Innovativeness of Enterprises in Poland in a Regional Context

Anna Golejewska[1]

Abstract

The article examines the innovativeness of enterprises in 69 Polish NUTS3 sub-regions in 2014. The analysis is based on unpublished regional data from the Polish Central Statistical Office covering the following variables: the share of enterprises which have incurred outlays for innovative activities, the share of enterprises implementing process or product innovations, the share of companies collaborating in the field of innovation, and the share of new or modernized products in total production sold in industrial companies. The analysis focuses on building rankings and cluster analysis of NUTS3 regions. As research methods, the author uses selected methods of multidimensional comparative analysis, principal component analysis and the hierarchical Ward's method. The results show that there are substantial differences among NUTS3 sub-regions as regards innovativeness of enterprises. The low level of cooperation does not foster innovation. Innovation outputs of enterprises are also unsatisfactory. The highest variation is seen in the share of new or modernized products in total production sold in industrial companies. The final effect of the cluster analysis is the division of regions into 7 groups. In the case of units where innovation inputs are not reflected in innovation outputs, it would be useful to explore regional and local factors influencing those relations. Further research is still needed.

Keywords: *innovation, enterprises, regional differences.*

INTRODUCTION

In the majority of the EU countries, there is a noticeable outflow of enterprises from innovative activity. The same applies in Poland, particularly to service enterprises. In well-developed economies with accumulated innovation potential this trend does not entail such enormous risks as in less innovative countries. Despite the declining percentage of innovative firms in Poland, one can observe an increase in expenditure on innovation, but it still remains below

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the EU average. The level of cooperation between Polish enterprises seems to be quite favorable in comparison to other countries; nevertheless, innovation cooperation remains unsatisfactory (Zadura-Lichota, 2015, pp. 5-63).

The activity of companies determines innovativeness at a national, regional and local level. Researchers on innovation issues often underline the importance of regions in the innovation process. There exists extensive evidence that knowledge and innovation are concentrated in selected regions, sub-regions or cities (Simmie, 2003; Nowakowska, 2009; Siłka, 2012; Golejewska, 2013; Golejewska, 2012). A region, through its specific assets including knowledge, learning ability, organizational culture, infrastructure, etc., has an impact on the competitiveness of local businesses and their innovative activity. Local competitive advantages result from a concentration of highly specialized knowledge, the presence of public institutions, competition, trade partners and consumers (Pinto, 2009).

The aim of the paper is to examine disproportions in innovativeness between enterprises in 69 Polish NUTS3 sub-regions in 2014. To achieve the main objective of the paper, the following detailed objectives are expected to be met: 1) presentation of the literature review; 2) empirical research on the innovativeness of Polish firms covering the creation of rankings and cluster analysis, and finally 3) conclusions.

LITERATURE REVIEW

Innovation has been and continues to be an important topic of study for a number of different disciplines, including economics, business, engineering, science, and sociology. The importance and role of knowledge assets in determining competitiveness, productivity, and finally output growth is a frequent theme in the spatial and non-spatial literature (Harris, 2008, p. 16).

Technology consists of three key elements: knowledge, skills and artefacts. Technological innovation involves "the process of applying knowledge and skills to combine an existing set of artifacts into a novel combination that fill a market demand and thereby create value" (Wolfe, 2011, p. 44). A firm is a central actor for the effectuation of innovation and technological change. Innovativeness determines the standards and directions of development of an enterprise, and thus its development and competitive advantage. Through a process of competition, firms with new products make firms with old products redundant and firms with more efficient modes of production eliminate less-efficient producers from the market. Differences in total factory productivity account for roughly half the differences in income across countries and are generally associated with differences in technological progress (Hall & Jones, 1999). Firms

introducing new products and new methods of production and distribution directly enhance economic growth (Bosma, Schutjens & Stam, 2011, p. 483).

A region may be regarded as an "innovation incubator" which provides appropriate conditions for the setting up and the development of innovative companies, as well as pro-innovation behavior among other important entities in a territory. Recent literature calls into question whether innovations emerge from the single inventor or even in whole internally within a firm or organization (Amara, Landry & Lamari, 2003; Wolfe, 2009; Johnson, 2011). Knowledge-based transformations should not be understood as the results of the actions of firms alone, "but as a structural characteristic of knowledge-based economies" (Leydesdorff, 2001, p. 4) and "a social process that depends on interaction and learning" (Hall, 2010, p. 10). The literature indicates various "territorial innovation systems" (Lagendijk, 1997; Moulaert & Mehmood, 2010). Their typology often includes industrial districts (focused on the growth dynamics of small and medium-sized enterprises), innovative milieu, regional innovation systems, clusters and learning regions (Lagendijk, 1997; Porter, 2000; De Propris & Crevoisier, 2011). The last ones may be treated as a general synthesis of the above-mentioned concepts (Moulaert & Mehmood, 2010).

Innovation is a complex and multidimensional activity that cannot be measured directly or with a single indicator. Measuring innovation has been studied extensively by scholars and practitioners. In the literature, even "innovation economics" exists - a sub-discipline that analyses the relationship between investments in innovation and their financial outcomes. Innovation indicators are split into four groups-generations, from less to more complex. The first group, focusing on a linear model of innovation, includes such indicators as R&D investment, research personnel, university graduates, etc. The second group is extended by output indicators. The third generation is focused on a wider set of innovation indicators and indexes based on surveys and the integration of publicly available data. The fourth generation is currently at an embryonic stage and includes knowledge, networks, risk, clusters, management techniques, etc. (Gamal, 2011, p. 10).

In the literature, two broad streams of research on the measurement of innovation are noticeable. The first one concentrates on innovation inputs, such as R&D intensity, and outputs, such as patents. Nevertheless, these measures merely concern a small part of all the possible innovation activities. Due to empirical evidence, the linkage between such measures and organizational innovativeness and economic growth is vague. An appropriate example is a research conducted by Booz (2005) based on 1000 top global innovation spenders which confirmed there was no significant relationship between R&D spending and nearly all measures of business success. The value of patents as indicators of innovation, at a micro level, is rather limited

(Gittleman, 2008). The second stream is focused on the macro level. In the EU, countries' innovation capabilities are measured through objective economic measures, such as the Oslo Manual (2005), the European Community Innovation, and the European Innovation Scoreboard (EIS) (Gamal, 2011, p. 9). Regional innovation performance, measured by the Regional Innovation Scoreboard, should be based on the same indicators as EIS. Nevertheless, for many of them regional data are not available and are calculated using only 18 of the 27 EIS indicators. Some indicators relating to entrepreneurial activity belong among others: R&D expenditure in the business sector as a percentage of GDP; SMEs innovating in-house as a percentage of SMEs**;** innovative SMEs collaborating with others as a percentage of SMEs**;** EPO patent applications per billion of regional GDP; SMEs introducing product or process innovations as a percentage of SMEs; SMEs introducing marketing or organizational innovations as a percentage of SMEs, sales of new-to-market and new-to-firm innovations as a percentage of total turnover etc. (Hollanders & Es-Sadki, 2017). In the paper, the author followed the approach of the Regional Innovation Scoreboard, in which input-type and output-type measures have been used simultaneously.

There have been and continue to be substantial differences among Polish regions as regards innovativeness (Kowalik, 2014**;** Golejewska, 2013; Górecka & Muszyńska, 2011; Nowakowska, 2009; Siłka, 2012). According to the findings presented in the Regional Innovation Scoreboard (2017), 7 out of 16 Polish regions have been classified as moderate innovators and none as innovation leader or strong innovator. Research results show that high innovation inputs do not often correspond with high innovation outputs (Golejewska, 2013). Polish regions are also internally diversified as regards innovativeness (Brodzicki & Golejewska, 2017). Disproportions between the best performing regions and the rest of the country are a big challenge for regional innovation policy.

RESEARCH METHODS

The group of analyzed regions consists of 69 units (out of 72 units according to the territorial breakdown of 1 January 2015). The analysis is based on unpublished regional data of the Polish Central Statistical Office covering the following variables: the share of enterprises which have incurred outlays for innovative activities, the share of enterprises implementing process or product innovations, the share of companies collaborating in the field of innovation, and the share of new or modernized products in total production sold by industrial companies. The fifth available variable - internal expenditure on research and

development – has been omitted from the analysis due to a significant lack of data. The data cover industrial enterprises employing more than 49 people and have been extracted from innovation statements in the industry (PNT-02). The analysis was conducted for 2014, the most recent year for which data were available up to this point. Due to a lack of data, three NUT3 regions have been omitted: Bialski (PL311), Ciechanowski (PL12B) and Nowotarski (PL 219).

The empirical analysis starts with the creation and comparison of innovativeness rankings on the basis of the method of ranks and method of standardized values. Some of the differences between the ranks have been explained by the results of the principal component analysis. Finally, a cluster analysis employing the hierarchical Ward's method was conducted. The applied method is effective in building homogenous clusters with the lowest inter-group variance (Grabiński, 2003, p. 110).

RESULTS AND DISCUSSION

Descriptive statistics of the analyzed variables are presented in Table 1. The highest coefficient of variation (75.4) was recorded for the share of sold production of new or substantively improved (modernized) goods in the sold value of industry, the lowest (19.1) for the share of enterprises which implemented process or product innovations. The results of the analysis of mean values indicate a very low level of innovation cooperation and sold production of new goods. This might suggest that there is still a mutual distrust between companies in Poland and also that they do not derive significant benefits from cooperation and implemented innovations.

Table1. Descriptive statistics

Variable	N	Mean	Median	Min.	Max.	Lower quartile	Upper quartile	Standard deviation	Coefficient of variation
X1	69	28.9	28.2	15.2	44.7	23.8	34.0	6.9	23.9
X2	69	14.1	13.2	5.1	29.1	9.9	17.6	5.5	38.7
X3	69	35.7	36.2	19.6	48.4	30.5	40.8	6.8	19.1
X4	69	10.1	8.0	0.7	44.3	4.2	12.9	7.6	75.4

Note: X1: share of enterprises which have incurred outlays for innovative activities in 2014 (input),
X2: share of enterprises involved in innovation cooperation in 2012-2014 (input),
X3: share of enterprises which implemented process or product innovations in 2012-2014 (output),
X4: share of sold production of new or substantively improved (modernized) goods introduced in 2012-2014 in sold value of industry in 2014 (output).
Source: own elaboration based on CSO data.

The highest share of enterprises which incurred outlays for innovative activities was recorded in PL213: city of Kraków – 44.7%, PL523: Nyski – 43.8%, PL514: city of Wrocław and PL127: city of Warszawa – 42.7%. The lowest, less than 20% - in PL116: Sieradzki, PL417: Leszczyński, PL634: Gdański, PL637: Chojnicki, PL312: Chełmsko-Zamojski, PL616: Grudziądzki and PL12D: Ostrołęcki. Enterprises implementing innovations most frequently cooperated in PL213: city of Kraków, PL326 Tarnobrzeski, PL343 Białostocki and PL514: city of Wrocław (in all sub-regions at least 25%). The lowest share of cooperating enterprises was recorded for PL616: Grudziądzki, PL417: Leszczyński, PL636: Słupski, PL116: Sieradzki, PL345 Suwalski and PL312: Chełmsko-Zamojski. In all cases, the share did not exceed 7.5%. Most of the leaders in the share of innovative enterprises were placed highly in the ranking based on implemented process or product innovations. The highest share of sold production of new or substantively improved (modernized) goods was recorded in Trójmiejski sub-region (44.3%), the city of Łódź (31.7%) and Ostrołęcki sub-region (25%). The difference between the best and the worst performing sub-region was, in this case, the highest in comparison to other variables. The lowest shares amounted to 0.7% in Siedlecki and 1.9% in Przemyski sub-region. Rankings by selected variables are presented in Table 2.

Table 2. Rankings by selected variables (method of ranks)

Rank	X1	X2	X3	X4	Rank	X1	X2	X3	X4
1	PL213	PL213	PL523	PL633	36	PL432	PL619	PL117	PL432
2	PL523	PL326	PL343	PL113	37	PL12C	PL332	PL224	PL332
3	PL514	PL343	PL127	PL12D	38	PL228	PL637	PL344	PL617
4	PL127	PL514	PL514	PL225	39	PL424	PL634	PL411	PL619
5	PL415	PL21A	PL415	PL638	40	PL218	PL117	PL516	PL116
6	PL325	PL127	PL213	PL129	41	PL618	PL115	PL619	PL22A
7	PL315	PL424	PL21A	PL518	42	PL331	PL623	PL426	PL637
8	PL21A	PL523	PL315	PL418	43	PL414	PL344	PL432	PL224
9	PL343	PL325	PL113	PL22B	44	PL517	PL411	PL115	PL623
10	PL314	PL613	PL229	PL218	45	PL431	PL324	PL617	PL424
11	PL22B	PL12A	PL217	PL517	46	PL411	PL12E	PL114	PL417
12	PL324	PL415	PL326	PL616	47	PL224	PL622	PL431	PL426
13	PL113	PL22C	PL517	PL613	48	PL427	PL428	PL218	PL636
14	PL326	PL524	PL314	PL325	49	PL117	PL515	PL622	PL12A
15	PL229	PL314	PL129	PL214	50	PL12E	PL217	PL515	PL523
16	PL22C	PL22A	PL325	PL514	51	PL217	PL638	PL128	PL415
17	PL524	PL114	PL22A	PL127	52	PL621	PL416	PL427	PL217

Rank	X1	X2	X3	X4	Rank	X1	X2	X3	X4
18	PL129	PL22B	PL418	PL326	53	PL515	PL617	PL331	PL621
19	PL225	PL516	PL22C	PL515	54	PL623	PL12D	PL618	PL431
20	PL22A	PL517	PL225	PL516	55	PL617	PL224	PL227	PL634
21	PL613	PL225	PL428	PL114	56	PL227	PL618	PL621	PL331
22	PL633	PL633	PL613	PL227	57	PL128	PL426	PL414	PL115
23	PL518	PL113	PL623	PL428	58	PL345	PL12C	PL634	PL344
24	PL418	PL418	PL518	PL343	59	PL115	PL431	PL416	PL312
25	PL428	PL229	PL323	PL22C	60	PL638	PL128	PL12D	PL427
26	PL332	PL432	PL22B	PL229	61	PL636	PL621	PL636	PL128
27	PL516	PL227	PL633	PL213	62	PL416	PL218	PL616	PL315
28	PL619	PL129	PL324	PL414	63	PL12D	PL315	PL345	PL12C
29	PL12A	PL331	PL524	PL524	64	PL616	PL312	PL638	PL622
30	PL114	PL228	PL214	PL416	65	PL312	PL345	PL228	PL117
31	PL344	PL427	PL332	PL314	66	PL637	PL116	PL312	PL618
32	PL214	PL214	PL12E	PL323	67	PL634	PL636	PL637	PL345
33	PL323	PL323	PL12A	PL411	68	PL417	PL417	PL417	PL324
34	PL426	PL518	PL424	PL21A	69	PL116	PL616	PL116	PL12E
35	PL622	PL414	PL12C	PL228					

Source: own elaboration based on CSO data (2014).

Ranking considering all variables, based on the method of ranks is presented in Table 3. The leaders among cities are Wrocław, Warszawa and Kraków. The top ten also includes Łódź and sub-regions of Podkarpackie (PL325, PL326), Małopolskie (PL 21A), Podlaskie (PL343), Opolskie (PL523) and Śląskie (PL 22B). Among the ten least innovative sub-regions, three represent the region of Pomorskie. These results differ from the results obtained by the method of standardized values (Table 4). This is particularly the case for such NUTS 3 sub-regions as Trójmiejski **(**PL633), Rzeszowski (PL325), Bytomski (PL228), Płocki (PL12C), Skierniewicki (PL117), Łomżyński (PL344) and the City of Poznań (PL415). In those cases, the differences amount to at least six places. In the case of Trójmiejski sub-region, a significant impact on the difference has the highest value of the share of sold production. Low values of this variable in Rzeszowski and Bytomski sub-region result in their lower position in the second ranking. In other cases, the sub-regions were classified higher in ranking based on the method of standardized values. In this case, it results mainly from a high value of the share of enterprises which implemented process or product innovations in those regions.

Table 3. Rankings of NUTS3 sub-regions (method of ranks)

Rank	NUT 3 region	Rank	NUTS 3 region	Rank	NUTS 3 region
1	City of Wrocław	24	Legnicko-Głogowski	47	Koszaliński
2	Capital City Warszawa	25	Krakowski	48	Starogardzki
3	City of Kraków	26	Łódzki	49	Częstochowski
4	Białostocki	27	Szczeciński	50	Inowrocławski
5	Rzeszowski	28	Warszawski Zachodni	51	Skierniewicki
6	Tarnobrzeski	29	Krośnieński	52	Szczecinecko-Pyrzycki
7	City of Łódź	30	City of Szczecin	53	Płocki
8	Oświęcimski	31	Sandomiersko-Jędrzejowski	54	Olsztyński
9	Nyski	32	Puławski	55	Siedlecki
10	Sosnowiecki	33	Zielonogórski	56	Piotrkowski
11	Bielski	34	Włocławski	57	Kaliski
12	Bydgosko-Toruński	35	Przemyski	58	Gorzowski
13	Warszawski Wschodni	36	Nowosądecki	59	Grudziądzki
14	Lubelski	37	Rybnicki	60	Chojnicki
15	Trójmiejski	38	Pilski	61	Świecki
16	City of Poznań	39	Koniński	62	Gdański
17	Tyski	40	Tarnowski	63	Elbląski
18	Poznański	41	Ełcki	64	Radomski
19	Gliwicki	42	Bytomski	65	Słupski
20	Wrocławski	43	Łomżyński	66	Sieradzki
21	Wałbrzyski	44	Jeleniogórski	67	Leszczyński
22	Opolski	45	Ostrołęcki	68	Suwalski
23	Katowicki	46	Kielecki	69	Chełmsko-Zamojski

Source: own elaboration based on CSO data (2014).

Table 4. Rankings of NUTS3 sub-regions (method of standardized values)

Rank	NUT 3 region	Rank	NUTS 3 region	Rank	NUTS 3 region
1	City of Kraków	24	Warszawski Zachodni	47	Starogardzki
2	City of Wrocław	25	Legnicko-Głogowski	48	Częstochowski
3	Capital City Warszawa	26	City of Szczecin	49	Ostrołęcki
4	Białostocki	27	Łódzki	50	Bytomski
5	Nyski	28	Krakowski	51	Kielecki
6	Trójmiejski	29	Szczeciński	52	Siedlecki

Rank	NUT 3 region	Rank	NUTS 3 region	Rank	NUTS 3 region
7	City of Łódź	30	Puławski	53	Olsztyński
8	Oświęcimski	31	Krośnieński	54	Szczecinecko-Pyrzycki
9	Tarnobrzeski	32	Sandomiersko-Jędrzejowski	55	Inowrocławski
10	City of Poznań	33	Przemyski	56	Piotrkowski
11	Rzeszowski	34	Włocławski	57	Gorzowski
12	Bielski	35	Zielonogórski	58	Świecki
13	Bydgosko-Toruński	36	Łomżyński	59	Kaliski
14	Warszawski Wschodni	37	Ełcki	60	Elbląski
15	Sosnowiecki	38	Tarnowski	61	Radomski
16	Tyski	39	Nowosądecki	62	Gdański
17	Lubelski	40	Pilski	63	Grudziądzki
18	Poznański	41	Rybnicki	64	Chojnicki
19	Gliwicki	42	Koniński	65	Słupski
20	Katowicki	43	Koszaliński	66	Suwalski
21	Opolski	44	Jeleniogórski	67	Chełmsko-Zamojski
22	Wrocławski	45	Skierniewicki	68	Leszczyński
23	Wałbrzyski	46	Płocki	69	Sieradzki

Source: own elaboration based on CSO data (2014).

Some of the aforementioned differences between scores might be explained by the results of principal components analysis (Górniak, 1998; Leech, Barrett & Morgan, 2005). In the analysis, the first component is a composition of variables x1, x2 and x3 and the second represents variable x4. According to the scree plot, the first component explains the total variance of the analyzed variables at 66.44%, the second at 22.78%. Generally, the differences between rankings result from implemented methods. In ranking, each variable has in principle the same meaning but after standardization what is very important is the dispersal of observations, which is the highest for the fourth variable and thus has a greater impact on the final results of this method. From Figure 1 it is clear that Component 1 is the most significant for PL213, PL314, PL127, PL343 and PL523 and the least significant for PL116, PL417 and PL312. Component 2 remains the most significant for PL633, PL113, PL12D, PL638 and PL225 and the least significant for PL523, PL415 and PL315 (see Figure 1).

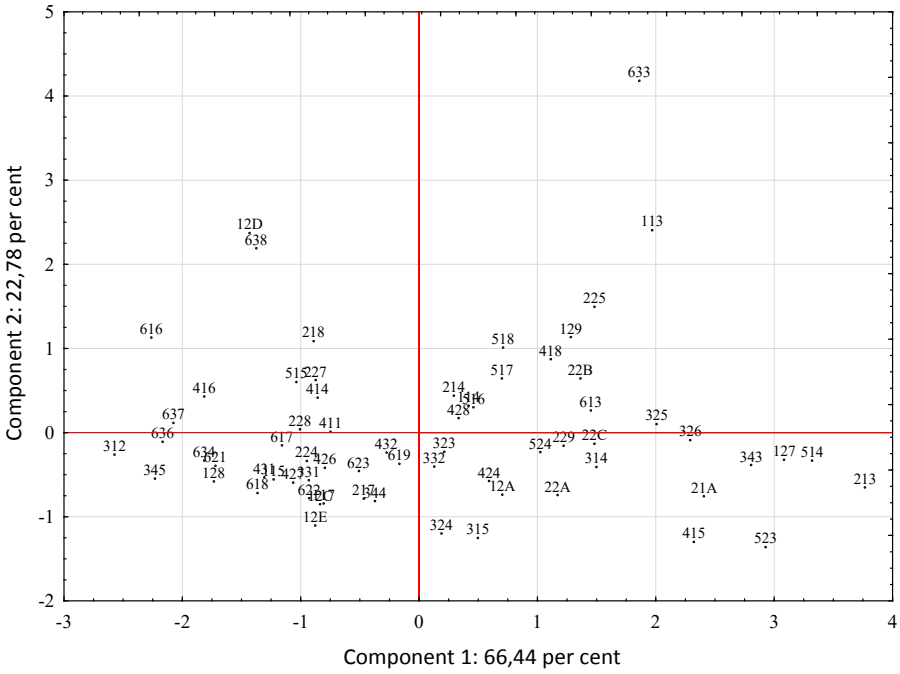

Figure 1. Results of principal component analysis

Source: own elaboration based on CSO data (2014).

The next step was the cluster analysis conducted using the hierarchical Ward's method. As a result, 69 sub-regions have been divided into 7 groups (see Table 5). The most numerous group consists of 16 NUTS3 sub-regions, the least numerous of 6 sub-regions. The results are presented graphically on the map (Figure 2).

The differences among groups were analyzed using mean values of the standardized variables (see Figure 3). The first group consists of 8 sub-regions located – apart from the capital region- in Małopolskie, Wielkopolskie, Dolnośląskie, Opolskie and in two Eastern regions: Podkarpackie and Podlaskie. It is characterized by the highest mean values of analyzed variables, apart from the value of sold production of new or substantively improved (modernized) goods which remains average. The second group comprises eight sub-regions located in Pomorskie (3 sub-regions), Wielkopolskie (2 sub-regions), Łódzkie and in two Eastern regions: Lubelskie and Podlaskie. In contrast to the previous group, the sub-regions have the lowest values of variables apart from sold production which remains low.

Table 5. Results of cluster analysis, Ward's method

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
PL514	PL312	PL619	PL516	PL515	PL431	PL518
PL213	PL116	PL315	PL517	PL616	PL115	PL113
PL21A	PL345	PL432	PL613	PL218	PL117	PL129
PL127	PL634	PL323	PL314	PL12D	PL217	PL633
PL523	PL636	PL324	PL114	PL638	PL128	PL225
PL326	PL416	PL344	PL214	PL227	PL228	PL418
PL343	PL417	PL332	PL12A	PL414	PL224	
PL415	PL637	PL426	PL524		PL331	
		PL12C	PL325		PL621	
			PL229		PL623	
			PL22A		PL622	
			PL22B		PL411	
			PL22C		PL427	
			PL424		PL617	
			PL428		PL618	
					PL12E	

Source: own elaboration based on CSO data (2014).

The third group consists of 9 NUTS3 sub-regions and is characterized by a high share of innovative enterprises in which the level of cooperation and implemented innovation remain respectively low and average while sold production is rather low.

The next group is much more numerous and consists of 15 sub-regions. It is heterogynous and it is characterized by a high share of innovative enterprises, highly involved in cooperation, a high share of enterprises which implemented innovations and an average share of sold production of new goods. The fifth group comprises 7 sub-regions with low values of all the indicators apart from high production sold. The most numerous group 6 is characterized by low values of all indicators and the lowest mean value of production sold. The last group is the least numerous one. It consists of 6 sub-regions, all located in different regions. It is characterized by the highest mean value of the share of sold production of new or substantively improved (modernized) goods.

Definite leaders of the first, best performing group are Kraków and Wrocław. In the weakest group 2, the highest innovation indicators have enterprises located in Słupski and Kaliski sub-region. In the third group, the most innovative are enterprises in Krośnieński and Puławski sub-region, and in the fourth group – enterprises located in Rzeszowski, Sosnowiecki and Bydgosko-Toruński sub-region. The leaders of the next group are enterprises of Nowosądecki and Rybnicki sub-region. The highest innovation indicators in the sixth group were recorded in Ełcki, Tarnowski and Pilski sub-region and finally, in the last group in the enterprises of Trójmiejski sub-region.

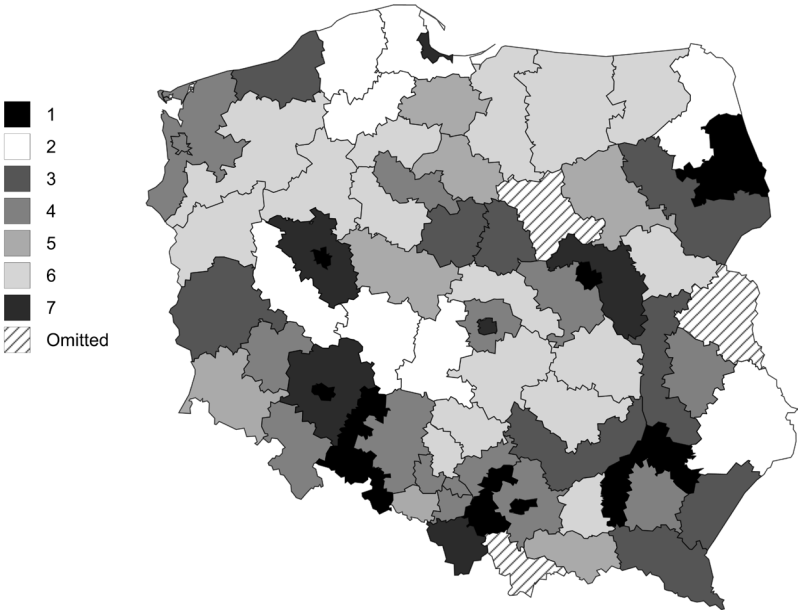

Figure 2. Results of cluster analysis, Ward's method, groups

Source: own elaboration based on CSO data (2014).

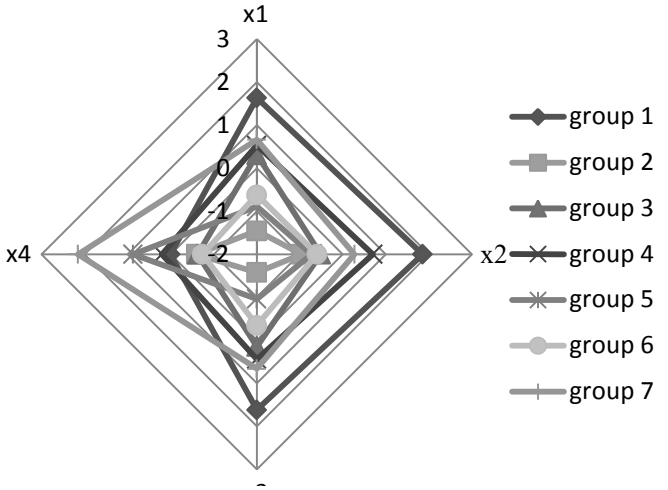

Figure 3. Mean values of variables by groups of regions

Source: own elaboration based on CSO data (2014).

CONCLUSION

Results of the analysis show that there are substantial disproportions in innovativeness between industrial enterprises located in different Polish NUTS 3 sub-regions. The greatest differences are visible in the share of sold production of new goods in the sold value of industry and in the level of innovation cooperation which remains unsatisfactory. The results confirm that there might still be a mutual distrust between companies in Poland as regards innovation activity and also that they might not derive significant benefits from cooperation and implemented innovations. The ranking scores show some differences mainly due to the high dispersal of observations for the share of sold production of new products. The scores confirm dominance at the forefront of major urban centers. Among the cities, the leaders are Wrocław, Warszawa and Kraków. It is noteworthy that not many of the Eastern sub-regions performed badly. The lowest innovation indicators have enterprises in Suwalski and Chełmsko-Zamojski sub-region. It is also interesting to note that three out of the ten worst performing sub-regions are located in the region of Pomorskie. Their low position results mainly from low innovation cooperation and a low share of sold production of new goods.

The final effect of the cluster analysis is the division of regions into 7 groups, of which the first one is characterized by the highest innovativeness of industrial enterprises and the second one by the lowest. The group in which low inputs translate into low outputs is group 6. The groups with high input variables are group 4 and group 7. In the latter group they translate into the highest share of sold production of new products. In group 5 low inputs correspond with the second highest value of the mentioned output indicator. Finally, group 3 consists of units in which the mean values of input and output variables are mixed: low or average. The groups of sub-regions are not "homogenous geographically" which means that Polish NUTS 2 regions are internally diverse as regards innovativeness of industrial enterprises. The only exception is Warmińsko-Mazurskie. As benchmarking, it could be interesting to identify sub-regions with high innovation outputs corresponding with lower or proportionate innovation inputs. In the case of units where inputs are not reflected in outputs, it would be useful to explore regional and local factors influencing those relations. It shall be a question for further study.

References

Amara, N., Landry, R., & Lamari M. (2003). Social capital, innovation, territory and public policy. *Canadian Journal of Regional Science*, *26*(1), 87-120.

Booz, A. H. (2005). Relationship between R&D spending and sales growth, earnings, or shareholder returns. Retrieved from http://www.boozallen.com

Bosma, N., Schutjens, V., & Stam, E. (2011). Regional entrepreneurship. In P. Cooke, B. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Toedling (Eds.), *Handbook of Regional Innovation and Growth* (pp. 482-494). Cheltenham: Edward Elgar Publishing.

Brodzicki, T., & Golejewska, A. (2017). Regional variation of innovation activity in Poland. The positive role of location in metropolitan areas affirmed. *Working Papers of Economics of European Integration Division*, *1*, 1-26.

De Propris, L., & Crevoisier, O. (2011). From regional anchors to anchoring. In P. Cooke, B. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Toedling (Eds.), *Handbook of Regional Innovation and Growth.* (pp. 167-180). Cheltenham: Edward Elgar Publishing.

European Commission. (2017). Regional Innovation Scoreboard 2017. Retrieved from http://ec.europa.eu/growth/industry/innovation/facts-figures/regional_pl

Gamal, D. (2011). How to measure organization innovativeness? An overview of innovation measurement frameworks and innovation audit/ management tools. Retrieved from http://tiec.gov.eg/backend/reports/measuringorganizationinnovativeness.pdf

Gittelman, M. (2008). Comment: The value of European Patents. *European Management Review*, *5*, 85-89.

Golejewska, A. (2013). Input-output innovativeness of Polish regions. *Social Research*, *4*(33), 87-97.

Golejewska, A. (2012). Innowacyjność a konkurencyjność regionalna krajów Grupy Wyszehradzkiej w latach 1999-2008. *Prace Komisji Geografii Przemysłu PTG*, *20*, 93-115.

Górecka, D., & Muszyńska, J. (2011). Analiza przestrzenna innowacyjności polskich regionów. *Acta Universitatis Lodziensis Folia Oeconomica, 253,* 55-70.

Górniak, J. (1998). Analiza czynnikowa i analiza głównych składowych. Retrieved from https://kb.osu.edu/dspace/bitstream/handle/1811/69494/ASK_1998_83_102.pdf

Grabiński, T. (2003). *Analiza Taksonomiczna Krajów Europy w Ujęciu Regionalnym*. Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie.

Hall, R. E., & Jones, Ch. I. (1999). Why do some countries produce so much more output per worker than others?. *Quarterly Journal of Economics, 114*(1), 83-116.

Harris, R. (2008). Models of regional growth: Past, present and future. *SERC Discussion Paper*, 2.

Hollanders, H., & Es-Sadki, M. (2017). *Regional Innovation Scoreboard. Internal Market, Industry, Entrepreneurship and SMEs*. European Union: Belgium.

Kowalik, J. (2014). Regional innovativeness strategies and their impact on innovativeness of provinces in Poland. A spatio-temporal analysis. *Comparative Economic Research, 17*(4), 121-135.

Johnson, S. (2011). *Where Good Ideas Come From*. New York: Riverhead Trade.

Lagendijk, A. (1997). *Will the New Regionalism Survive? Tracing Dominant Concepts in Economic Geography*. UK: University of Newcastle-Upon-Tyne.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2005). *SPSS for Intermediate Statistics: Use and Interpretation*. Mahwah, New Jersey: Lawrence Erlbaum Associates Publishers.

Leydesdorff, L. (2001). Knowledge-based innovation systems and the model of a triple helix of university-industry-government relations. Conference on new economic windows: New paradigms for the new millennium, September 14, Sacerno, Italy.

De Mel, S., McKenzie, D., & Woodruff, Ch. (2009). Innovative firms or innovative owners? determinants of innovation in micro, small, and medium enterprises*. IZA Discussion Papers*, *3962*, 1-32.

Moulaert, F., & Mehmood, A. (2010). Analysing regional development and policy: A structuralist realist approach. *Regional Studies*, *44*(1), 103-118*.*

Nowakowska, A. (Ed.). (2009). *Zdolności Innowacyjne Polskich Regionów*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.

OECD. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data* (3rd ed.). Paris: OECD.

Pinto, H. (2009). The diversity of innovation in the European Union: Mapping latent dimensions and regional profiles. *European Planning Studies*, *17*(2), 303–326.

Porter, M. E. (2001). *Clusters of Innovation: Regional Foundations of US Competitiveness*. Washington DC: Council on Competitiveness.

Siłka, P. (2012). Potencjał innowacyjny wybranych miast Polski a ich rozwój gospodarczy. *Prace Geograficzne*, *236*, 1-261.

Simmie, J. (2003). Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. *Regional Studies*, *37*(6–7), 607–620.

Strahl, D. (1998). *Taksonomia Struktur w Badaniach Regionalnych*. Wrocław: Wydawnictwo Akademii Ekonomicznej.

Wolfe, D.A. (2009). 21st century cities in Canada: The geography of innovation. Retrieved from: http://www.mun.ca/harriscentre/Misc/21stCenturyCities inCanada_2009_web.pdf

Wolfe, D. (2011). Neo-Shumpeterian perspectives on innovation and growth. In P. Cooke (Ed.), *Regional Innovation and Growth*. Cheltenham: Edward Elgar Publishing.

Zadura-Lichota, P. (Ed.). (2015). *Innowacyjna Przedsiębiorczość w Polsce. Odkryty i Ukryty Potencjał Polskiej Innowacyjności.* Warszawa: PARP.

Abstrakt

Artykuł analizuje innowacyjność przedsiębiorstw w 69 polskich podregionach NUTS-3 w 2014 roku. Analiza bazuje na niepublikowanych danych regionalnych GUS obejmujących następujące zmienne: udział przedsiębiorstw, które poniosły nakłady na działalność innowacyjną; udział przedsiębiorstw, które nawiązały współpracę w zakresie działalności innowacyjnej; udział przedsiębiorstw, które wdrożyły innowacje produktowe lub procesowe i udział produkcji sprzedanej wyrobów nowych lub ulepszonych w przedsiębiorstwach przemysłowych w wartości sprzedanej wyrobów ogółem. W opracowaniu przeprowadzono rankingi i analizę skupień. Zastosowane metody badawcze to wielowymiarowa analiza porównawcza, analiza głównych składowych i hierarchiczna metoda Warda. Wyniki potwierdziły istotne zróżnicowanie podregionów NUTS-3 w zakresie innowacyjności przedsiębiorstw. Niski poziom ich współpracy nie sprzyja innowacjom. Rezultaty działań innowacyjnych przedsiębiorstw również nie są satysfakcjonujące. Najwyższy poziom zmienności odnotowano dla udziału produkcji sprzedanej wyrobów nowych lub ulepszonych w wartości sprzedanej wyrobów ogółem. Wynikiem przeprowadzonej analizy skupień jest podział podregionów na 7 grup. W przypadku jednostek, w których potencjał nie przekłada się na innowacyjność należałoby zbadać lokalne i regionalne czynniki wpływające na te relacje. Niezbędne jest przeprowadzenie dalszych badań.

Słowa kluczowe: *innowacje, przedsiębiorstwa, różnice regionalne.*

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