INNOVATIVENESS OF EUROPEAN REGIONAL SPACE: CONVERGENCE OR DIVERGENCE?

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ABSTRACT

The aim of the article is to assess the convergence of innovativeness in European regions at the NUTS-2 level. In the first part of the work, the concept of region's innovativeness is defined and methods of its measurement are presented. Next, the conditions and determinants of convergence/divergence of innovativeness in the regional area are discussed. The theoretical part of the paper suggests that the issue of convergence in the field of innovativeness is a significant, but relatively poorly explored, research area in economic literature. The empirical part of the article presents the results of the study of sigma and gamma convergence of innovativeness in a group of European regions. The research sample consists of 220 regions from 22 European Union countries, as well as Norway, Serbia and Switzerland. The obtained results indicate the occurrence of sigma divergence processes and the lack of gamma convergence processes.

Key words: region, regional development, innovation, innovativeness, convergence

INTRODUCTION

In the modern economy, innovation is a key factor of development. Research on agglomeration processes and new production areas, which started in the 1980s, shows that the innovation processes have a regional context. Understanding innovation processes requires research into an innovative environment, understood as a set of territorially-oriented factors. The ability of the territorial system to create broadly understood innovations is defined as the region's innovativeness.

Considering the existence of specific factors affecting the management of innovation processes specific to given local systems, it is an important cognitive issue to assess changes in the innovation capacity of regions, which allows to determine whether regions are similar to each other in the level of innovativeness or there are reverse trends. In the practical dimension, the analysis of convergence/divergence of innovation can be helpful in assessing the effectiveness of regional policy implementation. It is worth noting that in the case of the European Union, one of the basic objectives of regional policy is to increase the economic cohesion of regions, including their innovativeness.

The aim of the article is to assess the convergence of innovativeness of European regions at the NUTS-2 level in 2009–2017. In empirical part of the paper, data from the Regional Innovation Scoreboard were used. The analyzes were two-track and included the study of sigma convergence and the evaluation of gamma convergence.

INNOVATIVENESS OF A REGION: SIGNIFICANCE AND MEASUREMENT

In the economic literature, there are different approaches to defining regional innovativeness. Most researchers identify the region's innovativeness with the category of innovative capacity of the regional space. In this approach, innovation is a derivative of pro-innovative tangible and intangible resources of the region and the ability to constant searching and using the results of innovation processes in economic practice [Niedzielski 2011]. Tacit and explicit knowledge plays a key role among the resources used for the development of innovation. Due to the complexity of knowledge and limited mobility of its tacit component, the trajectory of innovation processes should be considered with respect to the functioning of the regional innovation system, which is a complex research object, cultural and institutional infrastructure that dynamically accelerates the development of new products and processes in a given space [Markowski 2008]. In such a perspective, the region means a geographically defined and administratively supported structure including innovation networks and institutions that significantly affect the innovative results of business entities. Thus, the innovative potential of the region depends on the following factors [Li 2009]:

1. Expenditure on innovations made by companies, universities and research institutes located in the region.
2. Relationships between local participants of innovation processes.
3. Support for innovation processes by government/ /local government agencies and financial institutions.
4. Relationships between creators and users of knowledge used for the development and implementation of innovation.
5. Interactions between regional participants in innovation processes and innovators from outside the region.
6. Economic structure and innovative environment which are characteristic for the region.

Considering the above determinants of region's innovativeness, while measuring the innovative capacities at the regional level, one should take into account both input indicators in innovation processes and output indicators defining the results of the innovation activity. Depending on the purpose and scope of the study, the analysis of innovativeness may concern both the development of partial indicators and synthetic indicators. In both cases, the values of regions' innovation characteristics may be assessed in relation to reference values (e.g. average), or their changes over time. Among many approaches to assessing regional innovativeness, the methodology proposed by the European Commission as part of the Regional Innovation Scoreboard (RIS) project deserves attention. Together with the Community Innovation Survey (CIS) and the European Innovation Scoreboard (EIS), the Regional Innovation Scoreboard is the basic tool for measuring the innovation potential and its diversities in a regional perspective. In addition, it is a source of information that is necessary for the effective shaping of regional innovation policy.

CONVERGENCE OF INNOVATIVENESS AT REGIONAL LEVEL

In the 1980s, a research program on the processes of economic convergence of countries and regions was initiated. Intensive research on the phenomenon of convergence, anchored both in the neoclassical theory of growth – NTW, and in the theory of endogenous growth – TEC, led to the definition of many types of convergence and different ways of its verification [Islam 2003]. Despite the lack of consensus on the issue of defining convergence, it can be considered that it means the process of "approximating" and "similarizing" various initially dissimilar phenomena, which leads to the disappearance of differences between entities. In the literature, two classic approaches to convergence identification are most common, i.e. the sigma convergence test and the convergence beta test (unconditional and conditional) [Sala-i-Martin 1996]. The first one consists in analyzing the trends of changes in the level of dispersion of the analyzed economic indicator among regions or countries, which is reduced in the case of convergence (the so-called sigma convergence). Nevertheless, the second approach is based on a linear relationship between the average increase in the indicator in the analyzed period and its initial

level. In the case of negative dependence, regions or countries with a low initial level of the index achieve higher increases, enabling catching up of higher developed regions or countries. Verification of the beta convergence occurrence can be complemented by the study of changes in the ranking of the analyzed objects. This approach is called gamma convergence [Boyle and McCarthy 1997]. It is worth noting that the occurrence of beta convergence is a prerequisite for sigma convergence, however, it is not a sufficient condition [Sala-i-Martin 1996].

Most of theoretical as well as empirical works in the field of convergence in the regional area focus on income convergence. Taking into account the key role of innovation and technical progress in regional development [Strahl 2010, Crescenzi and Rodríguez-Pose 2011] and the importance of regional conditions in innovation processes [Feldman and Kogler 2010], the analysis of convergence of innovativeness at the regional level is an extremely important research problem. According to the assumptions of R&D activity models under the new theory of growth, the processes of knowledge production may be characterized by growing economies of scale, which in turn leads to the "outflow" of technology leaders and income divergence. Assuming Romer's argument [2005], learning processes and knowledge exchange between employees of the R&D sphere can be considered as prospective sources of increasing economies of scale in R&D activity, which allows to obtain the effects of synergy. It should be noted that in accordance with the proximity paradigm, interactive and collective learning is supported by proximity that is understood not only in the geographical dimension (distance in space, physical proximity), but also cognitive proximity (similarity and ability to "speak the same language") and organizational proximity (ability to undertake joint ventures) [Rallet and Torre 2005]. Moreover, the use of the current knowledge base for the production of new knowledge may lead to a situation where regions having a technological advantage will remain in a favorable position in the future. This assumption is consistent with the concept of path dependence, which indicates the existence of self-reinforcing mechanisms in the development of regions within the framework of determined structures and trajectories [Martin and Sunley 2006].

Nevertheless, the phenomenon of diffusion of knowledge makes it possible to eliminate the technological gap by imitating new solutions by technologically lagging regions. According to the technological gap theory, technologically lagging countries/regions have the potential to launch a catching-up process by implementing modern technological solutions, bypassing R&D, while incurring significantly lower implementation costs, compared to innovators [Gerschenkron 1962]. A prerequisite for making use of the so-called Veblen–Gerschenkron effect by regions with a low level of innovation is their ability to absorb innovations. As suggested by Döring and Schnellenbach [2006], new knowledge in a form of innovation is more easily absorbed by regions with a threshold level of knowledge resources and human capital. For example, Englmann and Walz [1995] developed a theoretical model, according to which lack of mobility of one of the production factors used in the production of capital goods with a high level of technological advancement prevents diffusion of knowledge and initiation of production of this good in a technologically lagging region. Considering the ability to create and imitate innovations, Niedzielski [2011] indicates the existence of three types of territorial systems, which include:

- regions capable of generating innovation;
- regions incapable of generating innovation but capable of absorbing and diffusing them;
- regions that have neither the ability to innovate nor imitate.

The effect of the occurrence of convergence processes of the level of innovativeness of objects in a specific regional space is the disappearance of the diversity between the specified territorial systems. In turn, confirmation of the so-called Gerschenkron's reverse hypothesis are divergence processes. As Kubielas [2009] notes, if it is true that at the sectoral level, national (regional) productivity and research capital are the conditions of effective absorption (knowledge, technology), the diffusion of technology on the international scale will lead to divergence rather than convergence.

Based on the considerations made, the following research question can be posed:

Are there any convergence processes in the field of innovativeness in the European regional space?

RESEARCH DATA AND METHODS

The source of data on the level of innovativeness of European regions is the RIS, which characterizes the innovation potential and innovation results of 220 regions from 22 European Union countries, as well as Norway, Serbia and Switzerland. The scope of the study covers the years 2009–2017.

To measure the region's innovation, a synthetic index representing the average of 18 standardized partial indicators was used. According to the eighth edition of the RIS, partial indices characterizing the level of innovation of European regions can be classified into four groups. The first one is referred to as framework conditions and includes indicators of population with higher education, participation in lifelong learning, international publications and the citations of scientific publications. The second group of indicators refers to investment in innovation and includes data on R&D expenditures in the private and public sector as well as other expenditures on innovation in small and medium-sized enterprises. Another set of indicators is characterized by innovation activity and concerns the tendency to introduce various types of innovations in small and medium-sized enterprises, undertaking cooperative activities, public-private partnerships, patent applications, design and trademarks applications. The last group are impact indicators that relate to employment and exports in the high/medium technologies sector and revenues from the sale of new products.

The σ convergence study was based on the standard deviation of the natural logarithms of the y_{it} innovation measure in the period t ($t = 1, 2, ..., T$) calculated according to the formula:

$$\sigma_t = \sqrt{\frac{\sum_{i=1}^{N}(\ln y_{it} - \ln \bar{y}_t)^2}{N}}$$

where: i – region's index (for $i = 1, ..., N$);
$\bar{y}_t$ – average level of the indicator in the considered group of regions in year t.

Decreasing trend of the standard deviation of the natural logarithms of the innovation measure confirms the occurrence of σ convergence.

In addition to the σ convergence measurement, the assessment of the occurrence of gamma convergence

was made. For this reason, the Kendall rank concordance coefficient was used with the following form:

$$RC_t = \frac{\text{variance}\left[\sum_{t=0}^{T} AR(Y)_{it}\right]}{\text{variance}\left[(T+1) \cdot AR(Y)_{i0}\right]}$$

where: $AR(Y)_{it}$ – rank of the studied region and in terms of the examined feature in time t;
T – interval between the first and the last test period;
$T + 1$ – number of years of study;
$AR(Y)_{i0}$ – rank of the studied region and in terms of the examined feature in the initial period $t = 0$.

The Kendall rank concordance coefficient assumes values in the interval <0; 1>. The hypotheses about the occurrence of (H_0) or the absence of (H_1) γ convergence can be expressed as follows:

$H_0 : RC_t = 0$

$H_1 : RC_t \neq 0$

In order to test the significance of the Kendall rank concordance coefficient, the following statistic test was used:

$$\chi^2 = T(N-1)RC_T$$

where: T – number of years of study;
N – number of regions.

RESULTS AND DISCUSSION

The results of the standard deviation calculations for the natural logarithms of the innovation measure are given in Table 1, and the graphical presentation together with the trend function is shown in Figure 1.

Based on the obtained results, it can be concluded that in 2009–2017 there was a slight upward trend in the standard deviation of the natural logarithms of the innovation indicator, which proves the occurrence of sigma divergence processes in the group of the analyzed regions. Confirmation of the observed regularity is a positive sign and significance of the coefficient on the time variable for the determined trend function.

When interpreting the results, it should be noted that they are in line with the results of the analyzes

Table 1. Values of standard deviations (*SD*) of natural logarithms of the innovation measure and their dynamics in the group of analyzed regions in 2009–2017

Year	SD	Chain index
2009	0.43	–
2011	0.42	0.99
2013	0.43	1.02
2015	0.47	1.08
2017	0.45	0.97

Source: Own elaboration.

carried out by Veugelers [2017], which investigated the processes of convergence of innovative capacities of EU countries in 2008–2015. As the author of the study points out, the level of heterogeneity of innovative capabilities of the examined objects in the analyzed period was high, yet, at the same time it did not show strong divergence. Importantly, high heterogeneity concerned all of the components of the innovative capacities of the EU countries, the diversification being the highest in the case of intensity of research and development works. It should be noted that different trends occurred in the years 1999–2006, as indicated by the study carried out by Strahl [2011]. In accordance with the results obtained in the European regional space, there have been favorable transformations in the area of innovation development, as in separate groups of countries, inter-regional disparities on the NUTS-2 level have been limited.

According to the adopted research procedure, the next stage of the analysis was to assess the occurrence of gamma convergence. As Boyle and McCarthy note [1996], based on sigma convergence research only, one cannot answer the question: do regions with low initial level of innovation catch up with more innovative regions? Analyzing data from 2009–2017, it can be concluded that most of the regions belonged to innovation followers or moderate innovators. The group of leaders was the most numerous in 2013, and in subsequent years its number began to decrease. As for modest innovators, they were the least numerous group among the studied regions (Table 2). In 2017, all regional leaders were in total in 11 countries. The most innovative region in the European Union was Stockholm, followed by Havedstaden and the south-east region in Great Britain. The majority of innovation leaders and strong innovators were located in the so-called Old Union. Moderate and modest innovators belonged mainly to the so-called New Union and countries of Southern Europe.

Table 3 contains the values of the Kendall concordance rank coefficients. The obtained results indicate the lack of gamma convergence in terms of the level of innovativeness in the European regional space. The calculated values of empirical statistics χ^2 exceed the critical values on the significance level $\alpha = 0.01$ adopted in the study.

Looking for the reasons for the absence of significant changes in the position (rank) of the regions
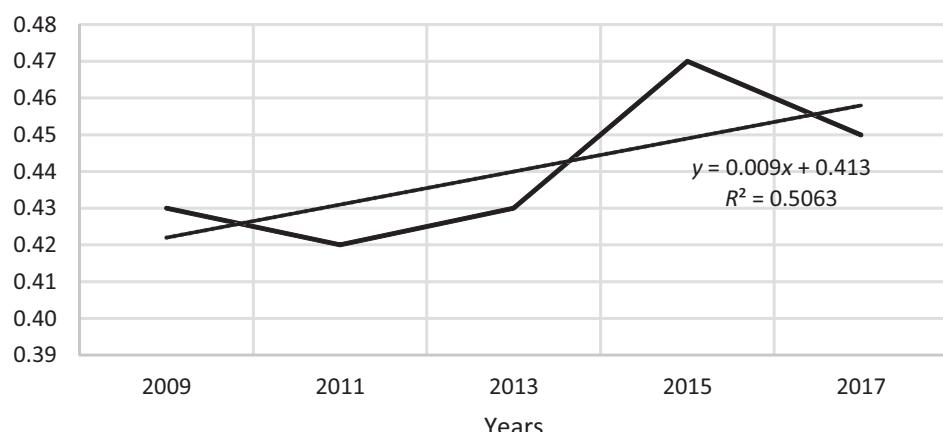

$$y = 0.009x + 0.413$$
$$R^2 = 0.5063$$

Fig. 1. Standard deviations (*SD*) of natural logarithms of the innovation index and trend function

Source: Own elaboration.

Table 2. Distribution of groups of regions with different levels of innovation

Year	Innovation leaders[a]	Innovation followers[b]	Moderate innovators[c]	Modest innovators[d]
2009	49	63	82	26
2011	48	65	80	27
2013	60	53	83	24
2015	54	58	76	32
2017	53	60	85	22

[a]Regions with a relative performance more than 20% above the EU average, [b]regions with a relative performance between 90 and 120% of the EU average, [c]regions with a relative performance between 50 and 90% of the EU average, [d]regions with a relative performance below 50% of the EU average.

Source: Own elaboration.

Table 3. Values of Kendall concordance rank coefficients

Year	Value
2009	1.000
2011	0.994
2013	0.991
2015	0.988
2017	0.984

Source: Own elaboration.

examined due to the level of their innovativeness, it is worth referring to the concept of the path dependance. According to this concept, the trajectory of innovation (new knowledge) development processes depends on the initial resource of knowledge and system-institution conditions. Thus, it can be expected that regions with a high initial level of innovativeness are developing more dynamically than regions lagging behind in terms of innovation capabilities. Confirmation of this thesis can be found in Markowska's research [2014], according to which, there is a tendency to strengthen European regions in the positions of both leaders and outsiders in the field of innovation. Her calculations show that there is a relationship between the average value of the innovation rate and the rate of change, which indicates the presence of self-reinforcing effects.

CONCLUSIONS

The theoretical considerations and their results of empirical research carried out in the work allow to draw the following conclusions:

1. Innovativeness of the region is most often identified with the concept of innovative capabilities, which should be based on the functioning of the regional innovation system. The measurement of the region's innovation capacity should include indicators of the input to innovative activity and indicators of the effects of innovative activity in a specific territorial space.

2. The results of research indicate that in 2009–2017 there was a slight upward trend in the standard deviation of the natural logarithms of the innovation indicator, which confirms the occurrence of sigma divergence processes in the group of analyzed European regions. In addition, there was no gamma convergence in the level of innovativeness in the European regional space. The observed regularities question the effectiveness of the current EU development strategy, i.e. *Europe 2020. A Strategy for Smart and Sustainable Development Fostering Social Inclusion*.

3. Further research work on the assessment of the diversification of the level of innovative capability of European regions should focus on club convergence and take into account the analysis of the dispersion of sub-indices characterizing the region's innovation.

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INNOWACYJNOŚĆ EUROPEJSKIEJ PRZESTRZENI REGIONALNEJ: KONWERGENCJA CZY DYWERGENCJA?

STRESZCZENIE

Celem artykułu jest ocena konwergencji innowacyjności regionów europejskich szczebla NUTS-2. W pierwszej części pracy zdefiniowano pojęcie innowacyjności regionu i przedstawiono sposoby jej pomiaru. Następnie omówiono uwarunkowania i przesłanki konwergencji/dywergencji innowacyjności w przestrzeni regionalnej. Rozważania teoretyczne sugerują, że problematyka konwergencji w zakresie innowacyjności jest istotnym, ale relatywnie słabo rozpoznanym obszarem badawczym w literaturze ekonomicznej. W części empirycznej opracowania przedstawiono wyniki badania konwergencji innowacyjności typu sigma i gamma w grupie regionów europejskich. Próba badawcza składa się z 220 regionów z 22 państw Unii Europejskiej, a także Norwegii, Serbii oraz Szwajcarii. Uzyskane wyniki wskazują na występowanie procesów dywergencji typu sigma oraz brak zachodzenia procesów gamma konwergencji.

Słowa kluczowe: region, rozwój regionalny, innowaje, innowacyjność, konwergencja