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Empirical Analysis of the Impact of the Green Economy on the Spatial Diversity of Entrepreneurship at the Poviats Level in Poland: Preliminary Study

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Abstract: Sustainable development combines economic, social, and environmental aspects in pursuit of long-term stability and prosperity. Entrepreneurship plays a key role in achieving these goals, and the green economy is becoming an important part of the transformation into a more sustainable future. Companies that apply the principles of the green economy contribute to regional development and better use of territorial capital. In the process of development, the regional economy faces growing local needs, changes in the quality of life and climate, and shrinking natural resources. The answer to the problems of the region can be a green economy and entrepreneurship. This article aims to analyze and assess the spatial variation of pre-entrepreneurship in poviats in Poland in the context of the green economy. The study aims to understand how different local factors influence the development of pre-entrepreneurship in the conditions of green transformation. In addition, the paper will attempt to identify spatial disparities in the implementation of green economy initiatives. The CRITIC-TOPSIS method was used to construct the synthetic measure. The results of the analysis are presented for the years 2010, 2013, 2014, and 2021. The measure of synthetic entrepreneurship ranged from 0.24 to 0.48 in 2010 and 0.24 to 0.52 in 2021, the measure of the green economy: 0.35–0.54 and 0.34–0.57. Individual elements of the territorial capital ofthepoviats determine their ability to function. Natural resources are important factors in the process of development and the transition toward a green economy. They affect the standard of living, the social situation, public safety, and the quality of the environment. Supporting less developed regions in entrepreneurship and the green economy through dedicated infrastructure and innovation programmes should be a key action. Local governments should promote investment in green technologies and sustainable infrastructure to reduce disparities between regions.

Keywords: entrepreneurship; green economy; spatial disparities; synthetic measure; CRITIC-TOPSIS method

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1. Introduction

In the process of responsible (sustainable) development, the regional economy faces, among other things, increasing local needs, changes in the quality of life and climate, depletion of raw materials, and environmental degradation. Local challenges also relate to territorial capital (its quality and structure), demographic aspects, the labor market, the level of entrepreneurship, and infrastructure. According to the OECD [1], sustainable

development means supporting economic development while ensuring that natural assets provide environmental resources and services at the same level.

Sustainable development, combining economic, social, and environmental aspects, forms the foundation of modern regional and economic development policies. Entrepreneurship is a key driver of this transformation, as innovative and sustainable business models can support the achievement of the development goals. A green economy, based on the efficient use of natural resources and the minimization of negative impact on the environment, becomes an essential element in the pursuit of sustainable development. There is a potential synergy between entrepreneurial development and a green economy, where sustainable business activity contributes to improving the quality of life of local communities and supports the long-term development of regions. The answer to the multidimensionality of social, economic, and spatial processes that make up the region's activities can be a green economy (GE). Its features include low carbon emission rates and efficient use of natural resources. It is based on achieving a balance between economic, environmental, and social objectives [2]. It is focused on multifunctionality and respect for the environment. Its introduction is a constant increase in strategic development opportunities for entrepreneurs and the economy. GE encompasses technological change, changes in production and consumption, and innovation in all areas relevant to green growth. In practice, GE encompasses activities that create and increase natural capital, reduce threats and risks to the environment (and its resources), and contribute to transformation in the aspect of business operations [3].

An appropriate entrepreneurial system makes a significant contribution to job creation, increasing people's economic capacity, as well as regional change, driving innovation. Economic activity is based on the use of natural, capital, and human resources [4].

This article aims to analyze and assess the spatial variation of pre-entrepreneurship in poviats in Poland in the context of the green economy. The study aims to understand how different local factors influence the development of pre-entrepreneurship in the conditions of green transformation. In addition, the paper will attempt to identify spatial disparities in the implementation of green economy initiatives. In addressing this issue, research questions were posed: how is the spatial diversity of entrepreneurship and green economy presented in terms of poviats in Poland? What is the level and structure of the relationship between entrepreneurship and the green economy? For the assessment of entrepreneurship and green economy, a synthetic measure (CRITIC-TOPSIS method) was used to classify poviats. The results of the analysis are presented for the years 2010, 2013, 2014, and 2021. This allowed us to indicate the dynamic aspects of the studied areas and the assessment of deviations related to cyclical changes in the poviat economy.

Although the functioning of the regions is analyzed from different perspectives, little is known about the impact of the green economy and entrepreneurship on the sustainable development of the districts and thus on the shape of their spatial diversity. Therefore, using statistical data, this study shows whether these factors strengthen the sustainable development of districts or weaken their influence. The statistical analysis is based on a linear analysis of the data, using the following research procedure:

(1) Identifyinga set of diagnostic variables,
(2) Performing a zero-unitarization,
(3) Weighting of selected variables using the TOPSIS-CRITIC method, and
(4) Selecting a statistical measure based on the adopted standard formula.

The study required answers to the following questions: How did changes related to entrepreneurship development affect the green economy and the development of districts between 2010 and 2020, taking into account spatial aspects? What are the spatial differences

in the relationship between entrepreneurship development policies and the green economy at the district level?

A systematic review of the literature allowed us to identify the research gap. The next section of the article presents the main variables and the data source. The authors also present the results of the study and formulate conclusions showing future directions of research.

The value of the article lies in the analysis of the relationship between the development of entrepreneurship and the green economy in poviats in Poland between 2014 and 2021. The research gap is shaped by the lack of analysis concerning the interconnections between the green economy and entrepreneurship in the context of their impact on the spatial differentiation of Polish poviats. Despite existing research on individual aspects, there is a lack of detailed research on how entrepreneurship drives green economy initiatives, how the green economy shapes the location and nature of entrepreneurial activity at the poviat level, and indirectly, how their synergistic impact affects the quality of life and resource management in various Polish poviats.. The novelty of the study is the integration of these interdependencies, taking into account the spatial dimension of the disparities. Identifying the impact of the green economy and entrepreneurship on mitigating or deepening existing disparities is a new research direction that can indicate potential remedial actions in public policy. The focus on the years 2014–2021 allows us to capture dynamic political and economic changes and their impact on entrepreneurship, the green economy, and the quality of life of the inhabitants, especially in the context of sustainable development.

2. Literature Review

In the context of sustainable development, the green economy and entrepreneurship are key elements that support the regional transformation into more resilient and sustainable economic systems. A green economy, based on the efficient use of natural resources, waste reduction, and the use of pro-ecological technologies, not only promotes environmental protection but also creates new opportunities for local businesses. Supporting entrepreneurship in the context of a green transition can lead to synergies, where the development of innovative, pro-ecological businesses supports both economic growth and the improvement of the quality of life of residents. Such cooperation between the green economy and entrepreneurship is essential to ensure a balance between economic, social, and environmental objectives, which is the basis for the sustainable development of the regions.

Diversified development involves the progressive spatial diversification of entrepreneurial behavior in individual regions while also having an environmental impact. An environmentally friendly green economy shaped in local (poviats) space is a key element of the sustainable development of regions [5]. While high-intensity use of natural resources can worsen the quality of the environment, it can contribute to deepening local development problems and thus promote environmental sustainability [6]. Promoting regional entrepreneurship affects spatial diversification and access to natural resources, which makes it an interesting subject of research [7]. As regards the relationship between entrepreneurship and sustainable development, empirical evidence indicates that spatial diversity is highly influenced by environmental impacts, and hence high intensity of natural resource use [8,9]. Active entrepreneurship will inevitably have to influence the level of development of regions to address spatial diversity [10]. Poor use of entrepreneurial behavior exacerbates disparities in development between regions and thus affects the quality of sustainable development [11,12]. In some local communities, significant progress has been made in the efficient use of natural resources [13]. Technological advances, which enable the

efficient use of entrepreneurship, have led to the cost-effective development of regions [14]. In addition, a progressive approach to the green economy has been required [15].

As part of empirical research, a preliminary panel study [16] was conducted to examine the impact of the green economy on the spatial diversity of entrepreneurship at the poviats level in Poland. Ensuring the sustainable development of the local economy or business activity requires appropriate conditions, the efficient use of endogenous resources, and the attraction of exogenous resources [17]. The process of economic development requires a steady increase in the consumption of raw materials and energy. This process contributes to increasing pollution and environmental degradation. Sustainable development requires a product life cycle policy as well as a circular economy (CE) policy. The aim should be to ensure proper waste management, energy saving, and material recovery, or environmental regeneration [18]. One of the basic principles of the circular economy is the 3R (reduction, reuse, recycle) principle [19].

CE leads to a reduction of environmental degradation and positive social impacts while stimulating economic development [20]. It is the opposite of a linear economy. Its activities can be described as obtaining raw materials, processing them, and then freely disposing of the product. Decreasing resources of raw materials in linear models of production and use of products, forcing references to economical waste management.

The green economy improves human well-being and reduces environmental risks and the consumption of natural resources. The instruments for the transition to a greener economy must be adapted to the level of economic development of each region. CE in classical theory is a multidisciplinary field. It is made up of social, environmental, and economic elements, the balance of which makes the economy sustainable [21]. It is interpreted as "4Rs" (i. e. reduce, reuse, recycle, and recover) [22]. CE benefits the region's economy and businesses, reducing the use of scarce resources, eliminating environmental pollution, and improving the quality of life of residents [23].

There are certain links between the elements of the green economy and the activities of businesses. These include natural capital, environmental efficiency of production, quality of life, and economic and social impact instruments. The socio-economic-environmental dimension of human activity is shaped by distance and location, the technical infrastructure of water and wastewater management, landscape, and demographic level. The deterioration of the environment has increased the need for changes in economic policies regarding environmental management.

Entrepreneurship, as the basis of actions initiated by local needs and available resources, is complex; many elements interact, creating the efficiency (effectiveness) of the system. Entrepreneurship is the process of using market-based methods to achieve business objectives and to achieve certain social or financial objectives. Economic, social, and environmental objectives are therefore considered jointly by businessmen [24]. It contributes to economic development and social well-being, is an engine of development, contributes to the creation of new jobs, and stimulates competition.

The development of regional economies and their communities is based on entrepreneurship. Businesses, as economic organizations, are constantly faced with challenges and changing market conditions. The level of diversification of entrepreneurship is shaped by, among others, the environment and natural resources, transport accessibility, large settlements, the level of development of enterprises, access to capital, and the level of infrastructure. The development of entrepreneurship is also influenced by social, financial, economic, and infrastructural factors.

There is a correlation between the variable fundamentals shaping business and the green economy. Their essence is to ensure cohesion in its three dimensions: economic, social, and territorial.

Although much research has been conducted on the relationship between the potential of regions and environmental sustainability, there is still a gap regarding how entrepreneurship and the green economy affect spatial sustainability, especially in poviats. Most research on this topic focuses on the green economy; however, it does not fully consider how entrepreneurship affects spatial diversity in terms of the quality of life of the population living in poviats in Poland. Finally, the interaction between the intensity of regional development, entrepreneurship, and the activities of the green economy for spatial diversity has not been studied. This leaves a gap in understanding how these combined factors shape the quality of life of the inhabitants of the studied regions and the efficiency of the use of natural resources. With this in mind, the research incorporates the concept of a green economy into regions, adding spatial diversity between poviats to show how a cooperative way of looking at the sustainability of regions can help improve the quality of life of the population. This perspective adds novelty to the existing literature, as the role of the green economy in the spatial diversity of poviats in Poland is often underestimated.

Sustainable development is a key objective of modern policies that seek to harmoniously integrate economic, social, and environmental aspects. Entrepreneurship, as a driver of innovation and growth, plays an important role in achieving the Sustainable Development Goals by introducing solutions that support efficient resource management and environmental protection. The green economy becomes a central element in the transformation process, promoting sustainable production and consumption, as well as reducing the negative impact of business activities on the planet. Cooperation between entrepreneurship and the green economy can create synergistic effects, improving the resilience of regions to climate change and other crises, while supporting their long-term development and social inclusion.

Spatial differences in the level of entrepreneurship and green economy development in poviats have a key impact on regional social and economic cohesion. In regions where there are significant disparities in these areas, regional integration may be weakened, which hinders the achievement of sustainable development. Therefore, it is worth investigating how these inequalities affect the quality of life of the inhabitants and the efficiency of the management of natural resources. In this context, the first research hypothesis assumes that spatial differences in the levels of entrepreneurship and the green economy development in districts have a key impact on regional social and economic cohesion, where greater disparities in these areas lead to a weakening of regional integration and sustainable development.

The second hypothesis suggests that the strength and structure of the relationship between the level of entrepreneurship and the development of the green economy in Polish poviats exhibit significant spatial variation and affect the efficiency of the use of natural resources at the regional level. Furthermore, the variation in the strength and structure of the links between entrepreneurship and the green economy may mean that in some countries, economic activity is more concentrated on sectors that intensively exploit natural resources, while in others, there is a greater orientation toward sustainable practices and environmental innovations. Understanding these relationships is crucial for identifying barriers to development and opportunities for political intervention aimed at promoting more even and sustainable development at the regional level.

3. Methods

The study is based on an analysis of the mutual relationships between the green economy and the spatial differentiation of entrepreneurship at the county level in Poland, aiming to understand how these two constructs interact and shape regional socio-economic cohesion and indirectly the quality of life of residents. It has an empirical and exploratory

character, which means that its primary goal is to outline the problem, test the methodology, and indicate directions for further, more in-depth research, rather than providing definitive conclusions. The study explores spatial differences in the level of entrepreneurship and the development of a green economy, analyzing the impact of green economy development on the level and nature of entrepreneurial activity and vice versa—the impact of entrepreneurship on the development of a green economy in the years 2010–2021.

The key elements of conceptualization include identifying and measuring diagnostic variables for both areas, developing synthetic measures using the CRITIC-TOPSIS method, analyzing their spatial distribution, examining statistical correlations between them, and their relationship with other socio-economic and environmental variables. The study aims to contribute to a better understanding of local interactions between the green economy and entrepreneurship, and their impact on Poland's spatial structure in the context of sustainable development, which has the potential to inform public policy in reducing regional disparities and promoting cohesive development. Next, using the CRITIC-TOPSIS method, synthetic measures were developed that enable the analysis of the spatial distribution of these phenomena, the examination of statistical correlations between them, and their relationship to other socio-economic and environmental variables, such as the level of urbanization, access to natural resources, and local policy. Attention was drawn to the importance of spatial analysis at the county level, which allows for the capture of regional patterns and differences in synergy between the green economy and entrepreneurship, as well as the identification of potential differentiating factors, such as local economic conditions or support for sustainable development. The empirical nature of the study is reflected in the use of real data and statistical methods for spatial analysis. The preliminary nature of the study emphasizes the limitation of the time frame and the testing of the applicability of the CRITIC-TOPSIS method in this type of analysis, which is a starting point for further research. The ultimate goal is to contribute to a better understanding of local interactions between the green economy and entrepreneurship, as well as their impact on Poland's spatial structure in the context of sustainable development. The study's results have the potential to inform public policy in the area of reducing regional disparities and promoting cohesive development, as well as identifying gaps in data and methodologies that can be considered in future, more advanced analyses (Figure 1).

Statistical data were collected based on Polish poviats. Their selection was related to the availability in Statistics Poland for the years 2010–2021. The study presents an analysis of data from 2010, 2013, 2014, and 2021, which were chosen due to their connection to key moments in the programming cycles of European Union funds in Poland and their impact on the investment aspects of green transformation. This enabled an assessment of the impact of EU policies on the development of entrepreneurship and the green economy in the context of the spatial differentiation of poviats in various phases of fund implementation (periods 2007–2013 and 2014–2020, and the beginning of 2021–2027). Furthermore, these years were chosen due to the availability of consistent and comparable statistical data at the poviat level published by the Central Statistical Office, which is essential for providing a solid empirical basis for the analysis. The study of these specific periods is of political and economic significance, allowing for an assessment of the effectiveness of past interventions, identification of trends and challenges, and formulation of recommendations for future regional development policies in the context of sustainable development and changing European Union priorities.

The analysis covers these years to capture the impact of financial interventions implemented under EU funds (2007–2013; 2014–2020; 2021–2027) and their impact on business development and the green economy. These years make it possible to identify long-term trends, structural changes, and adjustments in response to development policies and invest-

ments co-financed by EU funds. They also make it possible to assess the impact of economic, social, and environmental changes at the local level during the different programming phases of EU support. This provides an understanding of the relationship between regional policy, the availability of EU funds, and spatial variations in entrepreneurship and the green economy.

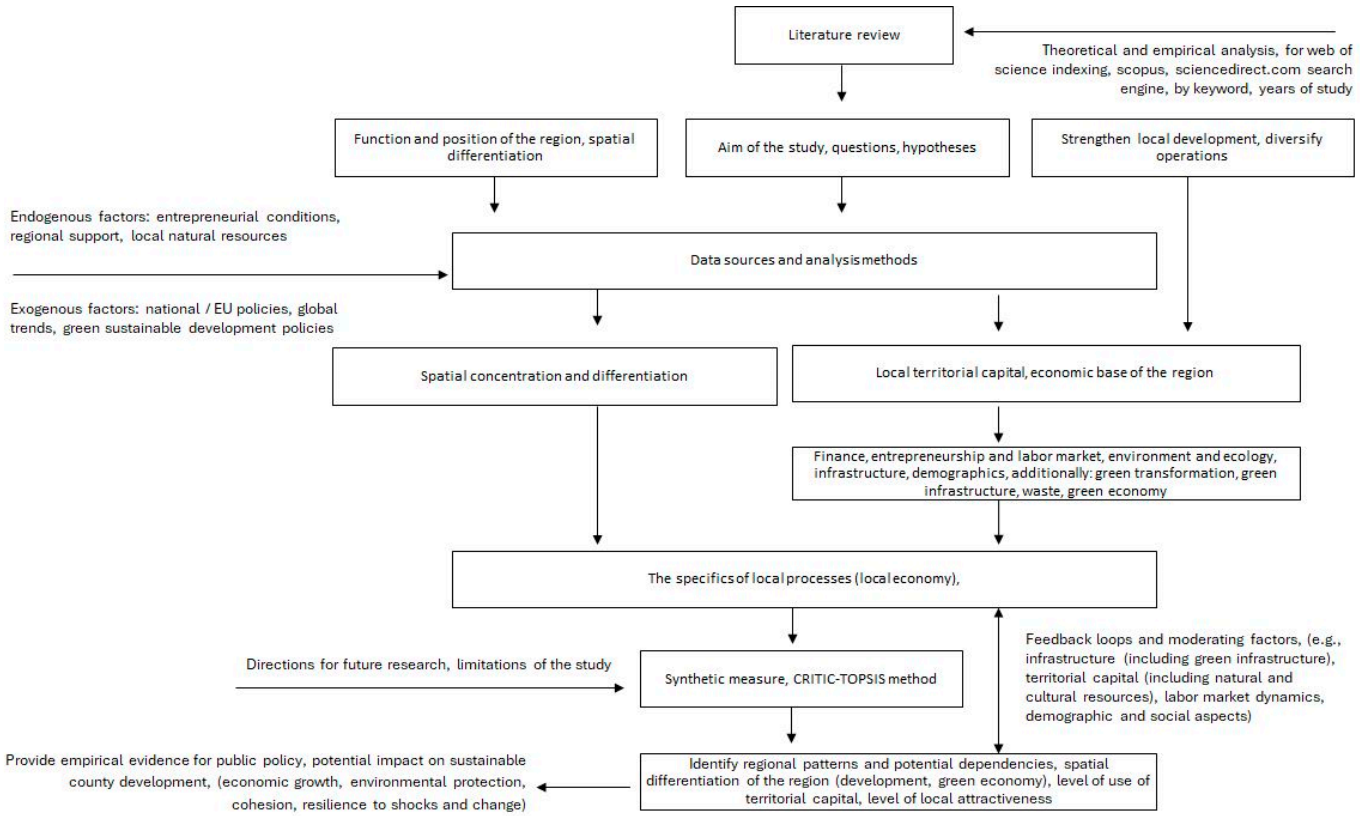

Figure 1. Research model.

The literature to be reviewed was identified through systematic searches in Scopus and Web of Science databases using key terms such as "green economy", "entrepreneurship", "sustainable development", "regional development", "spatial diversity", "circular economy", "ecological innovation", "environmental policy", and their combinations, limited to scientific publications (articles, monographs, reports, chapters) in English and Polish published between 2000 and 2023, which directly addressed the relationship between the green economy and entrepreneurship or their impact on regional sustainable development, containing empirical evidence or theoretical frameworks for analysis; non-academic publications older than 2000 and not thematically related were rejected. A synthetic measure (entrepreneurship, green economy) was used for the linear ordering of poviats described by many diagnostic variables (Table 1). The next steps of the synthetic measurement are as follows:

1. Indication of a set of diagnostic variables describing the phenomenon under study. They are recorded in the form of an observation matrix 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 j-th variable values for the i-th object,
i—object number (i = 1, 2, . . ., n),
j—variable number (j = 1, 2, . . ., m) [25].

Table 1. Diagnostic variables describing entrepreneurship and the green economy.

Diagnostic Variables	Unit	S/D
entrepreneurship		
Total industrial output sold (entities with number of employees > 9)	pln/per capita	S
Investment expenditures in enterprises	pln/per capita	S
Gross value of fixed assets in enterprises	pln/per capita	S
Entities registered in the register	units/per 1000 population	S
Entities newly registered in the REGON register	units/per 1000 population	S
Entities deleted from the REGON register	units/per 10,000 population	D
Individuals engaged in business activity	units/per 10,000 population	S
Business environment institutions	units/per 10,000 national economy entities	S
Share of newly registered creative sector entities in the total number of newly registered entities	%	S
Share of newly registered creative sector entities in the number of newly registered entities in total	%	S
Registered unemployed	persons/per 1000 population	S
Total employees	persons/per 1000 population	S
Total average gross monthly wages	pln	S
Green economy (in the poviat area)		
Expenditures of the district budget—Health protection	pln/per capita	S
Expenditures of the district budget—Municipal management and environmental protection	pln/per capita	S
Electricity consumption in rural areas	[kWh]/per capita	D
Electricity consumption in urban households	[kWh]/per capita	D
Distribution network per 100 km^2—water supply network	km/100 km^2	S
Distribution network per 100 km^2—sewerage network	km/100 km^2	S
Distribution network per 100 km^2—gas network	km/100 km^2	S
Sales of thermal energy per year by total location	GJ/per 1000 population	S
Share of legally protected areas in the total area	%	S
Number of natural monuments	szt/100 km^2	S
Total dust pollution emissions	[t/r]/km^2	D
Mixed waste collected during the year total	kg/per capita	D
Water consumption for national economy and population during the year total water consumption	m^3/per capita	D
Share of industry in total water consumption	%	D
Industrial and municipal wastewater treated as % of wastewater requiring treatment	%	D
Population using wastewater treatment plants as % of the total population	%	S
Woodland area (private and communal forests)	%	S

S/D; S—stimulant, D—destimulant; Source: own compilation based on data availability at Statistic Poland.

The green economy and entrepreneurship are closely linked, as innovative environmental solutions create new market opportunities while supporting sustainable economic development. Companies that invest in environmentally friendly technologies not only contribute to improving the quality of the environment but also gain market competitiveness. In the context of a green economy, entrepreneurship becomes a key driver of the transformation into a more sustainable economic model that takes into account both environmental and economic aspects. Implementing green innovation allows companies not

only to reduce operating costs but also to meet the growing demand for environmentally friendly products and services.

The diagnostic variables used in the study include a wide range of indicators that allow a comprehensive analysis of the development of entrepreneurship, the economy, and environmental protection in the studied region. These include both data on economic activity (e.g., investments in enterprises, value of fixed assets, number of registered entities) and indicators related to the creative sector and its impact on innovation and competitiveness. In addition, environmental and social aspects such as energy consumption, pollution emissions, and infrastructure related to water and wastewater management are taken into account, which allows us to assess the environmental impact of industrial activities. All these variables allow a holistic assessment of the conditions conducive to entrepreneurial development and indicate the potential for innovation, investment, and sustainability in a given area. Sustainability, which is a key element in the process of adaptation to the challenges of the modern world, is reflected in the integration of environmental, social, and economic aspects. Analysis of diagnostic variables allows for the identification of areas where the efficiency of resource management can be improved and engagement in pro-ecological and pro-social processes increased (Table 2).

Table 2. Descriptive statistics of synthetic measures of entrepreneurship and green economy.

	q Entrepreneurship				**q Green Economy**			
	2021	**2014**	**2013**	**2010**	**2021**	**2014**	**2013**	**2010**
Average	0.33	0.33	0.34	0.35	0.45	0.45	0.46	0.45
Minimum	0.24	0.23	0.24	0.24	0.34	0.33	0.34	0.35
Maximum	0.52	0.46	0.47	0.48	0.57	0.55	0.56	0.54
Range	0.28	0.24	0.23	0.24	0.22	0.22	0.23	0.19
Standard deviation	0.04	0.04	0.04	0.03	0.04	0.03	0.03	0.03
Coefficient of variation	12.17	10.69	11.27	9.74	7.74	7.71	7.12	6.99

Source: own compilation based on data availability at Statistic Poland.

To comprehensively analyze the interrelations between entrepreneurship and green economy at the county level in Poland, the study uses a set of quantitative variables that reflect the key dimensions of both phenomena. Selected entrepreneurship indicators, such as the value of industrial production sold, investment outlays, the number of new registrations and liquidations of entities, the involvement of individual entrepreneurs, and the presence of business support institutions, reflect the scale, dynamics, and structure of economic activity. At the same time, the variables characterizing the green economy encompass a broad spectrum of environmental aspects, including budget expenditures on environmental and health protection, energy and water consumption patterns, the scope of environmental infrastructure (water supply, sewage, gas networks), levels of dust pollution, municipal waste management, and the protection of natural resources through the participation of protected areas and the area of forests. The selection of variables presented in the study is justified by their ability to comprehensively reflect the key dimensions of both entrepreneurship and green economy at the poviat level, which enables empirical analysis of their mutual relations. Together, these diverse indicators enable the examination of how business activity affects the environment and green economy initiatives, as well as how environmental factors can influence local entrepreneurship, thereby providing valuable information for shaping policies that support sustainable development at the regional level. Such a selection of variables enables an empirical assessment of the mutual relations between these areas, revealing the potential impact of entrepreneurial activity on environmental factors and green economy initiatives, which in

turn shapes the spatial differentiation of poviats and provides significant information for sustainable development policies.

The study distinguished the following diagnostic variables presented in Table 2. Entrepreneurship-related variables analyze the level of economic activity, investment, and the labor market situation. They include data on the number of enterprises, new registrations, closures, employment, and average wages. The selection of variables in the area of entrepreneurship is based on their ability to synthesize the economic situation and the dynamics of entrepreneurial activity in different dimensions. The juxtaposition of these variables makes it possible to view entrepreneurship as a complex process conditioned by social, economic, and structural factors.

The green economy variables focus on energy consumption, waste management, the state of green infrastructure, and environmental protection at the county level, analyzing, among other things, electricity consumption, water, sewage and gas networks, pollution, and the protection of natural areas. The selected variables in the green economy area for the county allow a synthetic assessment of the state of the environment, natural resources, green infrastructure, and environmental protection activities that determine sustainable development and the quality of life of the inhabitants.

The analysis of variables (measures of central tendency, measures of variability, measures of correlation) allowed the elimination of quasi-constant variables. The variables selected for the next step are discriminatory and have little correlation with the others.

2. Then zeroed unitization was performed. It was made according to their types Xj ∈ S [26] according to the formula:

$$Z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \quad (2)$$

for the variable $X_j \in D$, the zeroing unitization is performed by the formula:

$$Z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \quad (3)$$

where:

$Z_{ij} \in [0;1]$,

S—stimulant,

D—destimulant,

$\max_{xij}$—maximum value of j-th variable (i = 1, 2, . . ., n (number of variables of analysis); j = 1, 2, . . ., m (number of variable values)),

$\min_{xij}$—minimum value of j-th variable,

x_{ij}—value of j-th variable for this object [27].

As a result of zeroing unitization, we obtain a matrix of Z_{ij} values:

$$Z_{ij} = \begin{bmatrix} z_{11} & z_{12} & \dots & z_{1m} \\ z_{21} & z_{22} & \dots & z_{2m} \\ \dots & \dots & \dots & \dots \\ z_{n1} & z_{n2} & \dots & z_{nm} \end{bmatrix}, \quad (4)$$

where: Z_{ij} is the unitaryized value of the jth variable for the ith object.

3. Weights for selected variables were then determined using the TOPSIS-CRITIC method. CRITIC (*Criteria Importance Through Intercriteria Correlation*) weights are determined based on standard deviations and correlations between variables [28]. The CRITIC-TOPSIS methodology was used to evaluate and rank poviats in terms of

green economy and entrepreneurship characteristics. The choice of this multi-criteria analysis is motivated by its ability to objectively determine the weights of individual indicators. The CRITIC method allows for the determination of criteria weights based on their variability and mutual correlations, which ensures a more empirically justified significance of individual indicators. TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) is a method that enables systematic and logical ranking of alternatives (in this case, poviats) by analyzing their distance from hypothetical positive and negative ideal solutions. It directly generates a ranking of the units being tested based on defined criteria and the designated ideal solutions. Integrating the CRITIC and TOPSIS methods allows for consideration of both the complexity of the relationships between criteria and the effective ranking of poviats in terms of their relative level of development of green economy and entrepreneurship. Variable weights are determined using the following formulae:

$$w_j = \frac{C_j}{\sum_{k=1}^{K} C_k},\ j = 1,\ 2,\ \ldots,\ K, \tag{5}$$

$$C_j = S_{j(Z)} \sum_{k=1} \left(1 - r_{jk}\right),\ j = 1,\ 2,\ \ldots K, \tag{6}$$

where:

C_j is the measure of the information capacity of the variable,

$S_{j(Z)}$ is the standard deviation calculated from the normalized values of the variable,

r_{jk} is the correlation coefficient between the characteristic and the characteristic.

The sum of the coefficients is 1. The normalized values of the diagnostic variables are multiplied by the weighting factor $\mathrm{w}j\left(\mathrm{Z}^{*}{}_{\mathrm{ij}} = Z_{ij} * w_j\right)$ [29].

4. In the next step, the synthetic measure is determined based on the formula:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+},\ gdzie\ 0 \le q_i \le 1,\ i = 1,\ 2, \ldots,\ n, \tag{7}$$

where:

$q_i \in [0; 1]$,

d_i^-—denotes the distance of the object from the antipode (from 0),

d_i^+ denotes the distance of the object from the pattern (from 1) [30].

Synthetic measurement made it possible to evaluate the phenomenon in the studied objects, both spatially and temporally, and to arrange them linearly. It provides a basis for comparing objects under analysis and allows to indicate weaker and better areas of activity of the individual. It can be a useful tool for assessing the appropriateness of past decisions [31]. The advantage of CRITIC-TOPSIS is to determine weights based on standard deviations and correlations between variables. It assigns higher weights to features with a high coefficient of volatility but a low correlation with other features.

5. The last stage of the study grouped poviats in terms of the synthetic measure of entrepreneurship and green economy. Then four groups of poviats were determined using the median $\bar{x}$ of the standard deviation $\left(S_q\right)$. Grouping was made according to the formula:

$$\begin{array}{ll} \text{Group 1} & \overline{x} + 2 * S_q \leq q_i \\ \text{Group 2} & \overline{x} + S_q \leq q_i < \overline{x} + 2 * S_q \\ \text{Group 3} & \overline{x} \leq q_i < \overline{x} + S_q \\ \text{Group 4} & \overline{x} - S_q \leq q_i < \overline{x} \\ \text{Group 5} & \overline{x} - 2 * S_q \leq q_i < \overline{x} - S_q \\ \text{Group 6} & q_i < \overline{x} - 2 * S_q \end{array} \quad (8)$$

To assess the diversity (distribution inequalities) of the studied population, the Gini coefficient was calculated (the concentration coefficient was calculated in the Statistica program, version 13.3). The Gini coefficient is expressed by the formula:

$$G(y) = \frac{\sum_{i=1}^{n}(2i - n - 1)y_i}{n^2\overline{y}}, \quad (9)$$

where:

y_i is the i-value of that observation,

$\overline{y}$ is the average value of all observations y_i [32].

Maps of spatial diversity of the studied poviats, scatter graphs, and bar graphs, as well as descriptive statistics and correlation analysis, were performed in Statistica.

4. Results

Key factors of the transformation into a green economy include the value of natural capital, legal regulations, economic and environmental costs, and changes in production and consumption patterns. The green economy aims to create incentives for business activities that ensure environmental sustainability and social inclusion [33]. The factors that can influence the development of the green economy and entrepreneurship are regional differences. The number of those that significantly shape the development of the green economy and entrepreneurship is limited and variable depending on the stage of development of the region. There is a lack of one ideal model in the areas indicated to strengthen the competitiveness of the region [25]. The company, as an element of the economic space, influences the process of transformation into a green economy. It has an impact on regional development, resource efficiency, and innovative actions [34].

Statistical characteristics of synthetic measures of entrepreneurship and the green economy of poviats indicate changes in differentiation (Table 2). Synthetic measures of entrepreneurship ranged from 0.24 to 0.48 in 2010 and 0.24 to 0.52 in 2021, green economy measures 0.35–0.54 and 0.34–0.57, respectively. Measures of the central trend take lower values from year to year for both entrepreneurship and green economy measures. In the case of volatility measures, we observe an increase in the value, which indicates an increase in the diversity of poviats. Average measures of entrepreneurship and the green economy show stability, suggesting that most districts have achieved some degree of adaptation to economic change. The variation is influenced by local conditions, access to resources, infrastructure, regional policies, or the level of innovation. These determine the ability of districts to adapt to the green economy. The analysis shows that although the average level of both measures shows stability, increasing spatial differentiation may pose a challenge to regional cohesion and sustainability.

The stability of average entrepreneurial and green economy measures at the poviat level, combined with increasing internal diversity, suggests complex dynamics of regional transformation processes. This stability may mask significant changes occurring in individual territorial units, where some poviats experience intensive development in both analyzed spheres, others stagnation, and yet others exhibit dysfunctional relationships between them. These discrepancies may be due to the heterogeneity of endogenous factors,

different historical development paths, diverse absorption of regional and national policies, as well as the specificity of local markets and economic structures. So, further research efforts should focus on breaking down this stability by using advanced methods of panel data analysis and spatial-temporal modeling, which will allow for identifying the development trajectories of individual poviats and the key determinants of success or failure in integrating entrepreneurship with the requirements of a green economy. A deeper understanding of the mechanisms that cause these differences is necessary to formulate effective and personalized policy recommendations that take into account the specifics of local conditions and address specific barriers to sustainable development at the regional level.

Measuring the performance of the green economy and entrepreneurship at the regional level has additional limitations compared to indicators at the national and international levels [35]. Proponents of endogenous development recognize that entrepreneurship allows for sustainable, independent, and long-term development. The structural characteristics of regions and the factors within them cause regions to differ in the scale of entrepreneurial activity and the transition toward a green economy.

Figure 2 shows the spatial diversity of poviats according to the synthetic measure of entrepreneurship and green economy (dark color means units with higher measurement value, lighter color—lower measurement value). The best districts were characterized by: high financial potential, higher level of financial independence, better level of entrepreneurship, and good potential of a green economy. The analysis shows that there are clear differences between poviats, suggesting that the level of economic development and adaptation to green business practices is unevenly distributed across the region.

The best districts are areas shaped by the rent of location, local development centers (Rzeszów, Kielce, Lublin, Białystok, Olsztyn), and the developing labor market and growth in the SME sector. They are also characterized, among other things, by the drainage of social potential (sucking potential from the periphery to the central center), which manifests itself in the balance of migration.

Entrepreneurial activity varies regionally, as a result of the structural features of the regions (location rents) and endogenous factors in their area. The factors that create a kind of field of forces that generate or block entrepreneurship in the region are the demography of the region, the regional labor market, the quality of human capital, housing resources and their standard, and infrastructure equipment.

Figure 3 allows us to indicate groups of objects with similar values of the synthetic measure. It provides information about the relationships between pairs of variables and shows unusual observations. The correlation coefficient for the relationship between the measure of entrepreneurship and the green economy is -0.004 in 2010 and 0.008 in 2021 (weak relationship). The bag chart illustrates the two-dimensional distribution of variables, showing statistically similar groups of poviats, including outliers, whose graphical shape in subsequent years may indicate that they differ slightly. These observations may suggest that countries differ in their level of entrepreneurship and implementation of the green economy, but their characteristics have remained relatively stable over the years. The shape of the groups in successive years shows little change in the distribution. This suggests stability in the development of these areas, despite global trends related to the green transition and changes in the economy. The analysis points to the need to further investigate the reasons for the weak relationship between entrepreneurship and the green economy, and the importance of identifying factors that influence the specificity of county groups and outliers in the green transition process.

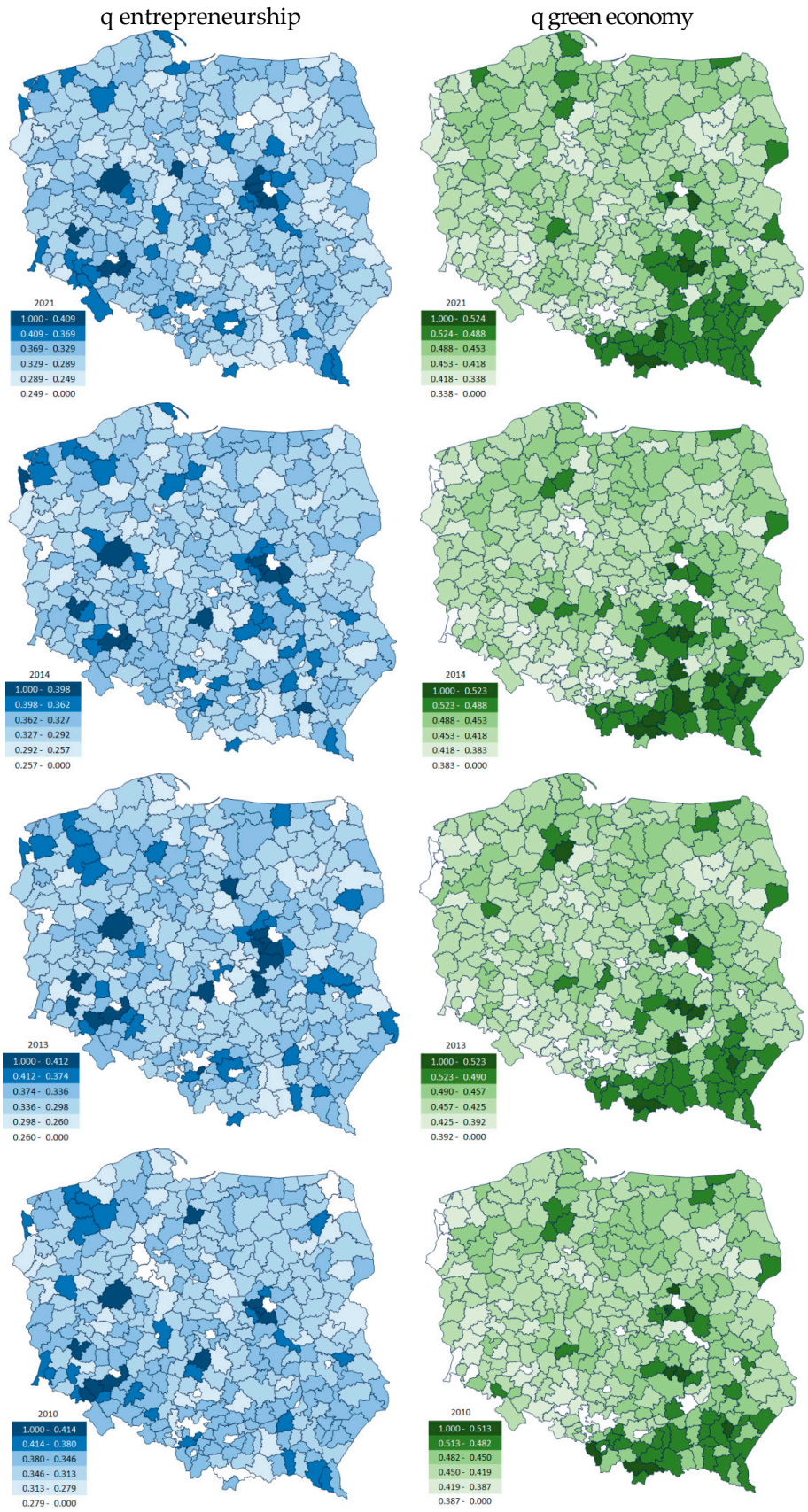

Figure 2. Spatial distribution by the synthetic measure of entrepreneurship and green economy in poviats in Poland (in 2010, 2013, 2014, 2021). Source: own compilation based on data availability at Statistic Poland.

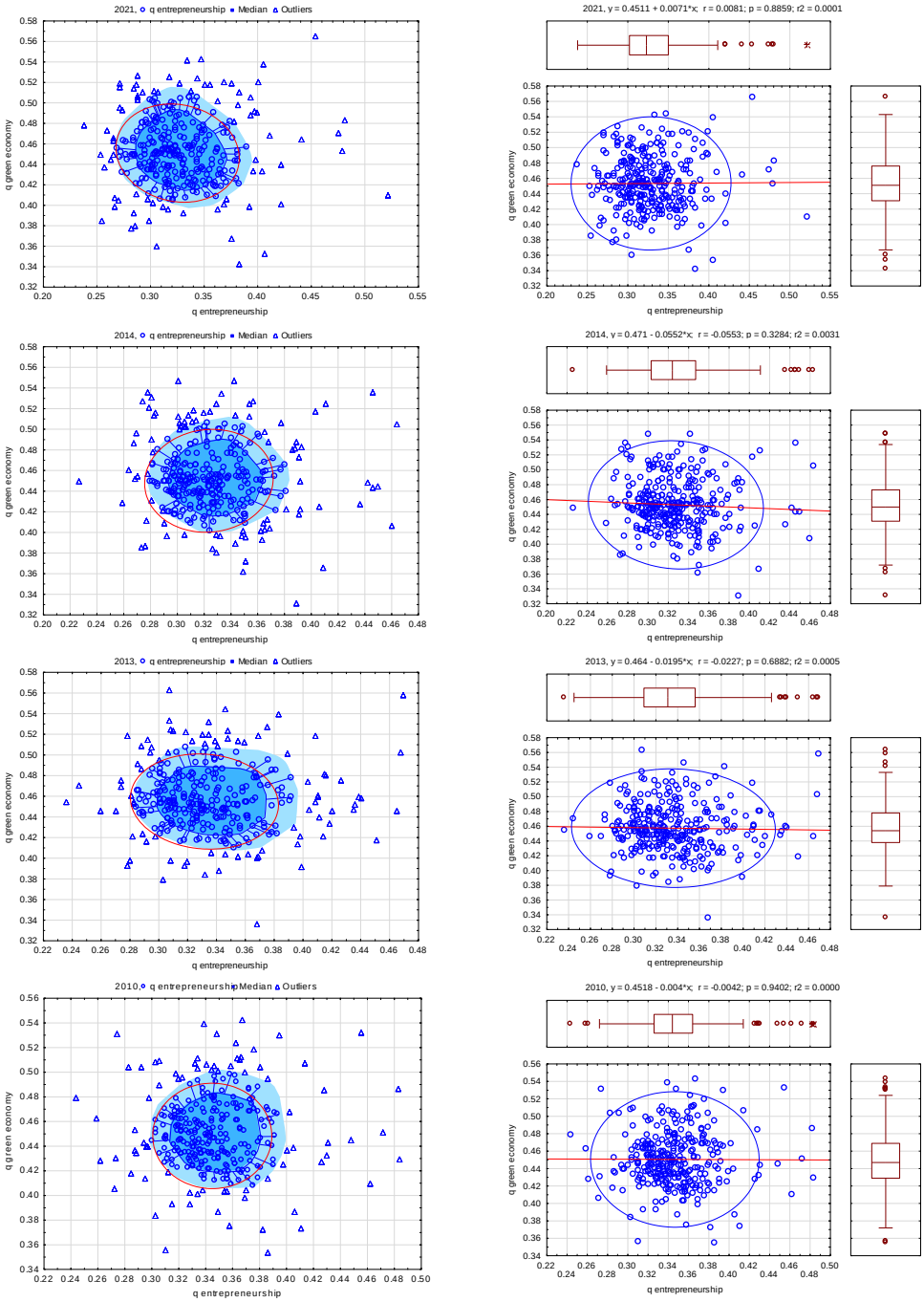

Figure 3. Bag chart, moustache frame, and dispersion for measures of synthetic entrepreneurship and green economy in poviats in Poland. Source: own compilation based on data availability at Statistic Poland.

Districts are characterized by spatial diversity in terms of entrepreneurship and green economy (Figure 4). The differentiation results from factors of a natural and historical nature, as well as natural processes of socio-economic development, and the influence of large and medium-sized cities on the region. The reduction of these inequalities is a matter of regional policy action and institutional support to take account of these determinants.

Reducing the growing spatial inequalities, signalled by the increase in Gini coefficients, requires targeted regional policy actions and institutional support mechanisms that take into account the identified diversities resulting from natural, historical, and socio-economic factors. Implementing programs that support regions with lower levels of entrepreneurship and green economy through dedicated infrastructure investments (e.g., water and sewage,

gas networks), technology and innovation transfer, and facilitating access to financing for SMEs involved in green transformation will be key. Furthermore, national policies should be more flexible and take into account the specifics of local conditions, such as access to resources, quality of human capital, or level of innovation, to effectively support adaptation to green business practices and promote sustainable development in all poviats, thereby reducing existing disparities.

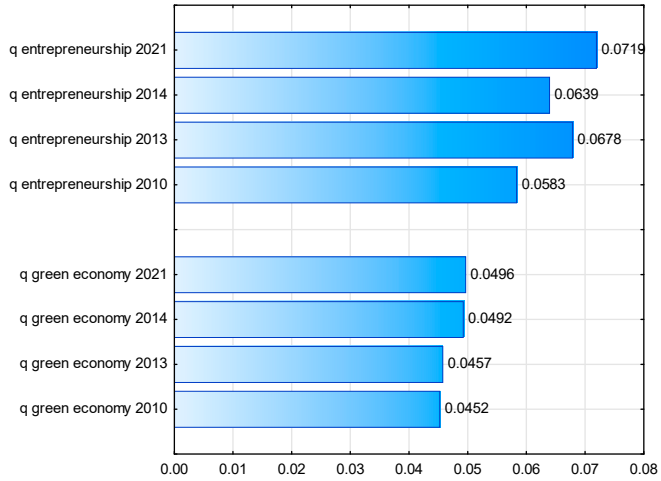

Figure 4. Gini coefficients of the synthetic measure of entrepreneurship and green economy in poviats in Poland (in 2010, 2013, 2014, 2021). Source: own compilation based on data availability at Statistic Poland.

Entrepreneurship must take into account economic prosperity as well as environmental integrity and sustainability. Resource planning and management are key to maximizing both social, environmental, and economic benefits [36]. Synthetic measure correlated (according to Pearson's correlation coefficient) was positive with, among others: the share of newly registered entities in the creative sector (0.55; 0.52 for Spearman's rank coefficient), entities entered into the register (0.52; 0.39), gross fixed assets in enterprises (0.51; 0.40), natural persons conducting business activity (0.46), outlays on investments in enterprises (0.45), average monthly gross remuneration (0.44; 0.41 minus z: share of legally protected areas in total area (−0.08), area of forest land (−0.14; −0.17). In the case of the Spearman rank coefficient, the synthetic measure of entrepreneurship is also negatively correlated with industrial and municipal wastewater (−0.06) and the share of legally protected areas (−0.11). The analysis shows the complex interplay between social, economic, and environmental factors that determine the level of entrepreneurship. This points to the need to balance entrepreneurship development activities with environmental protection and to promote investment and innovation as key drivers of neighborhood development.

Synthetic measure of the green economy was correlated with, among others, the share of legally protected areas in the total area (0.56; 0.52–and Spearman's rank correlation), the sewage network per 100 km^2 (0.38; 0.33) and gas (0.36), the area of forest land (0.36; 0.39), negatively with: water consumption for the national economy and population during the year (−0.23; −0.33), mixed waste (−0.33; −0.34), electricity consumption per inhabitant in the countryside (−0.39; −0,44), and the share of industry in water consumption (−0.42; −0.34). The conclusions suggest the need to further promote infrastructure solutions and reduce environmental pressures through more efficient management of resources and waste to enable a sustainable green economy.

The analysis points to a complex interaction between entrepreneurship, green economy, and sustainable development in a regional context. The results of the study suggest that

despite some stability in the development of entrepreneurship and the green economy, there is significant spatial diversification, which is caused by both local conditions and access to resources. Entrepreneurship, as a driver of economic development, should be coordinated with green economy initiatives, which, when combined, can contribute to improving the quality of life of residents and efficient management of natural resources. However, further study of the factors influencing this relationship is needed to support regions in their pursuit of more sustainable development, reducing inequalities between them, and promoting innovative circular economy solutions.

From a theoretical perspective, the results of the study suggest the need for further research into the relationships between entrepreneurship development, the green economy, and regional disparities. It is important to explore the mechanisms influencing the weak links between entrepreneurship development and the implementation of the green economy in individual poviats. Future research could focus on the role of regional policies in shaping sustainable development, paying attention to local factors such as demography, human capital quality, or access to innovative technologies. There is also a need to deepen the analysis of how individual sectors of the economy can better cooperate in the transformation process, integrating economic and environmental objectives.

Based on the study's findings, a key action should be to support regions that show less progress in entrepreneurship and the green economy, through dedicated infrastructure and innovation support programmes. Focus should be placed on improving access to resources, including finance for small and medium-sized enterprises (SMEs), which can play an important role in the green transformation process. It is also worth investing in green economy-related education and training to boost the skills of local entrepreneurs and workers. In addition, local governments should promote investments in green technologies and sustainable infrastructure, such as water, sewerage, and gas networks, which will help further develop the green economy in the region. Reducing disparities between regions is also an important step, in particular by supporting those areas that have more difficulty adapting to green business practices.

5. Discussion

As Zhu, Jiang, and Zhao point out, in the context of global climate change, promoting a low-carbon, green circular economy is imperative for harmonizing economic growth with environmental protection imperatives. A fundamental aspect of this undertaking is to increase the efficiency of the green economy, which is a prerequisite for sustainable economic development. The dominant reliance of global economic activity on extensive use of fossil fuels has contributed to significant environmental degradation, intensifying the emission of pollutants and carbon dioxide, the main anthropogenic factor of global warming. An analysis of the key determinants of the efficiency of the green economy reveals the significant role of energy intensity, economic development, urbanization, industrialization, transportation infrastructure, and government intervention, with the impact of these factors showing clear regional variations. Research results indicate that optimizing economic growth, reducing energy intensity, and supporting sustainable urbanization and industrialization are essential strategies for strengthening the effectiveness of the green economy [37].

An analysis of the diagnostic variables presented in Table 1 reveals the multidimensional and dynamic complexity of the economic structure, characterized by interdependencies between the level of entrepreneurship, as well as aspects related to environmental protection and sustainable development (green transformation, green economy). Interpretation of these indicators, taking into account their stimulant and de-stimulant nature, enables a holistic understanding of the mechanisms of the economy's functioning and

identification of key areas requiring strategic intervention to optimize its efficiency and sustainability. Ni, Liu, and Zhang argue that the growth of economic complexity stimulates green development in urban economies, generating lasting effects. Moreover, they identify a growing marginal impact of economic complexity on urban greening, implying that environmental benefits increase with urban complexity. An analysis of the mechanisms indicates that economic complexity contributes to the optimization of the industrial structure by displacing high-emission and resource-intensive sectors and strengthening the urban innovation ecosystem, among other things, by raising the level of innovation, entrepreneurship, technological progress, research and development cooperation, and knowledge transfer. The authors also emphasize that the impact of economic complexity on green urban development is moderated by external factors, such as energy efficiency, environmental regulations, and public oversight. Additionally, the heterogeneity analysis reveals that this effect varies depending on the level of human capital, administrative hierarchy, geographical location, and industrial structure. This study provides important conclusions concerning the optimization of the development trajectory of cities and the promotion of green transformation in urban areas [27].

Mondal, Singh, and Gupta emphasize that the dual benefits—social and economic—make green entrepreneurship a valuable tool for governments to achieve sustainable development goals. To fully utilize this potential, future policy interventions should support entrepreneurs initiating and running green ventures. Policymakers should not only promote new green initiatives, but also stimulate the identification and creation of new green business opportunities and encourage their commercialization by (a) stimulating applied research in the field of innovative products and services that address environmental and climate challenges, (b) subsidizing and promoting projects in the green and clean technology sectors, and (c) supporting entrepreneurship in these sectors as a mechanism for transforming green innovations into business projects. From a management perspective, new ventures should take into account both the environmental impact of their products and services, as well as the impact of the resources used in their operations. Efficient resource-based and climate-neutral production processes are crucial to prevent the negative impact of new economic activities on the environment and to offset the intended ecological benefits. Only minimizing environmental degradation in both the input and output phases makes green entrepreneurship contribute to truly sustainable development in all its dimensions [38].

As Chen et al. note, there is an imperative to find an optimal balance between ecological equivalence and economic development. Green entrepreneurship is a promising approach, generating synergy between economic prosperity and environmental protection. Changes in financial development and the mineral resources sector have an impact on the dynamics of green entrepreneurship. Understanding the positive correlation between financial development, the trade of mineral resources, and the development of green entrepreneurship can support decision-makers in formulating effective strategies promoting sustainable growth. The success of sustainable and green business projects depends on access to adequate financing and investment channels. Traditionally, mineral resources have been the foundation of economic growth and modernization, providing raw materials for energy, industry, and technological innovation. Nevertheless, their exploitation, processing, and use often involve significant negative environmental consequences, including greenhouse gas emissions, deforestation, and water pollution. Green entrepreneurship appears as a method of redefining the corporate landscape through the implementation of innovation and sustainable practices, in response to the urgent need to harmonize environmental protection with economic goals [39].

As Dmuchowski, Dmuchowski, Baczewska-Dąbrowska, and Gworek point out, the analysis revealed a growing demand from local government units for green and/or sustainable investments. At the same time, many significant barriers were identified that limit access to innovative forms of financing sustainable development at the local level, including insufficient involvement of private capital, regulatory and fiscal barriers, and limited opportunities to hedge currency risk. As a result, the authors emphasized the need to implement new support mechanisms, such as guarantees or innovative financial instruments, potentially supported by new institutions or dedicated facilities. In the context of Poland, which is facing a significant transformation challenge, the availability of adequate financial resources may be one of the main determinants of the effectiveness of climate change mitigation and adaptation efforts at the local level, and the current economic crisis may further exacerbate this deficit, despite the expected increase in public funding, particularly European Union funds under the "New Green Deal" initiative [40]. Ruiz, Martin-Moreno, and Perez point out that the European Green Deal is a comprehensive political strategy that includes eight key areas of intervention: biodiversity, sustainable food production, sustainable agriculture, clean energy, sustainable industry, construction and renovation, sustainable mobility, pollution elimination, and climate action (World Economic Forum). The long-term climate goal of this initiative is to achieve climate neutrality, defined as net-zero greenhouse gas emissions, by 2050. However, the authors emphasize that setting fair and effective climate goals for a group of countries with a high level of heterogeneity, such as European countries, poses significant challenges [41].

Starczewski et al. emphasize that industrialization has caused permanent environmental damage and that repairing it is a long-term process. In response to environmental degradation and urbanization, urban resilience is key, which is the ability of a city to respond to threats and adapt to sustainable development, characterized by stability and return to balance. The authors' research indicates that post-industrial cities often do not build resilience through green spaces, and the greatest loss of green spaces is in intensely developed areas, where agricultural land is converted into green spaces, but at the same time, green spaces give way to industry and urban development [42].

As Szymańska, Lewandowska, and Rogatka indicate, in the analyzed period (2004–2012), Poland observed an increasing dynamic change in the area of green, forested, and non-forested areas, respectively, by 13.2% and 2.3%. The authors emphasize that green areas, both in urban and rural areas, have multiple important functions, including ecological aspects (improving air quality, mitigating climate conditions, reducing urban heat island), technical and engineering (drainage, noise reduction, slope reinforcement), economic (harvesting forest products, timber harvesting), socio-cultural (recreation, education), and health, influencing physical and mental well-being. As a result, green spaces have a positive impact on the quality of life, understood as a broad concept of well-being. The problem of green spaces can be analyzed from the perspective of their functions and ecosystem services, including their role in maintaining biodiversity and promoting sustainable urban development. W niniejszym opracowaniu, autorzy przyjęli szeroką definicję „terenów zielonych", odnosząc się do obszarów pokrytych roślinnością na terenach wiejskich i miejskich, dzieląc je na parki rekreacyjne, zieleńce oraz zieleń uliczną i osiedlową [43].

Standar, Kozera, and Satoła indicate that high investment activity by local authorities, in the first financial perspective analyzed, resulted in even greater activity in the next one, with investment concentration in the years 2014–2020 being less homogeneous in individual macro-regions. The development ofalow-emission economy in these regions is conditioned by various socio-economic, environmental, and financial factors that have specific characteristics for each macro-region, influencing their low-emission development strategies. The authors' research results imply the need to adjust regional policy and

management of EU funds by developing support for less active municipalities, increasing training for local government officials, and promoting good practices at the local and regional levels [44].

To improve waste management, in the context of the natural environment (green economy) and entrepreneurship in Poland, as Grodzińska-Jurczak suggests, it is necessary to adapt national regulations to European Union standards, initiate projects that utilize alternative waste disposal methods, including advanced recycling technologies, increase financial outlays for waste management, motivate local authorities to implement sustainable waste management principles, and promote rational practices in this area among the public [45].

Brodny and Tutak indicate that Poland is characterized by significant regional variation in time and space. During the period in question, the Mazovian, Lower Silesian, and Pomeranian voivodeships stood out for their high level of development, while the Świętokrzyskie voivodeship was characterized by a low level. The results of the analysis confirm the correlation between high innovation, industrialization, stable infrastructure, economic development, and living standards. The authors conclude that these results identify regions that require strategic decisions regarding their future specialization and role in the national and European economy [46].

Implementing virtual reality (VR) technology in the tourism sector: revenue and prospects after the pandemic. The results suggest that VR adoption is related to perceived usefulness, experience with the technology, and attitude. COVID-19 also had a significant impact on the adoption of new technologies, opening the door to the introduction of VR in this sector. However, we realize that a lack of knowledge on issues such as the competitive position, return on investment in technological equipment, and support for the introduction of VR into business models prevents managers from adopting VR equipment. This study shows that VR can become part of the business strategies of travel companies. This is where business organizations can see VR as an effective way to meet customer needs and increase organizational efficiency [47].

6. Conclusions

The poviats in Poland have diverse environmental, social, and economic conditions that determine their development potential. An analysis of the years 2010–2021 reveals the stability of average entrepreneurship and green economy indicators, while their spatial diversity is increasing. This suggests that despite general economic adaptation, the ability to develop entrepreneurship in the context of a green economy is highly regionally differentiated, depending on local factors. Moreover, the weak correlation between these indicators points to the lack of synergy at the regional level. This heterogeneity and limited connectivity pose a challenge to cohesion and sustainable development, requiring specific policy interventions tailored to individual poviats.

Adequate potential for entrepreneurship and the green economy of countries affects the standard of living, social situation, and public security, which determines their development directions. The main problem with them is the scarcity of endogenous factors that are barriers to change and the process of their leaching out of their economy. The analysis shows that although the average measures of entrepreneurship and the green economy are stable, the increase in regional disparities poses a challenge to the country's socio-economic cohesion and sustainable development. The minimal relationship between entrepreneurship and the green economy indicates the need for further efforts to integrate the two. The level of entrepreneurship and the degree of involvement in the green economy at the county level are almost independent of each other, suggesting the need to better understand the factors that inhibit their interdependence. The differences between poviats are the result of

many local factors, such as access to natural resources, the state of infrastructure, the level of innovation, and the impact of regional policies.

An exploratory study of the district's economy should provide information for evaluating and correcting policies, internal disparities occurring in the unit, or variations between units.

This study makes a significant theoretical contribution by integrating the interrelations between entrepreneurship development and green economy in the context of spatial disparities at the county level in Poland, filling a research gap concerning a comprehensive analysis of their impact on sustainable development and spatial diversity, including the quality of life of residents. It incorporates the concept of green economy into regional analysis, confirming the complex interaction between these spheres and sustainable development, while pointing to the need for further research on the mechanisms that determine the weak links between entrepreneurship development and the implementation of green economy at the local level.

From a practical perspective, this study identifies the impact of the analyzed phenomena on regional inequalities, suggesting the need to support regions with lower levels of entrepreneurship and green economy development through dedicated infrastructure and innovation programs, and recommends coordinating entrepreneurship development with green economy initiatives, promoting investment and innovation, and further supporting infrastructure and effective resource management to achieve sustainable development.

The implications of the study reveal that spatial differentiation in the level of entrepreneurship and the development of the green economy at the district level has a significant impact on the socio-economic cohesion of regions, where greater disparities can impede integration and sustainable development. Furthermore, the observed diversity directly affects the quality of life of the inhabitants and the way natural resources are used, suggesting that a greater concentration of efforts in both areas may lead to more effective management. A key finding is also the identified minimal relationship between entrepreneurship and the green economy, which implies an urgent need to intensify efforts to integrate them. Finally, this study emphasizes that the differences identified between poviats are strongly influenced by local factors, such as the availability of natural resources, the state of infrastructure, the level of innovation, and the impact of regional policies, which indicates the need to take into account local specifics when designing interventions aimed at supporting sustainable development.

Future research should expand the analysis by including more variables, a dynamic perspective over a longer period, and the impact of outliers. Understanding the causes of observed spatial variability and local factors in the context of integrating green transformation with the economy is key. The focus should be on evaluating regional policies and the effectiveness of interventions, deepening the analysis of the relationship between entrepreneurship and the green economy at the district level. It is important to systematically examine the impact of outlying poviats and identify local endogenous factors that determine the integration of green transformation with economic activity. Further research should assess the effectiveness of regional policies and mechanisms of weak links between entrepreneurship and the green economy, as well as the role of regional policies in sustainable development and the potential for inter-sectoral cooperation.

The study is limited by the scope of publicly available diagnostic variables that can be found in public statistics, which is a certain hindrance because some data are unavailable or incomplete for all years covered by the study. Additionally, the difficulty in analysis stems from the lack of a clear definition of the green economy. The multidimensional nature of entrepreneurship, encompassing economic, social, and environmental aspects, also makes it difficult to conduct research and draw clear conclusions. Furthermore, it is

problematic to identify precise diagnostic variables that could clearly define sustainable entrepreneurship and its relationship to the development of a green economy, which poses a challenge in the analysis of spatial differences and sustainable regional development in terms of their local territorial capital. From a methodological perspective, the use of linear data analysis may not fully capture the nonlinear and complex interactions between the phenomena being studied, and the choice of the CRITIC-TOPSIS method, although justified, represents a specific approach to multi-criteria synthesis, the results of which may be sensitive to the data structure and method characteristics. Finally, the possibility of expanding the number of variables indirectly suggested in the conclusion indicates that the current analysis may not have exhausted all the important aspects of the phenomenon being studied, which is a potential limitation of the comprehensiveness of the conclusions.Results of studies focused on the assessment of the relationship between entrepreneurship and green economy (analysis often performed separately) of poviats in Poland in the years 2010–2021.

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