THE INNOVATION SYSTEM AS A PILLAR FOR A KNOWLEDGE-BASED ECONOMY – AN ANALYSIS OF REGIONAL DIVERSITY IN POLAND

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A b s t r a c t

The objective of the study was an evaluation of the regional diversity of the innovation system in Poland and changes which took place in this realm between 2009 and 2014. In the study, numerical taxonomy methods were used. A synthetic innovation index was built with the use of the non-model method. The results of analyses may be summarised as follows: regional disparities in the level of the innovation system in Poland have slightly decreased; however, they are still at the average level. This is confirmed by the value of the variability index, which dropped from the level of 31.6% in 2009 to the level of 29.9% in 2014. Regional convergence in the area of the innovation system was accompanied by internal convergence and divergence processes occurring in parallel in provinces. Internal convergence processes were observed in 11 provinces, and internal divergence processes were observed in the remaining five provinces, yet in the case of three of them, i.e. Kujawsko-Pomorskie, Świętokrzyskie and Warmińsko-Mazurskie, such processes had a marginalising effect.

SYSTEM INNOWACJI JAKO FILAR GOSPODARKI OPARTEJ NA WIEDZY – ANALIZA STANU ZRÓŻNICOWANIA REGIONALNEGO W POLSCE

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A b s t r a k t

Celem badań była ocena zróżnicowania regionalnego systemu innowacji w Polsce oraz zmian jakie zaszły w tym zakresie w latach 2009–2014. W badaniach wykorzystano metody taksonomii numerycznej. Syntetyczny wskaźnik systemu innowacji zbudowano z wykorzystaniem metod bez-wzorcowych. Wyniki analiz można podsumować następująco: regionalne dysproporcje w poziomie systemu innowacji w Polsce nieznacznie się zmniejszyły, nadal utrzymują się jednak na poziomie średnim. Potwierdzeniem tego jest m.in. wartość współczynnika zmienności, która z poziomu 31,6% w 2009 r., obniżyła się do poziomu 29,9% w 2014 r. Regionalnej konwergencji w zakresie systemu innowacji towarzyszyły równolegle zachodzące procesy konwergencji i dywergencji wewnętrznej województw. Procesy o charakterze konwergencji wewnętrznej obserwowano w jedenastu województwach, procesy dywergencji wewnętrznej w pozostałych pięciu, przy czym w przypadku trzech z nich: kujawsko-pomorskiego, świętokrzyskiego i warmińsko-mazurskiego, procesy te miały charakter efektu marginalizacji.

Introduction

According to the World Bank definition, the knowledge-based economy (KBE) is a type of economy where knowledge is created, acquired, transferred and used more effectively by enterprises, organisations, individuals and communities for greater economic and social development (DAHLMAN, ANDERSSON 2000, p. 32). Building a knowledge-based economy is closely related to the growth of innovation in the economy, increased significance of areas intensely using technology, and a highly qualified labour force (NOWAKOWSKA et al. 2011, p. 10). Such an economy is based on research and development activity, and innovations which lead to the modernisation of the economy and increased productivity, which, in turn, determines the volume of generated income (CZYŻ 2009, p. 79).

Four pillars are of key significance for the development of the KBE: a system of economic and institutional incentives, educated and skilled workers, an effective innovation system, and a modern and adequate information structure.

The third of the above-listed pillars of the KBE[1] – the innovation system – refers to the network of institutions, principles and procedures which influence the manner in which the economy purchases, generates, distributes and uses knowledge (CHEN, DAHLMAN 2006, p. 6). It may be defined as all public and private institutions that are inter-connected and that voice a demand for innovations, implement innovative projects, commercialise the results of R&D work, and influence the diffusion of innovations (KASPER-KIEWICZ 2014, p. 87). The institutions forming a part of the innovation system include (WERESA 2012, p. 34):

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[1] The remaining pillars of the KBE will be the object of separate studies in a series of articles regarding the issue of regional varieties of the KBE in Poland.

– enterprises, especially these which invest in innovative activity;

– universities and research institutes pursuing scientific studies;

– public and private institutions involved in general and vocational education;

– governmental institutions that finance, support and regulate innovative processes.

In other words, the innovation system is made up of mutually-engaged enterprises, scientific and research centres, universities, knowledge incubators and other organisations which may contribute to expanding the volume of knowledge, adapting it to local needs, and generating new products and services, technologies and methods of conducting business (SOKOŁOWSKA--WOŹNIAK 2006, p. 105). The operation of such a system relies on innovative processes occurring in enterprises and on the expanding of processes into other entities in sectors and regions, as well as on the shaping of such processes – mainly via state policy – at the national level (ZORSKA 2012, p. 33). Institutions that create the innovation system, form regional or even global research and innovation networks, and make skilful use of the growing knowledge resources thereby contribute to their development, commercialisation and market application (MADRAK-GROCHOWSKA 2013, p. 361). Cooperation among entities that make up the innovation system is beneficial for all of them, as it offers an opportunity for mutual learning and joint activities, and also creates social capital activating their work in a given system (SOETE et al. 2010, p. 1167).

An efficient innovation system is a system which creates an environment conducive to the conduct of research and development activity, leads to generation of new products, new processes and new knowledge, and thence is the main source of technical progress (CHEN, DAHLMAN 2006, p. 6). An efficient innovation system creates new technologies and enables efficient adaptation of the existing knowledge (ŻELAZNY 2006, p. 249). Proper management of innovative knowledge determines the use of knowledge resources and the creation of new knowledge (NOWAKOWSKA et al. 2011, p. 32). Therefore, an efficient innovation system is a system that enables efficient use of the existing resources of knowledge, the creation and distribution of new knowledge, and its transformation into innovations and the development of new technologies. The efficient innovation system should function both at the national level, as well as the regional level. Innovations are one of the factors influencing the modern diversity of the level of economic development. The spatial dimension of the innovation system is gaining increasing importance.

In the light of the above, the objective of the research was an evaluation of the regional innovation system in Poland, along with changes that took place in this respect between 2009 and 2014. An attempt was made to answer the

following question: *Do the changes taking place with respect to the regional diversification of the innovation system in Poland have the character of regional convergence or divergence processes?* The proposal for answering this research question was contained in the following research hypothesis: *Regional diversification of the innovation system in Poland is decreasing; thence, the process of regional convergence is taking place in this respect.*

The research was performed at the regional NUTS II level. The method of linear ordering was used, based on the synthetic variable and the method of grouping linearly ordered items. The time range of the study encompasses the period from 2009 and 2014, and was determined by the absence of complete and comparable data from the previous years for the variables selected for the study.

Study Methodology

In line with the Knowledge Assessment Methodology (KAM) developed in 1998 by World Bank experts, measurement of the knowledge-based economy takes place on the basis of numerous variables representing individual pillars of the KBE. Determinants of innovation taken into account in the above-mentioned methods include such variables as (CHEN, DAHLMAN 2006, p. 38, GORJI, ALIPOURIAN 2011, p. 49–54, UJWARY-GIL 2013, p. 165–168, *Measuring Knowledge...* 2016, p. 3):
   – number of academic employees in the R&D sector;
   – number of academic articles in academic and technical journals;
   – patent applications granted by the United States Patent and Trademark Office (USPTO);
   – expenditure on R&D as a percentage of GDP;
   – level of enrolment to technical and nature studies;
   – fees for licence usage;
   – export of technologically-advanced products.

In the reference literature on the subject it is possible to find numerous studies on the KBE and its individual pillars conducted on the basis of modified sets of variables as compared to the KAM (cf.: CHOJNICKI, CZYŻ 2003, KUKLIŃSKI, BURZYŃSKI 2004, PIECH 2006, STRAHL 2009, DWORAK 2012, *Regionalne Systemy Innowacji...* 2013, DWORAK et al. 2014, SKRĘTOWICZ, KOŻUCH-PROKOPIUK 2015). When choosing the variables, the authors tried to select those variables that describe the examined phenomenon best and were adequate to the level of the performed analysis (not all variables proposed in the KAM are available at the regional level). Furthermore, the authors were guided by the availability of data for the adopted research period.

In line with the definition adopted by the author of this paper, the system of innovations is made up by entities cooperating with respect to the creation, diffusion and use of knowledge. Therefore, the innovation system refers to the level of innovation of companies, and the research centres, universities and other organisations collaborating with them in such a system. At the stage of selecting variables, the author tried to choose those variables which corresponded to the adopted definition best. The author also selected the variables with respect to statistical issues (variability of variables and the degree of correlation with other variables). The final set of diagnostic variables on the basis of which the synthetic index describing the innovation system in provinces was built included the following variables:

– X_1: number of units which pursue R&D activity per 10,000 entities of the national economy entered in the National Official Register of Business Entities;

– X_2: level of internal expenditure incurred in R&D activity in conversion per capita;

– X_3: number of persons employed in R&D in a full-time equivalent (FTE) in conversion per 1,000 professionally active people;

– X_4: percentage of industrial companies which invested in innovation activity;

– X_5: share of net revenues from the sale of innovative products in industrial companies in total net sales revenues;

– X_6: industrial companies cooperating as part of a cluster initiative or other formalised cooperation in the percentage of innovation-active companies;

– X_7: number of companies possessing funds for the automation of production processes per 10,000 entities of the national economy entered in the National Official Register of Business Entities;

– X_8: patents granted by the Patent Office of the Republic of Poland in conversion to 1 million residents;

– X_9: share of human resources for science and technology[2] in the professionally active population;

– X_{10}: percentage of students pursuing technical and nature studies.

Synthetisation of variables was conducted with the use of non-model methods which consist in averaging the values of normalised variables. The normalisation of variables was performed with the use of the zeroed unitarisation procedure. On account of the fact that all variables were assigned with the character of stimuli[3], the procedure was performed according to the following formula (PANEK, ZWIERZCHOWSKI 2013, p. 37):

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[2] Total number of persons currently involved or potentially involved in work related to the development, distribution and application of scientific and technical knowledge.

[3] The character of diagnostic variables was assessed on the basis of substantive premises. Verification of the adopted character of variables was performed *ex post*, checking the correlation of individual variables with the synthetic variable.

$$z_{ij} = \frac{x_{ij} - \min_{i}\{x_{ij}\}}{\max_{i}\{x_{ij}\} - \min_{i}\{x_{ij}\}} \qquad i = 1,2, ..., n; j = 1,2, ..., m \qquad (1)$$

where:

z_{ij} – normalised value of the jth diagnostic variable in the ith object,

x_{ij} – value of the jth diagnostic variable in the ith object,

$\min_{i}\{x_{ij}\}$, $\max_{i}\{x_{ij}\}$ – minimum and maximum value of the jth diagnostic variable in the set of objects.

To ensure the comparability of provinces over years, diagnostic variables expressed in monetary units were provided in fixed prices of 2014; furthermore, all variables were treated as panel data. From the technical point of view, this means that in the formula according to which the unitarisation was performed, the minimum and the maximum values of each variable were designated from the entire panel of data, encompassing all years and provinces. The normalised variables were subjected to synthesising, in line with the following aggregating formula (PANEK, ZWIERZCHOWSKI 2013, p. 63):

$$s_i = \frac{1}{m}\sum_{j=1}^{m} z_{ij} \qquad i = 1,2, ..., n; j = 1,2, ..., m \qquad (2)$$

where:

s_i – value of the synthetic variable in the ith object,

z_{ij} – normalised values of the jth diagnostic variable in the ith object,

m – number of diagnostic variables.

The synthetic innovation index adopted values from the [0, 1] range. A higher value of the index means a more advantageous situation of a province with respect to the examined characteristics.

Regional Diversity of the Innovation System in Poland

The evaluation of regional diversity of the innovation system in Poland and changes that took place in this respect between 2009 and 2014 was performed on the basis of values of the synthetic innovation index in provinces which are presented in Table 1. The values higher than the average for a given year are marked in grey. The table also presents the arithmetic mean values of the synthetic innovation index for all provinces ($\bar{s}$), the variability index (V) and asymmetry (A), as well as the dynamics of changes occurring in individual provinces.

Synthetic innovation index in provinces between 2009 and 2014

Province	Value of the synthetic innovation index in provinces						Dynamics of changes in 2009–2014
	2009	2010	2011	2012	2013	2014	
Dolnośląskie	0.36	0.32	0.47	0.50	0.53	0.55	1.53
Kujawsko-Pomorskie	0.21	0.22	0.23	0.25	0.25	0.27	1.29
Lubelskie	0.23	0.23	0.32	0.30	0.29	0.38	1.65
Lubuskie	0.15	0.15	0.17	0.21	0.26	0.26	1.73
Łódzkie	0.23	0.25	0.31	0.33	0.37	0.42	1.83
Małopolskie	0.38	0.35	0.43	0.44	0.46	0.52	1.37
Mazowieckie	0.44	0.43	0.47	0.54	0.56	0.62	1.41
Opolskie	0.23	0.18	0.28	0.39	0.33	0.39	1.70
Podkarpackie	0.33	0.34	0.40	0.38	0.45	0.52	1.58
Podlaskie	0.22	0.20	0.24	0.35	0.34	0.33	1.50
Pomorskie	0.32	0.35	0.38	0.41	0.39	0.45	1.41
Śląskie	0.38	0.39	0.40	0.46	0.43	0.55	1.45
Świętokrzyskie	0.20	0.18	0.28	0.28	0.26	0.25	1.25
Warmińsko-Mazurskie	0.20	0.24	0.30	0.22	0.27	0.26	1.30
Wielkopolskie	0.24	0.29	0.36	0.32	0.36	0.37	1.54
Zachodniopomorskie	0.19	0.18	0.27	0.26	0.26	0.31	1.63
$\bar{s}$	0.27	0.27	0.33	0.35	0.36	0.4	1.48
V	31.6%	31.8%	26.3%	28.3%	27.6%	29.9%	–
A	0.65	0.40	0.04	0.34	0.63	0.29	–

Source: author's own calculations on the basis of data from the Bank Danych Lokalnych (2016).

Between 2009 and 2014, a significant improvement with respect to the innovation system was noted in all provinces. The average value of the synthetic innovation index for all provinces grew by almost a half in the examined period. The growth dynamics of this index in individual provinces was diversified. The highest growth dynamics were recorded in Łódzkie Province – 1.83 and Lubuskie Province – 1.73. The lowest growth dynamics were recorded in the Świętokrzyskie Province – 1.25 and the Kujawsko-Pomorskie Province – 1.29. It is important to note that the regional diversification of the innovation system in Poland in the entire examined period was at an average level[4], whereas the scale of such diversity, in comparison to the years 2009 and 2014, slightly decreased. This is confirmed by the value of the diversity index

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[4] In line with the interpretation functioning in the reference literature on the subject, a value of the variability index below 10% means non-significant variability, a value between <10%;40%> means variability at the average level, a value above 40% means significant non-uniformity of the feature in the examined sample.

which, from the level of 31.6% in 2009 dropped to the level of 29.9% in 2014. It is also worth noting that the lowest value, amounting to 26.3%, was recorded in 2011, and in the subsequent years its value interchangeably grew and dropped. Nevertheless, analysing the entire study period, it may be asserted that regional diversification of the innovation system in Poland slightly decreased, which means that a slow process of regional convergence took place in this respect. The observed tendency is also confirmed by the fact that the relation between the maximum and the minimum values of the synthetic innovation index in a given year decreased. In 2009 it amounted to 2.9, whereas in 2014 it dropped to 2.5. In the examined period, the value of the asymmetry index was also reduced – in this case the right side asymmetry, which means that there are fewer non-typical regions in the group of provinces, i.e. provinces where the level of the synthetic innovation index is definitely higher than the values typical for the majority of provinces.

The fact that regional convergence with respect to the innovation system in Poland was accompanied by internal convergence and divergence of provinces occurring in parallel is worth noting. The character of processes occurring in individual provinces was identified on the basis of values of the synthetic innovation index in 2009 and the dynamics of its changes between 2009 and 2014 in comparison to the average value for all provinces. The classification results are presented in Table 2.

Table 2

Classification of provinces on account of the character of internal processes occurring in their innovation systems between 2009 and 2014

Specification		Synthetic innovation index in 2009 in comparison to the average value	
		Lower than average	Higher than average
Dynamics of changes in the synthetic innovation index between 2009 and 2014 in comparison to average dynamics of changes of this index in the examined period	Lower than average	Divergence (marginalisation effect)	Convergence (falling behind effect)
		Kujawsko-Pomorskie Świętokrzyskie Warmińsko-Mazurskie	Małopolskie Mazowieckie Pomorskie Śląskie
	Higher than average	Convergence (catching-up effect)	Divergence (falling behind effect)
		Lubelskie Lubuskie Łódzkie Opolskie Podlaskie Wielkopolskie Zachodniopomorskie	Dolnośląskie Podkarpackie

Source: author's own study on the basis of data presented in Table 1.

Internal convergence processes were identified in 11 provinces. In the case of seven of them, they had the nature of catching up, and in the case of other four falling behind. Convergence with the catch-up characteristics was recorded in the following provinces: Lubelskie, Lubuskie, Łódzkie, Opolskie, Podlaskie, Wielkopolskie and Zachodniopomorskie. In 2009, these provinces were characterised by lower than average levels of the synthetic innovation index among all provinces; however, on account of greater than average growth dynamics in this respect, their situation in comparison to the average situation in provinces improved. Second type convergence took place in the following provinces: Małopolskie, Mazowieckie, Pomorskie and Śląskie. Falling behind, caused by below average growth dynamics of the synthetic innovation index in these provinces, did not influence the situation in Mazowieckie Province, which retained the leading position in this respect, yet it aggravated the situation of Małopolskie Province (cf. WIERZBICKA 2014).

Internal divergence processes were observed in five provinces, whereas, similarly as in the case of convergence processes, they were of a dual character. A higher than average level of the innovation system characterised Dolnośląskie Province and Podkarpackie Province even at the beginning of the examined period; additionally, they recorded high growth dynamics in this respect and thence distanced themselves from the average situation in the country. On the other hand, in Kujawsko-Pomorskie Province, Świętokrzyskie Province and Warmińsko-Mazurskie Province, divergence with the marginalisation effect was noticed. The low level of the innovation system at the beginning of the examined period, combined with low growth dynamics in this respect caused aggravation of the situation of such provinces in comparison to the average situation in the country. For example, in 2009, the synthetic innovation index in Świętokrzyskie Province was lower by 26% than the average value for all provinces, whereas in 2014 the difference amounted to as much as 37.5%. A similar situation also took place in Warmińsko-Mazurskie Province.

In consequence of such processes, the position of individual provinces with respect to the remaining ones underwent quite significant changes in the examined period. This is confirmed by the results of rankings prepared on the basis of values of the synthetic innovation index and the results of the grouping of provinces which was performed with the use of the standard deviation method (Tab. 3). In line with the assumptions of this method, the borders of divisions were designated on the basis of values of the arithmetic mean of the synthetic innovation index for provinces in general $\bar{s}$ and the level of standard deviation of this index $S(s)$ in the examined year (PANEK, ZWIERZCHOWSKI 2013, p. 118, 119). The collection of the examined items was divided into four groups:

1. Group with **a very high** level of the innovation system, encompassing objects with the values of the synthetic index within the range of $s_i \geq \bar{s} + S(s)$;

2. Group with **a high** level of the innovation system, encompassing objects with values of the synthetic index within the range of $\bar{s} + S(s) > s_i \geq \bar{s}$;

3. Group with **a low** level of the innovation system, encompassing objects with values of the synthetic index within the range of $\bar{s} > s_i \geq \bar{s} - S(s)$;

4. Group with **a very low** level of the innovation system, encompassing objects with values of the synthetic index within the range of $s_i < \bar{s} - S(s)$.

Mazowieckie Province is the leader with respect to innovations. The advantage of this province is the highest number of units with R&D activity in conversion per 10,000 entities of the national economy entered in the National Official Register of Business Entities, the highest level of internal expenditure on R&D activity in conversion per capita, and the highest number of people employed in R&D in conversion per 1,000 professionally active people. Another strong side of Mazowieckie Province is the highest share of human resources for science and technology among professionally active people in the country, and the highest number of patents granted by the Patent Office of the Republic of Poland per number of residents. Śląskie Province also holds a high position in the ranking – from third position in 2009 it moved up to second place in 2014, and was a province with a very high level of the innovation system during the entire examined period. The advantage of this province is the very high number of entities which pursue R&D activity, a high share of human resources for science and technology among professionally active people, as well as a high share of net revenues from sales of innovative products in industrial companies. Małopolskie Province also belongs to the group of provinces with a very high level of the innovation system. The advantage of this province is the highest percentage of people following technical and nature studies, a very high level of internal expenditure on R&D activity in conversion per capita, and a very high number of people employed in R&D in conversion per 1,000 professionally active people. Importantly, the position of Małopolskie Province has slightly deteriorated over recent years. From second position in 2009 it moved down to fifth place in 2014, and it was caused, among other things: the highest dynamics of decline of industrial companies cooperating as part of a cluster initiative or other formalised cooperation in the percentage of innovation-active companies (0.54 in comparison to the national average amounting to 0.15), as well as a high dynamics of decline share of net revenues from sales of innovative products in industrial companies (0.26 in comparison to the national average of 0.1 and in comparison to the high growth dynamics in Dolnośląskie Province – 2.1 and Śląskie Province – 1.52).

On the other hand, Podkarpackie Province recorded a great improvement with respect to the innovation system; in 2009, Podkarpackie was in the group

Table 3

Results of linear ordering and grouping of provinces according to the synthetic innovation index in 2009 and 2014

	2009			2014	
Position in ranking	Province	Level of innovation system	Position in ranking	Province	Level of innovation system
1	Mazowieckie		1	Mazowieckie	
2	Małopolskie	Very high $s_i \geq 0.35$	2	Śląskie	Very high $s_i \geq 0.52$
3	Śląskie		3	Dolnośląskie	
4	Dolnośląskie		4	Podkarpackie	
5	Podkarpackie	High $0.35 > s_i \geq 0.27$	5	Małopolskie	
6	Pomorskie		6	Pomorskie	High $0.52 > s_i \geq 0.40$
7	Wielkopolskie		7	Łódzkie	
8	Lubelskie		8	Opolskie	
9	Opolskie		9	Lubelskie	
10	Łódzkie	Low $0.27 > s_i \geq 0.18$	10	Wielkopolskie	Low $0.40 > s_i \geq 0.28$
11	Podlaskie		11	Podlaskie	
12	Kujawsko-Pomorskie		12	Zachodniopomorskie	
13	Warmińsko-Mazurskie		13	Kujawsko-Pomorskie	
14	Świętokrzyskie		14	Lubuskie	
15	Zachodniopomorskie		15	Warmińsko-Mazurskie	Very low $s_i < 0.28$
16	Lubuskie	Very low $s_i < 0.18$	16	Świętokrzyskie	

Source: author's own study on the basis of data presented in Table 1.

of provinces with a high level of the innovation system, yet in 2014 it was classified in the group with a very high level. Such great improvement within the realm of the innovation system in this province is an effect of the highest growth dynamics of internal expenditure on R&D activity in the country (4.3 in comparison to the national average amounting to 1.7), the number of people employed in R&D (4.1 in comparison to the national average of 1.5), and the percentage of people following technical and nature studies (1.6 with respect to the national average of 1.3).

The worst situation with respect to the innovation system is found in the following provinces: Świętokrzyskie, Warmińsko-Mazurskie, Lubuskie and Kujawsko-Pomorskie. These provinces were classified in 2014 in the group of provinces with a very low level of the innovation system. It is important to note that in 2009 only Lubuskie Province belonged to this group. Three other provinces joined this group as a result of internal divergence processes with a marginalising character that took place during the examined period. The weak side of Świętokrzyskie Province, which in 2014 had last position in the ranking of provinces, is the lowest percentage of industrial companies which invested in innovation activity in the country, and the number of people working in R&D. The weak side of Warmińsko-Mazurskie Province, which occupies the penultimate position in the ranking, is the lowest number of patents granted by the Patent Office of the Republic of Poland in the country in conversion per number of residents and the share of net revenues from the sale of innovative products in industrial companies. In Kujawsko-Pomorskie Province, the share of human resources in science and technology among professionally active people, and the percentage of students pursuing technical and nature studies is at the lowest level.

Summary

The prospects for Poland's economic development and building a knowledge-based economy depend, to a large degree, on its capacity for increasing the level of innovation in companies, universities, research institutes and public institutions. An efficient innovation system enables skilful use of the existing resources of knowledge, the creation and distribution of new knowledge, and its transformation into innovations and the development of new technologies. The spatial dimension of innovation systems is gaining greater significance. Innovations are significant factors influencing modern diversity in the level of economic development.

In the light of the above it is necessary to draw attention to the fact that a significant improvement with respect to the innovation system was recorded

in all provinces between 2009 and 2014. The average value of the synthetic innovation index grew by almost a half for all provinces in general. However, the dynamics of changes occurring in this respect in individual provinces was diverse. The highest growth dynamics of the synthetic innovation index were recorded in Łódzkie Province (1.83) and Lubuskie Province (1.73). The lowest growth dynamics were recorded in Świętokrzyskie Province (1.25) and Kujawsko-Pomorskie Province (1.29).

In consequence of the diverse dynamics of change and diverse levels of the innovation system at the beginning of the examined period, the group of provinces was characterised by internal convergence and divergence processes occurring in parallel. Convergence processes took place in the examined period in as many as 11 provinces. In the case of seven of them, i.e. Lubelskie, Lubuskie, Łódzkie, Opolskie, Podlaskie, Wielkopolskie and Zachodniopomorskie, they had the catching-up character, whereas in the case of the other four (Małopolskie, Mazowieckie, Pomorskie and Śląskie), they had the falling behind character. Only five provinces were characterised by divergence processes in this period, whereas in the case of two of them (Dolnośląskie and Podkarpackie) they had the character of distancing, and in the case of the remaining three – i.e. Kujawsko-Pomorskie, Świętokrzyskie and Warmińsko--Mazurskie, they had the marginalising character. This means that the situation in these three provinces was aggravated in comparison to the average situation in the country, whereas the distance dividing them from other provinces grew, and in 2014 was higher than at the beginning of the examined period. What is more, the position of these provinces also worsened in the ranking with respect to the innovation system. In 2014, they had the following positions: 13, 16 and 15, respectively, and were classified in the group of provinces with a very low level of the system of innovations; however, in 2009 they were included in a better typological group. The leader with respect to the innovation system is Mazowieckie Province, which – during the entire examined period – belonged to the group of provinces with a very high level of the innovation system. High positions in the ranking were also taken by Śląskie, Dolnośląskie, and Małopolskie, and in 2014 also by Podkarpackie, which, as a result of the divergence processes of a distancing character occurring in it, moved from the group with a high level to the group with a very high level of the system of innovations.

As a result of parallel processes of internal convergence and divergence, the structure of the group of provinces with respect to the innovation system became more uniform. The scale of regional diversity in this respect is still at the average level. This is confirmed by the value of the variability index, which dropped from the level of 31.6% in 2009 to the level of 29.9% in 2014. The decreasing dispersion of the innovation system in the group of provinces

means that a slow regional convergence process took place in this respect. The study hypothesis in which it was assumed that "regional diversity of the innovation system in Poland is decreasing, thence a regional convergence process is taking place in this respect" has been verified positively.

Summing up, changes which occurred between 2009 and 2014 with respect to the regional diversification of the innovation system in Poland are of a positive character. The speed of changes is, however, slow, and in relation to this Poland is a country where innovation processes are accompanied by quite significant diversification with respect to individual provinces.

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