Examining the impact of economic structural change on regional differences in Central Eastern Europe

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Abstract

In the years following the 1989-1990 regime change, the countries of Central and Eastern Europe (CEE) were confronted with a series of economic and political challenges. In addition to the pervasive influence of privatisation, the 1990s were a period of significant transition. By the turn of the millennium, the CEEs had reached their pre-transition levels of production, while the structure of the labour market and economic sectors had undergone significant transformation. The objective of this paper is to provide an account of the structural changes that have occurred in the economies of the CEE regions (in this study, Hungary, the Czech Republic, Poland, Romania, Slovakia and Slovenia) from the 2000s to the advent of the global pandemic. The present study focuses on NUTS-3 level regions in order to analyse in greater detail the regional catching-up processes, which have hitherto been the subject of investigation in studies utilising higher aggregated data. In light of the above, the research question that guides our investigation is as follows: what are the differences and similarities in the processes describing productivity change in NUTS-3 regions? While the majority of existing research compares catching-up processes with the EU average, our analysis compares countries with the group average, thereby offering a novel perspective on the catching-up issue.
The results demonstrate that the productivity data for the regions of Central and Eastern Europe exhibit a notable economic growth in the metropolitan centres, including Bratislava, Prague and Warsaw. However, the development of rural and less developed areas in this sense still lags behind that of metropolitan areas. The more developed regions are characterised by the development of higher value-added sectors, while the less developed regions are dominated by the modernisation of the agricultural and industrial sectors. Inequalities between countries continue to widen as the more developed regions have adapted more rapidly to sectoral structural changes.

Keywords: structural change, shift-share analysis, Central Eastern Europe, regional differences, Central Eastern Europe

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 marked 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 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-s is have 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-s 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-s context.

As a diverse and strategically important area, the Central and Eastern Europe region 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?

To address the research questions of how productivity has evolved across NUTS-3 regions in six Central and Eastern European country (Czehia, Poland, Hungary Slovakia Slovenia Romania) and how the composition effect, competition effect, and reallocation effect contribute to regional disparities. 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 East-Central 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 and simulated Theil index analysis 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

Structural change is widely regarded as a key engine of economic development, involving the gradual reallocation of employment and resources across sectors of differing productivity. In post-socialist Central and Eastern Europe, this process has been deeply intertwined with EU accession, market reintegration, and exposure to global production systems suppoerted 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 (Cristopherson 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 (Balog 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, where, and how they interact with local capabilities.

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. As for us, 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 is a core mechanism of 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 (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 choosed six countries - Hungary, the Czech Republic, Poland, Romania, Slovakia and Slovenia- to test and analyze the special peculiarities of these region has structural changes. 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. More or less, they also occupy similar positions in the global value chain, where the automotive industry plays a key role to varying degrees (Megyeri et al., 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.

On the methodology way, in our study 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), and the reallocation effect (REALL). The first component, the composition effect, measures the combination of different rates of productivity growth of industries in a region, reflecting sectoral modernisation. 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 is the reallocation effect, which measures the reallocation of employment over time between sectors at different productivity levels. It can be calculated as follows:

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

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).

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 (Egri-Polisch, 2024). In this analysis, we focus on data for NUTS 3 regions between 2000 and 2022, all data being obtained from Eurostat's database, where sectoral breakdowns by sector are available. At 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 determine the composition effect within the shift share analysis

Code	NACE activities
A	Agriculture. forestry and fishing
B-D-E-C	Mining and quarrying (B); electricity. gas. steam and air conditioning supply (D); water supply; sewerage. waste management and remediation activities (E),Manufacturing
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: based on Eurostat own editing

Although the analysis covers the entire period from 2000 to 2019, the financial crisis (2008–2009), the Covid-19 crisis (from 2020), as well as the Russian–Ukrainian war and the related energy crisis (from 2022) have 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.

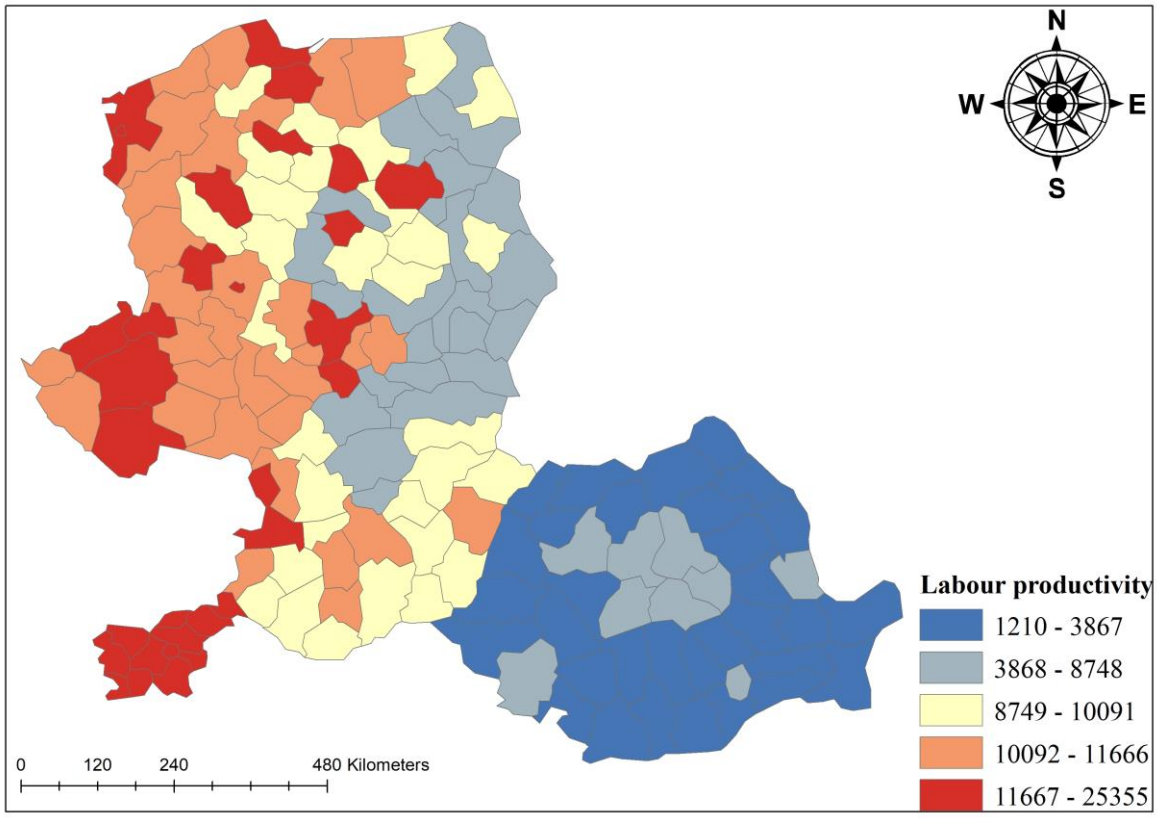
As metropolitan areas have a significant economic and social impact on the surrounding areas, urban and peri-urban areas are often treated together in regional analyses. We have done the same and, mainly based on Eurostat and literature recommendations (Vas et al. 2024), we have combined some of the metropolitan and suburban spatial elements. We merged the capital cities have regions with 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. So our total observation units number is 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)



Source: own editing based on Eurostat

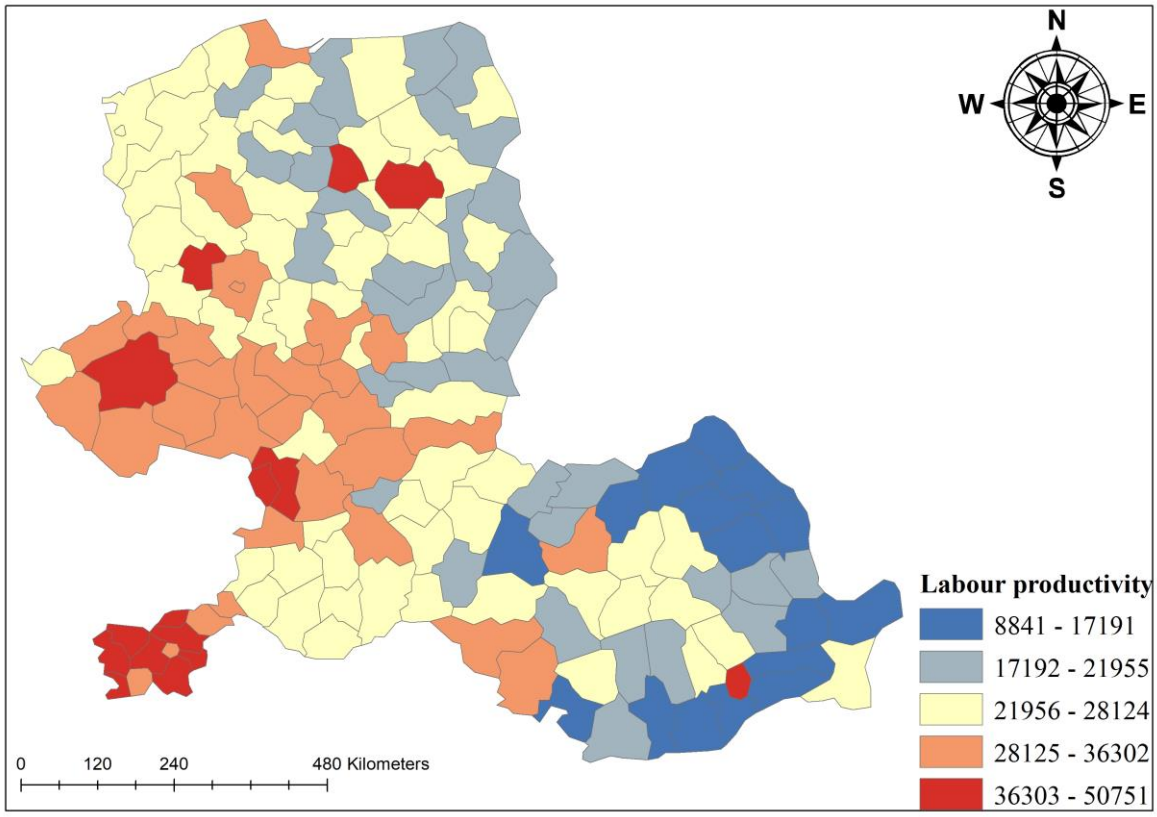
At the turn of the millennium, labour productivity levels were still strongly aligned with national borders, reflecting the enduring impact of country-specific institutional frameworks, reform trajectories, and pre-accession economic policies. Czechia and Slovenia stood out as uniformly high-performing 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. 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. 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—lagged 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.

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.

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



Source: own editing based on Eurostat

This core–periphery pattern reflected both historical legacies and path-dependent development processes. 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 later regional divergence within the CEE region.

The overall productivity levels increased significantly throughout Central and Eastern Europe between 2000 and 2019, yet the spatial inequalities largely persisted. 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).

By 2019, the spatial structure of productivity in Central and Eastern Europe had shifted in important ways. 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.

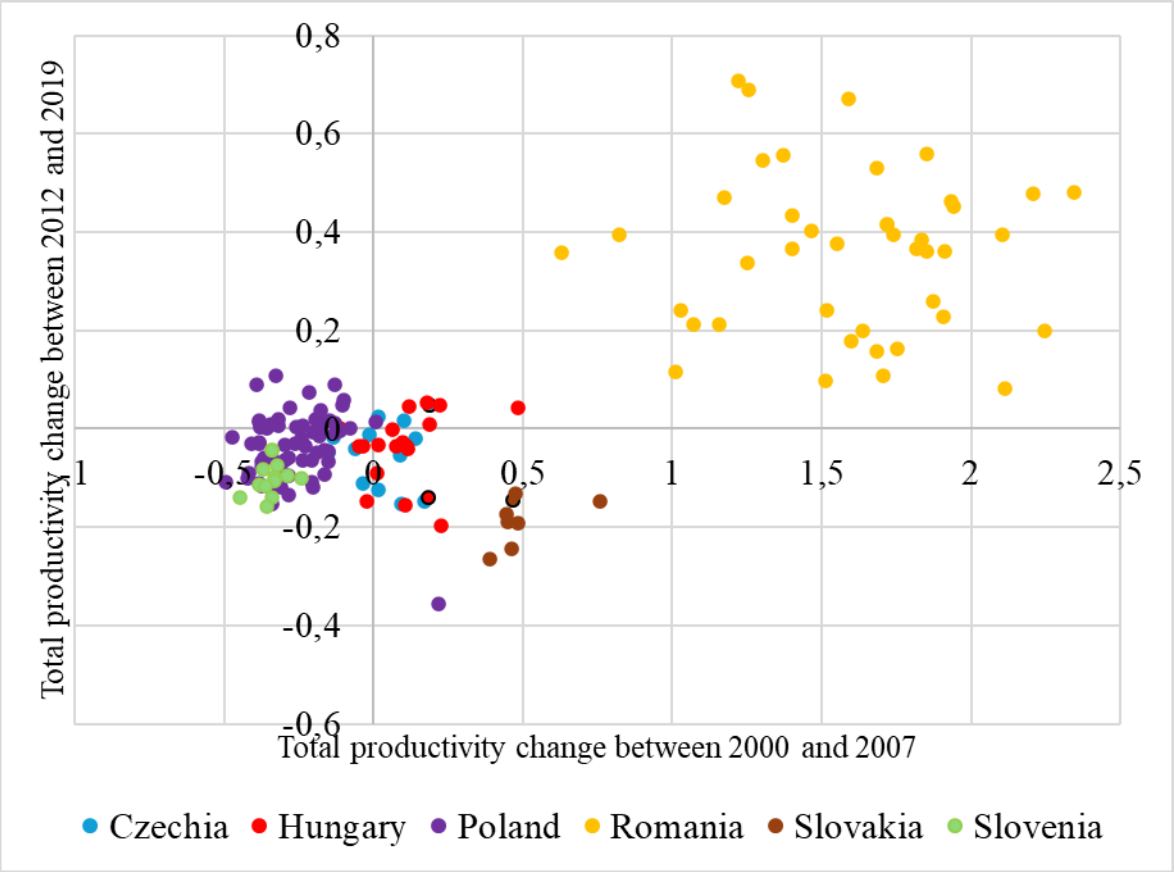
Capital city regions have consistently played a leading role in driving economic growth and productivity within Central and Eastern Europe. The Bratislava region in Slovakia stands out as a clear example, with labour productivity rising dramatically from €14,081 per person in 2000 to €50,751 in 2019. A similar trend can be observed in Prague has 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.

Moreover, in Poland, the historical phantom border that once clearly separated the more developed west from the lagging east became less visible by 2019, though not entirely 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 (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.

Figure 3 Results of shift-share analysis in examined periods. 2000-2007 and 2012-2019



Source: own calculation and editing based on Eurostat

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 Figure 3 summarizes the results for two sub-periods: 2000–2007 and 2012–2019.

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 through specialization in higher value-added activities.

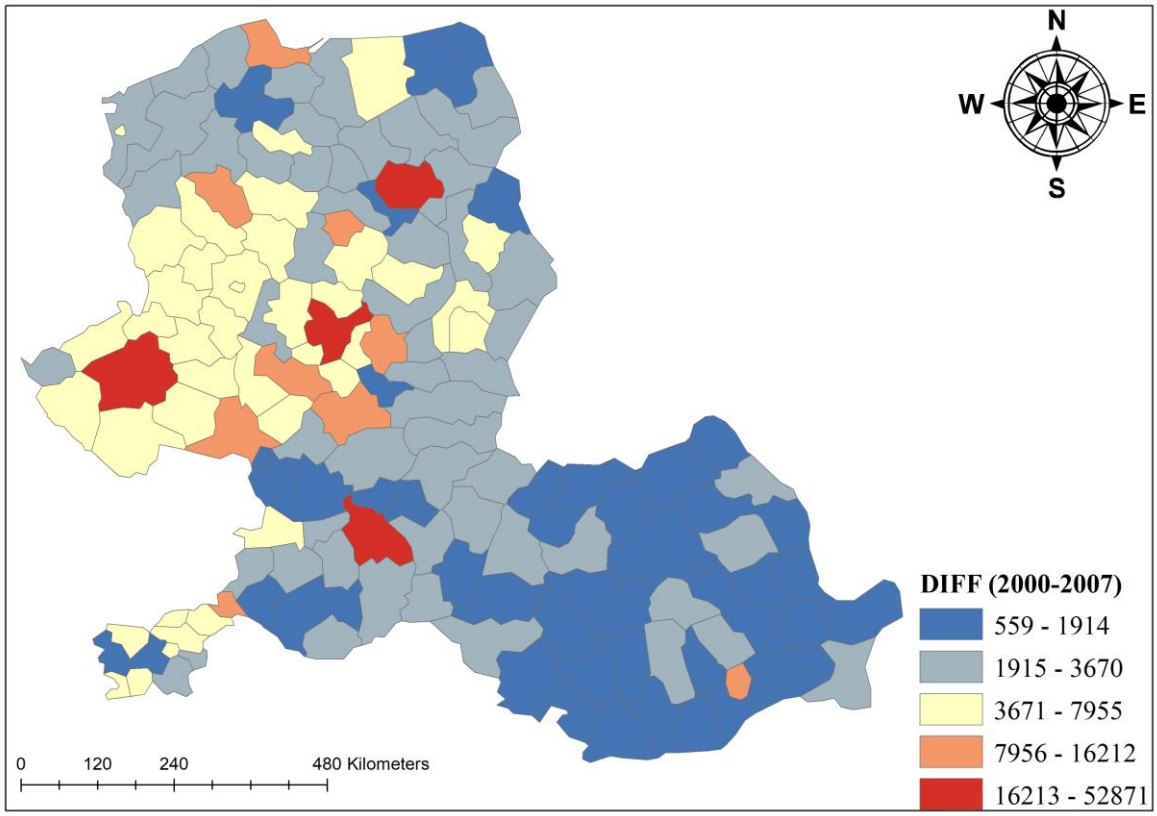
The second period (2012–2019) revealed more pronounced spatial inequalities across and within countries. While in the earlier period regional trends were more synchronized, by the 2010s regional specificities became more dominant. Romania again recorded the

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) again identified Romanian regions as high performers, now 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. The reallocation effect showed 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 dinamics in productivity at national and regional level, although regional disparities within the country remain significant. In the other countries, productivity dynamics were more 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.

When decomposing productivity growth through the shift-share analysis, it becomes possible to uncover the underlying dynamics behind aggregate increases. 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.

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



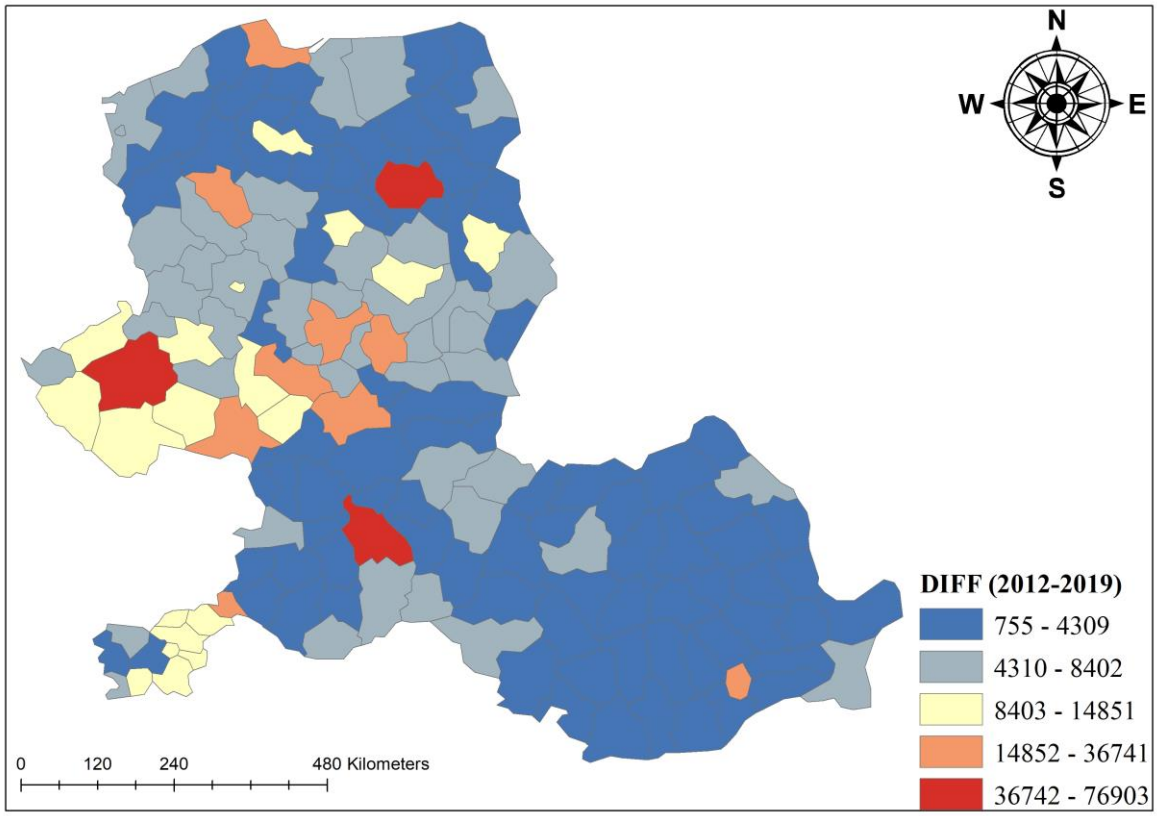
Source: own calculation and editing based on Eurostat

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).

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. While 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 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.

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



Source: own calculation and editing based on Eurostat

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 more by sectoral reallocation or compositional shifts rather than by increased efficiency.

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 tied 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 show the structural changes in the economies of the CEE regions from the 2000s to the Covid19 crisis. In line with this objective, our research question examined the differences and similarities in the describing productivity changes in NUTS-3 regions. The period is divided into two equal time periods, the former covering the years 2000-2007, and the latter the period 2012-2019, excluding the 2008 crisis, which can be clearly 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.

A 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 needed 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. Our point of view is that 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. We must analyze the future regional peculiarities of the current economic trends and phenomena.

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APPENDIX

Appendix 1. Results of shift-share analysis by componens 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	45866,48	39451,55	49436,9	132820,8	74185,2	29745,02
CZ031	Jihočeský kraj	6467,982	6527,614	6779,607	17099,97	11424,02	1422,4
CZ032	Plzeňský kraj	6217,543	5711,549	6477,005	17396,56	10111,26	1931,603
CZ041	Karlovarský kraj	2725,93	2619,922	2810,253	6156,512	5384,5	-652,029
CZ042	Ústecký kraj	7767,472	7527,085	8119,349	19826,6	13454,29	1447,904
CZ051	Liberecký kraj	4064,046	4224,732	4257,981	11253,49	6821,965	1295,997
CZ052	Královéhradecký kraj	5582,052	5403,458	5811,932	16569,14	9434,059	1791,898
CZ053	Pardubický kraj	5121,557	4878,415	5284,694	13663,94	8097,8	1808,153
CZ063	Kraj Vysočina	5052,939	4913,539	5276,924	13930,32	8879,37	1591,724
CZ064	Jihomoravský kraj	12402,31	11236,22	13129,46	36681,12	24425,42	3643,798
CZ071	Olomoucký kraj	5486,752	5916,835	5870,517	16606,8	11814,32	-72,8586
CZ072	Zlínský kraj	5910,676	5220,085	6014,24	16929,62	9220,265	2564,809
CZ080	Moravskoslezský kraj	12434,24	10796,11	12753,73	31159,36	22213,13	2723,939
HU110	Budapest	41048,78	36035,13	44373,28	101954,6	76902,88	5755,134
HU211	Fejér	3683,091	3605,58	3608,289	9684,724	4248,445	1779,6
HU212	Komárom-Esztergom	2877,549	2427,82	3052,174	7146,811	2617,733	1618,227
HU213	Veszprém	2401,708	2170,271	2466,292	5911,499	4018,021	72,67963
HU221	Győr-Moson-Sopron	4610,215	4375,039	4719,155	12825,99	5175,349	2422,023
HU222	Vas	2099,464	2133,988	2151,611	5224,001	2898,73	536,4655
HU223	Zala	2023,836	1827,031	2141,437	4434,151	3640,06	-87,8021
HU231	Baranya	2375,713	2435,154	2517,034	5471,529	5129,343	-1305,93
HU232	Somogy	1795,133	1671,067	1843,862	4241,872	3528,187	-519,144
HU233	Tolna	1482,61	1437,683	1491,724	4068,534	2488,427	-58,7763
HU311	Borsod-Abaúj-Zemplén	4091,844	3454,14	4147,007	10159,39	6888,062	-449,446
HU312	Heves	1975,161	1731,678	2020,656	5208,255	3004,092	70,70178
HU313	Nógrád	814,382	747,4484	850,339	1883,904	1774,667	-551,211
HU321	Hajdú-Bihar	3380,641	3143,911	3547,676	8548,861	7022,392	-664,797
HU322	Jász-Nagykun-Szolnok	2209,184	1995,75	2261,706	5381,635	3604,32	-14,846
HU323	Szabolcs-Szatmár-Bereg	2635,919	2435,137	2743,188	7404,058	5841,994	-1013,37
HU331	Bács-Kiskun	3112,577	2818,276	3273,612	9389,3	5456,208	550,5546
HU332	Békés	1969,824	1913,525	2034,142	4297,099	3936,43	-783,765
HU333	Csongrád-Csanád	2718,104	2454,227	2811,294	6572,936	5107,929	-425,446
PL911	Warszawa	41854,48	52870,65	48977,39	135650,8	72213,08	38235,61
PL711	Lódz	8332,299	10668,44	9442,257	26171,38	14017,68	3851,411
PL213	Kraków	10961,87	13609,93	12932,09	38422,69	24269,43	5384,652
PL415	Poznan	12319,62	16211,67	13881,79	37940,39	20568,58	10498,5

PL634	Gdansk	9806,204	12061,26	11074,25	31254,41	20800,44	6064,715
PL22A	Katowice	23563,88	27496,72	25190,69	60103,5	34418,21	14293,53
PL217	Tarnowski	1892,638	2459,716	2311,505	6074,302	4512,739	244,3968
PL218	Nowosądecki	1963,295	2753,969	2516,637	7157,161	5191,081	234,5645
PL219	Nowotarski	1188,517	1627,896	1496,189	3935,409	3171,908	151,0899
PL21A	Oświęcimski	2933,511	3809,973	3288,964	8687,802	5156,318	1325,866
PL224	Częstochowski	2807,582	3778,778	3580,215	9477,566	5363,584	1597,567
PL225	Bielski	4078,335	5992,976	4929,859	14014,86	7421,438	3394,417
PL227	Rybnicki	3765,287	4314,929	4148,488	11711,5	6431,593	2675,27
PL411	Pilski	2229,815	2883,95	2434,802	6816,246	3932,862	643,5102
PL414	Koniński	3320,476	4309,553	3769,139	11120,43	5988,502	1911,909
PL416	Kaliski	3553,465	4481,755	4003,197	12831,21	6497,543	2454,916
PL417	Leszczyński	3105,835	4130,174	3530,707	10538,17	5302,041	2378,21
PL424	Miasto Szczecin	3592,435	4702,071	4099,276	9474,361	8211,979	242,5135
PL426	Koszaliński	2086,689	2550,536	2336,548	5920,374	4621,552	148,0867
PL427	Szczecinecko-pyrzycki	1932,553	2496,545	2137,891	5112,212	3861,815	170,0439
PL428	Szczeciński	2769,025	3553,579	3110,124	8392,511	5717,865	1000,505
PL431	Gorzowski	2317,468	3046,772	2614,886	6662,829	4308,816	637,1144
PL432	Zielonogórski	3883,191	4499,427	4323,838	10986,39	6770,366	1329,161
PL514	Miasto Wrocław	6409,778	7955,345	7341,734	23969,31	14850,81	2549,504
PL515	Jeleniogórski	3085,43	3883,987	3423,336	9256,342	6183,443	823,0026
PL516	Legnicko-głogowski	5318,006	5012,939	5706,837	12410,65	6841,318	3639,463
PL517	Wałbrzyski	3689,567	4241,942	4100,404	9990,724	6570,873	702,2036
PL518	Wrocławski	2920,71	4035,038	3464,413	12594,29	5970,646	3713,456
PL523	Nyski	1683,61	2191,511	1980,846	4662,468	3268,784	226,9736
PL524	Opolski	4140,664	4825,956	4667,756	11849,1	7439,35	1320,572
PL613	Bydgosko-toruński	5929,105	7290,854	6615,325	16173,53	10903,4	1882,082
PL616	Grudziądzki	1736,186	2273,514	1947,566	5509,722	3371,544	636,5693
PL617	Inowrocławski	1795,929	2286,199	2002,154	4957,102	3211,08	525,4671
PL618	Świecki	936,4957	1254,897	1021,213	3216,825	1330,613	670,1259
PL619	Włocławski	1814,426	2354,978	2083,744	4953,408	3313,404	301,7617
PL621	Elbląski	2562,051	3167,195	2862,91	7557,903	5105,525	344,9252
PL622	Olsztyński	3482,278	4404,018	3875,705	9920,984	7990,518	-124,78
PL623	Ełcki	1215,838	1515,896	1356,755	3620,739	2633,197	-199,871
PL636	Słupski	1824,761	2117,434	1977,084	5427,616	3731,345	132,7251
PL637	Chojnicki	1040,143	1228,193	1160,606	3108,62	2141,487	35,64801
PL638	Starogardzki	2427,114	3020,945	2662,58	7125,033	4167,582	1071,379
PL713	Piotrkowski	3480,034	4338,277	3948,963	12333,82	5643,958	2600,554
PL714	Sieradzki	2232,553	2846,122	2574,735	6821,659	3689,466	695,6347
PL715	Skierniewicki	1828,551	2300,937	2140,198	5588,323	3213,816	656,0636
PL721	Kielecki	4435,294	5361,352	5191,862	11700,59	9769,955	660,444
PL722	Sandomiersko-jędrzejowski	2134,917	2843,659	2610,875	5722,281	4480,813	653,2723
PL811	Bialski	1218,011	1536,265	1464,025	3305,261	3206,492	-9,15966
PL812	Chełmsko-zamojski	2571,163	3214,189	3068,611	6088,978	6018,334	-274,789
PL814	Lubelski	4096,137	5104,952	4762,184	12769,75	10996,33	223,3542

PL815	Puławski	1913,919	2757,115	2366,477	5653,884	4198,739	746,7726
PL821	Krośnieński	1893,135	2645,45	2323,388	5651,499	4481,265	-34,2671
PL822	Przemyski	1426,818	1954,523	1816,546	3824,66	3793,871	-332,742
PL823	Rzeszowski	2856,433	3894,326	3605,892	11099,44	8401,656	1327,725
PL824	Tarnobrzeski	2882,115	3827,304	3513,794	9351,836	5162,746	1857,79
PL841	Białostocki	2982,197	3450,118	3404,662	8565,428	7106,445	32,65255
PL842	Łomżyński	1723,543	2142,643	1993,607	5363,516	3514,972	449,5991
PL843	Suwalski	1236,141	1516,391	1401,663	3535,128	2484,486	140,5269
PL921	Radomski	2846,729	3669,84	3268,769	8714,843	6067,212	843,2231
PL922	Ciechanowski	1680,289	2281,775	1893,034	5388,387	2995,801	921,1911
PL923	Płocki	3006,477	3503,438	3318,626	10506,99	3872,206	4096,536
PL924	Ostrołęcki	1764,93	2183,88	2019,571	5739,957	3536,703	951,234
PL925	Siedlecki	1928,208	2503,495	2263,843	6530,604	4136,579	1090,441
PL926	Żyrardowski	1333,492	1851,438	1552,83	4298,707	2584,669	1266,806
RO321	Bucuresti	27735,96	15939,49	28663,91	92365,32	36740,94	29598,5
RO111	Bihor	2739,278	1998,465	3231,793	7480,677	3300,557	2251,536
RO112	Bistriţa-Năsăud	1139,172	921,5974	1347,75	3244,095	1797,64	776,0303
RO113	Cluj	4232,973	3046,033	4987,973	15422,59	7883,889	5053,365
RO114	Maramureş	1621,798	1257,021	1886,368	5283,499	2566,073	1629,958
RO115	Satu Mare	1198,029	995,3813	1457,729	3754,64	1676,614	1306,092
RO116	Sălaj	837,5799	683,0516	1030,545	2565,829	1324,917	852,9638
RO121	Alba	1879,752	1224,847	2174,51	6065,765	1954,804	1569,301
RO122	Braşov	3504,809	2413,872	3823,16	11745,57	3767,808	3932,055
RO123	Covasna	920,8451	741,6744	957,3617	2820,175	831,884	620,9606
RO124	Harghita	1355,462	996,4005	1420,673	4005,756	1304,85	1092,19
RO125	Mureş	2605,534	1830,9	2791,038	7605,666	2998,534	1713,982
RO126	Sibiu	2338,736	1473,129	2553,305	8294,129	2513,659	2089,49
RO211	Bacău	2009,685	2000,165	2712,93	7150,877	2950,585	1320,804
RO212	Botoşani	963,3624	872,3102	1240,637	3829,512	1352,098	546,9246
RO213	Iaşi	2478,948	2388,155	3339,302	11764,62	5509,348	1755,145
RO214	Neamţ	1291,602	1345,909	1786,487	5444,187	1821,641	857,2524
RO215	Suceava	1886,934	1629,887	2382,963	7266,368	2720,388	1125,252
RO216	Vaslui	713,7771	751,6359	1017,797	3594,794	1498,929	163,3925
RO221	Brăila	1215,906	996,7909	1574,3	3347,034	1766,302	1062,07
RO222	Buzău	1377,866	1156,663	1713,588	4795,057	1854,498	1353,463
RO223	Constanţa	3632,841	3221,037	4636,689	11663,38	6312,011	4637,486
RO224	Galaţi	2318,184	1654,056	2490,936	5914,427	3395,373	1074,948
RO225	Tulcea	668,6075	607,7406	879,264	2331,222	1257,27	692,0689
RO226	Vrancea	1018,233	950,1601	1241,798	3434,741	1667,087	784,8553
RO311	Argeş	3542,049	2104,798	3856,253	9688,979	2976,098	3072,907
RO312	Călăraşi	664,1353	678,7396	867,2373	2728,389	949,6613	705,999
RO313	Dâmboviţa	2038,953	1247,766	2203,719	5902,072	2512,444	1848,496
RO314	Giurgiu	579,3742	559,4838	744,9139	2071,74	984,4579	529,3125
RO315	Ialomiţa	665,6017	754,9712	906,1275	2529,638	1123,652	941,7145
RO316	Prahova	3937,253	2758,017	4512,319	12387,41	3961,674	4637,89
RO317	Teleorman	967,915	1072,336	1296,025	3164,392	1392,977	1048,197

RO411	Dolj	2234,756	1885,002	2904,739	8130,954	3748,863	2313,102
RO412	Gorj	1678,144	1266,009	1994,007	5736,142	1842,449	2100,612
RO413	Mehedinţi	785,9846	714,0709	1010,836	2334,266	1154,204	518,5161
RO414	Olt	1177,087	1203,574	1493,088	4177,689	1785,255	1148,051
RO415	Vâlcea	1470,263	1193,062	1844,666	4578,56	1848,894	1554,626
RO421	Arad	2303,117	1596,727	2576,183	8556,378	1378,727	2377,371
RO422	Caraş-Severin	1316,692	857,9405	1416,943	3222,622	1366,671	1157,942
RO423	Hunedoara	2171,256	1502,044	2468,446	4920,609	2405,729	1623,34
RO424	Timiş	4542,999	2610,117	5000,502	15513,23	5303,44	5308,8
SI031	Pomurska	13615,72	10312,51	14455,7	41883,09	30995,33	1294,715
SI032	Podravska	6053,418	4449,644	6455,646	17837	10636,71	2435,479
SI033	Koroška	5171,746	4104,805	5333,111	12917,1	11968,13	-1177,56
SI034	Savinjska	5330,141	4244,121	5634,073	15908,46	9369,148	3635,696
SI035	Zasavska	5482,852	4062,834	5657,86	17249,92	11315,65	1735,508
SI036	Posavska	4413,963	3368,511	4671,56	12229,35	10566,21	156,8042
SI037	Jugovzhodna Slovenija	3951,851	3176,249	4244,558	13974,91	9634,892	990,4203
SI038	Primorsko-notranjska	5870,686	4561,151	6230,826	17085,35	11380,85	2399,233
SI041	Osrednjeslovenska	1099,65	1481,599	1247,293	2765,021	2022,09	-18,9651
SI042	Gorenjska	3901,623	4871,79	4314,764	9340,918	7584,928	-381,432
SI043	Goriška	854,4607	1069,161	892,0772	2150,929	1215,25	182,4515
SI044	Obalno-kraška	3266,822	4062,034	3534,282	8075,109	5254,775	1254,571
SK010	Bratislavský kraj	539,6968	688,1006	573,087	1066,345	754,7338	73,42527
SK021	Trnavský kraj	880,5784	1060,035	946,5477	2292,972	1454,295	259,2318
SK022	Trenčiansky kraj	1992,219	2513,657	2156,562	5344,91	2797,749	883,712
SK023	Nitriansky kraj	563,6942	701,0019	600,5357	1269,127	927,3361	114,7996
SK031	Žilinský kraj	10918,27	13603,64	12016,5	27358,63	25029,06	-3216,68
SK032	Banskobystrický kraj	2535,069	3116,263	2735,622	6507,637	4199,325	750,5093
SK041	Prešovský kraj	1677,368	2081,949	1825,748	3834,706	3304,305	-469,679
SK042	Košický kraj	1687,693	1996,116	1883,795	3638,06	3544,931	74,53842