also share structural similarities within the broader European core-periphery framework, which makes them suitable for comparative regional analysis.

In our methodology, we use a special form of shift-share analysis based on Capello and Cerisola (2023). Instead of using the EU average, we have compared the values of each region to the average of the countries studied, because only two regions have shown a lower than average level of productivity growth compared to the EU average. The total productivity change can be divided into the sum of the composition effect (MIX), competition effect (DIFF) and the reallocation effect (REALL). The first component is the reallocation effect, which measures the reallocation of employment over time between sectors at different productivity levels. The second, the competition effect, measures the different rates of productivity growth of an industry in a region compared to the same industry elsewhere, reflecting efficiency improvements. The third component, the composition effect, measures the combination of different rates of productivity growth of industries in a region, reflecting sectoral modernisation. It can be calculated as follows:

$$\left(\frac{P_r^1}{P_r^0} - \frac{P_{CCE}^1}{P_{CCE}^0}\right) = \sum_{i=1}^{n} \frac{E_{i,r}^0}{E_r^0}\left[\left(\frac{P_r^1}{P_r^0} - \frac{P_{i,r}^1}{P_{i,r}^0}\right) + \left(\frac{P_{i,r}^1}{P_{i,r}^0} - \frac{P_{i,CCE}^1}{P_{i,CCE}^0}\right) + \left(\frac{P_{i,CCE}^1}{P_{i,CCE}^0} - \frac{P_{CCE}^1}{P_{CCE}^0}\right)\right] \quad (1)$$

where P is the gross value added (GVA) per employed person; CCE is the weighted average of the countries under investigation; r refers to the given NUTS-3 region; i refers to the given sector; n is the total number of sectors examined (6); 1 is the final year of the examined period (2007 or 2019); 0 is the starting year of the examined period (2000 or 2012). This decomposition also requires some clarification regarding our interpretation of structural change. It should be noted that in our framework, structural change is not captured through employment reallocation alone, as in some classical shift-share formulations, but through the combined

dynamics of sectoral productivity (P = GVA per employed person). Since P already incorporates both output and employment, changes in employment are implicitly accounted for in the decomposition. In this sense, our interpretation of structural change follows Capello and Cerisola (2023), where relative sectoral productivity trajectories reflect both labour reallocation and efficiency improvements.

In addition, we have preferred GVA to GDP because it measures the economic value generated by individual industries, sectors or regions and therefore gives a more accurate picture of local economic performance, whereas GDP includes taxes and subsidies, which can vary significantly from region to region. In recent years, it has become increasingly apparent that NUTS 2 regions are too large and diverse (López-Villuendas & Campo, 2022), which has led many studies to focus on the much smaller NUTS 3 regions. In this analysis, we focus on data for NUTS 3 regions between 2000 and 2019, all data were obtained from Eurostat's database, where sectoral breakdowns are available. At the NUTS 3 level, we were able to identify 6 main sectors, as this was the only way to produce data for the Polish regions that were suitable for analysis (Tab. 1).

Table 1 The input main sector groups for determining the composition effect within the shift share analysis

Code	NACE activities
A	Agriculture, forestry and fishing
B-C-D-E	Mining and quarrying (B); Manufacturing (C); electricity, gas, steam and air conditioning supply (D); water supply; sewerage, waste management and remediation activities (E)
F	Construction
G-J	Wholesale and retail trade; transport; accommodation and food service activities; information and communication
K-N	Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities
O-U	Public administration and defence; compulsory social security; education; human health and social work activities; arts, entertainment and recreation; repair of household goods and other services

Source: own editing based on Eurostat.

In line with Eurostat's database structure, our calculations rely on gross value added (GVA) expressed in current euro. While the use of constant prices or PPS-based indicators is often preferred in order to eliminate the impact of inflation, relying on current values is a methodologically acceptable choice for us in this context for three reasons. First, since our analysis is primarily comparative across regions within the same countries and across countries over a relatively homogeneous integration period, inflationary effects are largely shared and do not distort the relative spatial patterns. Second, the shift–share decomposition focuses on differences in growth contributions (sectoral mix, competition, and reallocation), which are

ratio-based and therefore less sensitive to absolute price levels. Finally, several EU Cohesion Policy reports and applied regional studies have also employed current-price GVA for regional comparisons (Darvas et al., 2019; Di Caro & Fratesi, 2021; Medeiros et al., 2022), underlining the practical relevance and robustness of this approach. Accordingly, while we acknowledge the limitations of using current prices, we consider the results to reliably capture the structural and spatial dimensions of productivity dynamics in Central and Eastern Europe.

Although the analysis covers the entire period from 2000 to 2019, the financial crisis (2008-2009) has caused structural breaks in the time series. Therefore, in addition to considering the full period, we have also analysed two separate, crisis-free sub-periods – 2000-2007 and 2012-2019 – which are of equal length and thus easily comparable.

As metropolitan areas have a significant economic and social impact on the surrounding areas, urban and peri-urban areas are often treated together in regional analyses. We have done the same and, mainly based on Eurostat and literature recommendations (Vas et al., 2024), we have combined some of the metropolitan and suburban spatial elements. We merged the capital cities' regions with the suburbs in Czechia, Hungary, Poland and Romania. In addition, in the case of Poland, the theoretical population threshold was set at 400,000 inhabitants. This is because, beyond this size, even in Poland, the cities become significantly smaller, and – Brno being the exception – second-tier city regions in the other countries studied also fall below this threshold. Thus, our approach was rooted in a settlement-based perspective. Hence, we combined Bucharest-Ilfov, Budapest-Pest, Prague-Central Bohemian Region, Miasto Kraków-Krakowski, Miasto Łódź-Łódzki, Miasto Poznań-Poznański, Miasto Szczecin-Szczeciński, Miasto Wrocław-Wrocławski, Gdański-Trójmiejski, and Miasto Warszawa-Warszawski wschodni-Warszawski zachodni. Our total observation units are 156.

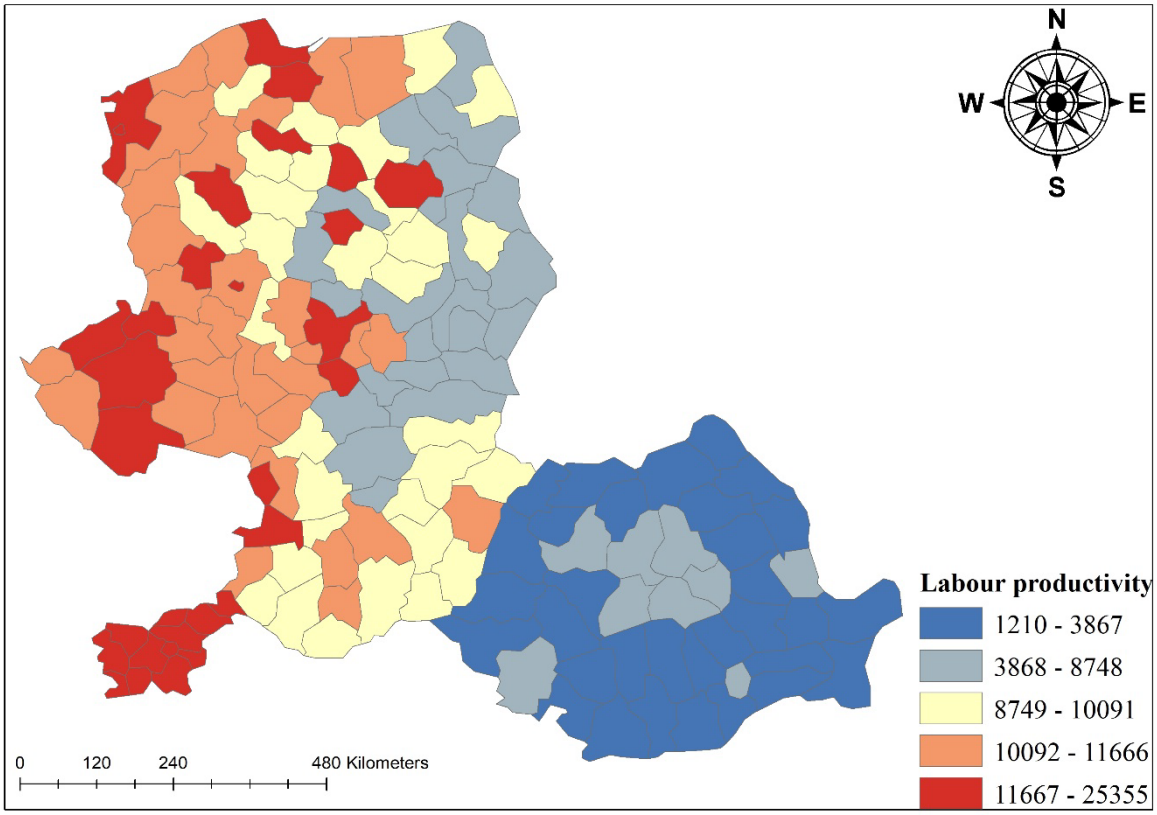
To sum up, our research design combines sectorally disaggregated regional data with a refined shift-share framework to capture both the sources and spatial structure of productivity change. By focusing on NUTS-3 regions and analyzing two distinct pre- and post-crisis periods, we aim to offer a granular and temporally nuanced view of structural transformation in the CEE region.

RESULTS

The map shows labour productivity levels (measured as gross value added per employed person) across NUTS-3 regions of six Central and Eastern European countries in the year 2000 (Fig. 1). The values are grouped into five categories based on quintiles, allowing for a

comparative assessment of regional performance on the eve of EU accession. This snapshot illustrates the spatial structure of economic development before large-scale European integration took effect and highlights the path-dependent legacies that shaped early productivity patterns across the region.

Figure 1 Labour Productivity Across NUTS-3 Regions in Central and Eastern Europe, 2000 (Real GVA per Employed Person, euro)



Source: own editing based on Eurostat.

At the turn of the millennium, labour productivity levels were still strongly aligned with national borders, reflecting the enduring impact of country-specific institutional frameworks, reform trajectories, and pre-accession economic policies (Burlea-Schiopoiu et al., 2021; Kuruczleki et al., 2022). Czechia and Slovenia stood out as uniformly high-performing countries, with virtually all of their regions falling into the top two quintiles. This reflects their relatively advanced industrial base, successful early restructuring, and stronger integration into Western European markets (Pelle & Tabajdi, 2023). In contrast, Romania displayed uniformly low productivity levels across the entire country, suggesting structural lag, weak FDI inflows, and limited participation in global value chains at that time (Dobrzanski et al., 2024). The remaining countries – Hungary, Poland, and Slovakia – exhibited more heterogeneous patterns,

with a mix of high- and low-performing regions, indicating transitional spatial structures in the making.

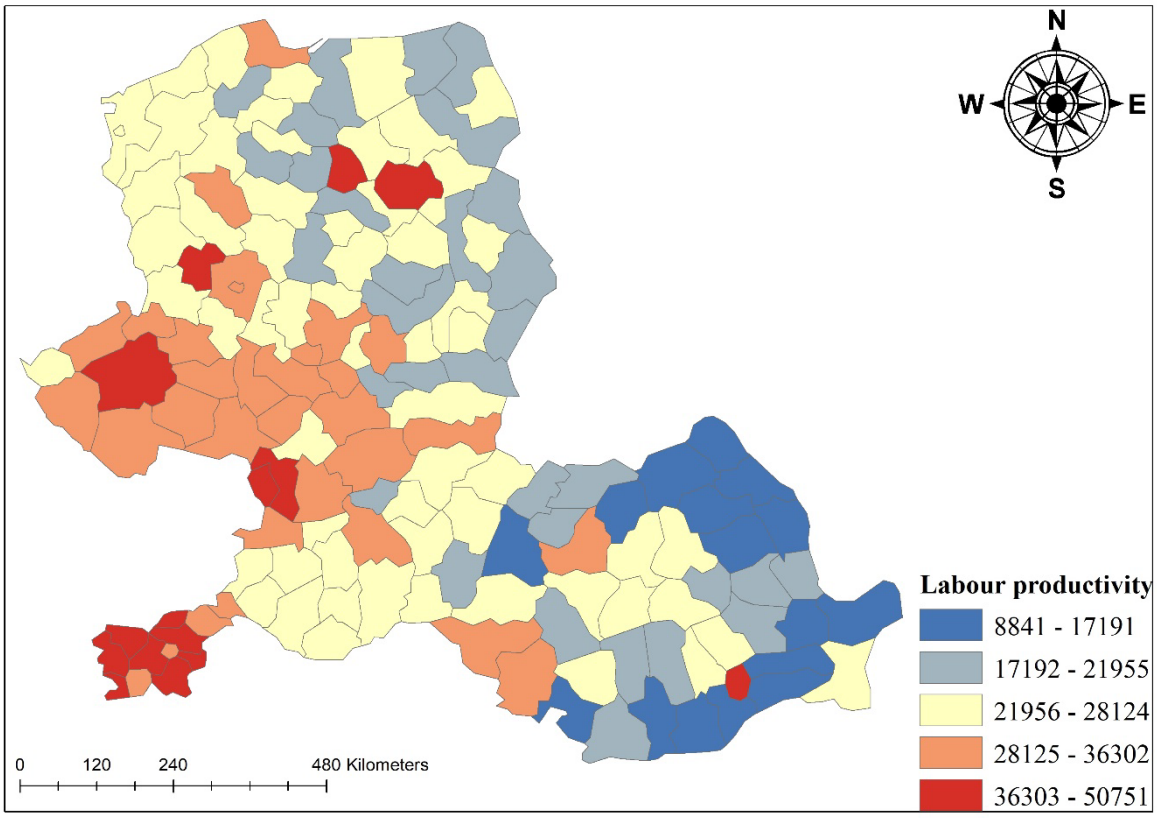
The spatial distribution of labour productivity in 2000 revealed a pronounced West-East divide within Central and Eastern Europe. The highest productivity levels were concentrated in the western regions of the area under study, particularly in Hungary, Poland and Slovakia. In contrast, eastern and inland regions of these countries – more remote from cross-border economic flows – were lagging behind. This divide was further accentuated by the urban–rural duality: urban centres and capital regions showed significantly higher productivity than rural hinterlands, a structural gap that became more pronounced as urban economies specialized in higher value-added sectors (Egri & Lengyel, 2024; Vas et al., 2024, Szakálné Kanó et al., 2025).

In Poland, early signs of an emerging urban hierarchy were already visible by 2000. Regions including Warsaw and major second-tier cities such as Kraków, Wrocław, and Poznań exhibited relatively high productivity, indicating their growing role as regional economic hubs. This spatial differentiation was not merely economic – it also reflected deep historical-geographical fault lines, often referred to as phantom borders. In Poland, for example, the western regions – formerly under German or Austro-Hungarian administration – were more developed than the historically agrarian eastern parts (Gorzelak, 2021).

This core-periphery pattern reflected both historical legacies and path-dependent development processes (Censolo & Colombo, 2016). Regions close to national capitals or transnational corridors – such as Győr, Bratislava, and Prague – emerged as early winners of economic restructuring, while more remote and predominantly rural areas were largely excluded from these gains. In Romania, the dominance of low-productivity regions across the entire country suggested delayed industrial modernization and limited integration into global value chains at the time. Overall, the map illustrated a spatially selective structural transformation process at the turn of the millennium, laying the foundation for future regional divergence within the CEE region.

The overall productivity levels increased significantly throughout Central and Eastern Europe between 2000 and 2019, yet spatial inequalities largely persisted (Dobrzanski et al., 2024). The 2019 labour productivity map demonstrates that, while many regions shifted into higher productivity categories compared to 2000, the core-periphery divide remained visible (Fig. 2).

Figure 2 Labour Productivity Across NUTS-3 Regions in Central and Eastern Europe, 2019 (Real GVA per Employed Person, euro)



Source: own editing based on Eurostat.

By 2019, the spatial structure of productivity in Central and Eastern Europe had shifted in important ways. In line with the literature (Smętkowski, 2015, 2018; Psycharis et al., 2020), while the west–east gradient remained a relevant factor, the urban–rural divide became even more pronounced, emerging as the dominant spatial cleavage across the region. Capital cities and major regional centres consistently outperformed their surrounding areas, and in most countries, these metropolitan areas not only maintained but further reinforced their productivity advantage. This pattern reflects the increasing concentration of high-value-added activities, investment, and innovation in urban cores, while many rural and peripheral areas experienced more modest growth.

Capital city regions have consistently played a leading role in driving economic growth and productivity within Central and Eastern Europe. The Bratislava region in Slovakia stands out as a clear example, with labour productivity rising dramatically from €14,081 per person in 2000 to €50,751 in 2019. A similar trend can be observed in the Prague region, where productivity increased from €16,128 to €50,476 per capita over the same period. The capital region of Poland has also demonstrated dynamic growth, with productivity per person rising from €18,701 in 2000 to €48,835 in 2019. Together, these cases highlight the pivotal role of

capital regions as drivers of structural upgrading and productivity gains in post-socialist Europe. Their continued outperformance reflects both inherited centrality and the ability to attract investment, talent, and innovation in the post-accession period (Sávai & Bodnár, 2024). However, a valuable contrast can be drawn with Budapest, whose performance as a metropolitan region has been relatively less dynamic, and Slovenia, which – despite lacking a dominant metropolitan centre – has managed to sustain a remarkably balanced and advanced productivity profile across its territory.

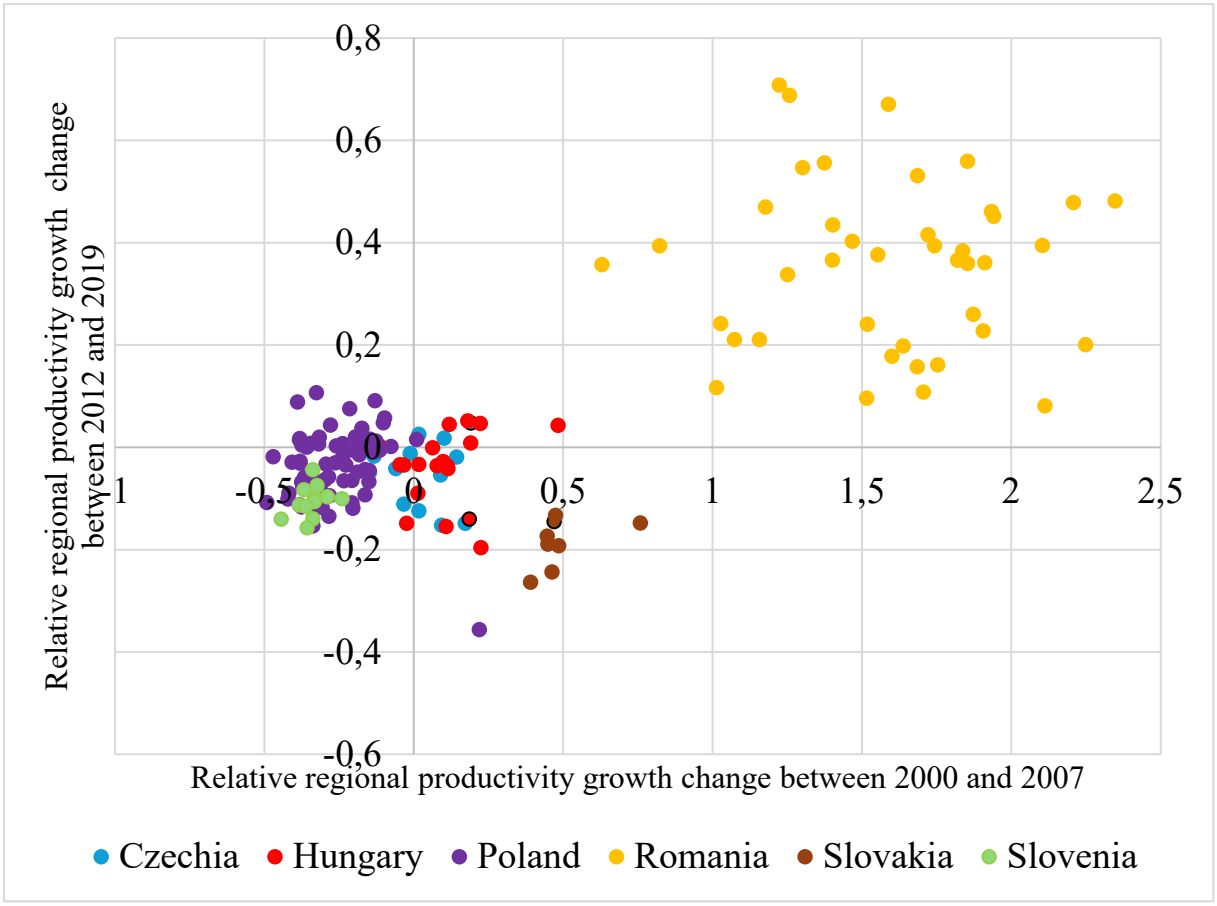
Moreover, in Poland, the historical phantom border that once clearly separated the more developed west from the lagging east (Gorzelak, 2021) became less visible by 2019, though not eliminated. The relative convergence of rural areas suggests some equalization of development opportunities across the national space, likely aided by infrastructure investments and EU cohesion funds. Slovenia maintained a strong and balanced productivity performance across its entire territory, confirming its role as one of the most consistently successful cases within the CEE region. In Hungary, however, the data indicate a relative decline in productivity position compared to other countries in the region, suggesting either stagnation in formerly leading regions or stronger advancement elsewhere. In contrast, Slovakia showed a more favourable productivity profile in 2019.

At the same time, Romania remained predominantly in the two lowest productivity categories, despite overall growth, indicating that convergence at the national level did not translate into balanced regional development. A few Romanian regions – particularly around Bucharest and Cluj-Napoca, Timisoara – emerged as relative exceptions, suggesting some degree of metropolitan-driven growth (Zsibók & Egyed, 2022; Horeczki et al., 2023). Nonetheless, peripheral areas continue to face substantial structural challenges and lag far behind national and regional productivity averages. For instance, Vaslui County in eastern Romania, while showing some improvement – from €1,210 per capita in 2000 to €8,841 in 2019 – remains one of the least productive regions in the entire sample. A similar pattern is observed in Neamț County, where productivity rose from €1,724 to €10,412 per person over the same period. Overall, the 2019 map reflects a process of spatially selective structural transformation, driven by global economic integration but moderated by national and regional institutional capacities.

An examination of productivity growth using shift-share decomposition provides additional insight into the spatial and temporal dynamics of structural change in the CEE region. As described in the methodological section, we compare each NUTS-3 region's total productivity

change to the weighted average of the six selected CEE countries. The scatterplot in Fig. 3 summarizes the results for two sub-periods: 2000-2007 and 2012-2019.

Figure 3 Results of relative regional productivity growth in the examined periods, 2000-2007 and 2012-2019



Source: own calculation and editing based on Eurostat.

In the first period (2000-2007), regions generally moved in closer alignment within each country. Notably, Romanian regions showed strong above-average productivity growth, indicating a clear convergence trend. This was largely driven by modernization in agriculture and industry, enabled by foreign direct investment inflows – especially into the manufacturing sector. The composition effect (MIX) confirms this catching-up process in most Romanian counties, and to a lesser extent, in Hungarian regions as well. The reallocation effect (REALL) also supports this trend, as labour began shifting from low-productivity sectors toward more productive branches. In contrast, in Czechia, Hungary, and Slovenia, the reallocation already reflects a transition from industry to services. The competition effect (DIFF) highlights that productivity growth in more developed areas was primarily driven by performance gains within sectors – particularly specialization in higher value-added activities.

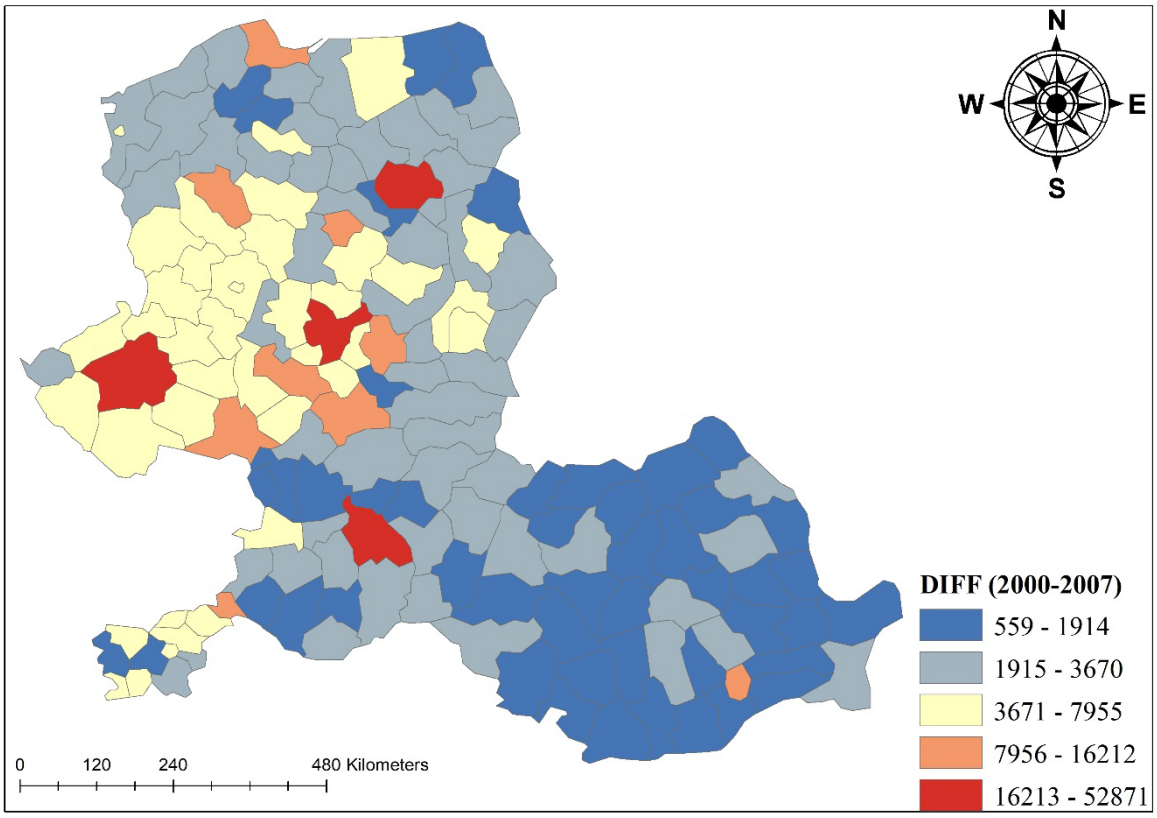
The second period (2012-2019) revealed more pronounced spatial inequalities across and within countries. While in the earlier period regional trends were more synchronized, by the 2010s, regional specificities had become more dominant. Romania again recorded the highest productivity growth, suggesting a continuation of its convergence trajectory. However, the role of the 2008-2009 global financial crisis must also be acknowledged, as the years between the two periods were marked by systemic shocks that influenced productivity trajectories. In this period, the composition effect became more prominent in Hungarian counties – mainly reflecting dynamics in agriculture and industry – whereas in Romania, this effect diminished. The competition effect (DIFF) identified Romanian regions as high performers again, joined by urban regions in Poland and Czechia. At the same time, some eastern regions in Poland and Hungary exhibited structural fragility and weaker productivity growth. In line with previous analyses (Sávai & Bodnár, 2024), the reallocation effect indicated a continued shift of labour in more developed areas toward knowledge-intensive and higher value-added service sectors.

Comparing the two periods revealed a multi-speed structural transformation. Romania experienced the most notable dynamics in productivity at the national and regional levels, although regional disparities within the country remain significant. In the other countries, productivity dynamics were lighter, and within-country disparities less pronounced. Overall, the findings suggest that while convergence occurred in certain lagging regions – particularly in Romania – urban regions across the CEE area remain the dominant engines of productivity growth (Sávai & Bodnár, 2024).

When decomposing productivity growth through the shift-share analysis, it becomes possible to uncover the underlying dynamics behind aggregate increases (Appendix). Both the composition effect (MIX) and the reallocation effect (REALL) exhibit similar spatial patterns, as productivity expansion tends to be higher in more urbanized areas due to the concentration of service-oriented sectors. In addition, over time, labour has increasingly shifted toward more productive branches of the economy – this was particularly pronounced in Romania.

If the aim is to isolate and interpret the efficiency-driven dimension of growth, special attention should be paid to the competition effect (DIFF). This component captures the extent to which regional productivity gains stem from superior performance within the same sectors, thus reflecting differences in production efficiency, innovation capacity, and institutional quality across regions (Fig. 4 and Fig. 5).

Figure 4 The dynamics of the competition effect (DIFF) within a Shift-Share decomposition between 2000 and 2007



Source: own calculation and editing based on Eurostat.

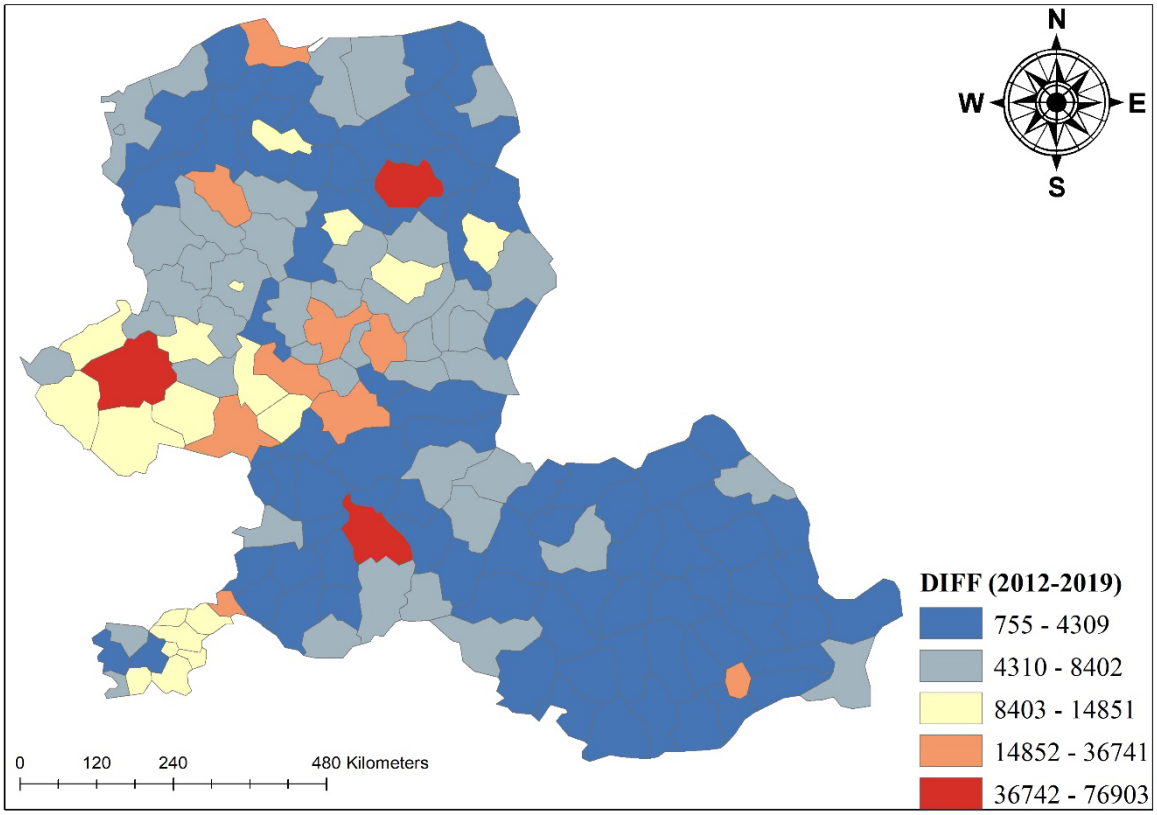
The spatial distribution of the competition effect (DIFF) between 2000 and 2007 reflects significant regional disparities in productivity performance driven by within-sector efficiency gains. Most regions in Romania, as well as large parts of Hungary and Slovakia, fall into the lowest two categories (blue and grey), indicating weak competitive performance.

A key observation is the strong influence of the national context: entire countries or macroregions exhibit relatively consistent performance levels. In particular, Slovenia, Czechia, and the western part of Poland clearly stand out with above-average DIFF values, suggesting that intra-sectoral productivity improvements were more widespread and systematic in these areas. This likely reflects stronger administrative capacities, early integration into global production networks, and higher levels of human capital or innovation activity.

Notably, regions such as Warsaw (Mazowieckie), Prague (Praha), Bratislava (Bratislavský kraj), and selected counties in Western Hungary (e.g., Győr-Moson-Sopron) and Southern Poland exhibit strong competition effects, suggesting that productivity growth in these areas was largely driven by superior performance within the same sectoral structure. This typically indicates higher innovation capacity, better infrastructure, and more efficient production systems, possibly supported by foreign direct investment (FDI) or urban agglomeration effects.

By contrast, many less developed areas, especially in Romania and parts of Slovakia and Hungary, show minimal DIFF contributions, which suggests limited gains in intra-sector productivity. In these areas, productivity growth – if present at all – was likely driven to a greater extent by sectoral reallocation or compositional shifts than by increased efficiency.

Figure 5 The dynamics of the competition effect (DIFF) within a Shift-Share decomposition between 2012 and 2019



Source: own calculation and editing based on Eurostat.

However, certain areas defied this trend. Slovenia and Czechia stand out for the broadly distributed and sustained competition effects across not only their capital regions but also rural and non-metropolitan areas. This enduring performance reflects strong subnational governance, stable industrial ecosystems, and the diffusion of innovation beyond core urban centres. Regions such as South Moravia (Jihomoravský kraj) and Podravska in Slovenia exemplify this territorial resilience, maintaining mid-to-high DIFF values throughout the period. This consistency suggests a more balanced and territorially inclusive growth model, where productivity gains were not overly concentrated in capital cities.

Nonetheless, the map also highlights noteworthy regional exceptions linked to industrial specialization, especially in automotive manufacturing. For instance: Žilina (Žilinský kraj) in Slovakia, home to the KIA Motors plant, demonstrated above-average DIFF values, suggesting

that the presence of globally integrated production networks may facilitate internal learning, technological spillovers, and local supplier upgrading. Similarly, Moravian-Silesian Region (Moravskoslezský kraj), encompassing Ostrava and linked to Toyota's operations, also shows moderate to strong DIFF values, indicating that even post-industrial regions can pivot toward efficiency-based growth when anchored by high-value global sectors.

In addition, the strong performance of second-tier cities – including Cluj (RO113), Kraków (PL213), and Poznań (PL415) – also reinforced the idea that urban productivity growth was no longer solely concentrated in capital regions. These areas leveraged growing tech sectors, university-industry partnerships, and EU funding effectively, translating into sustained within-sector efficiency improvements.

To sum up, the period between 2012 and 2019 illustrates a dual narrative: while many peripheral regions remained stagnant in terms of competition-driven productivity, a combination of sectoral specialization, institutional readiness, and urban dynamism enabled others. The differentiated performance of even similarly specialized regions points to the critical role of local innovation capacity, workforce quality, and multi-scalar governance in translating global sectoral presence into meaningful regional gains.

DISCUSSION AND CONCLUSION

The aim of our research was to present the structural changes in the economies of the CEE regions from the 2000s to the Covid-19 crisis. In line with this objective, our research question examined the differences and similarities in describing productivity changes in NUTS-3 regions. The period is divided into two equal periods, the former covering the years 2000-2007, and the latter the period 2012-2019, excluding the 2008 crisis, which can be interpreted as a structural break.

This paper set out to examine how structural change – captured through the composition effect (MIX), competition effect (DIFF), and reallocation effect (REALL) – contributed to regional productivity trajectories in six Central and Eastern European (CEE) countries between 2000 and 2019. The empirical analysis revealed a multi-speed, territorially uneven transformation process, shaped by sectoral specialization, labour market shifts, and integration into global value chains.

The study demonstrated that structural change did not occur uniformly across the region. Romania experienced the most pronounced productivity gains in the early 2000s, largely due to modernization in agriculture and manufacturing, supported by FDI inflows. Yet this

convergence remained partial and was accompanied by persistent internal disparities. In contrast, the 2010s were marked by the rising importance of competition-based (DIFF) effects – driven by within-sector efficiency gains – particularly in capital regions (e.g. Warsaw, Prague, Bratislava) and dynamic second-tier cities (e.g. Cluj, Poznań, Győr).

Moreover, the composition and reallocation effects played a stronger role in the initial phase of transition, enabling lagging regions to benefit from labour reallocation and structural upgrading (e.g. from agriculture to manufacturing, or from low-productivity to service sectors). However, as the economies matured, the competition effect became more dominant, indicating a gradual shift toward endogenous, innovation-led growth. This was especially visible in urban regions with strong institutional frameworks and educational capacity.

Country-level patterns showed that Slovenia, Czechia, and western Poland achieved more territorially balanced productivity gains, including in rural and intermediate regions. This reflected the benefits of decentralized innovation systems and robust public institutions, which helped mitigate excessive concentration of growth in capital cities.

In addition, the role of sectoral specialization – particularly in the automotive industry – proved critical. Regions such as Žilina, Ostrava, and urbanised Polish areas recorded high DIFF values, illustrating how integration into global production networks could stimulate regional competitiveness. Still, performance varied considerably even among similarly specialized regions, suggesting that local institutional quality and innovation ecosystems played a mediating role in converting specialization into productivity growth.

As a result, a new industrial paradigm has begun to take shape – one grounded in strategic autonomy, technological sovereignty, and regional cohesion. This paradigm shift entails more than short-term economic adjustment: it calls for a fundamental rethinking of industrial policy aimed at resilience and diversification, fostering innovation and sustainability not only at the national level but also within the regions that underpin the European economy. In this context, our findings supported a shift from place-blind to place-based regional policy (Iammarino et al., 2019). Productivity growth needs not only to be achieved but also more equitably distributed. Capital regions remained important engines of growth, but targeted interventions were necessary to support lagging areas and second-tier cities (Vas et al., 2024). Infrastructure development, investment in human capital, and stronger regional institutions appeared essential to unlock untapped potential.

Several broader policy implications emerged. While cost-driven nearshoring may have temporarily narrowed regional disparities, quality- and automation-driven industrial transformations posed a risk of deepening spatial inequalities – especially where structurally

weaker regions lacked institutional or innovation capacity (Dachs et al., 2019; Pedroletti & Ciabuschi, 2023; Capello & Dellisanti, 2024). The recent geopolitical and economic realignments further reinforced these concerns. Moreover, the outbreak of the war in Ukraine in 2022, the collapse of Europe's energy import framework, and structural shifts in the Chinese economy exposed the vulnerabilities of Germany's long-standing competitiveness model – one heavily reliant on cheap Russian energy and steady Chinese demand. These shocks revealed the fragility of the continent's export-oriented industrial core, which has long depended on geographically concentrated supply chains and energy sources. The future regional peculiarities of the current economic trends and phenomena merit further analysis.

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APPENDIX

Appendix 1. Results of shift-share analysis by components in examined periods

Region	Region_name	REALL (2000-2007)	DIFF (2000-2007)	MIX (2000-2007)	REALL (2012-2019)	DIFF (2012-2019)	MIX (2012-2019)
CZ010	Praha	45866	39452	49437	132821	74185	29745
CZ031	Jihočeský kraj	6468	6528	6780	17100	11424	1422
CZ032	Plzeňský kraj	6218	5712	6477	17397	10111	1932
CZ041	Karlovarský kraj	2726	2620	2810	6157	5384	-652
CZ042	Ústecký kraj	7767	7527	8119	19827	13454	1448
CZ051	Liberecký kraj	4064	4225	4258	11253	6822	1296
CZ052	Královéhradecký kraj	5582	5403	5812	16569	9434	1792
CZ053	Pardubický kraj	5122	4878	5285	13664	8098	1808
CZ063	Kraj Vysočina	5053	4914	5277	13930	8879	1592
CZ064	Jihomoravský kraj	12402	11236	13129	36681	24425	3644
CZ071	Olomoucký kraj	5487	5917	5871	16607	11814	-73
CZ072	Zlínský kraj	5911	5220	6014	16930	9220	2565
CZ080	Moravskoslezský kraj	12434	10796	12754	31159	22213	2724
HU110	Budapest	41049	36035	44373	101955	76903	5755
HU211	Fejér	3683	3606	3608	9685	4248	1780
HU212	Komárom-Esztergom	2878	2428	3052	7147	2618	1618
HU213	Veszprém	2402	2170	2466	5911	4018	73
HU221	Győr-Moson-Sopron	4610	4375	4719	12826	5175	2422
HU222	Vas	2099	2134	2152	5224	2899	536
HU223	Zala	2024	1827	2141	4434	3640	-88
HU231	Baranya	2376	2435	2517	5472	5129	-1306
HU232	Somogy	1795	1671	1844	4242	3528	-519
HU233	Tolna	1483	1438	1492	4069	2488	-59
HU311	Borsod-Abaúj-Zemplén	4092	3454	4147	10159	6888	-449
HU312	Heves	1975	1732	2021	5208	3004	71
HU313	Nógrád	814	747	850	1884	1775	-551
HU321	Hajdú-Bihar	3381	3144	3548	8549	7022	-665
HU322	Jász-Nagykun-Szolnok	2209	1996	2262	5382	3604	-15
HU323	Szabolcs-Szatmár-Bereg	2636	2435	2743	7404	5842	-1013
HU331	Bács-Kiskun	3113	2818	3274	9389	5456	551
HU332	Békés	1970	1914	2034	4297	3936	-784
HU333	Csongrád-Csanád	2718	2454	2811	6573	5108	-425
PL911	Warszawa	10962	13610	12932	38423	24269	5385
PL711	Lódz	1893	2460	2312	6074	4513	244
PL213	Kraków	1963	2754	2517	7157	5191	235
PL415	Poznan	1189	1628	1496	3935	3172	151
PL634	Gdansk	2934	3810	3289	8688	5156	1326
PL22A	Katowice	2808	3779	3580	9478	5364	1598
PL217	Tarnowski	4078	5993	4930	14015	7421	3394
PL218	Nowosądecki	3765	4315	4148	11711	6432	2675
PL219	Nowotarski	23564	27497	25191	60103	34418	14294

Region	Region_name	REALL (2000-2007)	DIFF (2000-2007)	MIX (2000-2007)	REALL (2012-2019)	DIFF (2012-2019)	MIX (2012-2019)
PL21A	Oświęcimski	2230	2884	2435	6816	3933	644
PL224	Częstochowski	3320	4310	3769	11120	5989	1912
PL225	Bielski	12320	16212	13882	37940	20569	10499
PL227	Rybnicki	3553	4482	4003	12831	6498	2455
PL411	Pilski	3106	4130	3531	10538	5302	2378
PL414	Koniński	3592	4702	4099	9474	8212	243
PL416	Kaliski	2087	2551	2337	5920	4622	148
PL417	Leszczyński	1933	2497	2138	5112	3862	170
PL424	Miasto Szczecin	2769	3554	3110	8393	5718	1001
PL426	Koszaliński	2317	3047	2615	6663	4309	637
PL427	Szczecinecko-pyrzycki	3883	4499	4324	10986	6770	1329
PL428	Szczeciński	6410	7955	7342	23969	14851	2550
PL431	Gorzowski	3085	3884	3423	9256	6183	823
PL432	Zielonogórski	5318	5013	5707	12411	6841	3639
PL514	Miasto Wrocław	3690	4242	4100	9991	6571	702
PL515	Jeleniogórski	2921	4035	3464	12594	5971	3713
PL516	Legnicko-głogowski	1684	2192	1981	4662	3269	227
PL517	Wałbrzyski	4141	4826	4668	11849	7439	1321
PL518	Wrocławski	5929	7291	6615	16174	10903	1882
PL523	Nyski	1736	2274	1948	5510	3372	637
PL524	Opolski	1796	2286	2002	4957	3211	525
PL613	Bydgosko-toruński	936	1255	1021	3217	1331	670
PL616	Grudziądzki	1814	2355	2084	4953	3313	302
PL617	Inowrocławski	2562	3167	2863	7558	5106	345
PL618	Świecki	3482	4404	3876	9921	7991	-125
PL619	Włocławski	1216	1516	1357	3621	2633	-200
PL621	Elbląski	9806	12061	11074	31254	20800	6065
PL622	Olsztyński	1825	2117	1977	5428	3731	133
PL623	Ełcki	1040	1228	1161	3109	2141	36
PL636	Słupski	2427	3021	2663	7125	4168	1071
PL637	Chojnicki	8332	10668	9442	26171	14018	3851
PL638	Starogardzki	3480	4338	3949	12334	5644	2601
PL713	Piotrkowski	2233	2846	2575	6822	3689	696
PL714	Sieradzki	1829	2301	2140	5588	3214	656
PL715	Skierniewicki	4435	5361	5192	11701	9770	660
PL721	Kielecki	2135	2844	2611	5722	4481	653
PL722	Sandomiersko-jędrzejowski	1218	1536	1464	3305	3206	-9
PL811	Bialski	2571	3214	3069	6089	6018	-275
PL812	Chełmsko-zamojski	4096	5105	4762	12770	10996	223
PL814	Lubelski	1914	2757	2366	5654	4199	747
PL815	Puławski	1893	2645	2323	5651	4481	-34
PL821	Krośnieński	1427	1955	1817	3825	3794	-333
PL822	Przemyski	2856	3894	3606	11099	8402	1328
PL823	Rzeszowski	2882	3827	3514	9352	5163	1858

Region	Region_name	REALL (2000-2007)	DIFF (2000-2007)	MIX (2000-2007)	REALL (2012-2019)	DIFF (2012-2019)	MIX (2012-2019)
PL824	Tarnobrzeski	2982	3450	3405	8565	7106	33
PL841	Białostocki	1724	2143	1994	5364	3515	450
PL842	Łomżyński	1236	1516	1402	3535	2484	141
PL843	Suwalski	41854	52871	48977	135651	72213	38236
PL921	Radomski	2847	3670	3269	8715	6067	843
PL922	Ciechanowski	1680	2282	1893	5388	2996	921
PL923	Płocki	3006	3503	3319	10507	3872	4097
PL924	Ostrołęcki	1765	2184	2020	5740	3537	951
PL925	Siedlecki	1928	2503	2264	6531	4137	1090
PL926	Żyrardowski	1333	1851	1553	4299	2585	1267
RO321	Bucuresti	2739	1998	3232	7481	3301	2252
RO111	Bihor	1139	922	1348	3244	1798	776
RO112	Bistriţa-Năsăud	4233	3046	4988	15423	7884	5053
RO113	Cluj	1622	1257	1886	5283	2566	1630
RO114	Maramureş	1198	995	1458	3755	1677	1306
RO115	Satu Mare	838	683	1031	2566	1325	853
RO116	Sălaj	1880	1225	2175	6066	1955	1569
RO121	Alba	3505	2414	3823	11746	3768	3932
RO122	Braşov	921	742	957	2820	832	621
RO123	Covasna	1355	996	1421	4006	1305	1092
RO124	Harghita	2606	1831	2791	7606	2999	1714
RO125	Mureş	2339	1473	2553	8294	2514	2089
RO126	Sibiu	2010	2000	2713	7151	2951	1321
RO211	Bacău	963	872	1241	3830	1352	547
RO212	Botoşani	2479	2388	3339	11765	5509	1755
RO213	Iaşi	1292	1346	1786	5444	1822	857
RO214	Neamţ	1887	1630	2383	7266	2720	1125
RO215	Suceava	714	752	1018	3595	1499	163
RO216	Vaslui	1216	997	1574	3347	1766	1062
RO221	Brăila	1378	1157	1714	4795	1854	1353
RO222	Buzău	3633	3221	4637	11663	6312	4637
RO223	Constanţa	2318	1654	2491	5914	3395	1075
RO224	Galaţi	669	608	879	2331	1257	692
RO225	Tulcea	1018	950	1242	3435	1667	785
RO226	Vrancea	3542	2105	3856	9689	2976	3073
RO311	Argeş	664	679	867	2728	950	706
RO312	Călăraşi	2039	1248	2204	5902	2512	1848
RO313	Dâmboviţa	579	559	745	2072	984	529
RO314	Giurgiu	666	755	906	2530	1124	942
RO315	Ialomiţa	3937	2758	4512	12387	3962	4638
RO316	Prahova	968	1072	1296	3164	1393	1048
RO317	Teleorman	27736	15939	28664	92365	36741	29599
RO411	Dolj	2235	1885	2905	8131	3749	2313
RO412	Gorj	1678	1266	1994	5736	1842	2101

Region	Region_name	REALL (2000-2007)	DIFF (2000-2007)	MIX (2000-2007)	REALL (2012-2019)	DIFF (2012-2019)	MIX (2012-2019)
RO413	Mehedinţi	786	714	1011	2334	1154	519
RO414	Olt	1177	1204	1493	4178	1785	1148
RO415	Vâlcea	1470	1193	1845	4579	1849	1555
RO421	Arad	2303	1597	2576	8556	1379	2377
RO422	Caraş-Severin	1317	858	1417	3223	1367	1158
RO423	Hunedoara	2171	1502	2468	4921	2406	1623
RO424	Timiş	4543	2610	5001	15513	5303	5309
SI031	Pomurska	13616	10313	14456	41883	30995	1295
SI032	Podravska	6053	4450	6456	17837	10637	2435
SI033	Koroška	5172	4105	5333	12917	11968	-1178
SI034	Savinjska	5330	4244	5634	15908	9369	3636
SI035	Zasavska	5483	4063	5658	17250	11316	1736
SI036	Posavska	4414	3369	4672	12229	10566	157
SI037	Jugovzhodna Slovenija	3952	3176	4245	13975	9635	990
SI038	Primorsko-notranjska	5871	4561	6231	17085	11381	2399
SI041	Osrednjeslovenska	1100	1482	1247	2765	2022	-19
SI042	Gorenjska	3902	4872	4315	9341	7585	-381
SI043	Goriška	854	1069	892	2151	1215	182
SI044	Obalno-kraška	3267	4062	3534	8075	5255	1255
SK010	Bratislavský kraj	540	688	573	1066	755	73
SK021	Trnavský kraj	881	1060	947	2293	1454	259
SK022	Trenčiansky kraj	1992	2514	2157	5345	2798	884
SK023	Nitriansky kraj	564	701	601	1269	927	115
SK031	Žilinský kraj	10918	13604	12016	27359	25029	-3217
SK032	Banskobystrický kraj	2535	3116	2736	6508	4199	751
SK041	Prešovský kraj	1677	2082	1826	3835	3304	-470
SK042	Košický kraj	1688	1996	1884	3638	3545	75

Source: own calculation and editing based on Eurostat.