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Barbara JURKOWSKA

Spatial diversification of socio-economic potential of the regions in Poland and Germany, particularly considering the Polish-German borderland

Summary. *The aim of the article is to demonstrate differences in various aspects of socio-economic life between the states of Germany and voivodships of Poland. Particular attention was devoted to the regions of the Polish-German borderland: Zachodniopomorskie, Lubuskie and Dolnośląskie voivodships and the neighbouring German states: Mecklenburg-Vorpommern, Brandenburg and Saxony. As a result of conducted taxonomic research, diversification among particular German states and voivodships in terms of socio-economic development was obtained.*

Hellwig's taxonomic method was used in the research of the level of socio-economic development of Poland and Germany. The study was based on data from Statistics Poland (GUS) and the Federal Statistical Office (Statistisches Bundesamt) in Germany. The analysis concerned years 2014—2017. The conclusions of the study are as follows: the greatest asset of the Polish regions is their demographic potential, which, combined with economic and innovation opportunities of the German regions, may become a stimulus for development in other areas of socio-economic life of the entire Polish-German borderland.

Keywords: Poland, Germany, Polish-German borderland, measure of development, comparative analysis.

JEL: C38

Differences occurring between economic phenomena are usually very complex and multidirectional; a given phenomenon is usually impacted by numerous other phenomena of economic, social, demographic, technological and other character (Nowak, 1994). Analysis of such development level and specification of its interregional disproportions requires applying specific methods of multidimensional comparative analysis. Application of such analysis can be found in numerous publications, e.g.: Hellwig (1968, 1990); Nowak (1990); Zeliaś

& Malina (1998); Piotrowska-Trybull (2004); Jurkowska (2014) as well as Pietrzak & Balcerzak (2016).

In order to examine socio-economic development level of the regions in Poland and Germany, multidimensional comparative analysis was applied. The research covered 32 regions including 16 German states and 16 Polish voivodships. Particular attention was devoted to 3 voivodships: Zachodniopomorskie, Lubuskie and Dolnośląskie and 3 neighbouring states: Mecklenburg-Vorpommern, Brandenburg and Sachsen. The main objective of the article was to indicate differences between the regions of Polish and German borderland and the distance separating them from other regions of Poland and Germany. The subject of the conducted analysis was to identify the development conditions of the regions at the Polish-German border.

ANALYSIS OF THE POLISH-GERMAN BORDERLAND IN THE SELECTED ASPECTS OF SOCIO-ECONOMIC AREA

In 2016, the Polish-German borderland was inhabited by 13.8 million people, 40.8% of whom lived in Poland and 59.2% in Germany. In terms of demographic situation, the Polish side is significantly different than the German one. In 2016, the Polish border area was inhabited by 5.6 million people, i.e. 14.7% of the total population of Poland. The largest number of citizens lived in Dolnośląskie voivodship (2.9 million), in the remaining voivodships the number of people ranged from 1.7 million in Zachodniopomorskie to 1.0 million in Lubuskie voivodship[1]. The German side was inhabited by 8.1 million people, which constituted 9.9% of the total population of Germany. Sachsen was the most populated state (4.1 million) and Mecklenburg-Vorpommern was the least populated one (1.6 million)[2].

Although more than 27 years have passed since the reunification of Germany, the differences between the two parts of reconciled Germany are still noticeable. They concern not only the socio-economic areas, but also the labour market (Budnikowski, 2017). At the end of March 2017, the unemployment rate in the western part of the country amounted to 5.3% and in the area of former German Democratic Republic (GDR) it reached 7.7%. In the whole country, the rate amounted to 5.8% and was the lowest since the reunification of Germany (Statistischen Bundesamtes, 2017). As far as the eastern side is concerned, the highest unemployment rate was recorded in the state of Mecklenburg-Vorpommern (9.6%), followed by Berlin (9.4%) and Sachsen-Anhalt (9.1%). The lowest rate of unemployment was observed at the south of Germany: in Bayern (3.5%) and in Baden-Württemberg (3.7%) (Bundesagentur für Arbeit, 2017).

In terms of GDP *per capita* in Purchasing Power Standard (PPS), the German side has a decisive advantage over the Polish side, with a threefold higher ratio. The Polish side recorded the highest rate in Dolnośląskie voivodship (76%) — 7% higher than the national average (fig. 1). Lubuskie and Zachodniopomorskie

[1] According to the data of Statistics Poland.

[2] According to the data of Federal Statistical Office (Statistisches Bundesamt).

voivodships were the less developed economic regions in Poland. GDP *per capita* there was lower than the national average, by 12% and 11% respectively (Eurostat, 2017).

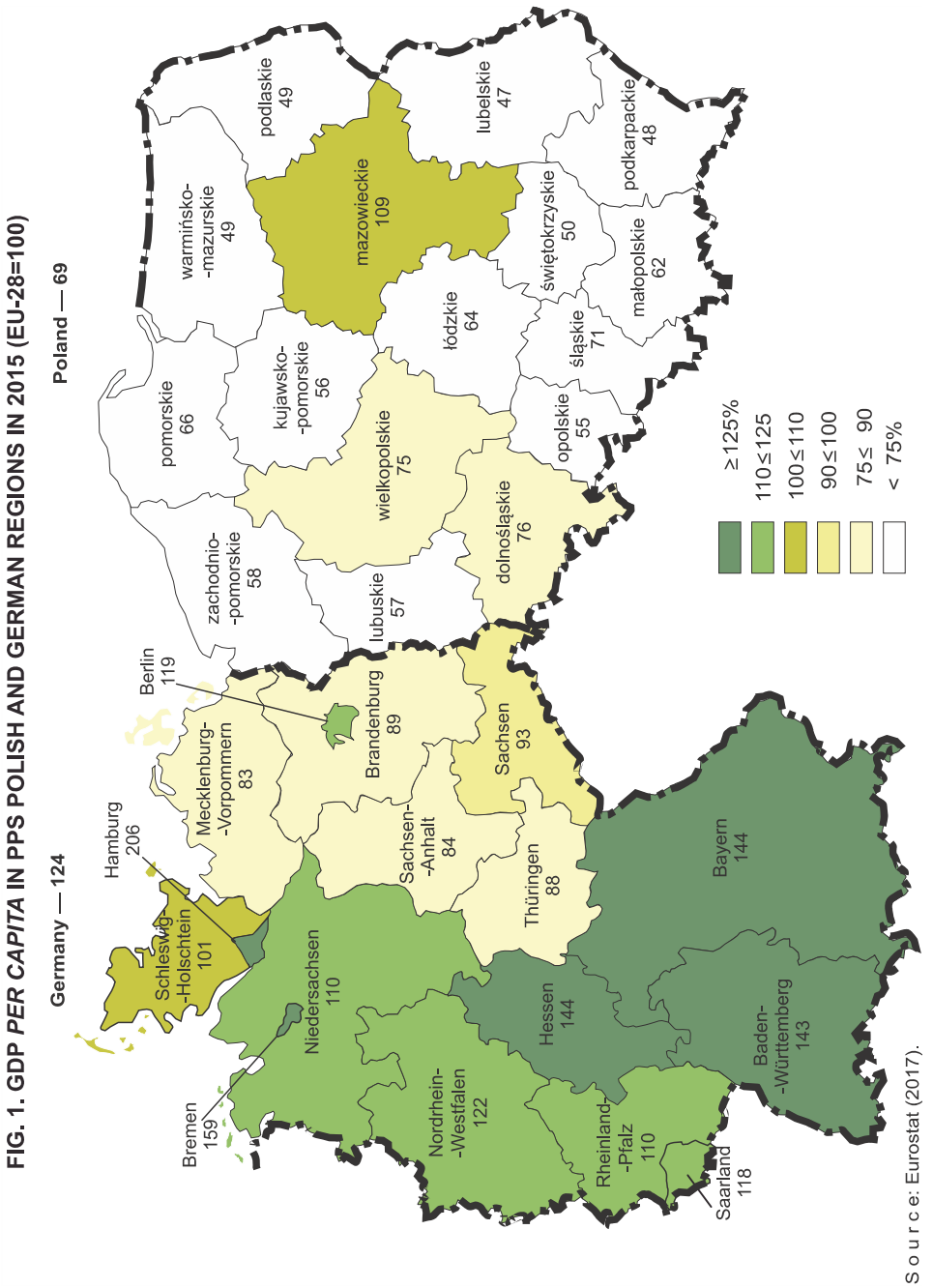


FIG. 1. GDP *PER CAPITA* IN PPS POLISH AND GERMAN REGIONS IN 2015 (EU-28=100)

Source: Eurostat (2017).

It should be noted that spatial diversification of GDP *per capita* in PPS confirms the existence of significant differentiation of the economic development level in the western part of Poland in comparison to the eastern regions. This trend is distorted by the metropolitan area of Warsaw, inflating the GDP of the whole Mazowieckie voivodship (Godlewska-Majkowska, 2011). On the German side, interregional differences in GDP *per capita* are lower than in Poland. Among the analysed regions, the highest rate in 2015 was recorded in Sachsen (93%) and the lowest in Mecklenburg-Vorpommern (83%).

RESEARCH ASSUMPTION

Examining the level of socio-economic development of Poland and Germany, Hellwig's method was applied. Such method was described in reference literature on numerous occasions (Nowak, 1990; Hellwig, 1968; Zeliaś, 2000), therefore, only its principal assumptions are presented below. A selection of primary variables was mainly determined by availability of statistical material and requirements governing the choice of traits. The data gathered and applied in the research was derived from the Polish and German, state as well as regional, statistical yearbooks. The set of diagnostic variables covered the following areas: social, demographic, labour market, technological, innovations and economic activity.

Two-stage elimination was the initial phase of the analysis. Coefficient of variation was applied at the first stage (Nowak, 1994):

$$V_j = \frac{S_j}{\bar{x}_j} \cdot 100\% \tag{1}$$

The variables for which the coefficient limit value was lower than 10%, were excluded from the set of variables.

The second stage of elimination was to reject the traits highly correlated with the other ones. It was achieved by using Pearson linear correlation coefficient:

$$r_{jk} = \frac{\sum_{i=1}^{n}(x_{ij} - \bar{x}_j)(x_{ik} - \bar{x}_k)}{\sqrt{\sum_{i=1}^{n}(x_{ij} - \bar{x}_j)^2 \sum_{i=1}^{n}(x_{ik} - \bar{x}_k)^2}} \quad (j,k = 1,2,\dots,m) \tag{2}$$

where:

r_{jk} — correlation coefficient between the dependent variable X_j and the independent variable X_k,
x_{ij}, x_{ik} — i observations of the variables X_j and X_k,
$\bar{x}_j, \bar{x}_k$ — average values of the variables X_j and X_k,
n — number of observations.

The critical value of correlation coefficient was set at 0.90.

The variables compared in the observation matrix are expressed in various measurement units, therefore, there is a need to make them dimensionless (Piotrowska-Trybull & Jurkowska, 2015). One of the normalisation methods is the standardisation according to the following formula (Kukuła, 2012):

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \ (i = 1, 2, \dots, n; \ \ j = 1, 2, \dots, m) \tag{3}$$

where:

z_{ij} — standardised value of j^{th} variable for i^{th} object,
x_{ij} — value of j^{th} variable for i^{th} object,
$\bar{x}_j$ — arithmetic mean of x_j variable,
s_j — standard deviation of x_j variable.

Such data was used to determine a model expressed as an abstract object with maximum values for each normalised trait. Thus the standardised multidimensional observation (m dimensional) will be phrased as a vector $\boldsymbol{z}_0 = [z_{01}, z_{02}, \dots, z_{0m}]$ (Walesiak, 2011). Whereas, in the case of i^{th} observations:

$$Z_{0j} = \max Z_{ij}, \text{ when a variable } Z_j \text{ is a stimulus}$$
$$Z_{0j} = \min Z_{ij}, \text{ when a variable } Z_j \text{ is a destimulus}$$

Due to the fact that the sets of diagnostic traits include the traits with various information resources related to the aim of the study, heterogeneous meaning of specific diagnostic traits in the description of classified objects of the weight are applied by determining the value of the similarities of the objects (Zeliaś, 2000; Nowak, 1990).

One of the discussed issues is selecting a proper distance measurement. In this research, the Euclidean distance was applied according to the following formula:

$$c_{io} = \left[\sum_{j=1}^{n} \left(z_{ij} - z_{oj} \right)^2 \right]^{1/2} \tag{4}$$

where:

c_{io} — the Euclidean distance between the i^{th} and j^{th} object,
z_{ij} — normalised value of j^{th} variable for i^{th} object,
z_{oj} — normalised value of j^{th} variable for the model object,
n — number of traits characterising the objects.

A synthetic indicator, defined as a taxonomic measure of development in the reference literature, is used to measure i^{th} spatial unit. This measure is used in research on collective territorial units and is universal enough to serve for analysing the traits of a given unit (Hellwig, 1968). The obtained c_{io} values served for computation of Hellwig's synthetic measure of development is calculated according to the following formula:

$$d_i = 1 - \frac{c_{io}}{c_o} \tag{5}$$

where:

$c_o = \bar{c}_o + 2S_0$,

$\bar{c}_o = \frac{1}{n}\sum_{i=1}^{n} c_{io}$,

$S_0 = \left[\frac{1}{n}\sum_{i=1}^{n}(c_{io} - \bar{c}_o)^2\right]^{1/2}$,

d_i — value of synthetic measure for i^{th} object,

c_{io} — generalised distance of i^{th} object from the model,

c_o — normalising factor,

$\bar{c}_o$ — arithmetic mean of generalised Euclidean distances of the objects from the model,

S_0 — standard deviation of generalised Euclidean distances of the objects from the model.

The interpretation of d_i values is as follows: the higher its value, the higher level of development achieved by a given object. The synthetic indicator assumes the values within the interval of [0.1].

To analyse the level of socio-economic development of the Polish voivodships and the German states, 48 primary variables were selected. For each of the variables, a descriptive statistics was prepared (tab. 1).

TAB. 1. A SET OF PRIMARY VARIABLES OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES AND THEIR CHOSEN DESCRIPTIVE STATISTICS

Variable (character)	Median	Skewness	Minimum (voivodship/state)	Maximum (voivodship/state)	Mean	V_j in %
X_1 — population density *per* km^2 (S)	141.500	3.605	59.00 (Podlaskie)	3948.00 (Berlin)	401.406	198.978
X_2 — women *per* 100 men (S)	104.255	0.712	101.72 (Baden-Württemberg)	109.88 (Mazowieckie)	104.599	2.011
X_3 — live births *per* 1000 population (S)	9.100	0.524	7.50 (Saarland)	11.10 (Hamburg)	9.116	10.299

TAB. 1. A SET OF PRIMARY VARIABLES OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES AND THEIR CHOSEN DESCRIPTIVE STATISTICS (cont.)

Variable (character)	Median	Skewness	Minimum (voivodship/state)	Maximum (voivodship/state)	Mean	V_j in %
X_4 — deaths *per* 1000 population (D)	10.725	0.706	9.13 (Pomorskie)	14.40 (Sachsen--Anhalt)	11.007	12.682
X_5 — infant deaths *per* 1000 live births (D)	3.639	0.397	2.30 **(Sachsen, Mecklenburg--Vorpommern)**	5.70 (Bremen)	3.581	22.285
X_6 — natural increase *per* 1000 population (S)	–1.680	–0.344	–6.66 (Sachsen--Anhalt)	1.50 (Pomorskie)	–1.887	114.069
X_7 — general birth rate (number of children to be born *per* woman at reproductive age — aged 15—49 for Poland, aged 15—50 for Germany) (S)	1.430	–0.160	1.21 (Opolskie)	1.59 **(Sachsen)**	1.401	8.870
X_8 — live births by mother's age (average age of mothers) (D)	29.750	0.274	28.5 **(Lubuskie)**	31.90 (Hamburg)	29.941	3.222
X_9 — population at productive age (women and men aged 15—65) compared to general population, in % (S)	68.997	–0.310	63.68 **(Sachsen)**	71.84 (Warmińsko--Mazurskie)	68.586	3.503
X_{10} — population past productive age (women and men aged 66 and more) compared to general population, in % (D)	16.046	0.375	12.81 (Warmińsko--Mazurskie)	23.66 (Sachsen--Anhalt)	17.374	20.031
X_{11} — population past productive age *per* 100 persons at productive age (D)	22.909	0.457	17.83 (Warmińsko--Mazurskie)	37.18 (Sachsen)	25.525	23.518
X_{12} — median age (D)	41.500	0.508	38.70 (Małopolskie, Pomorskie, Wielkopolskie)	50.20 (Sachsen--Anhalt)	43.213	8.937
X_{13} — average life span (S)	79.000	–0.077	75.90 (Łódzkie)	81.80 (Baden--Württemberg)	78.994	2.054
X_{14} — balance of interregional migration for permanent stay *per* 1000 population (S)	9.570	0.757	5.78 (Świętokrzyskie)	20.30 (Bremen)	10.562	34.047
X_{15} — marriages *per* 1000 population (S)	5.400	–0.400	3.60 (Hamburg)	6.90 **(Mecklenburg--Vorpommern)**	5.322	13.994

TAB. 1. A SET OF PRIMARY VARIABLES OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES AND THEIR CHOSEN DESCRIPTIVE STATISTICS (cont.)

Variable (character)	Median	Skewness	Minimum (voivodship/state)	Maximum (voivodship/state)	Mean	V_j in %
X_{16} — divorces *per* 1000 population (D)	1.850	–0.513	1.20 (Podkarpackie)	2.20 (Niedersachsen, Nordrhein--Westfalen, Rheinland-Pfalz, Saarland, Schleswig--Holstein)	1.844	13.841
X_{17} — number of students *per* 10 thous. population (S)	298.346	0.697	162.00 **(Lubuskie)**	547.61 (Hamburg)	329.638	33.239
X_{18} — share of population aged 15—64 with higher education in a general number of population at this age, in % (S)	25.950	1.076	19.70 (Saarland)	37.70 (Mazowieckie)	26.828	14.988
X_{19} — average usable area *per capita* in m^2 (S)	34.750	0.193	23.90 (Warmińsko--Mazurskie)	53.00 (Saarland)	36.366	28.103
X_{20} — unoccupied dwellings, in % (D)	2.686	0.579	0.08 (Świętokrzyskie)	14.20 **(Sachsen)**	4.353	104.876
X_{21} — dwellings *per* 1000 population (S)	443.550	0.053	304.80 (Podkarpackie)	573.00 **(Sachsen,** Sachsen--Anhalt)	441.181	19.248
X_{22} — beds in general hospitals *per* 100 thous. population (S)	780.500	0.886	505.00 (Wielkopolskie)	1308.00 **(Mecklenburg--Vorpommern)**	767.531	24.157
X_{23} — physicians *per* 100 thous. population (S)	313.500	0.543	160.00 (Wielkopolskie)	604.00 (Hamburg)	325.156	34.384
X_{24} — number of the unemployed *per* 1000 population (D)	40.750	–0.125	20.00 (Bayern)	58.10 (Podkarpackie)	41.081	25.687
X_{25} — unemployment rate (for economically active), in % (D)	6.450	0.327	2.90 (Bayern)	11.60 (Podkarpackie)	6.547	31.569
X_{26} — economic activity rate in the age group 15—64, in % (S)	72.800	–0.054	62.90 (Warmińsko--Mazurskie)	80.40 **(Sachsen)**	72.513	7.871
X_{27} — employment rate in the age group 15—64, women and men, in % (S)	68.350	–0.051	56.90 (Warmińsko--Mazurskie)	77.70 (Bayern)	67.728	9.397
X_{28} — share of total resources devoted to research and development (R&D) in GDP, in % (S)	0.900	1.825	0.18 **(Lubuskie)**	3.99 (Baden--Württemberg)	1.056	76.000

TAB. 1. A SET OF PRIMARY VARIABLES OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES AND THEIR CHOSEN DESCRIPTIVE STATISTICS (cont.)

Variable (character)	Median	Skewness	Minimum (voivodship/state)	Maximum (voivodship/state)	Mean	V_j in %
X_{29} — Human Resource in Science and Technology (HRST) as a share of economically active population in the age group 15—74, in % (S)	41.450	0.571	33.00 (Świętokrzyskie)	55.00 (Hamburg)	41.809	13.017
X_{30} — GDP in PPS *per capita* in euro (S)	23550.000	0.675	1300.00 (Lubelskie)	56600.00 (Hamburg)	24653.130	46.400
X_{31} — GDP *per capita* in PPS in 2014 (EU-28= =100) (S)	85.500	0.968	47.00 (Lubelskie)	206.00 (Hamburg)	91.250	43.487

N o t e. S — stimulus, D — destimulus. The bold is used for regions within the Polish-German borderland area.
S o u r c e: own study based on the data from Statistics Poland (stat.gov.pl) and Federal Statistical Office (www.destatis.de).

Due to the fact that the value of variability coefficient was too low $(V_j < 10\%)$, variables $X_2, X_7, X_8, X_9, X_{12}, X_{13}, X_{26}$ and X_{27} were eliminated from further research.

The selected value of Pearson correlation coefficient of 0.90 resulted in 4 traits: X_{10}, X_{11}, X_{20} and X_{30} being eliminated from the set of diagnostics variables. Among the traits of diagnostic variables, 2 central traits were distinguished: dwellings *per* 1000 persons and GDP *per capita* in PPS in 2014, (EU-28=100), which are called satellite traits, transferring information through other variables:

- central traits: X_{21} and X_{31};
- satellite traits: X_{10}, X_{11} and X_{20};
- isolated traits: $X_1, X_3, X_4, X_5, X_6, X_{14}, X_{15}, X_{16}, X_{17}, X_{18}, X_{19}, X_{21}, X_{22}, X_{23}, X_{24}, X_{25}, X_{28}, X_{29}$ and X_{31}.

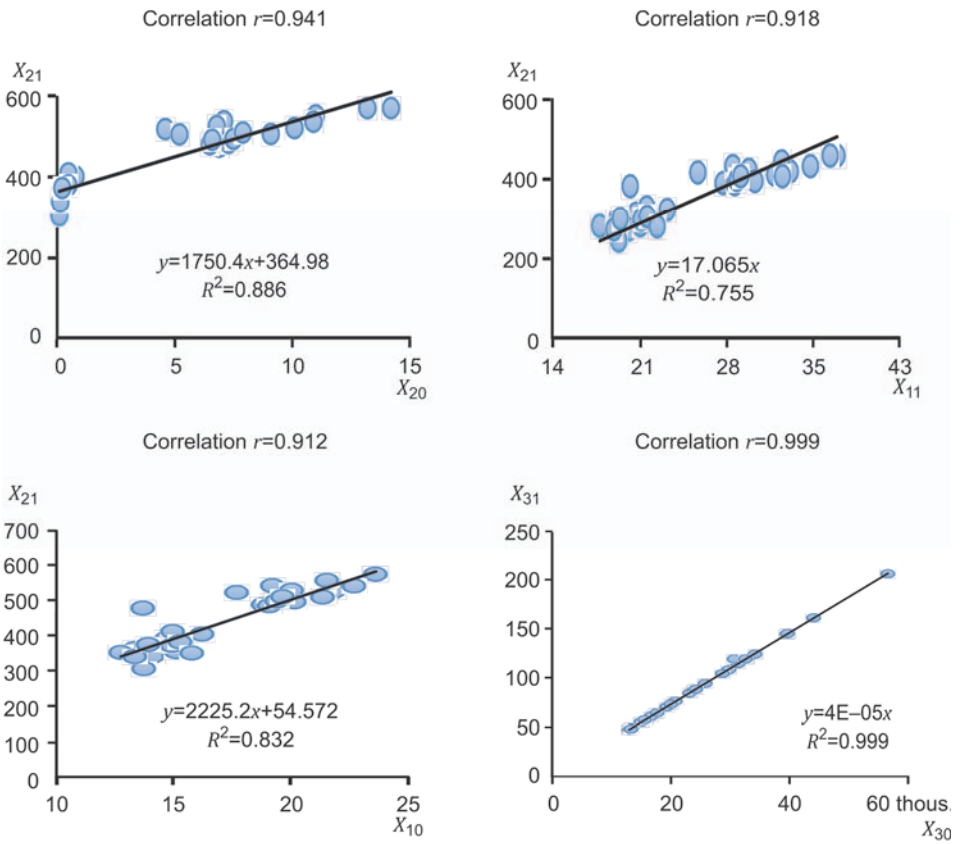
Analysis of the correlation matrix showed that X_{21} variable (dwellings *per* 1000 population) was mostly correlated with X_{20} variable (unoccupied dwellings, in %), of which the linear correlation coefficient amounted to 0.941. Whereas X_{31} variable (GDP *per capita* in PPS (EU-28=100) was very highly correlated with X_{30} variable (GDP in PPS *per capita* in euro), where the Pearson coefficient amounted to as high as 0.999 (tab. 2 and fig. 2).

TAB. 2. VALUE OF COEFFICIENTS IN PEARSON'S LINEAR CORRELATION OF VOIVODSHIPS AND STATES

Variable	X_{10}	X_{11}	X_{20}	X_{21}	X_{30}	X_{31}
X_{10}	1.000	0.998	0.914	0.912	0.462	0.464
X_{11}	0.998	1.000	0.926	0.918	0.464	0.465
X_{20}	0.914	0.926	1.000	0.941	0.525	0.528
X_{21}	0.912	0.918	0.941	1.000	0.693	0.694
X_{30}	0.462	0.464	0.525	0.693	1.000	0.999
X_{31}	0.464	0.465	0.528	0.694	0.999	1.000

S o u r c e: own study.

FIG. 2. CORRELATION CHARTS OF SPREAD SHOWING CO-DEPENDENCIES BETWEEN THE X_{21} CENTRAL VARIABLE AND X_{10}, X_{11} AND X_{20} SATELLITE VARIABLES AND BETWEEN X_{31} CENTRAL VARIABLE AND X_{31} SATELLITE VARIABLE



Source: as in the tab. 2.

Eventually, 19 variables were adopted for further empirical research. The set of traits featured destimuli X_4, X_5, X_{16}, X_{24} and X_{25} were converted according to formula (2) into stimuli. Diagnostic traits were assigned with weights determined by dividing the variables into 4 groups depending on their influence on regional development. A given group was assigned with traits that were subsequently divided by a number of traits in a given group in order to come up with weight of each coefficient (tab. 3).

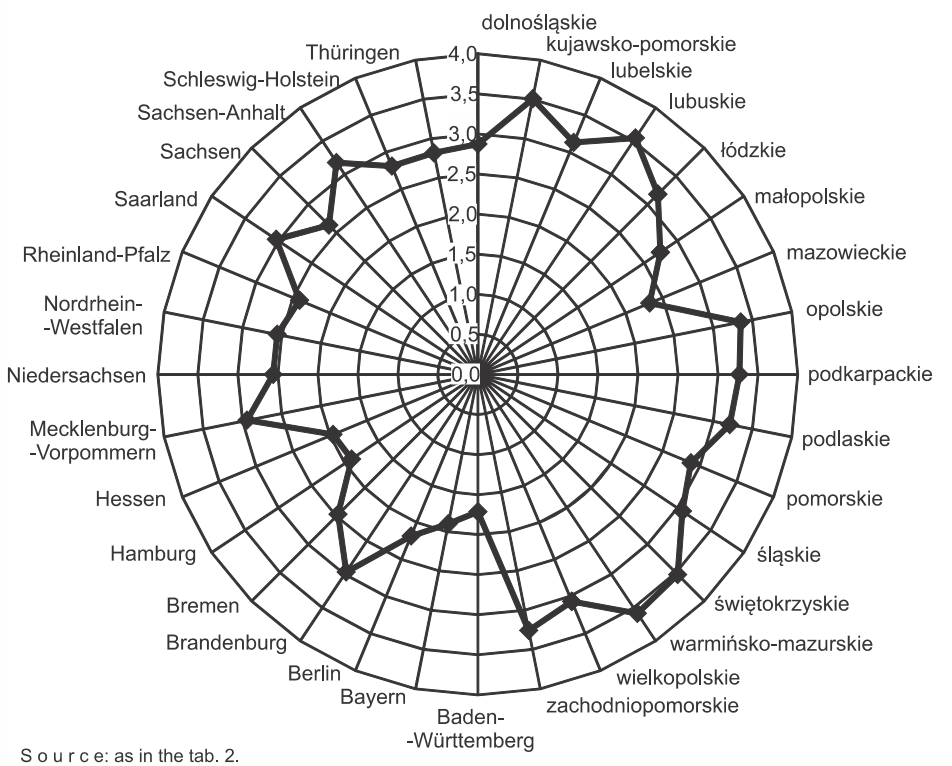
Next, a distance between each researched unit and a delineated development model was calculated according to formula (4) (fig. 3). Baden-Württemberg showed the smallest deviation from the development model and the Warmińsko-Mazurskie voivodship — the largest one.

TAB. 3. SET OF DIAGNOSTIC VARIABLES OF VOIVODSHIPS AND STATES ALONG WITH THEIR WEIGHTS

Group	Weight assigned to a group	Variable	Weight assigned to a variable
Demography	0.20	$X_1, X_3, X_4, X_5, X_6, X_{14}, X_{15}, X_{16}$	0.025
Higher education	0.20	X_{17}, X_{18}	0.100
Social situation.....	0.15	$X_{19}, X_{18}, X_{17}, X_{18}$	0.038
Labour market	0.10	X_{24}, X_{25}	0.050
Economic potential and innovation	0.35	X_{28}, X_{29}, X_{31}	0.117

S o u r c e: as in the tab. 2.

FIG. 3. EUCLIDEAN DISTANCE OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES FROM THE DEVELOPMENT MODEL IN 2016 (according to the Hellwig's method)



S o u r c e: as in the tab. 2.

The analysis of data included in tab. 4, in 2016, indicates that the highest values of the development synthetic indicator were recorded in Baden-Württemberg (1st), Hamburg (2nd) and Bayern (3rd), ranking them highest among

the regions in Poland and Germany. The poorest rankings and lowest values of Hellwig's development indicator were recorded in the following voivodships: Warmińsko-Mazurskie (32nd), Lubuskie (31st) and Świętokrzyskie (30th).

TAB. 4. SYNTHETIC INDICATORS OF SOCIO-ECONOMIC DEVELOPMENT LEVEL IN VOIVODSHIPS AND STATES (according to the development model method)

Region	Synthetic indicator	Item
Baden-Württemberg	0.556	1
Hamburg	0.508	2
Bayern	0.508	3
Hessen	0.492	4
Berlin	0.434	5
Mazowieckie	0.398	6
Rheinland-Pfalz	0.376	7
Bremen	0.361	8
Nordrhein-Westfalen	0.338	9
Niedersachsen	0.337	10
Sachsen	0.318	11
Małopolskie	0.290	12
Schleswig-Holstein	0.272	13
Thüringen	0.270	14
Dolnośląskie	0.256	15
Pomorskie	0.253	16
Mecklenburg-Vorpommern	0.234	17
Brandenburg	0.232	18
Saarland	0.215	19
Wielkopolskie	0.206	20
Śląskie	0.204	21
Lubelskie	0.189	22
Sachsen-Anhalt	0.177	23
Łódzkie	0.177	24
Podlaskie	0.169	25
Zachodniopomorskie	0.157	26
Podkarpackie	0.153	27
Opolskie	0.133	28
Kujawsko-Pomorskie	0.092	29
Świętokrzyskie	0.085	30
Lubuskie	0.082	31
Warmińsko-Mazurskie	0.071	32

S o u r c e: as in the tab. 2.

Based on the statistical description of the synthetic development indicator d_i, it can be stated that it is characterised by the right-side asymmetry. Skewness coefficient at 0.568 means that for most of the regions the value of synthetic indicator is below average. The average value of the synthetic indicator amounts to 0.485 and is relatively high (tab. 5).

TAB. 5. DESCRIPTIVE MEASUREMENTS OF THE SYNTHETIC DEVELOPMENT INDICATOR OF THE POLISH VOIVODSHIPS AND THE GERMAN STATES, 2016

Specification	d_i
Mean	0.267
Standard deviation	0.134
Median	0.246
Maximum	0.556
Spread	0.485
Skewness indicator	0.568

S o u r c e: as in the tab. 2.

CLASSIFICATION

Synthetic indicators allow for linear classification of objects. It consists of the identification of the groups with similar elements in terms of synthetic development indicator. In this research the classification was prepared with the use of arithmetic mean, which included division into 4 classes of socio-economic development:

1) (high level of development): $z_i > \bar{z}_2$,
2) (medium-high level of development): $\bar{x} < z_i \geq \bar{z}_2$,
3) (medium-low level of development): $\bar{z}_1 < z_i \geq \bar{x}$,
4) (low level of development): $z_i \geq \bar{z}_1$.

Finally, 4 different groups of regions were distinguished (tab. 6).

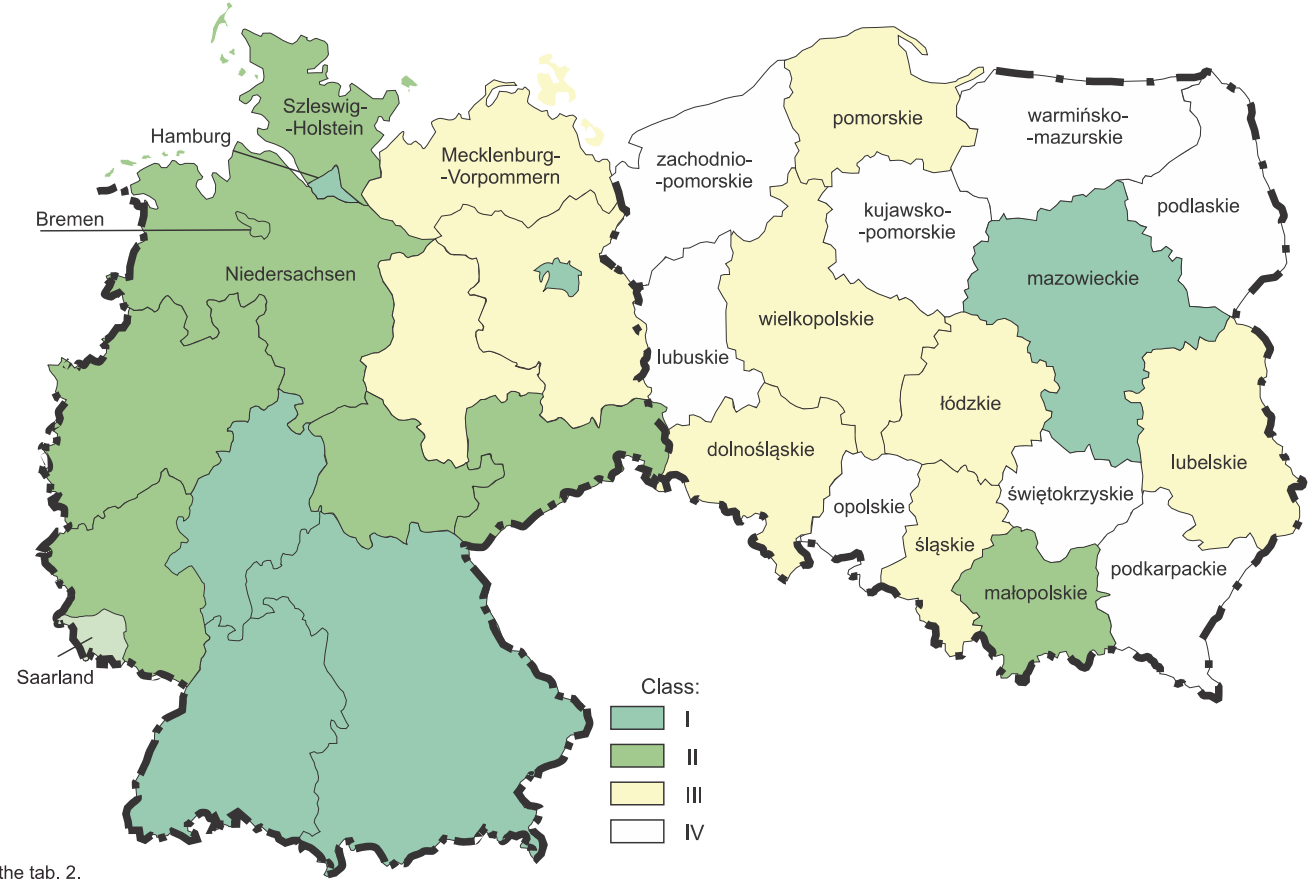
TAB. 6. CLASSIFICATION OF VOIVODSHIPS AND STATES IN LINE WITH THE THREE MEANS METHOD

Class	Classification intervals	Region
1	$z_i > 0.390$	Baden-Württemberg, Hamburg, Bayern, Hessen, Berlin, Mazowieckie
2	$0.267 < z_i \leq 0.390$	Rheinland-Pfalz, Bremen, Nordrhein-Westfalen, Niedersachsen, Sachsen, Małopolskie, Schleswig-Holstein, Thüringen
3	$0.172 < z_i \leq 0.267$	Dolnośląskie, Pomorskie, Mecklenburg-Vorpommern, Brandenburg, Saarland, Wielkopolskie, Śląskie, Lubelskie, Sachsen-Anhalt, Łódzkie
4	$z_i \leq 0.172$	Podlaskie, Zachodniopomorskie, Podkarpackie, Opolskie, Kujawsko-Pomorskie, Świętokrzyskie, Lubuskie, Warmińsko-Mazurskie

S o u r c e: as in the tab. 2.

The difference between the maximum and minimum value of Hellwig's taxonomic measurement of development amounted to 0.485. Values of the measurement oscillated between 0.556 (for Baden-Württemberg) and 0.071 (for Warmińsko-Mazurskie voivodship). Fig. 4 depicts the cartographic presentation of results.

FIG. 4. SPATIAL DIVERSIFICATION OF SOCIO-ECONOMIC DEVELOPMENT OF VOIVODSHIPS AND STATES (according to the Hellwig's method, grouping according to the three means method)



S o u r c e: as in the tab. 2.

The conducted comparative analysis indicated that the most developed group in terms of socio-economic development (class 1) was comprised of 6 regions, including 5 German states: Baden-Württemberg, Hamburg, Bayern, Hessen and Berlin, as well as Mazowieckie voivodship. The results of the research indicate significant differences between the regions where the urban centres with important metropolitan functions are located. Baden-Württemberg is the home of the oldest and most prestigious German universities, e.g. the universities in Heidelberg, Freiburg and in Tübingen (Kramer & Rudolf, 2010). This group includes two considerably significant states — Hamburg and Berlin — which undoubtedly have become the metropolitan areas of international recognition (Smętkowski, Jałowiecki & Gorzelak, 2009). Among the states, Hamburg obtained the best GDP *per capita* in PPS rate (206% of the EU average).

The class 2 included 8 regions, encompassing 7 states and only one voivodship — Małopolskie. This class contained one region of the Polish-German borderland — Sachsen which emerged as the region with the highest economic activity ratio in the age group 15—64 (ranked 1st among 32 regions of the aforementioned borderland) and recorded high share of human resources applied to the fields of science and technology in the total number of economically active population (ranked 4th). However, the region scored the lowest in terms of demographic dividend and unoccupied dwellings, ranking 32nd, last in both categories.

The class 3 proved to be the largest, covering 10 regions: 4 states and 6 voivodships. In this class, Dolnośląskie voivodship ranked the highest, standing out i.e. in terms of population at productive age (women and men aged 15—65 in total population (ranked 5th among 32 regions of Poland and Germany) and a number of students *per* 10 thous. of population (ranked 6th), followed by other regions from the Polish-German borderland area: Mecklenburg-Vorpommern, and Brandenburg. These states are very closely related as far as social and economic development is concerned. Mecklenburg-Vorpommern ranked 16th in terms of GDP *per capita*, and Brandenburg — 15th.

In the discussed classification, Polish voivodships ranked the lowest, forming the eight-element class, the weakest in terms of development (class 4). This group included 2 regions from the Polish-German borderland area: Zachodniopomorskie and Lubuskie voivodships. These areas proved to be distinguished due to high indicators of population at the productive age in total population (Zachodniopomorskie — 3rd and Lubuskie — 4th among the 32 regions of Poland and Germany) and low indicators of population past the productive age *per* 100 persons at the productive age (Zachodniopomorskie — 7th and Lubuskie — 3rd). However, the voivodships scored the lowest in terms of total expenditure on R&D and GDP (Zachodniopomorskie — 30th and Lubuskie — 32nd).

Conclusion

Conducted taxonomic analysis of socio-economic potential of the regions in Poland and in Germany, particularly considering the Polish-German borderland area, provided information on differentiation of this development and on

premises to mark out and plan the development directions in specific regions. Although it includes some significant guidelines for the development of strategic goals for each of the regions, it may not function as the only tool supporting decision-making process considering regional policy. It should be noticed that more than 27 years after the reunification of Germany, regional development disproportions among the states of former GDR and former Federal Republic of Germany are still noticeable (Jurkowska, 2014). The ”new” states, within the territory of former GDR, show significant regional disproportions. In 2015 GDP *per capita* (except for Berlin) was between EUR 24,909 (in Mecklenburg-Vorpommern) and EUR 27,776 (in Saxony). GDP in Berlin, as a distinguished state, amounted to EUR 35,627 *per capita*, which is a value below the country average (EUR 37,127)[3]. It is also noteworthy that the current migration situation in Europe has an impact on the socio-economic situation of German and Polish regions. Moreover, in the settlement of the Polish population and immigrants from Africa and Asia in the country, unoccupied dwellings in the eastern lands by the Polish population has a significant impact on the relations between the inhabitants of the Polish-German borderland. Most likely, in the future, the formation of a new community on the Polish-German border will cause cultural, customary, religious and economic changes. It is noteworthy that the results of the above comparative analysis are preliminary and may be used to determine the strategic objectives of regional development in Poland and Germany.

dr inż. Barbara Jurkowska — *Uniwersytet Zielonogórski*

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Przestrzenne zróżnicowanie potencjału społeczno-gospodarczego regionów Polski i Niemiec, ze szczególnym uwzględnieniem pogranicza polsko-niemieckiego

Streszczenie. *Celem artykułu jest zbadanie różnic występujących w wielu dziedzinach życia społeczno-gospodarczego pomiędzy województwami Polski a krajami związkowymi Niemiec. Szczególną uwagę zwrócono na województwa pogranicza polsko-niemieckiego: zachodniopomorskie, lubuskie i dolnośląskie oraz graniczące z nimi niemieckie kraje związkowe: Meklemburgię-Pomorze*

Przednie, Brandenburgię i Saksonię. W badaniu poziomu rozwoju społeczno-gospodarczego Polski i Niemiec wykorzystano taksonomiczną metodę Hellwiga. Podstawę stanowiły dane za lata 2014—2017: dla Polski pochodzące z GUS, a dla Niemiec — ze Statistisches Bundesamt.

Z badania można wywnioskować, że największym atutem regionów Polski jest ich potencjał demograficzny. W połączeniu z możliwościami gospodarczymi i innowacyjnymi regionów Niemiec może się to stać impulsem do rozwoju pogranicza polsko-niemieckiego w wielu sferach życia społeczno-gospodarczego.

Słowa kluczowe: Polska, Niemcy, pogranicze polsko-niemieckie, miara rozwoju, analiza porównawcza.