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The level of socio-economic development of regions in Poland

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Abstract. The development of regions within one country is an uneven process. States seek to reduce internal inequalities between particular regions through the implementation of appropriate economic policies, as is the case of Poland. The aim of the study is to evaluate the level of socio-economic development of regions in Poland (voivodships) in the years 2013–2019. For this purpose, a taxonomic analysis based on Hellwig's development measure was conducted and the Euclidean distance was applied to assess the difference between the obtained pattern and particular voivodships. On the basis of data provided by the Local Data Bank of Statistics Poland and through linear ordering, two rankings of voivodships were created: one reflecting their socio-economic development excluding environmental protection aspects and the other focusing solely on the issue of environmental protection. Low values of the coefficient of variation relating to a part of the analysed variables indicated that the development level of voivodships in the analysed period is in many respects very similar. The variables crucial for determining the differences between voivodships show that Mazowieckie Voivodship occupies high positions in both rankings (and is the leader in the ranking of socio-economic development excluding environmental protection aspects), while Warmińsko-Mazurskie Voivodship is characterised by a low level of development illustrated by both rankings.

Keywords: economic growth, socio-economic development, regional economics, voivodship, regional development differentiation, linear ordering, Hellwig's method

JEL: E01, O11, O30, O52, R11

Poziom rozwoju społeczno-gospodarczego województw

Streszczenie. Rozwój regionów w obrębie państwa jest procesem nierównomiernym. Poprzez odpowiednią politykę gospodarczą państwo dąży do zmniejszenia wewnętrznych nierówności. Dotyczy to również Polski. Celem badania omawianego w artykule jest określenie poziomu rozwoju społeczno-gospodarczego województw w latach 2013–2019. W badaniu zastosowano analizę taksonomiczną z wykorzystaniem miary rozwoju Hellwiga. Do oceny różnicy pomiędzy wzorcem i województwem wykorzystano odległość euklidesową. Na podstawie danych z Banku Danych Lokalnych GUS opracowano, za pomocą porządkowania liniowego, ranking województw pod względem sytuacji społeczno-gospodarczej z wyłączeniem aspektów środo-

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wiskowych i osobno ranking dotyczący ochrony środowiska. Wyniki badania pokazują, że poziom rozwoju województw w badanym okresie jest w wielu aspektach bardzo zbliżony (niskie wartości współczynnika zmienności). Na podstawie zmiennych najbardziej różnicujących województwa wykazano, że woj. mazowieckie zajmuje bardzo wysokie pozycje w obu rankingach (pod względem rozwoju społeczno-gospodarczego z wyłączeniem aspektów środowiskowych jest liderem), natomiast woj. warmińsko-mazurskie charakteryzuje się niskim poziomem rozwoju zilustrowanym przez obydwa rankingi.

Słowa kluczowe: wzrost gospodarczy, rozwój społeczno-gospodarczy, ekonomia regionalna, województwo, zróżnicowanie rozwoju regionalnego, porządkowanie liniowe, metoda Hellwiga

1. Introduction

The differences in the wealth between countries are one of the most widely-discussed topics (Goldin, 2019). For years, economists have wondered why today's society is more affluent than a hundred years ago (Felipe et al., 2010; Whitfield, 2012). Wealth and social well-being are researched by development economics. Social well-being, however, is not only a quantitative category but also a quality matter. What is more, when the analysis of economic development is concerned, it should be emphasized that it is influenced by factors which cannot be expressed quantitatively (Loayza & Soto, 2002).

As pointed out by Blanchard (2017), the interest in the standard of living is the reason why a lot of attention is paid to economic growth. Stachowiak (1996) claims that economic growth should be understood as the process of basic economic figures rising over time. Economic growth is also defined as an increase in the real value of gross domestic product in the economy (Nawrot, 2010). The theory of economic growth focuses on two groups of issues in particular: on the determinants of economic growth, i.e. those leading to the maximisation of the growth of the national income in a long-term perspective, and on determining the conditions guaranteeing a state of equilibrium, i.e. economic growth (Dach, 2011).

It is worth noting that different types of development may be distinguished, including socio-economic, technological or sustainable development. Within the above-mentioned studies, regional development must be singled out. Regional development in the broad sense is a process encompassing all the changes taking place in a region. The development of a region can be defined as a set of ongoing changes in the area of a given territorial unit, as a result of which the elements of its internal structure and the relationships between these elements are enriched (Kocurek, 2013).

In relation to the study of regional development, this paper presents a novel selection of variables which can be used to evaluate socio-economic development. The indicators used in this study are completely different from those described in

previous studies and aim to show development from a different angle. Poland was a beneficiary of the Horizon 2020 EU financial perspective – aid from the fund was used in every region of the country. The fact that the analysis presented in this paper was conducted when the initiative was still ongoing is innovative itself. The results from 2020 were not considered, as this was the year the COVID-19 pandemic started.

The aim of the study is to evaluate the level of socio-economic development of voivodships in the years 2013–2019. For this purpose, two rankings of the socio-economic development of voivodships in the years 2013–2019 were created. The rankings served to show which voivodship was the leader in terms of socio-economic development, and whose level of development was the lowest. Moreover, the study attempted to answer the question about which economic features of voivodships are similar and which are highly differentiated.

2. Literature review

There is a major difference between economic growth and economic development (Pisarski, 2014). Economic growth is defined as a continuous increase in the volume of production in a country (expressed, for example, by the level of GDP). Economic development is a process of changes occurring in the economy. It includes both positive quantitative and qualitative changes in economic variables (Gondek, 2016). While economic growth can exist without economic development, economic development results from economic growth. Economic growth is considered to be a measurable category, whereas economic development is a non-measurable one. A wider view of economic development is presented by socio-economic development. This field of science, similarly to economic development and economic growth, illustrates highly complex phenomena which are very difficult to assess unambiguously and objectively (Ziemiańczyk, 2010). Socio-economic development is the broadest concept, encompassing the general development tendency of a given country, region or territorial unit (Ziemiańczyk, 2010). There are many factors and components of economic development (Gondek, 2016). The most important ones include: the level of infrastructure, the level of education, the level of internal investments and the inflow of foreign direct investments, the level of citizens' savings, political stability and the prevailing law, the condition of the natural environment, the economic system, economic stability, foreign aid, natural resources, tax rates, the level of corruption, development of the tourism sector, human capital, prevailing religion and culture (Warczak, 2015). In the case of economic growth, i.e. when a country seeks to develop economically, it must focus not only on the economic sphere, but also on the social, legal, cultural and techno-

logical aspects. The complexity of the categories of socio-economic development necessitates the use of a set of measures in research and comparative analyses (Pawlas, 2015).

There are also many approaches to the measurement of economic growth. The traditional measures relate to the primary changes: Gross Domestic Product (GDP), Net Domestic Product (NDP), Gross National Product (GNP) and Net National Product (NNP), expressed in real or nominal values. The most commonly applied indicator is GDP, which is the value of products and services produced by the factors of production located in a given country, regardless of the ownership form. GDP is considered as an imperfect indicator, therefore it may be complemented by, for instance, greening GDP/GNP (Cieślik, 2008), the urbanisation ratio (Szymańska, 2002), the Measure of Economic Well-Being and the Measure of Economic Aspects of Welfare (Redclift, 2005), the Global Peace Index (Institute for Economics and Peace, 2018) and the Human Development Index (United Nations Development Programme, 2019).

Even when periodic unstable external conditions occured, the economic development of Poland in 1995–2015 was characterised by a relatively high, although decreasing growth rate, similar to the world economy average and higher than that achieved in highly developed countries of the EU and OECD (Kotyński, 2017). Since 2004, Poland has been an official member of the EU, which has undoubtedly influenced the present state of the national economy. According to the data from the World Bank (World Bank, n.d.), Poland ranked 39th in the world in terms of GDP *per capita* in 2020. This means that Poles were among the forty richest citizens of the globe. However, not all Polish regions experience the same socio-economic development. The primary purpose of the EU Cohesion Policy is to reduce regional disparities (Dziembała, 2019). It should be mentioned here that this policy is meant to contribute to achieving the main goal, i.e. cohesion throughout the EU, in accordance with the provisions of the Treaty of Rome, the Single European Act, the Treaty on European Union or the Amsterdam Treaty (Dziembała, 2016).

The issues related to the development of individual regions of the country are often analysed by Polish scientists both within quantitative and qualitative research. Qualitative research was conducted by Warzecha (2013b), who analysed as many as seven groups of variables in order to determine Hellwig's synthetic measure connected with socio-economic development. The conducted research showed disproportions in the level of information society development between voivodships. According to the study, Mazowieckie Voivodship was the most developed region. The differences between the voivodships were explained by the distinctive features of the particular regions and their spatial distribution.

Roszkowska and Filipowicz-Chomko (2016) focused on comparing the changes observed in each region resulting from the implementation of specific undertakings

towards sustainable development and assessing each region's progress in this respect. For this purpose, the researchers used the TOPSIS method, which confirmed the disproportions in the socio-economic development of voivodships. In many voivodships, despite a significant progress, the number of threats also increased. Roszkowska and Filipowicz-Chomko (2016) observed that the socio-economic differences between regions result from the gradual implementation of the EU Cohesion Policy.

Michoń (2017) drew attention to diagnostic variables relating to the three dimensions of the EU Cohesion Policy: economic, social and territorial, creating their synthetic indicators. Her research showed that development differences in voivodships were visible after the period of 10 years, between 2005 and 2015. According to her study, the strongest developing voivodships are those in western Poland. The researcher also noted that the differences in the development of voivodships were related to the objectives of the cohesion policy, which focused on enhancing competitiveness.

Klosa (2018) performed an analysis of the level of socio-economic development of Polish regions and showed the differentiation and classification of voivodships in this respect. Hellwig's method of development patterns and the zero unitarisation method were used in his research. The results of these studies proved convergent and indicated that the most highly developed voivodships are Dolnośląskie, Mazowieckie and Pomorskie.

3. Research method

The subject of the study was the socio-economic development of Poland. The source of the used data was the Local Data Bank of Statistics Poland. The research covered 16 voivodships and the years 2013–2019 were analysed. Such a choice of years was motivated by the EU Horizon 2020 policy carried out from 2014 to 2020. In 2020, the outbreak of the COVID-19 pandemic affected the economy (Fernandes, 2020; Sarkodie & Owusu, 2021; Shen et al., 2020), financial markets (Ali et al., 2020; Kubiczek, 2020; Zhang et al., 2020) and the then current economic policy (Ashraf, 2020; Sharif et al., 2020). Therefore, the year 2020 was not taken into consideration in the paper, so as to avoid the results of the conducted analysis being influenced by this phenomenon.

It should be emphasized that socio-economic development covers many categories. Warczak (2015) indicates the following aspects: economic, social, spatial, ecological, political, technical and local. Kocurek (2010) specifies many economic and non-economic determinants of development. Orłowska (2018) also underlines the multifaceted nature of economic development and lists such categories as socio-

cultural, environmental, infra-technical, economic and spatial. Depending on the type of research and analysed factors, scientists create their own divisions and categories. In this study, in order to assess the socio-economic development of the studied regions, 24 variables were distinguished using the expert selection method, which allows a broad comparison of the many aspects affecting socio-economic development and which are closely related to it. The selected variables come from several categories, i.e. economy and innovation, education, labour market, safety and health care, and environmental protection.

The absolute values were relativised through their division by population number to enable the comparison of voivodships. The choice of the population number as the basis for the relativisation is justified by the fact that the more inhabitants in a voivodship, the greater the budget revenues from taxes. Thus, a voivodship has a larger budget and may incur higher expenditures. The full names of the variables, their abbreviations and units are presented in Table 1.

Table 1. Variables used in the analysis concerning voivodship socio-economic development

Variables	Abbreviation	Unit
Economy and innovation		
EU funds for financing programmes and projects *per capita*	EU funds	PLN
Gross domestic product *per capita*[a]	GDP	PLN
Internal expenditure on R&D *per capita*	R&D expenditure	PLN
Use of ICT: computers in enterprises from the non-financial sector	ICT_n computers	%
of with having Internet access	ICT_n Internet	%
computers in enterprises of the financial sector[a]	ICT computers	%
of with having Internet access[a]	ICT Internet	%
Education		
University students per 10,000 population	Students	No. of persons
Passing secondary school final examinations (matura)	Matura exam	%
Graduates of graduate studies per 1,000 inhabitants	Graduates	No. of persons
Labour market		
Average monthly disposable income per person	Disposable income	PLN
Registered unemployment rate	Unemployment	%
Economic activity among working age people	Economic activity	%
Safety and health care		
Total expenditure of gminas (communes) and poviats (counties) on public safety and fire protection *per capita*	Security expenditure	PLN
Beds in general hospitals per 10,000 population	Beds	No.
Doctors working according to their basic workplace per 10,000 population	Doctors	People
Crimes identified by the police in total per 1,000 inhabitants	Crimes	No.

a No data for 2019 is available in the Local Data Bank.

Note. R&D – research and development, ICT – information and communication technologies.

Table 1. Variables used in the analysis concerning voivodship socio-economic development (cont.)

Variables	Abbreviation	Unit
Environmental protection		
Waste collected selectively in relation to total waste	Waste	%
Wild dumps on a total area of 100 sq. km	Landfills	No.
Pollutants retained or neutralised in pollution abatement equipment in the percentage of the total generated pollutants (dust)	Dust contamination	%
Pollutants retained or neutralised in pollution abatement equipment in the percentage of the total pollutants produced (gaseous)	Gaseous pollutants	%
Outlays on fixed assets for environmental protection *per capita*	Expenditure on environmental protection	PLN
Outlays on fixed assets serving water management *per capita*	Outlays on water management	PLN
Population using sewage treatment plants as a percentage of the total population	Population, purifiers	%

a No data for 2019 is available in the Local Data Bank.

Note. R&D – research and development, ICT – information and communication technologies.

Source: authors' work.

The first stage involved the verification of the variables and the elimination of the quasi-constant variables. For each variable, the coefficient of variation was calculated and then compared with the level required to qualify a given variable for analysis. The level was set at 10% (Jankowska, 2017; Pomianek, 2010; Warzecha, 2013a).

The variables selected for the analysis were divided into two groups of factors: shaping the socio-economic situation excluding environmental protection aspects and shaping environmental protection. They were further classified using the linear ordering method. Stimulants (S) and destimulants (D) were specified for all variables.

The first group – variables describing socio-economic development excluding environmental protection aspects – includes the following:

- R&D expenditure (S);
- Doctors (S);
- GDP (S);
- Students (S);
- Graduates (S);
- Crimes (D);
- Unemployment (D).

The second group – variables describing socio-economic development in terms of environmental protection – includes the following:

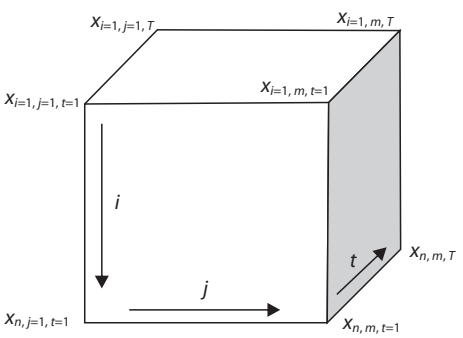
- Expenditure on environmental protection (S);
- Outlays on water management (S);
- Gaseous pollutants (S);

- Waste (S);
- Landfills (D).

The selected variables were used to determine which voivodships developed at the fastest pace. Then, they were ordered accordingly. The taxonomic measure of development (TMD) was used (Hellwig, 1968), as it is widely applied to assess the socio-economic development of territorial units (Jankowska, 2017; Maj, 2009; Miśkiewicz-Nawrocka & Zeug-Żebro, 2015; Pomianek, 2010; Warzecha, 2013a).

TMD is a synthetic indicator of the distance of an object from the pattern. In addition, TMD allows the ordering of a set of objects (voivodships) according to the distinguished features (variables), being a stimulant or destimulant. In the case of time series, the data set takes the form of a cube (Gatnar & Walesiak, 2009, p. 63; Jajuga, 1993, pp. 21–23), as shown in Figure 1.

Figure 1. Dataset structure as a cube



Note. *j*-th feature in *t*-th period for *i*-th object.
Source: author's work.

It is possible to present a data cube in the following form of a two-dimensional matrix:

$$\mathbf{X} = \begin{bmatrix} x_{11t} & x_{12t} & \cdots & x_{1jt} & \cdots & x_{1mt} \\ x_{21t} & x_{22t} & \cdots & x_{2jt} & \cdots & x_{2mt} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{i1t} & x_{i2t} & \cdots & x_{ijt} & \cdots & x_{imt} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{n1t} & x_{n2t} & \cdots & x_{njt} & \cdots & x_{nmt} \end{bmatrix},$$

where x_{ijt} means the values of the j-th feature in t-th periods for the i-th object ($i = 1, 2, ..., n$; $j = 1, 2, ..., m$; $t = 1, 2, ..., T$).

In the case of the analysed voivodships, n is equal to their number i.e. 16, while mT is the product of the number of periods (T) and the number of variables (m).

Due to the possibility of the occurrence of fluctuations in individual years, the values of the variables were averaged so that they represent the average pace of development in a given voivodship. Thus, the elements of matrix **X** have been averaged over the analysed periods forming a new matrix:

$$\mathbf{X}' = \begin{bmatrix} \bar{x}_{11} & \bar{x}_{12} & \dots & \bar{x}_{1j} & \dots & \bar{x}_{1m} \\ \bar{x}_{21} & \bar{x}_{22} & \dots & \bar{x}_{2j} & \dots & \bar{x}_{2m} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \bar{x}_{i1} & \bar{x}_{i1} & \dots & \bar{x}_{ij} & \dots & \bar{x}_{im} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \bar{x}_{n1} & \bar{x}_{11} & \dots & \bar{x}_{nj} & \dots & \bar{x}_{nm} \end{bmatrix},$$

where $\bar{x}_{ij}$ is the average value of the j-th variable in periods $t - T$ for the i-th object.

Then, in order to normalise the variables, all values were standardised according to the formula (Gatnar & Walesiak, 2009, p. 68)[1,2]:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}. \tag{1}$$

Based on the standardised variables, the following pattern was determined (Bąk, 2016):

$$z_{0j} = \begin{cases} \max\limits_i (z_{ij}) & \text{for stimulant} \\ \min\limits_i (z_{ij}) & \text{for destimulant.} \end{cases} \tag{2}$$

A pattern is an abstract object that illustrates an ideal voivodship. Next, for individual voivodships (lines), the Euclidean distance from the created pattern was determined using the following formula[3] (Bąk, 2016, 2018; Gatnar & Walesiak, 2004, p. 354; Hellwig, 1968):

$$d_{i0} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j})^2}. \tag{3}$$

[1] For more possible transformations, see Gatnar and Walesiak (2009, p. 68).
[2] A different approach is presented by Młodak et al. (2016), who replaced a number of explanatory variables with one determined synthetic measure.
[3] For more possible distance measures, see Gatnar and Walesiak (2009, p. 71).

It should be emphasized that the Euclidean distance is used as a measure of dissimilarity in many studies in the field of economic sciences (Czyżycki, 2012; Hellwig, 1968; Jankowska, 2017; Maj, 2009; Pawlas, 2015; Pomianek, 2010). The distances of individual variables calculated in this way were averaged for each voivodship $\left(\bar{d}_0 = \frac{\sum_{j=1}^{n} d_{i0}}{n}\right)$ and then the standard deviation was calculated $\left(s_0 = \sqrt{\frac{\sum_{j=1}^{m}(d_{i0}-\bar{d}_0)^2}{n}}\right)$.

Subsequently, Hellwig's development measure was determined for each voivodship. This measure is illustrated by the following formula (Bąk, 2016; Czyżycki, 2012; Hellwig, 1968):

$$d_i = 1 - \frac{d_{i0}}{d_0}, \tag{4}$$

$$d_0 = \bar{d}_0 + 2s_0. \tag{5}$$

It should be emphasized that if one of the voivodships was the best in terms of all the variables (constituting the pattern), the sum of the distances for individual variables would be 0.

4. Results

Socio-economic development may occur at a different pace over the years. Therefore, due to potential random fluctuations observed in certain years, the values of each variable were averaged for every voivodship. This way, the average level of socio-economic development in the analysed period was determined. The results are presented in Table 2. Among all the variables, the greatest variation was observed in wild landfill (85.05%) and R&D expenditure *per capita* (81.29%).

It should be noted that at the stage of compiling all the voivodships, several conclusions could already be drawn. Firstly, regardless of the sector, almost all of the surveyed enterprises used computers and Internet connection (this percentage grew on average every year). Secondly, the average pass rate of the Matura exam in voivodships ranged from 74.29% to 80.94%. Therefore, the level of education in voivodships is similar, because the Matura exam is the same for everyone and can be the basis for reference in education. This result, however, does not mean that the education system contributes to the success rate of all students. It is worth noting that in this case it is not possible to refer only to the education system, as the level of the pass rate may also be affected by the students' social situation.

Table 2. Average values of variables describing socio-economic development and their coefficient of variation in voivodships in 2013–2019

Variable	DŚL	K-P	LBL	LBU	ŁDZ	MŁP	MAZ	OPO	PKR	PDL	POM	ŚL	ŚW	W-M	WLKP	ZPM	CV in %
EU funds	58.27	69.39	39.37	65.57	24.71	50.96	26.09	43.39	52.71	33.30	31.33	27.74	37.21	38.49	29.03	41.76	**32.31**
GDP	53,556	39,318	33,439	40,264	45,083	43,633	77,148	38,683	34,127	34,802	46,546	50,085	34,940	34,191	52,223	40,455	**24.63**
R&D expenditure	498.93	199.21	329.06	134.60	358.40	827.83	1,447.34	169.16	414.69	231.43	594.94	341.77	157.50	163.57	373.24	171.00	**81.29**
ICT_n computers	96.66	95.04	95.23	95.76	93.53	94.44	96.30	94.77	95.30	95.43	95.51	96.09	93.90	94.20	94.21	94.57	0.91
ICT computers	99.15	98.92	100.00	98.22	99.65	99.70	99.28	100.00	100.00	100.00	99.73	99.23	100.00	100.00	100.00	99.40	0.50
ICT_n Internet	95.69	94.33	94.39	94.83	92.69	93.49	95.26	94.14	94.06	94.29	94.89	94.81	92.49	92.60	93.41	93.33	0.99
ICT Internet	99.15	98.53	100.00	97.02	99.65	99.70	99.28	100.00	100.00	100.00	99.73	98.77	100.00	99.48	99.23	98.28	0.80
Students	444	292	356	152	321	495	499	246	251	289	395	273	209	219	366	270	**30.95**
Matura exam	75.99	77.07	77.03	79.14	77.81	80.94	78.91	77.33	78.07	79.49	76.87	77.61	77.60	74.83	77.11	74.29	2.08
Graduates	5.50	3.68	4.79	1.67	4.02	6.82	6.15	3.52	3.43	3.93	4.65	3.62	3.10	2.88	4.66	3.07	**30.76**
Disposable income	1,587	1,395	1,337	1,499	1,487	1,444	1,855	1,416	1,191	1,446	1,571	1,562	1,353	1,377	1,458	1,530	9.51
Unemployment	7.81	12.21	10.47	9.21	8.99	7.17	7.27	9.21	11.69	10.46	7.87	6.96	11.30	14.56	5.41	11.46	**24.41**
Economic activity	75.51	73.79	74.74	73.20	77.86	74.37	79.93	74.91	73.49	75.86	75.56	72.49	74.09	70.23	76.69	72.19	3.00
Security expenditure	106.99	98.79	98.51	114.93	116.57	101.65	123.60	118.18	97.25	107.42	107.77	103.35	105.52	109.44	102.31	120.51	7.36
Beds	50.25	46.27	51.97	42.58	51.33	43.58	48.09	45.94	47.36	48.92	39.59	55.04	48.28	45.86	43.18	46.67	8.01
Doctors	22.07	23.76	24.81	20.20	27.04	23.50	27.06	19.61	21.23	25.36	22.19	24.29	23.39	20.79	15.37	25.04	**12.72**
Crimes	28.22	19.92	16.35	26.95	19.83	22.80	21.62	21.01	13.06	15.19	21.84	26.38	18.33	19.17	19.86	24.80	**19.53**
Waste	20.557	23.243	26.000	20.886	26.386	26.343	23.529	27.386	23.271	20.371	23.743	31.000	25.900	16.914	21.429	20.314	**14.34**
Landfills	1.157	0.257	0.486	0.271	0.786	1.829	0.400	1.529	0.657	0.414	0.371	2.543	0.543	0.100	0.257	0.657	**85.05**
Dust contamination	99.90	99.41	98.10	99.17	99.96	99.63	99.80	99.93	99.26	99.00	99.43	99.66	99.87	98.26	99.70	99.69	0.55
Gaseous pollutants	93.11	36.34	89.20	43.13	82.54	54.60	63.66	70.51	30.01	15.40	82.04	27.34	45.54	1.61	65.96	57.81	**48.6**
Expenditure on environmental protection	244.16	226.97	222.09	259.85	318.40	284.49	308.52	339.07	219.19	230.13	277.79	363.53	328.96	152.30	297.63	315.62	**19.67**
Outlays on water management	170.76	47.21	44.78	65.95	35.27	87.82	62.28	147.30	67.50	52.84	63.65	99.53	46.37	47.30	46.65	48.43	**52.53**
Population, purifiers	80.09	72.30	56.91	74.91	68.91	64.74	71.64	74.54	73.06	67.56	83.13	80.03	61.86	76.06	71.63	82.74	9.81

Note. Voivodships: DŚL – Dolnośląskie, K-P – Kujawsko-Pomorskie, LBL – Lubelskie, LBU – Lubuskie, ŁDZ – Łódzkie, MŁP – Małopolskie, MAZ – Mazowieckie, OPO – Opolskie, PKR – Podkarpackie, PDL – Podlaskie, POM – Pomorskie, ŚL – Śląskie, ŚW – Świętokrzyskie, W-M – Warmińsko-Mazurskie, WLKP – Wielkopolskie, ZPM – Zachodniopomorskie; CV – coefficient of variation, CV >10% is marked in bold.

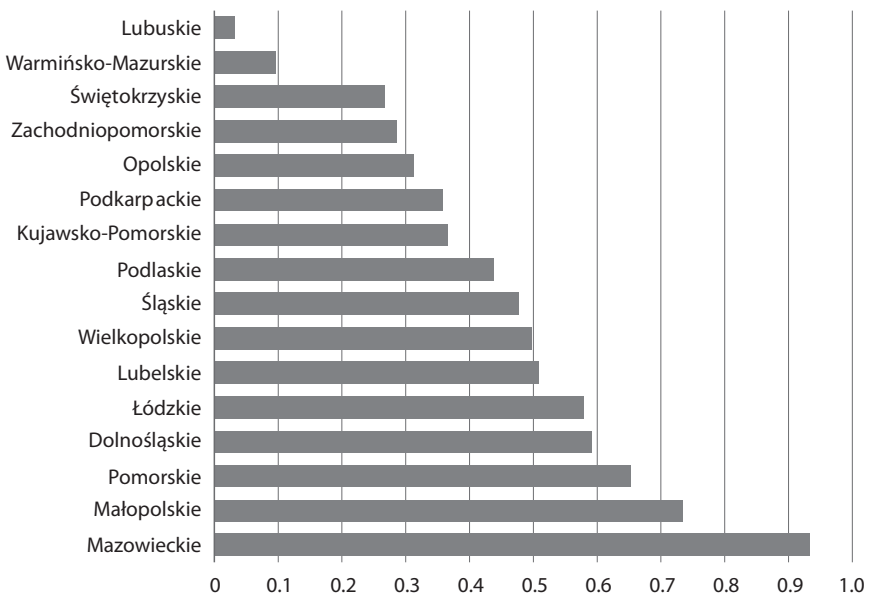
Source: author's work based on data from the Local Data Bank.

In the case of monthly disposable income per person, a large difference (of PLN 664) can be observed between the extreme voivodships (PLN 1,191 in Podkarpackie Voivodship and PLN 1,855 in Mazowieckie Voivodship). However, it is similar in most voivodships and this similarity is reflected in the low value of the coefficient of variation.

For variables from the environmental protection category, the values for the pollutants retained or neutralised in the pollution reduction devices in the percentage of the total generated pollutants are particularly important. Dust pollution is almost 100% neutralised in all the analysed voivodships; however, the effectiveness of gas pollution neutralisation is highly diversified.

Another aspect related to development in the ecological category is the percentage of the population connected to a sewage system and a sewage treatment plant. Although in Lubelskie Voivodship in the analysed period the percentage of the population was only 56.91% and in Pomorskie Voivodship it amounted to 83.13%, the remaining voivodships were close to the average (the coefficient of variation was 9% in 2019).

Figure 2. Socio-economic ranking of voivodships excluding environmental protection aspects in 2013–2019 according to the values of the TMD



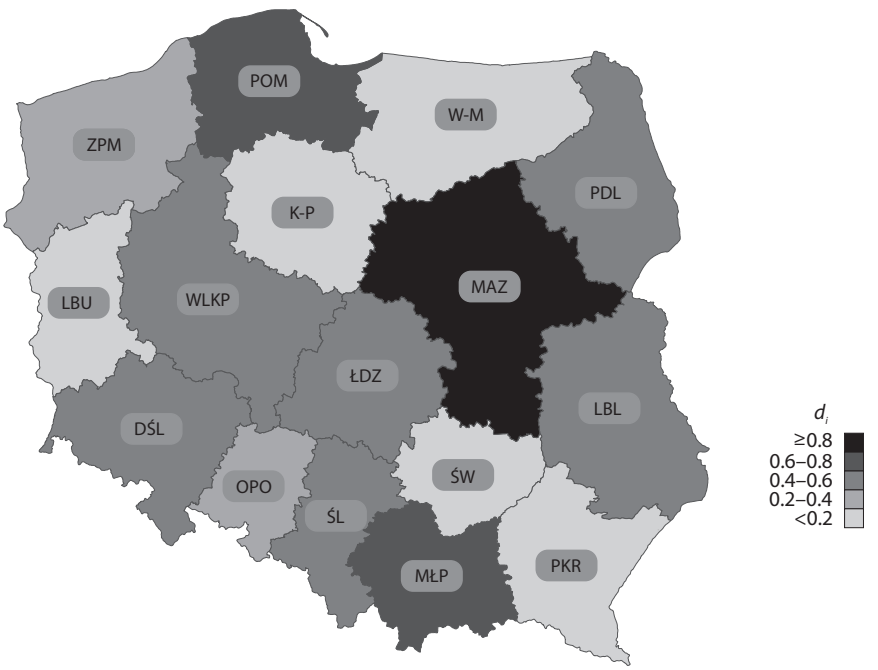
Source: authors' work based on data from the Local Data Bank of Statistics Poland.

The values of the variables were standardised (equation 1) and then patterns for two categories were determined accordingly (equation 2). In the next stage, the

distances from the pattern (equation 3) were calculated for particular variables and averaged for all voivodships, and then the TMDs (4) were determined. The ranking of voivodships in terms of socio-economic development excluding environmental protection aspects is presented in Figure 2.

The undisputed leader in the ranking is Mazowieckie Voivodship with its measure exceeding the level of 0.9, followed by Małopolskie Voivodship whose measure slightly exceeds 0.7. It is also worth noting that Warmińsko-Mazurskie and Lubuskie voivodships did not reach the level of 0.1, while the remaining voivodships have values of at least 0.2. Map 1 better illustrates these results.

Map 1. Socio-economic development excluding environmental protection aspects in 2013–2019 according to the values of the TMD

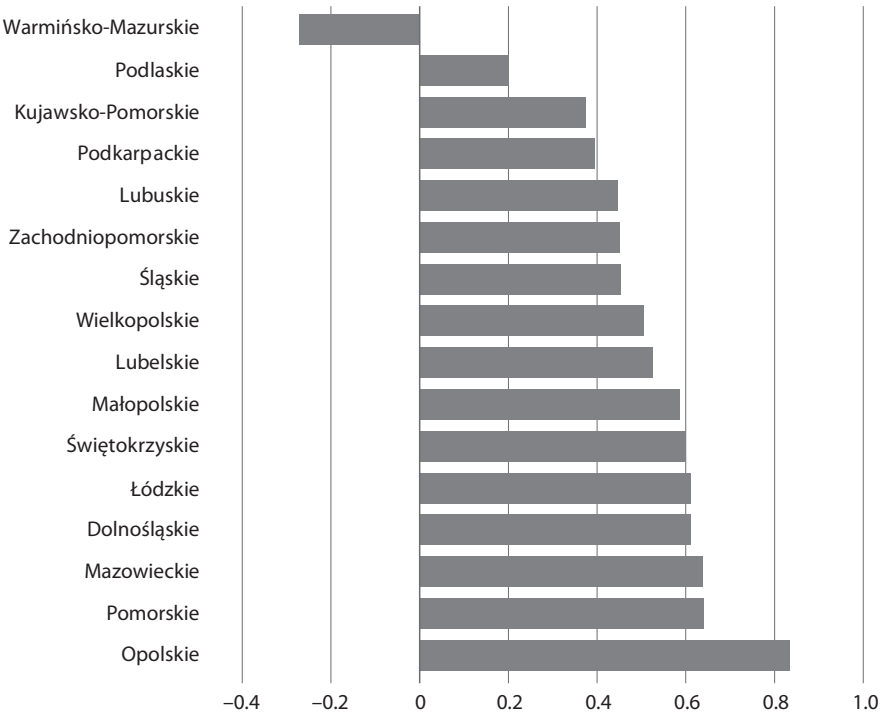


Note. As in Table 2.
Source: authors' work based on data from the Local Data Bank of Statistics Poland.

The lowest rate was noted in Lubuskie Voivodship. The high values of the coefficient for Mazowieckie Voivodship confirm that it is the centre of Poland's socio-economic development excluding environmental protection aspects.

The second ranking of voivodships was related to environmental protection. The results of the taxonomic analysis according to Hellwig's development measure are presented in Figure 3.

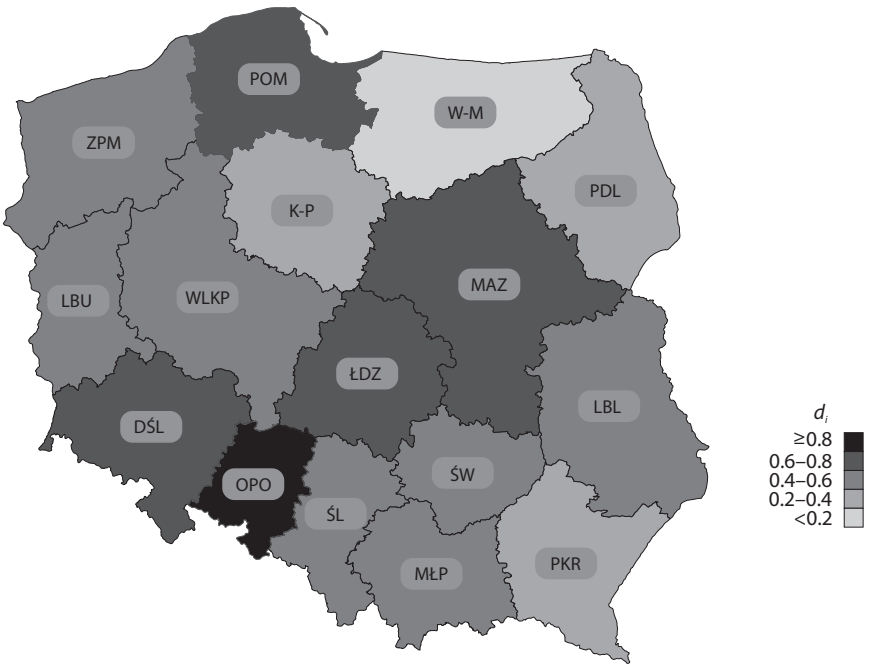
Figure 3. Environmental protection ranking of voivodships in 2013–2019 according to the values of the TMD



Note. In the case of large distances from the pattern, it is possible that observations have negative values of the indicator.
Source: authors' work based on data from the Local Data Bank of Statistics Poland.

The first conclusion regarding the environmental protection under consideration is the fact that Warmińsko-Mazurskie Voivodship definitely stands out from among the others in the negative sense, while Opolskie Voivodship is the unquestionable leader in this matter – it is the only region whose TMD exceeded the level of 0.8. The high value of the coefficient for Mazowieckie Voivodship is positively surprising. For a better understanding of the spatial diversity, the results are presented on Map 2.

Map 2. Environmental protection in 2013–2019 according to the values of the TMD



Note. As in Table 2.
Source: authors' work based on data from the Local Data Bank of Statistics Poland.

5. Discussion

The government's economic policy should support socio-economic growth and socio-economic development. It may be either faster or slower, depending on a number of factors. Therefore, it is natural that within one country some regions are strongly developed while others poorly. However, with the use of EU funds, it is possible to support the least developed regions (Dziembała, 2016, 2019).

Throughout the years 1995–2015, Poland developed rapidly, achieving a growth rate greater than that of highly developed countries of the EU and OECD (Kotyński, 2017). One of the factors contributing to this considerable growth were EU funds, which, despite targeting the poorer developed regions, did not ensure the same state of socio-economic development in the whole country, as evidenced by the results of the research by e.g. Klosa (2018) or Michoń (2017). Similar results were obtained in this study.

Using features which are characterised by great differentiation, the voivodships were classified according to socio-economic development excluding environmental

protection aspects and into those relating to environmental protection only. In the process, Mazowieckie Voivodship proved to be the leader in the first category. Michoń (2017) also showed that Mazowieckie Voivodship could boast the highest level of development, economic cohesion and social cohesion. Otherwise, voivodships differ significantly in terms of socio-economic development. Warzecha's analysis (2013a) led to similar conclusions. We can call it 'the capital city effect', as Warsaw is the most developed city in Poland, with the highest salaries, each year offering more benefits to people who live there. Moreover, the capital is home to all the most important national centres.

On the other hand, Warmińsko-Mazurskie Voivodship achieved very poor results in terms of socio-economic development excluding environmental protection aspects in the years 2013–2019 and ranks last in terms of environmental protection measures. Drabarczyk (2017) also reported low results of socio-economic development in this region.

The identified high diversity of variables from the environmental protection category shows the need for an in-depth analysis in the field of ecology, especially since environmental protection and sustainable development are among the priorities of the EU policies.

The relationship between economic development and environmental pollution has been observed by Kuznets (1955), who is the creator of the environmental Kuznets curve. His research showed that as a country develops, social inequalities increase to a certain point and then decline over time. Moreover, he noticed that in the initial stage of economic growth the level of environmental degradation increased. Nevertheless, this trend changes after reaching a certain level of income, called the 'turning point'.

The results of the differentiation in terms of the environment may indicate a different stage of socio-economic development of voivodships. Some of the more developed voivodships may specialise in a particular field, which places them in a stable situation, allowing these regions to focus on caring for the environment, e.g. Mazowieckie Voivodship. On the other hand, the voivodships of Kujawsko-Pomorskie, Warmińsko-Mazurskie, Podkarpackie and Podlaskie are lagging also in terms of this aspect of socio-economic development.

This paper has many practical implications. We obtained similar results to Klosa (2018) or Michoń (2017), therefore multidimensional inequalities are likely to exist in voivodships. Therefore, the effectiveness of the implemented programmes for voivodships should be evaluated and the objectives revised. This applies not only to the government's regional policy, but especially to where and how EU funds are allocated. Perhaps it is not the initiatives themselves that are faulty, but the fact that

the region's inhabitants and entrepreneurs either do not know about the programmes or fail to take full advantage of them.

The presented ranking can be treated as a point of reference for those seeking more detailed information about particular voivodships. Therefore, it can be used by people who would like to invest their capital in a given voivodship or who are considering changing their place of residence, because the results provide information about the level of development of particular regions and the improvements achieved there in the recent years.

The present study may also form the basis for conclusions as to the shape of future research. Further studies may use other classification and clustering methods to create a ranking from a different perspective. In addition, it is possible to use alternative distance measures (see Gatnar & Walesiak, 2004). The development of an alternative strategy of measuring economic development may also be considered in the future. Moreover, a study relating exclusively to climate and environmental issues may complement the present research.

The limitations of the study resulted from the availability of a restricted number of features. However, the variables selected for the research are characterised by high differentiation, which made them appropriate for the analysis. Thus, it should be noted that in many aspects voivodships are similar to one another. The analysed variables show that voivodships are diversified socio-economically, also in terms of environmental protection. Another limitation of the study is that it took into account the average values, not the final ones, i.e. the effect/state of development in the last analysed period was not taken into account, although a certain average value of the process was considered.

6. Summary

The evaluation of the socio-economic development of Polish voivodships in the years 2013–2019 was presented in this article and thus the set aim was achieved. The study used data from the Local Data Bank of Statistics Poland. Linear ordering according to Hellwig's development measure was applied in the performed analysis. The study included 24 variables which present a broad picture of socio-economic development. In order to reduce the value fluctuations in the time series, the annual values were averaged over the entire analysed period.

It is worth emphasizing that among the considered variables, as many as half of them can be classified as quasi-constants (with the coefficient of variation amounting to less than 10%). The low values of the coefficient of variation for the examined variables lead to the conclusion that the voivodships are similar in many respects. For instance, the coefficient of variations relating to the use of ICT is below

1%. Furthermore, the similarly high level of ICT development in voivodships indicates that Poland is highly digitised, which, in turn, means that the country's level of technological development is high.

The remaining variables were divided into two categories: socio-economic excluding environmental protection aspects (seven variables) and environmental protection aspects (five variables). Then, by means of linear ordering, a ranking of voivodships was created. It should be emphasized that two variables particularly differentiate the voivodships: internal expenditure on R&D *per capita* and wild dumps on a total area of 100 sq. km. The coefficient of variation relating to these features exceeds 80%.

The leader in terms of socio-economic development excluding environmental protection aspects was Mazowieckie Voivodship, while in terms of environmental protection Opolskie Voivodship took first place. The lowest positions were occupied by Lubuskie Voivodship and Warmińsko-Mazurskie Voivodship, respectively.

The research revealed the strengths and weaknesses of particular voivodships. This may become crucial for voivodship authorities in creating development strategies for the upcoming years. Furthermore, research should be repeated using the same methodology in order to ensure the comparability of results, while the reduction of disparities should be closely monitored, thus allowing the evaluation of the effectiveness of the EU Cohesion Policy programmes.

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