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Innovative Endeavors and Economic Development from the Regional Perspective

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Abstract

The paper discusses innovation-related issues as being factors of economic development of voivodships. The first part takes a close theoretical look at the essence of innovation and economic development, while highlighting the impact of innovation and innovativeness on regional socio-economic development. The second part is devoted to empirical application of taxonomic methods in ordering of objects to enable the ranking of voivodships regarding their levels of innovation and economic development. This part of the article is an attempt to evaluate the mutual dependency of both rankings of Poland voivodships. The objective of the current study is to determine the ranking of Poland's voivodships in respect of their levels of economic innovativeness, and economic growth as well as to evaluate the relationship between both phenomena.

Keywords: region, innovation, economic development, taxonomic methods

JEL: C38, O18, O30

Introduction

Innovation is, according to the definition proposed by Drucker (1992, 36), a qualitative difference acceptable to the populace. Both innovativeness and innovation are currently being considered, along with knowledge and human capital, as one of the most important factors of economic growth and development. The most important pre-requisites of economic development besides innovation and knowledge is wealth, the structure of the national economy and its mechanism of existence, the quantity, quality and distribution of goods and services as well as the state of the natural environment have also been considered the most important pre-requisites of economic development besides innovation and innovativeness (Smith, Campbell, and Skinner 1976). Proving that innovation is a dominant driving force of economic development has continued to pose difficulties. According to Prandecki (2013, 12) there is no clear evidence of the impact of innovation on economic development. This statement is the inspiration to undertake research studies assessing the existence of the links between innovation and economic growth from a regional perspective.

The objective of the current study was twofold: (1) to identify and classify the level of innovation and economic growth of Poland's voivodships, based on the NUTS-2 for 2005 and 2014 as well as (2) to analyze existing dependencies between innovation and economic growth of the voivodships. The research objective was implemented using Hellwig's synthetic development indicator as well as the Rank Spearman's coefficient of correlation.

1 Economic development vs innovativeness — theoretical treatise

Economic development embodies both on-going quantitative changes in the economy in terms of increases in basic macroeconomic indicators such as production, employment, investments, size of functional capital, incomes and consumption, as well as qualitative changes in respect of the socio-economic system, organization of civil societies, including other aspects of the economic framework

(Kwiatkowski 2006, 280). Qualitative changes, on the other hand, cover technical and technological advancements, improvements in economic network systems, including its links with the global economy, increases in employee qualifications, changes in the economic pattern aimed at modernization, increases in levels of micro- and macro-economic efficiency, the emergence of new products as well as improvement of existing ones. Development is, therefore, a composite quantitative growth and qualitative advancements in social, economic and natural systems (Markowski 2008, 13).

Economic development is strongly correlated with regional development. If regional development were to exist and be effective from the economic, social and ecological view-point, it ought to be based on local growth factors, local entrepreneurship, ecological sustainability and regional openness. Energy security and self-sufficiency, especially that based on renewable sources of energy is equally of great significance (Kuciński 2010, 22). The set of contemporary factors responsible for regional development can, according to another classification, be divided into three groups:

- technical infrastructure, namely facilities available in the region, including access to equipment, water supply and sewage, electricity, gas, central heating, telecommunications, computer, transport networks, including environmental protection, etc.;
- human capital — availability of skilled human resources and educated workforce, access to educational offers that enables lifelong learning as well as adaptation to the changing demands of the labour market; and
- "soft factors," that include social capital and innovation; the creation of favorable conditions for growing a knowledge-based economy, access to new technologies, diffusion of innovation, organizational culture and institutional facilities (Churski 2008, 33).

Socio-economic development in a market economy is mainly determined on the basis of the competitiveness of applicable technologies, organizational solutions, manufactured goods and services, etc. As competition is an inherent feature of modern development, it necessitates innovation and changes, which serve as creative responses to emerging opportunities and market challenges (Drucker 1992, 37).

Innovation, from the economic sciences point of view, can be treated narrowly or widely. The narrow perspective view associates innovation with changes in products and methods of production. In the wider perspective, however, innovation embodies technical and economic undertakings, namely the introduction of a new or significantly improved product, the introduction of new or significantly modernized production methods, the introduction of crucial organizational changes, the creation of new markets or new methods of sales, the use of new raw materials or new purchasing methods (Haffer 2009, 138).

In terms of the subject matter of innovation, the following component can be distinguished:

- product innovation
- process innovation
- social innovation
- economic innovation
- finance innovation
- organizational innovation (Koźmiński 2004, 105)

Innovation does emerge through the proper use of knowledge. The proper management and application of knowledge cannot be underrated, the consequence of which is intellectual capital and the appropriate utilization of the emerging outcomes of the use of such resources (Bogdanienko and Kuzel 2009, 407).

Zastempowski (2009, 441–447) distinguishes the following group of factors in the development of innovative potentials:

- economic requirements, namely economic conditions, the internationalization of the Polish economy, exchange rate stability, level of foreign investments, accessibility of foreign investments, unemployment rate, decisions of the Monetary Policy Council concerning interest rates, inflation rate and Energy costs)
- political and legislative requirements, namely legal stability and clarity of rules, stability of tax and administrative regulations, level of tax relief, innovation oriented policies, government

procurement, anti-trust policy, environmental protection policy, customs policy, the impacts of trade unions and bureaucracy
- socio-cultural and demographic requirements, namely level of education, work ethic, labor mobility, lifestyle, beliefs and norms of behavior, migration
- international requirements, namely integration with the EU, processes of globalization, the level of competition in international markets, forms of protection of national markets
- technological requirements, namely speed of transfer of techniques and technologies, pace of emergence of new inventions, patent protection, government policy on R&D, patenting procedures
- geographical requirements, namely geographic location, state of the infrastructure, access to natural raw materials, state of the natural environment

The issue of innovation as a strategic component in the processes of economic growth and development was first proposed by Schumpeter (1934) in his seminal work entitled *The Theory of Economic Development* (see: Piech 2009, 135–137). He emphasized the importance of entrepreneurship as the driving force of economic growth. Entrepreneurs, on the other hand create technical and financial innovation, faced with competition and dwindling profits. This leads to economic fluctuations, namely growths and declines thus creating business cycles. Schumpeter demonstrated relationships between business cycles and economic growth, thus creating the concept known as waves of innovation. Key innovations are, in accordance with this theory, the driving force of economic development and do occur cyclically (Schumpeter 1960).

Both innovativeness and innovation are together with knowledge and human capital currently considered as one of the most significant factors of economic growth and development. Regional development, according to Brol (2006, 16–17) is an on-going social and economic transformation process within voivodships which is attributable to three sets of factors namely, endogenous, exogenous and those defining the region's response ability to changes in the macro-environment. Innovation is observable in all three set of factors influencing regional economic development, namely:
- as an endogenous factor — the ability to create and innovate is a factor that improves and develops the infrastructure, techniques and technologies for the needs of regional entities;
- as an exogenous factor — it constitutes a distinctive impetus for the development and transformation of endogenous resources; and
- as a factor that determines the region's ability to respond to changes in the macro-environment — this being the expression of the vulnerability of entities operating in and for the needs of a given region on the adoption innovative solutions created within the national economy or in other countries (Nowacki 2009, 63).

The growing significance of innovation in contemporary developmental processes is being encouraged by the EU in its innovation policy (Budzyńska-Jatczak et al. 2002), which has been recognized as an essential component in building and developing a knowledge-based economy (Dyjach 2011, 219). However, innovation has not always generated high interests among researchers. Researchers have often focused their studies on long-term economic changes, relying on market performance indicators without applying innovation-related indicators. This trend is currently witnessing changes. Studies concerning the role of innovation, both in economic and social transformation, has grown in popularity in recent years. The concept of regional innovation systems is increasingly growing in popularity, thus constituting a reason for the re-discovering of the significance of regional scale and of specific regional resources in creating regional innovation and competitiveness. Regional development is the result of competition in places where local resources such as knowledge and skills, including its underpinning institutions and structures exist (Doloreux and Parto 2005, 133–134).

Arguments in support of the opinion that innovation is the dominant causal force of economic development remains difficult. Several studies do indicate the non-existence of dependencies between economic growth and development and innovativeness. Examples include work of Denison (1962) which postulates that massive R&D expenditures brings about insignificant benefits. Huebner (2005), on the contrary, posit it that innovation-related development has gone to its final phase. The Economist in 2013, however, concludes that Huebner's theory was premature.

Poland is one of the least innovative countries in Europe. This has been due to the slow pace of scientific adjustments, lack of understanding regarding the significance of innovation in sustainable economic competitiveness as well as lack of faith in Poland's innovative capacity (Golonka and Rychcińska 2013). In addition, several publications (including: Dyjach 2011; Jegorow 2016; Klóska 2014; Ratajczak 2008) have signaled extensive disparities in levels of innovativeness across various regions in Poland. The aforementioned arguments contributed to the decision to undertake, in the current study, an assessment of existing dependencies between innovation and economic growth from the regional perspective.

2 Empirical Material and Research Methodology

Economic growth and innovation are examples of two phenomena that can neither be observed directly nor measured using just one indicator. The multi-dimensional approach is widely adopted as a descriptive tool for such phenomena. Thus, this approach was also adopted in the current study. Publicly available statistical data sourced from the Local Data Bank of the Central Statistical Office of Poland (CSO) served as the empirical material. The study makes use of data sourced from 2005 and 2014. Analyses of the collated data was carried out using taxonomic methods for sorting and grouping objects.

Guided by the substantive premise as well as the availability and completeness of the statistical data sixteen indicator-type potential diagnostic variables were initially selected to assess the level of innovation in the various voivodships. The initially adopted list of diagnostic variables was reduced by rejecting a total of 4 variables, due to their low variability and duplication of same information. All quasi-constant variables, namely those variables whose coefficient of variation was less than 10% were eliminated. The Hellwig's parametric procedure for selecting features that allows for the identification of the so-called clusters and isolated features was applied to reduce variables that were weakly correlated with other diagnostic features (Hellwig 1981, 46). The clusters, usually consisting of features, similar to each other due to their high degree of correlation, contain one central feature and a number of satellite features. Those features that lie outside the cluster are referred to as isolated features. Features that are ultimately considered diagnostic are such that are central and isolated. A critical correlation coefficient of 0,7 was thus adopted, using the selective procedure.

Consequently, the taxonomic indicators that enable the assessment of the level of innovation in each voivodship were calculated based on a set of twelve diagnostic variables, namely:

- total external expenditure on R&D per capita,
- percentage of persons employed in R&D in the total active population,
- average share of innovative enterprises in overall number of enterprises,
- expenditure on innovative activities by enterprises in relation to the GDP,
- expenditure on innovative activities by companies per one professionally active person,
- percentage of industrial companies engaged in co-operative activities in areas of innovation relative to the total number of companies,
- percentage of companies in the service sector that co-operated in areas of innovation in overall number of companies,
- industrial companies that made expenditures in innovative activities,
- active research entities per 100 000 people,
- percentage of patents granted for local inventions per 100 000 residents,
- declared local inventions per 1 million inhabitants, and
- percentage of companies with their own websites.[1]

Traditional measurements of economic development are based on the National Accounting System. The most popular measure of levels of development is the Gross Domestic Product. The list of potential diagnostic variables for taxonomic analysis in this study consisted, initially, of 26 variables from which 9 were eliminated as they were considered quasi-constant. This is due to their

1. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

low efficacy in discriminating objects or were carriers of similar information. The resulting set of diagnostic variables is a set of 17 variables, namely:

- GDP per capita (in PLN);
- share of gross added value generated in accordance with grouped sections of the Polish Registry of Businesses (PKD) of 2007 in the overall gross value added (in %):
  - agriculture,
  - industry, civil construction,
  - services,
  - generation of electrical Energy per capita (in MWh),
  - motorway and express roads per 100 km^2 (in km),
  - wheat yields (in dt/ha),
  - percentage of population in retirement age,
  - percentage of innovative enterprises in the service sector,
  - percentage of employed persons according to sectors,
  - agriculture,
  - service;
- percentage of registered unemployment,
- share of monthly expenditures on food and non-alcoholic beverages in overall expenditures per capita (in %);
- infant mortality per 1 000 live births;
- number of medical doctors per 10 000 residents;
- number of hospital beds per 10 000 residents; and
- number of students per 10 000 residents.

All the variables were unified, using these formulas:

- for the stimulant

$$z_{ik} = \frac{x_{ik} - \min_i(x_{ik})}{\max_i(x_{ik}) - \min_i(x_{ik})}, \text{ and} \tag{1}$$

- for the destimulant

$$z_{ik} = \frac{\max_i(x_{ik}) - x_{ik}}{\max_i(x_{ik}) - \min_i(x_{ik})}. \tag{2}$$

Thus, fulfilling one of the leading demands of taxonomic analysis, namely the comparability of variables. Next, the distance of each object (voivodship) from the model as well as the synthetic variable for each voivodship were set:

$$d_i = \sqrt{\sum_{k=1}^{n}(z_{ik} - 1)^2}. \tag{3}$$

A relative indicator of development

$$z_i = 1 - d_i/d_0, \tag{4}$$

where $d_0 = \bar{d} + 2S_d$, that typically assumes value ranges of [0;1] was designed to standardize the synthetic variable. The closer the relative value of the synthetic indicator is to unity, the less the level of development for a given object differs from the model object (Nowak 1990).

The calculated values of the synthetic indicators were applied to divide the voivodships into typological groups, using the following classification pattern:

- class I (high level of the assessed phenomenon): $z_i \geq \bar{z} + S_z$
- class II (medium-higher level of the assessed phenomenon): $\bar{z} \leq z_i < \bar{z} + S_z$
- class III (medium-lower level of the assessed phenomenon): $\bar{z} - S_z \leq z_i < \bar{z}$
- class IV (low level of the assessed phenomenon): $z_i < \bar{z} - S_z$

3 Results of the study

The leader of innovation, in regional terms, selected on the basis of the calculated taxonomic indicators of levels of innovation in Poland's voivodships between 2005 and 2014 (tab. 1) was Mazowieckie Voivodship. The voivodship, especially its capital, Warsaw is considered the management hub and center of implementation of the latest technologies. It is one of Poland's most attractive locations for investments. The Mazowsze region boasts of advanced scientific and research and development potentials, located mainly in the capital city as well as in other major peripheral centers. This area notes the highest, nationwide, expenditures on R&D activities as well as great potentials of institutional environment for businesses centered mainly in metropolitan Warsaw, thus stimulating the region's economic development. The voivodship also boasts of significant economic potentials it inherited from erstwhile provincial capitals like Płock and Radom.

The Śląskie and Dolnośląskie voivodships of which have characteristically developed cities with distinctive metropolitan outlook with numerous industrial centers as well as Małopolskie Voivodship are also ranked high based on their levels of innovation. These regions are known for their abundance of potential professionals and intellectuals, concentration of highly qualified technical and economic staff. These areas also abound with significant academic centers, a well-developed network of scientific research, R&D, and design centers as well as a developed network of the institutional environment for local and regional development. The Śląskie Voivodship is additionally characterized by a high concentration of business and industrial activities as well as a high concentration of foreign investments, while the existence of numerous companies with diversified business profiles has resulted in the growth of cooperative networks.

The Lubuskie and Podlaskie voivodships of were undoubtedly the weakest in terms of their levels of innovation. The Lubuskie Voivodship of, with its observed relatively high ratio of number of businesses per capita as well as the highest recipient of EU supported financing per capita in Poland, displays a meagre percentage of large industrial companies and stands out as one of the weakest participants in the creation of the national GDP. Podlaskie Voivodship, on the other hand, with its clean and less undisturbed natural environment and with its typically agricultural landscape is typified by low economic competitiveness, very low foreign direct investments (FDI) nationally, very low incomes as well as one of Poland's lowest GDP per capita.[2]

The classification of the voivodships in respect of the levels of innovation, relying on estimates of taxonomic indicators resulted in the identification of only three groups, namely those with high, medium-high or medium-low levels of innovation. No low level phenomenon was identified. Only the Mazowieckie Voivodship was rated in the first class, being the highest level of the phenomenon over the two years of the study. The second typological class consisted of the Śląskie, Pomorskie and Wielkopolskie voivodships of in 2005, but by 2014, it was Śląskie, Wielkopolskie, Małopolskie and Zachodniopomorskie voivodships. The other voivodships were classified into the group with medium-low level of innovation.

The average, absolute and relative values of diagnostic features applied in the assessment of levels of innovation, achieved in each topological group of Poland's voivodships (see table 2) for 2014, point to the extensive differentials in the amount of external expenditures on R&D per residuals. The expenditures in the class with the highest level of innovation were 2,5 times higher than the Polish average and were almost nine times higher than the average expenditures in voivodships classified in group III. Significant differences are also observable in respect of level of expenditures on innovative endeavors in companies, the percentage of persons employed in R&D in overall population of the professionally active, number of active research institutions as well as reported and granted patents for local inventions. The differences in levels of expenditures on innovative activities were, nonetheless, stronger than the variation of effects of innovative activities such as the number of reported inventions or granted patents for inventions.

2. See: Strategia rozwoju społeczno-gospodarczego Polski Wschodniej do roku 2020. Ministerstwo Rozwoju Regionalnego, Warszawa, 2013 r. Załącznik do uchwały nr 121 Rady Ministrów z dnia 11 lipca 2013 r. (poz. 641), Monitor Polski Poz. 641.

Tab. 1. Synthetic indicators of levels of innovation in Poland's voivodships in 2005 and 2014

	2005			2014		
Voivodship	z_i	**Rank**	**Group**	z_i	**Rank**	**Group**
Dolnośląskie	0,350	8	III	0,691	2	I
Kujawsko-Pomorskie	0,354	6	III	0,340	10	III
Lubelskie	0,242	15	III	0,218	15	III
Lubuskie	0,242	14	III	0,263	13	III
Łódzkie	0,230	16	III	0,367	7	III
Małopolskie	0,354	7	III	0,409	5	II
Mazowieckie	0,999	1	I	0,999	1	I
Opolskie	0,302	11	III	0,305	12	III
Podkarpackie	0,368	5	III	0,340	11	III
Podlaskie	0,349	9	III	0,246	14	III
Pomorskie	0,479	3	II	0,340	8	III
Śląskie	0,570	2	II	0,435	3	II
Świętokrzyskie	0,243	13	III	0,340	9	III
Warmińsko-Mazurskie	0,346	10	III	0,205	16	III
Wielkopolskie	0,391	4	II	0,412	4	II
Zachodniopomorskie	0,251	12	III	0,395	6	II

Tab. 2. Mean value of diagnostic features adopted for the evaluation of levels of innovation by typological groups of voivodships (and total in Poland) in 2014

Diagnostic features	**Poland**	**I group**	**II group**	**III group**
Total external expenditure on R&D per 1 000 residents	70,02	177,53	38,84	18,56
Percentage of persons employed in R&D in the total active population	0,69	1,55	0,79	0,61
Average share of innovative enterprises in overall number of enterprises	14,11	16,80	14,65	13,82
Expenditure on innovative activities by enterprises in relation to the GDP	1,82	4,59	1,70	1,63
Expenditure on innovative activities by companies per one professionally active person	1 436,72	4 648,00	2 334,00	1 051,66
Percentage of industrial companies engaged in co-operative activities in areas of innovation relative to the total number of companies	5,26	5,40	5,70	5,18
Percentage of companies in the service sector that co-operated in areas of innovation in overall number of companies	2,52	4,90	2,75	2,30
Industrial companies that made expenditures in innovative activities relative to the total number of companies	13,60	14,45	13,72	13,52
Active research entities per 100 000 people	6,96	14,90	8,80	6,06
Percentage of patents granted for local inventions per 100 000 residents	5,23	8,60	9,30	4,35
Declared local inventions per 1 million inhabitants	94,96	178,40	123,70	84,12
Percentage of companies with their own websites	63,76	71,70	67,65	62,55

The relatively highest level of economic development during the two periods of research was achieved in Mazowieckie Voivodship (tab. 3). This was the only voivodship classified in the group of voivodships with a high level of economic development in 2014. The Dolnośląskie and Małopolskie voivodships which also belonged to this group in 2005, were in 2014 classified in the group of

voivodships with a medium-high level of economic development. It is worth mentioning that none of the other voivodships changed their classifications in typological groups between 2005 and 2014. Other voivodships also classified in this group of medium-high level of economic development besides those already mentioned were Łódzkie, Pomorskie, Śląskie, Wielkopolskie, and Zachodniopomorskie voivodships while the Kujawsko-Pomorskie, Opolskie, Lubelskie, and Lubuskie voivodships were classified into the medium-low level group. The group with the lowest level of economic development consisted of the eastern flank voivodships, namely Podkarpackie, Świętokrzyskie, Podlaskie, and Warmińsko-Mazurskie voivodships.

Tab. 3. Synthetic indicators of economic development of Polish voivodships in 2005 and 2014

	2005			2014		
Voivodship	z_i	**Rank**	**Group**	z_i	**Rank**	**Group**
Dolnośląskie	0,397	2	I	0,305	7	II
Kujawsko-Pomorskie	0,153	11	III	0,221	9	III
Lubelskie	0,140	12	III	0,163	11	III
Lubuskie	0,174	10	III	0,162	12	III
Łódzkie	0,240	8	II	0,329	6	II
Małopolskie	0,351	3	I	0,359	2	II
Mazowieckie	0,436	1	I	0,509	1	I
Opolskie	0,225	9	III	0,191	10	III
Podkarpackie	0,083	15	IV	0,091	16	IV
Podlaskie	0,106	13	IV	0,107	13	IV
Pomorskie	0,343	4	II	0,354	3	II
Śląskie	0,311	5	II	0,335	5	II
Świętokrzyskie	0,104	14	IV	0,093	15	IV
Warmińsko-Mazurskie	0,082	16	IV	0,099	14	IV
Wielkopolskie	0,305	6	II	0,291	8	II
Zachodniopomorskie	0,296	7	II	0,336	4	II

The comparative illustration of the average, absolute and relative values of the diagnostic features adopted for the assessment of economic development in each typological group of voivodships (tab. 4) does not indicate such strong disparities as was observed in the case of innovation. The strongest differentiation was observable in the level of GDP per capita, which in the case of voivodships in the class I was 175,4% of the national average, whilst that for class IV was less than 80%. A significant disparity was also observable in the proportion of innovative enterprises in the service sector, the number of students as well as doctors per 10 000 residents.

In comparing the grouping of voivodships into typological classes, based on the level of innovation and economic development, great similarities can easily be observed. The existing relationship between the ranking of voivodships relative to the phenomenon being studied was also corroborated by the value of Spearman's rank correlation, which for the 2005 classifications attained a value of 0,74, while for 2014 it was 0,75. The results thus obtained unequivocally confirm the significant impact of innovative activities on the level of economic development. The existence of impacts of economic development on innovation is undeniable bearing that the coefficient of correlation between the indicator of economic growth for 2005 and that for 2014 was assessed at 0,85.

Considering the fact that the feature that most strongly differentiates the typological groups of voivodships in respect of their innovativeness was expenditure on R&D, it can be concluded that the level of financing for innovative endeavors most strongly impacts the level of development of the voivodships.

Tab. 4. Mean value of diagnostic features adopted for the assessment of economic development by typological groups of voivodships (and total in Poland) in 2014

Diagnostic features	Poland	I grup	II group	III group	IV group
GDP per capita (in PLN)	38 049,38	66 755,00	41 257,00	33 081,00	30 228,00
Share of gross added value generated in agriculture section of the Polish Registry of Businesses (PKD) of 2007 in the overall gross value added (in %)	3,84	2,80	2,70	4,75	5,18
Share of gross added value generated in industry, civil construction section of the Polish Registry of Businesses (PKD) of 2007 in the overall gross value added (in %)	34,58	24,70	36,67	34,90	33,08
Share of gross added value generated in services section of the Polish Registry of Businesses (PKD) of 2007 in the overall gross value added (in %)	61,57	72,50	60,61	60,35	61,73
Generation of electrical Energy per capita (in MWh)	3,99	4,17	5,36	3,33	2,21
Motorway and express roads per 100 km^2 (in km)	0,83	0,59	1,25	0,70	0,29
Wheat yields (in dt/ha)	40,51	35,20	41,36	45,08	35,80
Percentage of population in retirement age	0,18	0,19	0,18	0,18	0,17
Percentage of innovative enterprises in the service sector	10,66	16,86	11,46	10,02	8,35
Percentage of employed persons in agriculture sector	0,23	0,17	0,17	0,25	0,34
Percentage of employed persons in service sector	0,49	0,64	0,53	0,47	0,42
Percentage of registered unemployment (in %)	14,57	10,70	13,06	15,65	17,10
Share of monthly expenditures on food and non-alcoholic beverages in overall expenditures per capita (in %)	0,26	0,21	0,25	0,26	0,29
Infant mortality per 1 000 live births	4,73	4,30	4,74	5,33	4,23
Number of medical doctors per 10 000 residents	45,19	61,06	46,83	42,84	40,69
Number of hospital beds per 10 000 residents	48,49	49,53	48,38	48,39	48,52
Number of students per 10 000 residents	400,44	589,00	450,57	336,75	329,25

Tab. 5. Rank Spearman's correlation coefficient between the ranking of voivodships in respect of their levels of innovation and economic development in 2005 and 2014

		Levels of innovation		Economic development	
		2005	2014	2005	2014
Levels of innovation	2005				
	2014	0,54			
Economic development	2005	0,74	0,85		
	2014	0,51	0,75	0,91	

Note: All correlation coefficients are significant at $p < 0,05$ level

Summary and Conclusions

Relying on literature studies as well as the results of the current research, the paper is a confirmation of the thesis that innovation and innovativeness are, in present times, the most significant factors of growth and economic development. Innovation in general, and in particular crucial innovations, serve as the drivers of economic growth. The taxonomic methods for classifying objects applied by the authors has enabled the ranking of the voivodships in respect of their levels of innovation and economic development. The ranking was consistent in both instances, namely those voivodships that occupied higher positions in the innovation ranking were also ranked in similar positions in respect of economic development. This was substantiated by the comparative analysis as well as the objective coefficients of rank Spearman's correlation. It is worth noting, however, the existence of a two-way dependency, which on the one hand is innovation contributing to economic growth, while on the other the necessity of favorable levels of economic development to produce inventors and innovation.

The list of voivodships that were characterized by both high level of innovation and economic development includes Mazowieckie, Dolnośląskie, Śląskie, and Małopolskie voivodships. The worst in this category are voivodships from the eastern flank. Analogically, voivodships with most favorable environmental and social-economic conditions are marked by higher levels of innovation and economic development, while existing disproportions between the voivodships are generated, likewise or first and foremost, by the concentration of financial expenditures in areas that offer the greatest impacts, while the less attractive areas remain marginalized.

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