Investigating the Nexus Between the Blue and Green Economy Towards' Economic Growth of South Africa

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Abstract

Economic growth has experienced massive disruptions in various economic sectors concerning the demand and supply of goods worldwide. This has led to significant attention from multiple scholars to discover the blue and green economy effects on economic growth. Numerous economies adopted either the blue or green economy due to high financing requirements, and insufficient revenues generated within the country context. This study applied a qualitative approach to investigate the nexus between the blue and green economy towards the economic growth of South Africa through secondary time series data from 1990 to 2020. The ARDL model was used to show a long-term equilibrium relationship between the blue and green economy and the economic growth of South Africa. The econometric techniques were executed to reveal the economic growth status of South Africa, concerning the blue and green economy. This research is innovative as it has integrated the blue and green economic idea to reveal that total factor productivity, and total greenhouse emission equivalent to C02 have a positive influence on the economic growth of South Africa. The positive GHGE_C02 is ushered by insignificance in both periods revealing that South Africa is behind in promoting some SDGs to sustain economic growth. This study has also found that adopting the blue and green economy aspect is an unavoidable key to achieving numerous Sustainable Development Goals which are fundamental for reaching economic growth. This study revealed that proper administration and utilization of water and environmental resources may assist in instigating economic growth. This study intends to encourage South African policymakers to adopt both the blue and green economy and to add a comprehensive system that will value adapting and modifying relevant, and effective strategies for sustainable economic growth, by considering the adoption of normal resource use through the blue and green economy while addressing economic growth challenges.

Keywords: Economic Growth, Blue and Green Economy, Resources, South Africa

INTRODUCTION

The global attention on the emerging paradigm of the ocean or maritime economy also known as the blue economy and the climate change and energy efficiency or environmental problems also known as the green economy (henceforward: blue and green) has grown in the heart of most developed countries economic and political agendas literature (Sachs, *et al*., 2021; Liang & Qamruzzaman, 2022). This has made African countries go all-out to respond to numerous economic, environmental, and societal crises enshrined in the United Nations (UN) Sustainable Development Goals (SDGs) no 8, 12, 13, 14, and 15, to establish the blue and green economy as alluded by Montmasson-Clair and das Nair (2017) and Partnership for Action on Green Economy

(PAGE) (2018). These SDGs are vital to promote sustained inclusive, and prominent economic growth. Furthermore, attaining full and productive employment, and decent work for all requires ensuring that sustainable consumption and production patterns are well maintained. Moreover, countries are keen to take urgent action to combat climate change and its impacts. Absolute considerations are directed to conservation, and sustaining the use of the oceans, seas, and marine resources for maintainable development to protect, restore, and promote the use of terrestrial ecosystems. Moreover, it is worthwhile to note that, the SDGs particularly distinguished the importance of forest sustainability and management, combat desertification, reverse land degradation, and halt biodiversity loss as itemized in the United Nations (2024).

The blue economy has also been referred to numerous concepts such as social inclusion, water-dependent businesses in the fields of tourism, and environmental sustainability. Its prominence strength was discovered in maritime ecosystems such as transportation, energy, and fishing, as well as transparent governance to encourage economic growth and development (Liang & Qamruzzaman, 2022; Ahammed, *et al*., 2024). According to Mahmood, Hussein, and Hussein (2018); Mahmood, and Hussein (2020); Muhaimid, Saleh, and Mohammed (2022), the blue economy is considered an economy where consumption and production patterns have low cost to increase human well-being and generate job opportunities. Furthermore, it was used to reduce environmental risks and economic scarcity by facilitating the continued delivery of goods and services for current and future generations to achieve comprehensive economic growth.

Among most definitions, this study recognized the contributions of the blue economy by Cisneros- Montemayor (2019) and Voyer *et al.* (2018) who emphasize that it can be used as a general link between economic growth and ecological sustainability to promote oceans as a way and a source of making a living, and new ideas to enhance good business. Furthermore, for environmental sustainability, economic development, and improved livelihoods to function, the ethical exploitation of marine resources that comprehend a broad range of industries, including aquaculture, shipping, tourism, renewable energy, and marine biotechnology must be used to harvest the expansion of the global economy and the development which provides new jobs, new business opportunities and expand the coastal economy, particularly in developing nations as mentioned by Ahammed *et al.* (2024).

Apart from numerous studies such as Cisneros- Montemayor (2019); Voyer *et al*. (2018), and Ahammed *et al.* (2024) that focus on the blue economy, the current study opted for both blue and green economy. Green economy as a concept, has been linked with different meanings, interpretations, and theories from numerous researchers. According to Lavrinenko *et al*. (2019), the green economy is understood as a social condition within a nation that originates in discussions around the environment and development. Furthermore, in 1992, the United Nations Conference on Environment and Development (UNCED) used this platform for discussion and promotion of numerous terms such as sustainable development. The current study adopted the green economy definition after Montmasson-Clair, and das Nair (2017), and Lavrinenko *et al*.

(2019). The green economy concept describes a long-term approach and objectives within a national economy to respond to economic recovery; poverty eradication; reduction of carbon emissions, and prevention of the degradation of ecosystems crisis. Furthermore, the green economy is an enabling tool for achieving resource productivity, and clean production, and is popular for the fulfillment of SDGs through the transition of economic, environmental, and societal pillars.

According to Dissanayake, Withanawasam, and Sarjoon (2021), the SDGs, blue and green economy purpose and vision are the same and are focused on improving human well-being, social inclusiveness, and the reduction of environmental risks. Furthermore, their economic growth perspective is rapt towards strengthening the existing governance mechanism and bringing available new economic policies as a requirement for economic expansion to balance the competing needs of both the economy and the environment through the blue and green economic standards. Hence, the researcher has identified that this growing strand of literature on the blue and green economy is gaining enormous power, however, the economic growth of South Africa remained unfavorable. Having understood this incident, entirely, the researcher saw an aperture to investigate the nexus between the blue and green economy towards the economic growth of South Africa.

The significance of this study provides weight, since the world has experienced the COVID-19 pandemic and realized that numerous businesses were shut down to sustain social or human safety with less regard to other things such as the economy and the environment. This problem was added amid some other existing challenges enlisted by Malima, Kilonzo, and Zuwarimwe (2022), Mutanda (2022), Kwilinski, Lyulyov, and Pimonenko (2023), as well as Pali (2024) such as the electricity crisis, poor water supply, looting as well as xenophobia challenges and sentiments that South Africa is judged for. It is worth noting that the quest for economic growth has been undermined despite the effort made to pursue either a blue or green economy in isolation. These challenges made the economic growth of South Africa present a different setting.
Then, this study serves as a significant path to advance knowledge about investigations of the nexus between the blue and green economy towards the economic growth of South Africa. Theoretically, the study has documented the appropriateness of the Environmental Kuznets Curve and the Ecological Modernization Theory in the context of the blue and green economy toward economic growth. As a result, this study has provided valuable improvements and understanding to the body of knowledge on the nexus between the blue and green economy that can refresh economic growth in general. The current study approach contradicts several researchers such as B ˘adîrcea *et al.* (2021), Dissanayake *et al.* (2021), and Muhaimid *et al.* (2022) who considered conceptual analysis, panel data, pooled mean group, fully modified ordinary least squares and the vector error correction model when analyzing blue economy framework. Further critiques were directed to the usage of macro panel data, dynamic system generalized methods of moments, cross-sectional autoregressive distributed lags, augmented mean group, and the common correlated effect mean group that was suggested by Khan *et al.* (2023), Gbolonyo,

Ofori, and Ojong (2024), and Wani, Loganathan, and Esmail (2024) when studying the green economy towards economic growth.

Previous scholars separated the blue and green economy which made their attempt uninspiring compared to the current study approach. This study applied the Autoregressive Distributed Lag techniques to check the nexus of blue and green economies concurrently toward economic growth. The ARDL technique was selected based on its prominence to connect the short-run and long-run influence on the blue and green economy setting concerning economic growth. The economic growth of South Africa condition has provoked the need to investigate the prevailing gap in the nexus between the blue and green economies towards economic growth. It is against this background, that the novelty of the current study concentrated on the nexus between the blue and green economy and economic growth using time series data spanning from 1990 to 2020 to improve economic growth. Hence, this study has made an effort to relate to, whether the nexus between the blue and green economies responds to the economic growth of South Africa or not. This study is organized as follows; literature review is presented in section 2. The study materials and methods form part of section 3, while section 4 was used to describe the analysis and interpretation of empirical results. Section 5 provides a conclusion and recommendations for policy directions.

LITERATURE REVIEW

The literature review is divided into theoretical and empirical literature.

Theoretical Literature

This section presents the environmental Kuznets curve and the Ecological Modernization Theory. The study executed the Environmental Kuznets Curve (EKC) due to its potential suggestions noted by Grossman and Krueger (1991), World Bank (1992), Levinson (2002), and Liu *et al*. (2018) to achieve sustainable economic growth in the future and to estimate various indicators associated with the environment. According to Perman, and Stern (2003), the EKCs are merely quadratic functions that are used to display income patterns. As a result, numerous economic activities positively damage the environment with the notion that as incomes rise, there are developments that transpire in environmental quality. Arrow *et al* (1995), Suri, and Chapman (1998), and Andreoni, and Levinson (2001) revealed that the inverse-U relationship of the EKC curve can be used to denote the existence of natural development within economic growth. Hence, fair economic service can be achieved when advanced economies export their greenhouse gasses to less-developed countries to clean their agricultural economies through polluting industrial economies. Alternatively, the inverse-U relationship involves internalizing and collective decision-making to manage pollution externalities and implementation within economies.

According to Grossman and Krueger (1991), Kuznets (1955), World Bank (1992), and Levinson (2002), the EKC pollution pattern takes superficial likeness to display the level of inequality, income per capita, and some measures of environmental quality that deteriorate the countries' economic growth. As a result, the environments of poor countries are likely to get more polluted as well as their economic growth. Whereas rich countries utilize the polluted environment to improve their economic growth. The inverse-U-shaped pollution income path is dependable to either Pareto-efficient policies, or sub-optimal behavior as mentioned by Andreoni, and Levinson (2001) and Levinson (2002). Furthermore, it symbolizes and senses the existence of market failures which implies that there are either unproductive/ wasteful or sufficient policies in place to justify laissez-faire pollution procedures.

According to Tenaw, and Beyene (2021), and Khan *et al*. (2023), the EKC theory is established on the scale effect, composition effect, and technique impact concepts. When the economy uses energy and raw materials natural resources also grow under the scale effect. Furthermore, the scale effect is harmful to the environment. Utilization of productive energy resources in the production and consumption processes decreases the level of unused waste and boosts the use of energy productivity. Accordingly, a rise in efficient usage of energy leads to energy savings which automatically increases and enhances sustainable economic development and environmental quality by reducing the level of carbon dioxide emissions. This serves as an implication that the EKC influences green technological innovation by promoting technologies and skills that use natural resources to save energy and protect the environment. It is worth noting that, after realizing the impact of the EKC on the environment, the current study also adopts the Ecological Modernization Theory (EMT), since it was identified as the best system and operation by the industrial developed world for avoiding the ecological or environmental misfortunes as also suggested by Spaargaren, and Mol (1992), Fisher, and Freudenburg (2001), Ahmed *et al*., (2022), and Khan *et al* (2023). Besides, the EMT was used to change and adjust industrial ecological processes to cause less damage to the environment by handling the green innovation influence on technical innovation towards ecological problems and to support the creation of a green economy. Moreover, the EMT is considered economically feasible and politically feasible, unlike the previous work on society environment associations.

The current study contributions and understanding of the ECK and EMT hypothetical is that the EKC inverse-U-shaped pollution-income paths result from systematic complex causes to indicate that there are market failures or effective provision of resources. The key insight is that the inverse-U is driven from a technological link to present desirable good and undesirable side-effect. The EMT theory clearly explains the market-changing aspects of environmental improvements and anticipated economic development to be completed by the political actors or officials. The current study selected theories that can be used to make contributions that will guide policymakers to refresh economic growth while minimizing environmental damage.

Empirical Literature

This section presents the nexus between the blue and green economy on economic growth. Dissanayake *et al.* (2021) assessed the conceptual nexuses between sustainable development and a blue-green economic economy to report that the use of a Blue-Green economy provides obvious features towards achieving numerous fundamental SDG goals. The study utilizes existing and available secondary literature such as books, journal articles, and reports, to name a few.

Muhaimid *et al.* (2022) measured the impact of the blue economy on economic growth for the selected European countries. The study utilized panel data for eleven selected countries from 2010-2019. The findings revealed that the total production of capital, and the total goods transported through the ports (both measured in tons) provide a positive influence on economic growth for Belgium, Netherlands, Bulgaria, Germany, Estonia, Slovenia, Spain, France, Croatia, Italy, and the United Kingdom only in the short run. However, the total fish production will cause a negative consequence on economic growth during the long run period as exposed by the robust pooled mean group (PMG) technique.

According to OECD (2016), by 2030 the global blue economy is projected to double its growth more than the general economy. Furthermore, the Food and Agriculture Organization of the United Nations (FAO) (2018) has highlighted the significance of fishing and aquaculture for nourishment as well as the welfare of people. As a result, millions of people are hired in these fields, although there is a need for those individuals to be capacitated in various areas such as managing the fish stock below the level of political sustainability, providing the correct treatment to combat disease, and as well as managing the marine biosecurity.

B ˘adîrcea *et al.* (2021) considered annual panel data from 2009 to 2018 to identify the causality relations between greenhouse gas emissions, the blue economy, and economic growth for 28 European Union (EU) countries. The fully modified ordinary least squares (FMOLS) estimator and the vector error correction model (VECM) were useful in revealing that the blue economy significantly influences greenhouse gas emissions during the long run period. On the other hand, the monodirectional relationship was recognized from the economic growth to greenhouse gas emissions which affect both the long-term and short-term period the other way round.

According to Hussein, ALSaqa, and Mahmood (2020); Ismail, Mahmood, and Hussein (2021), and Abdullah, and Hussein (2022), more than 820 million people worldwide livelihoods provided by the blue economy businesses such as shipping and related transport, energy generation, mining, construction, trading, as well as tourism, and research essential services. Furthermore, the blue economy is central to fishing and aquaculture livelihoods. The blue economy has created several distributions of opportunities and benefits worldwide, particularly in developing countries. As a result, the world's production of fish has increased to approximately 171 million tons. An estimated half of around 362 billion US dollars is provided from aquaculture, and fish represent almost 20% of the individual intake of animal protein. Moreover, approximately 3.2 billion people signify the global animal protein food supply with 17% of the global supply of animal protein food respectively. According to the International Fund for Agricultural Development (IFAD) (2024), there is a massive annual growth rate of about 6% which has been distinguished from the aquaculture sector and other core food production sectors. Approximately 60 million people are enjoying primary employment or livelihood such as fishing or aquaculture. Moreover, developing countries within Asia and Africa are responsible for more than 96%.

Ahammed *et al.* (2024) examined how blue economy elements affect China's economy using secondary time-series data from 1980 to 2019. The Autoregressive distributed lag (ARDL) approach was used to reveal that seafood availability in developing parts of China may boost economic development and reduce food poverty. Furthermore, the majority of the surfaces within the blue economy framework such as aquaculture, agriculture, forestry, fishing, and fisheries contribute positively to the advancement of Chinese economic development and can foster global collaboration to ensure the sustainability of water resources. Likewise, China has shown the potential to harness marine resources and intellectual property to promote fresh commercial prospects that enhance economic prosperity and environmental well-being concurrently. Lastly, total fisheries production, agriculture, forestry, fishing, aquaculture production, as well as trade, and gross capital formation revealed that there is positive, and statistically significant cointegration of China's economic development in the short run.

Gbolonyo, Ofori, and Ojong (2024) assessed if economic complexity promotes inclusive green growth using macro data and dynamic system generalized methods of moments (GMM) and the Driscoll-Kraay standard errors estimators for 22 selected African countries. The results showed that non-renewable energy reduces inclusive green growth, while renewable energy increases environmental and socioeconomic sustainability by decomposing inclusive green growth. Zaidi and Ferhi (2019) investigated the Sub-Saharan countries causal relationship between energy consumption, economic growth, and $CO2$ emission from 2002 to 2012. The dynamic simultaneous equation was used to reveal that there is a positive and functional causal relationship between energy consumption, economic growth, and $CO2$ emission in the long run. As a result, environmental quality was compromised since economic growth expansion has driven the level of energy demanded to be extreme.

Khan *et al*. (2023) considered 38 OECD countries to investigate how green innovation, energy efficiency, and foreign direct investment impact sustainable economic growth from 2000 to 2019. The study used the cross-sectional autoregressive distributed lags (CS-ARDL) estimator and Augmented Mean Group (AMG) test to report that green innovation, Energy Efficiency, and foreign direct investment swaps green economic development. Furthermore, the study reveals a positive, and statistically significant relationship that flows from both the long and short-run period to support and make necessary improvements on sustainable economic development within the OECD countries.

Wani, Loganathan, and Esmail (2024) employed the cross-sectional autoregressive distributed lag (CS-ARDL) method and the common correlated effect—mean group (CCEMG) estimator to investigate the role of green technology, green energy, foreign direct investment, and globalization on green economic growth in the G7 countries. The data spanning from 1995 to 2020 was collected from WDI, KOF Swiss Economic Institute, and OECD databases. The results of the study reveal that there is a long and short-run positive influence directed from green energy and FDI to green economic growth, which speeds up green economic growth and complements FDI within the G7 countries. Therefore, the researcher saw a gap in the nexus between the blue and green economy towards economic growth, which continues to support economic growth arguments. Even though, the previous researchers distinguished the blue and green economy as well as economic growth concepts, however, their attention was not based on investigating the nexus between blue and green economy towards economic growth. The current study is significant in establishing how the EKC and EMT can be executed to satisfy the economic growth gap for South Africa through the blue and green economy. Hence, this study anticipates minimizing the gap by developing some efficient measures and sharing its outcome not only for the South African economy but to also touch the global context. The study's prior expectation is that blue economy substitutions such as total fisheries production metric tons (TFP), aquaculture production metric tons (AP), and green economy proxies such as total greenhouse gas emissions kt of Co2 equivalent (GHGE_C02), and renewable energy consumption of total final energy consumption (RECON), are expected to spur positive economic growth. However, foreign direct investment (net inflows), and trade openness may either provide a positive or negative influence toward economic growth. The econo-metric techniques are presented in the upcoming section.

RESEARCH METHODOLOGY

The study methodology outlines the data period, model specifications, and various econometric techniques.

Data

The study is based on a quantitative approach and covers the period from 1990 to 2020. The data was sourced from the World Bank. Numerous econometric techniques were executed. The study period was dependent on the availability of data especially of the green economy which was limited to the year 2020.

Model Specification

The current study model is underpinned by Wang *et al.* (2023) approach which was formulated on the classical production function. Furthermore, Dissanayake *et al.* (2021) study was used to link blue and green economies to achieve vibrant and fundamental SDGs goals. However, this study accepted the EKC and EMT to connect the nexus between the blue and green economy towards economic growth. The production function uses labor, capital, and technology to drive economic progress through inputs and output (Wang, *et al.*, 2023). The classical production functional form is presented as thus:

$$Y = f(L, K, A) \tag{1}$$

Where, Y, indicates economic growth the dependent variable, followed by L, K, and A which denote labor input, capital formation, and levels of technology respectively. The current study modifies the model by substituting GDP per capita (current US$), (GDPPC) as a proxy for economic growth (Y), and blue and green economy were substituted for labor, capital, and technology. Economic growth and trade openness variables were also utilized by Kwilinski, Lyulyov, and Pimonenko (2023). Nevertheless, blue economy proxies' total fisheries production metric tons (TFP), and aquaculture production metric tons (AP), and green economy proxies such as total greenhouse gas emissions kt of Co2 equivalent (GHGE_C02), and renewable energy consumption of total final energy consumption (RECON), were adopted from Magazzino *et al.* (2023), Phang et al. (2023), Sikhunyana, and Mishi (2023), and Ahammed *et al.* (2024). Some control variables such as foreign direct investment (FDI) and trade openness (TO), were added concerning the existing literature to the model to minimize the partiality caused by omitted variables and to improve the study's functional form as thus:

$$Economic\ growth = f(blue, green) \tag{2}$$

Equation (2) adopted a linear format. Afterward, some variables were logarised for standardization since they were not in a percentage format. Then equation (3) was stated below to highlight the econometric model for the current study as follows:

$$LGDPPC_t = \beta_0 + \beta_1 \mathrm{LTFP}_t + \beta_2 L\mathrm{AP}_t + \beta_3 L\mathrm{GHGE\_C02}_t + \beta_4 \mathrm{RECON}_t + \beta_5 FDI_t + \beta_6 TO_t + \varepsilon_t \tag{3}$$

Where is the constant term; to shows the study coefficients estimates, symbolizes the logarised variables and is the error term.

Estimation Techniques

The study executed econometric techniques such as the ARDL cointegration bounds test, and diagnostic and stability tests to expose the South African economic growth condition concerning the blue and green economy. Furthermore, the selected econometric tests such as the descriptive statistics test and correlation matrix were vital to measure the frequency or occurrence, central tendency, and variation of variables, and used the Jarque–Bera probabilities to confirm the level of whether the standard distributions are normal or abnormal as alluded by Ahammed *et al.* (2023). Furthermore, the study applied correlation to distinct the existence of a positive, negative, or neutral relationship between the variables. The Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) unit root tests were conducted to show the variables that are static at the level and those that become stationary after differencing as mentioned by Dickey, and Fuller (1979), Phillips, and Perron (1988), Khan, and Gunwant (2024). Furthermore, the study executed the ARDL bounds test to distinguish the level of cointegration after variables have been classified as I(0) and I(1). The ARDL technique surpasses other econometric techniques such as the variance autoregressive (VAR) as it captures the long- and short-run estimates as well as the speed of adjustment (Johansen & Juselius, 1990, Pesaran, Shin & Smith, 2001). Lastly, the model diagnostic and stability were ensured as discussed in Mishra *et al.* (2019).

EMPIRICAL RESULTS DISCUSSION

Empirical results such as descriptive statistics and correlation matrix, ADF and PP unit root test, bounds tests, ARDL long run and short run. Lastly, diagnostics and AR inverse root were tested to validate the stability of the model as presented below.

Table 1: Descriptive statistics and correlation matrix test results, 1990-2020

	LGDPPC	LTFP	LAP	LGHGE_CO2	RECONS	FDI	TO
Mean	3.691	5.788	3.717	5.644	12.358	1.117	48.671
Minimum	3.432	5.640	3.450	5.505	7.600	-0.060	34.321
Maximum	3.941	5.962	3.989	5.744	18.600	5.368	65.974
Std. Dev.	0.157	0.080	0.140	0.085	4.267	1.125	8.157
Skewness	-0.087	0.283	-0.113	-0.356	0.335	1.949	-0.119
Kurtosis	1.495	2.618	2.481	1.543	1.361	7.679	2.201
Jarque-Bera	2.964	0.603	0.413	3.398	4.048	47.924	0.898
Probability	0.227	0.739	0.813	0.182	0.132	0.000	0.638
Observations	31	31	31	31	31	31	31
Correlation matrix							
	LGDPPC	LTFP	LAP	LGHGE_CO2	RECONS	FDI	TO
LGDPPC	1.000						
LTFP	-0.491	1.000					
LAP	-0.304	-0.138	1.000				
LGHGE_CO2	0.457	-0.332	0.035	1.000			
RECONS	-0.239	-0.094	0.309	-0.068	1.000		
FDI	-0.312	0.352	-0.201	0.062	0.381	1.000	
TO	-0.112	0.223	-0.313	0.234	0.097	0.173	1.000

Source: Authors ‘computation

The log of GDPPC which is economic growth minimum and maximum value of (3.432, 3.941), are surpassed by blue economy variables (LTFP, LAP), and green economy coefficients (LGHGE-C02, RECONS), which may suggest that they may be benefiting more and contributing less to the economic growth of South Africa. This is the symbol that although the country has embraced the green economy concept, yet, environmental degradation in South Africa is very high. All variables reveal normal distribution at a 5% level of significance which permits the current study to accept H0 and fulfill the Jarque-Bera normal distribution measure suggested by Ahammed *et al*. (2023). However, the level of FDI distribution raises concerns since is even below the 1% level. The LTFP, RECONS, and FDI are positively skewed, meaning that they are sensitive towards economic growth. TO deviate far from other variables by 8.15%. Even though, LGHGE_C02 displays a positive correlation which ranges between (+1 & −1), respectively, but is very low to convince that there is a positive correlation between a green economy and economic growth.

Table 2: ADF and PP unit root test results, 1990-2020

		Stationarity @		Stationarity @	
Variables	Model specification	ADF test statistic	PP test statistic	ADF test statistic	PP test statistic
LGDP	Trend and Intercept	-3.574	-3.568	-3.574*	-3.574*
LTFP	Trend and Intercept	-3.574	-3.568*	-3.574***	-
LAP	Trend and Intercept	-3.574***	-3.568	-	-3.574***
LGHGE-C02	Trend and Intercept	-3.568	-3.568	-3.574***	-3.574***
RECON	Trend and Intercept	-3.574	-3.568	-1.952***	-1.952***
FDI	Trend and Intercept	-3.568***	-3.568***	-	-
TO	Trend and Intercept	-3.568	-3.568	-3.603***	-3.574***
Note: *, **, *** symbolizes rejection of the null hypothesis at 10%, 5% and 1% respectively					

Source: Authors' computation

The ADF and PP tests were used to reveal that FDI is stationary at the level while LGDPPC, LTFP, LAP, LGHGE-C02, RECON, and TO are stationary at first difference. All the variables have a unit root based on the executed tests. Then, the ARDL bounds test is performed in Table 3.

Table 3: ARDL cointegration F-bounds test results, 1990-2020

Test Statistic	Value	Significance	I(0)/Lower bound	I(1)/Upper bound

F-statistic	22.18	10%	1.99	2.94
k	6	5%	2.27	3.28
		1%	2.88	3.99

Source: Authors' computation

The ARDL cointegration F-bounds test results of 22.18 confirm that there is a cointegrating relationship among the study-selected variables since is greater than the upper bound at 1%, 5%, and 10% significance levels. This outcome confirms that the I(0) and I(1) values are lower than 22.18% at all levels respectively. The study rejects the null hypothesis of no cointegration in favor of the alternative hypothesis as set by Pesaran *et al*. (2001). For that reason, there is a long-run link between the independent and dependent variables in the model.

Table 4: ARDL long-run, and short-run test results, 1990-2020

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTFP_(-1)	0.467349	0.129278	3.615065	0.0364**
LAP_(-1)	-1.447920	0.199618	-7.253470	0.0054***
LGHGE_C02_(-1)	0.971714	0.488954	1.987333	0.1410
RECONS_(-1)	-0.044704	0.013452	-3.323230	0.0449**
FDI_(-1)	-0.072777	0.011535	-6.309503	0.0080***
TO_(-1)	-0.002403	0.003296	-0.729138	0.5187
D(LTFP)	-0.979428	0.038330	-25.55237	0.0001***
D(LAP) _(-1)	0.892232	0.042526	20.98077	0.0002***
D(LGHGE_C02)_(-1)	-0.114960	0.106608	-1.078340	0.3599
D(RECONS) _(-1)	0.053122	0.003806	13.95632	0.0008***
D(FDI) _(-1)	0.023273	0.002220	10.48112	0.0019***
D(TO) _(-1)	-0.000840	0.000345	-2.432515	0.0931*
CointEq(-1)	-0.841047	0.034580	-24.32203	0.0002***

Authors' computation

ARDL long-run equations are presented thus:

(4)

The results of the study reveal that there is a vice versa relationship during the long-run and short-run period which is directed from blue and green economy and TO towards economic growth of South Africa. LTFP and LGHGE_C02 have a positive influence on economic growth. These results are in line with the study's prior expectations and these positive outcomes agree with Zaidi and Ferhi (2019), and IFAD (2024). Furthermore, the findings concur with the EKC meaning that natural economic growth development and opportunities are linked to total fish production and total greenhouse emissions which is equivalent to C02 to achieve sustainable economic growth in the future as also discovered by Andreoni, and Levinson (2001), and Liu *et al.* (2018). Moreover, the study also agrees with the EMT theory by revealing the market-changing aspects of environmental improvements and anticipated economic development. This implies that a 1% increase in LTFP and LGHGE_C02 will increase economic growth by 0.46% and 0.97% respectively, although they contradict B ˘adîrcea et al. (2021), and Muhaimid et al. (2022). Based on the current study outcome, the greenhouse gas emissions abbreviated as (GHGE_C02) suggest a positive correlation with economic growth. This implies that South Africa is capable of promoting inclusive SDGs, and prominent economic growth to attain additional prolific employment, and decent work for all and ensure consumption and production patterns as also alluded by Montmasson-Clair, and das Nair (2017) and PAGE (2018). The study outcome corresponds to and supports the notion raised by Tenaw, and Beyene (2021), and Khan *et al.* (2023), that the EKC theory applies the scale effect, composition effect, and technique impact concepts which automatically increases and enhances sustainable economic development and environmental quality by reducing the level of carbon dioxide emissions. The insignificance of GHGE_C02 in both periods reveals that South Africa has lagged behind in practicing some SDGs to sustain economic growth.

Whereas a 1% increase in LAP, RECONS, FDI, and TO will decrease economic growth by 1.14%, 1.14%, 0.07%, and 0.02% accordingly. In the long run, the LTFP, LAP, RECONS, and FDI are statistically significant at 1%, and 5% respectively. These results correspond with Khan et al. (2023), and Gbolonyo *et al.* (2024) who noted that energy productivity and foreign direct investment swaps economic development. As a result, these findings challenge the EKC notion that states that the use of energy and raw materials uses scale effect to grow natural resources even though is harmful to the environment. The EKC inverse-U-shaped curve reveals that there is pollution on income which results in systematic complex causes of market failures (by discouraging trade openness), and technological side-effects, particularly in resource provision while neglecting economic growth. Furthermore, the negative impact of FDI and TO on economic growth reveals that South Africa may be applying trade-offs to some of the green/ economic development as done in the 38 OECD countries (Khan, *et al*., 2023). These trade-offs can be recognized when economic growth remains suppressed even though FDI injections have increased. Moreover, the EKC was found to be influential in green technological innovation by promoting technologies and skills that use natural resources to save energy and protect the environment. However, the LGHGE_C02 is statistically insignificant in both periods while and TO is insignificant during the long run. The speed of adjustment noted by CointEq (-1), is crucial to explain the study motivation of the short-run towards the long-run. The error correction model (ECM), denotes that the speed of adjustment of -0.841, is statistically significant at 1%. These results suggest that the model will use the speed of 84.1% to adjust back to balance.

Table 5: Diagnostic test results, 1990-2020

Test	Null hypothesis	Probability	Results
Breusch-Godfrey Serial Correlation LM Test	No serial correlation	0.339> 0.05	The study accepts since the series has no serial correlation.
Heteroskedasticity Test: Harvey	No heteroskedasticity	0.305> 0.05	is accepted, meaning the model is free from heteroskedasticity.
Heteroskedasticity Test: Glejser	No heteroskedasticity	0.319> 0.05	There is no heteroskedasticity in the model, hence, is accepted.

Authors' computation

Based on the diagnostic test results summary presented in Table 5, the Breusch-Godfrey serial correlation LM test statistic is 1.856 and the probability value is 0.339 respectively. Hence, these results reveal that, or the null hypothesis is accepted because is greater than 0.05. This is a symbol that the model has no serial correlation. Furthermore, Harvey and Glejser heteroskedasticity tests were conducted with the observed R-squared of 26.970 and 26.679. They presented the probability chi-squares values of 0.305 and 0.319 which are more than 0.05, implying that the model has no heteroscedasticity. The study accepts the null hypothesis of no heteroscedasticity in the model.

The polynomial roots indicate that all inverse roots lie within the circle which satisfies the VAR stability condition as also established by Nadeem *et al*. (2020). The projected model is stable and aligns with the statistical requirements and the formal unit root test outcomes under Table 2.

CONCLUSIONS AND RECOMMENDATIONS

The study investigated the nexus between the blue and green economy towards economic growth in South Africa, for the periods of 1990-2020. The ARDL cointegration bound test was used together with time series data from the World Bank. The EKC and EMT were linked to the estimated model. The study revealed that there is a positive relationship between LTFP, and LGHGE_C02 during the long run. The blue economy that is crucial is LTFP, while the green economy significant indicator was found to be LGHGE _C02 during the study period. This result clarifies and confirms a correlation between economic growth and total greenhouse emissions equivalent to C02 as noted in Table 1. This study recommends that South Africa should abate

LAP, RECONS, FDI, and TO as they prompt negative economic growth. However, South Africa can also mitigate its level of vulnerability towards climate change by maintaining an economic growth balance through the blue and green economy. Moreover, the insignificance of GHGE_C02 in both stages reveals that South Africa is behind in promoting some SDGs to sustain economic growth. In addition, some major existing SDGs and environmental policies such as air pollution, responsible consumption, and production through the creation of more projects that value recycling are required to ensure that both cities and communities are sustainable. This can strengthen numerous SDGs to have a direct relationship and contribute positively towards economic growth instead of not being included or being less prioritized in the sustainable economic growth debate. Moreover, the study recommends that South Africa should consider rearranging existing policies or SDG no.6 clean water and sanitation, and emphasize it as avoiding wasting water and prioritizing saving water to promote public health. Specifically, South Africa should adopt an AI policy that will monitor water management in rivers, and water usage and apply some restrictions through sensors, and smart meter tracking to conserve water consumption, and natural resources and contribute to economic growth while reducing the environmental impact. South Africa can consider linking their existing economic growth policies to respond to SDGs based on these study findings and also prioritize that those policies are enlisted in all the National Strategic Development Plans to return anticipated economic growth. These policies should be decentralized from a national level to communities since SDGs are applied based on the global context. It is up to the country to embrace and align its economy through policies such as NDP, to enhance economic growth. South Africa should consider activating the existing blue, and green economy policies to get maximum economic growth. South Africa should encourage the development of green bonds and other financial instruments policies to channel investments towards economically sustainable projects. There is a need to provide funding and support for research and development of new green and blue technologies. Moreover, collaborating with other countries on environmental policy initiatives and knowledge sharing can amplify and promote public awareness of environmental issues towards sustainable economic growth practices. Lastly, the development of clear and enforceable regulations to ensure compliance with sustainability standards should be based on a strong regulatory framework.

Recognition of the current study recommendations may lead to the SDG potential rewards formula which will apply green and blue economies as catalysts of economic growth. The current study outcome can be used/ believed to also shape political commitment, investors perception, and economic development.

Due to various uncertainties, the current study method may be reconsidered for future researchers to include other blue and green economy estimates such as agriculture, fishing, forestry, mineral rents, arable land, natural gas rents, exports of goods and services, forest rents as well as renewable internal freshwater resources per capita. Furthermore, an investigation may be done by extending the sample size to provide fairness to the environment as well as the economy.

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