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THE LEVEL OF SOCIO-ECONOMIC DEVELOPMENT OF POLISH PROVINCES IN THE PERIOD 2005-2020

Ewa Szczucka https://orcid.org/0000-0002-3764-311X
Michał Gostkowski https://orcid.org/0000-0003-3606-1182
Institute of Economics and Finance
Warsaw University of Life Sciences – SGGW, Poland
e-mail: ewa_szczucka@sggw.edu.pl; michal_gostkowski@sggw.edu.pl

Abstract: Socio-economic development is a multi-dimensional and highly complex subject. The goal of the current regional policies, which are widely implemented around the world, is to equalize the level of development of regions. In order for these measures to be effective, there is a need for developing methods and its continuous improvement. One method that allows statistical and multidimensional description of the level of socio-economic development is the determination of synthetic measures. The purpose of the article is to assess the level of socio-economic development of Polish provinces in 2005–2020 and to identify groups of provinces with similar levels of development. The applied methods made it possible to create rankings of provinces. The results of the study showed a high spatial differentiation of the level of socio-economic development in Poland. The provinces with the highest level of socio-economic development in terms of selected variables were the Mazowieckie, Dolnośląskie, Pomorskie and Małopolskie provinces, and those with the lowest were the Podkarpackie, Warmińsko-Mazurskie and Świętokrzyskie.

Keywords: socio-economic development, multidimensional comparative analysis, synthetic measure of development level, provinces of Poland

JEL classification: B40, C38, C43, R10

INTRODUCTION

Socio-economic development is a complex and multifaceted issue that has long been of interest to economists. Although its level was once viewed only through the prism of economic measures, the modern approach is based on taking into

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account also the social aspects. Such process of shaping of the perception of socio-economic development can be found in the theory of development economics. In the current phase of socioeconomic development, there are regional differences in all countries around the world. These differences affect both the social and economic spheres, and are a key problem of regional policy practice and theory. The growth of natural variations of specific regions in a country is influenced by market forces. Accordingly, public authorities play an important role in reducing regional differences, and do so by pursuing an active regional policy [Kudełko 2004]. Also, the European Union, of which Poland has been a member since 2004, conducts regional policy, the primary goal of which is to reduce differences in the level of development of less developed areas [Adamiec 2017]. However, in order to carry out activities related to equalizing the level of development of regions, it is first necessary to make appropriate assessment.

The main purpose of the article was to characterize the spatial differentiation of the level of socio-economic development of Polish provinces during selected years within the period 2005-2020, and to analyze and compare the results in relation to selected methods (standardized sums method and Hellwig method), as well as to classify the provinces in terms of the level of development. It also formulated the following specific research objectives:

1. To verify whether the Mazowieckie province was ranked as first in all the years analyzed.
2. To evaluate the differences and consistency of the constructed rankings results.
3. To determine the similarities and differences in the classifications based on selected methods.

The article also sought to answer the research questions. The first was: can a decrease in values be observed for any of the selected diagnostic variables? The second was: in classifications based on selected methods, is the same provinces assigned to groups with the lowest level of socio-economic development?

The scientific contribution of the article was the development of two synthetic measures of the level of socio-economic development for provinces in Poland and their calculation for the years 2005, 2010, 2017 and 2020, as well as a comparison of the rankings of provinces and the classifications created. The synthetic measures were constructed on the basis of an existing, but modified and revised set of diagnostic variables. Compared to the results of the study, which used the original set of diagnostic variables for calculations, in this article the time frame was extended to include the year 2020. The data underlying the study came from the databases of the Statistics Poland – Local Data Bank. Methods of multivariate comparative analysis, i.e., the method of standardized sums and the method of Hellwig's development pattern, as well as the method of grouping objects into classes using a rule based on standard deviation and mean and Spearman's rank correlation, were used to assess the differentiation of the level of development.

The chapter including the literature review discusses the concept of socioeconomic development and its current perception related to the development economics theory. Next, the data used for the analyses was characterized, including the names of categories, groups and subgroups in the database of the Local Data Bank of the Central Statistical Office. The methodological chapter discusses the methods used, cites the formulas used in the analyses and presents the research procedure. The next part of the article is devoted to the results of the empirical research and is divided into four subsections. The first characterizes the synthetic measure of the level of development used in the study, the second presents the rankings of provinces in terms of the level of socio-economic development they have achieved, the third presents the classification of provinces taking into account the four groups relating to the level of development, and the fourth contains a discussion.

SOCIO-ECONOMIC DEVELOPMENT AND DEVELOPMENT ECONOMICS THEORY

Economic or socioeconomic development, as well as theories on the causes of its variation, have long been the subject of scholarly work in economics and socioeconomic geography [Churski 2012, p. 14]. It can be considered that one of the theories underlying the flourishing of research on socioeconomic development is the theory of development economics. The origins of this concept date back to the early 1940s [Bartkowiak 2010]. The concept of development economics itself originated from the desire to support the economic development of newly emerging post-colonial states. Initially, the development of countries was considered in the context of changes in the level of gross domestic product, and the development of a region was closely identified with economic development. At that time, such theoretical considerations of development economics as P. Rosenstein-Rodan's [1943] "big push" theory, R. Nurkse's [1953] sustainable growth theory, V. Rostow's [1956] "take-off" theory for self-growth, or H. Leibenstein's [1957] "minimum critical effort" theory were dominant.

Over time, in the 1970s, such an approach was modified and social determinants also began to be taken into account in considering development economics. The breakthrough event turned out to be the publication in 1969 of a study entitled "The World Employment Program" [Thorbecke 2006]. After that, the well-being of the individual became as important as economic development, and there was a definition of the basic needs of the individual, among which was access to health-related infrastructure [Johnston, Kilby 1975]. Nowadays, it is recognized that the potential for providing well-being to society is as important an aspect in assessing the level of development of regions as economic factors. This is confirmed by a large number of studies that include social aspects in the evaluation of a region, as well as global indicators assessing the socio-economic level that incorporate non-economic factors. An example is the Human Development Index (HDI), also called

the Socio-Economic Development Index, which is based on measures that include health and education indicators in addition to economic factors [Human Development… 2022].

Socio-economic development is a very broad concept and, according to D. Strahl [1998], takes into account the impact of three areas. The first is the economy-wide phenomena that shape the level of countries' economies and thus affect the living conditions of residents. The next area includes the residential environment, i.e. the housing situation, the labor market and public safety. The last area consists of institutions providing social services related to education, culture, upbringing, social welfare or health care.

In the classic typology of regions by L. Klaassen [1965, as cited in: Kudełko 2004], due to the pace and level of development, four fundamental types are distinguished. These are regions:

- highly developed and rapidly developing,
- highly developed but developing more slowly,
- underdeveloped but developing relatively fast,
- underdeveloped and slow developing.

Since the socioeconomic level is a multi-faceted and complex phenomenon, it is not possible to calculate it using a single indicator. One method that allows a statistical and multidimensional description of it is to determine a synthetic measure of level development. In developing synthetic measures, a number of often subjective decisions must be made regarding, among other things, the type of measure (benchmark or model-free methods), the choice of diagnostic variables, the method of normalization or the criteria for classifying objects. Despite this, using them, it is possible to concretize a fairly thorough and objective description of objects, as well as to organize and classify them [Malina 2020, p. 143].

Synthetic measures of development are considered the basic tool of analytical multidimensional comparative analysis derived from taxonomic methods. The purpose of the methods using it is to organize a set of objects of any specificity, which are included in a multidimensional classification space determined by a set of properties describing the elements under study [Grabiński et al. 1982]. Synthetic measures of the level of socio-economic development are widely used both at the regional [Bartkowiak-Bakun 2015; Dziekański 2014; Kutkowska et al. 2015; Roman 2018], national [Kudełko 2004; Malina 2004; Malina 2020] and global [Stec 2004] levels. In the literature regarding multivariate comparative analysis, a number of procedures have been developed, which differ, among other things, in methods when normalizing variables, determining variable weights or estimating the value of synthetic variables [Bąk 2018].

DATA

The data used in the research covered four years from the period 2005-2020 and were obtained from secondary sources, i.e. the database of the Local Data Bank (LDB) of the Central Statistical Office (GUS). Local Data Bank is the country's largest database of social, economic and environmental data. Data was downloaded for 16 provinces. The data used for the analysis was complete and available for all the years studied during the period under analysis. The names and numbers of categories, groups and subgroups of information locations in the LDB are shown in Table 1.

Table 1. Names and numbers of groups, categories and subgroups in the Local Data Bank for the data used

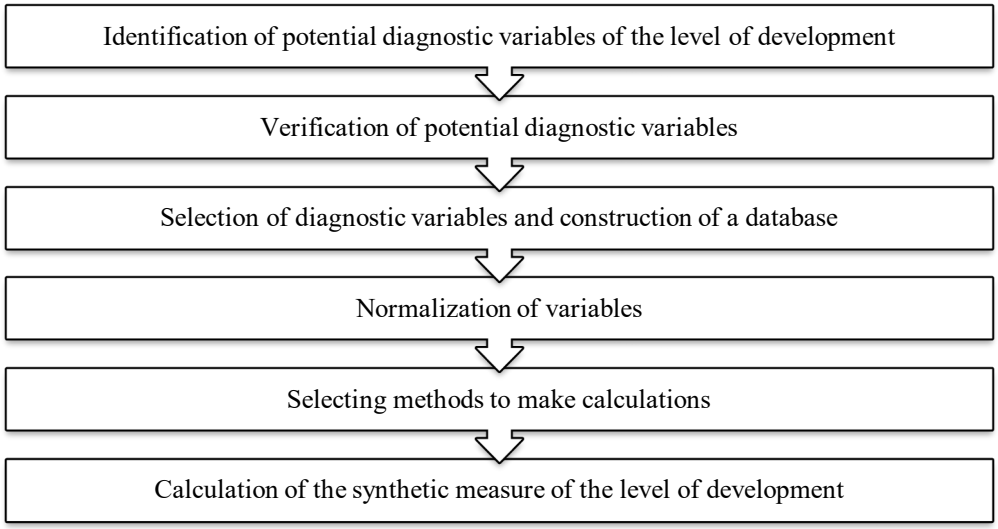
Category		Group		Subgroup	
Name	ID	Name	ID	Name	ID
Wages and salaries and social security benefits	K40	Wages and salaries	G403	Average monthly gross wages and salaries	P2497
Labour market	K4	Registered unemployment	G12	Registered unemployment rate	P2392
Health care, social welfare and benefits to the family	K22	Medical personnel	G265	Doctors – indicators	P3173
Higher education	K21	Indicators	G391	Higher education institutions students per 10 thousand population	P2383
Culture	K23	Performances and exhibitions	G229	Indicators of performances and exhibitions	P2382
Transport and communication	K8	Vehicles	G239	Road vehicles and tractors – indicators	P2420
Tourism	K18	Tourist accommodation establishments and their occupancy	G240	Tourist accommodation establishments – indicators	P2396
Entities of the national economy, ownership and structural transformations	K25	Entities of the national economy – indicators	G377	Entities – indicators	P2419

Source: own preparation based on GUS Local Data Bank

METHODS

The sample selection was purposive and included all provinces in Poland. To assess the socio-economic development of the provinces, an existing synthetic measure was used, which was modified for the purpose of the analyses. The procedure for constructing and calculating synthetic measures of the level of development can be divided into several main stages, which are shown in Figure 1.

Figure 1. Research procedure for constructing a synthetic measure of development level



Source: own preparation

Two methods were chosen for the calculation, i.e. the standardized sum method and the Hellwig development pattern method. Both belong to linear ordering methods, which in turn fall into the category of Multiple-criteria decision analysis (MCDA) methods, also known as Multiple-criteria decision making (MCDM) [Chojnicki, Czyż 1991; Bąk 2018; Koszela et al. 2020]. Hellwig's method was the first proposed linear ordering method in taxonomic and economic research [Hellwig 1968], and in practice is the most frequently chosen method [Wawrzyniak 2015]. In the literature, the comparison of Hellwig's development pattern method and the standardized sum method can be found [Wawrzyniak 2015]. Thanks to methods, it is possible to rank the studied objects in order from the best to the worst in terms of the analyzed phenomenon [Jajuga 1992, pp. 256-261], whereby the characteristics of the objects can be derived from numerous characteristics and properties called diagnostic variables, on the basis of which the so-called synthetic variable is formed [Kisielińska et al. 2021]. Variables that are intended to be arranged should be assessed using an interval scale. In the case where they are assessed using a range or quotient scale, it becomes necessary to normalize them [Gostkowski et al. 2019].

Standardization

The first stage of the process of constructing development measures is the same and consists in standardizing the diagnostic variables, that is, bringing them to comparability by eliminating different ranges of variability and units of measurement. Standardization proceeds according to the formula:

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j}, \tag{1}$$

where:

z_{ij} – standardized value of the *j*-th variable for the *i*-th object,
x_{ij} – the value of the *j*-th variable for the *i*-th object,
$\overline{x}_j$ – arithmetic mean of the variable x_j,
s_j – standard deviation of the variable x_j.

Standardized sum method

The development pattern calculated by the method of standardized sums can be determined after standardizing the variables according to formula (1). It is also necessary to convert the destimulants into stimulants by multiplying their standardized value by -1. After this procedure, the weight matrix is determined, according to the assumption:

$$w_j > 0 \text{ and } \Sigma_j^m w_j = 1. \tag{2}$$

The study established equal weights for all variables. The next step is to determine p_i using the following formula:

$$p_i = \sum_{y=1}^{m} w_j z_{ij}. \tag{3}$$

The resulting ranking reflects the value of the objects. The highest score is obtained by the best object in terms of the selected set of diagnostic variables, and the lowest score characterizes the worst object in the set. In order to transform the results so that they take values in the interval (0,1), the pattern (p_0) and anti-pattern (p_{-0}) should be calculated, using the following formulas:

$$p_0 = \sum_{j=1}^{m} z_{o_j} w_j, \tag{4}$$

$$p_{-0} = \sum_{j=1}^{m} z_{-o_j} w_j, \tag{5}$$

where:

$$z_{0j} = \max_i z_{ij} \text{ and } z_{-0j} = \min_i z_{ij}. \tag{6}$$

The last step is to calculate the final synthetic measure for each object according to the formula:

$$m_i = \frac{p_i - p_{-0}}{p_0 - p_{-0}}. \tag{7}$$

A higher value of the synthetic variable m_i means that the i-th object is more developed from the point of view of the variables considered in the analysis.

Hellwig's development pattern method

After standardizing the diagnostic variables according to formula (1), the development pattern P_0 is determined, whose coordinates $[z_{01}, z_{02}, \ldots, z_{0m}]$ are calculated according to the following procedure:

$$z_{0j} = \begin{cases} \max\limits_{i}(z_{ij}), \text{when } j \in S, \\ \min\limits_{i}(z_{ij}), \text{when } j \in D, \end{cases} \quad j = 1, 2, \ldots, m; i = 1, 2, \ldots, n, \tag{8}$$

where:

S – a set of stimulants, i.e. statistical characteristics whose increase in value indicates an increase in the level of a complex phenomenon.

D – a set of stimulants, i.e. statistical characteristics whose decrease in value indicates a decrease in the level of a complex phenomenon.

The next step is to calculate the distance of each object from the pattern determined as described above using the Euclidean distance which has the form:

$$d_{i0} = \sqrt{\sum_{j=1}^{m}\left(z_{ij} - z_{0j}\right)^2}, \qquad j = 1, 2, \ldots, m; i = 1, 2, \ldots, n. \tag{9}$$

Finally, the synthetic measure is defined as follows:

$$d_i = 1 - \frac{d_{i0}}{d_0}, \quad i = 1, 2, \ldots, n, \tag{10}$$

where: :

$$d_0 = \bar{d}_0 + 2S_0, \tag{11}$$

$$\bar{d}_0 = \frac{1}{n}\sum_{i=1}^{n} d_{i0}, \tag{12}$$

$$S_0 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(d_{i0} - \bar{d}_0\right)^2}. \tag{13}$$

Constructed in this way, the measure takes values in the interval (0,1) and the closer its value is to 1, the closer the object is to the benchmark representing the most favorable variable values.

Class designation

Knowing the values of development measures (7) and (10), it is possible to group objects into classes with similar levels of development. One method of grouping is to classify objects into four classes based on a rule based on standard

deviation and mean [Malina 2020; Nowak, 1990; Wawrzyniak 2015]. The rule is as follows:

Group I highest level of development): $s_i \geq \bar{s} + sd;$ (14)

Group II (high level of development): $\bar{s} \leq s_i < \bar{s} + sd;$ (15)

Group III (medium level of development): $\bar{s} - sd \leq s_i < \bar{s};$ (16)

Group IV (low level of development): $s_i < \bar{s} - sd,$ (17)

where:

s_i – expression for the value of the synthetic index (in the study, different names were designated for each of the two methods – m_i for the standardized sum method and d_i for the Hellwig development pattern method),

$\bar{s}$ – arithmetic mean of the synthetic indicator,

sd – standard deviation of the synthetic indicator.

RESEARCH RESULTS

The first stage of the research was initially planned to use 29 potential diagnostic variables reflecting eight categories. Due to the lack of data for all years, negligible discriminatory ability and high correlation coefficient in the field, eight variables were left to build a synthetic measure [Malina 2020]. The original intention was to use the same set of variables, but as a result of repeating the calculations for the years 2005, 2010 and 2017, the name of one variable was modified, and a variable from the "culture" category was replaced by another. A coefficient of variation value of greater than or equal to 10% was assumed. Table 2 presents the final summary of the variables representing each field, and gives their name, nature (stimulants or destimulants) and the percentage value of the coefficient of variation for 2020. The basic parameters of the variables for 2005, 2010, 2017 and 2020 are indicated in Appendix 1.

Considering the data in Table 2 and Appendix 1, it can be concluded that the variables chosen to construct the synthetic measure of the level of development exceed the assumed lower limit of the coefficient of variation (V > 10% for at least one year), and therefore have sufficient discriminatory capacity. In the provinces of Poland, the least variation was seen in the number of passenger cars per 1,000 population (X_6), as well as in the average gross monthly salary per person (X_1).

With six of the eight variables in relation to the average value, favorable changes can be observed in each successive year analyzed, i.e. increasing values for variables that are stimulants and decreasing values for variables that are destimulants. Unfavorable changes can be observed in only two cases. The first is the average number of college students per 10,000 people (X_4), which with each analyzed year presented a lower value than the previous one. The second case can be seen in the number of tourists using overnight accommodation per 1,000 people,

where the average value increased until 2017, only to fall in 2020 to a lower level than in 2010. This was likely related to the COVID-19 pandemic and the restrictions put in place at the time.

Table 2. List of diagnostic variables used to calculate the synthetic measure of socio-economic development

Category	Symbol and name of variable	Nature of variable	Coefficient of variation
Population income	X_1 – average monthly gross wages and salary per person [PLN]	stimulant	9.09
Labor market	X_2 – registered unemployment rate [%]	destimulant	25.60
Health care	X_3 – doctors entitled to practise medical profession per 10 thousand population[1]	stimulant	19.93
Education	X_4 – higher education institutions students per 10 thousand population	stimulant	33.14
Culture	X_5 – persons per 1 seat in theatres and musical institutions[2]	destimulant	58.12
Infrastructure and transportation	X_6 – passenger cars per 1000 population	stimulant	6.61
Tourism	X_7 – tourists accommodated per 1000 capita	stimulant	44.62
Economic potential	X_8 – entities entered in the REGON register per 10 thousand population	stimulant	16.93

Source: own compilation based on Malina [2020]

The unfavorable situation was evidenced by positive values of skewness for variables that are stimulants, which meant that the value of the results of more

[1] In the article by A. Malina [2020], the name of the diagnostic variable that was included in the final set of variables referred to doctors working by primary place of work per 10,000 people. It was noted that data for this variable were not available for 2005. Repeating the calculations, based on the average values of the variables for all years, it was found that the variable used referred to doctors with a licence to practice medicine per 10,000 population. The name of the variable has been corrected in the set of variables in this article.

[2] In the article by A. Malina [2020] in the category "culture" the variable referred to the number of population per 1 theatre. A search of the Local Data Bank database did not find such an indicator. Moreover, after analysing the average value for the indicator used by the author, which was approximately 11 for all the years covered by the study, it turned out that there would have to be more than 3.3 million theatres operating in Poland at that time, which is an overestimation – for example, in Poland in 2017 there were 187 theatres and music institutions conducting stage activities [Activities of centres... 2018]. Therefore, the diagnostic variable was changed to an indicator referring to population per 1 seat in theatres and musical institutions.

provinces was lower than the average value. The implication is that few provinces scored high enough to stand out from the rest. The variable X_1 referring to the average gross monthly salary per person and the variable X_5 characterizing the population per 1 seat in theaters and musical institutions were characterized by a high value of the asymmetry measure. With regard to skewness, it is worth noting the strongly increasing value of variable X_7, which represents the number of tourists using accommodation per 1,000 people.

Rankings of Polish provinces

Two methods of linear ordering were used to calculate the level of socio-economic development of Polish provinces for selected years in the 2005-2020 time period: standardized sum method (7) and Hellwig's development pattern (10). The results are shown in Table 3 and presented in alphabetical order in terms of the names of the provinces. Descriptive characteristics of the synthetic measure of development calculated by the indicated methods are presented in Table 4.

Table 3. Level of socio-economic development according to synthetic measures of standardized sums and Hellwig's development pattern in 2005, 2010, 2017 and 2020

Province	2005		2010		2017		2020	
	M1	M2	M1	M2	M1	M2	M1	M2
dolnośląskie	0.588	0.560	0.636	0.602	0.699	0.676	0.683	0.652
kujawsko-pomorskie	0.329	0.280	0.344	0.299	0.331	0.293	0.326	0.282
lubelskie	0.292	0.247	0.316	0.282	0.311	0.275	0.322	0.267
lubuskie	0.376	0.313	0.336	0.283	0.388	0.309	0.387	0.295
łódzkie	0.469	0.402	0.488	0.432	0.485	0.427	0.494	0.404
małopolskie	0.610	0.530	0.632	0.545	0.634	0.564	0.590	0.546
mazowieckie	0.900	0.764	0.914	0.815	0.891	0.798	0.843	0.673
opolskie	0.341	0.259	0.401	0.335	0.377	0.325	0.388	0.309
podkarpackie	0.150	0.120	0.106	0.094	0.118	0.108	0.105	0.095
podlaskie	0.379	0.316	0.376	0.314	0.345	0.278	0.349	0.266
pomorskie	0.591	0.542	0.618	0.583	0.666	0.621	0.644	0.604
śląskie	0.516	0.460	0.524	0.476	0.480	0.444	0.489	0.429
świętokrzyskie	0.245	0.230	0.289	0.263	0.239	0.225	0.243	0.217
warmińsko-mazurskie	0.173	0.148	0.207	0.181	0.178	0.158	0.194	0.177
wielkopolskie	0.524	0.434	0.573	0.479	0.545	0.445	0.539	0.425
zachodniopomorskie	0.517	0.397	0.527	0.423	0.528	0.458	0.536	0.460

M1 – development level calculated by the standardized sum method,

M2 – development level calculated by the Hellwig development pattern method.

Source: own calculations

Table 4. Descriptive characteristics of the synthetic measure of development calculated by the standardized sum method and the Hellwig development pattern method

Parameter	2005		2010		2017		2020	
	M1	M2	M1	M2	M1	M2	M1	M2
mean	0.438	0.375	0.456	0.400	0.451	0.400	0.446	0.381
minimum	0.150	0.120	0.106	0.094	0.118	0.108	0.105	0.095
maximum	0.900	0.764	0.914	0.815	0.891	0.798	0.843	0.673
standard deviation	0.185	0.165	0.192	0.175	0.200	0.185	0.187	0.167
coefficient of variation [%]	42.39	43.88	42.22	43.74	44.25	46.24	42.02	43.78
range	0.750	0.644	0.807	0.721	0.773	0.690	0.738	0.578

M1 – development level calculated by the standardized sum method,

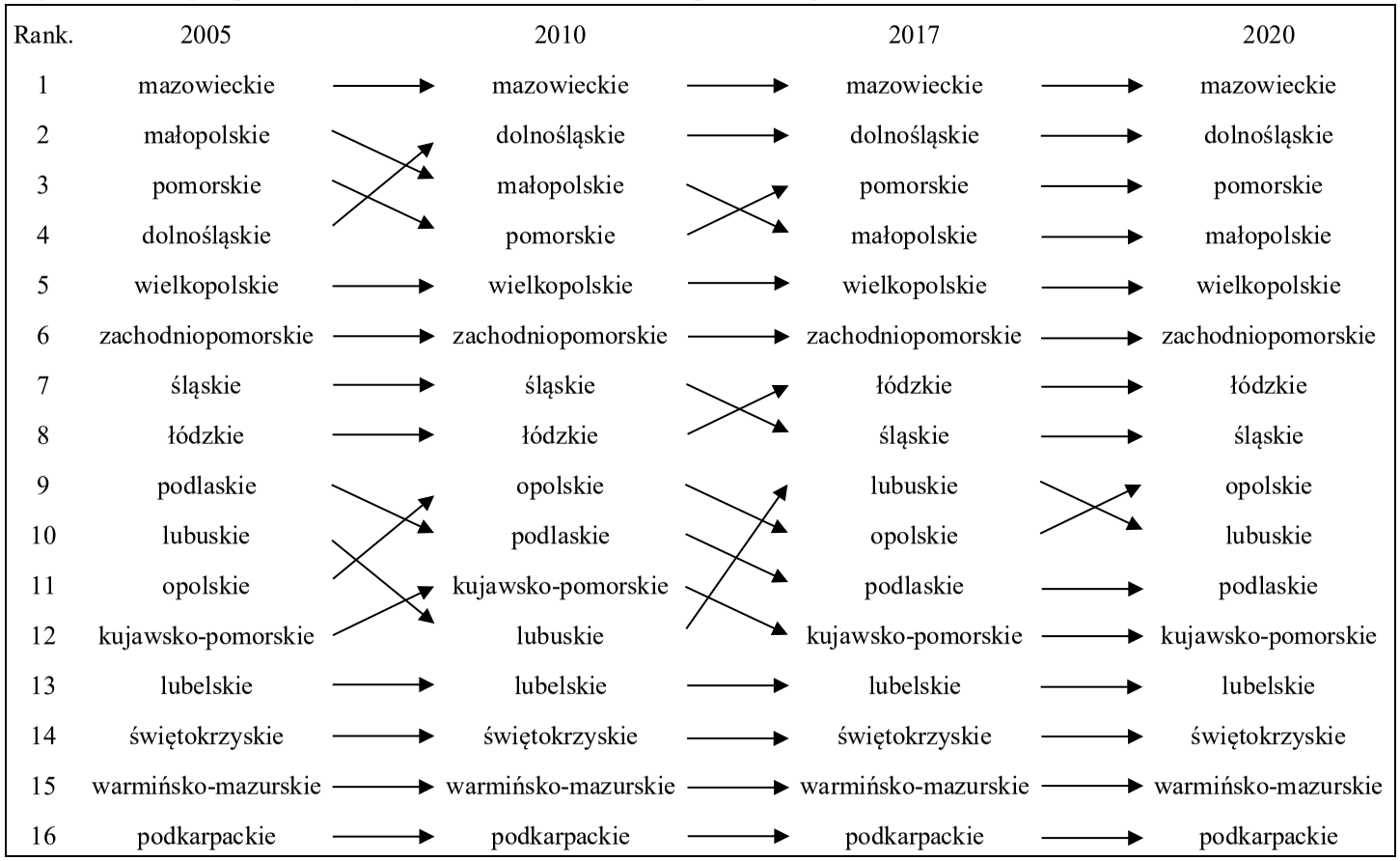
M2 – development level calculated by the Hellwig development pattern method.

Source: own calculations

The results highlight the high spatial differentiation of the level of socio-economic development in Poland. Analyzing the results, it can be said that regardless of the method chosen, the average value of the synthetic measure increased only when comparing the years 2005-2010, and when comparing the years 2010-2017 it was at the same level (Hellwig's development pattern method) or decreased (standardized sum method). In contrast, when considering 2017 and 2020, the average value of the synthetic measure decreased regardless of the method used. It is also important to note the range, the directions of change of which were the same with both methods used. When juxtaposing the years 2005 and 2010, its value increased, which means that the difference in the level of development between the province with the worst and the best score increased. Considering the years 2010, 2017 and 2020, with each successive analyzed year its value decreased, which can be considered a favorable phenomenon indicating the leveling of differences in development.

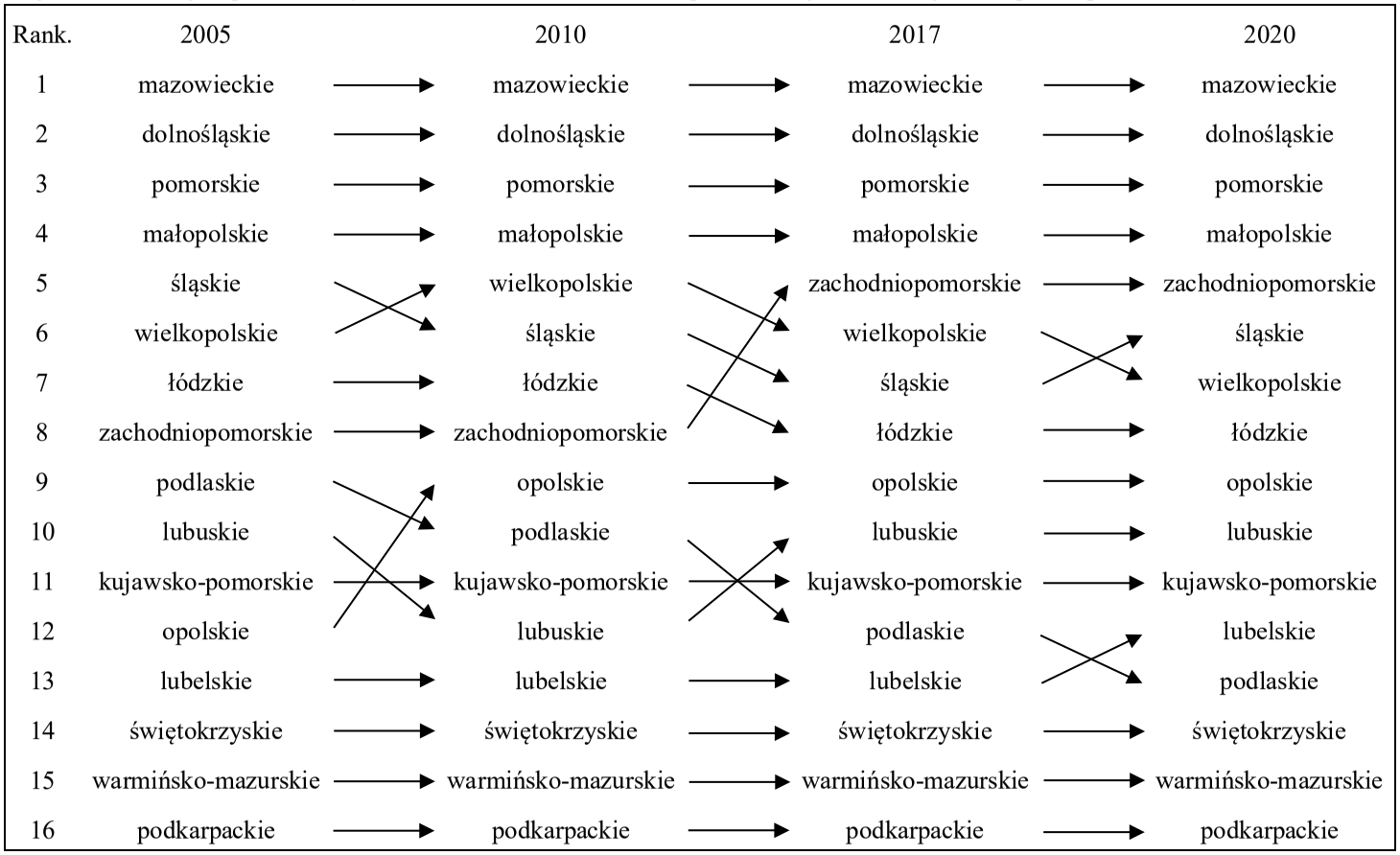
Based on the results obtained, a ranking of provinces was constructed for the four years under study. The ranking positions of individual provinces calculated using the standardized sum method are shown in Figure 2, and using the Hellwig development pattern method in Figure 3. The compatibility of the results obtained by both methods was checked by Spearman rank correlation.

Figure 2. Ranking of provinces by level of socio-economic development using the standardized sums method



Source: own preparation

Figure 3. Ranking of provinces by level of socio-economic development using the Hellwig development pattern method



Source: own preparation

The coefficient took the following values successively: 0.971 for the year 2005, 0.988 for the year 2010, 0.988 for the year 2017 and 0.976 for the year 2020. The results obtained show that the sequences obtained by the two methods are highly consistent. In both rankings in all analyzed years, the first place representing the highest level of socio-economic development in terms of the selected set of variables was occupied by the Mazowieckie province, and the last three positions went to the Świętokrzyskie, Warmińsko-Mazurskie and Podkarpackie provinces. The remaining 12 provinces were characterized by shifts in ranking position up or down by one, two or three positions. A decrease or increase in a province's position by k places was called a change by k position units for the purpose of discussing the results of the study. In both rankings, the changes of all provinces in all years totaled 22 positional units, despite the different temporal distribution. The most changes in positional units were observed when comparing 2010 and 2017, which may be due to a longer period (7 years) than when comparing 2005 and 2010 (5 years) and 2017 and 2020 (3 years). In addition to the Mazowieckie province, the highest positions were achieved by the Dolnośląskie, Pomorskie and Małopolskie provinces.

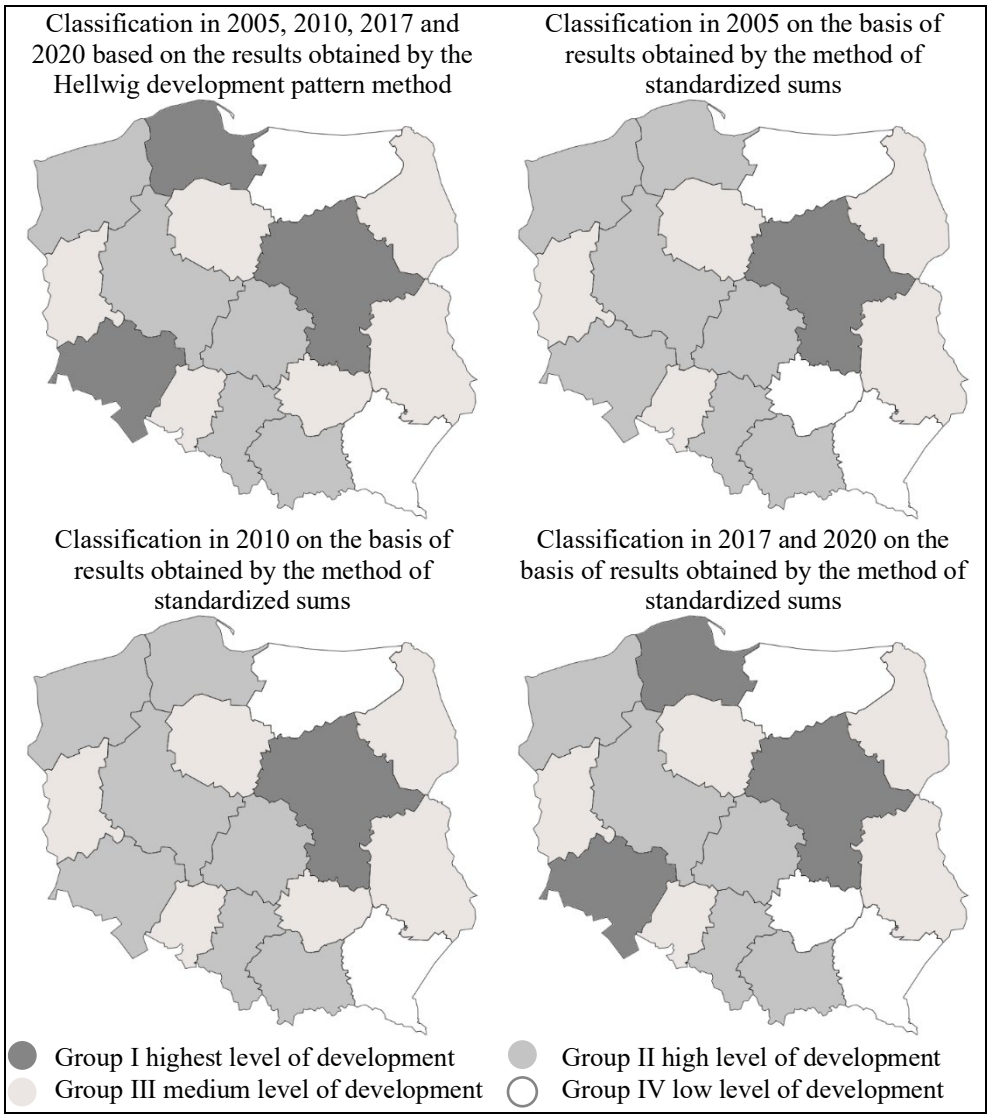
It is worth noting the Lubuskie province, which in the ranking made using results obtained by the method of standardized sums, was the only one to change its position by three position units (comparing 2010 and 2017), changing its place from 12 to 9. In the ranking made using results obtained by the method of Hellwig's development pattern, a change in position by three position units was observed with two provinces – Opolskie province, which between 2005 and 2010 changed its place from 12 to 9, and Zachodniopomorskie province, which was promoted from place 8 to 5.

Classification of Polish provinces

The provinces were assigned to four groups with similar levels of development considering the methods used. Spatial differentiation of provinces taking into account the achieved level of socio-economic development calculated by two methods is shown in Figure 4.

In the classification based on calculating the synthetic measure using Hellwig's development pattern method, the composition of the groups in all the years analyzed was unchanged, and the group with the highest level of socio-economic development (group I) included the Mazowieckie, Dolnośląskie and Pomorskie provinces. More restrictive in this regard was the classification based on the method of standardized sums, which assigned a smaller number of provinces to the group with the highest level of development and a larger number to the group with a low level of development (group IV). Only Mazowieckie province qualified for group I in 2005 and 2010, while three provinces were assigned to group IV except in 2005. On the other hand, in the classification based on Hellwig's development pattern method, only two provinces qualified for group IV: Warmińsko-Mazurskie and Podkarpackie provinces.

Figure 4. Spatial differentiation of the level of socio-economic development



Source: own elaboration

DISCUSSION

As a result of the research, the intended purpose was achieved, which was to characterize the spatial differentiation of the level of socio-economic development of Polish provinces in 2005-2020, and to analyze and compare the results in relation to the selected two methods of linear ordering, as well as to classify provinces

interms of the level of development achieved. The research conducted showed the existence of large disparities between regions, which is consistent with the results of other studies [Barska et al. 2022; Malina 2020; Rokicki 2016].

According to the results of the study, based on the selected set of variables in 2020, the highest socio-economic development regardless of the method used was characterized successively by Mazowieckie, Dolnośląskie, Pomorskie and Małopolskie provinces, while the worst was characterized by Podkarpackie, Warmińsko-Mazurskie and Świętokrzyskie provinces. The same ranking of the best provinces can be found in the conducted research on the socio-economic level in Polish provinces in 2020, in which the synthetic measure of the level of development was calculated using Hellwig's method on the basis of 21 diagnostic variables [Barska et al. 2022]. However, in the discussed studies, the order of provinces was different and they were Pomorskie, Małopolskie, Dolnośląskie and Mazowieckie provinces in turn. The provinces with the weakest level of development in the comparative study were Świętokrzyskie, Warmińsko-Mazurskie, and Lubuskie provinces, and Podkarpackie province was ranked only fourth, counting from the bottom. What seems surprising is the position of Lubuskie province, which in the 2020 survey conducted in this article was given a relatively high tenth position. However, it is worth noting that the same provinces were included in both lineups of the best sites.

SUMMARY

The article characterizes the level of socio-economic development of Poland's provinces in the years 2005, 2010, 2017, and 2020. This was the main objective of the study, which was achieved using a synthetic measure based on an existing but modified set of diagnostic variables. Analyzing the values of diagnostic variables, favorable trends of change were observed. The unfavorable changes with each successive year were a decrease in the average number of university students per 10,000 population, and in the comparison of 2017 and 2020 – a decrease in the number of tourists using accommodation per 1,000 people, which could be due to restrictions introduced as a result of the COVID-19 pandemic. Two methods of linear ordering were used to calculate the synthetic measure, i.e. the method of standardized sums and the method of Hellwig's development pattern. Based on the results, two rankings were created, in which the first place in terms of socio-economic development was consistently occupied by Mazowieckie province. Thus, the first research objective was achieved, which aimed to verify whether the Mazowieckie province ranked first in all the analyzed years. In the group of provinces with the highest level of development based on the selected set of variables, the Dolnośląskie, Pomorskie, and Małopolskie provinces were also distinguished. The last places were given to the Świętokrzyskie, Warmińsko-Mazurskie and Podkarpackie provinces.

The second and third research objectives were also achieved, thus accomplishing all the set goals. These objectives involved evaluating the differences

and consistency of the constructed rankings results, as well as determining the similarities and differences in the classifications based on the selected methods. Despite the high consistency in the ordering of the Polish provinces obtained by the two methods used, their rankings and classification were shaped differently.

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APPENDICES

Appendix 1. Descriptive characteristics of variables

Variable no.	Year	Descriptive measures					
		Mean	Median	Minimum	Maximum	Skewness	V
X_1	2005	2 321.60	2 221.33	2 081.76	3 227.04	2.44	11.80
	2010	3 181.44	3 109.88	2 877.43	4 279.55	2.26	10.67
	2017	4 217.73	4 133.04	3 802.98	5 523.65	2.05	9.85
	2020	5 174.03	5 032.13	4 707.81	6 581.81	1.76	9.09
X_2	2005	18.99	18.60	13.80	27.20	0.57	20.63
	2010	13.64	13.35	9.20	20.00	0.38	21.80
	2017	7.32	7.00	3.70	11.70	0.29	28.71
	2020	6.95	6.60	3.70	10.20	0.06	25.60
X_3	2005	31.16	32.90	20.00	44.60	0.06	21.30
	2010	32.78	34.70	23.60	46.10	0.13	20.62
	2017	35.88	38.15	24.90	49.60	0.10	21.27
	2020	38.25	39.30	26.80	50.20	0.03	19.93
X_4	2005	479.06	452.00	357.00	680.00	0.88	17.67
	2010	439.88	428.50	258.00	635.00	0.49	22.38
	2017	300.24	275.35	138.60	480.80	0.46	31.96
	2020	282.17	263.10	125.90	453.10	0.28	33.13
X_5	2005	691.56	618.00	352.00	1 270.00	0.92	38.33
	2010	678.50	579.00	289.00	1 572.00	1.83	45.98
	2017	544.50	446.50	161.00	1 404.00	1.69	55.55
	2020	508.50	402.00	169.00	1 347.00	1.84	58.12
X_6	2005	315.98	316.70	263.30	374.20	0.28	10.18
	2010	439.63	440.80	390.00	506.40	0.48	7.70
	2017	576.89	570.15	503.50	648.40	0.24	7.21
	2020	653.28	647.25	576.50	717.30	0.12	6.61
X_7	2005	397.85	331.62	180.17	764.05	0.74	41.94
	2010	481.95	390.21	220.44	862.37	0.59	36.74
	2017	740.71	576.23	425.71	1 447.47	1.18	41.15
	2020	421.20	338.12	222.23	836.43	1.14	44.62
X_8	2005	918.50	907.50	663.00	1 221.00	0.16	17.02
	2010	975.69	974.00	717.00	1 293.00	0.34	17.72
	2017	1 064.63	1 024.50	803.00	1 503.00	0.60	18.39
	2020	1 163.31	1 113.00	899.00	1 608.00	0.62	16.93

V – coefficient of variation.

Source: own calculations