Foreign Direct Investment, Non-Renewable Energy and Economic Growth: An Empirical Analysis from South Africa

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ABSTRACT

Purpose
This study aims to examine the connection between foreign direct investment, non-renewable energy, and economic growth in South Africa.

Methodology
The data was collected from the World Bank's website from 1990 to 2020. The VECM and Granger causality approaches were employed to evaluate the connection between Economic growth, FDI, and Non-renewable energy.

Findings
The findings show that a long-term equilibrium relationship exists among the variables. Further, the result of the Vector Error Correction Model (VECM), shows a coefficient value of 0.0038 indicating the short-term adjustment speed of the system towards its long-run equilibrium. The result of Granger causality shows no bidirectional Granger causality among any of the variables. There is a Unidirectional Causality between GDPC and NRENW.

Conclusion
The study concluded that non-renewable energy can enhance economic growth in these countries, but it can aggravate the degradation of the environment. Essentially, foreign direct investment (FDI) significantly and negatively affects growth, suggesting that FDI entry into African nations negatively affects the environment.

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1. Introduction

Its rapid development has impacted the political, social, and economic aspects of the global environment. Trading operations and financial commitments, such as the inflow and outflow of investments in physical facilities and stocks, can be considered as economic growth (EcG) that influences environmental sustainability (Lyu et al., 2021; Jeuland et al., 2021). The foundational connection between global economic progress and renewable and nonrenewable energy (NREn) has shifted due to ongoing economic integration and substantial structural development (Adekunle et al., 2022; Bekun et al., 2023). Furthermore, it has also influenced the potential relationship between economic growth, FDI, and NREn (Shakib et al., 2021). On the other hand, governments and authorities in developing nations like South Africa (SA) express concerns about the impact of FDI and NREn on climate change in the 21st century (Ahmed et al., 2016; Aydin, 2019). Examining the relationship between energy consumption and economic growth is crucial for emerging and developing countries. Examining the relationship between energy consumption and economic growth is crucial for emerging and developing countries. While there are numerous variables in this study, the key ones investigated for their relationships with other variables are non-renewable energy, FDI, and economic expansion, triggered by environmental deterioration.

To produce goods and services, nations seeking EcG (Y) must use energy resources. Research on climate change should therefore take into account the connection between CO2, energy consumption (including total energy, NREn, and REn energy), and EcG. Many study subjects in the literature on energy and environmental economics make use of econometric techniques such as cointegration, causation, and unit root.

According to the Environmental Kuznets Curve (EKC) theory, environmental degradation rises along with per-capita economic growth until it crosses a certain threshold, at which point it falls (Pata et al., 2021). The earliest assertion (Pollution Haven Hypothesis) which states that manufacturing engagement pollutes the environment which predominantly occurs in advanced economies with stringent environmental controls is now moving to developing nations that have lesser environmental regulations and are now mindful of the effects of NREn (Shakib et al., 2021).

Because of lax environmental regulation and evaluation whenever structural changes and FDI inflows take place in underdeveloped countries, it is invariably assumed that these are pollution hotspots. Climate change, which has evolved into a "lax target" for climate change, has also been harmed by the pollution haven theory in addition to the poor economies. FDI and foreign trade activity can both be promoted to reach this objective (Alola et al., 2019). The recent trends in global economic investment diversification, which involve both NREn and FDI, have mainly been neglected by advanced economic regulations (Ahmed et al., 2016; Pata et al., 2021).

The use of domestic investments and FDI inflows to supplement REn developments on the part of underdeveloped and developed countries is another key way that NREn funding stimulates the improvement of economic activity. The goal of this study is to revisit PHH's economic predictions for South Africa utilizing the vector error correction model, cointegration analysis, and causality technique. Given the country's current

energy position concerning foreign direct investment, the study seeks to determine whether the PHH holds for the South African economy. This article's primary goal is to close this gap by examining this relationship in a typical case of an emerging nation, SA, using the Vector Error Correction Method and Granger Causality Approach to determine the direction of causality between non-renewable energy and FDI, and more importantly, between NREN and economic growth. As a result, the empirical relationship between sustainable NREN consumption, FDI, and EcGr has expanded the legal ramifications for SA and possibly other developing nations. Understanding contemporary issues around sustainable energy issues has become a major focus in academia, especially difficulties with energy security, and energy poverty. The 2020s will see a rise in the demand for renewable energy (Adom et al., 2014; Liu et al., 2016; Mert et al., 2016). Energy generation is anticipated to originate from REn foundations of energy in years to come, it is crucial to recognize the primary components of supportable energy and their impact on the legal consequences of energy legislation. The consequences of globalization on energy use tend to be both positive and negative (Ahmad et al., 2020; Anwar et al., 2018; Banerjee et al., 2017). Contingent on the oversight and scope of the effects of international fiscal combination on the demand for sustainable energy, foreign trade barriers and climate legislation may be implemented in developing nations (Baz et al., 2021).

This study aims to determine how Vietnam's trade openness and net FDI inflows (FDI) affect the countries of NREn, REn, and CO2. The study can justify our choice for some good reasons. First, environmental deterioration has been a growing problem (Cheng, 1995). Vietnam, a rapidly expanding rising economy in Southeast Asia, must choose between economic growth and environmental preservation. Vietnamese economists and decision-makers are now focusing on environmental and energy challenges as they become more conscious of the dangers involved with enacting policies meant to foster economic growth. Finally, a dearth of pertinent data in Vietnam has prevented researchers from examining these interrelationships. The novel multivariate wavelet analysis (MWA) tools used in this work fill in these gaps in the literature. To examine the interrelationships in Vietnam and ascertain how they react at various frequencies and changes, these tools combine partial wavelet gain and coherency. Three main considerations led us to choose MWA as our partner. The level of trade openness (TO), net FDI inflows, nonrenewable energy consumption, renewable energy consumption, and CO2 emissions are examples of non-stationary data, so we must first employ a strategy for them. Second, the MWA can address the problem of a temporary database. Third, it's crucial to remember that decisions about environmental preservation or economic development are always made in conjunction with long-term strategies. A decision regarding a large-scale management strategy is neither quick nor simple. Because of this, it makes sense from both perspectives to account for the existence of short- and long-term decisions, which necessitates that these interactions be investigated concurrently at various frequencies. Wavelet analysis is a simple method for achieving this. Wavelets can be used to examine time-varying relationships in economics and finance.

In essence, the current work uses the vector error correction model, cointegration analysis, and causality technique to re-examine PHH's assertions for the South African economy. The purpose of the study is to determine if the PHH still applies to South Africa given its present energy position concerning foreign direct investment.

2. Literature Review

Earlier examination in this field analyzed the advantages of non-sustainable power and unfamiliar direct venture (FDI) on financial development by looking at the connections between inexhaustible, non-inexhaustible, and ecological debasement as well as the connection between monetary development and natural corruption. These examinations yielded shifting results; This ongoing review will feature probably the latest ones.

In principle, FDIs influence NREN through factors connected with scale, content, and method. As per the scale impact, unfamiliar direct ventures (FDIs) obstruct the development of NREN by empowering the exchange of grimy energy innovation for creation purposes, ordinarily during the beginning phases of monetary turn of events, which are embodied by far-reaching utilization of messy energy (Shahbaz et al., 2021). In any case, creation processes start to change towards greater climate count maintainable practices through asset redistribution, prompting the organization's impact, because of the hindering ecological weights related to the utilization of messy energy (Shahbaz et al., 2021). As per the technique impact, FDI increments homegrown capital venture through the exchange of cleaner energy advances, abilities, Research and development, and open market access, subsequently speeding up sustainable power creation (Suki et al., 2020).

Khan et al. (2021) supported the scale effect for 69 Belt and Road nations, whereas other researchers explicitly endorsed the process effect such as (Qamruzzaman et al., 2022; Tiwari et al., 2022; Doytch et al., 2016). The fact that FDI influences EG makes it moreover found. Modernization and dependence are the two key speculations that decide what FDI means for EG. As indicated by the modernization way of thinking, FDI supports homegrown capital speculation through information moves, which facilitates EG (Azam et al., 2021). Alongside working with Research and development and information move and administrative expertise, FDI additionally further develops EG. On the other hand, the reliance school of reasoning battles that FDI forestalls EG by empowering restraining infrastructures, which keeps assets from being apportioned productively (Khan et al., 2021). The FDI-EG writing has moreover delivered a scope of results because of these contending thoughts. Researchers found that FDI speeds up EG (Khan et al., 2021; Dankyi et al., 2022; Alvarado et al., 2017). Sokhanvar et al. (2019) and Kahouli et al. (2022) had different findings on the relationship between Renewable Energy Consumption (REC), Economic Growth (EG), and Foreign Direct Investment (FDI). However, there is still a lack of information on the direct impact of FDI on the REC-EG nexus. Therefore, we propose further examination by expanding existing frameworks and applying modernization theories to the topic. By differentiating BRICS and MINT countries, Shao et al. (2019) reevaluated the effect of unfamiliar direct ventures on the climate. The discoveries in the two locales are steady with the PHH hypothesis. It's vital to see that various examinations yielded various ends.

Adeel-Farooq et al. (2020) recommended that the wellsprings of the FDI stream decide what FDI means for the climate. They arrived at the resolution that unfamiliar direct speculation (FDI) from industrialized countries further develops nations' natural presentation though FDI from immature countries corrupts it. Xu et al. (2020) investigated the Chinese territories between 2002 and 2016 utilizing a semi-parametric methodology utilizing the STIRPAT model gave blended results.

The presence of both PHH and PHV in Chinese regions was confirmed by Ahmad et al. (2020). Zhang et al. (2019) employed the PVAR model to analyze data from 30 Chinese regions between 2001 and 2015. While FDI significantly increases CO2 emissions in sub-provincial investigations, it has a significant impact on overall CO2 emissions.

Demena et al. (2020) applied the meta-examination approach to 65 papers that yielded 1006 versatilities according to the PHV speculation by thinking about heterogeneity. They arrived at the resolution that FDI significantly decreases natural decay. Meanwhile, Aust et al. (2020) analyzed 44 countries to see whether FDI helps with the achievement of the Maintainable Advancement Objectives (SDG). The outcomes showed that unfamiliar direct speculation (FDI) well affected SDG scores, with FDI's positive effect on SDG accomplishment being more in North Africa and less in East Africa. Hille et al. (2019) confirmed the PHV speculation with regards to Korea and arrived at the resolution that FDI is believed to be one of the likely considers accomplishing the SDGs.

Shahbaz et al. (2021) analyzed the connection between FDI and fossil fuel byproducts utilizing GMM gauges for the period 1990-2015 and reasoned that the PHH speculation is upheld in MENA nations. The PHH speculation was supported by empirical analysis based on Hanif et al. (2019) DOLS and FMOLS estimates for Asian economies between 1990 and 2013. Finally, Nasir et al. (2019) affirmed that expanded FDI causes natural debasement in rising Asian countries. Shao et al. (2019) differentiated between BRICS and MINT countries to reassess the impact of unfamiliar direct ventures on the environment. The discoveries in the two districts are predictable with the PHH hypothesis. It's essential to see that various examinations yielded various ends. Adeel-Farooq et al. (2020) suggested that the source of foreign direct investment (FDI) determines its impact on the environment. They concluded that FDI from developed countries improves the environmental performance of host countries, while FDI from less developed countries hurts it. Demena et al. (2020) applied the meta-examination approach to 65 papers that yielded 1006 flexibilities corresponding to the PHV speculation by thinking about heterogeneity. They arrived at the resolution that FDI impressively reduces ecological decay.

3. Methodology

Theoretically, scale, composition, and method effects are how FDIs affect NREn and EcGr. According to the scale effect, FDIs impede the development of RE by encouraging the transfer of dirty energy technology for production purposes, typically during the early stages of economic expansion, which are typically characterized by rampant dirty energy consumption (Baz et al., 2019). The composition effect is a result of manufacturing processes beginning to shift toward more ecologically sustainable practices as a result of resource reallocation in response to the negative environmental impacts of using dirty energy. According to the method effect, FDI scales up economic growth by transferring cleaner energy technology, skills, R&D, and access to the open market (Ahmad et al., 2022; Appiah et al., 2018). The technique effect has been empirically supported by researchers like (Djellouli et al., 2022; Hamid et al., 2021; Hanif et al., 2019). Kahia et al. (2016) argued that the scale effect for 69 Belt and Road countries. Essentially, following the theoretical relationship established above, this study formulates the empirical model

as GDP = f (FDI, NREn, IMP, EXP) (1)

Where GDP = gross domestic product
NREn = non-renewable energy consumption
FDIv = Foreign Direct Investment
IMP = Import
EXP = Export
The econometric specification of the model is specified below:

$$GrDP = NREn + FDIv + EXPT + IMPT \quad (3)$$

$$GrDP = \beta_0 + \beta_1 NREn + \beta_2 FDIv + \beta_3 EXPT + \beta_4 IMPT \quad (4)$$

$$GrDP = \beta_0 + \beta_1 NREn + \beta_2 FDIv + \beta_3 EXPT + \beta_4 IMPT + \varkappa \quad (5)$$

$$GrDP = \beta_0 + \beta_1 NREn + \beta_2 FDIv + \beta_3 EXPT + \beta_4 IMPT + \hat{e} \quad (6)$$

Essentially, this study will employ the VECM and Granger causality test to validate the current connection amid FDIv, NREn, and GrDP for the South African economy. Data analysis of a country evaluation includes a transformation of data to attain the study's outcomes. Annual data has been collected and evaluated from 1990 to 2020. This study utilizes time series data and employs econometric models. Sources of data in this research are secondary data that have been analyzed through the quantitative model to make projections and estimate the impact of several variables on future economic growth.

Variables	Definition	Source
GrDP	*Gross Domestic Product Per Capita*	World Development Indicator, 2020
NREN	*Non − Renewable Energy*	World Development Indicator, 2020
FDIv	*Foreign Direct Investment*	World Development Indicator, 2020
ExP	*Export*	World Development Indicator, 2020
ImP	*Import*	World Development Indicator, 2020

4. Results and Discussions

Table 1 below represents the unit root testing which signifies I(0) and I(1) and serves as a benchmark for the application of VECM for the study and the optimum lags selection is based on the Schwarz information criterion.

Table.1.Unit Root

		ADF Null (H_0): Non-stationary				**DF-GLS Null (H_0): Non-stationary**			
		ADF_α				ERS_α			
z_t		τ_μ	1%	5%	Prob.	τ_τ	1%	5%	Prob.
Intercept	NREN	-1.96	-2.98	-3.97	0.28	-0.38	-2.64	-1.95	0.38
	GDP	-1.59	-3.57	-2.97	0.47	-1.37	-2.65	-1.95	0.18
	IMP	-1.51	-3.67	-2.96	0.51	1.09	-2.65	-1.95	0.28

	EXP	-3.06	-3.67	-2.96	0.04	2.83	-2.64	-1.95	0.00
	FDI	-2.73	-3.68	-2.97	0.08	-1.83	-2.65	-1.95	0.08
	$\Delta NREN$	-6.74	-3.68	-2.97	0.00	-6.03	-2.65	-1.95	0.00
	ΔGDP	-3.44	-3.67	-2.97	0.01	-3.52	-2.65	-1.95	0.00
	ΔIMP	-3.36	-3.67	-2.97	0.02	-4.57	-2.60	-1.95	0.00
	ΔEXP	-6.31	-3.69	-2.97	0.00	-8.97	-2.65	-1.95	0.00
	ΔFDI	-5.09	-3.69	-2.98	0.00	-7.03	-2.65	-1.95	0.00
Intercept with Time Trend	NREN	-0.33	-4.31	-3.57	0.98	-0.84	-3.77	-3.19	0.40
	GDP	-3.44	-3.68	-2.97	0.01	-3.52	-2.65	-1.95	0.00
	IMP	-0.34	-4.29	-3.57	0.98	-1.45	-3.77	-3.19	0.16
	EXP	-5.24	-4.29	-3.57	0.00	-5.43	-3.77	-3.19	0.00
	FDI	-3.43	-4.30	-3.56	0.06	-3.54	-3.77	-3.19	0.00
	$\Delta NREN$	-7.31	-4.31	-3.57	0.00	-7.28	-3.77	-3.19	0.00
	ΔGDP	-3.43	-4.31	-3.57	0.05	-3.59	-3.77	-3.19	0.00
	ΔIMP	-3.61	-3.77	-3.57	0.05	-3.77	-3.77	-3.19	0.00
	ΔEXP	-6.19	-4.32	-3.58	0.00	-6.42	-3.77	-3.19	0.00
	ΔFDI	-6.05	-4.34	-3.59	0.00	-7.31	-3.77	-3.19	0.00

Source: Author's own elaboration

Table.2.Lag Selection Criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2189.878	NA	3.78e+59	151.3709	151.6066	151.4447
1	-2059.132	207.3897	2.65e+56	144.0781	146.2308	144.5210
2	-2027.746	38.96195*	2.02e+56*	143.6376*	145.4925*	144.4498*

Source: Author's own elaboration

4.1. Johansen Cointegration Test

Johansen Juselius cointegration test was used in the study to determine the long-term relationships between the variables. Johansen's (1999) method provides the greatest likelihood for finite-order vector auto-regressions (VARs) and is simple to compute for such systems. The outcome is displayed in Table 3 below. Test of Unrestricted Cointegration (Trace).

Table.3.Unrestricted Cointegration Rank Test (Trace Statistics)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.654527	81.22013	69.81889	0.0047
At most 1 *	0.573864	50.39776	47.85613	0.0283
At most 2	0.341578	25.66084	29.79707	0.1391
At most 3	0.236022	13.54149	15.49471	0.0964
At most 4 *	0.179410	5.734222	3.841466	0.0166
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				

Source: Author's own elaboration

Table.4.Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.654527	30.82237	33.87687	0.1110
At most 1	0.573864	24.73692	27.58434	0.1110

At most 2	0.341578	12.11935	21.13162	0.5359
At most 3	0.236022	7.807270	14.26460	0.3986
At most 4 *	0.179410	5.734222	3.841466	0.0166
Note: Max-eigenvalue test indicates cointegration at the 0.05 level				

Source: Author's own elaboration

There exist stable and long-term equilibrium correlations among the variables, as shown in Table 4 above, in both the trace and maximum eigenvalue tests. VEC modeling can be carried out in further detail based on the assumption that cointegration linkages exist.

4.2. Vector Error Correction Model (VECM)

It should be emphasized that the error correction mechanism (ECM) aims to link the cointegrating equations' short-run dynamics to their long-run static dispositions. The Vector Error Correction Method (VECM) was used to capture the short-run variation, and the outcome is shown in Table 5 below. This model is estimated in the study so that causality and diagnostic tests can be performed. The result of the Vector Error Correction Model (VECM), shows the coefficient value of 0.003805 indicating the short-term adjustment speed of the system towards its long-run equilibrium. Specifically, it suggests that the system corrects about 0.003805 units of the deviation from the long-run equilibrium in each period.

Table.5.VECM Output

Cointegrating Eq:	**CointEq1**				
GDPC(-1)	1.000000				
FDI01(-1)	2.42E+10				
	(4.3E+09)				
	[5.68173]				
NRENW(-1)	-2.36E+11				
	(2.8E+10)				
	[-8.54908]				
LOGEXP(-1)	1.44E+10				
	(1.2E+10)				
	[1.18963]				
LOGIMP(-1)	6.34E+10				
	(2.2E+10)				
	[2.91373]				
C	-1.52E+12				
Error Correction:	**D(GDPC)**	**D(FDI01)**	**D(NRENW)**	**D(LOGEXP)**	**D(LOGIMP)**
CointEq1	0.003805	-1.14E-11	3.65E-12	-4.33E-12	-5.96E-13
	(0.08633)	(1.6E-11)	(1.5E-12)	(7.1E-12)	(2.1E-12)
	[0.04407]	[-0.73352]	[2.49485]	[-0.61010]	[-0.29054]
D(GDPC(-1))	0.650128	9.06E-11	2.83E-12	1.94E-11	4.03E-13
	(0.53624)	(9.6E-11)	(9.1E-12)	(4.4E-11)	(1.3E-11)
	[1.21238]	[0.94025]	[0.31078]	[0.44133]	[0.03162]
D(GDPC(-2))	-0.092805	-2.09E-10	6.84E-12	-2.28E-11	-4.79E-12
	(0.58038)	(1.0E-10)	(9.8E-12)	(4.8E-11)	(1.4E-11)
	[-0.15990]	[-2.00188]	[0.69562]	[-0.47918]	[-0.34759]
D(FDI(-1))	-6.81E+08	-0.151108	-0.053302	0.058370	0.008220
	(1.9E+09)	(0.33445)	(0.03155)	(0.15289)	(0.04421)
	[-0.36596]	[-0.45181]	[-1.68945]	[0.38177]	[0.18593]
D(FDI(-2))	-8.09E+08	0.017111	-0.036993	0.040612	-0.019741
	(1.5E+09)	(0.26560)	(0.02506)	(0.12142)	(0.03511)
	[-0.54747]	[0.06443]	[-1.47647]	[0.33448]	[-0.56228]

D(NRENW(-1))	-1.45E+10	0.657242	-0.156659	-0.092055	-0.035360
	(1.6E+10)	(2.83978)	(0.26789)	(1.29819)	(0.37539)
	[-0.92043]	[0.23144]	[-0.58480]	[-0.07091]	[-0.09419]
D(NRENW(-2))	1.17E+10	0.928647	0.092869	2.001143	0.116683
	(1.7E+10)	(2.98930)	(0.28199)	(1.36654)	(0.39516)
	[0.70070]	[0.31066]	[0.32933]	[1.46438]	[0.29528]
D(LOGEXP(-1))	34506744	0.019956	-0.024467	-0.597404	-0.008961
	(2.8E+09)	(0.50186)	(0.04734)	(0.22942)	(0.06634)
	[0.01236]	[0.03977]	[-0.51682]	[-2.60396]	[-0.13508]
D(LOGEXP(-2))	-3.81E+08	0.168897	0.005574	-0.312902	-0.001126
	(2.7E+09)	(0.48194)	(0.04546)	(0.22032)	(0.06371)
	[-0.14200]	[0.35045]	[0.12261]	[-1.42023]	[-0.01767]
D(LOGIMP(-1))	8.80E+09	-0.902741	0.264846	-0.212001	0.325768
	(1.9E+10)	(3.46432)	(0.32680)	(1.58370)	(0.45795)
	[0.45663]	[-0.26058]	[0.81042]	[-0.13386]	[0.71136]
D(LOGIMP(-2))	-2.39E+09	4.284101	-0.009090	-1.267139	-0.058016
	(1.6E+10)	(2.82130)	(0.26614)	(1.28974)	(0.37295)
	[-0.15251]	[1.51848]	[-0.03415]	[-0.98247]	[-0.15556]
C	2.28E+09	0.665986	0.006367	0.066682	0.054420
	(3.0E+09)	(0.54227)	(0.05115)	(0.24789)	(0.07168)
	[0.75600]	[1.22815]	[0.12447]	[0.26899]	[0.75919]
R	0.750033	0.420617	0.480290	0.467777	0.203949
Adj. R	0.726819	0.022290	0.122990	0.101873	-0.343336

Source: Author's own elaboration

4.3. Granger Causality Test

The results of the cointegration test show a stable link over time between the two variables, but more research is required to determine whether there is a causal connection. When the regression of K is based on previous values of K and past values of Z are added, the independence power of the regression can be considerably increased if variable Z is useful in predicting K. If so, Z is the Granger cause of K; otherwise, it is the non-Granger cause. P value is below the 5% level of significance, indicating that the null hypothesis that Granger causality exists must be accepted.

Table.6.Granger Causality Output

Null Hypotheses (H0)	Chi-Square	Probability	Remarks
GDPC does not Granger Cause N RENW	4.51	0.04	Uni-directional Causality (UDC)
NRENW does not Granger Cause GDPC	2.07	0.21	
GDPC does not Granger Cause FDI	1.63	0.50	Uni-directional Causality (UDC)
FDI does not Granger Cause GDPC	3.10	0.20	
GDPC does not Granger Cause EXP	0.20	0.60	No Causality
EXP does not Granger Cause GDPC	0.05	0.83	
GDPC does not Granger Cause IMP	0.03	0.79	No Causality
EXP does not Granger Cause GDPC	2.15	0.52	

Source: Author's own elaboration

In summary, as the results are shown in Table 6 above, there is no bidirectional granger causality among any of the variables. There is a Unidirectional Causality between GrDP and NREN. From the various empirical estimations, it is discovered that NREN has a positive impact on EcGr in the study. This recommends that despite the way that non-sustainable power can upgrade financial development in these nations, it can irritate the corruption of their current circumstance, and accordingly doesn't safeguard their current circumstance. Various studies confirmed the positive part of NREN in advancing

monetary development as well as causing ecological issues such, as (Kostakis et al., 2017; Lin et al., 2018; Muhammad et al., 2019; Keeley, 2018). The VECM assessment has shown a positive and significant coefficient of financial development.

Considering that most African countries rely on non-sustainable power sources like petroleum products, the significant impact of monetary expansion on environmental degradation prompts us to examine the fundamental factors affecting economic growth on the continent. Some studies claim that NREN promotes economic growth, such as the research on African nations (Mujtaba et al., 2021). According to the findings of several research, the energy sector is one of the main factors influencing economic growth (Shahbaz et al., 2021; Sokhanvar et al., 2022; Waheed et al., 2019; Zarsky, 1999; Zhu et al., 2016). However, it is believed that rising environmental deterioration is mostly caused by energy and economic expansion (Pegkas, 2015; Rahman et al., 2017; Adom, 2014; Dinda, 2004; Khan et al., 2020; Kahia et al., 2016; Kostakis et al., 2017).

Regarding the PHH or PHV hypothesis, the study concludes that foreign direct investment (FDI) significantly and negatively affects growth, suggesting that FDI entry into African nations has a lethal effect on the environment. Even while FDI plays a vital role in driving economic expansion, environmental quality can be adversely and severely impacted by it. Numerous investigations have offered factual proof of the importance. The hybrid function of foreign direct investment (FDI), contributes technological innovation to both environmental quality and economic progress. Other research revealed that the low amount of FDI inflow to the receiving nations could account for the detrimental effects of FDI on environmental quality. However, if FDI influx reaches a large level, it can greatly aid in enhancing the surroundings. According to Lee et al. (2008) and Lee (2005), technological innovation capabilities worsen the amount of environmental pollution when FDI inflow is small. However, if FDI inflow exceeds a threshold, technological innovation capabilities improve the quality of the environment.

Given that energy productivity lowers pollution by consuming less energy, policymakers should encourage it to address both economic and environmental deficiencies. The use of renewable energy sources instead of non-renewable ones improves environmental quality by increasing energy efficiency.

In the same context, lawmakers should finance energy-saving initiatives and introduce public-private partnership investments (PPPI) to support sustainable energy and other initiatives of a similar nature (Lin et al., 2018; Merican et al., 2007). Therefore, the best kind of public-private partnership would reduce global warming by offering private company's financial incentives to fund mitigation initiatives (Bildirici et al., 2020). The energy industry is one area where the public-private partnership can support investments in climate adaptation, as noted by (Doytch, 2020; Gui-Diby et al., 2015; Hanni et al., 2011). Consequently, implementing investments through public-private partnerships can both reduce environmental impact and promote economic growth.

Alternative green trade strategies that limit the import of coal, fossil fuels, and other dirty energy sources should be taken into consideration by the politicians in these nations. This approach can help reduce CO2 and facilitate the adoption of alternative energy solutions across national borders. Both trade balance and environmental quality will benefit. Consequently, it may be possible to achieve certain Sustainable Development Goals

(SDGs) simultaneously, specifically SDG 7 (cheap and clean energy) and SDG 13 (climate action).

5. Conclusion

The connection between FDI, REn and EcGr for the South African economy from 1990 to 2020 was examined in this paper. The study determined that GDP Granger causes REN in the South African economy, but REN does not Granger cause GDP utilizing the VECM and Granger causality approaches. The sightings of this study establish the GDP growth potential of the REC-EG nexus. Therefore, policies that encourage South Africa's GDP growth should be given top priority. Comprehensive policies at both national and local levels are necessary to support the implementation and expansion of renewable energy. The regional governments' lawmaking bodies should implement the required action to create a strong framework for environmental sustainability that overcomes the current obstacles to sustainability adoption. Incentives and a supportive environment for thriving domestic manufacturing of REn technologies and the parts they require could be included in policies, but this is not the only option. To facilitate the best adoption and use of REn, policymakers must put various strategic measures into place. For instance, education can increase knowledge about RE's existence, application, and importance. Education laws that mandate the inclusion of energy courses, particularly RE, in academic curricula should be established by policymakers. This would enable both the current generation and succeeding ones to implement and accommodate the usage of REn. Additionally, the cost of RE deters firms, especially big enterprises, from implementing and utilizing it. Large upfront expenses are associated with the majority of corporate and private RE programs, which discourages people from taking part. The government must offer some sort of help to make sure organizations or companies are adequately influenced to depend largely on Ren which will facilitate an ecologically friendly system in the country.

The study is constrained by the following factors. The results of this study cannot be used to reflect the economies of other nations in the sub-region because it exclusively focused on South Africa. As a result, later studies may include more sub-regions to increase the study's reach. Additionally, this study ignored sub-measures of REn like solar and wind energy and utilized REC as the only measure of RE. Therefore, the sub-components of RE should be used in additional investigations in the future. Additionally, this analysis focused on total FDI. In light of this, future investigations may employ the portion of FDI to REn for additional research. Lastly, although this study focused on the aggregate dataset, there are regional variances in economic growth, export, foreign direct investment, and import. So that effective multi-country policies may be created, imminent work can conduct studies that are panel in nature.

Author Contributions

Dr. Ahmed Adekunle conceptualized, analyzed, estimated results, tabulated data, and responded to reviewers' comments.

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Conflicts of Interest

The author declares no conflicts of interest.

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