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Conditions of the Local Green Economy in the Period 2010-2020

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Abstract: The green economy is an important tool for ensuring sustainable development, and is characterised by a high quality of life for the population, along with careful and rational use of natural resources. The aim of the article was to analyse the spatial differentiation of the green economy in 2010-2020. The research used a synthetic measure that allows for the studied districts to be ranked and grouped according to the main criterion, as well as investigating whether and to what degree the variables determine differentiation in the green economy. In order to achieve this aim, the authors used the following research methods: analysis of the subject literature, followed by statistical analysis using a synthetic measure. To construct the synthetic measure, the Technique for Order Preference by Similarity to an Ideal Solution method was used. The research results present the spatial differentiation of the selected districts in the period 2010-2020.

Keywords: green economy, spatial differentiation, synthetic measure

1. Introduction

Socio-economic development is linked to natural conditions, namely the physical and geographical environment. Elements of the geographical environment have an effect on one another and on society. The environment has an influence on the economy and is subject to degradation on the part of the economy (Małachowski, 2007). The deepening social and ecological problems in the modern world are determined to an increasing degree by the processes of the purchase and consumption of goods. Currently, it is emphasised that there is a need to change contemporary models of consumption to make them more sustainable. The widespread model of unsustainable consumption is the source of increasing degradation of the natural environment and the depletion of its resources, which as a consequence contributes to disturbing the ecological balance.

The green economy is one that promotes the well-being of the environment and quality of life, and considers them as equally or even slightly more important than economic development and financial growth (Kim et al., 2014, pp. 37-48). The green economy also improves prosperity – people's quality of life, increases social justice, lowers environmental risk and the depletion of natural resources. It has been examined on many levels e.g. the development of clean technologies, renewable sources of energy, improvement of energy efficiency, and the change to a more sustainable model of consumption and production (UN Conference, 2012). It does not replace the concept of sustainable and continuous development. From a spatial perspective, it relates to efforts on a regional and local level to reduce the burden on the environment, improve living conditions, and improve local and regional competitiveness (Hahnel, 2010).

The green economy is an important tool for ensuring sustainable development, and is characterised by a high quality of life for the population, along with the careful and rational use of natural resources (Dabyltayeva & Rakhymzhan, 2019). It contains an ecological aspect (reduction of CO_2 emissions, resource efficiency), and a social aspect (combatting social exclusion) (*Green Economy*, 2011). It can be analysed from a sectoral perspective (covering the renewable energy source sector, ecological building materials, ecological transport, water and waste management), and a spatial perspective (space management) (Ayres & van der Lugt, 2011).

The aim of the article was to analyse the spatial differentiation of the green economy in the period 2010-2020 for the selected districts in Poland. The study used a synthetic measure that allows for the ranking of the studied districts grouped according to the main criterion, as well as for investigating whether and to what degree the applied variables determine differentiation in the green economy. In order to achieve this aim, the authors used the following research methods: analysis of the subject literature, followed by statistical analysis using a synthetic measure. To construct the synthetic measure, the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method was employed. The research results present the spatial differentiation of districts in the years from 2010 to 2020.

2. Literature Review

The green economy (GE) is a sustainable economy in which the energy used is entirely from renewable sources. It constitutes a path for economic development that will be possible continuously, taking into account environmental constraints and criteria. GE is a way of acquiring and using resources (Loiseau et al., 2016), and the concept is multidimensional, taking into consideration economic, social and ecological dimensions (Ryszawska, 2013b). Environmental, social and economic problems are closely interlinked, as well as being complicated and complex. The increase in resource efficiency, the promotion of sustainable consumption and production, the fight against climate change, the protection of biodiversity, the fight against desertification, the reduction of pollution, and responsible management of natural resources and ecosystems are both a necessity and at the same time the driving force ensuring transformation towards the green economy (UN Conference, 2012).

The benefits of a green circular economy include: better resource and ecological efficiency, a smaller carbon footprint, less dependency on mined resources, and the management of by-products and waste materials from many sources (e.g. the agro-industrial industry). This concept is focused around the ideas of recycling, reuse, regeneration and maintaining a sustainable production process (Carus & Dammer, 2018). On a local scale, a sustainable development strategy is a useful tool in implementing the assumptions of this concept. This strategy should comprehensively and dynamically take into account the natural, social and economic phenomena occurring in a given district. The concept of sustainable development should therefore be implemented at all levels of management (national, regional and local). Action at local level should aim to develop aware, pro-ecological attitudes among the local community, as well as set the appropriate direction for production processes and raise the level of local eco-awareness (Rakoczy, 2009). Among the most important aspects of sustainable development are: harmonisation of socio-economic development with the natural environment, rational use of environmental resources, cessation of activities leading to irreversible changes in the environment, improving and maintaining the quality of life (for current and future generations), and limiting the detrimental effect of human activity on the environment (Piontek, 2002).

GE is an answer to global environmental, economic and social problems. It constitutes a path for economic development that will be possible continuously, taking into account environmental constraints and criteria regarding the availability of environmental resources and services (Allen & Clouth, 2012, pp. 6-8). The green economy is interpreted as the 4Rs: reduce, reuse, recycle and restore. These involve reducing the use of resources, preserving the natural capital and restoring resources (Lieder & Rashid, 2016, pp. 36-51). The circular economy constitutes efforts to achieve a waste-free economy. GE is one of the paths to sustainable development, and brings greater specification and operationalisation of sustainable development (Ryszawska, 2013b).

Specific relations occur between the individual elements of the green economy (the environment, the economy, infrastructure and society). These lead to areas being distinguished that allow for the state of the green economy to be monitored, i.e. natural capital, the environmental efficiency of production, the environmental quality of life of the population, and economic policies and their consequences (Global Green…, n.d.; Green Growth, n.d.; Strategia Europa 2000, n.d.) Adopting GE can be useful for economic and social reasons, as it helps in reducing environmental pollution, together with the appropriate use of limited resources (Elimam, 2017). However, measuring the green economy at regional level has additional limitations in comparison to indicators at national level (the authors propose their own set of diagnostic variables for assessing a given area) (Godlewska & Sidorczuk--Pietraszko, 2019).

The green economy and infrastructure are instruments that bring economic and environmental benefits through the use of natural solutions for supporting and strengthening investment, and for this reason are consciously included in the spatial planning and contemporary development of regions.

GE is an important concept for the development of the region. It is based on priority orientations related to the development of environmental technologies relevant to multifunctional development. At regional level, it is possible to introduce certain directions of change (to the measure of the region's resources and its territorial capital) that globally lead to sustainable socio-economic development. GE responds to global problems in both the environmental and the economic and social spheres (Godlewska, 2014). The green economy is a term that positions economic development in the context of a holistic view of nature and embraces inclusivity, diversity, difference, and equality in community and society (Vargas-Hernández et al., 2022).

3. Materials and Method

To examine the green economy in districts, a synthetic measure was used based on the *Technique for Order Preference by Similarity to an Ideal Solution* (TOPSIS) method, which allowed for a multi-dimensional and comprehensive view of the level of the phenomena in individual districts, the conducting of comparative analyses of sites and their linear ordering (Malina, 2020). The empirical data was gathered across 314 districts, the selection of which was to a large degree conditioned by the availability of data for districts in the Bank of Local Data at the Central Statistical Office (BDL GUS). The research was conducted dynamically, designating minimum $\{x_{ij}\}$ and maximum$\{x_{ij}\}$ values for the entire period 2010-2020.

The determination of a synthetic measure (of the green economy) was conducted in five stages.

Stage 1. Defining the research area and determining the set of diagnostic variables.

The adopted research area was a district, that is a local administrative unit (of all inhabitants) and the relevant territory, i.e. the basic unit for territorial division covering an area of several to a dozen or more communes, or the entire area of a town with district rights (i.e. communes with town status that have been granted district rights) (Rozporządzenie Rady Ministrów z dnia 7 sierpnia 1998 ...).

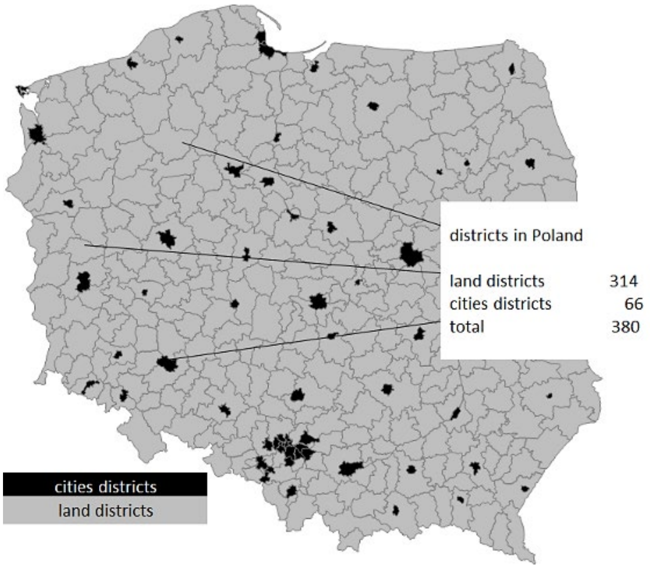

Figure 1. Research area – territorial districts in Poland

Source: own elaboration.

The multidimensionality of the regional economy and the dynamics of change, point to the need to rethink the way and extent to which development factors are defined (Churski et al., 2021). The OECD proposes a group of indicators to assess the characteristics of green growth and monitor its progress towards green growth. They point to the environmental productivity and resources of the economy: natural assets (resources), the environmental dimension of quality of life, and economic opportunities and policy responses-indicators that verify the economic opportunities associated with green growth (e.g., innovation policy) (OECD, 2017). Broniewicz et al. identified a set of indicators to assess adaptation to climate change and thus changes in the transition to a green economy (Broniewicz et al., 2022). The study, following Ryszawska, adopted a set of indicators centred around: natural capital, state policies supporting the green economy and socio-economic problems (Ryszawska, 2013a). The variables used in the research are presented below in Table 1.

Table 1. Variables characterising the green economy in districts

Number	Variable name	Unit	Stimulant/ Destimulant
X1	Expenditure on health care	PLN/inhabitant	S
X2	Electricity consumption in urban households	[kWh]/inhabitant	D
X3	Electricity consumption in rural areas	[kWh]/ inhabitant	D
X4	Users of water supply system as % of total population	%	S
X5	Using a sewage system as % of total population	%	S
X6	Water supply network	km/100 km^2	S
X7	Sewage network	km/100 km^2	S
X8	Gas network	km/100 km^2	S
X9	Heat sales per year (including from renewable sources)	[GJ]/ inhabitant	S
X10	Forest land area in total area	%	S

X11	Water consumption for the national economy and population	dam^3/ inhabitant	D
X12	Share of industry in total water consumption	%	D
X13	Expenditure on urban and rural cleaning	PLN/ inhabitant	S
X14	Share of treated wastewater in discharged wastewater	%	S
X15	Population using wastewater treatment plants in % of total population	%	S
X16	Share of recycled waste in generated waste	%	S
X17	Mixed waste collected per year	kg/ inhabitant	D
X18	Municipal wastewater treated per 100 km^2	dam^3/100 km^2	S
X19	Share of legally protected areas in total area	%	S

Source: own elaboration based on data availability from Statistics Poland.

The diagnostic variables vary over time and should therefore be analysed on an ongoing basis. The set of diagnostic variables is described by $X = \{X_1, ..., X_n\}$ (n – number of examined variables, assuming $m \geq n$), the set of communes in the study (multidimensional research area) as $Q = \{Q_1, ..., Q_m\}$ (m – numer of examined objects). The set of items thus described can be presented in the form of an observation matrix (data about items), X_{ij}:

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

where X_{ij} – is the value of *j*-th variable for *i*-th item, *i* – item number ($i = 1, 2, ..., n$), *j* – variable number ($j = 1, 2, ..., m$).

Stage 2. Reduction of diagnostic variables – statistical and substantive verification.

The identified set of diagnostic variables $X_1, ..., X_n$ was subject to selection on the basis of universality, measurability, availability, interpretability, completeness and comparability. For every *i*-th variable, the coefficient of variation was calculated (relative measure of dispersion) according to the formula:

$$V_i = \frac{S_i}{\bar{x}},$$

where V_i – is the coefficient of variation for *i*-th variable, S_i – the standard deviation for *i*-th variable, and $\bar{x}$ the arithmetic mean of *i*-th variable. Eliminated from the set were those variables satisfying inequality $|V_i| \leq V^*$, where V^* is the critical value of the coefficient of variation (= 0.10).

The research also adopted a threshold level for the correlation coefficient of $r^* = 0.75$ (Malina, 2004, pp. 96-97).

The selection of variables was also conducted on the basis of factor analysis using Statistica software (Malina, 2006).

Stage 3. Standardisation of diagnostic variable values – zeroed unitarization methods.

The selected diagnostic variables were divided into stimulants and destimulants (Łuczak & Wysocki, 2005). In cases of any doubt, the Grabiński procedure was applied, using the fact that stimulants should be positively correlated with stimulants, but negatively with destimulants (Grabiński, 1985, pp. 35-63).

Normalisation of diagnostic variables was carried out according to the zeroed unitarisation procedure, depending on the types of variables, $X_j \in S$ according to the formula:

$$Z_{ij} = \frac{x_{ij} - min_i x_{ij}}{max_i x_{ij} - min_i x_{ij}},\ Z_{ij} = 0 \Leftrightarrow x_{ij} = min_i x_{ij};\ Z_{ij} = 1 \Leftrightarrow x_{ij} = max_i x_{ij}.$$

Normalisation for the variable $X_j \in$ D, zeroed unitarisation is performed using the formula:

$$Z_{ij} = \frac{max_i x_{ij} - x_{ij}}{max_i x_{ij} - min_i x_{ij}}, Z_{ij} = 0 \Leftrightarrow x_{ij} = max_i x_{ij}; Z_{ij} = 1 \Leftrightarrow x_{ij} = min_i x_{ij},$$

where $max_i x_{ij} \neq min_i x_{ij}$, $max_i x_{ij} > min_i x_{ij}$, S – stimulant, D – destimulant, *i* = 1, 2…, *n* (number of selected variables for analysis); *j* = 1, 2…, *m* (number of cases of the variable value), max_{xij} – maximum value of *j*-th variable, min_{xij} – minimum value of *j*-th variable, x_{ij} – value of *j*-th variable for *i*-th item (Dziekański & Prus, 2020; Grabiński et al., 1989; Młodak, 2006), Z_{ij} value of the normalised *j*-th variable for *i*-th item, the value belongs to the range [0;1] (Kukuła & Bogocz, 2014; Walesiak, 2005, pp. 106-118).

As a result of the unitarisation process, a Z_{ij} (value of *j*-th variable for *i*-th item) matrix of feature values was obtained (Wysocki, 2010):

$$Z_{ij} = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & \cdots & z_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{bmatrix}.$$

Stage 4. Determining the value of the synthetic measure on the basis of the selected aggregation formula – the TOPSIS method.

Linear ordering is a synthetic variable. The first synthetic measure of development was proposed by Hellwig for assessing economic development in selected countries (Hellwig, 1968).

At the beginning of calculating the TOPSIS measure, the distances were calculated for every assessed item from the pattern (=1) and anti-pattern (=0). Next, the Euclidean distances were calculated for individual items from the pattern and anti-pattern of development:

$$d_i^+ = \sqrt{\frac{1}{n} \sum_{j=1}^{n} \left(z_{ij} - z_j^+\right)^2},$$

$$d_i^- = \sqrt{\frac{1}{n} \sum_{j=1}^{n} \left(z_{ij} - z_j^-\right)^2},$$

where *n* – the number of variables creating the pattern or anti-pattern, z_{ij} – is unitarised value of *j*-th feature for the studied unit, and z_j^+, z_j^- is the item pattern or anti-pattern (Zalewski, 2012, pp. 137-145).

The synthetic measure for the green infrastructure for individual items was determined on the basis of the formula:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+},$$

$$where\ 0 \leq q_i \leq 1, i = 1, 2, \ldots, n;$$

in which $q_i \in [0; 1]$; d_i^- is the distance of the item from the anti-pattern (from 0), and d_i^+ is the distance of the item from the pattern (from 1). Higher q_i values of the measure demonstrate a beneficial situation in the studied unit (Satoła, 2015, pp. 115-123).

Stage 5. Assessment of the results according to the synthetic measure – the linear ordering of items, distinguishing of typological classes, and determining the measure of the descriptive statistics.

In order to interpret the obtained measures, a division was applied into typological groups. The first, second and third quartiles were used as threshold values. In the first group, the size of the synthetic measure indicated a better unit, while in subsequent groups – weaker units (Nowak, 1990). The necessary calculations in terms of the descriptive statistics measures were conducted using Statistica software.

4. Research Results

Nowadays, in the context of resource scarcity, global climate change, environmental degradation and increasing demand for food, the green closed-loop economy is a promising strategy for promoting sustainable development. The spatial differentiation of the green economy in the selected districts in the period 2010-2020 in Poland is presented in Figure 2. The units with higher green economy values were districts located in southern, south-eastern and northern areas of Poland.

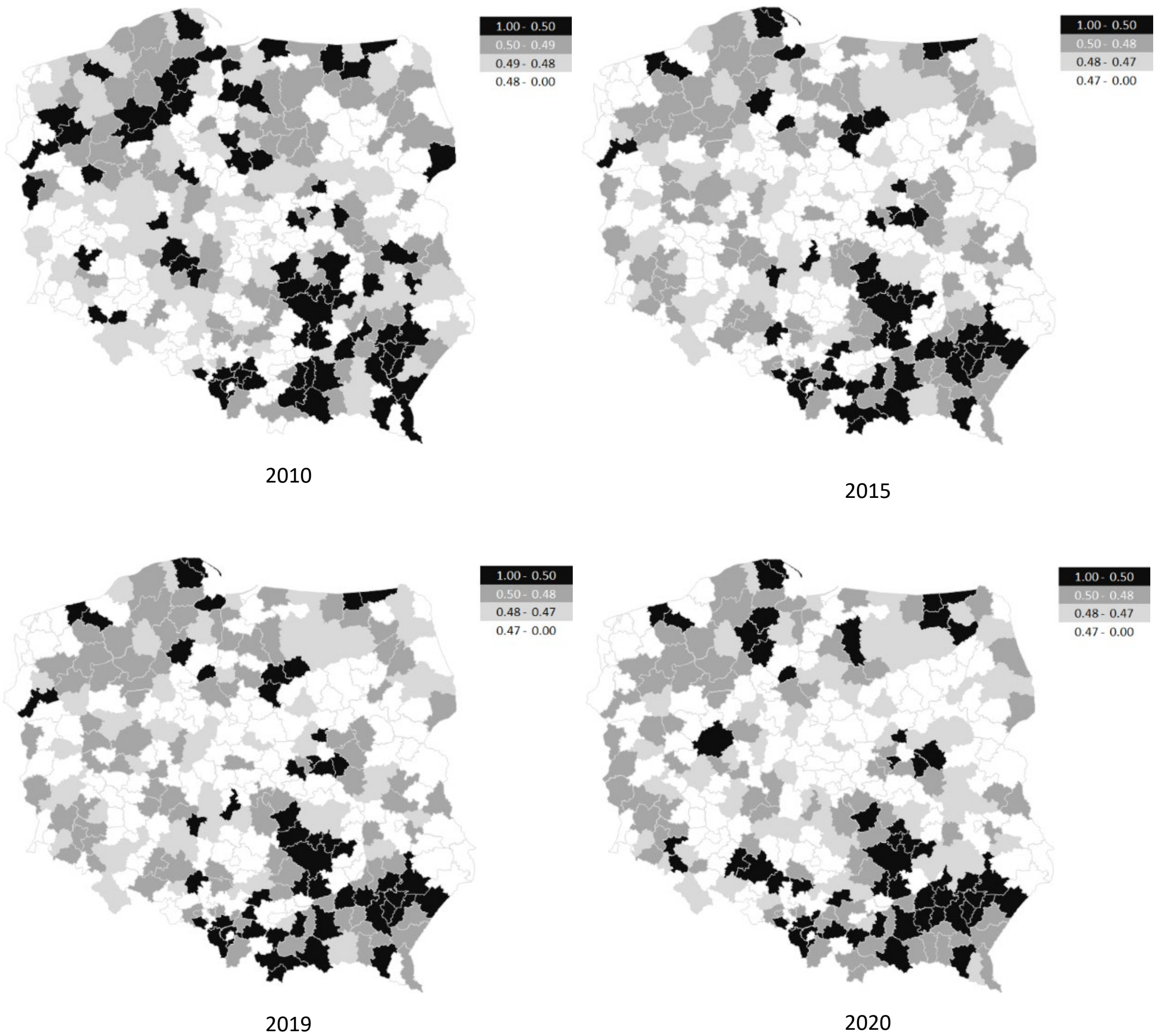

Figure 2. Spatial differentiation of the green economy in districts in 2010-2020

Source: own calculations.

Figure 3 presents the distribution model for the green economy variable, in which one can observe a slight left-sided skewness. This indicates that in 2020 a greater number of districts (173) obtained a value for the green economy variable higher than the average value. The largest group was of those in the range 0.46-0.48, which included 126 districts.

The data presented in Table 2 indicates a slight differentiation among districts as regards the green economy. The slight decline in the differentiation in 2020 in relation to 2010 shows an increase in the coefficient of variation and range, while the variance and standard deviation remain constant.

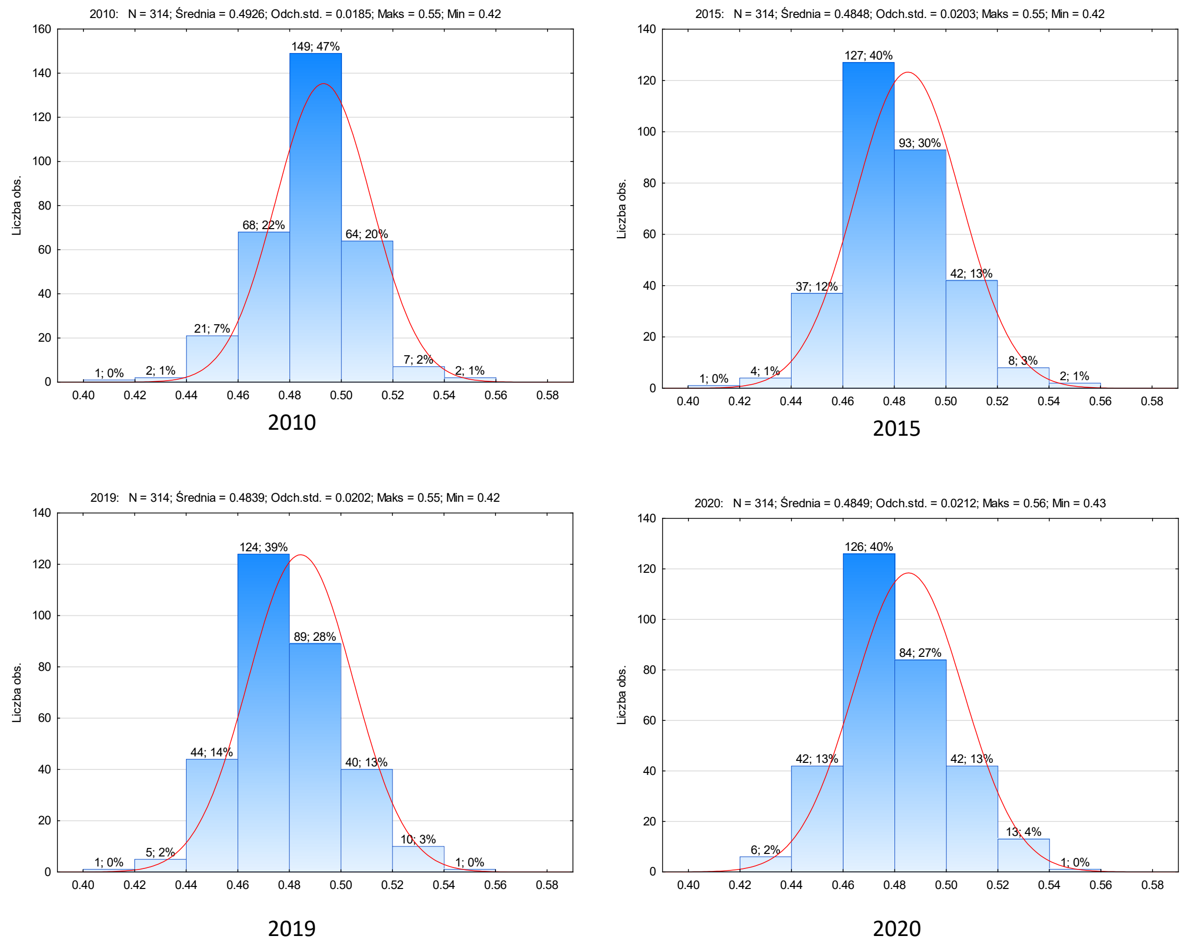

Figure 3. Distribution graph for the variable 'green economy' in districts in 2010-2020

Source: own elaboration.

Table 2. Differentiation of the synthetic measure of the green economy in districts in 2010-2020

Name	*q* of the green economy in the years			
	2010	2015	2019	2020
Average	0.49	0.48	0.48	0.48
Median	0.49	0.48	0.48	0.48
Minimum	0.42	0.42	0.42	0.43
Maximum	0.55	0.55	0.55	0.56
Lower (Quartile)	0.48	0.47	0.47	0.47
Upper (Quartile)	0.50	0.50	0.50	0.50
Range	0.13	0.13	0.13	0.13
Quartile (Range)	0.02	0.03	0.03	0.03
Variance	0.00	0.00	0.00	0.00
Standard deviation	0.02	0.02	0.02	0.02
Coefficient of variation	3.76	4.19	4.18	4.36
Skewness	–0.32	0.37	0.31	0.41
Kurtosis	1.04	0.39	0.26	0.26

Source: own elaboration.

The pattern of spatial differentiation in the level of socio-economic development of the studied districts may suggest the influence of natural conditions on the conditions of the green economy. Figure 4 shows that one can observe spatial differentiation of the concentration in the aspect of GE.

Figure 4. Spatial differentiation of the green economy in the studied districts by the Gini coefficient

Source: own elaboration.

Monitoring the green economy makes it possible to assess the effectiveness of government policy in this area. It allows international and inter-regional comparisons to be made. However, it is particularly important to obtain information that constitutes the basis for decision-making by public and private entities relating to the implementation of measures favouring green growth (Wyszkowska, 2016, pp. 54-74).

5. Conclusion

The green economy is an instrument for mitigation and adaptation to climate change, as well as for the development of the multifunctionality of both regions and districts. Initiatives undertaken within the concept of GE can be important from the perspective of reinforcing the regional and local economy in terms of its social, economic and environmental dimensions. Of crucial importance at this stage of transformation to the green economy is a reduction in the use of natural resources, which should benefit the economy socially, economically and environmentally.

The studied districts differ in terms of how far they have progressed in their transition to the green economy. This is due to natural as well as historical conditions and the process of socio-economic development to date. The GE level was influenced by the sewage network (0.4894), the share of recycled waste in generated waste (0.4612), the gas network (0.4312), the population using wastewater treatment plants (0.3029), the amount of mixed waste collected (0.1656), water consumption per capita (–0.1813), rural electricity consumption (–0.2359), and the share of industry in total water consumption (–0.2887).This is due to natural as well as historical conditions and the process of socio-economic development to date. The level of ZG was influenced by the sewage network (0.4894), the share of recycled waste to generated waste (0.4612), the gas network (0.4312), the population using wastewater treatment plants (0.3029), the amount of mixed waste collected (0.1656), water consumption per capita (–0.1813), rural electricity consumption (–0.2359), and the share of industry in total water consumption (–0.2887).

The green economy serves to improve the quality of life and social cohesion, as well as to lower the level of threat to the natural environment and ecological deficiencies. The green economy must be built based on a region's available potential, as well as planning, organisational, design and implementation solutions.

This research into the green economy in districts has demonstrated its spatial differentiation. The research results were influenced by: geographical location, function (i.e. agriculture, industry, tourism), local economic potential and development profile. Actions related to the green economy should focus on achieving social, economic and spatial cohesion. Additionally, the results of the analysis confirm the usefulness of synthetic measures for assessing complex phenomena. The information obtained also allows for the assessment of the effectiveness of applied developmental instruments, and of the sources of information on the disproportions that exist between units.

The results of the assessment indicate that it is necessary to deepen research from the perspective of the new relations between the green economy and the environment, ecology and entrepreneurship.

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Uwarunkowania lokalnej zielonej gospodarki w latach 2010-2020

Streszczenie: Zielona gospodarka jest ważnym narzędziem zapewnienia zrównoważonego rozwoju i charakteryzuje się wysoką jakością życia ludności oraz ostrożnym i racjonalnym wykorzystaniem zasobów naturalnych. Celem artykułu była analiza przestrzennego zróżnicowania zielonej gospodarki w latach 2010-2020. W badaniu wykorzystano syntetyczną miarę, która pozwala na uszeregowanie i pogrupowanie badanych powiatów według głównego kryterium, a także zbadanie, czy i w jakim stopniu zmienne te definiują zróżnicowanie w zielonej gospodarce. Aby osiągnąć cel, autorzy wykorzystali następujące metody badawcze: analizę literatury przedmiotu, a następnie analizę statystyczną z wykorzystaniem miary syntetycznej. Do konstrukcji miary syntetycznej wykorzystano metodę Technique for Order Preference by Similarity to an Ideal Solution. Wyniki badań przedstawiają zróżnicowanie przestrzenne wybranych powiatów w latach 2010-2020.

Słowa kluczowe: zielona gospodarka, zróżnicowanie przestrzenne, miara syntetyczna