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THE IMPACT OF EU STRUCTURAL FUNDS RELATED TO INNOVATION IN SOCIO-ECONOMIC DEVELOPMENT AT A LOCAL LEVEL

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Purpose: The aim of the paper is to verify the process of β-convergence at a local level in Poland within 2007-2016, taking the impact of spatial effects and obtained EU funds related to innovation on economic growth into account.
Design/methodology/approach: Spatial econometric methods were used in the research procedure. The modelling uses the economic aggregate, which is an alternative to the GDP measure of development. In addition, the traditional convergence equations were modified by adding variables defining spatial interactions to the specifications of the estimated models that may affect the rate of economic growth. The study covers data from all counties (NTS4) in Poland.
Findings: The estimated econometric models showed that between 2007-2016, there was a slow process of reducing economic inequalities between counties in Poland. The convergence process was conditioned by the amount of European funds obtained for innovation. The funds acquired in a given county stimulated the economic growth of this unit while, at the same time, having negative impact on the development dynamics of neighbouring units.
Originality/value: The added value of this elaboration is the inclusion of spatial effects affecting economic growth in the conducted analyses of conditional convergence. The presented study is one of a few in which the spatial impact was verified by including weights in the modelling of the matrix based on proximity, distance, flows and affiliation, carried out using data relating to all NTS4 units of a given European Union country.

Keywords: β-convergence, European funds, innovation, spatial effects, spatial regression models.

Category of the paper: research paper.

1. Introduction

The issue of inequality in the distribution of goods, income and capital has long been of interest to economists aiming to explain socio-economic development processes. The dynamics of this type of processes is manifested in the occurrence of business cycles, and spatial aspects are visible as differences in regional and local economic conditions. The challenge of contemporary development policy is to level the course of the business cycle and reduce excessive economic differences in the spatial dimension (Markowska-Przybyła, 2010). An important role attached to counteracting temporal and spatial development inequalities is related to the implementation of the European Union's regional policy. Its main objective is to guarantee economic and social cohesion within the Community by reducing territorial imbalances (Kisiała, Bajerski, Stępiński, 2017). The implementation of the cohesion policy is supposed to lead to convergence, which can be identified with the long-term reduction of differences in the level of socio-economic development across the EU territory (Rodríguez-Pose, Fratesi, 2004).

The problem of economic convergence, despite numerous attempts at empirical verification, has so far been generally regarded as controversial and unresolved (Kisiała, Suszyńska, 2017) Supporters of the convergence hypothesis, based on neoclassical growth models, argue that countries (regions) with a lower level of income *per capita* usually achieve higher rates of economic growth, which leads to the reduction of economic differences. In this approach, convergence results from the decreasing marginal productivity of production factors. However, post-Keynesian concepts, promoted, e.g. by Myrdal (1957), are equally popular. According to them, the economic growth is a spatially cumulative process, which means that rich countries or regions, thanks to the accumulated capital and access to resources, attract further economic activities and thus, limit the development opportunities of poorer areas. Although the latter may use so-called spread effects (i.e. development impulses induced by the expansion of prosperous areas), they are considerably reduced by so-called backwash effects (negative economic effects, such as the draining of labour, capital, goods and services to privileged areas). These processes lead to the deepening of economic inequalities, which is referred to as economic divergence (Puga, 1999).

Economic convergence studies are conducted mainly on an international and regional scale. Convergence analyses of local economies are much less frequent. Although there is a noticeable increase in interest regarding convergence research at the local level in foreign publications (Bukenya et al., 2002; Ying-Xia et al., 2005; Higgins et al., 2006; Bishop, Gripaios, 2006; Biedka et al., 2022), in the Polish literature, local studies (county or commune level of the country's territorial division) are very rare.

In the literature, an important role in stimulating the development of regions is often attributed to a strong innovation system (Gomułka, 1998). In the globalised world, knowledge becomes a key production factor, and the most important competence is creativity (Mączyńska, 2008). Poland's integration with the European Union has created conditions for increasing the level of innovation within the Polish economy and reducing the technological gap between the country and European leaders. This results from the possibility of spending the resources of the Community regional policy. Due to the fact that in the EU funds distribution system a key role is attached to the creation of innovative solutions, a significant scale of financial contribution enables the implementation of pro-innovation policy, which results in stimulating the processes of social and economic development of cities, regions and the country (Markowska, Strahl, 2012).

The goals of this article are determined by two research questions:

1. Was there a convergence process in Poland at the local level (between counties) and was it affected by the amount of funds obtained for innovation?
2. Were there spatial interactions in the convergence process and what was their mechanism of impact on the rate of economic growth?

Answers to the research questions were sought by verifying the β-convergence process at the local level (in counties) between 2007-2016. In econometric modelling, an alternative to the GDP measure of development, called the economic aggregate (EA), was used. In addition, the traditional convergence equations were modified by adding variables defining spatial interactions that may affect the rate of economic growth to the specifications of the estimated models.

2. Literature review

Research regarding the impact of the cohesion policy implementation on the economic growth of countries, regions or units at a lower tier of territorial organisation in the European Union (including, in particular, the occurrence of economic convergence) has a relatively long tradition. However, the findings made by the scientific community in such analyses are far from reaching some form of consensus (cf. e.g. Mohl, Hagen, 2010; Pellegrini et al., 2013). This, on the one hand, is due to the different temporal or spatial scopes of the analyses carried out and, on the other, to the different specifications of the econometric models used.

The study by Rodríguez-Pose and Fratesi (2004) should be considered as one of the first works that opened up the debate on the effectiveness of the European Union's regional policy to a wider extent. Using cross-sectional data for the 1989-1999 period, the authors found the occurrence of slow β-convergence between the regions included in the study (both in the model for all EU regions as well as in the specification limited to the least favoured regions only).

At the same time, very weak but positive and statistically significant impact of expenditure from European funds on economic growth was confirmed.

Since the time of publishing this publication, there have been a number of studies based on similar assumptions, the conclusions of which do not seem to confirm the findings achieved by Rodríguez-Pose and Fratesi (2004), or they confirm them only to a limited extent. These may include the study by Braidenbach et al. (2019), who analysed the impact of structural funds on changes in gross domestic product *per capita* in EU-15 regions between 1997 and 2008 (based on the models used, both including and excluding spatial effects). In this study, it was shown that the funds have a negative impact on economic growth in the analysed regions (between 0% and -0.5%). In addition, this impact is exacerbated by the presence of negative spatial effects.

Less pessimistic conclusions regarding the effectiveness of European Union regional policy were drawn by Antunes et al. (2020). The analysis allowed to confirm that there was β-convergence between regions in the period under study, but that European funds did not affect its occurrence (as a statistically insignificant variable). The authors pointed towards the need to coordinate the spending of structural funds with other policies and non-public investments in order to fully achieve the synergy effect.

Slightly different conclusions were reached in the study by Maynou et al. (2016). In this case, the analyses suggested that a β-convergence took place in the sample, while the positive direct impact of European funds' expenditure on economic growth was proven, while the existence of spatial effects in this respect (indirect impact of European funds) was not confirmed.

It is worth emphasising that apart from the analyses indicating the lack of evidence for the effectiveness of the cohesion policy implementation, there is a fairly numerous group of studies in which the positive impact has been confirmed of European funds on economic growth along with the incidence of indirect (spatial) effects as well as the occurrence of interregional convergence. Such conclusions can be found, among others, in the study by Fiaschi et al. (2018), who analysed the impact of structural funds on regional productivity, and in the work by Mohl and Hagen (2010) – but only in relation to regions characterised by the least favourable economic parameters. A positive assessment concerning the impact of European funds on economic growth in the EU-15 regions can also be found in the study by Rodríguez-Pose and Novak (2013), but with the caveat that it relates to the later of the two analysed programming periods (2000-2006).

A distinctive feature of all the above-mentioned studies has been the failure to include the regions of the member states in the analyses which accessed the European Union in 2004 or later. The main reasons for this are, on the one hand, the shorter period of implementing cohesion policy in the 'new EU' countries and, on the other, the different economic and institutional conditions in these countries in relation to the member states before the 'great enlargement'.

Exceptional work in this regard includes the study by Scottie et al. (2022), in which the authors analysed the impact of European funds on the level of economic growth in 256 regions of the EU-27 (excluding Croatia) during the 2007-2013 programming period. The results of the analysis indicate the occurrence of a fairly rapidly progressing β-convergence across regions (especially in comparison with the results of studies from earlier programming periods), with statistically significant and positive impact of expenditures on research and development, human capital and transport. The occurrence of positive indirect (spatial) effects of the implemented projects was also confirmed.

A separate and relatively sparsely represented group of analyses in the literature are those related to the impact of European funds on economic growth and competitiveness in individual member states at the local level. Among these, mention should be made of the work by Alecke et al. (2013), who analysed the impact of investment subsidies in one of the programmes co-financed by the 1994-2006 European Regional Development Fund directed towards enterprises for the purpose of increasing labour productivity per employee among a set of 225 local labour markets in Germany. This analysis showed a positive effect of the funds spent on labour productivity (a 1% increase in spending had an average effect of increasing labour productivity per employee by 0.3%). In addition, the occurrence of spatial effects was also identified (the influence of spatial units directly adjacent to each other). Similar conclusions were also formulated by Biedka et al. (2022), who carried out an analysis of the impact regarding structural funds earmarked for the development of human resources (expenditure under the Human Capital Operational Programme) on the level of development on a local scale in Poland's municipalities (measured by the country's *per capita* income).

3. Data and methods

The selection of variables characterising the economic growth of the analysed territorial units is of key importance for convergence studies. The measure commonly used in this regard is GDP *per capita*, which is most often applied at the national level, less frequently at the regional level. However, due to the lack of data on GDP at the level of counties in public statistics, an alternative measure called the economic aggregate (EA) was used (Korec, Polonyová, 2011; Romanowski, 2020). The economic aggregate is obtained by multiplying the number of employees (jobs) in the region (county) and the average monthly salary in the region (county). It is relative to the number of inhabitants (social variant) or the area of the unit (geographical variant).

The economic aggregate refers to the Clark division theory, in which there is an assumption of an increase in remuneration of production factors in accordance with their marginal productivity. This means that when analysing changes in the level of remuneration (e.g. average

remuneration in a county), one can estimate changes in the level of development. An alternative solution would be to measure productivity, which could technically relate to GDP (GVA) generated at the local level. In addition to the high costs of obtaining such data, in Poland, there is also a violation regarding the main assumptions of the Clark division theory (Hein, 2014). Since the 1980s, in many developed economies, due to the pressure on short-term profits, productivity curves have been rising and wage curves have stagnated or increased at a disproportionately lower level (Hein, 2014). Without going into political disputes, it is worth assuming that the size of wages on a local scale is a better measure of local development than the level of productivity (Kwiatkowski, Kucharski, 2011).

The economic aggregate (EA) has an explanatory power similar to the GDP indicator for a region (Hampl, 2005; Korec, 2009). Hampl (2005) presented justification for using EA in research at the level of regional and local economic development. This author emphasized the social and economic homogeneity taken into account by EA in the regions of Central Europe undergoing economic transformation. Importantly, EA *per capita* combines social and economic (salaries) elements by taking the stream of money passing through a given community into account. The disadvantage of the indicator is the construction of the average gross remuneration for a county. The measure is based on salaries of employees hired at entities of the national economy, excluding business entities employing up to nine people.

In addition to the quantification of economic growth at the local level, the implementation of research required determining the amount of EU support for projects related to innovation of each county in Poland. From the point of view of considerations in the work, the most important were the expenditures implemented under the intervention category numbered 01-09, belonging to the priority topic 'Research and technological development, innovation and entrepreneurship' (*RTD* variable). They are part of the policy supporting innovation (Romanowski, 2015). Relationships between science and industry are supported by expenditures within categories 01, 02, 04, 07, between enterprises - 05, 08, 09, between large enterprises and the local government - 06 (eco-innovations), and supporting all links - 03 (Table 1). The value of these funds was determined on the basis of the National IT System – IT System for Monitoring and Financial Control of the Structural Funds and the Cohesion Fund (SIMIK) database. The SIMIK database contained information on all projects implemented using EU funds within the 2007-2013 financial perspective.

All contracts that were implemented throughout the country were removed from the list because of the inability to conduct volatility analysis at the county level. In addition, contracts were removed for which their implementation was not territorially defined. Contracts that were implemented in a given voivodeship were left for analysis, as the amounts spent on a given project were evenly divided among all counties of a specified voivodeship.

Table 1.
Categories of interventions within the priority theme 'Research and technological development, innovation and entrepreneurship (RTD)'

Number of intervention category	Name of intervention category
01	R&TD activities at research centres
02	R&TD infrastructure (including physical plant, instrumentation and high-speed networks linking research centres) and specialised centres of technological competence
03	Technology transfer and improvement of cooperative networks between SMEs, as well as between SMEs and other businesses and universities, various institutions of post-secondary education, regional authorities, research centres and scientific and technological poles (scientific and technological parks, technopolises, etc.)
04	Support for R&TD, particularly in SMEs (including access to services related to R&TD services at research centres)
05	Services in the field of advanced support for companies and groups of companies
06	Support for SMEs in the promotion of products and environmentally-friendly processes (introduction of effective environmental management systems, adoption and use of pollution prevention technologies, integration of clean technologies into company production)
07	Investments in companies directly linked to research and innovation (innovative technologies, establishment of new enterprises by universities, existing R&TD centres and enterprises, etc.).
08	Other investments in enterprises
09	Other measures to stimulate research and innovation as well as entrepreneurship in SMEs

Source: adapted from Commission Regulation (EC) No. 1828/2006 of 8 December 2006, Annex II, pp. 31-34 and data available on the Portal of European Funds (PFE, 2014).

The value of expenditure under the priority *RTD* theme was calculated by summing up the values of the assigned intervention categories implemented in a given county. The values calculated in this way were relativised via dividing them by the number of inhabitants in individual counties.

In the research procedure, econometric methods were used. The research methodology was based on the classic β-convergence modelling approach popularised by Barro and Sala-i-Martin (1992; 2004). The formal analysis was reduced to the estimation of regression models, verifying whether there was a statistical relationship between the initial level of economic growth and its dynamics in the analysed period. In addition, it was examined whether the *per capita* growth at the local level was affected by EU funds allocated to innovation. For this purpose, the models were extended by adding a control variable, i.e. the value of EU funds for innovation obtained in individual counties in Poland for the 2007-2013 financial perspective (*RTD* variable). Finally, in order to check the impact of funds obtained in a given location (a given county) on other locations, a spatial component was added to the models in the form of a spatially lagged control variable (the value of EU funds obtained for innovation in neighbouring counties).

In the literature, such a group is referred to as spatial cross-regression models (SCM). They make it possible to detect interactions in a set of explanatory variables. Due to the lack of variable correlation with random components, SCM models can be estimated using the method of ordinary least squares (Suchecki, 2010; Górna, 2019).

Four types of spatial weight matrices were applied in the study. Each of them reflected the structure of connections between the analysed counties in a different way, and thus, enabled identification of the mechanism concerning the impact of neighbouring locations on a given object (county). They included:

1. Adjacency matrix W1 – in this case, the neighbourhood was defined using the criterion of a common border (spatial contiguity). It was assumed that the neighbours are counties that share a common border, regardless of its length (first-order contiguity matrix of queen type).
2. Distance matrix W2 –specification of the elements of this matrix was based on the measurement of the distance between counties *i* and *j*. Measurements were made in the Euclidean metric, and the weights were calculated using the linearly decreasing function $w_{ij} = d_{ij}^{-1}$ (inverse distance matrix).
3. Matrix of flows W3 –weights reflected the actual (real) connections between counties in terms of commuting to work. According to this matrix, neighbouring units are those between which employment-related population flows took place, and the individual weights w_{ij} were equal to the number of people commuting to work from the county *i* to *j*.
4. Block weights matrix W4 – the neighbourhood did not result from geographical proximity, but from belonging to the same group. Block weights connect every observation in a data set that belong to the same category. It was assumed that the neighbours of the *i*-th county will be other counties located in the same voivodeship.

Each of the spatial weights matrices reflected the structure of connections between counties in a different way, and therefore, their use in econometric modelling was the basis for verifying the spatial impact mechanism conditioning the process of economic convergence at the local level in Poland. Matrix W1 made it possible to show dependencies between counties, resulting from adjacency. The second matrix (W2) was based on the assumption that counties did not have to share a common border in order to interact with each other, and the strength of the impact in this case was influenced by the geographical proximity of counties. The next matrix (W3) favoured actual links (interactions) between counties over geographical proximity. These links were quantified by commuting, which could be influenced, on the one hand, by the distance, and on the other, by the certain attractiveness of individual counties as places generating jobs. Finally, the W4 matrix made it possible to identify regional conditions, recognising counties from the same voivodeship as neighbours.

The spatial weight matrices were row-standardised, which means that the sum of the weights of neighbours for each county was always the same (equal to 1). Therefore, it was possible to calculate spatial lag of a given variable in the form of a product of the weight matrix and this variable, interpreting it as a weighted average of this variable's values in neighbouring units (according to the applied spatial weight matrix).

The final form of the estimated models was as follows:

$$\ln\left(\frac{EA_{i,2016}}{EA_{i,2007}}\right)=\alpha_0+\alpha_1\ln\left(EA_{i,2007}\right)+\alpha_2 RTD_i+\alpha_3\left(\sum_{j\neq i}w_{ij}RTD_j\right)+\varepsilon_i\,, \quad (1)$$

where:

$EA_{i,2007}$ means income *per capita* (quantified by the value of the economic aggregate) in the *i*-th county (*i* = 1, 2, …, 379) during the initial period of analysis (2007),

$EA_{i,2016}$ is the value of this feature during the final period of analysis (2016),

RTD_i and RTD_j are the values of EU funds for innovation *per capita* obtained in the *i*-th and *j*-th county within the 2007-2013 financial perspective, respectively,

w_{ij} comprises an element of the spatial weights matrix W defining links between the *i*-th and *j*-th counties,

α_0, α_1, α_2 and α_3 constitute the estimated model parameters,

ε_i is the random component (model error term).

The basis for drawing conclusions about convergence or divergence was the statistical significance of the α_1 coefficient. A negative estimation of the parameter indicated the presence of convergence, while a positive value indicated divergence. The statistically significant estimation of the α_2 parameter was related to the recognition of EU funds allocated to innovation as a factor conditioning growth. Finally, the statistically significant estimation of the α_3 parameter (standing for spatial lag) could be interpreted as the occurrence of spatial effects (indirect impact of European funds).

4. Results

As previously mentioned, this paper is devoted to the analysis of β-convergence at a local level (between counties) in Poland. Regression modelling was carried out in four variants, each of them using a different spatial weights matrix. The obtained results are presented in Table 2.

Table 2.
Estimation results of convergence models

Model with the weight matrix:	α_0	***p*-value**	α_1	***p*-value**	α_2	***p*-value**	α_3	***p*-value**	R^2
W1	5.493	0.000	-0.126	0.000	0.057	0.000	-0.006	0.701	0.199
W2	5.514	0.000	-0.126	0.000	0.057	0.000	-0.009	0.547	0.200
W3	5.563	0.000	-0.126	0.000	0.056	0.000	-0.014	0.039	0.200
W4	6.083	0.000	-0.129	0.000	0.056	0.000	-0.079	0.028	0.209

Source: own calculations.

Econometric models showed that in the years 2007-2016, there was a slow process of reducing economic inequalities between counties in Poland. This means that in the analysed years, economic growth at the local level was in line with the convergence hypothesis. Negative and statistically significant estimations of the α_1 parameters relating to the variable $\ln(EA_{i,2007})$ proved that counties starting from a lower level of economic growth statistically, achieved a higher growth rate, thus, catching up with units in a better economic condition at the beginning of the study. A low value of the α_1 parameter, although negative and statistically significant, proved that the convergence process was very slow. The convergence process at the local level was conditioned by the amount of EU funds obtained for innovation-related purposes. Greater use of funds caused faster economic growth, as evidenced by positive (and statistically significant) estimates α_2. Funds allocated to research and technology development contribute to increasing the level of innovation and productivity, which results in stimulating social and economic development processes at the local level. When analysing cause-and-effect relationships, it should be borne in mind that there is a feedback loop between innovation and economic growth. Rich regions with a high level and dynamic growth have greater opportunities to obtain and allocate funds for research and development. At the same time, expenditure on innovation accelerates the dynamics of economic growth.

An opposite direction of the relationship was indicated by the estimations of the α_3 parameter relating to spatial lags in the value of EU funds used for innovation. This means that the funds obtained by the neighbours (regardless of the definition of neighbourhood used) weaken the growth dynamics in a given county. This may suggest that the conditions for spreading growth impulses generated by investments in research and technological development on a larger scale have not yet emerged. The obtained results seem to indicate that in the analysed period, pro-innovation investments in the neighbouring counties primarily built their competitive advantage. However, it can be presumed that over time, as the country enters higher levels of socio-economic development, the process of growth impulse diffusion to other areas becomes apparent. The innovation diffusion mechanisms should, in the long term, lead to a reduction in inter-county disproportions.

When analysing the results of modelling with the use of various spatial weight matrices, it should be noted that in the first two cases (adjacency matrix and distance matrix), the variables quantifying the level of using EU funds for innovation in neighbouring counties (i.e. spatial lags of the *RTD* variable), turned out to be statistically insignificant (p values 0.701 and 0.547, respectively). In turn, the use of the flows and block weight matrices showed the statistical significance of spatial lags ($p = 0.039$ and $p = 0.028$). This means that the interaction between counties in the discussed scope was not related to geographical proximity resulting from immediate vicinity or short distance. Therefore, spatial cross-regression models based on the W1 and W2 matrices are not an appropriate approach for conditional convergence analysis. The interaction may, however, be analysed through the prism of actual connections between

counties, which can be symptomatically measured by commuting volume (matrix W3). Nevertheless, these links were not innovation and growth carriers, but were rather associated with negative economic effects, such as the draining of labour, capital, goods or services from poorer to richer counties. In this case, the mechanism of spatial interaction led to the polarisation of local economies. Similar relationships were identified during the analysis of the model using the block weight matrix (W4). This may be related to the situation in which counties from the same voivodeship (understood as neighbours according to the matrix used) competed for the same funds distributed at the regional level. This competition resulted in the diversification of expenditures on research and technological development which, in turn, led to deepening development differences.

Finally, it should be noted that the estimated models have limited explanatory value. The coefficients of determination R^2 oscillated around the level of 0.2, which means that the variables included in the models explained approximately 20% of the variability in economic growth dynamics. It is worth emphasizing, however, that during regression modelling of β-convergence, high coefficients of determination are rare.

5. Discussion and conclusions

In light of the conducted research, it may be concluded that in the years 2007-2016, inequalities in the level of economic development of counties in Poland decreased. The process of economic convergence at the local level resulted from the negative relationship between the initial level and the rate of economic growth of individual counties. Moreover, it was conditioned by the amount of European funds obtained for innovation. The funds obtained in a given county stimulated the economic growth of this unit but, at the same time, had negative impact on the dynamics regarding development of neighbouring units.

The obtained results are only partly consistent with those found in earlier papers in which the convergence process was analysed at the local level (Ying-xia et al., 2005; Bishop, Gripaios, 2006; Higgins et al., 2006; Alecke et al., 2013; Biedka et al., 2022). As in these publications, this study confirmed the existence of the β-convergence process while, at the same time, showing the role of European funds as a factor positively influencing economic growth. However, opposite conclusions were reached as far as the impact of the spatial factor is concerned. The cited papers attribute the factor a significant role in stimulating the growth process, while the obtained results rather tend to recognise this factor as a de-stimulant. This may be due to several reasons:

1. different specification of the estimated econometric models (panel models vs. spatial regression models),
2. diversified research area (China, USA, Great Britain, Germany, Poland),

3. different spatial scale of conducted research (level of local labour markets, county and communal level),
4. diverse thematic scope of intervention included in the models (measures supporting infrastructure, human capital and innovation),
5. a different time range of the conducted research (German studies on the financial perspectives – 1994-2006 and Polish studies – 2007-2013).

The added value of this paper is the inclusion of spatial effects determining economic growth in the analysis of conditional convergence. The presented study is one of the few in which the spatial impact was verified by including weights based on contiguity, distance, flows and belonging to a specific group in the modelling of the matrix. While the use of the first two types of matrices did not reveal the occurrence of spatial interactions, the use of flow and block weight matrices turned out to be an appropriate approach in the conditional convergence analysis. Hence, further research considering spatial effects in convergence processes should be focused on explaining the mechanisms of mutual interactions of the analysed spatial units.

To some extent, the conclusions are weakened by the limited degree of the models' fit to empirical data (determination coefficients of the estimated models oscillated around 0.2). It seems that the rate of economic growth is a much more complex phenomenon than it would appear from the estimated regression models, even supplemented with variables determining the impact of the neighbourhood.

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References

1. Alecke, B., Mitze, T., Untiedt, G. (2013). Growth effects of regional policy in Germany: results from a spatially augmented multiplicative interaction model. *The Annals of Regional Science*, *50*, pp. 535-554.
2. Antunes, M., Viegas, M., Varum, C., Pinho, C. (2020). The Impact of Structural Funds on Regional Growth: A Panel Data Spatial Analysis. *Intereconomics*, *55*, pp. 312-319.

3. Biedka, W., Herbst, M., Rok, J., Wójcik, P. (2022). The local level impact of human capital investment within the EU cohesion policy in Poland. *Papers in Regional Science, Vol. 101,* pp. 303-325.
4. Bishop, P., Gripaios, P. (2006). Earnings convergence in UK counties: a distribution dynamics approach. *Applied Economics Letters, Vol. 13, No. 1,* pp. 29-33.
5. Breidenbach, P., Mitze, T., Schmidt, C. (2019). EU Regional Policy and the Neighbour's Curse: Analyzing the Income Convergence Effects of ESIF Funding in the Presence of Spatial Spillovers. *Journal of Common Market Studies, Vol. 57, No. 2,* pp. 388-405.
6. Bukenya, J.O., Gebremedhin, T.G., Schaeffer, P.V. (2002). Income convergence: a case study of West Virginia counties. *Research Paper,* 2002-03. Alabama: A&M University.
7. Commission Regulation (EC) No. 1828/2006 of 8 December 2006 laying down detailed rules for the implementation of Council Regulation (EC) No. 1083/2006 laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and of Regulation (EC) No. 1080/2006 of the European Parliament and the Council on the European Regional Development Fund; Annex III: List of data on operations to be communicated on request of the Commission for the purpose of documentary and on-site audit under Article 14, Official Journal of the EU L 45/3, http://www.ncbir.pl/gfx/ncbir/userfiles/_public/pl_1828_wykonawcze_corr_2_02_2007.pdf, 11.11.2015.
8. Fiaschi, D., Lavezzi, A., Parenti, A. (2018). Does EU cohesion policy work? Theory and evidence. *Journal of Regional Science, 58,* pp. 386-423.
9. Gomułka, S. (1998). *Teoria innowacji i wzrostu gospodarczego.* Warszawa: CASE.
10. Górna, K. (2019). *Analiza konwergencji gospodarczej regionów Unii Europejskiej z wykorzystaniem metod ekonometrii przestrzennej*. Toruń: Wydawnictwo Naukowe UMK.
11. Hampl, M. (2005). *Geografická organizace společnosti v České republice: transformat procesy a jejich obecný kontent.* Praha: Univerzita Karlova Praha.
12. Hein, E. (2014). Nasze pensje są sztucznie hamowane. Bez wzrostu płac grozi nam kolejny kryzys i rewolucja, wywiad dla portalu *Forsal.pl* z 30.10.2014, http://forsal.pl/artykuly/832443,hein-nasze-pensje-sa-sztucznie-hamowane-bez-wzrostu-plac-grozi-nam-kolejny-kryzys-i-rewolucja.html.
13. Higgins, M.J., Levy, D., Young, A.T. (2006). Growth and Convergence across the United States: Evidence from County-Level Data. *The Review of Economics and Statistics, Vol. 88, No. 4,* pp. 671-681.
14. Kisiała, W., Suszyńska, K. (2017). Economic growth and disparities: an empirical analysis for the Central and Eastern European countries. *Equilibrium: Quarterly Journal of Economics and Economic Policy, 12(4),* 613-631. DOI: 10.24136/eq.v12i4.32.
15. Kisiała, W., Bajerski, A., Stępiński, B. (2017). Equalising or Polarising: The Centre–Periphery Model and the Absorption of EU Funds under Regional Operational Programmes in Poland. *Acta Oeconomica, 67(2),* 413-434. DOI: 10.1556/032.2017.67.3.6.

16. Korec, P. (2009). General and individual reasons of development of regional structure of the Slovak Republic. In: A.I. Tatarkin (ed.), *Russia and Slovakia: modern tendencies of demographic and socioeconomic processes* (pp. 50-72). Ekaterinburg: Institute of Economics.
17. Korec, P., Polonyová, E. (2011). Zaostávajúce regióny slovenska – pokus o identifikáciu a poukázanie na príčiny. *Acta Geographica Universitatis Comenianae*, *Vol. 55, No. 2*, pp. 165-190.
18. Kwiatkowski, E., Kucharski, L. (2011). Konkurencyjność gospodarki a poziom wynagrodzeń (analiza na przykładzie polskich powiatów). *Zeszyty Naukowe, nr 9*. Kraków: Polskie Towarzystwo Ekonomiczne.
19. Mączyńska, E. (2008). Innowacje a rynek pracy. In: J. Kotowicz-Jawor (ed.), *Polska i Rosja na drodze do innowacyjnego rozwoju* (pp. 59-74). Warszawa: Wydawnictwa Key Text Sp. z o.o.
20. Markowska, M., Strahl, D. (2012). Evaluation of the European Union Regions Convergence Regarding Innovation. *Argumenta Oeconomica, 1(28),* pp. 41-67.
21. Markowska-Przybyła, U. (2010). Konwergencja regionalna w Polsce w latach 1999-2007. *Gospodarka Narodowa, 11-12*, pp. 85-110.
22. Maynou, L., Saez, M., Kyriacou, A., Bacaria, J. (2016). The Impact of Structural and Cohesion Funds on Eurozone Convergence, 1990-2010. *Regional Studies, Vol. 50.7,* pp. 1127-1139.
23. Mohl, P., Hagen, T. (2010). Do EU structural funds promote regional growth? New evidence from various panel data approaches. *Regional Science and Urban Economics*, *40*, pp. 353-365.
24. Myrdal, G. (1957). *Economic Theory and Under-developed Regions.* London: Gerald Duckworth & Co.
25. Pellegrini, G., Terribile, F., Tarola, O., Muccigrosso, T., Busillo, F. (2013). Measuring the effects of European Regional Policy on economic growth: A regression discontinuity approach. *Papers in Regional Science, Vol. 92, No. 1,* pp. 217-233.
26. Puga, D. (1999). The rise and fall of regional inequalities. *European Economic Review, Vol. 43, No. 2*, pp. 303-334.
27. Rodríguez-Pose, A., Fratesi, U. (2004). Between Development and Social Policies: The Impact of European Structural Funds in Objective 1 Regions. *Regional Studies, Vol. 38.1,* pp. 97-113.
28. Rodríguez-Pose, A., Novak, K., (2013). Learning processes and economic returns in European Cohesion Policy. *Investigaciones Regionales*, *25*, pp. 7-26.
29. Romanowski, R. (2015). *Wpływ wsparcia systemów innowacji na rozwój lokalny*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.

30. Romanowski, R. (2020). The impact of the Triple Helix model on the local development of Western Poland. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie, No. 146,* pp. 393-411. DOI:10.29119/1641-3466.2020.146.28.
31. Scotti, F., Flori, A., Pammolli, F. (2022). The economic impact of structural and Cohesion Funds across sectors: Immediate, medium-to-long term effects and spillovers. *Economic Modelling*, *111*.
32. Suchecki, B. (ed.) (2010). *Ekonometria przestrzenna. Metody i modele analizy danych przestrzennych.* Warszawa: C.H. Beck.
33. Ying-xia, P., Rong-hua, M., Ying, G., Xing-yuan, H. (2005). Spatial-temporal dynamics of regional convergence at county level in Jiangsu. *Chinese Geographical Science, vol. 15, No. 2,* pp. 113-119.
34. Žáček, J., Hrůza, F., Volčik, S. (2019). The Impact of EU Funds on Regional Economic Growth of the Czech Republic. *Finance a úvěr – Czech Journal of Economics and Finance, vol. 69, No. 1,* pp. 76-94.