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ASSESSMENT OF THE SPATIAL DISPARITIES OF THE GREEN ECONOMY IN THE VOIVODESHIPS OF POLAND IN 2010-2020

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ABSTRACT: The development of a green economy in a situation of resource scarcity, global climate change, and environmental degradation means entering a new path of socio-economic development that will more effectively implement the goals of sustainable development. The level of its regional polarisation is stimulated by demographic, natural and technological, economic and social factors. The aim of the research was to identify and assess the level of regional polarisation in terms of the development of the green economy in voivodeships in Poland using a synthetic measure. The basis for the analysis was a set of substantively and statistically analysed diagnostic variables from 2010-2020 available in Statistics Poland. The result of the analysis was the presentation of regional polarisation and the ordering of voivodeships in Poland in 2010-2020 in terms of the synthetic measure - green economy. The green economy of voivodeships should be built based on available endogenous resources, as well as planning and organisational solutions specific to the voivodeship. The use of a synthetic measure to assess activities in the area of the green economy makes it possible to evaluate the effects, as well as to take corrective measures of the voivodeships' in this area.

KEYWORDS: green economy, spatial diversification, sustainable development, synthetic measure, voivodship

Introduction

Over the decade, there has been an increase in societies' ecological awareness. This translates into changes in public policy, which directly affects the economy itself. Public authorities are responsible for making laws and are the largest investors in most modern economies. Therefore, it is responsible for targeting and properly implementing the demands arising from the concept of the green economy.

In terms of resource scarcity, global climate change, environmental degradation and growing demand for food, the green economy (GE) is a strategy to support sustainable development. The concept of a green economy itself is part of the Europe 2020 strategy implemented in the European Union (EU). Its entities are primarily individual countries. In this context, it is important to remember the cohesion policy, which is the main instrument supporting socioeconomic convergence in European regions. Many projects related to the development of the green economy were co-financed by various EU funds (including cohesion policy).

Polarisation and the development of regions are natural problems for every country. Its level is determined by natural capital, financial capital, entrepreneurship and the previous level of development. This also applies to demographic variables, labour market, infrastructure, and environment (Churski et al., 2021). Differences in the potential of regions are consistent with most theories of regional development, although these theories, derived from different scientific orientations, explain the diverse spatial dynamics of socio-economic processes in different ways (Korenik & Zakrzewska-Półtorak, 2011).

The aim of the research was to identify and assess the level of polarisation in terms of the development of the green economy in voivodeships in Poland using a synthetic measure. The calculated synthetic measure enabled the assessment of the green economy in voivodeships in Poland, as well as their ranking and grouping. To achieve the assumed goal, the authors conducted a literature analysis, statistical analysis, and synthetic measure analysis. The basis for the analysis was a set of substantively and statistically analysed diagnostic variables from 2010-2020 available in Statistics Poland. The data presentation covers two consecutive programming periods of EU funds (2007-2013; 2014-2020). Due to the observed discussions and doubts surrounding the issue of GE, the authors decided to formulate the following research question: What is the spatial polarisation of GE in terms of voivodeships in Poland? What variables shape GE in voivodeships? How do we assess GE at the voivodeship level?

In the article, the authors focus their research on the assessment of the green economy of voivodeships in Poland in 2010-2020. Research indicates the importance of selected variables in the process of regional polarisation of the green economy in voivodeships in Poland. This may help in developing a set of variables (resulting from endogenous territorial capital), allowing for the assessment

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of the risk associated with the green economy or the policy pursued so far in this area.

Literature Review

The Green Economy is a Circular Economy (CE). It aims to solve environmental problems. These include increased pollution, excessive waste and unsustainable use of resources. CE, in which the value of products and materials is kept in the economy for as long as possible. The authors define the green economy as a closed-circuit economic system that improves the quality of life of the inhabitants of a territorial unit while reducing threats to the natural environment. This leads to a reduction in environmental degradation (resulting, among others, from the expansion of the industrial sector and excessive use of natural resources) and positive social effects. The green economy seeks to reconcile economic and environmental performance by adopting an appropriate relationship between business and the environment, aiming to exploit sustainable production and consumption (Morseletto, 2020).

Development is unsustainable. The essence of the concept of polarisation is the assumption that existing states of imbalance drive a development process that may lead to even greater interregional disproportions. The problem of space polarisation was presented independently by Myrdal (1957). As a consequence of economic activity, economic growth causes the erosion of natural capital and excessive pollution. Green growth is important for economic development and is necessary for improving the environment (Xu et al., 2022). Following Churski et al. (2021), the authors also point out the need to rethink the method and scope of defining and using regional development factors in the interpretation of socio-economic development processes in this context.

The circular economy emphasises the need to efficiently use resources and optimise product design to reduce resource consumption. The polarisation of the development of the green circular economy in individual regions can be attributed to geographical location, level of economic development, and resource distribution. Geographic factors shape the structures and industrial systems of regions. Disparities in levels of economic development and industrial structures result in noticeable differences in carbon dioxide emissions between regions. Developed regions have lower levels of carbon dioxide emissions. Economically less developed regions face challenges in reducing their carbon footprint (Di et al., 2023).

Igliński et al. (2022) point to the green economy and its impact on the energy transformation. In Poland, the transition to renewable energy sources is a mix of various energy sources. Grzelak and Kryszak (2023) presents a model that allows for comparison and ranking of efficient farms and examination of the sources of progress of (in)efficiency of farms towards greater sustainability (or green econ-

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omy). As Borys et al. (2022) point out, achieving climate goals is becoming a challenge facing humanity in the green transformation of the regional economy.

As Szyja (2013) points out, the green economy is related to the Green New Deal. Its essence is to create a new dimension of management processes using environmentally friendly solutions. Its elements can be found in the National Strategy for Regional Development 2030. It indicates the effective use of the internal potentials of territories and their specialisations to achieve sustainable development of the country.

The green economy indicates the need to base the economy on renewable processes that promote biodiversity, benefiting people now and in the future (D'Amato & Korhonen, 2021). An important part of it is waste recycling, the aim of which is to recover raw materials, determine their impact on ecosystems and biodiversity, and the consequences of this impact on the transition to an ecological economy. They are sequentially transformed into useful heat, electricity and fuel (Bucea-Manea-Țoniș & Zecheru, 2022).

The green economy is intended to ensure a sufficient supply of resources and other ecosystem services for economic development while minimising the adverse impact on the environment. Areas subject to continuous assessment under GE should include both natural capital and the environmental quality of life of people (i.e. the relationship between the environment and society) (OECD, 2014). The relations between the economy and the environment, as well as social aspects related to the economy or the environment (i.e. environmental and resource productivity, natural value base, environmental dimension of quality of life, economic opportunities and political responses, socio-economic context), should be monitored in the GE aspect (OECD, 2011).

UNEP (2012) does not provide any arbitrary set of indicators. He proposes a methodology for creating systems of such indicators, assuming that countries appropriate to their specific conditions should develop their own monitoring systems. Attention should be paid to the specific environmental conditions (geographical location, climatic zones) and socio-economic conditions of the country or economic structures.

The set of indicators proposed by Broniewicz et al. (2022) can be used to assess legislation in terms of adaptation requirements to climate change (and thus changes in the transition to a green economy). Indicators are collected in four main areas of monitoring: natural capital, ecological efficiency of production, environmental quality of life and economic policies and their consequences (Godlewska & Sidorczuk-Pietraszko, 2019). As Ryszawska (2013) points out, the sets of indicators are to be focused on several topics: natural capital, state policy supporting the green economy and socio-economic problems. Examples of indicators include forest area, protected areas, energy consumption, energy productivity, renewable energy production, waste recycling, environmental spending and development, environmental innovation, employment and policy instruments. The set of indicators selected by the authors focuses (after Ryszwska

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(2013)) on natural capital, state policy and socio-economic problems, assessment of the state of the environment, risk of resource consumption, resource productivity, biodiversity, access to ecosystem services and the quality of life-related to the environment. The problem the authors encountered in this aspect is the availability of data collected at the voivodeship level by Statistics Poland.

A green economy leads to improved quality of life as well as social equality or a reduction in the scarcity of natural resources. GE refers to three pillars simultaneously, i.e., environment, economy, and quality of life. They are treated as an essential basis for sustainable development. GE enables sustainable management of local resources to provide greater returns on natural, human and economic capital (Bogović & Grdić, 2020). The green economy shapes economic growth while enabling the region to achieve climate and environmental goals. The desired relations between the economy and the natural environment should indicate the necessary changes in business activities in order to reduce environmental problems (Herodowicz, 2018).

Research methods

The subject of the research was voivodeships in Poland. The time scope of the analyses performed included the years 2010-2020. The results are presented for extreme years. The data was presented to show changes occurring in two programming periods of EU funds (2007-2013; 2014-2020). Statistic Poland data was used as empirical material. A voivodeship is a local government unit, a regional self-government community performing tasks in the field of public administration (NTS 2, 16 units) (Ustawa, 1998).

A synthetic measure was used to analyse the spatial diversity of the green economy. The following stages were used in its determination process:

1. determining a data set of diagnostic variables describing the green economy,
2. the terms stimulant and destimulant,
3. standardisation of variables in accordance with the zero unitisation method,
4. designating a synthetic measure for voivodeships,
5. evaluation of the survey results and linear ordering of voivodeships (Malina, 2020).

The construction of the synthetic measure was preceded by the selection of diagnostic variables describing the multidimensional phenomenon of the green economy. They meet both substantive and statistical criteria (i.e. assessment of the coefficient of variation (threshold value =|0.10|) and correlation). The correlation was assessed based on the inverse matrix. This allowed for the elimination of the so-called quasi-constant variables. The variables selected for analysis are characterised by sufficient discriminatory ability and are only slightly correlated with the others. The research was carried out in a dynamic way, determining the min{xij} and max{xij} values for the entire period. The selected input variables

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are slightly correlated with the remaining ones and are characterised by sufficient discriminatory ability (Malina, 2020).

They illustrate, among others, resource management, biodiversity protection, sustainable consumption and production models, renewable energy sources, and energy and material efficiency. The study identified the following variables presented in Table 1.

Table 1. List of variables describing the green economy

	Variables	unit
X1	Total expenditure on health care	PLN/pc
X2	Outlays on fixed assets for environmental protection, expenditure on waste management	1 000 PLN/PC
X3	Outlays on fixed assets serving environmental protection and water management	PLN/pc
X4	Electricity consumption in the countryside	kWh/pc
X5	Total electricity production (including from renewable sources)	GWh/pc
X6	The share of agricultural land in the total area	%
X7	The share of forests in the total area	%
X8	Share of legally protected areas in the total area	%
X9	The share of ecological species in the total area	%
X10	Share of active landfill areas (where municipal waste is neutralized – as of December 31) in the total area	%
X11	Waste collected selectively in relation to total total waste	%

Source: authors' work based on Statistics Poland (2020).

The assessment of the green economy at the voivodeship level involves limitations in the selection of variables. Diagnostic variables were recorded as an observation matrix. It was written as X_{ij}

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix}, \quad (1)$$

where:
X_{ij} – denotes the values of the j-th variable for the i-th object, matrix of dnaych objects,
i – object number (i = 1, 2, ..., n),
j – variable number (j = 1, 2,. .., m).

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In the further part of the study, the direction of the variable preferences in relation to the general criterion under consideration was determined. They were divided into stimulants and destimulants (Łuczak & Wysocki, 2005). In doubtful cases, it is worth using Grabiński's procedure (Grabiński, 1985).

The set of diagnostic variables selected for the construction of a synthetic measure of the green economy of voivodeships in Poland includes: S (stimulant) = {X1, X2, X3, X4, X5, X6, X7, X8, X9, X11} and D (destimulant) = {10}.

To make the diagnostic variables comparable, the zero edunitarisation method was used. Following Zeliaś (2000), the same (unit) weights were adopted for all variables.

To assess the spatial diversity of the green economy of voivodeships in Poland, a synthetic measure based on the TOPSIS method (Technique for Order Preference by Similarity to an Ideal Solution) was used. The synthetic measure for individual objects was determined based on the formula:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+}, where\ 0 \leq q_i \leq 1, i = 1, 2, \ldots, n, \tag{2}$$

with the proviso that:
q_i – value of the synthetic measure,
d_i^- – means the Euclidean distance of the object from the anti-pattern (from 0),
d_i^+ – means the Euclidean distance of the object from the pattern (from 1).

A higher value of the measure indicates a better situation of an individual in the analyzed area (Özkan et al., 2021).

In the final stage of the research, grouping of voivodeships in terms of a synthetic measure – green economy. Four classes were determined using the mean ($\overline{x}$) standard deviation (S_d). In the first quartile group you can find the most developed voivodeships, in the last one – the least developed (due to the measure of the green economy). The grouping was made according to the formulas:

Group 1	$\overline{x} + S_d \leq q_i$
Group 2	$\overline{x} \leq q_i < \overline{x} + S_d$
Group 3	$\overline{x} - S_d \leq q_i < \overline{x}$
Group 4	$q_i < \overline{x} - S_d$

In the evaluation of the obtained results, maps of the spatial diversity of the synthetic measure – green economy, made in the Statistica program, were presented. Additionally, both Pearson's linear correlation coefficient and regression analysis were calculated (a synthetic measure of the green economy – dependent variable; socio-economic diagnostic variables – independent variables; carried out in Grtel programs).

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Results of the research

After calculating the synthetic green economy measure, the voivodeships were divided into 4 groups. In 2010, the level of the synthetic measure of voivodeships ranged from 0.33 (Śląskie) to 0.44 (Świętokrzyskie), in 2020 it is higher and ranges from 0.42 (Śląskie) to 0.55 (Lubuskie). In the first group, there were 3 voivodeships in 2010 and 2020, and in the fourth weakest group – 2 and 1, respectively (Table 2).

Table 2. Synthetic measure of the green economy of voivodships in Poland in 2010, 2020

		2010			2020	change of position from 2010 to 2020
I	Świętokrzyskie	0.44	I	Lubuskie	0.55	↑
	Lubuskie	0.42		Kujawsko-pomorskie	0.50	↑
	Kujawsko-pomorskie	0.41		Mazowieckie	0.50	↑
II	Pomorskie	0.40	II	Podlaskie	0.49	↑
	Zachodniopomorskie	0.40		Opolskie	0.48	↑
	Łódzkie	0.38		Lubelskie	0.47	↑
	Podkarpackie	0.38		Łódzkie	0.47	↓
	Podlaskie	0.38		Małopolskie	0.47	↑
	Warmińsko-mazurskie	0.38				
III	Małopolskie	0.37	III	Świętokrzyskie	0.47	↓
	Opolskie	0.37		Dolnośląskie	0.46	↑
	Dolnośląskie	0.36		Podkarpackie	0.46	↓
	Lubelskie	0.36		Wielkopolskie	0.46	↑
	Mazowieckie	0.36		Warmińsko-mazurskie	0.45	↓
				Zachodniopomorskie	0.45	↓
				Pomorskie	0.44	↓
IV	Wielkopolskie	0.34	IV	Śląskie	0.42	–
	Śląskie	0.33				

↑(+) change of position; ↓(-) change of position; – no change of position
Source: authors' work based on Statistics Poland (2020).

In 2020, the first (best) group included the following voivodeships: Lubuskie, Kujawsko-Pomorskie, Mazowieckie (in 2010: Świętokrzyskie, Lubuskie, Kujawsko-Pomorskie, respectively). The second group included the following voivodeships: Podlaskie, Opolskie, Lubelskie, Łódzkie, Małopolskie (in 2010:

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Pomorskie, Zachodniopomorskie, Łódzkie, Podkarpackie, Podlaskie, Warmiansko-Mazurskie, respectively). The next third group included the Świętokrzyskie, Dolnośląskie, Podkarpackie, Wielkopolskie, Warmińsko-Mazurskie, Zachodniopomorskie Voivodeships (in 2010: Małopolskie, Opolskie, Dolnosląskie, Lubelskie, Mazowieckie). The last, fourth group (the weakest) included the Śląskie Voivodeship (in 2010: Wielkopolskie, Śląskie). The position of voivodeships in the aspect of GE was influenced by expenditure on health care, electricity consumption, as well as collected waste, area of forests and legally protected areas (which results from the diagnostic variables adopted for the study).

The synthetic measure – green economy, determined by the TOPSIS method, made it possible to divide the voivodeships into 4 groups and also to indicate the changes that occurred in the examined period (while maintaining the procedure and selected changes in the subsequent examined years). As shown in Figure 1, we observe spatial differentiation of the voivodeship in terms of the green economy (the best units are marked in black, the weaker units are marked in a lighter color).

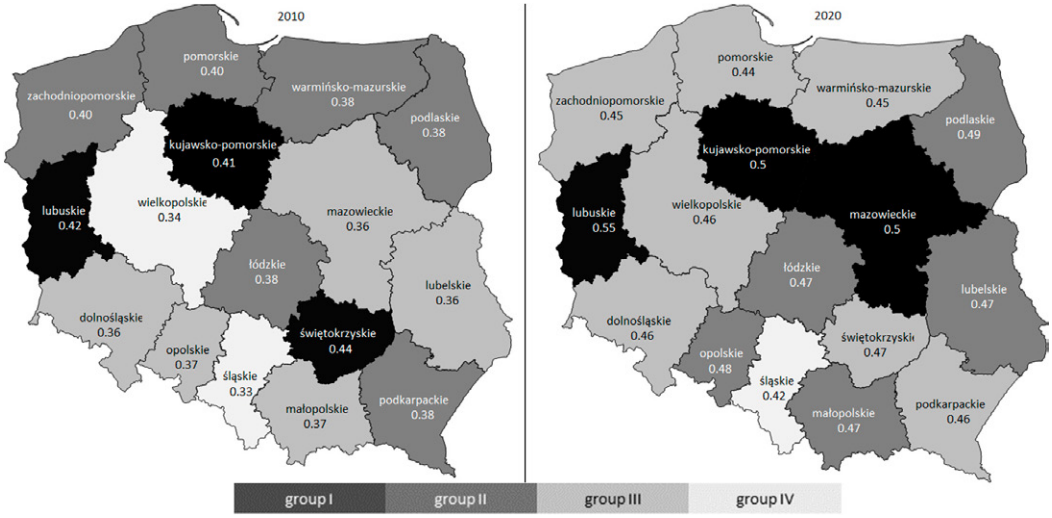

Figure 1. Spatial differentiation of the synthetic measure green economy in voivodships in Poland in 2010, 2020

Source: authors' work based on Statistics Poland (2020).

Table 3 presents the statistical characteristics of the synthetic measure of the green economy of voivodeships in Poland in 2010 and 2020. They do not clearly indicate a decrease or increase in the diversity of the phenomenon. Both the average, minimum and maximum of the synthetic measure increase. The change in the size of the range and quartile range means that voivodeships are becoming more similar (reducing their polarisation). The value of the coefficient of varia-

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tion of the synthetic measure ranged from approximately |0.08| to |0.06|, which indicates a reduction in polarisation. In the case of the green economy measure, we observe a right-skewed distribution (As > 0). This indicates the weakness of the voivodeship in the examined area. Kurtosis indicates the uneven distribution of variable values.

Table 3. Statistical characteristics of the synthetic measure of the green economy in the voivodships in Poland in the years 2010, 2020

	2010	2020
Min	0.33	0.42
Max	0.44	0.55
Range	0.11	0.13
Average	0.38	0.47
Median	0.38	0.47
Standard deviation	0.03	0.03
Quarterly deviation	0.02	0.01
Coefficient of variation(=1)	0.08	0.06
Positional coefficient of variation(=1)	0.05	0.03
Quartilerange	0.04	0.02
Skewness (asymmetry)	0.25	1.02
Kurtosis (measure of concentration)	0.03	2.36

Source: authors' work based on Statistics Poland (2020).

The strength of the relationship between the synthetic measure of the green economy and the diagnostic variables was both positive and negative. Calculation of the Pearsonlinear correlation between the value of the GE measure and socio-economic variables. GE is determined in 2020 by total health care expenses (0.810), electricity consumption in rural areas (0.183), agricultural land (0.166), forest area (0.205), and legally protected areas (0.120). Active waste landfills (-0.145) and separately collected waste (-0.300) had a negative impact on WG in 2020. In 2010, respectively: expenditure on health care (0.178), forest area (0.362), legally protected areas (0.509), ecological lands (0.275) and active waste landfills (-0.271) and separately collected waste (-0.291; at $p<0.005$).

In order to assess the impact of diagnostic variables of the circular economy on the spatial variability of the synthetic agricultural measure, a regression model (classical least squares model) was estimated, describing the relationship of the variables as follows:

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$$F \text{ (a synthetic measure of the green economy)} = 0.001X1 + 0.247X2 + \\ + 0.0001X3 + 0.0001X4 + 3.416X5 + 0.002X6 + 0.003X7 + 0.002X8 + \\ + 26.245X9 + 0.002X10 - 0.083.$$

Table 3 presents the results of the regression analysis of the green economy of voivodeships in Poland. The presented model has a coefficient of determination R-squared of 0.77 and an adjusted R-squared of 0.75. Further increasing the multivariate model would slightly increase the R2 value. F-statistic (13, 162) 43.57.

Table 3. Results of the regression analysis of the green economy of voivodships in Poland

		Coefficient	Standard Error	Student's t Test	p-Value
	const	−0.083	0.0290442	−2.845	0.0050
X1	Total expenditure on health care	0.001	5.30814e-05	10.22	<0.0001
X2	Expenditures on waste management	0.247	0.0288132	8.569	<0.0001
X3	Expenditures on fixed assets for environmental protection and water management	0.0001	9.33889e-06	7.795	<0.0001
X4	Rural electricity consumption	0.0001	1.19019e-05	9.883	<0.0001
X5	Total electricity production	3.416	0.356226	9.591	<0.0001
X6	Share of agricultural land in total area	0.002	0.000257800	7.478	<0.0001
X7	Share of forests in total area	0.003	0.000330224	8.101	<0.0001
X8	Share of legally protected areas in total area	0.002	0.000115189	19.28	<0.0001
X9	Share of ecological species in total area	26.245	1.55431	16.89	<0.0001
X10	Waste collected selectively	0.002	0.000114538	17.52	<0.0001

Arithmetic mean of dependent variable	0.414	Standard deviation of the dependent variable	0.040
Sum of residua squares	0.030	Residual standard error	0.014
Coefficient of determination R-square	0.894	Corrected R-square	0.887
F(13, 162)	138.435	P-value for the F test	0.000
Logarithm of credibility	513.529	Akaike Information criterion	−1005.058
Bayesian information criterion Schwarza	−970.183	Crit. Hannana–Quinna	−990.913

classical least squares methodestimation, observations used 1-176; synthetic measure of the green economy – dependent variable; socio-economic diagnostic variables – independent variables;

Source: authors' work based on Statistics Poland (2020) in the Gretl program.

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Discusion/Limitation and future research

This article uses diagnostic variables (substantively and statistically analysed) to analyse the polarisation of the green economy in voivodeships in Poland. The designated synthetic green economy measure enabled the assessment of voivodeships in Poland and their ranking and grouping. The socio-economic variables indicated in the article (which fall within the scope of variables indicated by Ryszawska (2013)) concern natural capital, state policy and socio-economic problems, assessment of the state of the environment, and the level of waste. The problem, however, is that there is no consensus on how to measure GE at the voivodeship (municipal or poviat) level. The systematic approach proposed in this article can complement existing knowledge. As part of the measurement of economic variables, it is not enough to assess activities for the green economy; it is necessary to assess the social, infrastructural and ecological elements of the endogenous potential (as indicated by the authors). Also, the availability of data (at a specific level of administration, e.g. voivodeships) may influence the measurement of progress towards a green economy. Analyses in the GE area are performed primarily at the country level, which makes it difficult to compare the material presented by the authors with other publications.

Developing a green economy is the best way to slow down negative environmental effects. The green economy requires the creation of a catalogue of indicators describing it (including economic aspects, ecological footprint and energy analysis). Economic development in many regions of the world (e.g. Taiwan) is based on the exploitation and use of non-renewable resources. This requires a change in the development model towards increasing sustainable development (Chen et al., 2011).

The growing pressure on the use of environmental resources, especially non-renewable ones, forces various official entities to take actions aimed at improving production efficiency in this area. The implementation of these activities should be monitored to assess their effectiveness. Monitoring the green economy, as Wyszkowska (2016) points out, seems to be advisable. It allows for assessing the effectiveness of state policy in this area. Enables international comparisons. However, it is particularly important to obtain information that constitutes the basis for making decisions by public and private entities relating to the implementation of activities conducive to green growth.

The effects of the transformation towards a green economy may be negative for countries with fossil fuel-based and high-emission energy. If future solutions in the analysed area are not adapted to the specificity of the analysed entity or energy sector and supplemented with solid financial support, they may constitute a development barrier (barrier to the transformation of the local economy). An appropriate level of sustainable energy is environmental responsibility as well as an element of social justice. Implementing a circular economy to ensure its appropriate effectiveness requires a holistic approach (Drejerska et al., 2020).

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In developed countries, the main burden of waste management falls on the organised (formalised) and mass municipal waste management system. The operation of these systems is regulated by legislation at local, national and international levels. At the same time, some waste fractions are completely or partially excluded from this system (e.g. bulky waste, used clothing, food, green waste, or metals). As in developing countries, they are managed partly through informal ventures, the organisation of which, including the method of operation, scale and spatial scope, varies. The formal system is organised hierarchically and strictly regulated by law. On the other hand, informal activities are regulated by regulations or sets of rules for everyday life. Thus, municipal waste management in developed countries creates a complex mosaic of activities, organisations and institutions that contribute to reducing the amount of waste and its nuisance (Ciechelska et al., 2023).

The results of the conducted research can be a source of information for provincial authorities about the disproportions between units in order to determine potential directions for optimising the green economy policy. The results also enable comparisons between voivodeships (while maintaining the procedures and variables presented in the article) and indicate the directions of possible actions to reduce polarisation between voivodeships within GE. For comparison between regions, the proposed methodology should cover the same variables in the indicated research areas.

The obtained results indicate the need to expand subsequent research with new diagnostic variables (and increase their number), conduct an analysis over an extended period of time in order to learn about the trends of changes, analyse outliers and determine their impact on the situation of the studied area, taking into account new areas that may influence GE level, i.e. demography, ecology, infrastructure, entrepreneurship, or building a synthetic measure based on another method (CRITIC-TOPSIS), assessment of the direction and strength of the influence of outlier variables on the main criterion.

In terms of limitations regarding the research carried out, the following should be indicated: the availability of data within public statistics, comparability of data, changes in legal provisions, changes in the scope of tasks performed by territorial units, changes in administrative division, changes in the socio-economic situation, and random events.

Conclusions

Systematic research on the green economy should provide the information necessary for the authorities to assess and correct their policy in terms of GE. Regions, depending on their socio-economic characteristics, differ in terms of the degree of advancement of the transition to the green economy. They also differ in the scale of changes that occurred during the period under study. This results

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from both natural conditions (natural resources, forest areas, and legally protected areas) and historical conditions (in terms of the development process) as well as health care expenses, electricity consumption, and collected waste.

Assessing the green economy of voivodeships is a difficult task. It requires taking into account many different variables of their territorial capital, the selection of which may have a significant impact on the results obtained and the possibility of using the method for assessments between regions from different countries. Measuring the green economy is difficult due to the transformation period and the effects of the economic slowdown, as well as the availability of data in public statistics (data collected at the voivodeship level).

Regional authorities' green economy policies should support both improved efficiency and progress towards greater sustainability. The aspect of the natural environment is an important element in the assessment of the green economy and the economic development process. At the current stage of development, it is necessary to slow down the consumption of natural resources, which will contribute to improving the condition of the natural environment.

In spatial terms, the appropriate level of the green economy results from the desire to reduce the burden on the natural environment by creating attractive conditions for living and business operations in line with the specificity of the regional economy. Creating a green economy requires the simultaneous involvement of states, enterprises and societies for environmentally and consumer-friendly solutions.

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The contribution of the authors

Conceptualization, P.D., Ł.P., A.W. and M.W.; literature review, P.D., Ł.P., A.W. and M.W.; methodology, P.D., Ł.P., A.W. and M.W.; formal analysis, P.D., Ł.P., A.W. and M.W.; writing, P.D., Ł.P., A.W. and M.W.; conclusions and discussion, P.D., Ł.P., A.W. and M.W.

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References

Bogović, N. D., & Grdić, Z. S. (2020). Transitioning to a Green Economy—Possible Effects on the Croatian Economy. *Sustainability*, 12(22), 9342. https://doi.org/10.3390/su12229342

Borys, T., Bugdol, M., & Puciato, D. (2022). Barriers to achieving climate goals. An external context. Economics and Environment, 82(3), 8-37. https://doi.org/10.34659/eis.2022.82.3.476

Broniewicz, E., Bukowska, J., Godlewska, J., Lulewicz-Sas, A., & Sidorczuk-Pietraszko, E. (2022). Climate change adaptation in ex-ante assessment of legal acts – a proposal of indicators for Poland. Economics and Environment, 82(3), 52-73. https://doi.org/10.34659/eis.2022.82.3.525

Bucea-Manea-Ţoniş, R., & Zecheru, T. (2022). Untapped Aspects of Waste Management versus Green Deal Objectives. *Sustainability*, *14(18),* 11474. https://doi.org/10.3390/su141811474

Chen, Y., Chen, C.-Y., & Hsieh, T. (2011). Exploration of sustainable development by applying green economy indicators. Environmental Monitoring and Assessment, 182, 279-289. https://doi.org/10.1007/s10661-011-1875-3

Churski, P., Herodowicz, T., Konecka-Szydłowska, B., & Perdał, R. (2021). Rethinking Regional Development Factors. In P. Churski, T. Herodowicz, B. Konecka-Szydłowska & R. Perdał (Eds.), *European Regional Development* (pp. 97-150). Cham: Springer. https://doi.org/10.1007/978-3-030-84659-6_4

Ciechelska, A., Kusterka-Jefmańska, M., & Zaremba-Warnke, S. (2023). Municipal waste management as a polycentric system –the example of Poland. Economics and Environment, 83(4), 76-90. https://doi.org/10.34659/eis.2022.83.4.541

D'Amato, D., & Korhonen, J. (2021). Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. Ecological Economics, 188, 107143. https://doi.org/10.1016/j.ecolecon.2021.107143

Di, K., Chen, W., Zhang, X., Shi, Q., Cai, Q., Li, D., Liu, C., & Di, Z. (2023). Regional unevenness and synergy of carbon emission reduction in China's green low-carbon circular economy. Journal of Cleaner Production, 420, 138436. https://doi.org/10.1016/j.jclepro.2023.138436

Drejerska, N., Vrontis, D., Siachou, E., & Golebiewski, J. (2020). System solutions for the circular economy on the regional level: The case of Green Lungs of Poland. Journal for Global Business Advancement, 13(4), 447-458. https://doi.org/10.1504/JGBA.2020.112388

Godlewska, J., & Sidorczuk-Pietraszko, E. (2019). Taxonomic Assessment of Transition to the Green Economy in Polish Regions. Sustainability, 11(18), 5098. https://doi.org/10.3390/su11185098

Grabiński, T. (1985). Metody określania charakteru zmiennych w wielowymiarowej analizie porównawczej. Zeszyty Naukowe Akademii Ekonomicznej w Krakowie, 213, 35-63. (in Polish).

Grzelak, A., & Kryszak, Ł. (2023). Development vs efficiency of Polish farms – trade-off or synergy effects? Economics and Environment, 84(1), 287-304. https://doi.org/10.34659/eis.2023.84.1.543

Herodowicz, T. (2018). The spatial differentiation of the intervention of the regional policy of the EU supporting pro-environmental economic changes in Poland. Economics and Environment, 64(1), 96-109. https://ekonomiaisrodowisko.pl/journal/article/view/180

Hickel, J. (2021). *Mniej znaczy lepiej. O tym jak odejście od wzrostu gospodarczego ocali świat.* Kraków: Wydawnictwo Karakter. (in Polish).

Igliński, B., Krukowski, K., Mioduszewski, J., Pietrzak, M. B., Skrzatek, M., Piechota, G., & Wilczewski, S. (2022). Assessment of the Current Potential of Hydropower for Water Damming in Poland in the Context of Energy Transformation. Energies, 15(3), 922. https://doi.org/10.3390/en15030922

Korenik, S., & Zakrzewska-Półtorak, A. (2011). *Teorie rozwoju regionalnego – ujęcie dynamiczne.* Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu. (in Polish).

Lorek, S., & Spangenberg, J. H. (2014). Sustainable consumption within a sustainable economy – beyond green growth and green economies. Journal of Cleaner Production, 63, 33-44. https://doi.org/10.1016/j.jclepro.2013.08.045

Łuczak, A., & Wysocki, F. (2005). *Wykorzystanie metod taksonometrycznych i analitycznego procesu hierarchicznego do programowania rozwoju obszarów wiejskich.* Poznań: Wydawnictwo Akademii Rolniczej im. Augusta Cieszkowskiego w Poznaniu. (in Polish).

Malina, A. (2020). Analiza przestrzennego zróżnicowania poziomu rozwoju społeczno-gospodarczego województw Polski w latach 2005–2017. Social Inequalities and Economic Growth, 61(1), 138-155. https://doi.org/10.15584/nsawg.2020.1.10 (in Polish).

Morseletto, P. (2020). Targets for a circular economy. Resources, Conservation and Recycling, 153, 104553. https://doi.org/10.1016/j.resconrec.2019.104553

Myrdal, G. (1957). *Economic Theory and Underdeveloped Regions.* London: Gerald Duckworth.

OECD. (2011). *Towards Green Growth: Monitoring Progress – OECD Indicators.* https://www.oecd.org/greengrowth/48224574.pdf

OECD. (2014). *Green Growth Indicators 2014.* https://wedocs.unep.org/bitstream/handle/20.500.11822/9434/-Green_Growth_Indicators-2014OECD_GreenGrowth-Indicators_2014.pdf.pdf?sequence=3&isAllowed=y

Özkan, B., Özceylan, E., Kabak, M., & Dikmen, A. U. (2021). Evaluation of criteria and COVID-19 patients for intensive care unit admission in the era of pandemic: A multi-criteria decision making approach. Computer Methods and Programs in Biomedicine, 209, 106348. https://doi.org/10.1016/j.cmpb.2021.106348

Ryszawska, B. (2013). Zielona gospodarka – teoretyczne podstawy koncepcji i pomiar jej wdrażania w Unii Europejskiej. Monografie i Opracowania Uniwersytetu Ekonomicznego we Wrocławiu, 247, 250. (in Polish).

Statistics Poland. (2020). *Local Data Bank*. https://bdl.stat.gov.pl/bdl/start

Szyja, P. (2013). Znaczenie programów Zielonego Nowego Ładu dla rozwoju społeczno-gospodarczego. In A. Górka & P. Szyja (Eds.), *Zielony Ład Gospodarczy oraz wybrane problemy rynku energii i gospodarki wodnej* (pp. 31-279). Kraków: Katedra Polityki Przemysłowej i Ekologicznej Uniwersytetu Ekonomicznego w Krakowie. (in Polish).

UNEP. (2012). *Measuring Progress towards an inclusive Green Economy*. https://wedocs.unep.org/bitstream/handle/20.500.11822/32438/MPGE.pdf?sequence=1&isAllowed=y

Ustawa z dnia 5 czerwca 1998 r. o samorządzie województwa. (Dz. U. z 1998 r. Nr 91, poz. 576). https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu19980910576 (in Polish).

Wyszkowska, D. (2016). Wskaźniki zielonej gospodarki dla Polski oraz pozostałych krajów Unii Europejskiej. Wiadomości Statystyczne, 10(665), 54-74. (in Polish).

Xu, J., Zhao, J., She, S., & Liu, W. (2022). Green growth, natural resources and sustainable development: Evidence from BRICS economies. Resources Policy, 79, 103032. https://doi.org/10.1016/j.resourpol.2022.103032

Zeliaś, A. (2000). *Taksonomiczna analiza przestrzennego zr*óżnicowania poziomu życia w Polsce w ujęciu dynamicznym. Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie. (in Polish).

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OCENA ZRÓŻNICOWANIA PRZESTRZENNEGO ZIELONEJ GOSPODARKI W WOJEWÓDZTWACH POLSKI W LATACH 2010-2020

STRESZCZENIE: Rozwój zielonej gospodarki, w sytuacji niedoboru zasobów, globalnych zmian klimatycznych, degradacji środowiska, oznacza wejście na nową ścieżkę rozwoju społeczno-gospodarczego w bardziej efektywny sposób realizującego cele zrównoważonego rozwoju. Poziom jej polaryzacji regionalnej stymulowany jest przez czynniki demograficzne, przyrodnicze i technologiczne, gospodarczo-społeczne. Celem badań była identyfikacja i ocena poziomu polaryzacji regionalnej pod względem rozwoju zielonej gospodarki w województwach w Polsce za pomocą miernika syntetycznego. Podstawą przeprowadzonej analizy był zestaw merytorycznie i statystycznie przeanalizowanych zmiennych diagnostycznych z lat 2010-2020 dostępnych w ramach Statistics Poland. Efektem analizy była prezentacja polaryzacji regionalnej oraz porządkowanie województw w Polsce w latach 2010-2020 pod względem miary syntetycznej – zielonej gospodarki. Zielona gospodarka województw powinna być budowana w oparciu o dostępne zasoby endogeniczne, a także charakterystyczne dla województwa rozwiązania planistyczne i organizacyjne. Zastosowanie syntetycznego miernika do oceny działań w obszarze zielonej gospodarki pozwala na ocenę efektów, a także podjęcie działań naprawczych województw w tym zakresie.

SŁOWA KLUCZOWE: zielona gospodarka, zróżnicowanie przestrzenne, zrównoważony rozwój, miernik syntetyczny, województwo

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