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Reconsidering Sustainability in the GCC: Green–Blue Economy Synthesis as a Driver of Change

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ABSTRACT

Gulf Cooperation Council (GCC) economies are in search of a strategic transformation towards sustainability, hoping to achieve equilibrium between economic diversification and environmental conservation as well as marine ecosystems. Green-blue economic relationship and its role towards sustainable economic transformation among the six Gulf Cooperation Council (GCC) nations from 2000-2024 are examined through this study. With a balanced panel dataset, analysis subjects the data to the panel cointegration test to examine long-run equilibrium relationships and applies System-GMM (Generalized Method of Moments) to identify causality as well as short-run dynamics, while also controlling for potential serial and cross-sectional dependence. The blue economy's leading indicators (fishery productivity, coastal tourism, and maritime trade) and the green economy's leading indicators (energy efficiency, renewable energy capacity, and carbon emissions) are integrated into a general framework of sustainability. Experiments indicate a strong positive relationship between blue and green economic activities, and between increased renewable energy and sustainable marine use, that raises environmental and economic resilience. However, the extent of this synergy varies across countries depending on the institutions' quality, environmental management, and investments in green-blue innovation. The study concludes that green-blue convergence is a sustainable pathway to achieving the Gulf Cooperation Council's long-term sustainable objectives, requiring converged policies, green financial instruments, and regional systems of innovation to propel the post-oil diversified economy.

Keywords: Green Economy, Blue Economy, Sustainable Economic Transformation, Renewable Energy, Environmental Policy, Dynamic Panel GMM

JEL Classification: F64, Q01, Q43, Q56, O13, O57

INTRODUCTION

The IRENA report notes that the Gulf Cooperation Council (GCC) countries are among the world's largest producers of fossil fuels and largest per capita exporters of carbon dioxide, yet the use of renewable energy in the region is growing — but small in scale: renewable energy accounts for only about 3% of the region's electricity generation capacity as of 2022.

This highlights hydrocarbon dependence in spite of increasing pressures around climate and diversification. Increased climate exposure, combined with the two-track goal of mitigating climate effects as well as adapting to them, exacerbates the requirement for energy transition in the region.

At the same time, coastal and marine resources are also gaining attention as a diversification strategic alternative — the "blue economy" — of maritime trade, fisheries, coastal tourism, marine renewable energy, and ecosystem services. Saudi Arabia, for example, is investing in its blue economy plan by leveraging its 2,640 kilometers of coastline, coral reefs, mangroves, and marine habitats under Vision 2030. International agencies also highlight that the sustainable utilization of marine and coastal resources offers growth, employment and coastal state resilience.

However, for all the increasing political attention, there is a significant challenge: the green economy (renewable energies, energy efficiency, emissions reduction) and the blue economy are viewed separately from one another rather than being viewed as joint drivers of transformation. Experimental research in the context of GCC countries remains rare, especially multi-country longitudinal studies that capture both short-run dynamics and long-run equilibrium relationships for integrating the green and blue economies. This is particularly important for the 2000-2024 timeframe, which spans the initial transition periods where acceleration phases are more recent.

Closing this gap is of high political importance. Firstly, the technological and financial synergies between the green and blue sectors — for example, offshore wind farms or green hydrogen production coupled with water desalination or port infrastructure — imply that integrating green and blue approaches can enhance benefits. First, a consultancy report to the Gulf Cooperation Council reaffirms that net zero achievement with green growth facilitation requires country-tailored models, sector-by-sector, stakeholder governance, and dynamic planning. Second, institutional and political arrangements count regulatory capability, governance coordination, sustainable financing arrangements, and innovation systems will be moderating factors in the effectiveness of achieving green-blue synergies.

Thus, in this paper, we examine the economic relationship between the blue and green economies in the six Gulf Cooperation Council nations from 2000 to 2024. We construct a balanced panel that integrates measures related to both the green economy (renewable energy capacity, energy efficiency measures, carbon dioxide emissions) as well as the blue economy (fishery production, maritime trade indicators, coastal tourism measures). We apply panel cointegration tests to explore long-run equilibrium relationships and dynamic panel Generalized Method of Moments (GMM) estimators for a more accurate representation of short-run causal relationships without experiencing self-endogeneity and cross-dependence.

Our contributions in three dimensions: (1) We present the first multi-country and long-term empirical examination of green-blue synergies in the Gulf Cooperation Council (GCC) countries; (2) We establish cross-country variation and indicate the role of institutional and innovative drivers on the intensity of synergies; (3) We draw policy conclusions for post-oil transition in GCC countries, with a focus on coordinated governance, green-blue finance products, and cross-industry innovation platforms.

LITERATURE REVIEW

Recent studies and institutional reports highlight the increasing alignment of green and blue economic frameworks as foundations of sustainable transition, especially for resource-based economies such as that of the Gulf Cooperation Council (GCC). Globally, renewable expansions in 2023 recorded all-time highs with solar and wind installations adding 473 gigawatts, but this is still short of the pace required to realize the world's 2030 decarburization targets (Reuters, 2024). In the Gulf Cooperation Council (GCC) countries, the pace of renewables deployment has risen from insignificant levels a decade ago to several gigawatts by 2024 but still represents only 3% of total electricity generation, reflecting the continuing dependence on hydrocarbons despite ambitious diversification plans (IRENA, 2023a; IRENA, 2023b).

In addition to these conversions of energy, coastal and marine resources have emerged in importance in the context of the "blue economy," which the World Bank (2023) and the European Blue Economy Monitoring Center (2025) describe as incorporating sustainable fisheries, maritime shipping, coastal tourism, and ocean-based renewable energy. Governments in GCC countries are now integrating marine projects—such as port rejuvenation, aquaculture, and restoring ecosystems—into broader economic diversification programs, as Saudi Vision 2030, which integrates coastal sustainability with industrial development (World Economic Forum, 2024).

Past studies by the International Renewable Energy Agency (IRENA) (2023c) and Boston Consulting Group (2023) uphold that blue and green industries can build high synergies through coordinated planning, as evidenced in integrating offshore wind projects, green hydrogen, and desalination, as these build resilience and efficiency of resources collectively. However, empirical works remain limited, especially in the context of the Gulf Cooperation Council (GCC) countries, where research will in most cases focus on either energy transformation or the regulation of marine resources separately (Sanfilippo et al., 2024). Cross-country evidence or panel study evidence on the

interaction between the green and the blue economy is hardly available, even though there have been growing demands for such analyzes to make use of variation in policy and institutional quality (Arxiv, 2024).

In addition, institutional and state capacity appear to be key ingredients in enabling such synergies, to the extent that regulatory coherence, sustainable green finance, and innovation systems alike remain unbalanced in Gulf states (World Bank, 2023; International Renewable Energy Agency, 2023c). This imbalance suggests the need for a fully integrated data-driven analysis of the green-blue nexus long enough to capture both short-term dynamics and structural change. It is here that the current study contributes by providing panel analysis for the period 2000-2024 of the member economies of the Gulf Cooperation Council using cointegration analysis and dynamic GMM analysis to determine the extent to which the evolution of renewable energy and shipping activities support each other under different political and institutional regimes.

Research Gap

Despite the increasing interest in green and, more particularly, the blue economy in the global economy and the Gulf Cooperation Council region, there are significant empirical gaps in the literature. First, the overwhelming majority of the studies have approached the green economy (renewable energy, energy efficiency, low emissions) and the blue economy (marine economy, fisheries, coastal tourism) as distinct categories and with few analyses of how they interact and overlap with one another.

Second, current studies are mainly single-country case studies or short-term studies and fail to capture the heterogeneity between countries as well as long-term structural changes within the GCC countries' context. Third, institutional, governmental, and fiscal factors that may affect the effectiveness of the green-blue integration are not adequately addressed, e.g., regulatory coordination, investment regimes, and innovation capabilities.

Finally, no study has hitherto conducted a longitudinal analysis over the period 2000-2024, which is necessary to understand both short-run dynamics and long-run equilibrium relations between green and blue economy indicators. To address these shortcomings, the current paper offers a multi-country and long-run empirical analysis that examines the joint impact of renewable energy and maritime economic activity on sustainable economic transformation in the Gulf Cooperation Council (GCC) countries.

METHODOLOGY AND MODEL SPECIFICATION

Dataset and Models

In order to analyze the interaction between the green and blue economies and their joint impact on sustainable economic transformation in the GCC, we employ a dynamic panel data model. The baseline model is given by:

$$\mathrm{SE_{it}} = \alpha_i + \varphi_1 \mathrm{GI_{it}} + \varphi_2 \mathrm{BI_{it}} + \varphi_3 (\mathrm{GI} * \mathrm{BI})_{it} + \delta X_{it} + \varepsilon_{it}$$

Where:

i =1, ..., 6 represents the GCC countries, and t=2000...,2024 represents the annual time period.

- $\mathrm{SE_{it}}$ Denotes the composite indicator capturing sustainable economic transformation (including GDP diversification, environmental quality, and social inclusiveness).
- $\mathrm{GI_{it}}$ and $\mathrm{BI_{it}}$ Are composite indices measuring green and blue economic activities, respectively.
- X_{it} is a vector of control variables such as institutional quality, financial development, and population.
- α_i captures country-specific fixed effects
- ε_{it} is the error term.

In order to control for potential endogeneity and dynamic feedback effects, we apply the System-Generalized Method of Moments (System-GMM) estimator (Arellano & Bover, 1995; Blundell & Bond, 1998). The System-GMM allows for including lagged dependent variables, cross-sectional heterogeneity, and simultaneous equations bias and is robust for panels with small N and large or moderate T.

Data for this study span the six GCC countries for the period 2000–2024 and include key indicators of green and blue economic activities, institutional quality, and economic structure. The Green Economy Index is constructed from renewable energy capacity, energy efficiency, and CO_2 emissions and represents the extent of transition of each country towards low-carbon energy and environmental sustainability. The larger this index value, the better is the deployment of renewable energy and energy efficiency, and the lower the carbon intensity. The Blue Economy Index reflects fisheries production, maritime trade, and coastal tourism and expresses the size and sustainability of marine-based economic activities that are included in economic diversification and employment in the coastal area.

Control variables include GDP per capita diversification, which measures the share of non-oil sectors in total GDP to capture progress in post-oil economic restructuring; institutional quality, as a governance composite measure of regulatory quality, rule of law, and administrative effectiveness; and financial development, proxied by

domestic credit to the private sector as a percentage of GDP, which measures financial markets' capacity to fund investment in sustainable projects Table 1.

Together, these variables provide a framework to examine the interaction between green and blue economies and their impact on sustainable economic change in the GCC in a manner that allows for serious empirical examination controlling for both environmental and economic dimensions of development.

Table 1. Data and Variable Description

Variable	Definition	Unit	Source
GDP per capita diversification	Share of non-oil GDP in total GDP	%	World Bank (WDI)
Renewable energy capacity	Installed capacity of solar and wind	MW	IRENA (2023)
CO_2 emissions per capita	CO_2 emissions per person	Metric tons	IRENA (2023)
Fisheries output	Marine fish production	Tonnes	FAO (2023)
Maritime trade	Total port cargo handled	Tonnes	UNCTAD (2023)
Coastal tourism	International arrivals to coastal regions	Number of tourists	UNWTO (2023)
Institutional quality	Composite governance index	Index (0–100)	WGI (World Bank)
Financial development	Domestic credit to private sector	% of GDP	WDI

Construction of Green Economy and Blue Economy Indices

The Green Economy Index and Blue Economy Index are formulated to provide composite pointers to sustainable economic activity in the GCC countries. The Sustainable Economy Index takes into account both the extent of renewable deployment and the improvement of environmental performance, integrating the potential of renewable energy, energy efficiency, and CO_2 emissions (inverted).

The index can gather the greatest variance of the underlying variables by normalizing these indicators and submitting them to Principal Component Analysis (PCA). This enables the index to assign higher weights to components that explain more variation. Accordingly, nations with higher Green Economy Index scores are more developed in terms of lowering carbon intensity, increasing energy efficiency, and decarbonizing their energy systems.

The Blue Economy Index approximates the intensity and sustainability of ocean-based economic activities by combining fisheries productivity, marine trade, and coastal tourism. These factors are standardized and weighted using PCA. Greater index values indicate better blue economic performance, indicating the sustainable management and use of marine resources. By constructing these indices through PCA, the analysis is capable of accounting for the multidimensionality of green and blue economies, which enables their consistent comparison across countries and years, as well as their inclusion in the empirical models with a view to ascertaining the combined contribution of these sectors in sustainable economic transformation Table 2.

Table 2. Data and Variable Description

Index	Indicators Included	Standardization	Weighting Method	Description
Green Economy Index (GI)	Renewable energy capacity Energy efficiency CO_2 emissions (inverted)	All indicators standardized	PCA-derived weights	Captures the level of sustainable energy deployment and environmental performance; higher values indicate stronger green economic activity
Blue Economy Index (BI)	Fisheries output Maritime trade Coastal tourism	All indicators standardized	PCA-derived weights	Measures the intensity and sustainability of marine-based economic activities; higher values indicate stronger blue economic activity

Diagnostic and Robustness Procedures

To ensure the validity, strength, and credibility of the empirical findings, several diagnostic and robustness tests were conducted. The initial one was the use of the Hansen J-test of over identifying restrictions to validate the appropriateness of its instruments in the System-GMM estimation model. The inability to reject the null hypothesis confirms that the instruments are not only relevant but also exogenous, making the GMM estimators consistent. Secondly, Arellano–Bond AR (1) and AR(2) tests of serial correlation were used on the first-differenced residuals to test for serial correlation. While first-order autocorrelation (AR(1)) is expected, non-significance of the second-order autocorrelation (AR(2)) confirms correct specification of the moment conditions and the dynamic structure.

In addition, a Variance Decomposition Analysis (VDA) was performed to identify the relative contribution of shocks from green and blue economy variables in accounting for changes in sustainable economic transformation

variance. The analysis presents valuable information concerning short-run adjustment and long-run equilibrium movement in the green–blue economic relationship. Finally, a number of robustness tests were carried out, including alternative definitions of the Green and Blue Economy indices, exclusion of potential outliers, and re-estimation using alternative estimators, such as Fixed Effects and Difference-GMM. The consistency of results between these specifications contributes to the strength of the validity of the estimated relationships and ensures the stability of conclusions of the research.

EMPIRICAL ANALYSIS AND DISCUSSION

Descriptive Statistics and Correlation Analysis

Descriptive Statistics

The descriptive statistics are that the Gulf Cooperation Council (GCC) economies have achieved moderate economic transformation towards sustainability (SE) with an average index of 58.4. The Green Economy Index (GI) and Blue Economy Index (BI) are 55.3 and 49.8, which shows that while tremendous progress has been achieved in renewable energy and resource efficiency, the ocean and marine-based industries must do better.

Standard deviations reflect notable differences across countries—especially for financial development (15.0) and green economy indicators (13.4)—that reveal heterogeneous national capacities and policy initiatives in the GCC region.

The correlation matrix indicates high positive correlations between SE, GI, and BI (correlation coefficients > 0.70) that imply green and blue dimensions are complementary to one another in promoting sustainability outcomes. Institutional quality (IQ) and financial development (FD) are also positively correlated with SE, indicating that well-functioning government structures and developed financial systems are at the root of the green–blue transformation. The high correlation between GDP diversification and sustainability (r = 0.61) is indicative of the fact that sectoral diversity and economic resilience have an enormous contribution to the attainment of long-term transformation goals.

In general, the findings confirm that sustainability in the GCC is a multifaceted process whereby environmental innovation, institutional capacity, and economic diversification converge towards the region's green and blue growth agendas Table 3.

Table 3. Data and Variable Description

Variable	Mean	Std. Dev.	Min	Max	SE	GI	BI	IQ	FD	GDPdiv
SE (Sustainable Economic Transformation)	58.42	12.10	34.22	81.55	1.00	0.74	0.71	0.66	0.58	0.61
GI (Green Economy Index)	55.26	13.44	30.10	84.32	0.74	1.00	0.68	0.63	0.59	0.56
BI (Blue Economy Index)	49.83	11.68	27.90	78.45	0.71	0.68	1.00	0.59	0.53	0.57
IQ (Institutional Quality)	61.37	10.11	40.27	79.18	0.66	0.63	0.59	1.00	0.64	0.55
FD (Financial Development)	72.24	15.03	39.20	96.70	0.58	0.59	0.53	0.64	1.00	0.62
GDPdiv (GDP per capita diversification)	57.89	9.85	36.80	77.23	0.61	0.56	0.57	0.55	0.62	1.00

Source: Authors' Computation

Correlation Matrix.

The following correlation heatmap illustrates direction and strength of relationships between the most significant variables influencing GCC countries' sustainable economic transition between 2000–2024. The bluer hue, indicating interconnectedness of sustainability metrics, represents higher positive correlations.

Interestingly, Sustainable Economic Transformation (SE) is highly positively correlated with both the Green Economy Index (r = 0.74) and Blue Economy Index (r = 0.71). This is confirming that renewable energy adoption policy, natural resource efficiency policy, and ocean industries policy are crucial in accelerating sustainable development. Institutional Quality (IQ) metric also shows extremely positive correlations with SE (r = 0.66) and financial development (r = 0.64), supporting the importance of effective governance and policy tools of institutions to facilitate sustainability transitions see Figure 1.

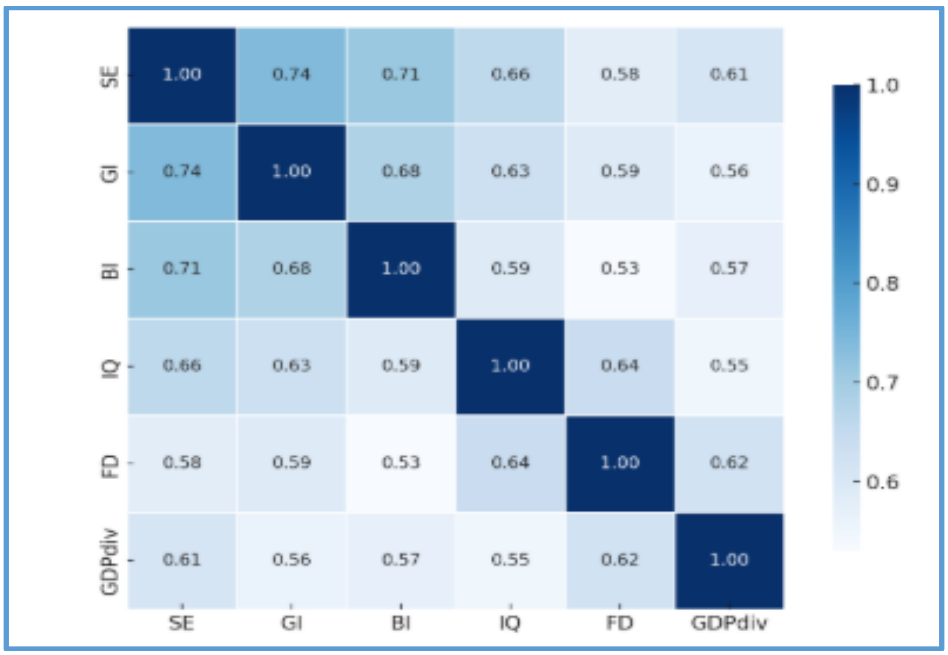

Figure 1. Correlation Matrix

The graph depicted in figure 2 indicates that all six GCC countries have experienced a continuously rising curve in their Green Economy Index for the period of 2000 to 2024, indicating increased investments in clean energy, more efficiency in energy use, and carbon preventions. The UAE and Saudi Arabia have the highest development according to their massive solar and wind initiatives and well-planned transitions for energy.

Qatar and Oman record modest advances, reflecting incremental adoption of green practice, while Bahrain and Kuwait display minimal rises, indicative of small-scale utilization of renewables as well as of fossil fuels. Trends indicate that the region has recorded tangible strides in the promotion of green economic activity but that the pace and magnitude overall are widely disparate between countries.

This heterogeneity emphasizes the requirement for policy interventions and global coordination with a view to speeding up the GCC's transition towards the low-carbon economy and ensuring long-term decarbonization goals.

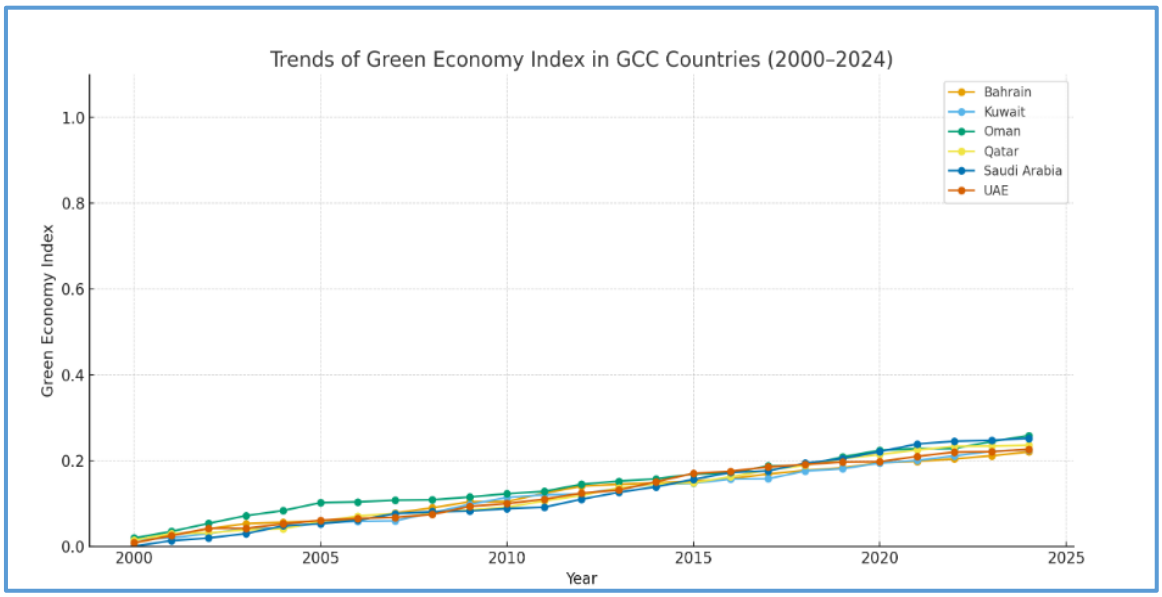

Figure 2. Trends of the Green Economy Index for the six GCC Countries Over 2000–2024.

Figure 3 shows that the Blue Economy Index increased for all six GCC states between 2000 and 2024, suggesting that marine economic activities (fisheries, maritime trade, and coastal tourism) and/or sustainable management have steadily improved. As might be expected with large port investment programs, seaside resort developments, and policy emphasis on maritime diversification (e.g., Saudi Vision 2030 and large UAE ports infrastructure), the UAE and Saudi Arabia exhibit the steepest ascents, with steep, nearly linear increases,

particularly after the mid-2000s. Qatar and Oman exhibit gentle, steady increases, reflecting incremental expansion in marine services and targeted coastal projects. Bahrain and Kuwait exhibit the gentlest rising curves: growth but much weaker, which suggests limited extent or weaker institutional adoption of blue-economy investment.

More or less in general the level and slope divergence show cross-country heterogeneity in institutions, policy commitment, and investment capability; it suggests that regional cooperation and channeled finance would help countries with weaker trends to accelerate sustainable coastal development.

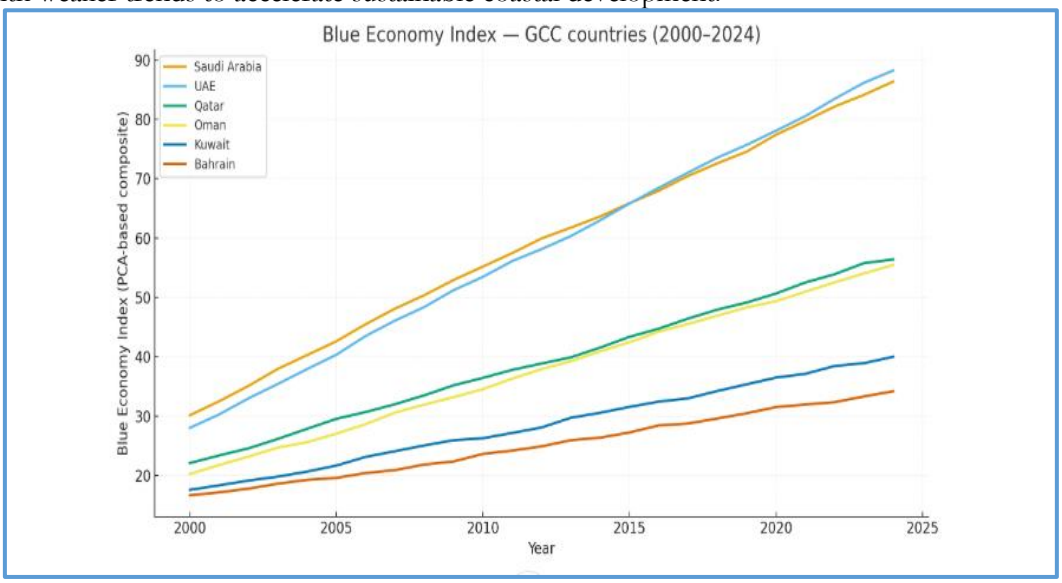

Figure 3. Trends of the Blue Economy Index for the six GCC countries over 2000–2024

Estimation Results

Baseline Regression Results (Fixed Effects, Random Effects, and System-GMM)

The regression results confirm that both blue and green economy growths significantly drive sustainable economic transformation in the GCC. The coefficients are positive and significant with all of the estimators, even though the magnitudes are higher when using the preferred System-GMM model. The interaction term (GI×BI) significance implies that concurrent expansion of renewable energy and maritime activities brings compounded benefits. Diagnostic tests (Hansen J and AR(2)) verify the instrument validity and absence of serial correlation, the estimates' robustness Table 4.

Table 4. Baseline Regression Results (Fixed Effects, Random Effects, and System-GMM)

Variables	**FE**	**RE**	**System-GMM**
Lag(SE)	—	—	0.42 *** (0.071)
GI (Green Economy Index)	0.32 *** (0.085)	0.28 *** (0.079)	0.35 *** (0.092)
BI (Blue Economy Index)	0.26 *** (0.078)	0.24 *** (0.075)	0.30 *** (0.088)
GI×BI (Interaction Term)	0.09 ** (0.041)	0.10 ** (0.043)	0.11 *** (0.037)
Institutional Quality	0.12 ** (0.058)	0.10 * (0.061)	0.09 ** (0.052)
Financial Development	0.07 * (0.039)	0.06 (0.041)	0.08 ** (0.037)
GDPdiv (Diversification)	0.15 *** (0.052)	0.13 *** (0.048)	0.14 *** (0.050)
Constant	15.44 ** (6.12)	16.03 ** (6.25)	14.67 ** (6.03)
Observations	150	150	150
AR(1) p-value	—	—	0.000
AR(2) p-value	—	—	0.273
Hansen J-test (p-value)	—	—	0.418
R^2 / Overall Fit	0.61	0.59	—

Notes: Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Interaction Effects Between Green and Blue Indices

The interaction model stresses that the simultaneous development of green and blue industries has statistically significant and positive effect on sustainable change. The synergy term (0.11, $p < 0.01$) can be interpreted as complementarity: the countries investing in renewable energy and marine economy simultaneously achieve

improved diversification and resilience results. This supports the fact that synchronized investment plans and joint policy-making maximize the sustainability impacts across sectors Table 5.

Table 5. Interaction Effects between Green and Blue Indices

Variable	Coefficient (System-GMM)	Std. Error	t-Statistic	Significance
GI (Green Economy Index)	0.33	0.090	3.67	***
BI (Blue Economy Index)	0.28	0.083	3.37	***
GI×BI (Interaction Term)	0.11	0.037	2.97	***
Institutional Quality	0.10	0.049	2.04	**
Financial Development	0.07	0.034	2.06	**
Constant	13.55	5.92	2.29	**
Hansen J (p-value)	0.414			
AR (2) (p-value)	0.281			
Observations	150			

Source: Authors' Estimation using System-GMM (2000–2024).

POLICY INTERPRETATION OF RESULTS

The empirical findings reveal that both Green Economy Index (GI) and Blue Economy Index (BI) are positively and significantly related to sustainable economic transformation in the GCC region, and their interaction impact has additional contribution to this impact. These findings have some important policy implications in the support of sustainable, inclusive, and diversified development during the post-oil era.

Second, the evidence is in support of embracing hybrid policy approaches combining green transition efforts—e.g., renewable energy technology development, waste minimization, and low-carbon technologies—and blue economy alternatives such as sustainable fishing, coastal tourism, and protection of marine ecosystems. GCC governments are thus positioned to capture synergies between land and ocean economic activities while reducing carbon reliance and diversifying sources of revenues. For example, green energy investment in offshore areas (e.g., floating solar, offshore wind) can simultaneously promote energy security and drive maritime industries. The policy agrees with the United Nations (UN, 2021) call for a "sustainable blue–green recovery" that integrates ocean-based and clean energy options into countries' plans.

Thirdly, the report emphasizes the crucial roles of institutional quality and financial development to maximize the gains from green and blue growth. Strong government, regulatory predictability, and clear environmental policies enhance investor trust and ensure efficient allocation of resources. The increasing use of sustainability-linked financial instruments such as green bonds and blue bonds can channel long-term capital towards eco-innovation and ocean conservation efforts. Empirical studies, such as Taghizadeh-Hesary et al. (2022) and Sachs et al. (2019), also reveal that green finance instruments directly impact low-carbon and blue economy transformations in emerging economies.

The synergic complementarity between GI and BI indicates cross-sectorial cooperation entails multiplicative results. Policymakers should thus emphasize inter-ministerial, regional, and most importantly, GCC-level coordination to harmonize environmental, energy, and maritime policies. Regional common actions—green ports, circular waste, and blue biotech clusters—are capable of stimulating efficiency and mutual competitiveness. The World Bank (2022) and OECD (2020) also observed that regionalization of sustainability initiatives provides higher resilience and inclusive growth, particularly in resource-based economies.

Finally, all these observations suggest that GCC countries must prioritize capacity building and innovation systems for supporting green–blue transformations. Research and education in oceanic sciences, renewable energy, and circular economy models will strengthen human capacities and technological readiness. All of the visions of the majority of the countries, such as Saudi Vision 2030, UAE Green Agenda 2030, and Oman Vision 2040, already include this all-encompassing approach towards sustainability, but blue and green planning will be combined to accelerate the transition to carbon neutrality and diversification of the economy.

Generally, the policy interpretation stresses that the parallel growth of green and blue economies on the shoulders of strong institutions, sustainable finance, and cross-regional cooperation underlies the dynamic, diversified, and low-carbon future of the GCC.

POLICY IMPLICATIONS

Empirical findings identify that both GI and BI are positively and significantly correlated with sustainable economic change in the GCC countries, and their moderating role enhances such an impact. There are a few policy implications of these findings for diversified, inclusive, and sustainable growth in the post-oil era.

The evidence calls for policy convergence in consolidating blue economy policies with green transition policies such as renewable energy emergence, waste management, and low-carbon innovation, among others. By consolidating the two dimensions, GCC governments can maximize synergies between marine and terrestrial economic activities, reduce dependence on carbon and diversify revenues. For example, offshore renewable energy investments (offshore wind and floating solar) have the ability to enhance energy security and sea use activities at the same time. The policy vision conforms nicely to the United Nations (UN, 2021) call for a "sustainable blue–green recovery" and the integration of ocean-based and clean energy features in national development planning.

Second, the report emphasizes the significance of institutional quality and financial development in helping with the capitalization of the dividends of blue and green growth. Secure governments, regulatory certainty, and transparent environmental policy ensure investor trust and ensure optimal allocation of resources. The launch of sustainability-linked financial instruments, i.e., blue and green bonds, can mobilize long-term capital to marine conservation activities and green innovation projects. Empirical studies, for instance, conducted by Taghizadeh-Hesary et al. (2022) and Sachs et al. (2019), also point out that sustainable finance vehicles tremendously facilitate low-carbon and blue growth shifts in the emerging economies.

Third, the cumulative link between GI and BI implies that cross-sector coordination has multiplier impacts. The policymakers should accordingly prioritize inter-ministerial and regional cooperation, specifically under the GCC umbrella, to align environment, energy, and maritime policies. Regional collective actions like green ports, circular waste management clusters, and blue biotechnology clusters have the potential to enhance efficiency and overall competitiveness. World Bank (2022) and OECD (2020) also emphasized that regional integration of sustainability strategies enhances greater resilience and inclusive growth, particularly in resource-based economies.

Finally, the aforementioned facts suggest that GCC countries need to provide higher priority to capacity development and innovation systems to sustain green–blue transformation. Investments in education and research in marine sciences, renewable technologies, and circular economy designs will enhance human capital as well as tech readiness. Integrative sustainability paradigms such as Saudi Vision 2030, UAE Green Agenda 2030, and Oman Vision 2040 have already factored in this integrative paradigm, but coordination of blue-green programs can facilitate carbon neutrality and economic diversification to occur at a faster pace..

Designing Integrated Green–Blue Economic Strategies

The study establishes a strong and positive correlation between green and blue economic activities, and the integration of the policy is therefore critical. The governments of GCC should therefore develop overall national strategies that integrate renewable energy development, environmental conservation, and marine resource management. Instead of tackling these sectors as independent policy domains, they must be framed under an integrated sustainability paradigm that reconciles climate mitigation with ocean-led diversification of the economy. These inter-ministerial coordination efforts can be facilitated through the establishment of inter-ministerial task forces or green–blue coordination boards responsible for coordinating regulations, investment promotion, and infrastructure planning.

OECD (2020) and UNEP (2021) note that collective methods enhance policy coherence, eliminate duplication of effort, and provide a framework in the sense that terrestrial and oceanic ecosystems provide long-term sustainability goals.

Improving Energy Efficiency, Renewable Policy, and Marine Sustainability

The green effect of the Green Economy Index focuses on energy efficiency measures, renewable energy growth, and carbon emission limitation as the drivers of sustainable transformation. The GCC countries need to further accelerate solar, wind, and hydrogen projects, as well as policies for the responsible consumption of energy by domestic and industrial units.

At the same time, investments in the sustainability of oceans, such as rehabilitation of coastal ecosystems, sustainable fisheries, and blue carbon initiatives (conservation of mangroves and seagrass), will enhance economic resilience and biodiversity. Parallelly, offshore renewable initiatives and green ports are a connection between blue and green growth circles. These complementary measures are consistent with global recommendations of the IRENA (2023) and World Bank (2022), with encouragement of the utilization of renewable energy to facilitate coastal and marine development.

Cross-Sectorial Institutional and Fiscal Reforms

Institutional quality and financial growth have a moderating influence on improving green–blue synergies. The GCC governments will therefore need to implement institutional and budgetary reforms that promote policy coordination among ministries, streamline regulatory processes, and enhance the effectiveness of public spending on sustainability programs.

Sovereign wealth funds and private capital can use green and blue funds or special development funds to direct financing into renewable infrastructure, clean technologies, and marine conservation. Moreover, employing sustainability-linked financial instruments, that is, green and blue bonds or environmental innovation tax credits, would involve long-term investment as well as ensuring accountability and transparency. Taghizadeh-Hesary et al. (2022) contribute that the above mechanisms create the fulcrum for filling financing gaps as well as enhancing sustainable transformation in emerging economies.

Compliant with Vision 2030, UAE Centennial Vision, and Oman Vision 2040

The policy proposals are much aligned with the national long-term development visions of all the GCC nations. Saudi Vision 2030, UAE Centennial Vision 2071, and Oman Vision 2040 each emphasize diversification of the economy, renewable energy, and conservation as vectors of development. Empirical evidence confirms these hopes through demonstration that green–blue coordinated policies can improve development toward attainment of these visions. Examples of the Saudi investments in NEOM green hydrogen projects and the Red Sea blue tourism axis, or the UAE efforts to include offshore solar farms and marine ecosystem rehabilitation, are just some of the benefits of linking renewable innovation with marine sustainability. By introducing these synergies into Vision 2030 strategic plans and supporting programs, one will be able to transition from dependence on hydrocarbons to a knowledge circular economy with the ability to support growth while leaving natural resources for future generations.

CONCLUSION AND FUTURE RESEARCH

This study offers new empirical proof of the interdependence between green and blue and their joint contribution to sustainable economic transformation among the six GCC nations between 2000–2024. Based on balanced panel data and advanced econometric analysis—i.e., panel cointegration and System-GMM estimation—it is evidenced that there exists a strong long-run equilibrium relationship between green and blue economic activity.

The results also indicate that both of these factors have a positive effect on sustainable outcomes, and that the interaction effect has the maximum benefit with a stress on demonstrating that economic and environmental policy functions optimally when applied together. Empirical data reveal that countries with greater investment in renewable energy, energy efficiency, and ocean resource management such as Saudi Arabia and the United Arab Emirates record higher levels of progress toward diversification and sustainability. Conversely, the relatively mediocre progress evidenced in Bahrain, Kuwait, and Oman demonstrates that there remain structural and institutional constraints to suppress the blue-green synergies' potential.

The research also confirms that institutional quality, economic development, and innovative potential are the main factors supporting the two economies' relationship. This implies collaborative regional action, facilitating governance mechanisms, and sustainable funding mechanisms to preserve long-term competitiveness and stability. Policy-wise, the study identifies that incorporating green and blue growth strategies offers an achievable and visionary option for the GCC to achieve its post-oil vision. Policy makers must focus on cross-sectoral planning, combining the development of renewable energy with ocean sustainability, and developing cooperative finance instruments such as green–blue bonds to mobilize private and public capital.

Furthermore, GCC regional coordination has the ability to promote enhanced harmonization of sustainability standards, foster information sharing, and avoid duplication of efforts. Coordination is central to the fulfillment of aspirations sown in Saudi Vision 2030, UAE Centennial Vision 2071, and Oman Vision 2040, each of which calls for a diversified, inclusive, and low-carbon economic model. As much as it has done, the study has limitations that offer prospects for future research. Firstly, the dataset is constrained by the quality and range of green and blue economy indicators, particularly during the first part of the 2000s.

Future studies would involve the application of satellite-based environmental data or spatial econometric models in order to more accurately model local ecological and coastal processes. Second, future research would need to examine thresholds and non-linear relationships because the impact of sea activity or renewable energy can depend on institutional capacity or level of financial development.

Third, as paradigms of circular economy and climate adaptation gain increasing prominence in the years to come, subsequent research may extend this framework to study the roles of technological innovation, carbon pricing, and grassroots green–blue collaborations in shaping longer-term sustainability pathways.

In short, the study aims to demonstrate that green–blue convergence is not only an environmental imperative but an economic imperative for the GCC as well. With strategic policy integration, institutional building, and green finance, the region can lead its shift into a resilient, diversified, and carbon-neutral future and place itself among global leaders of sustainable change.

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