Effect of Energy and CO2 Consumption on the Economy in Sub-Sahara Africa

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Abstract—The study focused on the long-term related effect among energy consumption (EC), CO2 production and economy growth (EG) of 12 randomly selected countries in sub-Saharan Africa. We used validation and causality tests in the 2008–2018 annual record. Special effects vary from country to country, in the long term, strong consumption of energy and economy growth in many countries has been linked with an increment in air pollution. The observation of the longitudinal study showed economic growth resulting in short-term CO2 emissions in Benin, the Democratic Republic of Congo, Ghana, Nigeria and Senegal, reflecting a lack of economy. This would not be possible without affecting the environment. The effect between CO2 and EG in Gabon, Nigeria and Togo has shown that environmental policies aimed at reducing pollution can be harmful. economic growth. In addition, long-term economic and CO2 production in Nigeria has been closely linked to the long-term links to Congo and Gabon. In the long-run, greenhouse gas emissions are the result of EC, EG and CO2 emission in Benin, Ivory Coast, Nigeria, Senegal, South Africa and Togo.

Key words—Energy consumption, Economic growth, CO2 emission

I. INTRODUCTION

The major cause of carbon dioxide (CO2) emissions is pollution. To preclude global warming and its effects, some countries agreed by signing the Kyoto Protocol and have pledged to reduce their productions. The twenty-one session of the United Nations General Assembly (COP21) in Paris in December 2015. This is an important guide to efforts to diminish greenhouse gas emissions and their consequences. The distribution of specialized literature has addressed these problems and the conclusion of these articles are mixed per country, energy variation and aesthetic approaches. Research has shown that pollution is at the highest growth point in the country, with the exception of more income at the border, as reported by Kuznet Environmental Curve (EKC).

Moreover, majority of previous research focused on the link between power generation ([3.25.3] and others) and pollution ([10.25.26] and others)). However, there is little attempt to demonstrate these two relationships within the same framework. The objective of this study was to close the interval in the Sub-Sahara Africa. The Sub-Sahara of Africa represent an attractive case study on the subject, as

air pollution is an important political problem for politicians and environmentalists. Over 75% of sub-Saharan Africa is responsible for energy and air pollution associated with fixed fuel consumption which accounts for over 4,000 premature deaths per day [14]. The sector also has the option of conducting little research in sub-Saharan Africa, despite emerging literature on the link between efficiency, EC and impurity of the environment.

This article looks at the connection between EC, EG and CO2 emissions in 12 sub-Saharan countries. Data was gathered from the World Bank, International development indicators from 2008–2018. The purpose of this section is to examine the impact of carbon dioxide on sub-Saharan Africa's economy and provide solutions and steps to help in the reduction of CO2 emissions.

II. LITERATURE REVIEW

The connection among energy, environment and economy is becoming more important nowadays. From a perspective, Jorgenson and Wilcoxon have done an admirable job of transforming the connection among energy, environment and economy through change. This connection seems to be as powerful as it works. [16] Although the use of natural resources is important for the economy, it causes pollution of the environment.

[8.9] created a theoretical framework to describe the EKC model of the environment using the Solow model. As EKC took into account the technological changes in the Solow Shrink model, this was a significant advantage in making it a sustainable approach. [23] proposed a recent meta-analysis that uses environmental impact assessment and EG. Perhaps it is caused by the fact that some models treat impurity as a form of benefice and others as a disadvantage. [5] studied the link between economy, CO2 production and energy consumption in developed countries between 2001 and 2017, and showed that the GMM and GMM regulations are not at risk and show that this is the case yes He emphasized on EG of EC, but has a clear effect on CO2 in new economies and a significant effect on EC, but there is a direct influence on CO2 emissions in new areas.

In developing countries, [6] investigated the link between renewable energy usage and CO2 emissions between 1980 and 2014. Using dynamic OLS and OLS testers, they noticed an important role in economic growth and energy consumption in CO2 emissions. Remember that economic growth and EC are reducing environmental quality. For carbon dioxide emissions, Dong et al. (2019) Growth, population, non-renewable energy and energy intensity have a direct and direct impact on global and regional carbon dioxide emissions and renewable energy emissions of carbon dioxide worldwide. [29] examined the connection between EC, EG, and CO2 emissions in China. It resulted that there is a one-sided reason for long-term EG, EC and consumption for CO2 emissions. It resulted that CO2 emissions and EC were not contributing to economic growth. [20] used data from the ASEAN index and report evidence on the short-term cause of CO2 emissions for EC and the long-term factor for EC and CO2 emissions for economic growth [1].

III. METHODOLOGY

Case studies and data mining include Sahara, Benin, Cameroon, Republic of Congo, Democratic Republic of Congo (Dr Congo), Ivory Coast, Gabon, Ghana, Kenya, Nigeria, Senegal, Africa), South and Togo. we calculated and analyzed real GDP (dollar values), increase electricity (E) for EC and carbon dioxide (CO2) emissions from the World Bank Database and using their permanent indices [28] covering the seasons between 2008 and 2018. We focused on two main goals. First aim is to evaluate how EC, EG, CO2 emission are connected in the long-run. The second focused on the dynamic causality between them. Cointegration and causality tests were done in a trivial context.

To study the longevity effect among EC, CO2 emissions and GDP, we referred to [21]. This approach worked better than small samples, compared with other sources such as [12] [26] ([5, 13, 15]). The bounds test may be used regardless of whether D (1) or D (0) are the regressors. This is to avoid the risk of adverse side effects. The test should include a randomized controlled trial using a variety of models as

$$\Delta y_t = \gamma_0 + \sum_{i=1}^m \delta_{1i} \Delta GDP_{t-i} + \sum_{i=0}^n \pi_{1i} \Delta E_{t-i} + \sum_{i=0}^p \theta_{1i} \Delta CO2_{t-i} + \beta_1 GDP_{t-1} + \beta_2 \Delta E_{t-1} + \Delta CO2_{t-1} + \varepsilon_t \quad (1)$$

Note that in (1) each variable is treated as the dependent variable. Here is an important property of the sum method because it specifies exactly which dependent variable and independent variable in a given relation. The longitudinal delay m, n, p was selected in respect of the width-response model with the scaling factor of 5. (1) also includes different frequencies and bands. The simulation results in the long-term correlation coefficients between variables, using the coefficient of variation in (1). The null hypothesis was defined as $\beta_1 = \beta_2 = \beta_3 = 0$ which was evaluated using

the F-statistic. Yet, its asymptotic distribution was non-standard under the null hypothesis.

The autoregressive vector (VAR) statistical test was performed. However, when clamped in the system, the temporal link among the variables should be a model in a model of error correction that includes incorrect correction time ([12]). Therefore, Granger's research was based on the following models:

$$\Delta GDP_t = \alpha_1 + \sum_{j=1}^p \beta_{1j} \Delta GDP_{t-j} + \sum_{j=1}^p \gamma_{1j} \Delta E_{t-j} + \sum_{j=1}^p \sigma_{1j} \Delta CO2_{t-j} + \mu_1 ECT_{t-1} + \varepsilon_{1t} \dots (2)$$

$$\Delta E_t = \alpha_2 + \sum_{j=1}^p \beta_{2j} \Delta GDP_{t-j} + \sum_{j=1}^p \gamma_{2j} \Delta E_{t-j} + \sum_{j=1}^p \sigma_{2j} \Delta CO2_{t-j} + \mu_2 ECT_{t-1} + \varepsilon_{2t} \dots (3)$$

$$\Delta CO2_t = \alpha_3 + \sum_{j=1}^p \beta_{3j} \Delta GDP_{t-j} + \sum_{j=1}^p \gamma_{3j} \Delta E_{t-j} + \sum_{j=1}^p \sigma_{3j} \Delta CO2_{t-j} + \mu_3 ECT_{t-1} + \varepsilon_{3t} \dots (4)$$

where ECT_{t-1} is defined as a delay in the correction of errors obtained by a longitudinal correction. Without the numerator, this statistic is not welcome and the sample size has been reduced on VAR at the first difference if the difference was D(1). The false learning model allowed for the differences between Granger's long-term and short-term causal relationships. The long-term relationship was obtained by examining the relative importance of ECT_{t-1} while the time-dependent relationship evaluated the importance of the delayed dynamic terms. For (2), real energy consumption did not produce GDP in the short term if $\gamma_{11} = \gamma_{12} = \gamma_{13} = \dots = \gamma_{1p} = 0$. Similarly, for EG in (3), does not lead to strong EC if none of β_{2j} is statistically different from zero.

IV. EMPIRICAL ANALYSIS

Prior to the adoption of limit test in respect of the unit roots in the variables used. This procedure is important in making sure that any parameter is D (2). Limit test was conducted with the assumption that the variable depends on D (1) and the regression is D (0) or D (1). To investigate the rooting of serial devices, the unit test unit recognized the Phillips and Perron units [28] (hereinafter referred to as PP) has been implemented. This test was carried out on models with a continuous trend at different levels and constant first set of differences. This is illustrated by the results described in Table 1, all-time series have elements and end after creation first difference after discovering that none of the D (2) series exists, try it postdoctoral limit tests have become more important due to the restricted amount of observations, the delay of 5 is selected.

TABLE 1. PHILLIPS AND PERRON UNITS ROOT TESTS

Countries	Stage			Lag (1)		
	GDP	Energy	CO2e	Δ GDP	Δ Energy	Δ CO2e
Benin	- 3.231*	- 2.169*	- 3.259*	-5.086	-5.529	-6.450
Cameron	-4.829*	-0.189*	- 4.310*	-5.125	-3.112	-7.367
Congo	-1.102*	-0.536*	- 3.973*	-4.642	-7.376	-7.560
Dr Congo	-2.351*	-2.647*	- 2.780*	-3.965	-7.716	-6.734
Cote d'Ivoire	-1.671*	-1.838*	- 2.871*	-4.795	-6.523	-7.248
Gabon	-4.172*	-1.654*	- 4.213*	-5.42	-7.789	-10.361
Ghana	-2.662*	-1.549*	- 4.348*	-5.101	-7.552	-18.310
Kenya	-4.223*	-2.785*	- 1.526*	-6.523	-6.235	-5.321
Nigeria	-0.005*	-1.773*	- 2.423*	-5.320	-5.201	-6.982
Senegal	-2.202*	-0.520*	-4.225	-6.754	-5.592	-9.610
South Africa	-2.246*	-2.863*	-2.59*	-3.249	-6.025	-5.810
Togo	-4.111*	-1.492*	-6.023	-7.515	-7.829	-12.923

Notes: Note: Required 5% values are 3,529 maximum and 2,941 for the original difference *, which means rejecting the zero assumption that the unit is in the dataset

TABLE 2. BOUNDS TEST FOR COINTEGRATION

Countries	F_{GDP}	F_E	F_{CO2}	Cointegration?
Benin	3.035* (4)	5.494* (3)	4.972** (3)	present
Cameron	15.323* (4)	11.252* (1)	5.859** (3)	present
Congo	19.337* (3)	1.893(4)	11.450* (1)	present
Dr Congo	1.758 (4)	6.652* (4)	2.354 (3)	present
Cote d'Ivoire	8.459* (4)	3.893 (4)	7.589* (3)	present
Gabon	13.785* (4)	3.253 (4)	7.458* (3)	present
Ghana	8.258* (4)	13.425* (3)	12.698* (3)	present
Kenya	5.270** (3)	12.452* (4)	7.625* (3)	present
Nigeria	8.354* (4)	4.252* (3)	6.752* (3)	present
Senegal	6.235* (4)	1.245(3)	11.235* (1)	present
South Africa	7.589* (1)	6.520* (3)	4.258* (3)	present
Togo	2.425 (3)	1.635 (4)	6.358* (1)	present

The results of the F statistics with valid values are shown in Table 2. Please note that the assigned exact values are greater than the average values valid as reference number [38] For example, the most important limitation in this study in case III is 0.1 and 0.06 higher than in case studies [38] up to 5% and 10% respectively. According to the F factor, there are correlation data between the three variables in all countries studied. This means that EC, CO2 emissions and real GDP were not required for too long. The F factors estimated by Togo only reject the null hypothesis of absence when CO2 is a dependent variable. Congo, Ivory Coast, Gabon and Senegal seem to be integrated using GDP or CO2 as a dependent variable. Border analyzes in Ghana, Nigeria and South Africa confirm the interdependence of segregation, even when using a dependent variable.

Because the expected exchange rate is calculated, the results are shown in Table 3. As shown in this table, the usage of energy contributed significantly to electricity production in Benin, Congo, Ghana, Nigeria, Senegal, South Africa and Togo. Economic growth is also linked to high consumption in Benin, Côte d'Ivoire, Côte d'Ivoire, Nigeria and South Africa, which meaning they have high growth and contribute to the environment pollution. The results of this study are beyond its scope [2], where intake and dietary benefits have been reported. CO2 emissions in the sample of 35 countries are positively related to the population. Impact on energy consumption, which supports the growth of the CO2 economy in [19]. Economic impact, sustainable development, countries like Benin, Côte d'Ivoire, Ghana, Nigeria, Senegal, South Africa and Togo need to develop pollution control measures to help eliminating impurity without causing damage on the economic development. The economic crisis has led to increased food security in Cameroon, the Democratic Republic of Congo and Kenya. Although the link indicates the purpose of Granger, there is no reference to the reason reporting guidelines. The MEC insulation test was carried out.

	Exact critical values for F-statistics (T=40)			
	0.05		0.1	
	D(0)	D(1)	D(0)	D(1)
Case I	3.587	6.118	4.2270	5.433
Case III	3.235	4.231	2.354	3.568
Case IV	5.253	6.253	4.236	5.658

Notes: The critical value of F-statistics is based on empirical models per 40,000 observations.; T is the sample size. * Ma ** indicates that the null hypothesis was used at the 0.05 and 0.1 values, respectively. The parameters in the equations are given in (.)

TABLE 3. LONG TERM EFFECTS

Countries	Dependent Variable	CO2	Energy	GDP
Benin	CO2	-	1.119 (1.723)**	1.253 (2.235)*
Cameroon	Energy	0.242 (1.180)	-	0.235 (6.329)*
Congo	CO2	-	1.903 (6.776)*	-0.258 (- 1.953)*
Dr Congo	Energy	-0.381 (- 4.582)*	-	0.325 (4.258)*
Cote d'Ivoire	CO2	-	-0.087 (- 0.687)	0.535 (7.369)*
Gabon	CO2	-	-2.693 (- 2.581)	-4.459 -5.582(- 3.253)*
Ghana	CO2	-	-1.365 (- 7.685)*	-0.025 (-0.253)
Kenya	Energy	-0.005 (0.569)	-	0.492 (7.358)*
Nigeria	CO2	-	1.569 (1.876)**	1.23 (2.253)*
Senegal	CO2	-	1.235 (5.893)*	-0.017 (-0.358)
South Africa	CO2	-	0.898 (5.658)*	1.452 (6.235)*
Togo	CO2	-	0.839 (5.698)*	-0.002 (-0.068)

Notes: (.) are t-statistics. * and ** denote significance at the 5% and 10% levels, respectively.

V. CONCLUSION

This article explored the link between energy consumption, growth and carbon emissions in 12 countries in sub-Saharan Africa. There are empirical findings between long-term energy consumption and economic growth in countries with higher CO2 emissions. The results showed positive results, evidence of economic growth associated with short-term CO2 emissions in Benin, Dr Kong, Ghana, Nigeria and Senegal, which mean that economic growth cannot be achieved without environmental impact, emissions CO2 for the economy is increasing in Gabon, Nigeria and Togo. A causal relationship between EC emissions and short-term CO2 emissions has been described in Nigeria, Congo and Gabon and sources from Benin, Congo, Ivory Coast, Gabon, Ghana and Nigeria have been accepted. long term. A one-sided causal link with the true consequences of domestic pollution in Benin, the Democratic Republic of Congo, Ghana and Senegal suggests actions in these countries to reduce the risk of CO2 emissions without intervention. short-term economic growth.

To enable economic development in countries like Benin, Congo, Ivory Coast, Gabon, Ghana, Nigeria, Senegal, South Africa and Togo, governments must embrace environmental protection policy. This will help reduce emissions by promoting clean energy generation, it is also crucial for African countries to improve their energy efficiency via technology, transport and various processes. Especially in Nigeria. CO2 policy must take into account the continued use of electricity to avoid widespread use of gasoline. Therefore, further investments are needed in the development of electric vehicles.

VI. REFERENCE

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