UDC 339

ALTERNATIVE ENERGY AND ENVIRONMENTAL SUSTAINABILITY FOR BRICS COUNTRIES: DOES THE GOVERNMENT'S FINAL CONSUMPTION EXPENDITURE MATTER?

Damiyano David*
Post-Doctoral Researcher, Department of Development Studies, Faculty of Business and Economic Sciences, Nelson Mandela University, Gqeberha & Honorary Research Associate, Faculty of Management Sciences, Durban University of Technology, Durban, South Africa

Mago Stephen, Professor
Department of Development Studies, Faculty of Business and Economic Sciences, Nelson Mandela University, Gqeberha, South Africa

Dorasamy Nirmala, Professor
Faculty of Management Sciences, Durban University of Technology, Durban, South Africa

*E-mail: davydamex@yahoo.co.uk

ABSTRACT
Alternative energy and natural gas not burning of fossil fuels, leads to environmental sustainability. The study examined the role of alternative and nuclear energy in stimulating environmental sustainability while considering the role played by the government expenditure in the BRICS bloc over the period 1990-2021. The study confirmed that environmental sustainability received significant attention from researchers in different countries worldwide. The study found that GDP has a negative impact on carbon dioxide emissions, while alternative energy, government consumption expenditure and natural resources have a positive relationship with carbon dioxide emissions. Therefore, BRICS countries should invest in new technologies to cater for environmental sustainability.

KEY WORDS
Energy sources, BRICS, regulations, government, technology.

Climate change, biodiversity loss, and pollution are three global planetary crises detrimental to a sustainable environment (United Nations, 2019). As the world is now fostering economic growth, the environment is left under threat, resulting in an abrupt escalation of conflicts between industrialists and environmental activists (Danish, 2020). Environmental activists are propelling the need to make systematic changes to a shift toward a more sustainable environment. The environment is said to be sustainable if it manages to tackle social and economic issues without compromising the ability of the next generation to acquire their needs (Xue et al., 2021). United Nations Global Compact (2018) states that the world needs to shift from burning fossil fuels to natural resources and alternative energy to achieve environmental sustainability. The Paris Climate Agreement (2019) reported that about 85% of the world's population relies on non-renewable fossil energy, and emits about 70% carbon dioxide (CO_2), thus exacerbating the deterioration of environmental sustainability. Like any other regional blocs that share a common goal, BRICS countries (Brazil, Russia, India, China and South Africa) initiated the adoption of alternative energy technologies. They encouraged their member states to cease all activities that lead to greenhouse gas emissions. To effectively ensure environmental sustainability, BRICS countries intended to accelerate the critical components of their energy transformation. The Energy Policy Review (2021) asserted that BRICS is among the regional blocs in the world promoting actions and investment in alternative energy to improve their environmental sustainability. Environmental experts purport that investment in alternative and nuclear energy and natural resources is the most sustainable way to reduce climate change,

pollution and loss of biodiversity. Khan et al. (2022) stated that the use of renewable energy sources, such as water, geothermal heat, sun and tides, makes the country achieve a sustainable environment. Nathaniel et al. (2020), argued that to reduce greenhouse gas emissions effectively, there is a need to invest in hybrid energy comprising both nuclear and renewable energies. However, following this credence, this paper seeks to examine the effect on alternative energy, natural resource and government final consumption expenditure for BRICS countries. The chapter also included other variables such as GDP and government final consumption expenditure to identify their effect on environmental sustainability.

METHODS OF RESEARCH

This study used macroeconomic data collected from the World Bank Indictors (WBI) that is, real GDP per capita (GDP), government final consumption expenditure (govern), alternative and nuclear energy (alter), carbon dioxide emission (CO2) and natural resources (natural) for BRICS during 1990-2021. To meet the objective of this study, a panel vector auto regression (PVAR) is used. The empirical framework used by Khan et al. (2021) is borrowed and presented as follows:

$$(CO_2 \text{ emission} = f(\text{real GDP , govern, alter, natural}) \quad (1)$$

Where: CO_2 emission is carbon dioxide emission (greenhouse gases/metric tons from fossil fuels), govern is government final consumption expenditure (excluding military expenditure), alter is alternative energy use (including solar and hydropower/metric tons), GDP is real GDP per capita (US$), natural represents natural resources (as a % of GDP).

The equation (1) is transformed in to an econometric equation as follows:

$$CO_2 = \beta_0 + \beta_1 alter + \beta_2 GDP + \beta_3 Govern + \beta_4 natural + \mu \quad (2)$$

RESULTS AND DISCUSSION

In examining the relationship that exists between alternative energy sources, natural resources, and government consumption expenditures on environmental sustainability for the BRICS, the study initially undergoes a panel unit root test to check for stationarity. In order to provide proper results for policymaking, we performed the Levin-Lin-Chu unit root test. It was performed under the hypothesis that the variables under investigation are not stationary, against the alternative hypothesis that the variables are stationary.

Table 1 – Levin-Lin-Chu unit root test (Eviews 12)

Variable	Statistics	Prob*	Interpretation
Alter: Levin, Lin & Chu t*	-1.17785	0.1194	Not stationary
D(Alter) Levin, Lin & Chu t*	-6.99880	0.0000***	Stationary
Gover Levin, Lin & Chu t*	-0.01224	0.2021	Not stationary
D(Gover) Levin, Lin & Chu t*	-2.54332	0.0014**	Stationary
CO_2 Levin, Lin & Chu t*	-1.66636	0.1478	Not stationary
D(CO_2) Levin, Lin & Chu t*	-4.90608	0.0000***	Stationary
GDP Levin, Lin & Chu t*	-0.89969	0.1841	Not stationary
D(GDP) Levin, Lin & Chu t*	-7.27096	0.0000***	Stationary
Natur Levin, Lin & Chu t*	-1.40337	0.1803	Not stationary
D(Natur) Levin, Lin & Chu t*	-108.264	0.0000***	Stationary

As shown above, we present the Levin, Lin, and Chu unit root test results in tabular form with the option of constant or movement. Therefore, it is shown that all the variables (alternative and nuclear energy use (alter), government consumption (govern), carbon dioxide emission (CO2), gross domestic product (GDP), and natural resources (natur)) are not stationary at levels. Under this scenario, we are forced to perform the same test for the

first time. Therefore, the results reported that, at the 1% level of significance, alternative and nuclear energy use has become stationary, government consumption expenditure has become stationary at the 5% level of significance, carbon dioxide emissions (CO2) have become stationary at the 1% level of significance, and gross domestic product (GDP) and natural resources have become stationary at the 1% level of significance as well. As a result of this, at the first difference, we reject the null hypothesis, which stresses that the variables are not stationary.

In table 2 below, we performed the Pedroni cointegration test in order to check whether there is a long-run relationship among the variables included in this study. The test was conducted under the hypothesis that there is no cointegration against the alternative hypothesis, which confirms the presence of a long-term relationship. The results of the Pedroni cointegration demonstrate that at all levels of significance, there is no evidence of a long-run relationship among the variables in question for the BRICS. Therefore, we failed to find evidence to reject the null hypothesis. Table 2 below demonstrates the results of the Pedron cointegration analysis.

Table 2 – Pendroni Cointegration Test (Eviews 12)

	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	0.203974	0.4192	-0.098652	0.5393
Panel rho-Statistic	0.605297	0.7275	0.571787	0.7163
Panel PP-Statistic	-0.884938	0.1881	-0.885134	0.1880
Panel ADF-Statistic	-0.889261	0.1869	-0.848804	0.1980
Group rho-Statistic	1.256038	0.8954		
Group PP-Statistic	-0.654257	0.2565		
Group ADF-Statistic	-0.442482	0.3291		

Due to the large number of data sets (1990–2021), the maximum number of lags was set at one. The Akaike information criterion (AIC), FPE, HQ and LR chose lag order one from the output, while the Schwarz information criterion (SC) chose lag order two. As a result, Lag Order 1 was chosen for this investigation.

Table 3 – VAR Lag Order Selection Criteria (Eviews 12)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-387.3480	NA	0.000230	5.812563	5.920166	5.856290
1	777.2048	92.49457*	1.56e-11*	-10.69933*	-9.515699	-10.21834*
2	802.6426	44.84586	1.55e-11	-10.70582	-8.984171*	-10.00619

Following the results of Pedroni cointegration analysis, we suggested vector auto-regression (VAR) analysis as the most appropriate technique to use in this study. Table 4 below represents the outcomes from the VAR analysis.

Table 4 – Panel VAR (PVAR) results (Eviews 12)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCO2	1.000043	0.176170	5.676595	0.0000***
LALTERC	-0.039354	0.015721	-2.484217	0.0008***
LGDP	0.132359	0.018055	7.330873	0.0000***
LGOVC	-0.116630	0.026491	-4,402511	0.0000***
LNATURALC	-0.133572	0.055852	-2.391515	0.0071**
C	-0.095819	0.089944	-1.065316	0.2871
R-squared	0.978771			
Adj. R-squared	0.977126			
Sum sq. resids	3.962586			
S.E. equation	0.175265			
F-statistic	594.7646			

In table 4 above, we estimated the short-run results for the effects of alternative energy, natural resources, and government final consumption expenditures on environmental sustainability for the BRICS. The VAR results show an R-squared of 0.978771 (98%). This

implies that 98% of the total variation in carbon dioxide emissions (CO2) is explained by alternative and nuclear energy (alter), natural resources (natural), government final consumption expenditure (gover), and gross domestic product (GDP), and only 2% is captured in the error term. Thus, we confirmed that the model is of good fit and is correctly specified. The short run results demonstrate that, alternative energy (alter) is negatively related with carbon dioxide, that is, ceteris paribus, a 1% increase in alternative energy use, the amount of carbon dioxide emissions decreases by 0.0393 (3.9%). The coefficient for natural resources is negative and statistically significant at 5% level of significance that is, holding other things constant, a 1% increase in the use of natural resources would trigger a 13% decrease in carbon dioxide emissions. The coefficient for government final consumption expenditure (Govern) is negatively related to carbon dioxide emissions, that is, ceteris paribus if the government increases its final consumption expenditure by 1%, carbon dioxide emissions decreased by 12%. However, the coefficient for Gross Domestic product (GDP) is positive and statistically significant at all levels of significance, that is, if GDP increases by 1%, holding other things constant, the amount of carbon dioxide emission (CO2) increases by 13%. This results demonstrate that, natural resources (natural), alternative energy (alter) and government final consumption expenditure (Govern) improves environmental sustainability in BRICS countries, while Gross Domestic Product (GDP) negatively affect sustainable environment. This is consistent with the results obtained by (Lee, 2017, Jun et al. 2018, Dong et al. 2019, Saidi, 2020, Mahmood et al. 2020, Nathaniel et al. 2021) who found alternative and nuclear energy and natural resources to have a negative relationship with carbon dioxide emission (CO2). However, GDP was positively related to carbon dioxide emission. To this end, the BRICS countries are therefore, recommended to minimize using energy that emits high toxic gases that devastates the environment, such as hydropower, geothermal power, and nuclear power.

CONCLUSION

This paper examined the relationship between alternative and nuclear energy, natural resources, and government final consumption expenditure for the BRICS countries using a panel vector auto-regression. The study employed data extracted from World Bank Indicators (WBI) spanning from 1990 to 2021. This paper employed the panel vector auto-regression (PVAR) analysis, which juxtaposes the ordinary VAR technique, where variables are endogenously determined, with the panel data analysis, which consists of cross-sectional data. The empirical results show that alternative energy use (alter), natural resources (natural) improves environmental sustainability. However, GDP growth increases carbon dioxide emissions (CO_2) which in turn negatively affecting the environmental sustainability. The use of natural resources for energy and alternative and nuclear energy help to reduce environmental pollution and increases economic growth, therefore, policymakers in BRICS countries should focus on designing policies that promotes the investment in nuclear energy, this will capacitate them to meet a rapid increase in the demand for energy and to reduce energy import dependency. The BRICS countries must promote the use of natural resource, since the empirical results reported that, it contributes to sustainable environment.

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