NUTS2 regions of the Visegrad countries during the Covid-19 pandemic and recovery

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The study examines the economic recovery of NUTS2 regions in the Visegrad Group (V4) countries after the Covid-19 pandemic. Using Ferenc Jánossy's trendline theory, the authors assess recovery by comparing current development levels to pre-crisis trends, not just pre-pandemic levels. The focus is on gross domestic product (GDP) per capita adjusted for purchasing power parity (PPP) to gauge recovery duration and influencing factors. It also investigates the changes in peripheral area lags due to the pandemic across these regions.

The study finds that numerical values are less relevant due to distortion, but comparisons using consistent methodology reveal regional impacts, opportunities, and effective practices. It highlights significant regional differences: areas with diversified economies and adaptable sectors, like Łódź Voivodeship (Łódzkie) in Poland and the Bratislava Region (Bratislava) in Slovakia, fared better, while tourism and service-dependent regions struggled more. The analysis underscores the importance of sectoral diversity and adaptability in crisis mitigation.

Slovakia and Hungary experienced varied impacts due to economic policies and structural characteristics. The Bratislava Region (Bratislava) adapted quickly while Budapest's dominance grew, increasing rural underdevelopment. Regions reliant on tourism, such as Prague (Praha) and Balaton, saw severe declines, whereas agriculture and industry sectors remained relatively stable. We are also planning the second part of the study, supplemented with 2024 data, using our current experiences.

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Introduction

The present study's authors examine the recovery of regions in the so-called Visegrad Group (V4) from the crisis caused by Covid-19 pandemic. They fundamentally use Ferenc Jánossy's trendline theory, published in 1966, to investigate the recovery. The essence of this theory is that economic recovery following crises does not end when economic growth reaches the pre-crisis level. According to Jánossy, the process is completed when the level of development attained matches the trend value calculated from pre-crisis data. The authors examine this in the current research, seeking to determine how long the recovery from the Covid-19 crisis takes or took and what factors influence(d) the process. To answer this question, they analyze the per capita gross domestic product (GDP per capita PPP) trend calculated with purchasing power parity in the V4 countries. The study addresses how the lag of peripheral areas has decreased or increased due to the health crisis in each country and region.

Literature review

The theoretical framework of this research focuses on three main areas: economic crises, the conditions of the examined countries, and Jánossy's theory. The 21st century's economic history has been marked by successive crises, starting with the 2008 financial crisis and continuing through the Covid-19 pandemic (Igari 2023). Recovery from Covid-19 was ongoing when the Russian–Ukrainian conflict intensified in February 2022. Military actions between Israel and Palestinians followed this in October 2023, and the hostilities continue.

In "The System of Political Economy", Ruhland (1901) analyzed crises in advanced cultures and found that the interest-based money system was a critical factor in their decline. The compound interest system leads to unsustainable growth and wealth inequality, eventually causing societal regression and decline. Historical examples include the financial crisis of the Roman Empire in AD 33 (Tacitus 2003) and medieval Hungarian monetary issues (Draskóczy 2014). Similar patterns occurred with the French revolutionary assignats, where Napoleon's monetary reform eventually resolved the crisis (Rouanet et al. 2020).

Economic crises recur over time, a phenomenon aligned with theory of economic cycles. Various factors, including currency devaluation, over-lending, wars, and pandemics, trigger crises today. Koubi (2005) found that wars negatively affect economic growth during the conflict but can lead to higher post-war growth rates. The ongoing Russian–Ukrainian conflict has global impacts, disrupting supply chains and causing an energy and raw material crisis (Khudaykulova et al. 2022, Lim et al. 2022, Lavsi 2022, Orhan 2022). The conflict is driven by competition for Ukraine's resources, with various international actors pursuing different strategies for influence (EBRD 2022, Moberg 1996, Brennan 2023, Link 2023).

The effects of crises vary based on regional contexts. For instance, the Covid-19 pandemic severely impacted industrial production but neutralized regional economic indicators such as export-import trade and retail stability (Lukas et al. 2021). The Ukrainian conflict also affects these indicators. Developed economies can better manage crises with their more extensive reserves than countries struggling before the crisis. Neighboring countries face additional economic challenges due to the influx of refugees but may also gain labor market or trade advantages.

This study examines the economic growth trajectories of the V4 countries (Slovakia, Hungary, Poland, and the Czech Republic). These countries, once part of the Soviet sphere, joined the EU in 2004 and have experienced varied development paths (Ondos et al. 2024, Benedek–Veres 2023). Slovakia is in the eurozone, while Hungary, Poland, and the Czech Republic use their national currencies. The EU accession promised convergence, but development has been uneven, with national progress sometimes outpacing regional convergence (Kertész 2004, Kocziszky–Szendi 2023).

EU regional policy aims to help less developed regions catch up, but whether this results in true convergence or maintains existing disparities is debatable (Lengyel–Kotosz 2018, Tóth 2023). The EU uses the NUTS classification (Szabó 2005) system to assess regional development. Hungary's NUTS levels include NUTS1 regions like Transdanubia and NUTS2 statistical regions. Slovakia's NUTS2 regions are self-governing, while Poland's NUTS levels include voivodeships and sub-regions. The Czech Republic's NUTS1 is the country itself, with NUTS2 regions comprising development regions like Prague (Praha) and Moravian-Silesian (Moravskoslezsko).

Jánossy's (1966) trend theory explores convergence and growth recovery, focusing on the post-World War II recovery period. His theory posits that countries follow an exponential trend of increasing economic growth rates, termed the modernization rate. Jánossy emphasized fitting trends to maximum points on a production curve rather than average growth and noted that recovery ends when growth reaches the pre-crisis trendline. This theory helps analyze the four V4 countries' convergence between 2000 and 2019, examining whether their economic paths show similar or varying degrees of convergence and pace.

Methodology

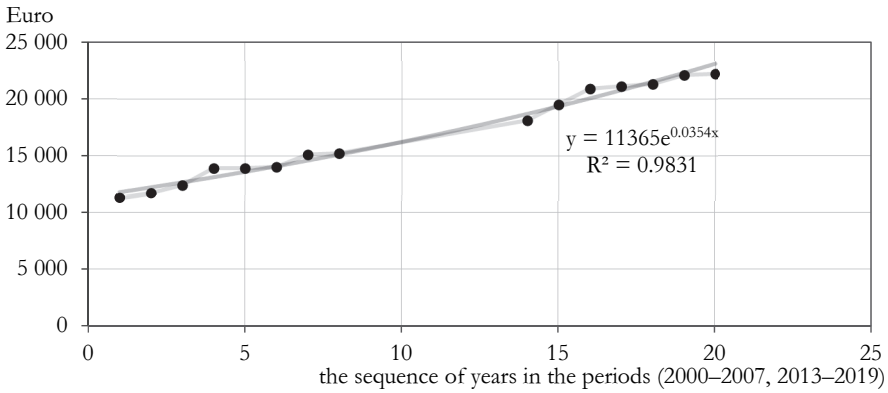
According to the Eurostat website, the data series "Gross domestic product (GDP) at current market prices by NUTS2 regions per inhabitant" met our requirements for 2000–2022.

- According to the spreadsheet available on the website, the data meet the requirement of consistent methodology.
- We chose the exponential trend commonly used in national studies for regional growth.

- In line with Jánossy's study, it is necessary to identify trends, excluding crisis periods. Our preliminary examinations suggest that the exponential trend provides a good fit for the periods outside of the crisis.
- Although data for the V4 countries indicates the duration of the financial crisis that began at the end of 2007, this is not necessarily relevant at the regional level. Based on the fit, we tested several solutions and concluded that the most appropriate approach is to exclude the values from 2008–2012 and post-2020 from our calculations. This approach aimed at achieving standardization. Figure 1 shows the incomplete data series for the Warsaw (Warszawski stołeczny) and the exponential trend.
- The data series is considered sufficiently long, containing 15 values.

Figure 1

GDP per capita at current market prices in Warsaw



Source: own editing based on Eurostat data (Eurostat 2024a).

The indicator that well represents the fit to the trend, the coefficient of determination, shows an extremely high value of 98.41%. This is true even though the GDP value was high in 2003 and 2006 and low in 2013, compared to the trend. Although the data from the crisis years are not visible, they suggest that the crisis period in the examined central region ended later than the years we excluded from the trend analysis might indicate. Specific differences appear in every region. From this perspective, our study is somewhat biased, but it is suitable for identifying regions that perform well and poorly compared to their trend and central region.

The trend formula was determined using Excel. The authors then extended the trend to the pandemic-affected period of 2020–2022. They calculated the percentage deviation of the actual data from the trend, analyzed the obtained data, and explained the results. Additionally, they examined which regions lag relative to the central region increased and which decreased. Some possible reasons were considered based on the numerical data. The percentage deviation from the trend calculated by the authors, which forms the basis of the comparison, is a distorted indicator of its value.

$$D_i = ((GDP_i\ (2022)\ /GDP_i\ (2022)\ *) - 1) \times 100\ [\%] \quad (1)$$

were Di: percentage deviation from the calculated trend in the i-th region; GDP_i (2022): GDP per capita in the i-th region in 2022, published by the Statista website; GDP_i (2022) *: based on the trend we calculated, the expected GDP was calculated at purchasing power parity per capita in the i-th region in 2022.

The essence of the second calculation is how the backwardness of the peripheral regions changed during the examined period of the twin crises in health and inflation. The ideal situation would be to reduce the backlog. The goal is the creation of countries close to equilibrium yet with an obvious center. The formula used by the authors:

$$W_i = ((GDPi\ (2019)\ /GDPk\ (2019)) - (GDPi\ (2022)\ /GDPk\ (2022)) \times 100\ [\%] \quad (2)$$

where W: the percentage change in the lag of the i-th region compared to the central region (negative W means approaching GDP values); GDPi (2019) The GDP of the i-th NUTS2 region calculated on PPP per capita in 2019; GDPk (2022) The GDP per capita of the center belonging to the i-th NUTS2 region in 2022.

For the sake of accuracy, we also report the peripheral lags of the current year in the middle section of the tables.

$$D_i = (1 - (GDP_i\ (2022)\ /GDP_k\ (2022)\ *) \times 100\ [\%] \quad (3)$$

Analysis

Polish NUTS2 regions

Table 1 presents data on Poland's regions. Values indicating good performance are highlighted in bold, while gray background indicates adverse economic facts. These assessments include explanations based on contemporary and current literature.

In 2021, the Łódź Voivodeship (Łódzkie) achieved a GDP growth of 0.6%. The outstanding performance was observed in the textile and manufacturing sectors, which quickly shifted to producing medical textiles during the pandemic. Additionally, they developed filtering materials that effectively protect against bacteria and viruses (Nowakowska et al. 2024). As the burden on human resources becomes increasingly evident, national and regional leaders are working to identify shortcomings and draw lessons from experiences to better understand occupational impacts in managing future epidemics, pandemics, or public health crises (Jiménez 2023). Łódź Voivodeship's (Łódzkie) central location also facilitated logistics and distribution, mitigating disruptions caused by the pandemic (Strachan 2021).

The Podlaskie Voivodeship (Podlaskie) observed a growth of 10.2% in 2022. The agricultural sector played a key role in this strong performance, as food production and export were less affected by disruptions. The region's location near the borders of Belarus and Lithuania facilitated ongoing cross-border agricultural trade (Jarosz-Angowska et al. 2022). In 2020, Poland's agri-food foreign trade showed significant

growth. Agricultural enterprises successfully increased labor profitability and reduced the negative gap in labor productivity (Czubak–Pawłowski 2020).

In the Warmian-Masurian Voivodeship (Warmińsko-Mazurskie), a growth of 7.8% occurred in 2022. Due to the region's rural and agricultural nature, it was less dependent on services and tourism, which were severely affected by the pandemic (Gajewski 2022). The Lower Silesian Voivodeship (Dolnośląskie) grew by 4.4% in 2022. Its economy is diversified, with significant technological and innovation investments that continued to attract domestic and foreign capital despite the pandemic (Nowak 2021). The 9.3% improvement observed in the Silesian Voivodeship (Śląskie) by 2022 followed an initial decline in manufacturing and heavy industry due to government infrastructure projects and the revival of the coal and steel industries.

Implementing innovative projects by mining and processing companies facilitated the recovery of these industries, which contributed to economic growth and job creation (Dragan–Zdyrko 2023). The recovery of global markets further supported this process, resulting in significant regional development.

Table 1

Performance of Polish regions

NUTS2 region	Trend		Position compared to the own trend			Backlog in the current year from the center				Change in lag from the center			
			%										
	Beta1	Beta0	2020	2021	2022	2019	2020	2021	2022	2019/2020	2020/2021	2021/2022	2019/2022
Warszawski stołeczny	1.052	18.246	–4.00	–2.53	–1.26								
Małopolskie	1.052	7.472	–4.22	1.03	3.45	58.48	58.45	56.80	56.29	–0.03	–1.65	–0.50	–2.19
Śląskie	1.048	9.202	–7.53	–0.55	9.29	53.29	54.67	52.14	48.25	1.38	–2.53	–3.89	–5.04
Wielkopolskie	1.053	8.931	–4.16	–0.97	2.70	50.50	50.10	49.16	**47.90**	–0.40	–0.94	–1.26	–2.60
Zachodniopomorskie	1.043	8.128	–1.90	2.90	8.56	62.08	61.83	60.89	59.62	–0.25	–0.94	–1.28	–2.46
Lubuskie	1.046	7.652	–5.35	–0.27	6.98	63.07	63.02	61.82	59.79	–0.05	–1.20	–2.03	–3.28
Dolnośląskie	1.057	8.548	–6.35	–1.24	4.37	50.30	49.50	47.30	**44.76**	–0.80	–2.20	–2.54	**–5.54**
Opolskie	1.049	7.015	–5.81	1.27	6.54	64.07	64.21	62.20	60.84	0.14	–2.02	–1.36	–3.23
Kujawsko-pomorskie	1.044	7.660	–2.30	3.12	**11.26**	63.67	63.02	61.82	59.62	–0.65	–1.20	–2.21	–4.06
Warmińsko-mazurskie	1.045	6.569	–3.25	1.19	7.81	68.86	67.99	67.23	65.73	–0.87	–0.77	–1.49	–3.13
Pomorskie	1.049	8.427	–5.53	1.61	**11.02**	55.69	56.66	54.19	50.70	0.97	–2.47	–3.49	–4.99
Łódzkie	1.053	7.636	–2.41	0.58	4.99	57.09	55.86	55.12	53.67	–1.22	–0.74	–1.45	–3.41
Świętokrzyskie	1.045	6.808	–3.51	1.31	5.00	67.47	67.20	66.29	65.73	–0.27	–0.90	–0.56	–1.73
Lubelskie	1.049	6.083	–5.31	–1.01	6.00	68.86	68.99	68.16	66.43	0.12	–0.83	–1.72	–2.43
Podkarpackie	1.048	6.210	–5.88	–0.01	3.50	67.86	68.59	67.23	66.61	0.72	–1.36	–0.62	–1.26
Podlaskie	1.048	6.372	–2.21	1.61	10.17	67.07	66.60	65.92	63.64	–0.47	–0.68	–2.29	–3.43
Mazowiecki regionalny	1.057	6.589	–6.65	–1.82	9.85	60.48	60.83	59.22	54.72	0.36	–1.62	–4.50	**–5.76**

Source: own compilation based on Eurostat data (2000–2022) (Eurostat 2024c).

The Masovian Voivodeship (Mazowiecki region)'s performance increased by 9.8% in 2022, approaching the central performance level. The region has strong government and financial services sectors, making it less vulnerable to pandemic-caused disruptions. In cooperation with the government, the financial sector effectively managed crisis response measures (Czeczeli et al. 2020). Strong IT and communication sectors supported a rapid transition to remote work. Favorable legislation for the construction industry enabled the realization of numerous residential complexes (Badura 2021). The capital itself did not reach the trend due to stricter regulations; however, its surroundings did, reducing its lag.

Gajewski (2022) examined the post-Covid-19 economic development of Polish NUTS4 regions. According to his findings, three factors influence development:

1. Regions that withstood the first wave of the 2008 crisis better showed greater resilience to the impacts of the pandemic.
2. Higher per capita production in a region is associated with reduced crisis resistance, likely due to the integration of industry into globalized chains.
3. Regions with a higher proportion of agricultural employment fared better during the crisis, likely due to the capability for self-sufficiency and a higher level of agricultural modernization.

Gajewski also describes that the less developed, peripheral regions appeared better protected from the impacts of the pandemic-caused crisis. He suggests that a possible reason for this is that less developed regions are less prone to financial bubbles and other imbalances that typically accumulate in service-dominated innovative areas.

Czech NUTS2 regions

Table 2 shows the GDP changes of the Czech regions. Several factors influenced Prague (Praha)'s economic performance. Although there was a sharp decline in 2020, the city's recovery in 2022 (0.3%) was likely due to its diversified economy, strong service sector, and significant technological investments, which helped mitigate economic disruptions (Özsoy et al. 2022).

The performance of Central Bohemia (Střední Čechy) showed continuous negative deviations until 2021, likely due to disruptions in the manufacturing sectors. Central Bohemia's (Střední Čechy) proximity to Prague (Praha) may have intensified the negative economic interdependencies, which were further exacerbated by the pandemic (Roszko-Wójtowicz et al. 2022). By 2022, similar to the capital, it reached and exceeded its trend. Northwest (Severozápad)'s economic performance was also influenced by its proximity to Germany, particularly due to border closures hampering cross-border trade and industrial performance. The region's slight recovery in 2022 might indicate the resumption of the automotive industry or manufacturing as restrictions ease (Perdana–Vielle 2023).

However, the European Commission's 2022 country report somewhat nuances these results. It states that the intense nature of the green transition negatively impacts coal regions in the Northwest (Severozápad), increasing unemployment. Without effective response strategies, this leads to higher poverty, household indebtedness, and early school leaving (EC 2022). Several factors influenced the economic performance of the Moravian-Silesian (Moravskoslezsko). The region, known for its industrial base, experienced significant declines, especially in traditional sectors. The brewing industry faced challenges, with several breweries reporting declines or bankruptcies, while others found new markets or switched to producing hand sanitizers, following global trends (Perdana–Vielle 2023).

Table 2

Performance of Czech regions

NUTS2 region	Trend		Position compared to the own trend			Backlog in the current year from the center				Change in lag from the center			
			%										
	Beta1	Beta0	2020	2021	2022	2019	2020	2021	2022	2019/2020	2020/2021	2021/2022	2019/2022
Prague (Praha)	1.041	29.038	–8.60	–3.24	0.34								
Central Bohemia (Střední Čechy)	1.031	13.790	–6.74	–5.13	0.59	58.51	60.29	62.21	**61.72**	1.78	1.91	–0.49	3.20
Southwest (Jihozápad)	1.032	12.672	–3.68	–1.99	–1.26	62.07	61.43	63.24	64.58	–0.65	1.81	1.34	2.50
Northwest (Severozápad)	1.027	11.635	–5.83	–3.44	**0.65**	68.89	69.21	70.59	70.84	0.32	1.38	0.26	1.96
Northeast (Severovýchod)	1.035	11.423	–0.41	0.38	**2.20**	63.16	62.24	64.26	65.12	–0.92	2.03	0.86	1.96
Southeast (Jihovýchod)	1.039	12.151	–3.05	–1.33	0.47	59.29	57.54	59.26	**60.08**	–1.75	1.73	0.82	**0.79**
Central Moravia (Střední Morava)	1.039	10.775	–4.62	–1.77	–0.04	63.47	62.88	63.97	64.71	–0.58	1.09	0.74	1.25
Moravian-Silesian (Moravskoslezsko)	1.040	10.769	–11.77	–8.08	–4.80	64.71	64.99	65.59	65.67	0.29	0.60	0.08	**0.96**

Source: own compilation based on Eurostat data (2000–2022) (Eurostat 2024c).

Like the previous region, the Southeast (Jihovýchod)'s economic performance was influenced by several factors; its improvement following the 2022 pandemic is linked to its robust agricultural background. The region, less dependent on international tourism, relies more on local and regional markets, which provide significant protection against the economic impacts of the pandemic (Mogila et al. 2022).

The economic development of Czech regions during the pandemic showed significant variability, influenced by industrial structure, geographical location, and sector-specific dynamics. Regions with diversified economies or strong agricultural

sectors, such as Prague (Praha) and Southeast (Jihovýchod), were more resilient to the crisis. In contrast, areas characterized by significant international exposure and heavy industrialization, such as Moravian-Silesian (Moravskoslezsko) and Northwest (Severozápad), faced more significant challenges.

These results suggest economic resilience depends on economic diversification, adaptive industrial capabilities, strategic geographical advantages, and effective regional and national policy responses.

Slovakian NUTS2 regions

The pandemic's impact on different regions of Slovakia was significant, and the changes in their economic performance reflect this well (Table 3). The regions responded differently to the challenges of the pandemic, resulting in varying degrees of economic growth or decline.

The economic performance of the Bratislava Region (Bratislava) fell significantly short of its trend during the pandemic, with a 16.8% lag observed in 2020, which worsened to 22.1% in 2021, and the lag from the trend persisted in 2022. Despite this, rapid growth is expected, mainly due to the region's strong economic foundations and central role, where the diversity of economic activities and high-level services can help mitigate the impacts of the crisis. The presence of multinational companies and high-value-added services can contribute to a faster economic recovery (Domonkos–Pawera 2022).

The Bratislava Region (Bratislava) presents a unique case, deviating unfavorably from its GDP per capita (PPP) trend. This deviation, however, cannot be solely attributed to the absolute level of GDP per capita, which was the highest in regional comparison before the pandemic (Klimovský et al. 2021). It is a case of a rapidly growing economy experiencing a slowdown. Notably, this region had the highest labor costs per employee, and the number of self-employed individuals and SMEs was only half to a third of the values measured in other areas (Guzi–Fabo 2021). This region stands out as the leader in innovation in Slovakia. Its strengths include a high proportion of the population with higher education, a significant number of employees in medium and high-tech industries, and substantial public sector spending on R&D (Nagy–Lăzăroiu 2022).

In Western Slovakia (Západné Slovensko), economic performance did not deteriorate as much as in the central region. However, this area also did not reach its own trend by 2022. The lag compared to the central region steadily decreased by 4.51% between 2019 and 2022. Thus, Western Slovakia's (Západné Slovensko) economy did not suffer as much from the restrictions, which were enough to narrow the gap with the Bratislava Region (Bratislava). The industrial sector and agriculture adapted relatively quickly to the challenges of the pandemic. Nevertheless, due to the decline in tourism, such as the decreased visitation rates of Trencín and the significant

downturn in the service sector, the region's performance was not the best in the country (Kramáreková et al. 2023).

Central Slovakia's (Stredné Slovensko) economic performance also declined during the pandemic. However, the lag compared to the central region decreased by 59%. The region's economic growth was primarily driven by industrial production and the quick adaptability of local businesses. Agriculture and forestry, which play important roles in this region, proved resilient during the pandemic. Nevertheless, the region could not fully exploit its potential due to the lack of infrastructural development and weak transportation links (Almášiová et al. 2023).

Eastern Slovakia's (Východné Slovensko) economic performance also declined during the pandemic. The lag compared to the central region decreased by 5.1% between 2019 and 2022. The region's economic structure and labor market were less able to respond to the challenges of the pandemic. Due to the lower level of industrialization and the dominance of agriculture, Eastern Slovakia's (Východné Slovensko) economic growth was limited, and the lack of local infrastructure development further worsened the region's competitiveness (Štefan–Pregi 2023).

Currently, several NUTS3 regions have their own innovation strategies (the Nitra and Košice municipal regions), while others are updating theirs (the Bratislava municipal region) or creating new ones (the Banská Bystrica municipal region). However, in general, comprehensive innovation strategies are lacking in the regions, and within these regions, the dynamics of development and innovation potential vary (MIRRI 2021).

The stringent restrictive measures severely impacted Slovakia's economic development. However, relying on the internal market and leveraging the regions' convergence may enable the realization of its potential.

Table 3

Performance of Slovak regions

NUTS2 region	Trend		Position compared to the own trend			Backlog in the current year from the center				Change in lag from the center			
			%										
	Beta1	Beta0	2020	2021	2022	2019	2020	2021	2022	2019/2020	2020/2021	2021/2022	2019/2022
Bratislavský kraj	1.048	23.227	–16.79	–22.12	–23.45								
Západné Slovensko	1.044	9.424	–10.43	–9.20	–8.22	60.00	59.73	56.55	**55.49**	–0.27	–3.18	–1.06	–4.51
Stredné Slovensko	1.044	8.081	–10.78	–4.94	**–2.04**	64.90	65.37	60.71	58.96	0.47	–4.66	–1.75	–5.94
Východné Slovensko	1.041	7.418	–7.96	–3.89	–2.40	69.61	68.87	65.48	64.55	–0.74	–3.40	–0.93	**–5.06**

Source: own compilation based on Eurostat data (2000–2022) (Eurostat 2024c).

Hungarian NUTS2 regions

Table 4 shows the economic performance of Hungary's regions during the pandemic period. The Western Transdanubia (Nyugat-Dunántúl) region exhibited a significant negative deviation from its own trend in both 2020 and 2021 (more than 11% in both cases), which the pandemic-related interruption of cross-border economic activities with Austria and Slovakia could have caused. The reduction of the deviation by 2022 can be explained by easing border restrictions and the resumption of economic activities; however, the previous high steep trend was not achieved (Behringer et al. 2023).

The Northern Great Plain (Észak-Alföld) has shown positive deviations in recent years, likely due to its strong agricultural foundations. Agriculture, less affected by pandemic restrictions than other sectors, provided stability to the region's economy. The region's performance reflects the resilience of food production and supply chains during global disruptions (Hadházi et al. 2021).

Similar to the Northern Great Plain (Észak-Alföld), the Southern Great Plain (Dél-Alföld) has improved over the years, although it started with a negative deviation in 2020. The region's agricultural production may have mitigated the economic impacts, highlighting the critical role of agriculture in regional economic stability (Lencsés et al. 2023).

We have observed constant positive deviations in Budapest since 2021. As Hungary's capital and economic hub, Budapest maintained its economic activities through the service, technology, and financial sectors, which could quickly adapt to the pandemic. The city's diverse economic structure allowed the business sector to transition to remote working systems, minimizing productivity declines rapidly. Companies operating in the technology and financial sectors already have the necessary infrastructure and digital tools to facilitate remote work, so these sectors can continue to operate continuously and, in some cases, even grow (Zsibók 2022).

Furthermore, Budapest plays a crucial role as a significant cultural and educational center, which provides additional stability to the city's economy. Universities and research institutes quickly transitioned to online education, thereby maintaining knowledge sharing and research activities (Altaleb et al. 2023). Although lockdowns and travel restrictions severely impacted the city's tourism and hospitality sectors, state support and recovery measures helped businesses survive the challenging times. Budapest's transportation and logistics infrastructure also played a significant role in ensuring economic activities did not halt. The rapid adaptation of freight transport and supply chains ensured that essential services and products remained continuously available, contributing to the maintenance of economic stability (Benedek et al. 2022).

Table 4

Performance of Hungarian regions

NUTS2 region	Trend		Position compared to the own trend			Backlog in the current year from the center				Change in lag from the center			
			%										
	Beta1	Beta0	2020	2021	2022	2019	2020	2021	2022	2019/2020	2020/2021	2021/2022	2019/2022
Budapest	1.039	21.723	–3.68	1.53	7.95								
Pest	1.032	9.562	–4.35	3.00	**15.80**	62.05	61.42	60.83	58.82	–0.63	–0.60	–2.00	**–3.23**
Közép-Dunántúl	1.038	9.824	–6.50	1.65	7.35	55.77	56.47	55.12	**55.44**	0.70	–1.35	0.32	–0.33
Nyugat-Dunántúl	1.036	11.365	–11.78	–11.63	–6.13	53.46	54.53	56.89	**57.04**	1.07	2.36	0.15	3.58
Dél-Dunántúl	1.034	7.615	–1.81	3.67	11.70	67.51	67.24	67.32	67.02	–0.26	0.08	–0.30	–0.48
Észak-Magyarország	1.041	6.659	–3.31	3.30	3.91	68.13	67.46	66.93	68.63	–0.68	–0.53	1.70	0.49
Észak-Alföld	1.035	7.128	0.51	4.32	**12.18**	69.18	68.10	68.70	68.45	–1.08	0.60	–0.25	**–0.73**
Dél-Alföld	1.039	7.495	–0.74	2.44	8.57	65.41	64.22	64.96	65.06	–1.18	0.74	0.10	–0.35

Source: own compilation based on Eurostat data (2000–2022) (Eurostat 2024c).

The Hungarian region's performance during the pandemic showed a complex interplay between geographical location, sectoral composition, and external economic dependencies. Regions like Western Transdanubia (Nyugat-Dunántúl) faced challenges due to their high dependence on cross-border trade and industry, particularly with Austria, experiencing significant economic downturns during border closures. The trend before the crisis was steeply rising; despite all efforts, the region has not yet been reached. In contrast, regions with a strong agricultural base, such as the Northern Great Plain (Észak-Alföld) and Southern Great Plain (Dél-Alföld), demonstrated remarkable resilience, underscoring the importance of sectoral diversity in regional economic stability.

Regions most lagging behind their capitals

Northwest (Severozápad) lags behind the capital, Prague (Praha), by 69.91%, likely due to fewer industrial and technological developments.

Subcarpathian Voivodeship (Podkarpackie) falls behind Warsaw (Warszawski stołeczny) by 66.61%, indicating its geographical and economic isolation from the main economic center.

Podlaskie Voivodeship (Podlaskie) lags behind the capital region by 66.43%, possibly due to low public and private sector investments.

Table 5

Total lag behind the center in 2022

(%)

Country/NUTS2 region	Total lag
Poland	
Warsaw (Warszawski stołeczny)	0.00
Lesser Poland Voivodeship (Małopolskie)	56.29
Silesian Voivodeship (Śląskie)	48.25
Greater Poland Voivodeship (Wielkopolskie)	47.90
West Pomeranian Voivodeship (Zachodniopomorskie)	59.62
Lubusz Voivodeship (Lubuskie)	59.79
Lower Silesian Voivodeship (Dolnośląskie)	44.76
Opole Voivodeship (Opolskie)	60.84
Kuyavian-Pomeranian Voivodeship (Kujawsko-Pomorskie)	59.62
Warmian-Masurian Voivodeship (Warmińsko-Mazurskie)	65.73
Pomeranian Voivodeship (Pomorskie)	50.70
Łódź Voivodeship (Łódzkie)	53.67
Świętokrzyskie Voivodeship (Świętokrzyskie)	65.73
Lublin Voivodeship (Lubelskie)	66.43
Subcarpathian Voivodeship (Podkarpackie)	66.61
Podlaskie Voivodeship (Podlaskie)	63.64
Masovian Voivodeship (Mazowiecki regionalny)	54.72
Czech Republic	
Prague (Praha)	0.00
Central Bohemia (Střední Čechy)	59.13
Southwest (Jihozápad)	62.15
Northwest (Severozápad)	69.91
Northeast (Severovýchod)	62.87
Southeast (Jihovýchod)	59.75
Central Moravia (Střední Morava)	63.39
Moravian-Silesian (Moravskoslezsko)	64.49
Slovakia	
Bratislava Region (Bratislava)	0.00
Western Slovakia (Západné Slovensko)	55.49
Central Slovakia (Stredné Slovensko)	58.96
Eastern Slovakia (Východné Slovensko)	64.55
Hungary	
Budapest	0.00
Pest	61.07
Central Transdanubia (Közép-Dunántúl)	51.82
Western Transdanubia (Nyugat-Dunántúl)	48.59
Southern Transdanubia (Dél-Dunántúl)	65.68
Northern Hungary (Észak-Magyarország)	63.85
Northern Great Plain (Észak-Alföld)	67.88
Southern Great Plain (Dél-Alföld)	62.65

Source: own compilation based on Eurostat data (2000–2022) (Eurostat 2024b).

The least lagging regions compared to their capitals

Western Transdanubia (Nyugat-Dunántúl) has a relatively small disadvantage of 48.59% compared to Budapest, which may indicate better resilience or efforts in recovering from economic downturns.

Central Transdanubia (Közép-Dunántúl) lags behind Budapest by 51.82% but performs better than other peripheral areas, likely due to strong regional policies supporting economic activities.

Central Bohemia (Střední Čechy) falls behind Prague (Praha) by 59.13%. Still, this percentage is relatively small compared to other regions, benefiting from its geographical proximity and integrated transportation network with the capital.

Discussion

Among Polish regions, Warsaw (Warszawski stołeczny) is the most developed, reflecting a common trend in countries where the capital is an independent NUTS2 region. Historically significant regions like the Silesian Voivodeship (Śląskie), Masovian Voivodeship (Mazowiecki region), and Greater Poland Voivodeship (Wielkopolskie) are increasingly pivotal to Poland's economic progress. Economic crises, such as the 2008 credit crisis and the Covid-19 pandemic, have had minimal impact on the spatial differentiation of Polish industry, suggesting long-term trends (Jablonski–Kilar 2024). Evidence supports this, as living standards across regions converged between 2006 and 2016 despite the credit crisis (Kowerski–Bielak 2019). Most Polish NUTS2 regions saw an increase in industrial and service companies investing in innovation from 2018 to 2022, particularly notable in 2021, possibly due to the need for new solutions in the service sector. This trend indicates that industrial companies generally had more resources for innovation than service companies during this period.

EU spatial planning and cohesion policies shape the Czech Republic's NUTS2 policies. Spatial planning, governed by the Act on Planning and Building (Stavební zákon), sets priorities and development directions at national and regional levels. Local plans regulate municipal policies, while regional councils (Krajské zastupitelstvá) coordinate regional strategies. However, the link between territorial and strategic plans and state budgets is weak, as noted in the "Strategic Framework Czech Republic 2030" (Kárníková 2017). The absorption of the European Fund for Strategic Investments (EFSI) is crucial for regional development, with per capita levels highest in the Southeast (Jihovýchod) and lowest in Prague (Praha) (Ernst–Young 2023). More populated regions benefit more from EFSI funds, suggesting the need to assess EFSI absorption alongside NUTS2 operational programs. Introducing NUTS3-level evaluation could also be beneficial, as NUTS3 regions are significant beneficiaries of EU funding (Wishlade et al. 2019).

Despite having the most evenly distributed income in the EU, Slovakia struggles with regional income inequality, which is evident in GDP per capita and labor income disparities. Ďurček et al. (2024) also noted these differences, pointing to a substantial increase in the differences between the "West" and the "East" of Slovakia between 2001 and 2019. For typification, the districts were characterized by four basic socio-economic indicators: the average monthly wage of an employee, the unemployment rate, the relative indicator of recipients in material need, and the average expenditure on pensions for a per capita aged 63 years and over. Masárová–Ivanová (2018) also identified significant differences between the V4 countries. Regional differences depend on economic, social, and structural changes, human capital, infrastructure, geography, and the region's potential. The Bratislava Region (Bratislava), home to about 10% of the population, has a GDP per capita three times higher than other regions (IMF 2024). The IMF attributes this disparity to labor productivity and working hours. Convergence in incomes is occurring, with the lowest GDP growth in Bratislava Region (Bratislava) and the highest in Eastern Slovakia (Východné Slovensko). Addressing income inequality should focus on enhancing productivity and labor markets in lower income areas. Increasing investment in these regions, where current investment levels are lower than in the Bratislava Region (Bratislava), could boost GDP by up to 15% and further improve education. Additionally, increasing housing stock and integrating socially vulnerable groups, like the Roma community, could support the labor market and regional growth (IMF 2024, Stundziene–Saboniene 2019, Psacharopoulos–Patrinos 2004).

Focusing on growth poles and investment in economically lagging regions is crucial for development in Hungary. EU funds predominantly support more developed areas, but addressing inequalities requires investment in underdeveloped regions. Effective territorial policy-making must align sectoral policies and social agendas with regional needs. Regional differentiation is essential for development policy at both national and EU levels. Territorial delimitation should create a focus that aligns with development goals (Finta–Dombi 2021). The link between industrial production and foreign direct investment significantly impacts regional development. Regions with high foreign investment, such as Fejér, Győr-Moson-Sopron, and Komárom-Esztergom, play a key role in Hungary's economic growth, with Budapest also being a major growth center.

Conclusion

The study aimed to analyze the recovery of the Visegrad Group (V4) regions from the Covid-19 crisis, with particular attention to the economic performance restoration based on the trendline theory. According to Ferenc Jánossy's theory, economic recovery is complete when economic growth reaches the trendline projected for a non-crisis period. The research relied on the analysis of GDP data calculated at PPP

per capita and examined the performance of the Polish, Czech, Slovak, and Hungarian regions from 2000 to 2022.

The study results showed significant differences in the pace and extent of economic recovery among the regions of the V4 countries. Some regions, such as Łódź Voivodeship (Łódzkie) in Poland, performed exceptionally well due to their rapid adaptability and central location. In contrast, others, particularly areas reliant on tourism and services, faced more significant challenges. Regions with an agricultural sector, such as Podlaskie Voivodeship (Podlaskie) and Warmian-Masurian Voivodeship (Warmińsko-Mazurskie) in Poland, performed relatively better since food production and export were less affected by the disruptions caused by the pandemic. Industrial regions that quickly adapted to new manufacturing demands, such as the production of medical devices, also fared better during the crisis.

Economically diversified regions, such as Prague (Praha) in the Czech Republic and Budapest, proved more resilient to the impacts of the crisis. These regions quickly adapted to the pandemic situation by leveraging the strengths of their services, technology, and financial sectors. Interrupting cross-border economic activities posed a significant challenge for border regions, especially when strict border closures hindered trade and the free movement of labor. However, some regions, such as Eastern Slovakia (Východné Slovensko), partially offset these negative effects by stimulating local economic activities.

Based on the provided data, this analysis offers a crucial insight into the performance of regions in relation to their own trends and the central cities within the V4 group. The disparities among regions, stemming from variations in investment, infrastructure, and economic policies, are not just inevitable but can significantly impact the economic health of the regions. This underscores the urgent need for targeted policies to foster more balanced regional development. The ongoing research conducted post-Covid and during various economic crises will play a pivotal role in deepening our understanding of these dynamics and making policy interventions more effective.

The limitations of the research include its reliance primarily on GDP data calculated at PPP per capita, which, although valuable indicators of economic performance, do not fully cover all aspects of the crisis's impacts. Essential factors such as labor market changes, the burden on healthcare systems, and social and mental well-being indicators, which can also significantly affect the speed and success of regional recovery, were not considered in measuring economic performance. Additionally, detailed data were limited in evaluating the impacts of government measures and economic policy decisions introduced during the pandemic, making it challenging to assess the effectiveness of these measures accurately. Furthermore, the research did not account for pre-crisis structural differences that could influence regions' response to the crisis and recovery capabilities.

Future research opportunities include a deeper and more comprehensive analysis of economic performance, employing a multidimensional approach to examine the interrelationships between labor market data, health and social indicators, and the varied impacts on different sectors. Moreover, it would be important to monitor and evaluate the long-term effects of governmental and regional policy measures, particularly in terms of how these measures contributed to enhancing the economic resilience of the regions. Research should also extend into the post-crisis period to understand how economic trends develop and anticipate long-term impacts. Analyzing interregional cooperation and knowledge sharing could also be important, as identifying and adapting successful recovery strategies can significantly contribute to maintaining economic stability and growth.

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