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Assessing Economic Profiles of Coastal Regions in the Blue Economy: A Radar Chart Approach

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Abstract: This study investigates the features of regional development within the Blue Economy system, focusing on sustainable growth and resilience in coastal regions. The Blue Economy emphasizes the sustainable and equitable use of marine resources, requiring a development model that integrates economic, ecological, and social dimensions. This research explores how regional development under the Blue Economy can be understood, assessed, and supported through analytical tools. Using a multi-step tool that combines interquartile range (IQR) analysis, clustering methods, and z-score normalization, representative coastal economies are identified to provide insights into the stability, specialization, and economic efficiency of the Blue Economy. Additionally, a radar chart tool is introduced to assess and visualize the region's profiles, offering an accessible means for planning by highlighting economic strengths, vulnerabilities, and sectoral dependencies. The findings emphasize the need for a balanced development approach tailored to each region's socio-economic and ecological context to foster resilience and sustainability. Further enhancements to these tools are proposed, including incorporating additional socio-economic and ecological indicators, to broaden their applicability for comprehensive assessments of the development of the regions in the Blue Economy system. This research thus provides valuable tools for stakeholders to monitor and strengthen the economic health of coastal regions, supporting sustainable regional development within the Blue Economy.

Keywords: Blue Economy; Economic development; Regional development; Coastal regions; Regions' resilience

1. Introduction

"No water, no life. No blue, no green," as noted by American marine biologist Sylvia Earle, underscores the fundamental connection between marine ecosystems and life on earth. This statement highlights the critical importance of healthy marine environments not only for maintaining biodiversity but also for supporting sustainable human development. This interdependence forms the conceptual foundation of the Blue Economy, which advocates for the responsible and sustainable use of marine resources to promote economic growth, enhance social well-being, and safeguard ecological integrity. Unlike models driven by environmental degradation or unsustainable exploitation, the Blue Economy emphasizes a balance between economic objectives and long-term environmental stewardship. Given that oceans cover approximately 70 percent of the Earth's surface, they serve not only as the planet's largest habitat but also as a central pillar of the Blue Economy, enabling sustainable development across sectors such as fisheries, tourism, renewable energy, and marine biotechnology (United Nations, 2022).

The concept of the Blue Economy marks a shift from traditional linear exploitation of natural resources, which often leads to their depletion (Djoric, 2022). It involves decoupling socio-economic development from environmental degradation while enhancing human well-being (Spalding, 2016). Elegbede et al. (2023) identify the primary objectives of the Blue Economy as fostering economic and social development while ensuring the sustainability of marine and coastal ecosystems. In parallel to the Green Economy, which focuses on terrestrial sustainability, the Blue Economy extends sustainable development principles to marine environments (Figueiredo & Cristina Mihaela, 2022; Sikhunyana & Mishi, 2023; Zukauskiene & Snieska, 2023).

In this context, the Blue Economy is increasingly viewed as a strategic tool for advancing the UN Sustainable Development Goals (SDGs). While SDG 14 (Life Below Water) is most directly associated with marine sustainability, Blue Economy activities also contribute to achieving goals related to poverty reduction (SDG 1), inclusive economic growth (SDG 8), climate action (SDG 13), and sustainable consumption (SDG 12). This integration reinforces the multidimensional importance of the Blue Economy in global sustainability agendas.

To better conceptualize these linkages, the study draws on SDG clustering models that emphasize interdependencies between ecological, social, and economic systems. Niestroy (2016) and Van Soest et al. (2019) propose various groupings of the 17 SDGs to reflect their systemic interactions, referring to SDGs 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land) as the "Nexus Group" of goals. These goals form the biosphere foundation in their "wedding cake" model of sustainable development (Uitto, 2019), underscoring that environmental health is essential to sustaining both social well-being and economic progress.

Positioning the Blue Economy within this framework highlights its potential to strengthen resilience in coastal regions, where climate change, biodiversity loss, and environmental degradation increasingly threaten development. Activities aligned with the Nexus Group—such as marine conservation, carbon sequestration, and ecosystem restoration—are therefore not only ecological imperatives, but also economic necessities.

In academic literature, the terms Blue Economy, Ocean Economy, and Maritime Economy are often used interchangeably, yet they reflect different priorities and conceptual foundations. The Ocean Economy generally refers to economic activities directly or indirectly linked to oceans, such as fisheries, tourism, and offshore energy, often with a focus on growth and industrial output. The Maritime Economy is more narrowly defined, typically encompassing traditional maritime sectors such as shipping, ports, and naval industries. In contrast, the Blue Economy places sustainability at its core, promoting the responsible and equitable use of ocean and coastal resources to achieve long-term economic, social, and environmental benefits.

While all three frameworks engage with marine resources, the Blue Economy distinguishes itself by explicitly integrating environmental stewardship and social inclusion into its growth strategies. As Smith-Godfrey (2016) argues, it offers a pathway toward sustainable marine industrialization. However, as Bari (2017) notes, realizing this vision is increasingly challenged by climate change, overfishing, pollution, and habitat degradation. Scholars such as Abhinav et al. (2020) and Youssef (2023) emphasize that addressing these challenges requires a multidisciplinary and integrated approach—one that considers the complex interactions among ecological health, economic development, and social well-being within marine ecosystems.

Given this framework, coastal regions—where land meets the ocean or sea—play a significant role in the Blue Economy. Encompassing ecosystems such as beaches, estuaries, and flatlands, these regions are vital for biodiversity and human activities, from fishing to tourism. Coastal regions provide provisioning, regulating, cultural, and supporting ecosystem services (Kosanic & Petzold, 2020), including coastal protection, carbon sequestration, and habitat support, all of which hold high economic value (OECD, 2024).

However, the definition of these regions requires a clear approach due to their ecological and socio-economic diversity. In this paper, the term coastal region is used in two complementary ways: (1) in the ecological sense, to refer to sub-national zones adjacent to marine areas, and (2) in the analytical sense, to refer to EU Member States classified as coastal countries according to the NUTS (Nomenclature of Territorial Units for Statistics) classification. While in EU policy and statistical discourse "region" often denotes sub-national units, this study adopts the national level as the primary unit of analysis, aligning with the scope of available macroeconomic data and the structure of Blue Economy sectoral indicators.

According to OECD (2009), a coastal region can refer to a sub-national rather than a supra-national area below national boundaries with significant economic links to the sea. Based on the definition from the Britannica (2024), a region is a cohesive area that is homogeneous in selected defining criteria and is distinguished from neighboring areas or regions by those criteria. According to Van Langenhove (2013), a region refers to a territorial space or a characteristic of that space. Based on Hartshorne (1959), it is an area that is distinctive in some way from surrounding areas. Folch & Spielman (2014) define a region as a categorization of space based on shared physical characteristics. This definition underscores the geographic and ecological distinctions that make coastal regions unique. Meanwhile, Paasi (2010) describes a region as a social construct, shaped by historical, cultural, and social dimensions. This perspective underscores how human activity and societal values influence the development of coastal areas. According to Cambridge Dictionary (n.d.), a region may refer to a specific part of the world or an official subdivision of a country with distinct characteristics. Within the European Union, Eurostat defines coastal regions as those with a coastline or where more than half the population resides within 50 kilometers of the sea (European Union, 2022). This geographic context corresponds to the idea of functional regions—areas defined not by administrative boundaries, but by shared environmental and economic features. Despite the value of coastal regions, escalating degradation due to human activities and climate change poses serious risks to their development (Laino & Iglesias, 2023; Sandifer & Scott, 2021). Recognizing these vulnerabilities, the blue economy emphasizes the importance of a balance between resource exploitation and environmental protection, ensuring the sustainable functioning of blue economy sectors. In doing so, the blue economy aims not only to stabilize coastal regions, but also to support the UN SDGs, addressing global challenges such as climate change, biodiversity loss and marine pollution (Barbier, 2023; Sumaila & Tai, 2020).

As coastal regions face increased pressure, cities and communities within these areas become pivotal to advancing the Blue Economy. Coastal cities act as innovation hubs, while communities are directly impacted by environmental and economic shifts. This reciprocal relationship underscores the importance of local governance in managing marine resources and maintaining resilient coastal economies. Mogila et al. (2024) highlight the significance of Blue Economy activities in coastal development, emphasizing economic hubs created by industry clusters, from fishing to shipbuilding. Public-private partnerships and strategic infrastructure investments further enhance this regional economic resilience.

However, while the Blue Economy presents notable opportunities, it also raises challenges, including social and environmental risks. Scholars highlight injustices associated with blue growth, including dispossession of local fishers, unequal economic benefits, and environmental degradation (Bennett et al., 2021). The tension between the goals of economic growth and environmental sustainability remains a central debate, pointing to the need for inclusive and balanced development models. As a holistic framework, the Blue Economy emphasizes the integration of social, economic, and environmental objectives, recognizing that effective marine resource management is essential to long-term sustainability.

This study aims to establish a framework for developing tools to assess the economic dimension of coastal regions within the Blue Economy system. By evaluating key indicators of economic performance and sectoral stability within the Blue Economy, it establishes a foundational toolkit for gauging the economic status and growth potential of coastal regions.

Aligned with the study's objectives, the research questions addressed in this paper are:

RQ(1): How can regional development be understood within the Blue Economy system?

RQ(2): What tools are effective for assessing the economic status of Blue Economy activities in coastal regions?

RQ(3): In what ways can Blue Economy assessment tools inform and support resilient development strategies for coastal regions?

Future research will build on this framework by integrating socio-economic and environmental dimensions, addressing some of the limitations posed by an initial focus solely on economic aspects. Given the Blue Economy's inherently multidimensional nature, the extended research will incorporate environmental and social indicators to provide a more comprehensive view of development. These future advancements will allow for a more holistic evaluation of Blue Economy contributions, supporting stakeholders in crafting strategies that balance economic growth with environmental sustainability and social equity across diverse coastal regions.

Scientific background and literature review: The Blue Economy has emerged as a pivotal framework for resilient development, emphasizing the equitable and efficient utilization of marine resources. It integrates economic growth, ecological preservation, and social equity, addressing global challenges such as climate change, biodiversity loss, and regional disparities (Smith-Godfrey, 2016; Spalding, 2016).

Conceptual Foundations of the Blue Economy

The conceptual underpinnings of the Blue Economy emphasize sustainability and the optimization of marine resources for economic and social benefits (Djoric, 2022; Spalding, 2016). As highlighted by Elegbede et al. (2023), the Blue Economy seeks to harmonize economic growth with the preservation of marine ecosystems and the promotion of social inclusion. Similarly, Figueiredo & Cristina Mihaela (2022) discuss its alignment with the 2030 Agenda for Sustainable Development, representing a shift from exploitative practices to a sustainable and resilient framework.

Terms such as "Blue Economy," "Ocean Economy," and "Maritime Economy" are often used synonymously but differ in their emphasis, which can create conflicts among stakeholders and spark debates about balancing growth with conservation. While the "Blue Economy" prioritizes sustainability and resilience, other frameworks may focus exclusively on economic expansion (Bari, 2017; Smith-Godfrey, 2016). A comprehensive literature review by Youssef (2023) underscores the multidimensional nature of the Blue Economy, encompassing its economic, social, and environmental dimensions.

Regional Development within the Blue Economy

The Blue Economy is inherently linked to regional development, particularly in coastal areas, though its influence extends beyond these zones. Coastal regions serve as critical hubs for industries such as tourism, shipping, and renewable energy (Mogila et al., 2024). The OECD (2024) advocates for a territorial approach that addresses the specific characteristics of coastal areas, while the European Union (2022) provides statistical definitions to aid targeted policymaking.

Geographical and ecological diversity render coastal regions distinctive, necessitating tailored strategies for sustainable development. This is evident in the works of Paasi (2010) and Kosanic & Petzold (2020), who emphasize the socio-economic and environmental heterogeneity of these regions. Foundational definitions of regions, as presented by Hartshorne (1959) and Van Langenhove (2013), further underscore the importance of cohesive and context-specific planning for coastal and maritime zones.

Socio-Economic and Environmental Challenges

Despite its promise, the Blue Economy faces significant socio-economic and environmental challenges. Key issues include resource overexploitation, marine pollution, and climate change, all of which threaten the long-term viability of Blue Economy activities (Bennett et al., 2021; Sumaila & Tai, 2020). Sikhunyana & Mishi (2023) explore the socio-economic benefits and risks associated with the Blue Economy, contrasting its impacts with those of the Green Economy. Moreover, Sandifer & Scott (2021) and Laino & Iglesias (2023) highlight the vulnerability of coastal regions to extreme weather events and rising sea levels.

Barbier (2023) advocates for the "greening" of the Blue Economy, proposing strategies to reconcile economic development with ecological preservation. Similarly, Mogila et al. (2024) underscore the importance of innovation, public-private partnerships, and strategic investments in addressing regional vulnerabilities and fostering resilience.

Analytical Tools and Methodologies

The study of regional development within the Blue Economy relies on robust analytical tools and methodologies. Techniques such as IQR analysis (Geor, 2023), hierarchical clustering (Murtagh & Legendre, 2014), and Z-score normalization (Chikodili et al., 2021; Kirch, 2008; Venkataanusha et al., 2019) have been applied to identify representative regions and assess their stability. The Herfindahl-Hirschman Index (HHI) (Brezina et al., 2016) is another widely utilized metric that evaluates sectoral diversification and specialization, offering insights into economic resilience and dependency.

2. Methodology

In this study, the Member States of the European Union are used as the primary units of analysis. The research consists of two main stages: first, the identification of a representative set of countries for analysis; second, a comparative assessment across countries and Blue Economy sectors with the aim of developing a tool for profiling structural indicators of the Blue Economy in EU countries.

The focus is placed exclusively on 22 coastal EU Member States, as identified according to the NUTS (Nomenclature of Territorial Units for Statistics) classification. These countries have direct access to marine or coastal areas, which is a fundamental prerequisite for the existence and functioning of Blue Economy sectors such as coastal tourism, living and non-living resources, marine transport, ocean energy, port activities, shipbuilding and repair.

The remaining five landlocked EU Member States—Austria, Czechia, Hungary, Slovakia, and Luxembourg—were excluded from the analysis due to their lack of direct access to marine space, which significantly limits the potential for the development of marine-based industries. In these countries, the gross value added (GVA) generated by Blue Economy sectors remains marginal, and the structural presence of such industries is minimal.

The adopted geographic criterion ensures a focus on countries where the Blue Economy is economically significant and structurally embedded within national economies. Furthermore, it enables the construction of an analytically comparable sample of countries with access to marine resources and similar sectoral profiles.

Empirical data used in the study were obtained from the European Commission's Blue Economy Observatory and the Blue Indicators Tool. The dataset includes secondary statistical data for the 22 selected coastal countries covering the period from 2009 to 2021.

To assess the scale and relative importance of the Blue Economy within national economies, the data were normalized by calculating its contribution of national GVA, as defined in Eq. (1). This metric enables the assessment of the relative significance of Blue Economy sectors within national economies, independently of their absolute economic size.

$$\text{BE-Ratio}_{c,t} = \text{BE GVA}_{c,t} / \text{GDP}_{c,t} \tag{1}$$

where, $\text{BE-Ratio}_{c,t}$ – Blue Economy contribution to GDP for country c in year t (expressed as a decimal or ratio); $\text{BE GVA}_{c,t}$ – GVA of the Blue Economy for country c in year t; $\text{GDP}_{c,t}$ –Gross Domestic Product for country c in year t.

Identification of a representative set of countries for analysis: To enhance the robustness and reliability of the country selection process, this study employs a combined methodological approach that integrates IQR analysis, Ward's hierarchical clustering, and z-score normalization. Each method contributes a distinct but complementary perspective, and their integration is designed to mitigate selection biases that could arise when applying any single method in isolation.

IQR analysis filters out extreme deviations and statistical outliers by selecting countries whose Blue Economy contribution to GDP lies within the IQR (Q1–Q3), thus identifying statistically typical cases (Chikodili et al., 2021; Geor, 2023). However, central tendency alone does not ensure that these countries are structurally comparable in terms of economic profiles.

To address this, Ward's hierarchical clustering is applied to group countries based on structural proximity in their Blue Economy metrics. This method minimizes within-cluster variance and enhances group homogeneity, making it suitable for identifying functionally similar cases in comparative research (Murtagh & Legendre, 2014).

To further validate representativeness, z-score normalization is used to standardize the Blue Economy contributions across countries. This allows for the identification of countries with relatively average performance—those whose z-scores lie between –0.5 and 0.5 (Diamantopoulos et al., 2023; Kirch, 2008; Venkataanusha et al., 2019). Z-score normalization also ensures comparability across different scales and mitigates the impact of absolute economic size. The combined use of these three methods enables a multidimensional filtering process: statistical typicality (via IQR), structural similarity (via clustering), and relative average behavior (via z-score). This triangulated approach improves the internal validity of the selected sample and controls for potential biases related to scale sensitivity, structural heterogeneity, and distributional skewness. Similar combinations of statistical and clustering methods have proven effective in multivariate outlier detection and robust sample construction in applied research contexts (Chikodili et al., 2021; Wang & Ahmad, 2024).

For the selected countries, a further analysis of the structure and performance of the Blue Economy in the respective countries and sectors was carried out, taking into account several economic indicators: GVA; Gross Profit (GP); Employment (EMP); Turnover (TOV). These variables are crucial for measuring the scale of business activity in the Blue Economy.

Comparative analysis between countries and between industries to form a tool for assessing the profile of the Blue Economy of countries: For a more in-depth analysis, the Coefficient of Variation (CoV) was used, calculated as the ratio of the standard deviation to the mean; this metric was used to assess the variability of each sector's performance over time, as shown in Eq. (2). Based on CoV, variability in sectors was defined as: Very Low Variability CoV < 0.15; Low Variability 0.15 ≤ CoV < 0.3; Moderate Variability 0.3 ≤ CoV < 0.5; High Variability 0.5 ≤ CoV < 0.75; Very High Variability CoV ≥ 0.75.

$$\mathrm{CoV}=\sigma_s/\mu_s \tag{2}$$

where, σ_s – standard deviation of the performance metric for sector s over time; μ_s – mean of the performance metric for sector s over time.

To determine which countries are more dependent on certain sectors and how diversified or specialized their economy is, the HHI was calculated and analysed using Eq. (3).

$$\mathrm{HHI}=\sum_{i=1}^{n} S_i^2 \tag{3}$$

where, S_i – share of sector i in the Blue Economy of a given country and n – total number of sectors.

Based on HHI (Brezina et al., 2016), economies can be identified as high diversified to high specialized: High Diversification HHI < 0.15; Moderate Diversification 0.15 ≤ HHI < 0.25; Moderately Specialized 0.25 ≤ HHI < 0.4; Highly Specialized HHI ≥ 0.4.

An overview of sectoral variability across countries and a cross-sector analysis was conducted to identify whether significant patterns emerge in a cross-industry or cross-country focus.

This study uses the CoV as a standardized indicator to assess sector stability in the Blue Economy, focusing on GVA, GP, employment and turnover for each sector. By calculating the average CoV across these variables, this study provides a clear measure of relative stability and variability for each sector in the region.

To assess sectoral stability and variability within the Blue Economy, the EU Blue Economy Stability Benchmark was created based on the CoV values of the sectors in the EU's highly efficient coastal economies: Latvia (LV), the Netherlands (NL), Portugal (PT), Spain (ES), Finland (FI) and Bulgaria (BG). This benchmark reflects the typical patterns of stability and variability in the countries that contribute the most to the EU's blue economy, offering a reference point for other EU coastal economies.

To establish a suitable benchmark for interpreting sectoral variability, two potential metrics were considered: the Average CoV across countries and the CoV Dispersion Index. Due to the need to provide a single country analysis, we decided to use Average CoV as the main benchmark. This choice was made according to the criterion of applicability to the analysis of one country, since the index of dispersion requires an inapplicable case of a single country.

To visually present and compare each country's industry profile to the benchmark, radar charts were used. These charts provide an intuitive comparative view of the value of CoV in different sectors and allow for rapid assessment of sectoral compliance or deviation from expected patterns of stability, identifying areas of economic resilience and vulnerability in different countries.

To confirm the effectiveness and applicability of the EU Blue Economy Stability Benchmark, the radar chart model was tested with countries outside the representative sample, notably Croatia and Romania, which fall outside the IQR of highly performing EU coastal economies used to create the benchmark. These countries were selected due to their distinct economic profiles and higher and correspondingly lower contributions to the blue economy compared to the reference countries. Emissions testing allows us to assess whether a radar chart benchmark can be used as a tool to identify sectoral vulnerabilities and provide meaningful information about a wider range of economic conditions.

Data collection: Secondary data on Blue Economy performance indicators, including GVA, GP, Employment (EMP), and Turnover (TOV), were sourced from EU Blue Economy Observatory (2024). Additional data on Gross Domestic Product (GDP) were obtained from Eurostat (2024) to contextualize the economic contributions of the Blue Economy sectors within the broader economy.

The selection of these four indicators is grounded in both conceptual relevance and data availability. These metrics represent the core indicators used by the European Commission's Blue Economy Observatory and are consistently available across all EU member states with coastal access. GVA reflects the net contribution of Blue Economy sectors to national economic output, while GP captures operational profitability and sectoral efficiency. EMP accounts for the labor intensity and social dimension of the Blue Economy, and TOV provides insight into the market scale and economic dynamism of each sector.

Together, these indicators enable a multifaceted assessment of the Blue Economy's performance—covering productivity, profitability, employment generation, and economic scale. Their harmonized and cross-nationally comparable nature makes them a robust foundation for structural analysis and country-level comparison. However, the exclusive reliance on these indicators also constitutes a limitation of the study, as they do not reflect environmental, informal, or qualitative aspects of Blue Economy development. Future research may benefit from incorporating broader socio-ecological dimensions, as more comprehensive datasets become available.

3. Results

Building on the methodology, this study applies a comprehensive analytical framework to assess the economic characteristics and performance of the Blue Economy across EU coastal countries. Using IQR analysis, Ward's clustering, and z-score normalization, a subset of representative countries was identified to exemplify typical Blue Economy contributions. In the next stage, sectoral metrics such as the CoV and the HHI were applied to evaluate sectoral stability, diversification, and specialization. Together, these methods support a detailed examination of structural economic profiles, allowing for the identification of both resilient and vulnerable sectors across regions. The results below present these findings, highlighting sectoral distributions and economic patterns that shape the Blue Economy in the selected countries.

Out of the 27 European Union member states, 22 are classified as coastal—either due to their geographical position or population proximity to the coastline. These include: Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain, and Sweden.

An IQR boxplot (Figure 1) and a histogram (Figure 2) were used to illustrate the distribution of Blue Economy contributions across these countries. The visualizations highlight the countries falling within the middle 50% of the distribution. Countries within this range were considered representative of "typical" Blue Economy performance.

Countries within the IQR include Spain, Latvia, Portugal, the Netherlands, Bulgaria, Finland, Lithuania, Sweden, Italy, and France. The results of the interquartile analysis indicate that all countries falling within the IQR are positioned below the median, suggesting a left-skewed distribution. This implies that most EU coastal countries exhibit relatively modest Blue Economy contributions, while a few high-performing countries elevate the overall average, thereby distorting the distribution.

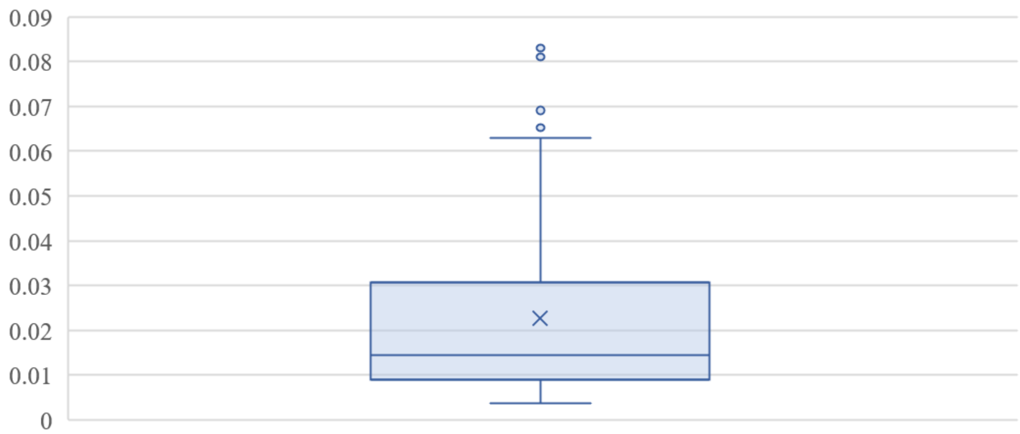

Figure 1. IQR boxplot of blue economy contributions

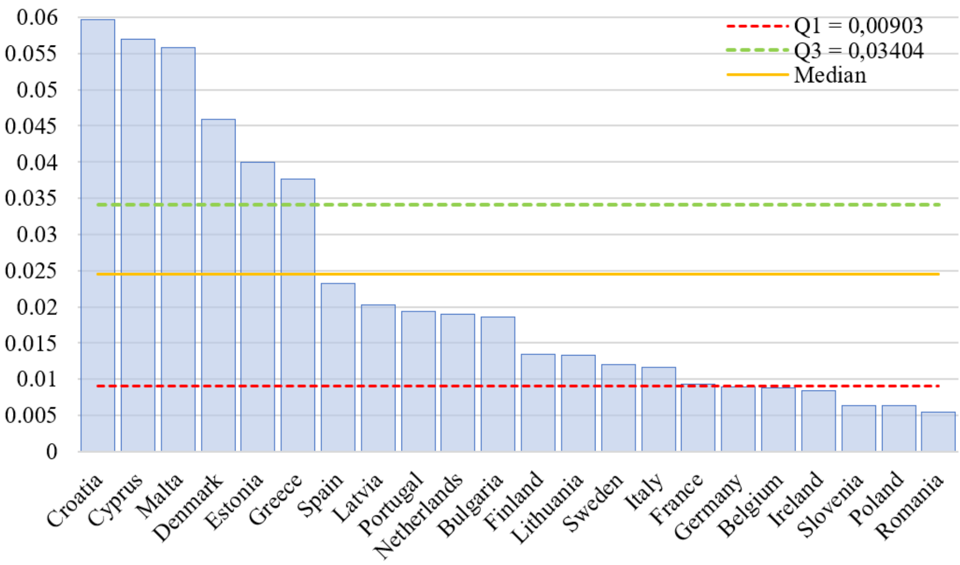

Figure 2. Blue economy contributions to GDP among EU coastal countries

According to the results of the Ward's hierarchical clustering, two distinct clusters were identified. Cluster 1 consists of countries that demonstrate relatively similar Blue Economy contribution patterns over the examined period. These countries exhibit greater stability and consistency, as reflected in their proximity to the cluster centroid. In contrast, Cluster 2 includes countries with higher variability or unique contribution trajectories, marked by more divergent or fluctuating patterns in their Blue Economy indicators (Table 1).

Table 1. Ward's method cluster analysis results

Cluster		Contribution Range	Distance from Centroid
Cluster 1	Belgium	0.001592	0.802043
	Bulgaria	0.03268	1.806068
	Finland	0.005838	0.236446
	France	0.004361	0.711036
	Germany	0.003804	0.802599
	Ireland	0.00693	1.033909
	Italy	0.00594	0.274751
	Latvia	0.015357	1.58874
	Lithuania	0.004884	0.725446
	Netherlands	0.005913	1.419585
	Poland	0.001411	1.2831
	Portugal	0.015842	1.428926
	Romania	0.003006	1.504092
	Slovenia	0.001955	1.282331
	Spain	0.016437	2.088138
	Sweden	0.006455	0.362217
Cluster 2	Croatia	0.052694	2.254503
	Cyprus	0.065679	2.448565
	Denmark	0.01856	2.172551
	Estonia	0.035441	2.348866
	Greece	0.035192	2.70745
	Malta	0.04138	1.642677

All countries previously identified as falling into the IQR for Blue Economy GDP contribution are present in Cluster 1, confirming that they share similar data patterns across years. After analyzing the distribution of the z-score—aimed at selecting countries that show the least variability in their contributions to the Blue Economy, having most of their z-scores in the range of -0.5 to 0.5—Bulgaria, Finland, Latvia, the Netherlands, Portugal, and Spain were finally singled out for further in-depth analysis. The final selection involved countries appearing consistently in all three analyses: IQR analysis, clustering, and z-score normalization. Such countries were chosen as the most representative (Table 2).

Using both sectoral CoVs for the GVA variable and the HHI (Table 3) indicators, along with the structure of the Blue Economy by sector as a percentage of each country's total Blue Economy (Table 4), an assessment was made of the profile, stability, and degree of specialization or diversification of each country's Blue Economy.

Table 2. Representative country selection based on IQR, clustering, and Z-score analysis

Country	In IQR	In Z-Score (-1 to 1)	In Z-Score (-0.5 to 0.5)	In Cluster 1
Spain	Yes	Yes	Yes	Yes
Latvia	Yes	Yes	Yes	Yes
Portugal	Yes	Yes	Yes	Yes
Netherlands	Yes	Yes	Yes	Yes
Bulgaria	Yes	Yes	Yes	Yes
Finland	Yes	Yes	Yes	Yes
Lithuania	Yes	Yes	No	Yes
Sweden	Yes	Yes	No	Yes
Italy	Yes	Yes	No	Yes
France	Yes	Yes	No	Yes
Germany	No	Yes	No	Yes
Belgium	No	Yes	No	Yes
Ireland	No	Yes	No	Yes
Slovenia	No	Yes	No	Yes
Poland	No	Yes	No	Yes
Romania	No	Yes	No	Yes
Estonia	No	Yes	No	No
Greece	No	Yes	No	No
Croatia	No	No	No	No
Cyprus	No	No	No	No
Malta	No	No	No	No
Denmark	No	No	No	No

Table 3. Summary of sectoral variability (CoV) and HHI scores

Sector	NL	PT	LV	ES	FI	BG
Coastal Tourism	High	Low	Low	Low	Low	Low
Living Resources	Very Low	Low	Low	Low	Very Low	Very High
Maritime Transport	Very Low	High	Moderate	Low	Very Low	Moderate
Non-Living Resources	High	Moderate	NaN	Very High	NaN	Very High
Ocean Energy	Very High	NaN	NaN	NaN	NaN	NaN
Ports Activities	Very Low	Low	Very Low	Low	Very Low	High
Shipbuilding and Repair	Very Low	Moderate	Low	Moderate	Low	Very High
HHI	0.2095	0.4833	0.3012	0.4826	0.2336	0.4679

Table 4. Sectoral structure of the blue economy

Sector	NL	PT	LV	ES	FI	BG
Coastal tourism	8%	66%	35%	67%	32%	66%
Living resources	9%	19%	15%	13%	8%	8%
Maritime transport	27%	2%	5%	3%	25%	4%
Non-living resources	16%	0%	NaN	0%	NaN	2%
Ocean energy	1%	NaN	NaN	NaN	NaN	NaN
Ports activities	30%	9%	39%	13%	20%	10%
Shipbuilding and repair	10%	3%	6%	4%	16%	9%

The Netherlands exhibits a highly diversified Blue Economy (HHI: 0.2095). Maritime transport and port activities demonstrate very low CoV values, indicating consistent sectoral performance. In contrast, non-living resources and shipbuilding and repair sectors show high volatility, suggesting greater sensitivity to external market conditions. Portugal is characterized by strong specialization in coastal tourism (HHI: 0.4833), which shows low volatility. However, maritime transport and non-living resources display high and moderate CoV values, respectively, indicating a higher exposure to global fluctuations. Latvia maintains a moderately diversified profile (HHI: 0.3012). Port activities are the most stable sector, with a very low CoV. Living resources, as well as shipbuilding and repair, also show low variability, while maritime transport demonstrates moderate volatility.

Spain is another tourism-specialized country (HHI: 0.4826), with coastal tourism accounting for 67% of its Blue Economy and exhibiting low volatility. However, non-living resources and shipbuilding and repair sectors show moderate to very high volatility, pointing to sectoral vulnerabilities. Finland presents moderate diversification (HHI: 0.2336). Port activities (20%) and living resources (8%) both show very low CoV values, while shipbuilding and repair (16%) demonstrate low volatility. The economy lacks a dominant sector, indicating balanced sectoral distribution. Bulgaria has a specialized economic profile (HHI: 0.4679). While coastal tourism (66%) exhibits low volatility, both living and non-living resource sectors are marked by very high CoV values, suggesting instability (When interpreting CoV results, it is important to proceed with caution. A low CoV is often interpreted as a sign of stability, but it may also reflect sectoral maturity or, conversely, structural inertia and stagnation. Similarly, a high CoV does not necessarily imply risk; in some cases, it signals active development or sectoral transformation, particularly in emerging sectors. Since CoV does not reflect the direction of change, it may obscure underlying trends such as persistent decline or steady growth. Therefore, contextual understanding is essential. The combination of CoV and HHI provides a more nuanced view of sectoral specialization and resilience across countries and helps identify regions that may be vulnerable, especially in economies with a high degree of specialization.).

In summary, countries with stable core sectors such as the Netherlands, Finland, and Latvia exhibit low volatility in key industries like port activities and maritime transport. This contributes to the overall stability and resilience of their Blue Economies. In contrast, economies with structural dependence on coastal tourism—namely Spain, Portugal, and Bulgaria—demonstrate low variability in this sector, suggesting relative stability. However, such specialization indicates limited diversification, which may heighten vulnerability to sector-specific shocks.

Sectoral sensitivity is particularly notable in non-living resources (especially in Spain and Bulgaria) and maritime transport (Portugal), implying exposure to external market fluctuations that can compromise economic stability.

The shipbuilding and repair sector shows a wide range of volatility across countries, from very low to very high, with trends that align with national economic structures. In diversified economies such as the Netherlands, Finland, and Latvia, the sector tends to be relatively stable. Conversely, in more specialized economies—Portugal, Spain, and Bulgaria—the sector demonstrates moderate to high volatility, underscoring structural fragility.

Table 5. Overview of sectoral CoV by indicator and country in the blue economy

Sector	Value	NL	PT	LV	ES	FI	BG
Coastal Tourism	GVA	High	Low	Moderate	Low	Low	Moderate
	GP	High	Moderate	Moderate	Moderate	Moderate	Moderate
	EMP	Low	Very Low	Low	Very Low	Very Low	Low
	TOV	High	Low	Low	Low	Low	Low
Living Resources	GVA	Very Low	Low	Low	Moderate	Very Low	High
	GP	Low	Moderate	Moderate	High	Low	High
	EMP	Very Low	Low	Low	Low	Very Low	High
	TOV	Very Low	Low	Low	Low	Very Low	Very High
Maritime Transport	GVA	Very Low	High	Moderate	Low	Very Low	Moderate
	GP	Low	Very High	Moderate	Moderate	Low	Moderate
	EMP	Low	Low	Low	Low	Very Low	High
	TOV	Very Low	Moderate	Low	Low	Very Low	High
Non-living Resources	GVA	High	Moderate	-	Very High	-	Very High
	GP	High	High	-	Very High	-	Very High
	EMP	Low	Low	-	Low	-	High
	TOV	High	Low	-	High	-	Very High
Ocean Energy	GVA	Very High	-	-	-	-	-
	GP	Very High	-	-	-	-	-
	EMP	Very High	-	-	-	-	-
	TOV	Very High	-	-	-	-	-
Ports Activities	GVA	Very Low	Low	Very Low	Moderate	Very Low	High
	GP	Low	Moderate	Very Low	High	Low	High
	EMP	Very Low	Low	Moderate	Low	Very Low	High
	TOV	Low	Low	Very Low	Low	Very Low	Very High
Shipbuilding & Repair	GVA	Low	Moderate	Low	Moderate	Low	High
	GP	High	High	High	Very High	Very High	Very High
	EMP	Low	Moderate	Low	Low	Low	High
	TOV	Very Low	Moderate	Low	Moderate	Low	Very High

Since ocean energy is present only in the Netherlands (within the selected sample of countries), it was excluded from the cross-country and cross-sector analysis to prevent distortion in comparative interpretation.

A deeper analysis of sectoral variability across GVA, GP, employment (EMP), and turnover (TOV) indicators

(Table 5) shows that Bulgaria and Latvia—countries with pronounced or moderate specialization—exhibit high CoVs in key sectors such as coastal tourism, living resources, and shipbuilding and repair. This pattern points to increased economic vulnerability resulting from sectoral concentration and reduced diversification.

Spain and Portugal, although also highly specialized (particularly in tourism and living resources), present moderate to low CoVs in GP and EMP in those sectors. This suggests that their established infrastructure and diverse service offerings may help cushion demand shocks.

In contrast, the Netherlands and Finland, characterized by more diversified economies, display low CoVs in sectors such as maritime transport and port activities—highlighting the structural stability provided by coordinated infrastructure. However, sectors more exposed to global competition, such as shipbuilding, still reveal moderate to high variability, indicating differentiated exposure to international market dynamics.

Cross-sectoral analysis revealed universally stable sectors or sectors with high variability, regardless of the country's profile. Universally stable sectors: port activities and maritime transport show very low to moderate variability through most of the variables in most countries, highlighting domestic stability likely supported by infrastructure and generated demand. Coastal Tourism: generally, countries display low to moderate variability, except for the Netherlands, which exhibits high variability, potentially indicating its greater sensitivity.

Sectors with high volatility across countries: non-living resources and shipbuilding and repair show consistently high CoVs across metrics and countries, indicating inherent sensitivity to global markets and investment cycles, and may also be indicative of emerging sectors such as ocean energy in the Netherlands.

The benchmark indicator of the stability of the EU Blue Economy is calculated based on the values of the CoV across all available variables for sectors in the highly efficient coastal economies of the EU: Latvia (LV), the Netherlands (NL), Portugal (PT), Spain (ES), Finland (FI), and Bulgaria (BG) (Figure 3). This benchmark provides an understanding of typical patterns and allows for the creation of a reference radar chart to analyse the economic profiles of Blue Economy countries (Figure 4).

In the radar charts, light blue shading represents the benchmark (expected stability), while dark blue shading reflects each country's actual performance. In addition, sectors that are not present within the Blue Economy of a particular country are excluded from its chart.

In countries with a diversified Blue Economy, the radar chart profile tends to have a compact, balanced shape, aligning closely with the benchmark figure. This alignment suggests stability and resilience across multiple sectors. In contrast, for countries with moderately specialized or highly specialized economies, the profile shows that the sectors of specialization often lie within the benchmark boundaries, while other sectors tend to exhibit variability beyond the benchmark. This deviation indicates greater vulnerability and instability in non-specialized sectors, making these economies more susceptible to sector-specific risks and fluctuations.

The radar charts for Croatia and Romania (Figure 5) were overlaid onto the EU Blue Economy Stability Benchmark to facilitate a direct visual comparison between the expected stability of the benchmark and the actual CoV values observed in these countries. Croatia and Romania were not selected as representative countries in the initial filtering phase due to their extreme positions in terms of Blue Economy contribution, with Croatia representing the highest and Romania the lowest contributions within the sample. This overlay approach highlights how each country deviates from the benchmark, particularly showing whether sector-specific variability aligns with or exceeds the expected levels of stability. This comparison provides insights into the robustness of each country's Blue Economy sectors relative to the EU benchmark, with deviations indicating areas of higher sectoral volatility and potential vulnerability.

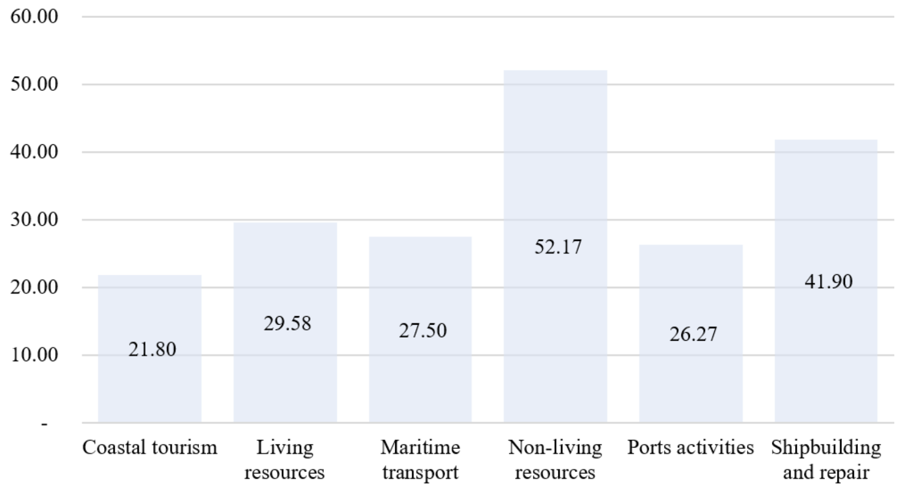

Figure 3. Benchmark values for blue economy sectors

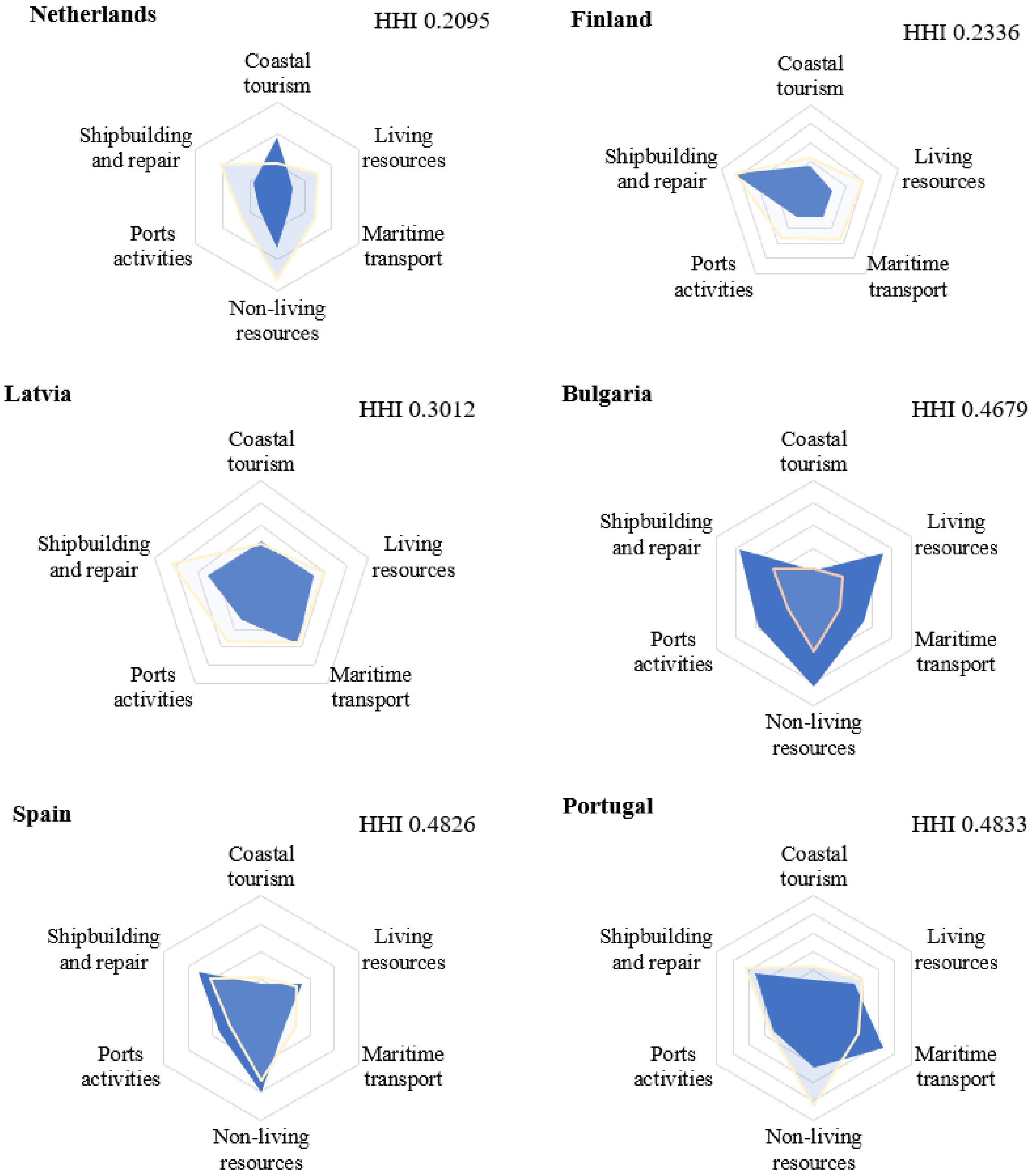

Figure 4. Economic profiles of blue economy countries

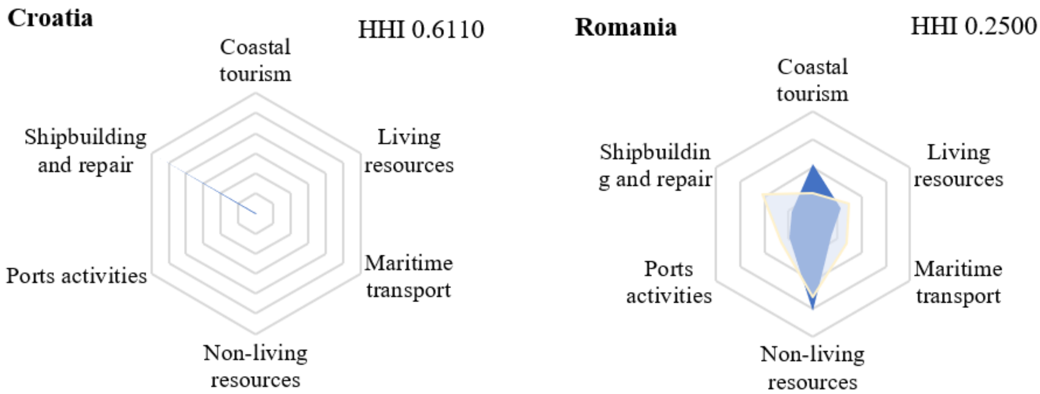

Figure 5. Economic profiles of control blue economy countries

Croatia exhibited a high CoV in the shipbuilding and repair sector, significantly exceeding the benchmark, while Romania displayed elevated CoV values in coastal tourism and non-living resources. These deviations highlight specific sectors where these countries experience heightened economic volatility, effectively identifying areas that diverge from the benchmark.

While Croatia shows volatility across multiple sectors, Romania demonstrates closer alignment with the benchmark in certain sectors, such as port activities and shipbuilding and repair (which account for 29% and 35% of the country's Blue Economy, respectively). This alignment suggests pockets of resilience within Romania's otherwise variable profile.

Upon excluding the shipbuilding industry from the radar chart (Figure 6), Croatia's profile emphasizes stability in its dominant sector, coastal tourism (which accounts for 77% of its Blue Economy), along with some deviations from the benchmark in other Blue Economy sectors.

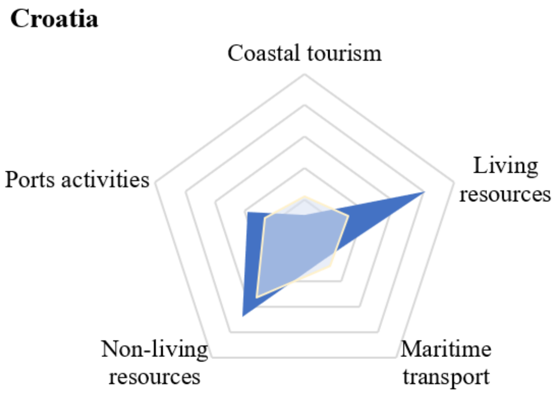

Figure 6. Croatia's economic profile after excluding extreme CoV values

The overall shape of the radar chart profiles confirms the pattern observed in earlier comparisons: countries with diversified Blue Economies tend to display a more compact and balanced profile, while those with greater sectoral specialization exhibit more pronounced variability. This supports the hypothesis that a compact radar chart shape reflects economic diversification and structural stability.

4. Discussion

The radar chart methodology, which overlays each country's sectoral CoV values onto the EU Blue Economy Benchmark, serves as a diagnostic tool for assessing structural stability, economic strengths and weaknesses, and potential areas for strategic policy intervention. By visually comparing national profiles with a composite benchmark derived from stable and representative economies, radar charts provide an accessible yet analytically robust way to identify deviations from ideal structural balance.

However, several methodological limitations of the radar chart must be acknowledged at the outset. First, the method entails a degree of subjectivity in visual interpretation, particularly when assessing the shape, symmetry relative to the benchmark, and compactness of the chart. Second, the reduction of sectoral variability to an average CoV value may obscure intra-sectoral disparities, which is particularly problematic in unstable economies or marginal sectors. Third, the method is sensitive to outliers, which can distort the overall visualization—creating a misleading impression of volatility or, conversely, of stability. Finally, the absence of complete data for certain sectors (e.g., ocean energy) limits the full comparability across countries. Despite these limitations, the radar chart remains a valuable tool—especially when used in conjunction with other methods—for high-level structural analysis of the Blue Economy.

Radar charts allow for the assessment of economic resilience and structural specialization by observing the alignment or divergence of each country's profile from the benchmark. A compact, balanced radar shape indicating consistent CoV values across sectors suggests a diversified and stable economic structure. Countries such as the Netherlands and Finland exemplify this pattern, with a relatively even distribution of Blue Economy activity across sectors.

Conversely, irregular radar shapes with pronounced peaks and troughs extending beyond the benchmark suggest a specialized economy vulnerable to sector-specific shocks. For instance, Bulgaria shows substantial CoV values exceeding the benchmark across nearly all sectors—except for coastal tourism, which comprises the bulk of its Blue Economy. This highlights an overreliance on a single sector that, despite its low volatility, may be either flourishing or declining; a lack of dynamic change may signal inertia within the sector. Sharp peaks beyond the benchmark may reflect either positive developments (e.g., investment booms) or negative events (e.g., abrupt downturns). The inability of the radar chart to determine the underlying cause of such deviations constitutes another methodological limitation to consider in the interpretation of results.

Importantly, external shocks—such as the COVID-19 pandemic, geopolitical disruptions, or regulatory changes—can introduce volatility that may skew radar chart results. While the CoV is designed to capture relative variability, it cannot differentiate between temporary disruptions and long-term trends. For instance, Finland's tourism sector showed high CoV due to a steep drop in activity during COVID-19 after years of stable growth. In contrast, Bulgaria's tourism sector exhibited a low CoV not because it was unaffected, but because it had been gradually declining before the crisis. The pandemic merely accelerated an existing trend. This comparison illustrates that low variability may mask stagnation or structural decline, while high variability may reflect resilience or adaptability. Radar chart outputs must therefore be interpreted in conjunction with longitudinal context and crisis-specific assessments.

In specialized economies, this interpretive challenge becomes particularly acute. A low CoV in a dominant sector may initially appear to signal resilience or sectoral stability. However, in such cases, it could just as likely indicate structural inertia, lack of innovation, or long-term underinvestment. Without periodic disruptions, such sectors may appear stable on the surface but remain vulnerable to future shocks due to their inability to adapt or diversify. Thus, for economies heavily dependent on one sector, radar charts should not be interpreted at face value without considering underlying sectoral dynamics and their responsiveness to external influences.

It is also important to highlight that the benchmark indicator developed in this study incorporates the period 2009–2021, thus capturing structural patterns that include the economic impact of the COVID-19 pandemic. By doing so, the benchmark reflects both pre-crisis trajectories and pandemic-induced disruptions, making it a more robust reference point for interpreting sectoral stability and vulnerability across the Blue Economy.

To test the universality of the constructed benchmark profile, radar charts were applied to Romania and Croatia—two economies that were not part of the representative country sample. These cases were deliberately selected as outliers: Romania has the lowest Blue Economy contribution to national GDP among all EU coastal states, while Croatia has the highest. Comparing these extreme cases with the benchmark chart makes it possible to evaluate its applicability beyond "typical" economies and demonstrates the method's capacity to detect structural patterns even in atypical national profiles.

To illustrate this, radar charts were applied to both Romania and Croatia. Romania presents a compact radar shape, confirming a diversified Blue Economy structure. However, it displays high CoV values in sectors such as coastal tourism and non-living resources, indicating elevated volatility. Other sectors, such as port activities and shipbuilding, align more closely with the benchmark. In Croatia's case, the shipbuilding sector exhibited exceptionally high CoV values, significantly distorting the overall radar chart.

To improve the interpretability of the national profile, this sector was removed from both the national and benchmark charts. The resulting adjusted radar chart revealed a more stable profile, with coastal tourism emerging as the least volatile sector. This outlier-based adjustment illustrates the flexibility of the radar chart method while underscoring the importance of carefully managing extreme values to preserve cross-country comparability.

Moreover, the exclusion of certain sectors, such as ocean energy, from radar chart analysis does not distort cross-country comparison but rather enhances its accuracy in cases where data is missing or unevenly distributed. Since ocean energy is an emerging sector in the EU, its data coverage remains sparse and highly volatile—naturally resulting in high CoV values due to its developmental nature. Including such a sector in the benchmark could artificially inflate variability and skew interpretations. Therefore, for countries where ocean energy is not present or not consistently measured, it was methodologically sound to exclude this vector from both the national profile and the benchmark chart. This ensures analytical alignment between the countries compared and allows the radar to reflect only comparable sectoral dynamics. A similar approach was applied in the case of Croatia, where the shipbuilding and repair sector was temporarily excluded due to extreme volatility. By recalibrating the radar chart accordingly, we ensured a more interpretable and meaningful visualization, without compromising analytical rigor. This underscores the value of radar charts as adaptable tools that can be customized without losing comparability—provided that exclusions are consistently applied across compared units.

In addition to static visualization, the radar chart approach offers analytical adaptability for various applications, including comparisons across time periods or between different sets of indicators. Nevertheless, its capacity to capture multidimensional complexity remains limited without further methodological development.

To address this, future research could explore the development of composite indices that integrate economic, social, and environmental dimensions of the Blue Economy. Such indices could significantly enhance the interpretive strength of radar charts and reduce the current over-reliance on the CoV as a sole indicator of sectoral volatility. Specifically, this may involve:

Sector-specific impact coefficients, quantifying the social, environmental, and economic contributions of each Blue Economy sector. These would support a more nuanced understanding of trade-offs and synergies.

Multidimensional correlation analysis, identifying interdependencies between sectoral stability and broader social or ecological outcomes, including the presence of hidden risks in otherwise strong-performing sectors.

Composite Blue Economy Health Indices, combining indicators of stability, diversification, social equity, and environmental performance. These indices could serve as multidimensional benchmarks for long-term strategic planning and sustainable regional development.

Such tools would facilitate a more integrated assessment of sustainability performance, providing meaningful reference points for goal-setting, policy alignment, and progress tracking at both national and sub-national levels. While this article is primarily focused on economic indicators—specifically GVA, employment, GP, and turnover—due to data availability constraints, future research could broaden the analytical scope by incorporating measures of social well-being (e.g., job quality, local economic integration) and ecological performance (e.g., ecosystem impacts, carbon emissions intensity).

Moreover, complementary analyses, such as tracking shifts in sectoral specialization, employment concentration, and sectoral share dynamics, could help identify vulnerabilities or resilience patterns at both sectoral and territorial levels. This may also allow for cross-sectoral comparisons to detect key drivers of growth or decline.

Ultimately, such composite indices would support more coherent monitoring of progress toward the SDGs and offer researchers, planners, and coastal managers a more reliable basis for evidence-based decision-making. These tools could better reflect the interconnected nature of economic activity, social development, and environmental integrity across both marine and coastal—and even non-coastal—regions, where Blue Economy sectors, though limited in scope, are still present and relevant.

5. Conclusions

This study expands the understanding of regional development within the Blue Economy as a dynamic and multidimensional system. Moving beyond traditional economic perspectives, the Blue Economy emphasizes the sustainable and equitable use of marine resources to ensure both economic growth and social well-being. Regional development in this context is measured not only by economic performance but also by environmental resilience, social inclusion, and the ability to adapt to external pressures. Achieving balanced development requires harmonizing growth with sustainability, tailored to the unique socio-economic and ecological conditions of each region. By fostering sustainable resource management, the Blue Economy contributes to the creation of more resilient, adaptive, and inclusive coastal regions that can serve as hubs for investment, research, and long-term strategic planning.

In response to RQ(2), this study proposes an assessment tool for evaluating the economic status of Blue Economy activities that can be applied to both countries and territorial regions. Through a multi-step analytical framework—combining IQR analysis, clustering methods, and z-score distribution—representative coastal economies were identified. Following a detailed sectoral analysis, a tool was developed to assess regional economic profiles, capturing sector-specific stability, specialization, and overall economic efficiency. This framework allows analysts to assess how individual sectors contribute to structural resilience and intersectoral balance.

In response to RQ(3), the radar chart is presented as a diagnostic tool for evaluating the structural profile of Blue Economy sectors. By overlaying sectoral CoV values on a benchmark, radar charts enable stakeholders to identify vulnerabilities, strengths, and the degree of specialization or diversification. A compact and symmetrical radar shape indicates a balanced economy, while sharp peaks or troughs highlight sectoral instability or dependence. This makes the tool valuable not only for academic analysis but also for strategic regional planning and sustainability assessments.

At the same time, although intuitive and adaptable, the radar chart methodology has certain limitations—particularly its sensitivity to outliers and reliance on average CoV values, which may obscure intra-sectoral variation. To enhance its analytical capacity and support more robust decision-making, future research may consider the development of composite indices that integrate economic, social, and environmental aspects. These may include: sector-specific impact coefficients to evaluate trade-offs between economic gains and social or environmental costs; multidimensional correlation analysis to identify interdependencies between economic performance, ecological impact, and social outcomes; composite Blue Economy health indices incorporating metrics of stability, diversification, equity, and ecological integrity—applicable at both national and sub-national levels.

While this study focused primarily on economic indicators (GVA, employment, turnover, and profit), it provides a foundation for more integrated assessments. The application of CoV as a structural stability metric requires cautious interpretation, as low variation may reflect either harmonious development or sectoral stagnation. Therefore, understanding these values in context—particularly in light of shocks such as the COVID-19 pandemic—is essential for distinguishing between sustainable resilience and structural inertia.

At this stage, the proposed tool already allows for cross-country comparisons, the visual detection of potentially risky structural patterns, and the creation of a foundation for future research. Its flexibility and adaptability make it suitable for diverse regional contexts. In the future, combining this approach with more advanced indicators and multidimensional indices will enhance the accuracy of interpretation and the depth of analysis.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

References

Abhinav, K. A., Collu, M., Benjamins, S., Cai, H., Hughes, A., Jiang, B., Jude, S., Leithead, W., Lin, C., Liu, H., Recalde-Camacho, L., Serpetti, N., Sun, K., Wilson, B., Yue, H., & Zhou, B. Z. (2020). Offshore multi-purpose platforms for a Blue Growth: A technological. environmental and socio-economic review. *Sci. Total Environ., 734*, 138256. https://doi.org/10.1016/j.scitotenv.2020.138256.

Barbier, E. B. (2023). Greening the ocean economy. *Front. Environ. Econ., 2,* 1096303. https://doi.org/10.3389/frevc.2023.1096303.

Bari, A. (2017). Our oceans and the blue economy: Opportunities and challenges. *Procedia Eng.*, *194*, 5–11. https://doi.org/10.1016/j.proeng.2017.08.109.

Bennett, N. J., Blythe, J., White, C. S., & Campero, C. (2021). Blue growth and blue justice: Ten risks and solutions for the ocean economy. *Mar. Policy, 125,* 104387. https://doi.org/10.1016/j.marpol.2020.104387.

Brezina, I., Pekár, J. Čičková, Z., & Reiff, M. (2016). Herfindahl-Hirschman index level of concentration values modification and analysis of their change. *Cent. Eur. J. Oper. Res., 24*(1), 49–72. https://doi.org/10.1007/s10100-014-0350-y.

Britannica. (2024). Region. https://www.britannica.com/science/region-geography

Cambridge Dictionary. (n.d.). Region. https://dictionary.cambridge.org/dictionary/english/region

Chikodili, N. B., Abdulmalik, M. D., Abisoye, O. A., & Bashir, S. A. (2021). Outlier detection in multivariate time series data using a fusion of K-medoid, standardized Euclidean distance and Z-score. In *Information and Communication Technology and Applications*. Springer International Publishing, pp. 259–271. https://doi.org/10.1007/978-3-030-69143-1_21.

Diamantopoulos, A., Schlegelmilch, B., & Halkias, G. (2023). *Taking the Fear out of Data Analysis: Completely Revised. Significantly Extended and Still Fun*. Edward Elgar Publishing. https://doi.org/10.4337/9781803929842.

Djoric, Z. (2022). Blue economy: Concept research and review of the European Union. *Zbornik Matice Srpske Za Drustvene Nauke, 182*, 233–256. https://doi.org/10.2298/ZMSDN2282233D.

Elegbede, I. O., Akintola, S. L., Jimoh, A. A. A., Jolaosho, T. L., Smith-Godfrey, S., Oliveira, A., Oladosu, A. O., Ramalho, D. C., Moruf, R. O., Afolabi, S., & Oloko, A. (2023). Blue Economy (Sustainability). In *Encyclopedia of Sustainable Management*. Springer International Publishing. pp. 1–9. https://doi.org/10.1007/978-3-030-02006-4_401-1.

EU Blue Economy Observatory. (2024). In depth analytical tool. https://blue-economy-observatory.ec.europa.eu/depth-analytical-tool_en

European Union. (2022). Statistical regions in the European Union and partner countries: NUTS and statistical regions 2021: 2022 edition. https://data.europa.eu/doi/10.2785/321792

Eurostat. (2024). Gross domestic product (GDP) and main components (output, expenditure and income). https://ec.europa.eu/eurostat/databrowser/product/page/namq_10_gdp__custom_13023202

Figueiredo, F. & Cristina Mihaela, S. R. (2022). From green growth to the blue growth in the 2030 agenda goals. *Bull. Transilvania Univ. Braşov*, *14*(63), 23–30. https://doi.org/10.31926/but.ssl.2021.14.63.3.3.

Folch, D. C. & Spielman, S. E. (2014). Identifying regions based on flexible user-defined constraints. *Int. J. Geogr. Inf. Sci.*, *28*(1), 164–184. https://doi.org/10.1080/13658816.2013.848986.

Geor, J. (2023). Understanding quartiles and quintiles: Dividing data for analysis and comparison. *Math. Eterna, 13*(3).

Hartshorne, R. (1959). *Perspective on the Nature of Geography*. Literary Licensing.

Kirch, W. (2008). Z-score. In *Encyclopedia of Public Health*. Springer Netherlands. https://doi.org/10.1007/978-1-4020-5614-7_3826.

Kosanic, A. & Petzold. J. (2020). A systematic review of cultural ecosystem services and human wellbeing. *Ecosyst. Serv.*, *45*, 101168. https://doi.org/10.1016/j.ecoser.2020.101168.

Laino, E. & Iglesias, G. (2023). Extreme climate change hazards and impacts on European coastal cities: A review. *Renew. Sust. Energ. Rev., 184,* 113587. https://doi.org/10.1016/j.rser.2023.113587.

Mogila, Z., Ciolek, D., Toroj, A., & Zaucha, J. (2024). How important is the blue economy for regional development?—The case of Poland. *Mar. Policy, 168,* 106303. https://doi.org/10.1016/j.marpol.2024.106303.

Murtagh, F. & Legendre, P. (2014). Ward's hierarchical agglomerative clustering method: Which algorithms implement ward's criterion? *J. Classif.*, *31*(3), 274–295. https://doi.org/10.1007/s00357-014-9161-z.
Niestroy, I. (2016). How are we getting ready? The 2030 agenda for sustainable development in the EU and its member states: Analysis and action so far. IDOS. https://www.idos-research.de/en/discussion-paper/article/how-are-we-getting-ready-the-2030-agenda-for-sustainable-development-in-the-eu-and-its-member-states-analysis-and-action-so-far/
OECD. (2009). How regions grow: Trends and analysis. https://www.oecd.org/content/dam/oecd/en/publications/reports/2009/06/how-regions-grow_g1gh9f21/9789264039469-en.pdf
OECD. (2024). The blue economy in cities and regions: A territorial approach. https://www.oecd.org/en/publications/the-blue-economy-in-cities-and-regions_bd929b7d-en.html
Paasi. A. (2010). Commentary. *Environ. Plann. A Econ. Space*, *42*(10), 2296–2301. https://doi.org/10.1068/a42232.
Sandifer, P. A. & Scott, G. I. (2021). Coastlines, coastal cities, and climate change: A perspective on urgent research needs in the United States. *Front. Mar. Sci.*, *8*, 631986. https://doi.org/10.3389/fmars.2021.631986.
Sikhunyana. Z. & Mishi. S. (2023). Access, participation and socio-economic benefits of blue versus green economy: A systematic literature review. *Local Environ.*, *28*(12), 1552–1572. https://doi.org/10.1080/13549839.2023.2238748.
Smith-Godfrey, S. (2016). Defining the blue economy. *Marit. Aff. J. National Marit. Found India*, *12*(1), 58–64. https://doi.org/10.1080/09733159.2016.1175131.
Spalding, M. J. (2016). The new blue economy: The future of sustainability. *J. Ocean Coastal Econ.*, *2*(2), 8. https://doi.org/10.15351/2373-8456.1052.
Sumaila, U. R. & Tai, T. C. (2020). End overfishing and increase the resilience of the ocean to climate change. *Front. Mar. Sci.*, *7*, 523. https://doi.org/10.3389/fmars.2020.00523.
Uitto, J. I. (2019). Sustainable development evaluation: Understanding the nexus of natural and human systems. *New Dir. Evaluat.*, *2019*(162), 49–67. https://doi.org/10.1002/ev.20364.
United Nations. (2022). UN Ocean Conference. https://www.un.org/en/conferences/ocean2022
Van Langenhove, L. (2013). What is a region? Towards a statehood theory of regions. *Contemp. Polit.*, *19*(4), 474–490. https://doi.org/10.1080/13569775.2013.853392.
Van Soest, H. L., Van Vuuren, D. P., Hilaire, J., Minx, J. C., Harmsen, M. J. H. M., Krey, V., Popp, A., Riahi, K., & Luderer, G. (2019). Analysing interactions among sustainable development goals with integrated assessment models. *Glob. Transit.*, *1*, 210–225. https://doi.org/10.1016/j.glt.2019.10.004.
Venkataanusha, P., Anuradha, Ch., Chandra Murty, P. S. R., Kiran, Ch. S. (2019). Detecting outliers in high dimensional data sets using Z-score methodology. *Int. J. Innov. Tech. Explor. Eng.*, *9*(1), 48–53. https://doi.org/10.35940/ijitee.A3910.119119.
Wang, S. & Ahmad, N. S. (2024). Robust classification of UWB NLOS/LOS using combined FCE and XGBoost algorithms. *IEEE Access*, *12*, 151030–151045. https://doi.org/10.1109/ACCESS.2024.3480236.
Youssef, M. (2023). Blue economy literature review. *Int. J. Bus. Manag.*, *18*(3), 12. https://doi.org/10.5539/ijbm.v18n3p12.
Zukauskiene, J. & Snieska, V. (2023). The importance of investment for the green economy in countries at different levels of development. *J. Manag.*, *39*(2), 47–53. https://doi.org/10.38104/vadyba.2023.2.06.