

***AIR ACCESSIBILITY, RESILIENT REGIONS AND ECONOMIC
CONVERGENCE IN THE EASTERN EUROPE - TERRITORIAL EVIDENCES
SUPPORTING THE POLICY DESIGN AND THE DECISION MAKERS***

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Abstract: The analysis of the relation between the regional air accessibility and the economic convergence, in selected countries from the Eastern Europe, emphasizes the role played by the territorial endowment in the economic growth. While other studies explore the factors that contribute to the economic convergence from a statistical point of view, our approach is based on the spatial analysis. Using tools such as the geographical weighted regression and measures of the spatial autocorrelation of the GDP dynamics at NUTS3 scale, our research reclassified the Eastern European regions based of the relation between the territorial advantages (air accessibility and connectivity) and the rhythm of economic convergence. The time series we used include information both for the ante-crisis and the economic crisis period, allowing us to also investigate the resilient regions in the analyzed area. Detecting the regional resilience is our secondary objective, making our research more suitable for matters of policy design.

Keywords: air accessibility, resilient regions, economic convergence, geographical weighted regression, Eastern Europe

1) Introduction

The process of economic convergence is essential in the fulfillment of the main objectives that guide the territorial policies in the EU. Although intuitive, the concept of economic convergence is difficult to define, the limitations being induced by the shift from the theoretical dimension of the convergence to the empirical and applied one. If, in theory, the large number of the convergence approaches reflects discrepancies between economic schools and diverse epistemological stands, effectively measuring this process is reduced to the calculation of parameters in equations that capture the absolute or relative dynamic of economic performance indicators - GDP, gross added value, purchasing power index and household income. (Montfort, 2008). Most often, without taking into account the spatial dimension of the convergence process, the parameters previously described are estimated using econometric models that ignore the regional and the territorial complexity, complexity that is at the base of the economic catching-up rhythm. In practical words, refining this unclear image of the territorial complexity involves the formalization of the spatial effects that

can accelerate or decelerate the convergence - neighborhood effect or spatial autocorrelation, territorial belonging or territorial autocorrelation, regional or national hierarchies of the analyzed spatial units (Grasland, 2012).

Thus, as with other economic or planning concepts, passing from the statistical dimension to the geo-statistical one represents the main methodological challenge, but also the main way to clarify the relation between the processes of regional economic convergence and the territorial advantages (air accessibility and connectivity, air traffic of passengers and freight, territorial endowment with air infrastructures etc.). Seeking to compare the results provided by different methods of beta-convergence estimation, in this paper we analyze how important is the role played by the air accessibility in the dynamic of the GDP, in selected countries from Eastern Europe.

2) Literature review and concepts

The existent literature provides a large number of definitions of the concept of accessibility. The TRACC Project (Transport Accessibility at regional/local scale and patterns in Europe) defines accessibility as “a construction of two functions, one representing the activities or opportunities to be reached and one representing the effort, time, distance or cost needed to reach them” (Spiekermann and Wegener, 2011), being a major factor of economic attractiveness of cities and regions (DSA et al., 2013). The Reports dealing with the Economic and Social Cohesion (2007, 2010) describe accessibility as *an indispensable condition of the economic growth within the European Union, having a direct impact on the attractiveness of regions*, while the Green Paper on Territorial Cohesion (2008) emphasizes the importance of the local and regional accessibility, as key factors in ensuring equitable access to services, networks and European hubs. Bruinsma and Rietveld (1998) defines accessibility as “the potential of opportunities for interaction”, and Redondi et al. (2013) as “a way to measure how people and activities from a location are able to reach other locations using transport networks”.

All these definitions include the economic theory of the location and the importance of the distance. In most cases, improving accessibility leads to economic growth, because *the reduction of transport costs provides a location the opportunity to benefit from the advantages of production costs* (Krugman, 1991). Reviewing the main studies centered on the accessibility concept, we notice that it insists on the analysis of different types and accessibility indicators (Harvey, 1987; Geurs and Wee 2004; Reynolds-Feighan and McLay, 2006; Spiekermann and Wegener, 2006; Kouwenhoven, 2008; Burghouwt and Redondi, 2013). Thus, according to Wegener and al. (2002), “the accessibility indicators describe the location of an area with respect to opportunities, activities or assets existing in other areas and in the area itself, where ‘area’ may be a region, a city or a corridor”.

The existence of an extensive literature relating to the concept of air accessibility explains the importance of this topic for researchers, governments, airlines and airports, due to the large number of users of air services and the strong interdependence of economic development, tourism and migration phenomena (Skinner, 1976; Cattani, 2004; Dobruszkes, 2006; Malina, 2006; Malighetti et al., 2007; Dobruszkes et al., 2011; Maertens, 2012; Fröhlich and Niemeier, 2011; Redondi et al., 2013; Suau-Sanchez et al., 2014). Koster et al. (2011), Harvey (1986), Skinner (1976) showed that the accessibility of airports in terms of travel time is determinant for the choice of an airport by air travelers, increasing the accessibility of an airport having beneficial consequences to improve its market position. The concept of connectivity falls in relation to a number of variables used to assess the performance of airports.

The concept of resilience has recently been introduced in studies dealing with the impact of the economic, social and ecological dislocations on regional economies (Hudson, 2010; Simmie and Martin, 2010), based on ideas from fields such as ecology, social psychology, medicine and physics (Mohaupt, 2008).

Recent scientific papers suggest the need to consider multiple dimensions of the concept of regional resilience, the first of these being *the ability of a regional economy to resist the changes or to maintain its basic functions despite external economic shocks* (Foster, 2007; Hill et al., 2010, Hudson, 2010, Simmie and Martin, 2010). The second dimension of this topic is conceived as *a region's ability to maintain or return to a pattern of long-term development in the context of an external shock* (Ficenec, 2010, Hill et al., 2010). The third dimension relates to *the long-term adaptability of regional economies* (Pendall et al., 2010, Pike et al., 2010; Simmie and Martin, 2010).

Among the relevant and innovative studies that analyze the economic crisis and the regional resilience issues, from a territorial perspective, we mention the “Economic Crisis: Resilience of Regions” (ECR2) ESPON Project. A general definition of the concept of resilience, given in the ECR2 Project, refers to “the ability of a regional economy to withstand, absorb or overcome an external economic shock”. The economic resilience is seen thus as a key tool in the elucidation of what Hassink (2010) described as “one of the most intriguing questions in economic geography (...) why some regional economies manage to renew themselves, whereas others remain locked in decline”. A number of regional and urban studies have explored the applicability of this concept to regional and local scale (Foster, 2007; Hill et al, 2008). The recent literature focuses on the analysis of the territorial impact, caused by the specific economic shocks (Martin, 2012) and on the factors that are able to sustain the economic resilience (Healy, 2014).

3) Methodology and data quality check

The datasets used in this research are provided by EUROSTAT and ESPON M4D Project. The EUROSTAT source allowed us to build time-series for 234 NUTS3 from the Eastern Europe, collecting indicators like the GDP, the gross added value, regional unemployment etc. From all these datasets only the GDP/inhab. was used in the beta-convergence analysis. The indicators describing the air accessibility at NUTS3 scale are available on the ESPON Database portal for 3 distinct years - 2001, 2006, 2011. The geometries for the NUTS3 level of geographical representation were downloaded from GISCO, the EUROSTAT GIS division. All the maps and the spatial analysis are based on the three sources mentioned in this part of the paper.

Our methodological approach aims to relate and to explore the GDP/inhab. yearly change rate with indicators of territorial endowment (air accessibility) in the frame of the beta-convergence model. In order to estimate the parameters describing the role of the air accessibility, as a factor of GDP/inhab. dynamics, we use two different types of regression analysis, a classical ordinary least square method and the geographical weighted regression. The last one is able to locally determine the coefficients of the predictors (for each NUTS3) using a mobile kernel of fixed or variable size (Charlton M., 2002). The results will be compared for three periods of analysis: before the economic crisis, during the economic crisis and for 2001-2011. These two complementary methods (OLS and GWR) will provide information regarding the regional resilience for 2008-2011.

4) Results and discussions

In this part we estimate the relation between the economic growth at NUTS3 scale and factors of territorial endowment, in the frame of the beta-convergence process. Our intention is to relate the dynamics of the GDP/inhab. from 2001 to 2011, using an ordinary least square regression where the predictors are variables describing the territorial accessibility. This method will provide the coefficients of the regression, coefficients that depict the progress of the beta-convergence and the role played by the air accessibility of the NUTS3 in the studied area. Mathematically, the formalization of the model is rather simple to approach.

$E_{t+n} = a + b \cdot \log(Y_t) + c \cdot Z$, where

E_{t+n} = the dynamic of the beta-convergence indicator (GDP, GVA, consumption, income etc.)

Y = the level of the convergence indicator at moment t

Z = predictors such as air accessibility, volume of flows or other explanatory variables

a, b, c = parameters of the ordinary least square regression.

The dynamic of the beta-convergence indicator was calculated as an annual average rhythm of growth :

$E_{t+n} = ((GDP/inhab.t+n/GDP/inhab.t)^{(t+n-t)} - 1)$,

where:

t = the chronological base of reference - 2001

$t+n$ = the last year in the dataset - 2008 or 2011, if the model is applied for the ante-crisis period

Applying the statistical model for the NUTS3 form the Eastern Europe emphasizes some important aspects:

- the process of beta-economic convergence is active for two periods - 2001-2008 and 2001-2011. For the last case, the statistical quality is more reduced, indicating a deceleration in the process of the economic catching-up, due to the financial crisis.

- for the crisis period (2008-2011) the statistical model is not valid as we assist at a stop in the economic growth and trends of reversing of the economic accumulation of GDP.

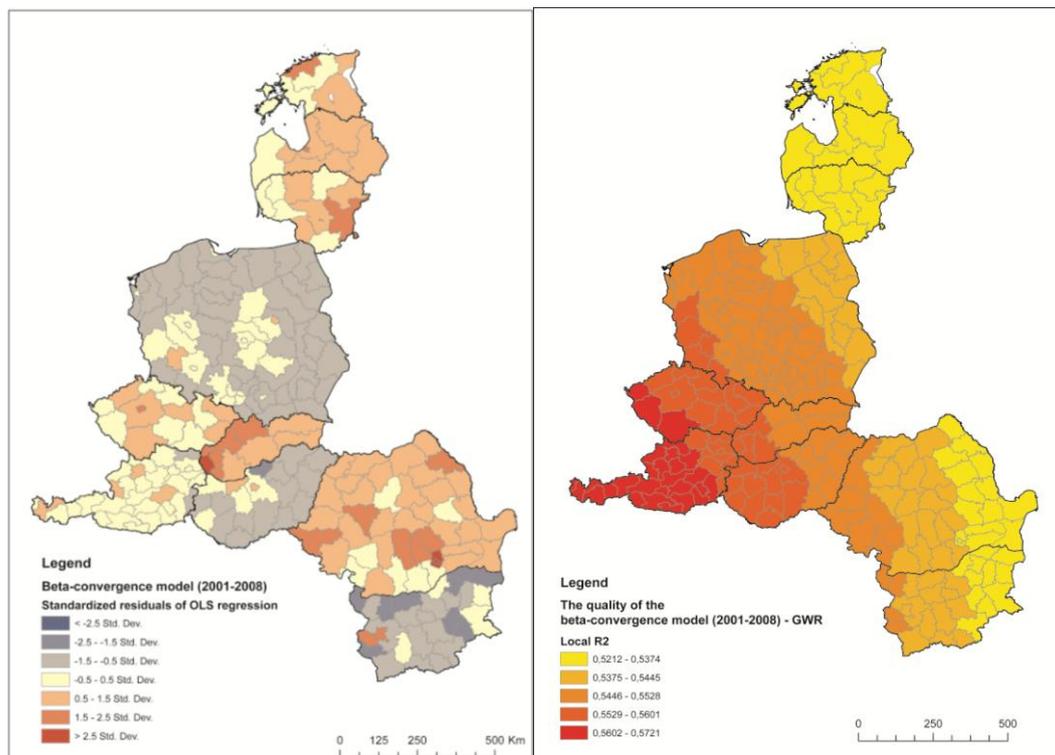


Figure 1 - Standardized residuals of the beta-convergence (OLS regression) for 2001-2008 Local quality of the beta-convergence model (GWR) for 2001-2008

However, implementing the model at Eastern European scale points out the role played by the air accessibility, during the economic convergence process. Grasland (2012) and Monfort (2008) highlight the impact played by the spatial and territorial variables in the dynamic of the convergence process. The introduction of the spatial lag in the beta-convergence model is rather a methodological innovation. One way to solve the problem of the spatial lag in the ordinary least square model is using the geographical weighted regression (Fotheringham, S., Brunsdon, C., Charlton M., 2002, Mitchell A., 2005) or the local smoothing.

In this logic, we have systematically compared the results obtained by the statistical classical model with the alternative geo-statistical method of geographical weighted regression. Three models were retained in our analysis, allowing us to observe the role played by the air accessibility in the beta-convergence process, together with the economic performance of the NUTS3.

The **first model** presents an acceptable level for the coefficient of determination ($R^2=0.52$). Less interesting as values, the coefficients of the model are relevant by their sign. In this case, the negative value of the GDP/inhab. in 2001 suggests that the starting level in the convergence process explains the annual change rate of the economic catching-up. High levels of GDP are associated with a slower rhythm of growth, while inferior starting positions ensure a more accelerated change rate of the economic indicator (GDP/inhab.). The sign associated with the air accessibility emphasizes the role played by the territorial endowment, a good position in the air network of flows explaining a part of the GDP dynamic.

			Coef. of det.	Accessibility	Beta	Explained variable
	Period	Years	R2	Air accessibility at t (coef.) -c	GDP/inhab . NUTS3 (coef.) -b	GDP/inhab. dyanmics
Model 1	T	2001	0.52	0.02	-0.04	Annual change rate
	t+n	2008				
Model 2	T	2008	0.02	0.003	0.01	Annual change rate
	t+n	2011				
Model 3	T	2001	0.47	0.01	-0.02	Annual change rate
	t+n	2011				

Table 1 - Synthetic presentation of the beta-convergence model. (2001-2008, 2008-2011, 2001-2011)

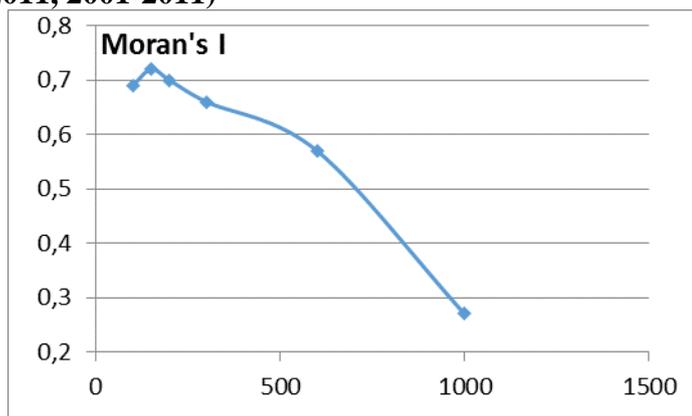


Figure 2 - Moran's I variation as a function of distance for the standardized residuals of the beta-convergence model no.1

The three models we propose are sound from a statistical point of view (not significant p values associated with the predictors), however, they are problematic from a geo-statistical point of view. As the residuals are spatially auto-correlated (Moran's I index), they indicate the presence of non-stationary predictors and suggest the existence of spatial gradients, both for the economic performance and the air accessibility. The canonical-statistical models of beta-convergence are not able to intersect these gradients. Introducing the spatial lag in the methodology proposed by the geographical weighted regression enables the detection of these gradients, by the mapping process of the local coefficients (b and c). In that case, one will observe that the air accessibility shows patterns of spatial distribution that favors some regions or acts as penalties for other NUTS3. Moreover, the spatial distribution of the local coefficient associated with the air accessibility is not dictated by hazard. The cartographic analysis indicates that higher values are concentrated in the inert economic NUTS3 of Bulgaria, on the Western Romanian border and in the highly urbanized regions of Central Czech Republic.

The beta-convergence analysis for the crisis period of 2008-2011 derives a different spatial configuration. The **second model** is the less performing from the three versions we

built, with an insignificant coefficient of statistical determination - $R^2 = 0.02$. The geographical weighted regression doubles this conclusion, the coefficients associated with the air accessibility being reduced and statistically not sound.

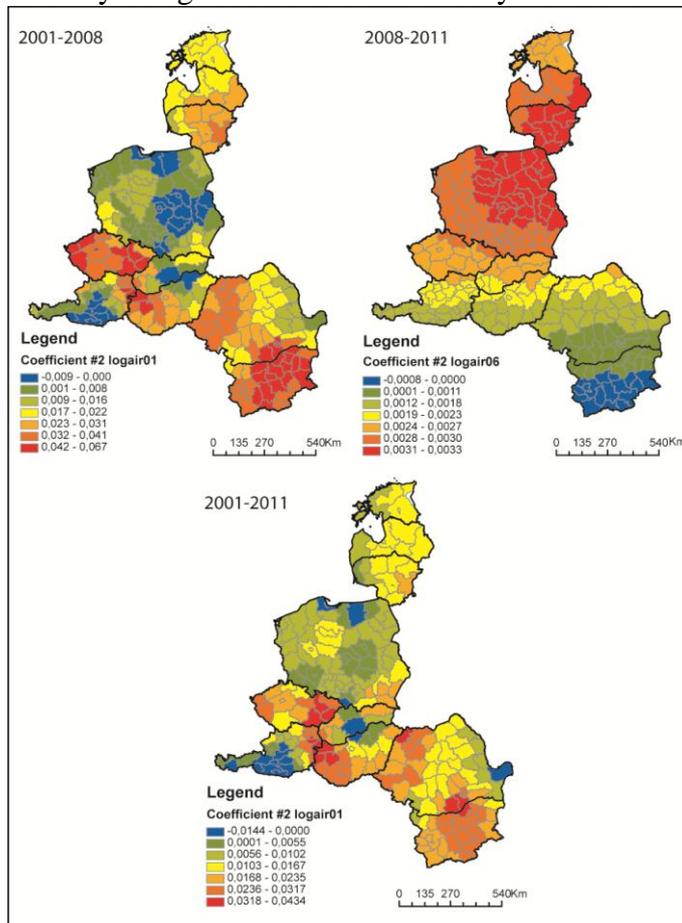


Figure 3 - Spatial distribution of the air accessibility coefficients, estimated using geographical weighted regression. GWR beta-convergence model for 2001-2008, 2008-2011 and 2001-2011

Replicating the beta-convergence model for the period 2001-2011, both with a canonical-statistic approach and a geo-statistical one, partially overlap the conclusion of the **first model**. When we include data from the crisis period, the parameters of the regression are more reduced.

The preliminary analysis of the beta-convergence points out some important geographical aspects that can be used for policy recommendations. Building and exploiting the three models (doubled by a geographical weighted regression) clearly shows that the air accessibility behaves as a factor of economic growth, at NUTS3 scale. This first conclusion is valid for periods of intense economic growth (2001-2008). For the crisis period, the inefficiency of the beta convergence models demands for a better understanding of the economic turbulences affecting the NUTS3. As the annual change rate of the GDP/inhab. presents contrasts in the territorial distribution, we can relate these dynamics to the evolutions of the air accessibility by proposing a qualitative typology in four classes.

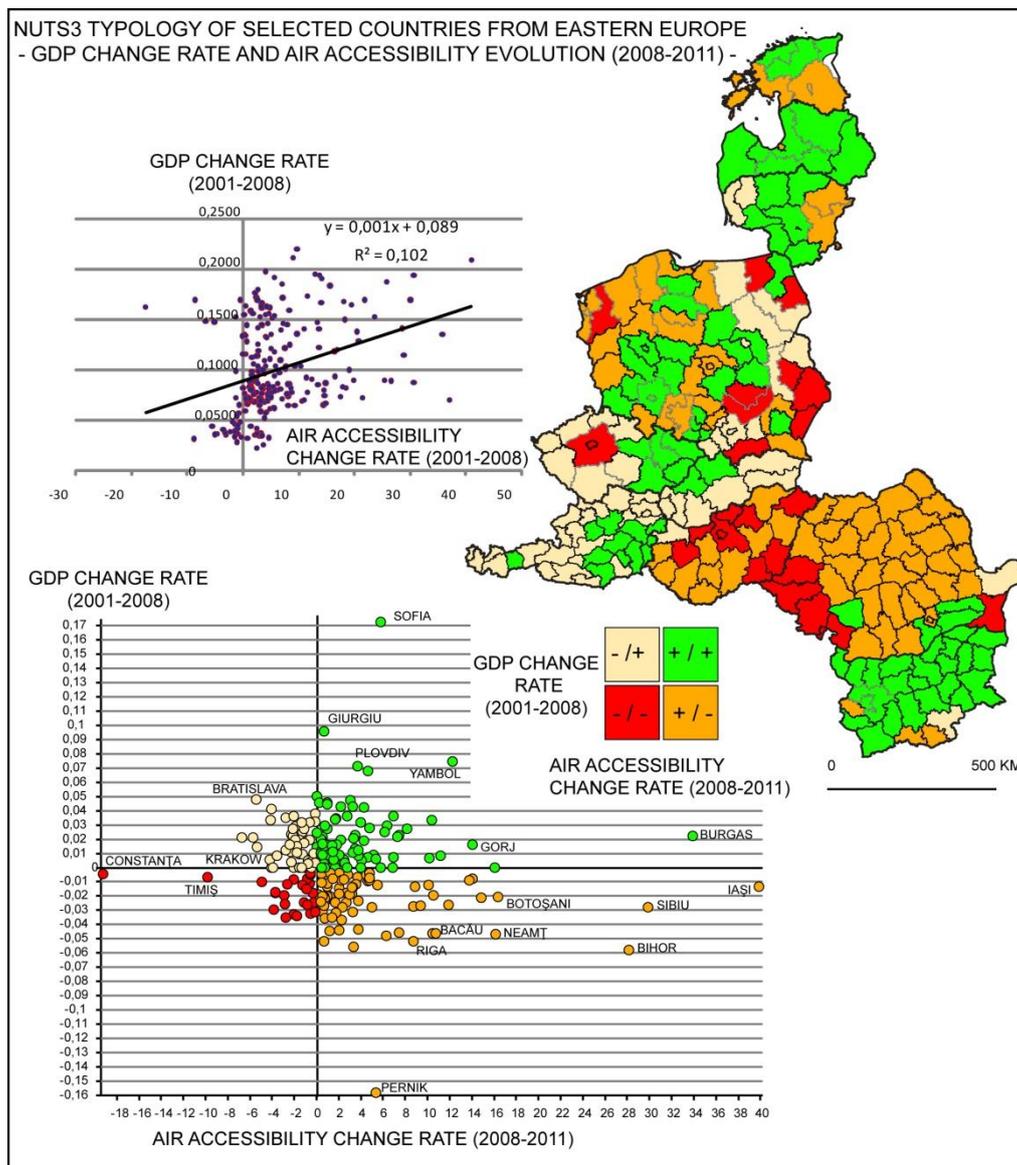


Figure 4 - NUTS3 typology of selected countries from Eastern Europe - GDP change rate and air accessibility evolution (2008-2011) -

The first class (double decrease for GDP/inhab. and accessibility) includes NUTS3 from Romania, Hungary, Czech Republic, Poland and Slovakia. Dynamic NUTS3 before the crisis, like Pest, Budapest, Timis or Constanta, were put together with peripheral and economically inert counties, such as Szalbog-Szatmar-Bereg (Hungary) or Elcki (Poland), emphasizing the unexplained territorial patterns in the manifestation of the economic crisis.

At the opposite (double decrease for GDP/inhab. and accessibility), counties like Sofia, Yambol or Giurgiu escape the crisis effects on the economic performance and consolidate their position in the air accessibility hierarchy.

Maybe the most interesting NUTS3 class is composed by Bratislava, Wien, Krakow and similar metropolitan counties that, despite a decrease in the air accessibility, present positive change rates of the GDP even during the economic crisis. We can suspect that these NUTS3 benefit from local economic systems that are resilient in periods of turbulence, a resilience that the beta-convergence models is able to detect by more advanced geo-statistical formalization.

5) Conclusions

In this article we have studied the role played by factors of territorial endowment in the dynamic of economic performance. The methodological frame was assured by the beta-convergence calculation, while the explained variable was the GDP/inhab. change rate and the predictor indicator the air accessibility at NUTS3 scale. The formalization was proposed for three periods of time: 2001-2008, 2008-2011 and 2001-2011, following recent economic cycles. Our approach involved several steps, like the collection of data, the statistical and spatial analysis exploration and the elaboration of a regional typology serving as a discussion basis for policy recommendations.

The main conclusion of our study highlights the fact that the classical model of beta-convergence should be doubled by analysis that mobilizes the geographical factors of GDP rate of change. These factors can be intersected using the geographical weighted regression, especially for a close-up on the local variability of the coefficients explaining the average annual change rate of the economic performance. Moreover, the estimation of the local quality of the beta-convergence model indicates that this process is shaped by a West-East gradient and that the role of the air-accessibility is not equally important all over the Eastern European space.

The economic crisis reset the trends of economic convergence, bringing into discussion the role of the resilience for the performance of the local economic systems. Our hypothesis sustains that, by using spatial lag in canonical models (beta or sigma convergence), research can detect and quantify more easily this regional attribute. The final typology we proposed is an example on how spatial analysis can be mobilized to provide policy recommendations for decision-takers, linking the applied research with the elaboration of the policy design.

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