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The Polish-Ukrainian borderland through the prism of convergence and resilience from 2004 to 2020

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Abstract. The escalation of the conflict in Ukraine in February 2022 highlighted the need for a fresh approach to regional economic analysis. This study examines the relationship between convergence and resilience in border regions, focusing on the period from 2004 to 2020. Resilience was measured by GDP *per capita*, while convergence was assessed using the σ-convergence test. Data were sourced from Statistics Poland and the State Service of Statistics of Ukraine. The results show that, although the 2008 crisis impacted Ukrainian regions, border regions in both Ukraine and Poland demonstrated a greater capacity to recover. Ukrainian border regions, in particular, exhibited faster recovery compared to non-border regions (nBR). The research also indicates that regions with greater convergence are more resilient. This finding is crucial to understanding the ongoing economic impact of the war in Ukraine, highlighting the critical role of border regions in the economies of both countries.

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1. Introduction

The complexity of regional economic imposes ever new demands on statistical research. The unstable political situation, various financial crises and the impact of technology are just some of the factors that affect regional economic performance. The authors of this work, following recent comparative studies on various economic phenomena such as asymmetry, resilience or convergence (Hippe et al., 2022; Jakubowski & Wójcik, 2023) posed the following research questions:

1. What was the impact of the 2008 global financial crisis and the annexation of Crimea on Ukraine's convergence processes?
2. How did Polish regions perform in terms of convergence and resilience during the analysed period?
3. Were the Polish-Ukrainian borderland regions subject to similar processes in the analysed period, or were they different?
4. What is the relationship between the degree of regional resilience and the pace of convergence in the period 2004–2020?

The study was based on the available primary data from Statistics Poland, Central Statistical Office of Poland, for the period 2004–2020. The year 2004 was chosen as the starting point of the analysis due to its pivotal economic and institutional significance—it marks Poland's accession to the European Union, which had a profound impact on access to structural funds, regional development dynamics, and cross-border cooperation opportunities. This institutional shift laid the foundation for intensified convergence processes and makes 2004 a meaningful baseline for analysing long-term economic resilience in the Polish-Ukrainian context. The final year of analysis, 2020, precedes the onset of the COVID-19 pandemic's major economic impact and the escalation of the war in Ukraine (which began in February 2022, although the annexation of Crimea and initial conflict in Donbas started in 2014). Including data beyond this point would introduce substantial structural breaks, complicating the comparability of pre-crisis dynamics and limiting the possibility of identifying long-term trends in convergence and resilience. The dataset does not include the refugee crisis of 2022. The primary source of statistical information for Ukraine is the State Service of Statistics of Ukraine and the National Bank of Ukraine.

Historically, patterns of economic resilience can be considered in the context of the following crises: the financial crisis of 2008, the annexation of Crimea in 2014, and the 2020–2023 pandemic, which strongly affected entrepreneurship in many economies (Gorynia & Kuczewska, 2023). Due to the lack of statistical data for 2022, the impact of the crisis related to the ongoing war in Ukraine was not considered. The specific features of these regions-conomic, cultural, and social asymmetry-were considered significant factors in the conclusion (Szpakowska et al., 2016; Paszkowicz & Hrynenko, 2019). The cohesiveness of border regions is a considerable challenge even within the European Union. It is even more of a problem in the case of regions bordering a non-EU country. The financial crisis of 2008–2010, the annexation of Crimea in 2014, and later COVID-19 (Martin, 2021) affected border areas differently than internal border regions according to similar analyses (Hippe et al., 2022). The situation in these regions can be adversely affected by turbulence limiting or changing cross-border flows (Castells, 1999).

This study adopted the σ-convergence method to analyse convergence processes and kernel density estimation to perform a graphical analysis of the distribution. As in other works, resilience was measured by GDP *per capita* (di Caro, 2020; Mazzola & Pizzuto, 2020; Martinho, 2021).

Our main objective was to reveal the differences between Polish and non-EU regions (Ukraine) in terms of vulnerability to crises, resistance to external shocks (which may be engaging in the context of the current situation in Ukraine), adaptability and ability to rebuild. We reflect on the role of regions on the EU's external border in times of crisis and indicate the direction the convergence processes have taken in these regions, thus contributing to the debate on the resilience of border regions not only within the EU, but also in non-EU regions and internal convergence in their countries.

This study contributes to the literature by providing a comparative cross-border analysis of resilience and convergence between an EU member state (Poland) and a neighbouring non-EU country (Ukraine). The paper addresses a research gap concerning the asymmetry of resilience mechanisms in EU and non-EU border regions.

2. Theoretical framework

The concept of economic convergence is most often defined through the frameworks of sigma (σ) and beta (β) convergence. Sigma convergence refers to a reduction in the dispersion of income levels or economic indicators across regions, while beta convergence implies that poorer regions grow faster than wealthier ones (Barro, 1992; Sala-i-Martin, 1996; Gömleksiz et

al., 2017; Mendez, 2019). Regional resilience, on the other hand, has evolved as a key concept to assess a region's capacity to absorb, adapt to, and recover from external shocks. Martin and Sunley (2015) emphasise resilience as a multi-dimensional process involving resistance, recovery, re-orientation, and renewal. This is further supported by Hill et al. (2008) and González-Quintero & Ávila-Foucat (2019), who highlight both quantitative and qualitative approaches to operationalising resilience. These theoretical foundations support the empirical framework of this paper and guide the interpretation of the results, particularly in terms of identifying mechanisms of convergence and adaptation in the face of economic shocks.

3. Material and research methods

In scholarly discourse, two principal notions of convergence are commonly acknowledged, as delineated by Sala-i-Martin in 1996: sigma convergence (σ-convergence) and beta convergence (β-convergence). Sigma convergence manifests when there is a discernible reduction over time in the disparity of *per capita* income or other analogous phenomena across different regions or countries. In contrast, beta convergence pertains to the correlation between the initial level and the mean growth rate of GDP *per capita*. GDP *per capita* has been widely used as a performance indicator in both convergence and resilience research (Sala-i-Martin, 1996; Hill et al., 2008; Martin & Sunley, 2015), due to its accessibility, comparability, and empirical robustness. While it captures primarily economic dimensions, its use is justified in cross-national analyses where institutional and social data may be lacking or inconsistent. All GDP *per capita* data are expressed in national currency units and were not adjusted for purchasing power parity (PPP). This limitation is acknowledged when interpreting cross-country comparisons. This concept of beta convergence is further bifurcated into two categories: absolute convergence and conditional convergence. Absolute convergence postulates that countries or regions gravitate towards a uniform state of weighted growth irrespective of their initial conditions. Essentially, this implies that less affluent countries or regions tend to grow at a more accelerated pace compared to their wealthier counterparts. The presence of convergence is quantitatively assessed using the σ-convergence test. While β-convergence is often used in parallel to assess catch-up effects relative to initial conditions, the current study focuses on σ-convergence due to its suitability for tracking distributional changes across regions over time. This approach also reflects data availability constraints and allows for a more straightforward interpretation in a cross-country comparative setting. Within this framework, the σ-convergence criterion evaluates fluctuations in growth rates by examining the standard deviation across a temporal spectrum. Additionally, the coefficient of variation (CV) is mathematically represented by the following formula:

$$CV = \sigma/\mu \times 100$$

where σ is the standard deviation and μ is the mean value.

The trajectory of the curve serves as an indicator of σ-convergence and divergence. Furthermore, any alterations or disruptions observed in the graphical representation could potentially signify the impacts of economic crises. A higher coefficient value denotes a greater level of disparity. Conversely, when disparities within a specific region diminish, there is a corresponding reduction in dispersion, which in turn leads to a decrease in the coefficient of variation. This relationship highlights the direct correlation between regional income disparities and the coefficient of variation, making it a critical metric in the analysis of economic convergence or divergence. Various graphical methods, such as histograms, kernel estimation, and Salter graphs, can be employed to analyse distributions. In this study, the kernel density estimate, as proposed by Quah in 1996, was used to demonstrate the processes under examination. This estimate acts as a form of approximation of the probability distribution. The principle underlying such an estimator is notably straightforward. It estimates probability based on aggregating observations near a given point of interest. The closeness of an observation is determined by a parameter known as the window width. A narrower window leads to a more irregular graph, whereas a broader window produces a smoother representation. The selection of the kernel function marginally influences the function's estimate. However, the crucial aspect is the choice of window width. The presence of multimodality in these density estimators indicates a lack of convergence, or in other words, polarisation. Conversely, if the distribution estimated through this method is unimodal, it may suggest convergence. Nevertheless, it is important to note that kernel density estimation is contingent upon several assumptions and requires large sample sizes for precise outcomes. A significant precondition, often not met, is the assumption that data is independent across specific periods. This is a notable concern, given that time series data frequently exhibits autocorrelation.

Economic resilience, when quantified using GDP, offers the clear benefit of a transparent operationalisation process and readily accessible, harmonised data.

In this context, resilience, adaptability, and recovery capacity were evaluated by calculating growth rates over specified intervals to ascertain the ramifications of the economic crisis. These measurements were operationalised as follows:

- *Resilience*: This was assessed by comparing the year immediately preceding the crisis, 2008, with the year of the short-term impact, 2009. This comparison aims to gauge the immediate effects of the crisis and the economy's initial response.
- *Adaptability*: The period from 2009, identified as the year of the lowest impact, to 2010, earmarked for assessing short-term adaptability, was analysed. This measurement focuses on the economy's ability to adapt and recover in the immediate aftermath of the crisis.
- *Regenerative Capacity*: This longer-term measure examined the period from 2009, the lowest impact year, to 2020, thus evaluating the long-term regenerative capacity of the economy. This analysis is intended to understand how well the economy has managed to recover and grow over a more extended period post-crisis.

The following formula was used:

$$R = \frac{y_{t1}}{y_{t2}}$$

where R is the change between the two time points *t*1 and *t*2, and y_t is the time series corresponding to GDP *per capita* in subsequent years.

The formula in question is designed to yield values within the range of (0, ∞). In this framework, values falling below 1 signify a decline in GDP *per capita* between two specific periods, denoted as t1 and *t*2. The extent of the decrease is directly proportional to the deviation of the value from 1—the further the value is from 1, the more significant the decline. Conversely, values exceeding 1 indicate an increase in GDP *per capita* between the same periods. Similar to the decline case, the increase's magnitude is correlated with the distance of the score from 1, with more significant deviations reflecting more substantial gains. This formula, therefore, provides a quantitative measure of economic growth or contraction over specified time intervals. It should be noted, however, that GDP *per capita* reflects only the economic dimension of resilience. Other aspects, such as institutional adaptability or social cohesion, lie beyond the scope of this study due to data limitations but represent important avenues for further research.

The authors of this study hypothesised that the Polish-Ukrainian borderland, thanks to the flows of labour force, would demonstrate resilience during the crisis and that internal convergence would relate to the levelling of differences within the Polish-Ukrainian border region to a small extent. The strength of the adopted research method is that processes in two countries may be observed, making it possible to compare phenomena coinciding. The selected research problem limits the study to two economies, and the results should not be generalised to other border regions due to the specificity of the study area.

4. Results

Analysis of the convergence process in the presented research covers 16 years, so conclusions may be safely drawn regarding the emerging trends in the regional development of both economies. Due to the coefficient of variation used, σ-convergence allows for a straightforward interpretation of the results, hence its application in this study. The research was planned in three sections: for entire economies in regional terms (Ukraine and Poland), Polish-Ukrainian border regions (BR) and the rest (nBR). The de-lineation of the Polish-Ukrainian border region is presented in Figure 1.

Figure 2 illustrates the change in the coefficient of variation between 2004–2020 for Poland and Ukraine. Significant disparities in regional differences between Poland and Ukraine are clearly evident. In the analysed period, there was a slight increase in regional inequality in GDP *per capita*. It was simi-lar for both countries, but the initial level of disparity for Ukrainian regions was much higher than for Polish areas. Convergence processes have often been analysed by other authors in the context of the impact of structural policy on levelling differences in socio-economic development and catching up with EU28 countries (Wójcik, 2017, 2021). These analyses confirm the thesis that all voivodeships in Poland have closed their gap in terms of GDP *per capita* concerning the EU28 average. Still, this gap was the slowest to shrink in the eastern regions of Poland (Wójcik, 2021). The impact of structural funds on liv-ing standards is somewhat debatable, as, according to research, it mainly affects the level of infrastruc-ture development (Wojtowicz, 2019). From a historical perspective, the advancement of integration pro-cesses in Ukraine encounters many barriers, leading to more tremendous regional disproportions. In the literature, convergence is mainly presented from the perspective of Ukraine's transformation (Abdulla, 2021). Unfavourable macroeconomic and micro-environmental circumstances undermining Ukraine's economic development (rapid devaluation of the hryvnia, military operations in eastern Ukraine,

high levels of corruption, etc.) have harmed regional development since 2013. A significant increase in the export of goods and services in the border regions of Ukraine and Poland, which positively impacted the region's situation, only happened in 2017, mainly due to agricultural sector goods with low added value (Prytula et al., 2021). Migration significantly impacted the trends in the development of Ukrainian re-gions. In 2014, an Association Agreement was concluded between the European Union and Ukraine. Since this year, the number of Ukrainian citizens migrating to the European Union (EU) in search of work jumped significantly, especially after the outbreak of armed conflict in eastern Ukraine. In 2021 alone, people of Ukrainian nationality received 875,794 residence permits for paid employment in EU Member States, thus becoming the most prominent external source of labour in the EU. While data from 2021 provide a useful context, they are presented as indicative of post-period trends and do not form part of the core analysis (2004–2020). As a result, the economies of the Member States have become signifi-cantly dependent on Ukrainian workers, which became evident during the labour shortages of the COVID-19 crisis, which forced the EU to close its borders (Dubenko, 2021). In 2014–2021, almost 5 million Ukrainian citizens received a residence permit in EU-28 countries for the first time.

Labour migration from Ukraine to Poland after 2014 has influenced regional resilience by allevi-ating unemployment struggles in Ukraine and contributing to economic growth in Polish border regions. Empirical studies provide insights into the dynamics and ramifications of this migratory flow. One criti-cal study by Habchak and Dubis (2019) explores the motivations and implications of Ukrainian labour migration to the EU. They suggest that the increase in labour force participation abroad has resulted in reduced unemployment rates in Ukraine, especially in regions with high outmigration like Lviv and Ode-sa. The inflow of remittances has played an essential role in sustaining local economies, thereby enhanc-ing regional resilience. Melnychenko et al. (2022) further discuss how post-2014 migration trends affect-ed trade relationships between Ukraine and Poland. Their findings indicate that the growth of migrant communities has led to increased bilateral trade and business, promoting economic development in Polish border regions. Mulska et al. (2020) highlight the feedback loop through which returning migrants bring back skills and capital, enhancing the socio-economic development of their home regions. Vaa-gland and

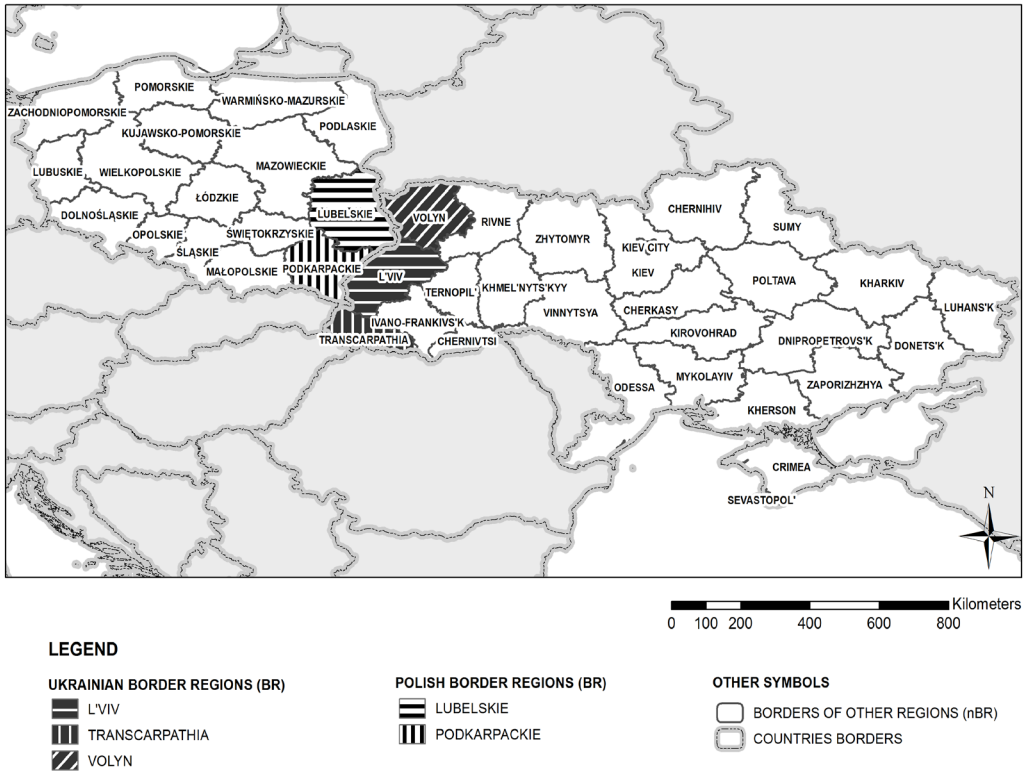

Fig. 1. Delimitation of the region studied
Source: own elaboration

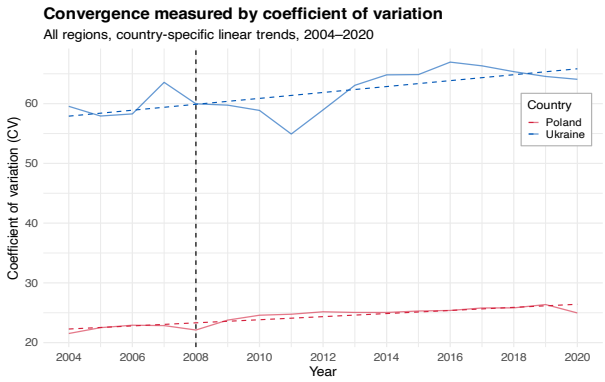

Fig. 2. Change in the coefficient of variation in Polish and Ukrainian regions in the 2004–2020 period
Source: own elaboration

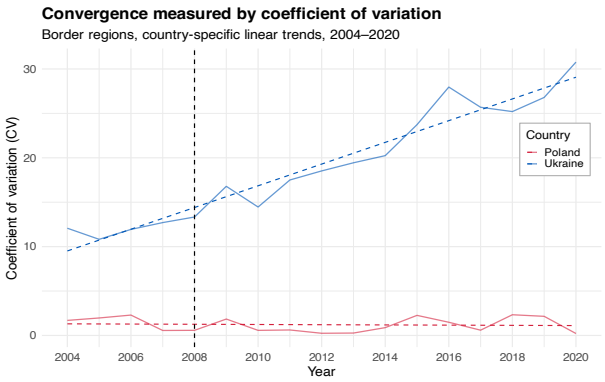

Fig. 3. Change in the coefficient of variation in the Polish-Ukrainian border region in the 2004–2020 period
Source: own elaboration

Chmiel (2023) emphasise policy-related aspects of Ukrainian migration to Poland, noting that while migrants often face discrimination, they also play a vital role in filling labour market gaps and contributing to resilience on both sides of the border.

Figure 4 presents the coefficient of variation for all regions of Poland and Ukraine between 2004 and 2020, serving as a measure of convergence. Lower values indicate reduced regional dispari-ties, signifying greater internal cohesion. The trends for Poland (represented by the red line) indicate a relatively stable and low coefficient of variation, with a slight upward trend. This suggests that regional disparities in development levels remain relatively minor and do not exhibit significant changes over time. Conversely, the coefficient for Ukraine (depicted by the blue line) is substantially higher, implying pronounced regional disparities. Between 2004 and 2010, the variability was unsta-ble, with notable fluctuations, followed by a consistent upward trend from 2010 onward. This indi-cates that regional disparities in Ukraine have been intensifying over time. A vertical blue line marks a potentially significant event around 2010, which could correspond to an administrative reform, a shift in economic policy, or another crucial factor influencing regional development. These findings suggest that Poland exhibits stronger regional cohesion than Ukraine, where increasing disparities may be attributed to economic instability, political uncertainty, and ongoing conflicts.

The data indicate a stable CV in Poland, suggesting limited economic disparities between border regions and the rest of the country. In contrast, Ukraine exhibits a clear upward trend in CV, indicating increasing regional economic divergence in its border areas. This phenomenon can be ex-plained by several economic and political factors. First, Poland, as a beneficiary of the European Union's cohesion policy, has received substantial financial support for infrastructure and businessde-velopment in border regions, contributing to their relative economic stability (Gorzelak, 2020). Fur-thermore, EU regional policy has facilitated cross-border cooperation programs, enhancing economic integration and infrastructure improvements along the Polish-Ukrainian border (Szymańska & Kurowska, 2021).

The political destabilisation mentioned below refers primarily to the loss of control over parts of Donbas and Crimea, processes already discussed in the introduction as part of the 2014 geopoliti-cal crisis. Conversely, in Ukraine, political destabilisation since 2014, including the loss of control over parts of Donbas and Crimea, has led to declining investments and widening economic dispari-ties between border regions and the country's central areas (Mykhnenko, 2020). Additionally, armed conflicts and limited access to international financial support have resulted in declining eco-nomic activity, population outflows, and infrastructure degradation in Ukraine's border regions (Mykhnenko, 2022). The data from Figure 3 thus indicate a pronounced divergence process in Ukrainian border regions, posing a significant challenge for future cross-border cooperation and eco-nomic convergence. In the context of Ukraine's post-war reconstruction, targeted investments aimed at strengthening the economy of these regions and improving cross-border infrastructure will be cru-cial for fostering integration with EU markets.

The observed divergence in Ukraine's regions can be linked to institutional instability and uneven decentralisation progress following the 2014 reforms. These reforms, while aiming to en-hance

fiscal autonomy and governance capacity, have varied in terms of effectiveness across regions, influencing their economic resilience differently (Udovychenko et al., 2017; Michalski et al., 2022; Rabinovych et al., 2023). The decentralisation process is widely recognised as a structural transfor-mation affecting regional development paths. In resilience theory, such institutional shocks are key variables influencing recovery, adaptability, and long-term regional performance (Martin & Sunley, 2015; Hill et al., 2008; Sensier et al., 2016).

During (Table 1) the analysed period, Ukrainian regions noticeably had a much higher CV, and both BR and nBR manifested similar trends. The analysis of economic resilience during and after the 2008/2009 financial crisis reveals significant disparities between Poland and Ukraine, as well as varying dynamics between border (BR) and non-border (nBR) regions.

1. In the crisis year of 2008/2009, Ukraine's resilience index was 0.9301, indicating a contraction in GDP *per capita*. This aligns with studies highlighting Ukraine's vulnerability during global economic downturns (Kwiatkowski & Szczygielski, 2010). Conversely, Poland's resilience in-dex stood at 1.0474, reflecting a GDP *per capita* growth of approximately 5%. This resilience is consistent with findings on Poland's robust economic performance during the crisis (Grosse, 2011).
2. During the adaptation phase, Ukraine experienced rapid economic growth, with a resilience in-dex of 1.285. This surge is corroborated by research on Ukraine's post-crisis recovery strategies (Melnyk & Klymchuk, 2012). Poland's resilience index during this period was 1.049, indicating a continued, albeit modest, growth trajectory. This aligns with analyses of Poland's sustained economic stability post-crisis (Bohle & Greskovits, 2012).
3. In the recovery phase, Ukraine's resilience index rose to 1.786, signifying a GDP *per capita* in-crease of nearly 80%. This substantial growth is supported by studies on Ukraine's economic re-forms and external support mechanisms (Pivovarsky, 2013). Poland's resilience index was 1.694, reflecting a slightly lower, yet significant, growth rate. This is consistent with research on Po-land's economic convergence and EU integration benefits (Świderska, 2014).
4. The analysis indicates that border regions (BR) in both countries exhibited a more pronounced recovery compared to non-border regions (nBR). This observation aligns with studies suggesting that proximity to EU markets and cross-border cooperation can enhance regional economic resil-ience (Kaczmarek & Ratajczak, 2015). In Ukraine, BR regions benefited from intensified trade and collaboration with neighbouring countries, facilitating faster economic normalisation. In Po-land, while the overall economy remained relatively stable, BR regions experienced accelerated growth due to increased cross-border interactions (Kaczmarek & Ratajczak, 2015).

The Figure 6 presents changes in GDP per capita for all regions of Poland and Ukraine in the peri-od 2004–2020, using an index-based approach (2004 = 100). The analysis adopts the perspective of re-gional economic resilience, defined as the ability of regions

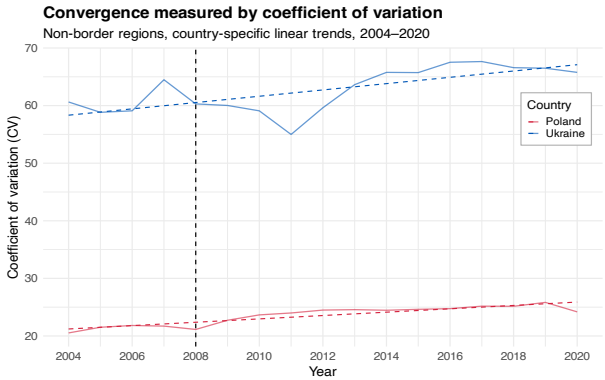

Fig. 4. Change in the coefficient of variation in other regions outside the Polish-Ukrainian border area in the 2004–2020 period
Source: own elaboration

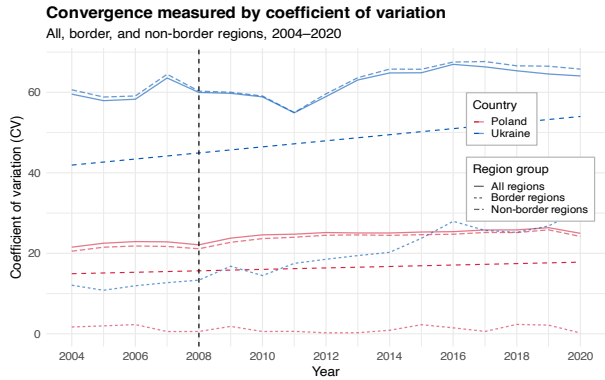

Fig. 5. Comparison of the coefficient of variation for BR and nBR as well as for Poland and Ukraine
Source: own elaboration

to withstand and recover from economic or political shocks while maintaining a path of economic growth (Martin & Sunley, 2015; Sensier et al., 2016). Empirical data reveal significant differences in the nature and stability of economic growth be-tween Poland and Ukraine. Poland demonstrates a relatively stable and continuous growth trajectory of GDP per capita, suggesting a high level of economic resilience among its regions. This pattern aligns with previous research emphasising the importance of robust institutions, economic diversification, and effective use of EU structural funds as key determinants of regional resilience in new EU member states (Rodríguez-Pose & Hardy, 2015; Capello et al., 2021).

Conversely, Ukraine exhibits substantial fluctuations in GDP *per capita* growth, with marked declines (notably in 2009 and 2014–2015) followed by periods of recovery. The decline in 2009 can be attributed to the global financial crisis, while the sharp recession in 2014–2015 resulted from geopolitical shocks, including the annexation of Crimea and the war in Donbas (Åslund, 2015). The severe volatility in Ukraine's economic trajectory indicates low systemic resilience, driven by institutional instability, limited access to external support mechanisms (such as EU cohesion policy), and weaker integration into global markets (Gennaioli et al., 2014). It is also noteworthy that despite pronounced disruptions, Ukraine's average long-term growth trend in GDP *per capita* remains positive and steep, likely reflecting the effect of a low base and ongoing economic transformation. This dynamic corresponds to the notion of transformational resilience, where an economy undergoes structural change after experiencing shocks (Simmie & Martin, 2010). However, in Ukraine's case, this process is uneven and persistently hindered by institutional and political challenges.

In conclusion, the presented data confirm existing findings in the literature on the pivotal role of institutional capacity, cohesion policies, and geopolitical stability in shaping the development trajectories and economic resilience of regions (Bristow & Healy, 2014; Crescenzi et al., 2016). As an EU member state, Poland demonstrates greater adaptive capacity and stability,

Table 1. Resilience results divided into three periods.

Method	Country	Resilience (2008–2009)	Adaptability (2009–2010)	Regenerative Capacity (2009–2020)
Baseline	Poland	1.0474	1.049	1.694
	Ukraine	0.9301	1.285	1.786
BR	Poland	1.0314	1.052	1.710
	Ukraine	0.9224	1.284	1.975
nBR	Poland	1.04974	1.049	1.692
	Ukraine	0.93110	1.285	1.760

Source: own elaboration

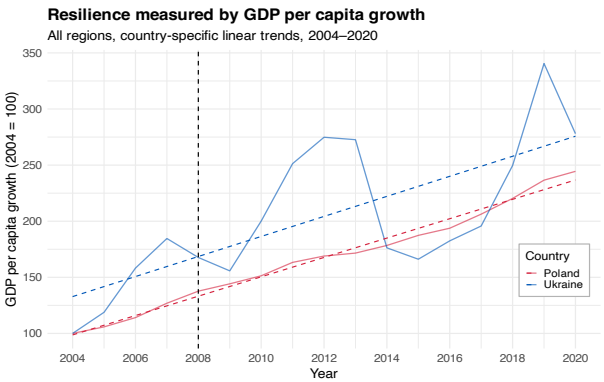

Fig. 6. Resilience of Polish and Ukrainian regions in the 2004–2020 period
Source: own elaboration

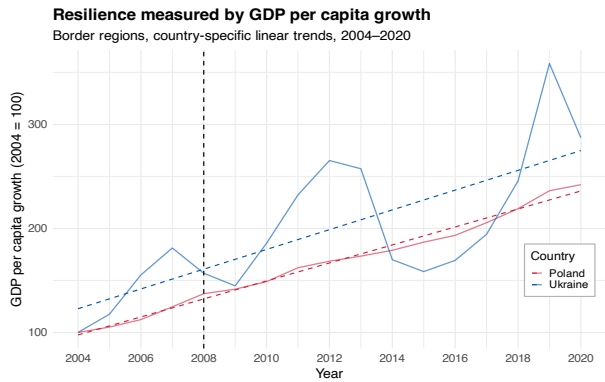

Fig.7. Resilience Polish and Ukrainian border regions in the 2004–2020 period
Source: own elaboration

whereas Ukraine remains vulnerable to both internal and external destabilising factors.

Figure 7 presents the evolution of GDP *per capita* in the border regions of Poland and Ukraine from 2004 to 2020, indexed to a base year of 2004 equaling 100, and serves to illustrate regional economic resilience understood as the capacity of territories to withstand, absorb, and recover from external shocks such as financial crises or geopolitical disruptions. The trajectory of Polish border regions reveals a consistent and steady growth pattern, with minimal fluctuations throughout the period, reflecting a high degree of adaptive resilience supported by institutional stability, EU cohesion policy mechanisms, and cross-border cooperation frameworks. In contrast, Ukrainian border regions display a markedly volatile pattern of economic development, characterised by pronounced peaks and troughs, particularly during and after the global financial crisis of 2008–2009 and the geopolitical crisis of 2014–2015, the latter corresponding to the annexation of Crimea and the onset of conflict in Eastern Ukraine. The data suggest that while Ukrainian border regions demonstrate limited resistance-based resilience, they exhibit elements of transformational resilience, as indicated by post-crisis recoveries, although these are unstable and inconsistent over time. The divergence in growth stability between the two countries is also captured by the linear trend lines, with Ukraine showing a steeper average growth trajectory, likely influenced by a low initial base and dynamic post-crisis rebounds, whereas Poland demonstrates a more moderate but continuous upward trend. These patterns align with the literature emphasising the critical role of multi-level governance, institutional maturity, and geopolitical positioning in shaping the resilience of peripheral regions, particularly those located at the external frontiers of the European Union.

The Figure 8 illustrates the GDP *per capita* growth trajectories of non-border regions (nBR) in Poland and Ukraine between 2004 and 2020, using an index with 2004 as the base year (2004 = 100), and serves to analyse regional economic resilience, defined as the ability to withstand, adapt to, and recover from economic or geopolitical shocks. The growth paths of Poland's non-border regions are characterised by a steady and stable upward trend, with minimal volatility throughout the period, suggesting a high level of adaptive resilience. This pattern is likely supported by institutional maturity, strong urban centres, well-developed infrastructure, and access to EU cohesion policy instruments, which collectively buffer these regions from external disruptions. In contrast, Ukraine's non-border regions exhibit a more volatile growth pattern, with notable contractions around 2009 and 2014–2015, corresponding to the global financial crisis and the onset of internal conflict and geopolitical instability. However, these fluctuations are slightly less severe than those observed in Ukraine's border regions, indicating a relatively greater capacity for recovery in internal territories. This divergence can be explained by Ukraine's deep regional disparities, which are widely acknowledged in the literature as being rooted in historical, economic, and geopolitical differences across the country's territory. Studies by Swianiewicz and Klimowski (2021) highlight that Ukrainian regions differ not only in terms of economic performance but also institutional capacity,

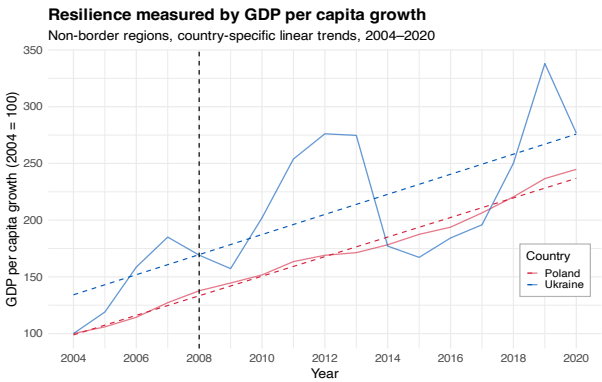

Fig. 8. GDP *per capita* growth for Polish and Ukrainian regions (2004=100)
Source: own elaboration

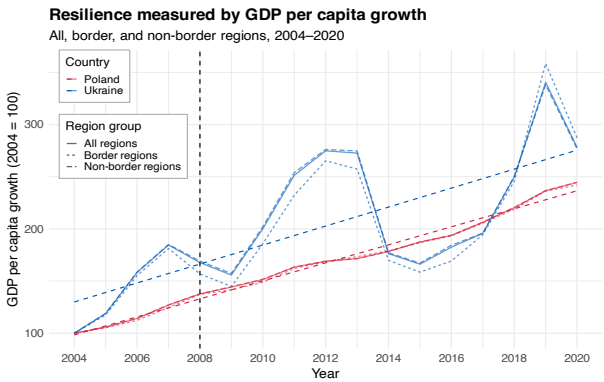

Fig. 9. GDP *per capita* growth for Polish and Ukrainian regions (2004=100) divided into three types of regions
Source: own elaboration

geopolitical orientation, and access to administrative and fiscal resources. Non-border regions, particularly those encompassing or located near major cities such as Kyiv, tend to be more economically diversified and better connected to national decision-making structures, which enhances their resilience. In this context, non-border regions could leverage structural advantages, including market size and institutional proximity, to foster a more stable recovery trajectory. While Poland's non-border regions demonstrate continuous and robust growth regardless of shocks, reflecting the institutional and policy stability of an EU member state, Ukraine's internal regions display a mixed pattern of vulnerability and recovery that reflects long-standing territorial asymmetries and a complex transition context. These findings are consistent with broader literature on regional resilience, which underscores the importance of institutional quality, multilevel governance, and spatial heterogeneity in shaping differential capacities to manage and recover from shocks across regions.

Figure 9 presents GDP per capita growth trajectories for all regions, border regions (BR), and non-border regions (nBR) in Poland and Ukraine between 2004 and 2020 (2004 = 100). Ukraine (in blue), with the vertical blue line marking the approximate onset of the global financial crisis around 2008. In the case of Poland, the three trajectories (All, BR, nBR) closely align, indicating minimal disparities between border and non-border regions. The growth pattern is steady, linear, and resistant to external shocks, including the 2008 financial crisis and later geopolitical tensions in neighbouring countries. This suggests a high degree of territorial cohesion and effective regional development policies supported by EU structural funds and national redistribution mechanisms. The data reflect strong systemic resilience and a balanced territorial model, in which regional economies, regardless of their location, exhibit similar levels of stability and adaptive capacity.

In contrast, Ukraine exhibits significant regional divergence and pronounced volatility. The trajectories for BR and nBR regions differ markedly, especially during periods of crisis. Substantial contractions are evident in 2009 and 2014–2015, particularly within border regions, which appear more exposed and vulnerable to external and geopolitical shocks. While non-border regions show slightly greater stability, they are still affected by systemic crises. The aggregated growth line for all Ukrainian regions lies between the two subcategories but is notably fragmented, indicating an overall lack of systemic resilience and the absence of robust mechanisms for mitigating territorial disparities. The observed patterns are consistent with findings in the literature emphasising the role of institutional asymmetries, uneven levels of development, differential access to infrastructure, and the destabilising effects of armed conflict on local economies. Ukraine's internal disparities are shaped by historical and geopolitical legacies, and regions differ considerably in their capacity to adapt and recover (Rodríguez-Pose, 2013; Swianiewicz & Klimowski, 2021; Gánovská et al., 2021). In sum, Poland demonstrates a resilient and territorially cohesive growth model, whereas Ukraine reflects a more fragmented and vulnerable regional structure, with border regions bearing the brunt of systemic and geopolitical disruptions.

5. Conclusions

The empirical results derived from the series of figures presented in this study reinforce the argument that the Polish and Ukrainian regions under analysis demonstrate markedly different resilience trajectories, with clear distinctions between border (BR) and non-border (nBR) territories. Unlike studies focused solely on homogeneous EU regions (Hippe et al., 2023), this analysis includes Ukrainian regions, which are characterised by profound structural and institutional asymmetries, particularly along the eastern and southern borderlands (Jakubowski & Wójcik, 2023). The sharp separation between Poland and Ukraine in terms of GDP *per capita* distributions—further disaggregated into BR and nBR—visually confirms the persistent development gap between the two countries, as well as internal disparities within Ukraine.

In Poland, the minor deviations between BR and nBR regions suggest a territorially cohesive development model supported by EU integration mechanisms. The convergence in GDP *per capita* trajectories, along with the relatively symmetrical distribution of income across regions, reflects the stabilising effects of EU cohesion policy and infrastructure investment, and is consistent with the broader catching-up process observed in European border areas (Hippe et al., 2023). The Polish border regions, while slightly lagging behind their non-border counterparts, nonetheless exhibit a resilient growth path and a high degree of synchronisation with national development trends. In contrast, the Ukrainian case presents a fragmented and volatile regional structure, where border regions demonstrate lower GDP *per capita*, higher vulnerability to external shocks, and limited post-crisis recovery capacity. This is particularly evident in the years following the global financial crisis of 2008 and the annexation of Crimea in 2014, both of which had profound and regionally uneven impacts. These

findings align with prior observations that resilience dynamics in immature or transitioning economies such as Ukraine may significantly deviate from those in more institutionally mature systems (Łaźniewska, 2022). Given these structural and institutional differences, the conclusions drawn from this study should be interpreted within the specific context of the Polish-Ukrainian borderland. While certain patterns may resonate with broader border dynamics in Central and Eastern Europe, the results are not intended to be generalised to other cross-border regions without further comparative investigation. Regional disparities in Ukraine are further compounded by low administrative capacity, underdeveloped local economies, and exposure to geopolitical risk—all of which influence the differentiated resilience patterns identified in the presented figures.

The analysis also echoes the conclusions of Bristow and Healy (2017), who argue that regional development and diversity are shaped by complex and often under-explored causal factors. As demonstrated in the comparison of BR and nBR trajectories in both countries, the interpretation of resilience is contingent upon the selected indicators and spatial disaggregation (Łaźniewska et al., 2022). Moreover, the figures suggest that border regions, particularly in the Polish-Ukrainian context, embody both vulnerability and potential. While these regions exhibit reduced resilience in the short term (Hippe et al., 2022), especially in response to abrupt exogenous shocks, they also demonstrate signs of long-term convergence. This duality highlights the necessity of designing policies that not only foster structural transformation but also reinforce short-term adaptive capacities.

Given the vast asymmetry of socio-economic needs along the Polish-Ukrainian border, it is difficult to propose universally applicable strategies to strengthen resilience at the municipal or sub-regional level. Policymakers should prioritise infrastructure investment, cross-border cooperation, and institutional strengthening to enhance resilience in vulnerable regions. EU cohesion instruments could play a critical role in mitigating divergence along external borders. Nonetheless, the findings strongly suggest that future research should prioritise labour market dynamics, institutional responsiveness, and cross-border cooperation as key dimensions of short-term and structural resilience in this complex and geopolitically sensitive space.

From these findings, several policy insights emerge. First, convergence and resilience should be treated as complementary policy objectives rather than separate domains. Reducing regional inequalities is essential not only for cohesion but also for strengthening systemic adaptability. Second, border regions should be approached as laboratories of resilience, where innovation, institutional cooperation, and cross-border partnerships can generate models for balanced recovery. Third, in the context of Ukraine's reconstruction, targeted investments in border infrastructure, governance capacity, and human capital will be crucial for building both immediate stability and long-term convergence with EU standards. Overall, this research highlights the importance of embedding resilience thinking into the design of regional development and cohesion policies. Strengthening resilience requires a multidimensional approach-combining economic convergence, institutional reform, and territorial cooperation to ensure that border regions can serve not as peripheries of vulnerability, but as strategic spaces of integration and recovery within an evolving European regional system.

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