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ECONOMIC INFRASTRUCTURE AS FACTOR OF THE REGION'S COMPETITIVENESS

Abstract

The paper presents results of an evaluation on Polish regions' spatially-diversified competitiveness, and their associated economic infrastructure. On this base, an interdependence between the regions' competitiveness and their infrastructure development was analyzed. For the analyis, taxonomical measures were used, calculated by the Z. Hellwig method, based on diagnostic variables, and depicting various aspects of the competitiveness and state of the economic infrastructure of each region.

JEL Classification Code: **R11, C15**.

Keywords: economic infrastructure, regions' competitiveness, Z. Hellwig method.

Introduction

A region's competitiveness is its ability to achieve positive results both in economic growth and social welfare levels as compared to other regions. To create the regions' competitiveness scales, the most important factors are the endogenous potential elements (Alarcón 2004, p. 73), including the economic infrastructure, ranging from devices and objects used for transportation communications, energy, irrigation, and land reclamation services (Wojewódzka-Król, 2002, p. 13). They are confirmed by domestic and international analyses (Calderón, Servén 2004; Gardiner, Martin, Tyler 2004; Ratajczak 1999). The economic infrastructure is a factor affecting labor productivity and capital. Its development leads to the reallocation of the economic

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activity. Infrastructure investments are necessary due to the insufficient condition of capital inflow. Regions' activation strategies using economic infrastructure development, mainly transportation, lead to increasing the openness of regions and can contribute into the competitive product inflow from other areas (Rossert 2000, p. 130). In the evaluation of regions' competitiveness, it is possible to exploit a wide set of measures (cf. e.g. Herb 2005). GDP per capita, and value added, are synthetic measures of the competitiveness which reflect the result of actions in many models of a region's competitiveness included i.e. in the Pyramid of Competitiveness (Gardiner, Martin, Tyler 2004) and that of the Competitiveness (Martin, 2003). Considering presented premises, an evaluation of the interdependence between the Polish regions' competitiveness and their economic infrastructure equipment was accepted as the fundamental purpose of the article. Methodological evaluation and its results are presented in the next sections of the article.

1. Methodological evaluation of regions' competitiveness and their economic infrastructure equipment

The assessment of the regions' competitiveness and their economic infrastructure equipment was conducted using the Z. Hellwig method (Hellwig 1968) which enables constructing the synthetic index according to a fragmentary variables diagnostic, reflecting various aspects of analyzed facets.

Next stages of the analysis included:
- creating the preliminary list of diagnostic denominators,
- creating the final set of diagnostic denominators,
- standardization of diagnostic denominators,
- constructing the fragmentary, synthetic and general taxonomical indexes,
- distinguishing groups of competitiveness levels (Kolenda 2006; Panek 2009).

The preliminary list of diagnostic denominators included all indicators, available in public statistics, referring to various aspects of the regions' competitiveness. In creating the final set of diagnostic indicators based on this list, variables - characterized by a relatively high diversity - were selected. Variables were determined according to the classical variation coefficient. They assumed that weak diagnostic properties are those denominators, for which the classical variation coefficient based on the standard deviation, is smaller than the threshold value of 10%. As a result of the elimination of unimportant indicators -for which the variation coefficient was smaller than 10%- , a final set of diagnostic indicators was received. It is a base for the further analysis, and a basis for the calculation for every variable of the synthetic index.

The diagnostic variable set of the region's competitiveness and economic infrastructure equipment evaluation is described in Table 1. The variables' values were assumed according to data collected under the public statistics and disclosed by

the Central Statistical Office. Accepting such a source ensured the comparability of statistical data and their relatively high credibility. A quality system existing in GUS guarantees these statistical denominators (GUS 2014).

Table 1. The diagnostic variable set of the region's competitiveness and economic infrastructure equipment evaluation

Taxonomical Index		Diagnostic Variables	
Symbol	Name	Symbol	Name
Region's Competitiveness Evaluation Indexes			
x_1	Macroeconomic Indexes	$x_{1.1}$	GDP per capita [PLN]
		$x_{1.2}$	Total value added [PLN]
Economic Infrastructure Equipment Indexes			
x_2	Transport Infrastructure	$x_{2.1}$	density of regional, commune province roads with a hard surface [km/100 km^2]
		$x_{2.2}$	density of regional, commune province roads with a hard improved surface [km/100 km^2]
x_3	Water Supply Infrastructure	$x_{3.1}$	density of a waterworks distribution network [km/100 km^2]
		$x_{3.2}$	number of waterworks combinations connected with residential buildings and collective settling per 1 km^2
		$x_{3.3}$	consuming water from the water supply system per 1 resident
x_4	Sewerage infrastructure	$x_{4.1}$	density of the sewer distribution network [km/100 km^2]
		$x_{4.2}$	number of sewer combinations connected with residential buildings and collective settling per 1 km^2
		$x_{4.3}$	sewers seen off to 1 resident
x_5	Gas Infrastructure	$x_{5.1}$	density of an active gas network [km/100 km^2]
		$x_{5.2}$	active combinations connected with residential buildings and collective settling per 1 km^2
		$x_{5.3}$	residential buildings and collective settling per 1 km^2
x_6	Energy Infrastructure	$x_{6.1}$	electricity consumption per 1 resident
		$x_{6.2}$	density of the heat distribution network [km/100 km^2]
		$x_{6.3}$	sale of the thermal energy [GJ/1000 people]

Source: Own study.

The necessary condition to set the synthetic index of the regions' competitiveness and their economic infrastructure equipment correctly is their denominators standardization, in which the variables will be comparable and their character standardized by transforming de-stimulants into stimulants (Grabiński, Wydymus, Zeliaś 1989, p. 27).

In the regions' competitiveness evaluation, the denominators standardization was done by conducting the standardization *j*-th variable in *i*-th region. The calculations were done using following formulas:
– for stimulants:

$$t_{ij} = \frac{x_{ij} - \bar{x}}{S_j}$$

– for de-stimulants:

$$t_{ij} = -\frac{x_{ij} - \bar{x}}{S_j}$$

where:
t_{ij} – standardized value of *j*-th index in *i*-th subdivision,
x_{ij} – value of *j*-th denominator in *i*-th subdivision,
$\bar{x}$ – the arithmetic mean of *j*-denominator value,
S_j – standard deviation in x_j denominator distribution.

Using the final set of diagnostic indicators after the standardization, values of Hellwig taxonomical indexes of development were calculated for each region, i.e. synthetic indexed were calculated for each of distinguished variables and fragmentary indexes - for aspects distinguished under individual areas.

In the Hellwig method, according to the matrix of standardized variables, a model object of following coordinates was set:

$$O = [x_{0j}]$$

where:
$x_{0j} = max_i \{t_{ij}\}$ – for stimulants,
$x_{0j} = min_i \{t_{ij}\}$ – for de-stimulants,
t_{ij} – standardized value of *j*-th index in *i*-th subdivision.

Calculating the synthetic index of the regions competitiveness only the formula for stimulants was used, because amongst the denominators admitted to the evaluation there weren't any de-stimulants.

The next step was to set the Euclidean distance from the model object:

$$d_{i0} = \sqrt{\sum_{j=1}^{m} (t_{ij} - x_{0j})^2}$$

where:
d_{i0} – Euclidean distance between i-th and the model object,
t_{ij} – standardized value of *j*-th index in *i*-th subdivision,
$i = 1, 2, \ldots, n$,
$j = 1, 2, \ldots, m$.

Considering presented assumptions it is possible to calculate the synthetic index from the following formula:

$$S_i = 1 - \frac{d_{i0}}{d_0}$$

where:
d_{i0} – Euclidean distance between i-th and the model object,
d_0 – the unit critical distance from the model:

$$d_0 = \bar{d}_{i0} + 2 \cdot S_0$$

$\bar{d}_{i0}$ – arithmetic mean of taxonomical distances between the object i-th and the model object:

$$\bar{d}_0 = \frac{1}{n} \cdot \sum_{i=1}^{n} d_{i0}$$

S_0 – standard deviation of taxonomical distances between i-th and the model object:

$$S_0 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_{i0} - \bar{d}_0)^2}$$

In the above model, the synthetic index of the regions competitiveness and their equipping with the economic infrastructure the Si assumes values from the period [0.1]. Maximum value of the Si index (1) reflects the so-called model, i.e. the region, in which all analyzed variables accept the maximum values.

In the adopted method, along with increasing the value of the synthetic index, both the region's competitiveness or a level of equipping it with the infrastructure also increase. Differences between indexes show a distance in the development of individual regions.

2. Spatial diversity of a region's competitiveness

In the evaluation of a region's competitiveness, the following indicators (Table 2) were taken into account:
– GDP per capita,
– total gross value added.

GDP per capita of mazowieckie region is about 80% higher than the average in Poland and about 44% higher than in the second in turn dolnośląskie region. A gross value added is also much higher. In consequence this region is characterized by the

highest competitiveness. Relatively maximum values of the competitiveness synthetic index were reached śląskie, wielkopolskie and dolnośląskie regions.

Table 2. Calculating the synthetic index of the regions competitiveness

Region	Variable Value		Standardized Variable Value		Euclidean Distance	Synthetic Index
	$x_{5.51}$	$x_{5.52}$	$t_{5.51}$	$t_{5.52}$	$d_{5.5}$	$S_{5.5}$
Dolnośląskie	44 961.00	115 163	0.958	0.440	3.34	0.53
Kujawsko-pomorskie	32 596.00	60 077	-0.342	-0.336	4.79	0.33
Lubelskie	26 919.00	51 428	-0.939	-0.457	5.31	0.25
Lubuskie	32 795.00	29 474	-0.321	-0.767	5.09	0.28
Łódzkie	36 750.00	81 919	0.095	-0.028	4.26	0.40
Małopolskie	34 107.00	100 098	-0.183	0.228	4.28	0.40
Mazowieckie	64 790.00	300 184	3.044	3.047	0.00	1.00
Opolskie	31 771.00	28 344	-0.429	-0.783	5.17	0.27
Podkarpackie	26 801.00	50 096	-0.952	-0.476	5.33	0.25
Podlaskie	28 485.00	30 077	-0.774	-0.758	5.39	0.24
Pomorskie	37 822.00	75 727	0.207	-0.115	4.25	0.40
Śląskie	42 830.00	174 198	0.734	1.272	2.91	0.59
Świętokrzyskie	29 552.00	33 233	-0.662	-0.714	5.28	0.26
Warmińsko-mazurskie	28 635.00	36 551	-0.759	-0.667	5.32	0.25
Wielkopolskie	41 285.00	125131	0.572	0.581	3.49	0.51
Zachodniopomorskie	33 485.00	50685	-0.249	-0.468	4.82	0.32
Arithmetic mean	35 849.00	83 899.06	0.00	0.00	4.31	0.39
Standard Deviation	9 508.90	70 976.77	1.00	1.00	1.39	0.20
Variation Coefficient	27%	85%			32%	50%
Max	64 790.00	300 184	3.04	3.05	5.39	1.00
Min	26 801	28 344	-0.95	-0.78	0.00	0.24

Source: Own study, based on GUS data.

3. Spatial diversity of a region's economic infrastructure equipment

Transportation infrastructure

Analysis of transportation infrastructure spatial diversity was based on the density of regional, commune, province roads with a hard surface and density of railway lines (Tab. 3.). The calculated synthetic index of the infrastructure development is characterized by the highest level of the changeability (the variation coefficient is 50%), and span between the region with the highest and the lowest equipment level is – 5,4.

Śląskie region is characterized by the highest synthetic index value. The density of roads in this region is 179.6 km/100 km^2 and is almost two times higher than the average in Poland, and over three times higher than in the region with the lowest transport

infrastructure equipment (Warmińsko-mazurskie region). Śląskie region also has the best developed rail grid. The density of the rail line is 2.5 - times higher than the average in Poland, and 3.5 – times higher than in the region with the lowest density.

Table 3. Calculating the taxonomical index of a regions' transport infrastructure equipment

Region	Variable value		Standardized variable value		Euclidean distance	Synthetic index
	$x_{6.11}$	$x_{6.12}$	$t_{6.11}$	$t_{6.12}$	$d_{6.1}$	$S_{6.1}$
Dolnośląskie	94.37	8.9	0.030	0.612	3.63	0.46
Kujawsko-pomorskie	89.61	7.0	-0.107	0.012	4.18	0.38
Lubelskie	84.89	4.1	-0.243	-0.904	5.01	0.26
Lubuskie	59.23	6.9	-0.981	-0.020	4.79	0.29
Łódzkie	108.54	5.8	0.438	-0.367	4.19	0.38
Małopolskie	157.82	7.4	1.856	0.138	3.22	0.52
Mazowieckie	97.27	4.8	0.113	-0.683	4.63	0.31
Opolskie	90.04	9.2	-0.095	0.706	3.65	0.46
Podkarpackie	84.89	5.7	-0.243	-0.398	4.59	0.32
Podlaskie	61.03	3.8	-0.930	-0.998	5.48	0.19
Pomorskie	67.68	6.8	-0.738	-0.051	4.64	0.31
Śląskie	179.58	17.4	2.482	3.295	0.00	1.00
Świętokrzyskie	114.72	6.2	0.616	-0.241	4.00	0.41
Warmińsko-mazurskie	53.27	5.1	-1.153	-0.588	5.32	0.21
Wielkopolskie	91.17	7.0	-0.062	0.012	4.15	0.38
Zachodniopomorskie	59.19	5.3	-0.983	-0.525	5.16	0.23
Arithmetic mean	93.33	6.96	0.00	0.00	4.17	0.38
Standard Deviation	34.75	3.17	1.00	1.00	1.28	0.19
Variation Coefficient	37%	46%			31%	50%
Max	179.58	17.40	2.48	3.29	5.48	1.00
Min	53.27	3.8	-1.15	-1.00	0.00	0.19

Source: Own study, based on GUS data.

Water supply infrastructure

In the aspect of water supply infrastructure, three diagnostic denominators were used to construct the fragmentary index (Tab. 4), where two denominators describe a region's water supply infrastructure equipment, and the third one shows its use level, i.e.

- density of the waterworks distribution network [km/100 km^2],
- number of waterworks combinations connected with residential buildings and collective settling per 1 km^2.
- consuming water from the water supply system per 1 resident.

Table 4. Calculating the taxonomical index of a region's water supply infrastructure equipment

Region	Variable value			Standardized variable value			Euclidean distance	Synthetic index
	$x_{6.21}$	$x_{6.22}$	$x_{6.23}$	$t_{6.21}$	$t_{6.22}$	$t_{6.23}$	$d_{6.2}$	$S_{6.2}$
Dolnośląskie	72	43	31.5	-0.554	0.758	0.256	3.47	0.41
Kujawsko-pomorskie	123	21	32.1	1.015	-1.263	0.416	3.96	0.33
Lubelskie	79	44	26.6	-0.338	0.849	-1.048	3.97	0.33
Lubuskie	47	27	30.0	-1.323	-0.712	-0.143	4.99	0.16
Łódzkie	121	31	34.5	0.954	-0.344	1.054	3.01	0.49
Małopolskie	117	36	26.6	0.831	0.115	-1.048	3.71	0.37
Mazowieckie	116	60	36.5	0.800	2.319	1.587	1.45	0.75
Opolskie	74	22	29.0	-0.492	-1.171	-0.409	4.86	0.18
Podkarpackie	75	40	22.2	-0.461	0.482	-2.219	5.02	0.15
Podlaskie	62	29	30.9	-0.861	-0.528	0.096	4.47	0.24
Pomorskie	78	32	32.9	-0.369	-0.253	0.629	3.79	0.36
Śląskie	163	35	29.8	2.245	0.023	-0.196	2.91	0.51
Świętokrzyskie	109	21	26.6	0.584	-1.263	-1.048	4.75	0.20
Warmińsko-mazurskie	60	27	30.6	-0.923	-0.712	0.017	4.66	0.21
Wielkopolskie	99	50	35.5	0.277	1.400	1.321	2.19	0.63
Zachodniopomorskie	45	38	33.3	-1.384	0.298	0.735	4.24	0.28
Arithmetic mean	90.00	34.75	30.54	0.00	0.00	0.00	3.84	0.35
Standard Deviation	32.51	10.89	3.76	1.00	1.00	1.00	1.03	0.17
Variation Coefficient	36%%	31%	12%				27%	50%
Max	163.00	60.00	36.50	2.25	2.32	1.59	5.02	0.75
Min	45.00	21.00	22.20	-1.38	-1.26	-2.22	1.45	0.15

Source: Own study, based on GUS data.

Calculated synthetic indexes show the high diversity in the regions' water supply infrastructure equipment. The variation coefficient is about 50%, and the span between the region with the highest and the lowest infrastructure development level is 5.

Mazowieckie region contains the highest level of water supply infrastructure equipment. The value of the taxonomical index in this region was 0.75. In the group with the highest development level of the water supply infrastructure are the Wielkopolskie (0.63) and Sląskie (0.51) regions.

Sewerage infrastructure

Region's sewer infrastructures are described by three diagnostic variables (Tab. 5). Much like with the water supply system, the first two denominators described regions' sewer infrastructure equipment, the third reflects its use level:

– density of the sewer distribution network [km/100 km^2],

– sewers seen off to 1 resident,
– number of sewer combinations connected with residential buildings and collective settling per 1 km^2.

Table 5. Calculating the taxonomical index of a regions' sewerage infrastructure equipment

Region	Variable value			Standardized variable value			Euclidean distance	Synthetic index
	$x_{6.31}$	$x_{6.32}$	$x_{6.33}$	$t_{6.31}$	$t_{6.32}$	$t_{6.33}$	$d_{6.3}$	$S_{6.3}$
Dolnośląskie	43.8	42	50.6	0.146	0.003	0.038	4.09	0.31
Kujawsko-pomorskie	38.7	35	51.6	-0.075	-0.381	0.218	4.38	0.26
Lubelskie	19.3	55	47.1	-0.915	0.717	-0.591	4.79	0.19
Lubuskie	21.4	28	46.2	-0.824	-0.765	-0.753	5.55	0.06
Łódzkie	28.4	43	57.7	-0.521	0.058	1.314	4.03	0.32
Małopolskie	70.1	33	58.1	1.285	-0.491	1.386	3.37	0.43
Mazowieckie	31.8	88	62.5	-0.374	2.529	2.177	2.92	0.50
Opolskie	35.3	23	48.6	-0.222	-1.040	-0.321	5.16	0.12
Podkarpackie	77.2	30	43.2	1.593	-0.655	-1.292	4.81	0.18
Podlaskie	14.2	55	45.6	-1.136	0.717	-0.860	5.11	0.13
Pomorskie	45.3	37	45.5	0.211	-0.271	-0.878	4.76	0.19
Śląskie	99.3	29	45.3	2.550	-0.710	-0.914	4.48	0.24
Świętokrzyskie	36.3	23	51.4	-0.179	-1.040	0.182	4.92	0.17
Warmińsko-mazurskie	22.2	36	47.2	-0.790	-0.326	-0.573	5.18	0.12
Wielkopolskie	34.9	75	49.3	-0.240	1.815	-0.195	3.73	0.37
Zachodniopomorskie	28.7	39	56.3	-0.508	-0.161	1.063	4.22	0.28
Arithmetic mean	40.43	41.94	50.39	0.00	0.00	0.00	4.47	0.24
Standard Deviation	23.09	18.21	5.56	1.00	1.00	1.00	0.71	0.12
Variation Coefficient	57.10%	43.43%	11.04%				15.96%	50.00%
Max	99.30	88.00	62.50	2.55	2.53	2.18	5.55	0.50
Min	14.20	23.00	43.20	-1.14	-1.04	-1.29	2.92	0.06

Source: Own study, based on GUS data.

Calculated synthetic indexes show a high diversity in the regions' sewerage infrastructure equipment. The variation coefficient is about 50%, and the span between the region with the highest and the lowest infrastructure development level is 8.

Mazowieckie region, as noted with water supply infrastructure, has the highest level of sewer infrastructure equipment. The value of taxonomical index in this region was 0.5. In the group with the highest development level of the sewerage infrastructure are Małopolskie (0.42) and Wielkopolskie (0.37) regions.

Gas infrastructure

In the aspect of gas infrastructure, three diagnostic denominators were used to construct the fragmentary index, i.e.:

- active combinations connected with residential buildings and collective settling per 1 km^2,
- residential buildings and collective settling per 1 km^2,
- density of the active gas network [km/100 km^2].

Mazowieckie region, as with the water supply and sewerage infrastructure, has the highest level of gas infrastructure equipment. The value of taxonomical index in this region was 0.5. In the group with the highest development level of the gas infrastructure is also Wielkopolskie (0,45) and Podkarpackie (0,4) regions. The span between the region with the highest and the lowest infrastructure development level is almost 6.

Table 6. Calculating the taxonomical index of a regions' gas infrastructure equipment

Region	Variable value			Standardized variable value			Euclidean distance	Synthetic index
	$x_{6.41}$	$x_{6.42}$	$x_{6.43}$	$t_{6.41}$	$t_{6.42}$	$t_{6.43}$	$d_{6.4}$	$S_{6.4}$
Dolnośląskie	31.4	46	112.3	-0.217	0.149	0.616	4.08	0.34
Kujawsko-pomorskie	14.6	45	59.9	-0.641	0.096	-0.965	5.02	0.19
Lubelskie	28.4	47	70.7	-0.293	0.202	-0.639	4.58	0.26
Lubuskie	20.5	25	124.7	-0.492	-0.963	0.991	5.02	0.19
Łódzkie	17.8	37	55.9	-0.560	-0.327	-1.086	5.30	0.15
Małopolskie	136.9	30	117.5	2.440	-0.698	0.773	3.86	0.38
Mazowieckie	35.9	101	147.0	-0.104	3.060	1.664	2.54	0.59
Opolskie	16.1	25	70.9	-0.603	-0.963	-0.633	5.54	0.11
Podkarpackie	93.5	37	114.9	1.347	-0.327	0.695	3.69	0.41
Podlaskie	5.0	48	36.4	-0.883	0.255	-1.675	5.48	0.12
Pomorskie	25.8	40	91.2	-0.359	-0.169	-0.021	4.59	0.26
Śląskie	118.5	28	94.2	1.977	-0.804	0.070	4.21	0.32
Świętokrzyskie	29.1	23	61.5	-0.275	-1.068	-0.917	5.57	0.10
Warmińsko-mazurskie	7.8	54	59.8	-0.812	0.572	-0.968	4.87	0.22
Wielkopolskie	36.9	60	119.8	-0.079	0.890	0.843	3.42	0.45
Zachodniopomorskie	22.3	45	133.4	-0.447	0.096	1.253	4.16	0.33
Arithmetic mean	40.03	43.19	91.88	0.00	0.00	0.00	4.50	0.28
Standard Deviation	39.69	18.89	33.13	1.00	1.00	1.00	0.86	0.14
Variation Coefficient	99%	44%	36%				19%	50%
Max	136.90	101.00	147.00	2.44	3.06	1.66	5.57	0.59
Min	5.00	23.00	36.40	-0.88	-1.07	-1.67	2.54	0.10

Source: Own study, based on GUS data.

Energy infrastructure

Calculation of the energy infrastructure development level was based on three variables, referring to the infrastructure of the electric power transmission and heating (Tab. 7), i.e.:

– electricity consumption per 1 resident,
– sale of the thermal energy [GJ/1000 ludności],
– density of the heat distribution network [km/100 km^2].

Śląskie and Mazowieckie are the two regions with the most developed energy infrastructure. In these regions, the synthetic index is over 0.8, and is over 30% higher than the next region below it. The span of the synthetic index for regions with the highest and the lowest infrastructure equipment is almost 6.

Table 7. Calculating the taxonomical index of a regions' energy infrastructure equipment

Region	Variable value			Standardized variable value			Euclidean distance	Synthetic index
	$x_{6.51}$	$x_{6.52}$	$x_{6.53}$	$t_{6.51}$	$t_{6.52}$	$t_{6.53}$	$d_{6.5}$	$S_{6.5}$
Dolnośląskie	741.1	12.25	5.57	-0.004	0.405	0.119	3.40	0.49
Kujawsko-pomorskie	724.9	8.72	5.67	-0.196	-0.172	0.187	3.85	0.42
Lubelskie	663.1	7.38	4.65	-0.929	-0.391	-0.502	4.75	0.29
Lubuskie	730.8	3.20	3.63	-0.126	-1.073	-1.190	5.23	0.22
Łódzkie	786.0	11.10	7.11	0.528	0.217	1.159	2.81	0.58
Małopolskie	811.6	14.79	3.78	0.831	0.819	-1.089	3.72	0.44
Mazowieckie	888.3	20.49	8.43	1.740	1.750	2.050	0.84	0.87
Opolskie	836.2	5.08	4.92	1.122	-0.766	-0.319	4.16	0.38
Podkarpackie	573.1	7.84	3.88	-1.995	-0.315	-1.021	5.64	0.16
Podlaskie	739.5	4.84	6.10	-0.023	-0.805	0.477	4.14	0.38
Pomorskie	820.2	10.52	6.83	0.933	0.122	0.970	2.81	0.58
Śląskie	793.6	25.64	7.57	0.618	2.591	1.469	1.26	0.81
Świętokrzyskie	597.1	3.86	3.46	-1.710	-0.965	-1.305	5.98	0.10
Warmińsko-mazurskie	690.5	5.69	5.08	-0.604	-0.667	-0.211	4.61	0.31
Wielkopolskie	766.0	7.62	4.67	0.291	-0.351	-0.488	4.15	0.38
Zachodniopomorskie	701.6	7.33	4.94	-0.472	-0.399	-0.306	4.40	0.34
Arithmetic mean	741.48	9.77	5.39	0.00	0.00	0.00	3.86	0.42
Standard Deviation	84.41	6.12	1.48	1.00	1.00	1.00	1.41	0.21
Variation Coefficient	11%	63%	27%				36%	50%
Max	888.30	25.64	8.43	1.74	2.59	2.05	5.98	0.87
Min	573.10	3.20	3.46	-1.99	-1.07	-1.30	0.84	0.10

Source: Own study, based on GUS data.

Synthetic evaluation of spatial diversity in infrastructure development

Taking into account the variables diagnostic -used for the evaluation of the development of individual types of the infrastructure- a synthetic index of the regions' economic infrastructure equipment was calculated. In those calculations, like in appointing fragmentary indexes identical methodological, assumptions were applied, i.e.:
- all diagnostic variables were compared in one matrix,
- a standardization of diagnostic variables was conducted,
- indexes of the infrastructure development were calculated for every region,
- regions were classified according to the index of the infrastructure development value.

Results of the calculations are compared in Table 8. Synthetic index values of a regions' economic infrastructure equipment were characterized by a high diversity – the variation coefficient was 50%. Spans between the region's with the highest development of infrastructure level (Małopolskie) and the lowest (Lubuskie) was 6.7.

Table 8. Synthetic index of the regions' development according to the criterion of the economic infrastructure in 2011

Region	Infrastructure development index	Position	Concurrency Level
Mazowieckie	0.51	1	very high
Śląskie	0.46	2	
Małopolskie	0.37	3	
Wielkopolskie	0.37	4	
Dolnośląskie	0.34	5	high
Łódzkie	0.30	6	
Pomorskie	0.26	7	
Kujawsko-pomorskie	0.24	8	low
Zachodniopomorskie	0.22	9	
Lubelskie	0.19	10	
Opolskie	0.17	11	
Podkarpackie	0.16	12	very low
Warmińsko-Mazurskie	0.13	13	
Podlaskie	0.13	14	
Świętokrzyskie	0.11	15	
Lubuskie	0.10	16	

Source: Own study.

The Mazowieckie, Śląskie, Wielkopolskie, and Małopolskie regions possess the highest level of economic infrastructure development. Slightly lower indexes of economic infrastructure development can be found in Dolnooślaskie, Pomorskie and Lódzkie regions. These six regions consist of relatively high level of urbanization, and

also have urban agglomerations, including a high level of saturation with different types of infrastructure.

Evaluation of Relations Between the Economic Infrastructure Development and a Region's Competitiveness

In analyzing the interdependence between the level of infrastructure development and a region's competitiveness, a coefficient of Pearson linear correlation was calculated between the competitiveness synthetic index, and the economic infrastructure development synthetic index (Tab. 9). Moreover, correlation coefficients were calculated between competitiveness synthetic index, and the economic infrastructure synthetic index of individual types of the economic infrastructure. Such an approach allowed not only for the statement, whether a relation between the infrastructure development and a region's competitiveness exists, but also enabled to check whether the relation exists between the development of individual types of the infrastructure and the region's competitiveness.

Table 9. Relation between the infrastructure development and region's competitiveness

Region	Economic infrastructure development index						Region's competitiveness index
	Transport	Water supply	Sewerage	Gas	Energy	Total	
Dolnośląski	0.46	0.41	0.31	0.34	0.49	0.34	0.53
Kujawsko-Pomorski	0.38	0.33	0.26	0.19	0.42	0.24	0.33
Lubelski	0.26	0.33	0.19	0.26	0.29	0.19	0.25
Lubuski	0.29	0.16	0.06	0.19	0.22	0.10	0.28
Łódzki	0.38	0.49	0.32	0.15	0.58	0.30	0.40
Małopolski	0.52	0.37	0.43	0.38	0.44	0.37	0.40
Mazowiecki	0.31	0.75	0.50	0.59	0.87	0.51	1.00
Opolski	0.46	0.18	0.12	0.11	0.38	0.17	0.27
Podkarpacki	0.32	0.15	0.18	0.41	0.16	0.16	0.25
Podlaski	0.19	0.24	0.13	0.12	0.38	0.13	0.24
Pomorski	0.31	0.36	0.19	0.26	0.58	0.26	0.40
Śląski	1.00	0.51	0.24	0.32	0.81	0.46	0.59
Świętokrzyski	0.41	0.20	0.17	0.10	0.10	0.11	0.26
Warmińsko-Mazurski	0.21	0.21	0.12	0.22	0.31	0.13	0.25
Wielkopolski	0.38	0.63	0.37	0.45	0.38	0.37	0.51
Zachodniopomorski	0.23	0.28	0.28	0.33	0.34	0.22	0.32
A coefficient of Pearson linear correlation between the competitiveness synthetic index, and the economic infrastructure development synthetic index	0.32	0.89	0.77	0.74	0.83	0.89	

Source: Own study.

The coefficient of Pearson linear correlation confirm the thesis of relations between the level of infrastructure development and a region's competitiveness. Maximum indexes of a coefficient of Pearson linear correlation were achieved for the waterworks and energy infrastructure. The interdependence in these two types of the infrastructure is very strong. The relation for the gas and sewer infrastructure is also strong. A relation is relatively weak between the competitiveness of regions, the level of infrastructure development.

Conclusions

Presented analyses indicate the significant diversity existing in Poland in the level of infrastructure development and the competitiveness of regions. Calculated indexes confirm occurrence of the interdependence between the competitiveness of regions, the level of infrastructure development.

Considering meaning of the economic infrastructure in creating the competitiveness of regions, regions' governments should intensify activities aimed to improve the state and structures of the economic infrastructure in the region. Investments should be carried out particularly in areas with the low level of infrastructure equipment. Insufficient equipping the region with the economic infrastructure is a barrier of its development. As a result individual areas diversifying is deepening, leading into large social groups exclusion, mainly the young people.

Financing the infrastructure investments from the EU funds is a chance to improve the equipping Polish regions with the economic infrastructure. In financial perspectives 2007-2013 in all regions numerous investments including different types of the economic infrastructure were carried out. However their scope was too low to make up the long-term negligence and considerably improve the state of the depreciated infrastructure. It was also insufficient in order to make up the developmental distance towards EU regions of the European Union with the highest level of competitiveness.

References

Alarcón A. L., 2004, *Regional Competitiveness; the need for coordination between public and private action*, [in:] S. Rudolf (ed.), *Emerging Markets. Social, Political and Economic Challenges*, University Press, Łódź.

Calderón C., Servén L., 2004, *The Effects of Infrastructure Development on Growth and Income Distribution*, World Bank Policy Research Working Paper, No. 3400.

Gardiner B., Martin R., Tyler P., 2004, *Competitiveness, Productivity and Economic Growth across the European Regions*, University of Cambridge.

Góralski L., Lazarek M., 2009, *Czynniki kształtujące konkurencyjność regionów*. Zeszyty Naukowe SGGW, Polityki Europejskie, Finanse i Marketing, nr 1(50).

Grabiński T., Wydymus S., Zeliaś A., 1989, *Metody taksonomii numerycznej w modelowaniu zjawisk społeczno-gospodarczych*, Wydawnictwo Naukowe PWN, Warszawa.

GUS, 2014, *Jakość w statystyce*. http://bip.stat.gov.pl/dzialalnosc-statystyki-publicznej/jakosc-w-statystyce/ (access 8.01.2014).

Hellwig Z., 1968, *Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju i strukturę wykwalifikowanych kadr*, Przegląd Statystyczny, nr 4.

Kolenda M., 2006, *Taksonomia numeryczna. Klasyfikacja, porządkowanie i analiza obiektów wielocechowych*, Wydawnictwo Akademii Ekonomicznej, Wrocław.

Martin R., 2003, A Study on the Factors of Regional Competitiveness. A final report for The European Commission Directorate-General Regional Policy, Cambridge Econometrics & ECORYS NEI, http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/3cr/ competitiveness.pdf (access 05.02.2014).

Panek T., 2009, *Statystyczne metody wielowymiarowej analizy porównawczej*, Wydawnictwo Szkoły Głównej Handlowej, Warszawa.

Ratajczak M., 1999, *Infrastruktura w gospodarce rynkowej*, Akademia Ekonomiczna w Poznaniu, Poznań.

Rossert B., 2000, *Contributing to regional development through project selection*, EBI Papers, No. 1.

Wojewódzka-Król K. (red.), 2002, *Rozwój infrastruktury transportu*. Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk.

Zioło M. 2005, *Konkurencyjność gmin, powiatów, regionów i scenariusze jej osiągania*, [w:] B. Filipiak, M. Kogut, A. Szewczuk, M. Zioło, *Rozwój lokalny i regionalny. Uwarunkowania, finanse procedury*, Fundacja na rzecz Uniwersytetu Szczecińskiego, Szczecin.