A C T A U N I V E R S I T A T I S L O D Z I E N S I S
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THE ANALYSIS OF DIVERSIFICATION TENDENCIES IN THE REGIONAL INNOVATIVENESS OF EU COUNTRIES 1999–2012[1]

1. INTRODUCTION

European countries are extensively diversified in many respects; however, major attention of politicians, decision makers and managers at the national and regional level is focused on problems related to the level of development, job market or social wealth. The development of knowledge-based economies and innovation, support for the economy taking effective advantage of the available resources that are both more environmentally friendly and competitive, as well as support for an economy featuring high employment levels, ensuring social and territorial cohesion, represent strategic goals for united Europe to be achieved in the years to come.

Innovation is recognised as one of the important elements considered to be useful in accomplishing the specified indicator levels included in the Europe 2020 Strategy. The level of innovation is highly diversified in the European Union countries (Hollanders 2014). According to the recent research results with regards to the regional innovation scoreboard (Hollanders et. al. 2014), the diversification at the level of the EU NUTS-2 regions is also quite significant.

The objective of this article is an attempt to evaluate changes of the regional innovation diversification in the European Union countries over the course of two time periods, 1999–2008 and 2008–2012, by applying, among others, the trends of both the regional innovation indicator and standard deviation.

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2. REGIONAL INNOVATION – MEASUREMENT PROBLEM

Innovation is most frequently analysed in the context of a company's functioning, but in the course of the last several years it has also been discussed quite often from the perspective of a given territory – a country or a region. Nowakowska (2009) indicates that it is a region (a territory) that plays a particular role in the processes of knowledge and innovation creation, since innovation is assigned to a particular location. It is constructed within the scope of a defined territory which by having at its disposition specific, key and unique resources necessary in the process of its creation results in the fact that the "*transfer*" of innovation is not possible.

Innovation, in terms of a country or region, constitutes an important development factor and determines the level of economic competitiveness. The evaluation of innovation levels facilitates comparisons between countries and regions, as well as allows for running effective regional policy. The occurring extensive diversifications with regards to innovation in the European space constitute a challenge for the decision makers who, by means of instruments and tools of the carried out policy, aim at reducing these differences. The increase of the innovation level, but also the decrease of disproportions in the level of innovation, represents one of the strategic goals presented in the Europe 2020 document (Europe 2010).

Innovation measurement has been carried out for several years within the framework of the EU member states. The subsequent presentations published in studies covering national and regional innovation in the EU, depending on the year, referred to a different number of indicators. The number of variables at the level of regions depended on the approach presented in evaluations assessing innovation of the EU countries, and such approaches are still evolving. The most recent study of the EU member states innovation level was carried out in 2014 (Hollanders, Es-Sadki 2014), similar to the NUTS-2 level regions (Hollanders et. al. 2014).

The measures applied for regional innovation evaluation, used in the study by H. Hollanders and his team, were as follows (Hollanders et. al. 2014):

- Percentage population aged 25-64 having completed tertiary education,
- R&D expenditure in the public sector as % of regional GDP,
- R&D expenditure in the business sector as % of regional GDP,
- EPO patents applications per billion regional GDP (in PPS€),,
- Non-R&D innovation expenditures as % of turnover,
- SMEs innovating in-house as % of SMEs,
- Innovative SMEs collaborating with others as % of SMEs,
- Employment in knowledge-intensive services and employment in medium-high/high-tech manufacturing as % of total workforce,

– SMEs introducing product or process innovations as % of SMEs,
– SMEs introducing marketing or organisational innovations as % of SMEs,
– Sales of new to market and new to firm innovations as % of turnover.

The presented list is yet another set of indicators, since the methodology and adequate list of indicators in the approach to regional innovation measurement and its evaluation at the national level that can be applied at a satisfactory level to measurements of "*creative destruction*" – the term used by J. A. Schumpeter with reference to innovation.

Starting from the first approach to evaluation of the EU regions innovation in 2002 within the framework of Regional Innovation Scoreboard (RIS) (*European*… 2002), the set of indicators covered 7 indicators (in 2002), up to 13 on the list from 2003, to 7 in 2006, up to 16 in the next analysis conducted in 2009 and 12 indicators in 2012, to reach finally the above-mentioned 11 in 2014.

3. METHODOLOGY FOR EVALUATING THE EU COUNTRIES DIVERSIFICATION IN TERMS OF INNOVATION AT REGIONAL LEVEL

The approach suggested in the study was carried out in the course of the following stages:

1) Identifying regional innovation measures and the construction of a database covering two periods referring to the same indicators and for the same EU regions at the NUTS-2 level:
   a. 1999–2008,
   b. 2008–2012.
2) Achieving data comparability by the so-called global normalisation using extreme values from the entire analysed period as reference points.
3) Calculating innovation indicators (*W*) based on innovation measures for each region subject to analysis in each of the analysed years in both time periods.
4) Specifying the mean indicator (*W*) values for each region in the first and second periods, and then trends in the EU countries.
5) Calculating the standard deviations of the regional innovation indicator in each analysed year within the framework of particular countries, as well as specifying trends in the standard deviations characteristics for particular member states in both time periods.
6) Evaluating the obtained results (changes in time and in the EU countries in both periods).

The suggested approach will facilitate the identification of these countries within which the decreasing regional innovation diversification was observed, as well as the countries characterised by stable diversification and those in which regional differences became more extensive.

4. VARIABLES APPLIED IN THE EVALUATION PROCESS AND THEIR DIVERSIFICATION IN THE EU REGIONS

This study is based on data collected from the Eurostat database for the European Union NUTS-2 level regions – excluding Croatia and disregarding four overseas French regions (Guadeloupe, Martinique, Guyane, Réunion) and two Spanish regions (Ciudad Autónoma de Ceuta and Ciudad Autónoma de Melilla). The performed analyses covered a total of 264 EU-27 regions. For the purposes of regional innovation evaluation, the following set of indicators discussed and indicated in the study by M. Markowska (2012) was selected:

- WORK_EDUC – percentage share of tertiary education workforce in the total workforce number in a region;
- LLL – percentage share of population aged 25–64 participating in life-long learning in a region;
- KIS – workforce in knowledge-intensive services as the percentage of the working population;
- KIS 2 – workforce in knowledge-intensive services as the percentage share of the population working in services;
- HRST – human resources for science and technology, i.e.: the total number of people actually employed in science and technology against the working population;
- HIT – workforce in high and mid-tech (as % of working population); and
- EPO – number of patents registered in a given year in the European Patent Office (EPO) per 1 million of the workforce.

The time span of the conducted research refers to two overlapping time periods, i.e.: 1999–2008 and 2008–2012. The reason for this division is the method of data presentation in the Eurostat database. It results from the new approach to the terminology used by the European Classification of Economic Activities (NACE) from 1997, which was updated and changed in 2008. The reasons for the changes in the international classification resulted from the dynamic transformations occurring in all sectors of economy and the development of new domains, especially those related to services as well as to information and communication technologies. Major differences

refer to business activities and therefore also those related to the job market, including e.g. the definitions of the workforce employed in the high-tech industry sectors and knowledge-intensive services, which resulted in a loss of comparability.

The missing values of the EPO have been fulfilled by linear trend estimates.

Complete data series were obtained by applying gap filling techniques such as: extrapolation and interpolation, specifying mean values for the missing information in the data series, spatio-temporal analogies, the method of nearest neighbours and the analysis of structures.

Due to the changes in defining some variables, a short set of characteristics of their diversification was presented, as well as of the entire analysis, in two time perspectives.

Global normalisation was conducted in order to calculate *W* innovation indicator, which required specifying, in each period of the study, one maximum and one minimum value based on a given variable value from all years altogether (Table 1). Global normalisation facilitates the comparison of indicator values, both dynamic and spatial, as well as in total; i.e.: it is possible to compare e.g.: the indicator value for region A in 2008 with the indicator value for region B in 2011.

Table 1. Global normalisation – reference points for the period 1999–2008 (Period I) and 2008–2012 (Period II)

Variable	Minimum		Maximum		Minimum shifted (–0,01)		Maximum shifted (+0,01)	
	I	II	I	II	I	II	I	II
HRST	8.50	12.81	63.10	72.29	8.49	12.80	63.11	72.30
HIT	0.44	0.31	22.27	20.69	0.43	0.30	22.28	20.70
KIS	7.37	14.71	61.09	65.99	7.36	14.70	61.10	66.00
KIS2	21.80	30.16	81.85	72.72	21.79	30.15	81.86	72.73
HIT2	1.95	4.01	58.97	70.38	1.94	4.00	58.98	70.39
WORK_EDUC	2.11	8.41	56.40	74.73	2.10	8.40	56.41	74.74
LLL	0.13	0.71	34.32	36.09	0.12	0.70	34.33	36.10
EPO	0.03	0.22	1 942.54	1 190.96	0.02	0.21	1 942.55	1 190.97

Source: own calculations.

Definitely, the most extensive diversification (evaluated as the quotient of the highest and the lowest value) was characteristic in this period for the EPO variable, with LLL and HIT to follow. Whereas in the cases of KIS, HRST and KIS 2, the ratio of extreme values was respectively: 8.3, 7.4 and 3.8. The dynamic evaluation of EU regional diversification based on the variation coefficient[2] level shows decreasing disproportions for seven variables (except HIT).

[2] Defined as the percentage of standard deviation ratio and the mean value.

The second analysed period covers 2008–2012. Additionally, in this case, just as it was true for the period 1999–2008, the global normalisation of variable values illustrating regional innovation was performed (see: Table 1).

Only in the case of the HIT variable was the increase of maximum to minimum relations observed, compared to the previous period. In case of the remaining variables, however, at almost unchanged sequences in the comparison of extreme values, the reduction of disproportions was recorded. The evaluation of the variable values' diversification by means of the variation coefficient indicated that diversification was higher for the HIT and HIT2 variables and remained at an unchanged level for EPO in the period 2008–2012, whereas for the remaining five variables the decreasing diversification was noticed in the European Union NUTS-2 level regions.

5. REGIONAL DIVERSIFICATION OF INNOVATION IN THE EU COUNTRIES IN THE PERIOD 1999–2008

The evaluation of the EU countries' diversification in terms of innovation covered both the trends of *W* innovation coefficient mean values and its standard deviation. In the latter case, the countries with one NUTS level region were obviously not analysed and, therefore, to compare trend parameters for *W* average value there are 27 observations, while only 21 for the standard deviation. The countries with regions whose mean *W* values were the highest at the beginning of the study included Sweden, Denmark and Finland, whereas the lowest were characteristic for Spain, Portugal and Romania (see: Table 2).

The rate of the innovation indicator (*W*) average changes in the analysed decade was different. There were growth rates higher than one (an average annual increase of the *W* indicator by 1% was recorded in such countries as Slovenia, Latvia and Italy), as well as negative rates (Cyprus, Sweden and Bulgaria).

The following countries are distinguished in terms of their average initial diversification level (SD) with reference to regional innovation:

- Spain, the Netherlands, Belgium and Hungary – the highest initial diversification; and
- Bulgaria, France and Poland – the lowest initial diversification.

As far as the rate of innovation diversification in the EU countries at the regional level is concerned, the highest average increase was observed, among others, in Slovakia, Poland and Denmark, whereas the average SD dropped in the Netherlands, Hungary and in Sweden (this situation referred to a total number of nine countries).

Using information from Table 2, Table 3 presents mutual relations referring to the value of average growth level of the innovation indicator against its standard deviation change (lower deviation indicates the convergence of regions – in terms of the analysed characteristics) in the period 1999–2008.

Table 2. Trend parameters for the period 1999–2008

Country	***a* aver.**	***b* aver.**	**p *b* aver.**	***a* SD**	***b* SD**	**p *b* SD**	**Ranks of average *W* slope**	**Ranks of SD slope**
AT	26.61	0.97	0.0001	5.22	0.006	0.8978	4	11
BE	40.65	0.34	0.0008	7.44	-0.059	0.1981	19	16
BG	23.29	-0.10	0.0924	3.35	0.092	0.0687	25.5	7
CZ	25.65	0.73	0.0002	5.44	0.004	0.9388	8	12
DE	39.66	0.54	0.0000	7.21	0.032	0.1896	16	10
DK	45.90	0.79	0.0000	5.20	0.121	0.0357	7	3
EL	12.43	0.54	0.0000	4.66	0.050	0.0993	15	9
Country	***a* aver.**	***b* aver.**	**p *b* aver.**	***a* SD**	***b* SD**	**p *b* SD**	**Ranks of average *W* slope**	**Ranks of SD slope**
ES	25.10	0.92	0.0000	9.43	-0.082	0.0005	5	17
FI	45.54	0.64	0.0005	5.46	-0.047	0.5704	13	15
FR	31.15	0.62	0.0000	3.87	0.083	0.1872	14	8
HU	26.20	0.48	0.0000	7.33	-0.152	0.0175	17	20
IE	30.53	0.71	0.0001	5.88	-0.108	0.0059	10	18
IT	21.75	0.99	0.0000	4.13	0.096	0.0045	3	6
NL	37.03	0.45	0.0035	8.31	-0.289	0.0035	18	21
PL	18.68	0.72	0.0000	3.87	0.124	0.0274	9	2
PT	12.99	0.69	0.0001	6.28	-0.021	0.5565	11	13
RO	15.77	0.33	0.0008	5.05	0.117	0.0054	20	4
SE	50.95	-0.10	0.6603	6.28	-0.116	0.0240	25.5	19
SI	28.03	1.27	0.0000	4.99	0.102	0.1184	1	5
SK	24.01	0.90	0.0001	6.49	0.300	0.0029	6	1
UK	42.85	0.18	0.0382	5.66	-0.042	0.2505	23	14
Single NUTS-2 countries								
CY	30.04	-0.43	0.2884	---	---	---	27	---
EE	30.69	0.32	0.0031	---	---	---	21	---
LT	33.52	0.65	0.0013	---	---	---	12	---
LU	31.13	0.05	0.7931	---	---	---	24	---
LV	27.90	1.12	0.0009	---	---	---	2	---
MT	34.77	0.30	0.0244	---	---	---	22	---

Symbols: a – intercept, b – slope, SD – standard deviation. Note: correlation coefficient significant at the level α =0.100 are marked in bold.

Source: own calculations.

While testing the significance for 8 degrees of freedom, the lower significance level of $\alpha = 0.1$ was adopted. The evaluation of the results indicates that, for the purposes of regional innovation level diversification alignment

in particular countries, a relative growth of the *W* innovation indicator mean value as well as the reduction of standard deviation were more favourable.

The majority of analysed countries (19 out of 21 from the group of countries with at least two NUTS-2 regions) recorded – at the regional level – a significant W mean value increase. A drop in the innovation indicator average between 1999–2008 was observed only in Sweden (insignificant) and Bulgaria (significant). In Sweden, a simultaneous reduction of regional diversification as well as an insignificant decline of the *W* indicator average level (at the highest initial level of average innovation level) was recorded in this matter, whereas in Bulgaria its increase was recorded. A significant increase in regional diversification in terms of the innovation indicator level (along with the simultaneous increase of average level) was noted at the regional level of countries such as Denmark, Greece, Italy, Poland, Romania and Slovakia.

Table 3. Trend changes for the period 1999–2008

Specification		**Standard deviation *W***			
		significant decline	**insignificant decline**	**insignificant growth**	**significant growth**
Average *W*	**significant growth**	ES, HU, IE, NL	BE, FI, PT, UK	AT, CZ, DE, FR, SI	DK, EL, IT, PL, RO, SK
	insignificant growth	---	---	---	---
	insignificant decline	SE	---	---	---
	significant decline	---	---	---	BG

Source: own calculations.

While comparing the average of the innovation indicator in the years 1999 and 2008 it should be emphasised that the percentage change of *W*'s standard deviation is negatively correlated with the average indicator level. Higher innovation level is favourable for regional convergence in this respect.

The evaluation also covered the average growth rate using the linear function against an average percentage growth (by an exponential function) – see: Figure 1. A very strong correlation, $r = 0.976$, refers to the relation of absolute and percentage changes in the first period.

A higher initial level of *W* indicator allows one to obtain an average larger reduction of W's standard deviation (see: Figure 2), i.e. regional convergence. The correlation, however, is rather small, since a SD drop of over 2% was recorded by both Hungary, with an initial average slightly over 25, and Sweden, with an initial average almost twice as high.

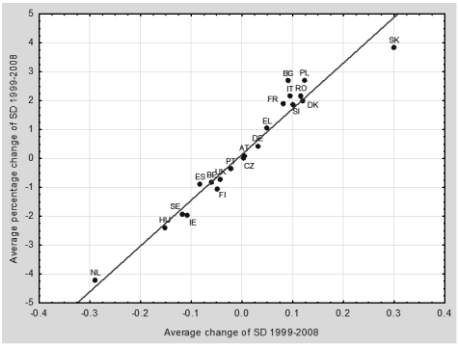

Figure 1. Relation between slopes of linear and exponential trends in SD

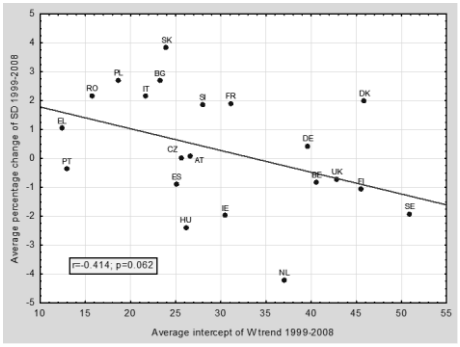

Figure 2. Relation between starting level of *W* and average percentage change of SD

Source: own calculations.

The correlation between the absolute change in standard deviation (r = -0.359) is not much smaller. It is statistically insignificant, however. The initial standard deviation level is significantly negatively correlated with both its absolute and percentage change.

6. REGIONAL DIVERSIFICATION OF INNOVATION IN THE EU COUNTRIES IN THE PERIOD 2008–2012

In the period 2008–2012, the first and last three countries in the regions where the initial mean value of the innovation indicator *W* was, respectively, the highest and the lowest constitute the same countries as in the period 1999–2008.

The highest average rate of *W* indicator changes occurs in the second period, even though it was half as long – for the regions of the first three EU countries ordered at the levels of 2.19 (Luxemburg), 1.97 (Ireland) and 1.67 (Portugal). For a total of 9 countries, it is equal to or greater than one. In this period, negative values of *W* indicator average rate of change were not recorded, whereas the lowest increases were characteristic for regions of Italy, the Netherlands and Bulgaria (see: Table 4).

A high average diversification of regional innovation levels in the initial analysed period was characteristic for Slovakia, Denmark and Spain, whereas a low average was characteristic for Austria, Italy and again for Poland. On the other hand, the growing rate of regional diversification changes was observed to the largest extent in Finland, Romania and Spain. The reduction

of diversification was true for Slovenia, Bulgaria and Portugal – the list includes a total of 9 countries. Among them, the following countries are repeated: Hungary, the Netherlands, Portugal and Great Britain, representing countries in which the regional disproportions in innovation level were subject to reductions in a longer period of time.

Table 4. Trend parameters for the period 2008–2012

Country	***a* aver.**	***b* aver.**	**p *b* aver.**	***a* SD**	***b* SD**	**p *b* SD**	**Ranks of average *W* slope**	**Ranks of SD slope**
AT	33,97	1.14	**0.0002**	4.19	0.260	0.1288	6	5
BE	46.00	0.55	**0.0013**	7.30	0.110	0.5952	22	8
BG	20.28	0.24	0.3351	5.29	-0.340	**0.0069**	25	20
CZ	31.88	0.92	**0.0024**	6.62	-0.220	0.3050	10	18
DE	45.23	0.41	**0.0858**	7.42	0.060	0.4928	24	9
DK	51.43	0.72	**0.0238**	8.91	0.280	**0.0446**	15	4
EL	17.97	0.84	**0.0314**	6.59	-0.170	0.4866	12	17
ES	29.57	1.26	**0.0002**	7.93	0.300	**0.0375**	5	3
FI	48.75	0.64	**0.0255**	6.02	0.610	0.3922	20	1
FR	37.62	0.78	**0.0423**	5.86	0.050	0.6428	14	10
HU	29.06	0.66	**0.0049**	4.65	-0.040	0.5750	19	16
IE	38.04	1.97	**0.0098**	4.45	0.010	0.9845	2	12
IT	27.80	0.02	0.9030	4.22	0.030	0.3971	27	11
NL	44.01	0.16	0.3934	4.83	-0.001	0.9551	26	13.5
PL	25.50	0.67	**0.0021**	4.29	-0.010	0.7382	17.5	15
Country	***a* aver.**	***b* aver.**	**p *b* aver.**	***a* SD**	***b* SD**	**p *b* SD**	**Ranks of average *W* slope**	**Ranks of SD slope**
PT	16.68	1.67	**0.0073**	5.89	-0.270	**0.0008**	3	19
RO	17.05	0.46	**0.0327**	6.36	0.510	**0.0065**	23	2
SE	50.71	0.71	**0.0088**	7.64	0.140	0.1547	16	7
SI	38.23	0.88	**0.0132**	7.68	-0.530	0.2312	11	21
SK	30.89	1.00	**0.0531**	10.12	0.230	0.1666	7	6
UK	43.88	0.79	**0.0084**	6.59	-0.001	0.9963	13	13.5
Single NUTS-2 countries								
CY	27.56	0.98	0.0701	---	---	---	8	---
EE	33.90	1.28	**0.0281**	---	---	---	4	---
LT	28.02	0.67	**0.0044**	---	---	---	17.5	---
LU	44.08	2.19	**0.0301**	---	---	---	1	---
LV	25.74	0.62	0.1717	---	---	---	21	---
MT	28.46	0.95	0.0809	---	---	---	9	---

Symbols: as in Table 2.

Source: own calculations.

Table 5 illustrates (based on the data from Table 4) the relation of the *W* indicator mean value increases with its standard deviation changes (this deviation reduction confirms regional convergence) in the period 2008–2012.

Table 5. Changes in the *W* average vs. changes in SD for the period 2008–2012.

Specification		Standard deviation *W*			
		significant decline	**insignificant decline**	**insignificant growth**	**significant growth**
Mean values *W*	**significant growth**	PT	CZ, EL, HU, PL, SI, UK	AT, BE, FI, FR, IE, SE, SK, DE	DK, ES, RO
	insignificant growth	BG	NL	IT	---
	insignificant decline	---	---	---	---
	significant decline	---	---	---	---

Source: own calculations.

Due to the fact that in the course of significance testing there were only 3 degrees of freedom, the smaller significance level $\alpha = 0.1$ was again adopted. The interpretation of the results – in line with the expected regional innovation improvement, along with the simultaneous equalisation of development levels in this matter – is as follows: in the case of the *W* innovation indicator mean value its increase was better, whereas it declined for the standard deviation.

In the case of the majority of the countries (18 out of 21) in the period 2008–2012, a significant increase of the innovation indicator mean value was recorded. In the context of reducing innovation level differences, the most favourable situation in a given country's regions occurred in Portugal during this period.

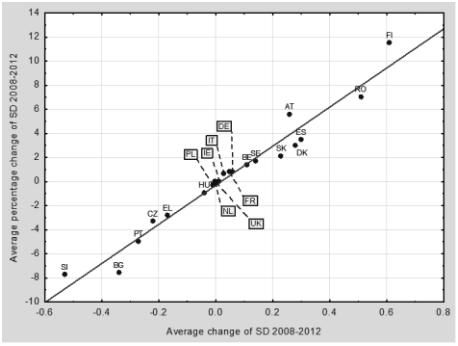

Figure 3. Correlation of linear and exponential slopes of SD trends

Source: own calculations.

The slow reduction of regional diversification along with the significant improvement of innovation level in relation to the initial value was recorded in the Czech Republic, Greece, Poland, Slovakia, Hungary and also in Great Britain. Meanwhile, in Romania, Spain and Denmark, the significant

improvement of the average innovation level was accompanied by an increase of regional diversification in this respect.

A comparison of the average increase rate by linear function against the average percentage increase (exponential function) in 2008–2012 is presented in Figure 3.

7. THE COMPARISON OF EVALUATION RESULTS FOR REGIONAL INNOVATION DIVERSIFICATION IN THE EU COUNTRIES IN BOTH TIME PERIODS

The next step was an attempt to compare the obtained results in terms of, among others: the *W* innovation indicator dynamics (Figure 4), interdependencies between the initial level of *W* and its annual average growth (Figure 5), the dynamics of standard deviation changes (Figure 6), the relation between the standard deviation initial level and its dynamics (Figure 7), and the relation between the average innovation indicator dynamics and the dynamics of standard deviation (Figure 8).

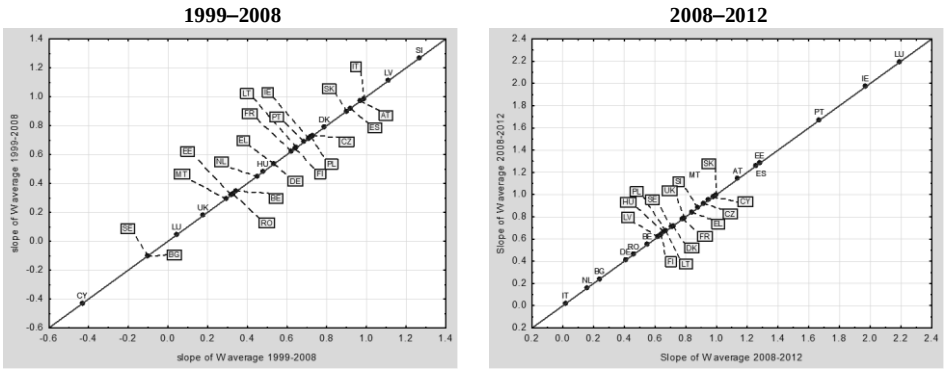

Figure 4. The dynamics of *W* indicator

Source: own calculations.

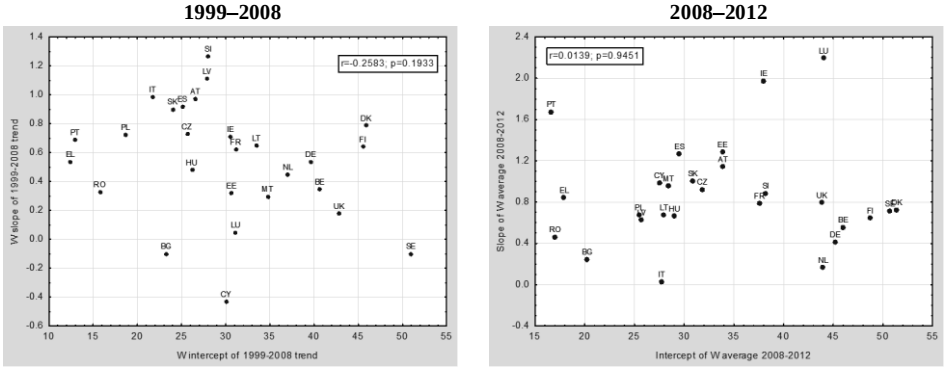

Figure 5. The relation between the initial level and annual average *W* increase

Source: own calculations.

Based on the data presented in Tables 2–5 as well as the analysis of Figures 4–8, it is possible to indicate countries in which *W* indicator increase was simultaneously accompanied in both analysed periods by:

– significant increase of regional diversification in terms of innovation: Denmark and Romania;
– insignificant increase of regional diversification in terms of innovation: Austria, Germany and France); and
– insignificant reduction of disproportions in relation to innovation: Great Britain.

Moreover, in Portugal, following an insignificant decline of regional innovation diversification in the first analysed period, the decline in the second one is significant. In contrast, in Bulgaria, after the initial significant growth of regional innovation diversification in the period 1999–2008, along with a significant decline of the average *W* indicator level a significant drop in diversification was recorded in terms of innovation at the NUTS-2 level, accompanied by an insignificant increase of *W* indicator mean values.

The initial decline in the average innovation level in Sweden and the reduction of regional diversification in the first analysed period were replaced by a level increase along with an insignificant regional diversification growth in this matter.

The observed phenomenon pictured on Figure 7 is rather obvious. It is much more difficult to reduce small diversification. The higher the initial regional diversification, the smaller the SD percentage change (and the higher the chance for diversification reduction).

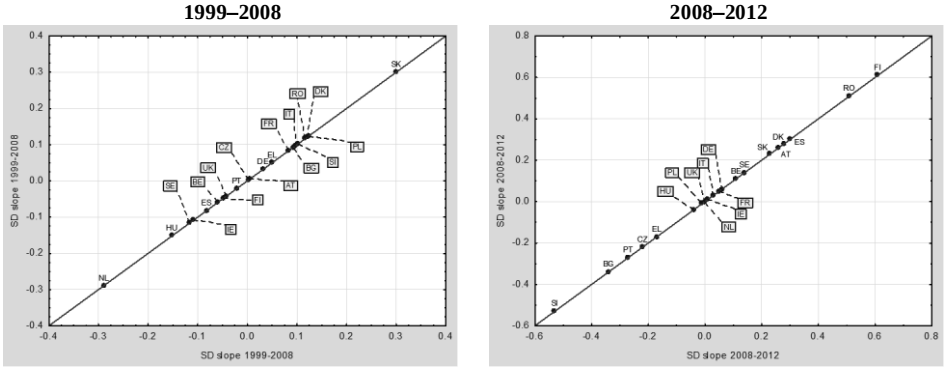

Figure 6. The dynamics of standard deviation changes

Source: own calculations.

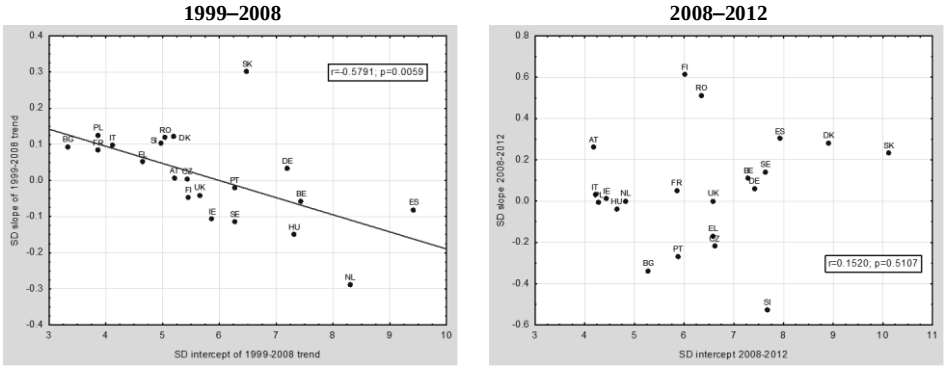

Figure 7. The relation of standard deviation initial level and its dynamics

Source: own calculations.

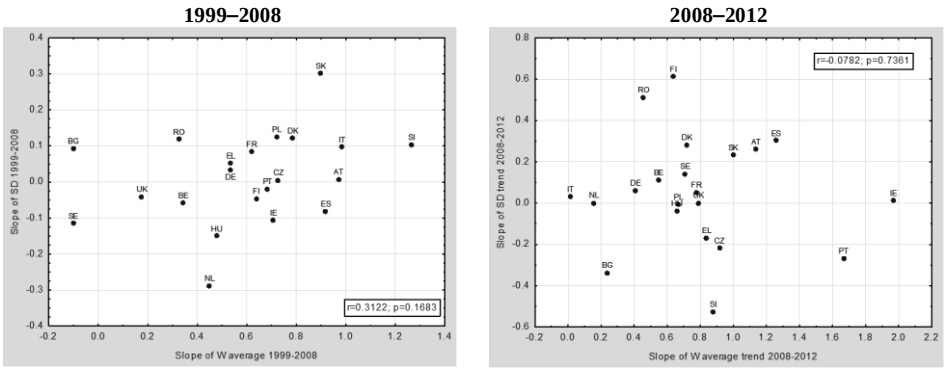

Figure 8. The relation of *W* mean value dynamics with the dynamics of standard deviation

Source: own calculations.

If Slovakia, a definite outlier, was eliminated, a reduction of regional diversification (i.e.: SD reduction) was recorded in all countries excluding Germany, for which the initial indicator standard deviation amounted to at least 6.

Table 6. Correlation matrix of trend coefficients

Variable	*a* aver. I	*b* aver. I	*a* SD I	*b* SD I	*a* aver. II	*b* aver. II	*a* SD II	*b* SD II
***a* aver. I**	1.0000	-0.2583	0.2681	-0.3594	**0.8977**	-0.1365	0.2882	0.3275
	N=27	N=27	N=21	N=21	**N=27**	N=27	N=21	N=21
	p=---	p=0.193	p=0.240	p=0.110	**p=0.000**	p=0.497	p=0.205	p=0.147
***b* aver. I**	-0.2583	1.0000	0.0201	0.3122	-0.0733	-0.0240	0.0649	-0.0368
	N=27	N=27	N=21	N=21	N=27	N=27	N=21	N=21
	p=0.193	p=---	p=0.931	p=0.168	p=0.716	p=0.905	p=0.780	p=0.874
***a* SD I**	0.2681	0.0201	1.0000	**-0.5791**	0.2908	0.1738	0.0649	0.2298
	N=21	N=21	N=21	**N=21**	N=21	N=21	N=21	N=21
	p=0.240	p=0.931	p=---	**p=0.006**	p=0.201	p=0.451	p=0.196	p=0.316
***b* SD I**	-0.3594	0.3122	**-0.5791**	1.0000	-0.3255	-0.0629	**0.3916**	0.0023
	N=21	N=21	**N=21**	N=21	N=21	N=21	**N=21**	N=21
	p=0.110	p=0.168	**p=0.006**	p=---	p=0.150	p=0.786	**p=0.079**	p=0.992
***a* aver. II**	**0.8977**	-0.0733	0.2908	-0.3255	1.0000	0.0139	0.2928	0.2928
	N=27	N=27	N=21	N=21	N=27	N=27	N=21	N=21
	p=0.000	p=0.716	p=0.201	p=0.150	p=---	p=0.945	p=0.198	p=0.198
***b* aver. II**	-0.1365	-0.0240	0.1738	-0.0629	0.0139	1.0000	0.0720	-0.0782
	N=27	N=27	N=21	N=21	N=27	N=27	N=21	N=21
	p=0.497	p=0.905	p=0.451	p=0.786	p=0.945	p=---	p=0.756	p=0.736
***a* SD II**	0.2882	0.0649	0.0649	**0.3916**	0.2928	0.0720	1.0000	0.1520
	N=21	N=21	N=21	**N=21**	N=21	N=21	N=21	N=21
	p=0.205	p=0.780	p=0.196	**p=0.079**	p=0.198	p=0.756	p=---	p=0.511
***b* SD II**	0.3275	-0.0368	0.2298	0.0023	0.2928	-0.0782	0.1520	1.0000
	N=21	N=21	N=21	N=21	N=21	N=21	N=21	N=21
	p=0.147	p=0.874	p=0.316	p=0.992	p=0.198	p=0.736	p=0.511	p=---

Symbols: as in Table 2.

Source: own calculations.

The relations between the parameter values of innovation indicator trends as well as standard deviation parameter trends in both analysed periods were also evaluated by applying correlation coefficients. For this, see: Table 6 above.

The data included in the correlation matrix confirm the following:

– a strong (0.898) positive correlation occurs between initial (start) values in the trends of the mean aggregate values of the *W* innovation indicator in the course of both analysed periods, indicating the persistence of the situation. This is also illustrated by the almost unchanged sequence of the EU countries' ordering in terms of *W* mean values (see: also Figure 9);

– a low (high) SD initial level (of diversification) in the first analysed period remains strongly (negatively) correlated with the indicator value of the SD

directional trend, confirming the reduction of diversification in EU countries at regional level in terms of the innovation level; and

– a positive relation between the rate of changes (the values of the SD directional trend in the first period) and the initial value of the average innovation diversification in the second analysed period confirms that the observed declines in Period I influence the reduction of diversification at the "*start*" of the second period.

It is characteristic that no significant correlations were recorded in the second period except the obvious relation between the average changes in SD values and percentage values. It can be assumed that the short time period is not a reason here, but rather the global economic crisis to which different countries and regions reacted in diverse ways.

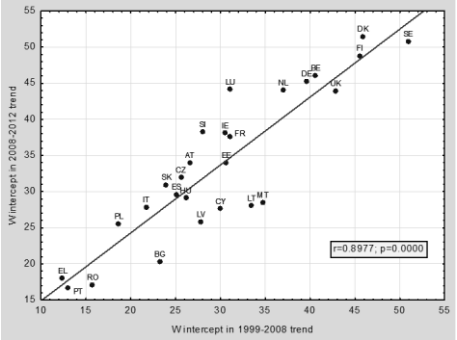

Figure 9. Comparison of the initial values (theoretical initial level in the first analysed year) of *W* mean trends from both periods

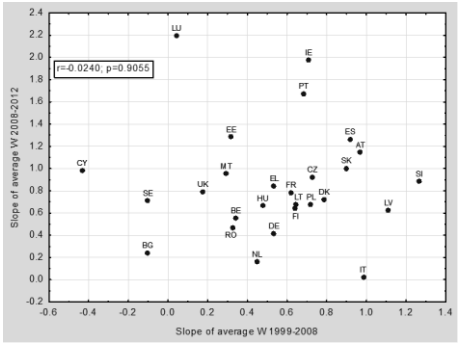

Figure 10. Comparison of the mean dynamics value of *W* standard deviations (b parameter) in both periods

Source: own calculations.

The strong correlation of the initial levels (calculated even according to a slightly different terminology) indicates that in the first analysed period, no distinctive differences in the EU countries innovation level occurred. It is interesting to note the presence four countries with one NUTS-2 level region – LV, CY, LT and MT – next to each other (Figure 9).

It is worth noting the absence of any significant correlation between the following values (see: data in Table 6):

– average *W* dynamics in both analysed periods (Figure 10),
– initial SD levels (Figure 11),
– SD dynamics in the first and the second period (Figure 12).

Another interdependence, which is illustrated below (Figure 13), is difficult to interpret. If attention is paid to the points presenting positive SD percentage changes (i.e.: diversification increase), it refers to these countries that achieved the lowest *W* average level (significantly below 30) in 2008.

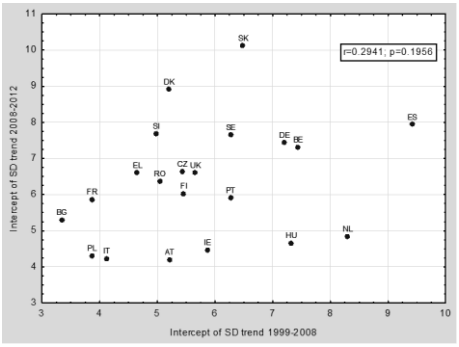

Figure 11. Comparison of the initial values of SD average trends in both periods

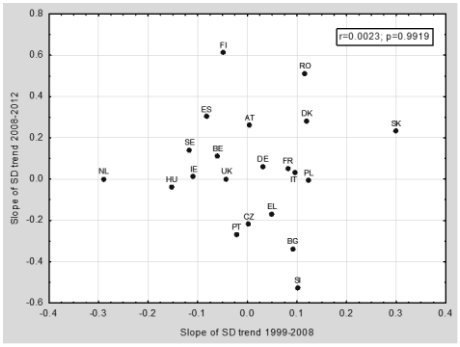

Figure 12. Comparison of the average SD dynamics (b parameter) in both periods

Source: own calculations.

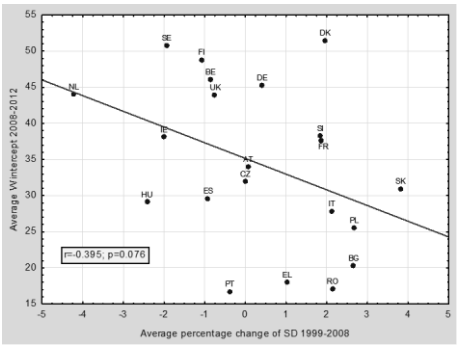

Figure 13. Correlation between average percentage changes in SD within 1999–2008 and intercept of the W average from 2008–2012

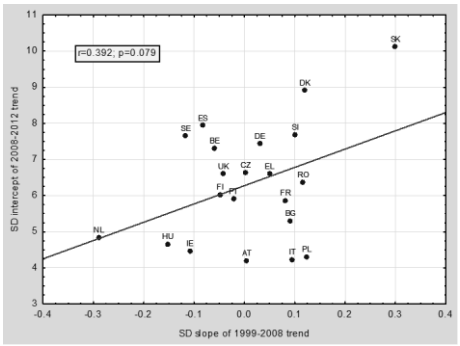

Figure 14. Correlation between the SD slope in 1999–2008 and intercept in 2008–2012

Source: own calculations.

On the other hand, the correlation illustrated by Figure 14 between the directional coefficient of the standard deviation trend in the period 1999–2008 and the trend initial point in 2008 is rather obvious. Positive correlation means that the diversification increase in the first analysed period should be interpreted that the SD in the second period "*started*" from a higher level.

8. CONCLUSIONS

The performed evaluation indicates that if the particular measures applied in specifying the *W* synthetic innovation indicator are analysed in terms of their changeability, then, compared to the first analysis period, the diversification for HIT and HIT2 variables increased and did not change for the EPO. However, in the case of the KIS, KIS2, LLL, HRST and WORK_EDUC variables, diversification decline was observed in the EU NUTS-2 level regions.

The initial mean value of the *W* innovation indicator in the first evaluated period (calculated based on mean values of all evaluated countries in NUTS-2 level regions) amounted to 30.1 and 33.8 in the second one. The minimum values were 12.4 and 16.7, and the maximum values were 50.95 and 51.4. The quotient of extreme values dropped from 4.1 in the first period down to 3 in the second.

In the first analysed period, a regional mean *W* value above 40 calculated for the occurring trends was characteristic for Belgium, Denmark, Finland, Sweden and Great Britain. In the second period, these countries were joined by Germany and Luxembourg. An average *W* indicator (initial value) lower than 20 was recorded in Greece, Poland, Portugal and Romania; in the second period, Greece, Portugal and Romania remained in this group.

Following the application of standard deviation, the evaluation of changes in regional innovation diversification in the EU countries indicated that:

– in the period 1999–2008, the highest initial average regional diversification level was characteristic for Spain, the Netherlands, Belgium and Hungary, and in the period 2008–2012 for Slovakia, Denmark and again Spain;

– the lowest level was observed in the first period in Bulgaria, France and Poland, while in the second one this was true for Austria, Italy and again Poland;

– the highest average diversification increase in terms of regional innovation in the period 1999–2008 was recorded in countries such as Slovakia, Poland and Denmark, and in the years 2008–2012 in Finland, Romania and Spain; and

– the reduction of regional disproportions (evaluated based on the rate of SD changes) in innovation was characteristic for the Netherlands, Sweden, Hungary, Ireland, Spain and Great Britain in the first period, and for Slovenia, Bulgaria, Portugal and Spain in the second period.

Hungary, the Netherlands, Portugal and Great Britain are listed among the countries with regions where the reduction of disproportion in innovation was observed in both of the analysed periods.

Despite the higher regional mean value of the *W* indicator in the first analysed period, a reverse tendency as well as low SD indicator and its initial growth was recorded for the regional space of Poland. In the second period, increased *W* values were accompanied by diversification decline (albeit statistically insignificant). In both periods, however, the initial SD value (average diversification) was still relatively low compared to the other EU countries.

REFERENCES

European Innovation Scoreboard 2002: EU Regions (2002), European Trend Chart on Innovation, Technical Paper No 3, European Commission.

Europe 2020. A strategy for smart and sustainable development fostering social inclusion (2010), Communication from the European Commission, COM(2010) 2020, final version, Brussels.

Hollanders H., Es-Sadki N. (2014), *Innovation Union Scoreboard 2014*, Enterprise and Industry, European Union.

Hollanders H., Es-Sadki N., Buligescu B., Leon L. R., Griniece E., Laura Roman L. (2014), *Regional Innovation Scoreboard 2014*, Enterprise and Industry, European Commission, 2014

Markowska M. (2012), *Dynamiczna taksonomia innowacyjności regionów*, Wrocław University of Economics Publishing House.

Nowakowska A. (2009), *Regionalny kontekst procesów innowacji*, (in:) Nowakowska A. (ed.), *Budowanie zdolności innowacyjnych regionów*, Wydawnictwo Biblioteka, Łódź.

ABSTRACT

The measurement of innovation, the role of which in economic processes is mainly analysed in the context of competitive position, is applied in the assessment of both enterprises and economy sectors, as well as with reference to particular countries, regions and municipalities. Innovative activities, as M. E. Porter emphasises, allow for particular territories to achieve a competitive advantage.

The objective of this paper is to present the results of seeking an answer to the question about the changes which have occurred in regional innovation diversification in the European Union countries in the period 1999–2012.

The realisation of this defined goal requires determining the value of the innovation indicator for each EU NUTS-2 level region based on the characteristics describing regional innovation in dynamic perspective. The study presents an algorithm for this indicator specification, as well as the statistical properties it covers.

This is followed by calculating the standard deviation for the EU regions in each year of the study (excluding countries with just one NUTS-2 level region). The estimated linear and exponential trends, including the slope coefficients significance testing, are to indicate the countries characterised by stable diversification as well as those where regional differences became more extensive.

ANALIZA DYNAMIKI REGIONALNEGO ZRÓŻNICOWANIA INNOWACYJNOŚCI W KRAJACH UE, W LATACH 1999–2012

ABSTRAKT

Pomiar innowacyjności, której rola w procesach gospodarczych rozpatrywana jest w głównej mierze w kontekście pozycji konkurencyjnej, znajduje zastosowanie w ocenie zarówno przedsiębiorstw jak i sektorów gospodarki, ale także poszczególnych państw, regionów i gmin. Działania innowacyjne, jak podkreśla M. E. Porter, pozwalają bowiem na osiągnięcie przewagi konkurencyjnej określonych terytoriów.

Celem artykułu jest przedstawienie wyników poszukiwania odpowiedzi na pytanie jak zmieniało się regionalne zróżnicowanie innowacyjności w krajach Unii Europejskiej, w latach 1999–2012.

Realizacja tak postawionego celu wymagała ustalenia wartości wskaźnika innowacyjności, dla każdego regionu Unii Europejskiej szczebla NUTS 2, na podstawie charakterystyk opisujących regionalną innowacyjność w ujęciu dynamicznym. W pracy przedstawiony zostanie algorytm ustalania tego wskaźnika oraz cechy statystyczne, które on obejmuje.

W następnym kroku dla regionów krajów UE dla każdego roku z okresu badanego obliczone zostało odchylenie standardowe (z wyłączeniem krajów obejmujących tylko jeden region szczebla NUTS2). Oszacowane trendy liniowe i wykładnicze, wraz z testowaniem istotności współczynników kierunkowych wskazały kraje, w których obserwowano zmniejszające się regionalne zróżnicowanie innowacyjności, kraje o stabilnym zróżnicowaniu oraz kraje gdzie te różnice regionalne uległy pogłębieniu.