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An Empirical Analysis of the Environmental Kuznets Curve: the Case of Cameroon*

Çevresel Kuznets Eğrisinin Bir Ampirik Analizi: Kamerun Örneği

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ABSTRACT

This study investigates the association between financial development, trade openness, economic growth (GDP), and environmental quality (CO_2) in Cameroon from 1980-2016. To examine the relevance of the Environmental Kuznets Curve (EKC), the squared of GDP is included in the model. The Johansen-Juselius co-integration tests demonstrate that a robust long-run relationship exists between the variables. Specifically, GDP influences carbon dioxide emissions negatively, while GDP squares positively. The Granger causality tests further indicate that the GDP and GDP squared caused CO_2 emissions uni-directionally in the short-run with no feedback. The findings settled that the EKC, with a U-shape relationship, is relevant in Cameroon. Therefore, it is recommended that the government focus on implementing policies that raise growth with minimal emissions of pollution.

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ÖZ

Bu çalışma 1980-2016 dönemi Kamerun'un finansal gelişme, ticaret açıklığı, ekonomik büyüme (GSYH) ve çevre kalitesi (CO_2) arasındaki ilişkiyi araştırmaktadır. Çevresel Kuznets Eğrisini (ÇKE) incelemek için, modelde GSYH ve GSYH karesi içerilmektedir. Johansen-Juselius Eş-Bütünleşme Testi uygulanmıştır ve bulgular, finansal gelişme, ticaret açıklığı, GSYH ve karbondioksit emisyonu arasında uzun dönemli sağlam bir ilişkinin olduğunu göstermektedir. Özellikle, GSYH çevre kalitesini negatif etkilerken, GSYH karesi ile çevre kalitesi arasında pozitif bir ilişki sergilenmektedir. Granger nedensellik analizi, kısa dönemde GSYH ve GSYH karesi CO_2 emisyonuna tek yönlü neden olduğunu göstermektedir. Bu sonuç, U- şekiili ilişkinin, Kamerun'da geçerli olduğunu, ve tersine uzun dönemde CO_2 emisyonu ekonomik büyüme ile birlikte artmaktadır. Bu nedenle, hükümetin, en düşük düzey kirletici emisyonu ile büyümeyi artıran politikalara odaklanması önerilmektedir.

1. Introduction

Nowadays, the world is considered a global village due to the rapid advancement in technology that has facilitated trade between countries. International trade is beneficial in transforming economies, in creating jobs and in alleviating poverty in most countries (Mishra, 2000). Nonetheless, the benefits of trade are not evenly distributed especially in third world countries where the gaps between the rich and the poor are still high. This therefore warrants the development of growth models and strategies to boost trade between states.

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The neoclassical growth model, by Solow (1956) stipulates that poor countries are growing faster to catch-up with other rich ones. This model assumed a decreasing return in physical capital and that income disparity in most part of the world occurs as a result of differences in productivity between countries. As an example, the model is relevant for the East Asian economies where the People's Republic of China, the Republic of Korea, and Singapore are catching-up with the industrialized economies (Chandra et al., 2013). For African countries, the rate of catching-up with the advanced economies is slow as the model predicted.

This model is however limited in the sense that it does not focus on trade-environment nexus (TEN), environmental-growth nexus (EGN) and sees technology as exogenously determined. In this study, we have augmented the Solow growth model by looking at the trade-environment nexus (TEN) and environmental-growth nexus (EGN). Cameroon is described as one of the giant economies in Sub Saharan Africa with growth rate that has undergone three main evolutions since independence (Bamou & Master, 2007). Firstly, a period of robust growth from 1960 to 1986 prompted by the good performances of the primary agricultural sector, a downturn from 1987 to 1994, during the oil crisis and a cumulative trend since 1994.

Agriculture is the backbone of Cameroon's economy, employing more than 70% of the population (Amoro & Shen, 2012). For this country to achieve a rapid growth, more resources need to be exploited. This is quite perplexing considering the trade-off between economic activities and environmental damages. At this instance, it is relevant for researchers to find out the nature of the relationship that exists between economic growth and environmental quality.

Before the 1980s, the trade flows to most African countries were quite insignificant (Çina &Nulambeh, 2017). This was due to the fact that many political leaders in Africa had some hostile policies in regard to private sector development and foreign companies in particular. Being young states just emerging from independence, most of them were skeptical of engaging with foreign firms in most of their key sectors. But today, many African countries have taken positive measures and initiated economic reforms, with the target to increase the role of the private sector and trade competitiveness. Likewise, increasing number of African countries are now allowing foreign participation in the privatization of their state owned enterprises.

The financial sector is often regarded as the "engine of growth" in any economy. Aghion et al. (2005) predict that countries with more critical level of financial development may turn to converge to the growth rate of the advanced societies and that variables such as education, geography, health, policy, politics, and institutions do not affect the significance interaction between financial development and economic growth. While, Levine (2014) state that, financial development is a good predictor of future economic growth, capital accumulation, and technological change. Beck (2013) argues that financial sectors act as engine of growth in facilitating payment and the provision of intermediary services between the lenders and borrowers. In other words, this sector is very vital, since it offers households, and firms with good managerial fascilities.

Meanwhile, the impact of foreign trade on environment has been subjected to intense debates. International trade between countries often generate the issue of pollution havens hypothesis, where nations with weak environmental regulations turn to attract more pollutanting industries. Many a times, the impact of trade on environment habitually lead to a reduction in environmental pollutions or an adverse effect on the environment, making this relationship to remain inconclusive. Bernard & Mandal (2016) settle that foreign trade has a detrimental effect on environment, since it raises carbon dioxide emissions. Sun et al., (2019) on the other hands, demonstrate that international trade is negatively related with environmental pollutions and thus has a beneficial effect.

Based on the above, this study will jointly investigate the impact of energy consumption, foreign direct investment, human capital, financial development and economic growth on environmental quality by employing the Cameroon time series data in the co-integrating framework. This is usually model using the environmental Kuznest curve (EKC), proposed by Kuznets (1955) to study the relationship between income inequality and economic growth. It was later developed by Grossman & Krueger (1991), Panayotou (1993) and Selden & Song (1994) to examine the association between economic growth and environmental pollution. The environmental Kuznets Curve (EKC) is a postulated relationship between the indicators of environmental pollution and economic growth (per capita income). This theory states that in the early stages of economic development, pollutions increase and reach a maximum point before falling at a certain level of per capita income. According to this theory, a rapid growth in income and technology leads to improvement in the quality of the environment.

In this present study, the relationship between financial developments, trade openness, economic growth, and environmental quality is examined, employing the Cameroon time series data in co-integrating framework. This test will permit us to find out whether the hypothesis of the EKC is relevant in Cameroon. The study is motivated considering the fact that no known research of this nature has been conducted in Cameroon. Likewise, researchers often cast doubt whether the EKC, having an inverted U-curve is meaningful for developing countries (Gill et al., 2018). The rest of the paper is structured as follows. Section 2 presents the literature review and section 3 sets out the methodology. Section 4 covers the results and finally, section 5 discusses the policy implications and recommendations.

2. A Review of Related Literature

2.1 Theoretical Literature

In the literature, two hypotheses are mostly used to study the relationship between trade openness and carbon dioxide emissions: the Pollution Havens Hypothesis (PHH) and the Pollution Halo Hypothesis. The pollution havens hypothesis states that interanational trade will cause countries with weak environmental regulations to attract more polluting industries from stronger nations and as environmental regulations improves, the demand for air quality turn to increase (Harrison, 1997). On the other hands, the pollution

halo hypthesis, states that foreign trade, bring about the improvements in the quality of environment in developing countries, since it often go along with the transfer of skills, technology, capital, and better management techniques. In other words, foreign enterprises have the tendency to transfer clean energy and technology to developing countries that will further reduce the level of carbon dioxide emissions.

Also, researchers, frequently used the Environmental Kuznets Curve (EKC) hypothesis to explain the relationship between economic growth and environmental pollution. This was first introduced by Kuznets (1955), to study the inverse relationship between income inequality and economic growth. It was later revitalized, to study the relationship between economic growth and environmental quality by Grossman & Krueger (1991).

The EKC hypothesis postulates that in the initial stage of economic development, an increase in national income is accompanied by an increase in environmental pollution. After that, a stage is reached in the developmental process of a country after which an increase in national income is not complemented with an increase in environmental pollution.

The reason being that, in the early stage of development, nations do not usually care for the quality of the environment, as more utilization of natural resources is essential in building up a nation. However, once a certain level of income is riched, nations try to care about the quality of their environment, since certain environmental issues generate health problems. In other words, an inversed U-shaped association exists between economic growth and environmental pollution. This simply means that in the process of development, nations will come accross difficult situations, before getting better in the long-run.

According to Panayotou (1993), five factors could best explain the nature of the EKC: economic size (GNP), the sectoral structure of the economy, demand for environmental goods, level of technology, and the effectiveness of conservation policies. To illustrate these points, the author first notes that the larger the size of the economy, the greater the depletion of natural resources, with the emission of more greenhouse gases.

Secondly, the shape of the EKC depends on the structure of the economy. Agrarian economies turn to emit less carbon dioxide emissions compared to industrialized economies. This explains the reason why countries that are dominated by agriculture turn to generate fewer pollutants compared to industrialized economies. But as a nation develops, the structure of its economy also changes (from agriculture to industry and services).

Thirdly, technology equally accounts for the differences in environmental quality between countries. countries with the same economic structures and different levels of technology may, however, emit a different level of industrial waste. This is because, poorly maintained industrial machinery and plants are less efficient in material and energy use, and turn to produce a high amount of waste materials than new and better maintained industrial plants.

Fourthly, environmental awareness equally accounts for the shape of the EKC. As the author stated, in the early stages of economic development, the poverty rates are often high, tax collections are not effective and environmental awareness (being income elastic) is quite low . The government turns to focus on poverty alleviation, and little funds are allocated for environmental protection. This partly explains the reasons why the demand for a quality environment in third world countries is low. Lastly, strong environmental policy could also justify the reasons for environmental conditions in most nations. Countries with strong environmental regulations turn to have lower emission rates compared to those with weak policy. Meanwhile, it is stated that economic growth might come to a steady state if majors are not taken in re-controlling the spead of pollution (CO2) Solow (1963) and Pettinger (2017).

2.2 Empirical Literature

Policy makers and economists are concerned about economic growth and its impacts on the environment in both developed and developing countries. This has generated a number of studies and vast literature in this area. In the case of Cameroon, there are inadequate empirical studies that examine the impact of economic activities on the environment. Besides, the quest to archive a sustained growth in developing countries remains an issue of great concern, owing to the fact that most of these countries have limited environmental policies.

Tiwari (2011) investigates the impact of environmental quality on economic growth, using two important variables as indicators of environmental qualities (environmental pollutions and energy consumption). The results show that energy consumption and population Granger-cause economic growth. In term of correlation, it was found that CO2 emissions negatively impact growth. Likewise, Agarwal (2012) analyzed the joint impact of economic growth, FDI and financial development on environmental quality using time series data that runs from 1980 to 2008. The author equally confirmed the existence of a negative link between economic growth and the environment in Malaysia.

Aboagye (2015) examines the impact of environmental qualities on economic growth in Sub Saharan countries (SSA), using panel data that runs from 1985-2010. This paper differs in that the author went further to examine the effect of industrialization and urbanization on the environmental quality and found that industrialization unambiguously harms the environment while rapid urbanization is revealed to have increased the environmental pollution. The author concludes that pollution (CO2 emissions) increases with growth in the long run. Hilaire & Fotio (2015) survey the impact of economic growth on environmental quality (CO2) in Cameroon, Congo, Gabon and the Democratic Republic of Congo for the period 1978 to 2012 and came out with parallel results.

Aka (2008) studies the impacts of trade intensity (share of exports plus imports in GDP) and economic growth on air pollution (CO2 emissions) in Sub-Saharan Africa for the period 1961-2003. The author employs the recent Autoregressive distributed lag (ARDL) method of analysis

and obtained similar results, indicating that pollution negatively impacts growth in the long run. Moreover, Phimphanthavong (2013) investigate the relationship between economic growth and environmental degradation using time series analysis between 1980 to 2010. While focusing the EKC's hypothesis, it was confirmed that at the early stage, economic growth increases environmental pollution, which turns to fall after reaching a certain level of average income per capita, confirming the existence of the EKC hypothesis.

In addition to the above, Zheng et al. (2015) explores the correlation between economic growth and environmental pollution in some Chinese cities for the period 2004 to 2012, while Valadez & Hu (2016) examine the impact of economic growth and trade on environmental quality and both studies conclude a negative association between economic growth and environmental quality. Furthermore, Bond et al. (2015), Carillo & Maietta (2017) equally obtained a similar outcome.

Contrary to the above, some findings have indicated a positive association between economic growth and environmental quality. Awad (2017) recently carried out a study to examine the impacts of income on carbon emissions in Sub Saharan Africa, using panel data for the period 1990-2014. It was established that pollution positively impacts growth in Sub Saharan Africa in the long run. Alege & Ogundipe (2013), Fakher & Abedi (2017) recently analyses the link between economic growth and environmental quality in some selected developing countries using panel data from 1983 to 2013. Both findings concluded that economic growth positively impacts environmental quality in the longer term.

It is vital to note that the negative association between economic growth and environmental quality, support the existence of the environmental Kuznets curve (Agarwal, 2012). In this regard, Aka (2008), Phimphanthavong (2013), Aboagye (2015) and Carillo & Maietta (2017) conclude that a negative correlation exists between economic growth and environmental quality, thus supporting the presence of the environmental Kuznets curve. On the other hand, Holtz-Eakin & Selden (1995), Alege & Ogundipe (2013), Awad (2017), Fakher & Abedi (2017) conclude that economic growth positively impacts pollution in the long run.

3. Methodology

3.1 Model specification

Researchers have employed different models to look at the impact of economic growth on the environment. In this paper, we examine the relationship between environmental quality, trade openness, financial development and economic growth in Cameroon by employing the model of the environmental Kuznets curve. The model is specified as demonstrated below:

$$CO_{2t} = f(TO_t, FD_t, GDP_t) \quad (1)$$

$$LNCO_{2t} = \alpha_0 + \alpha_1 LNTO_t + \alpha_2 LNFD_t + \alpha_3 LNGDP_t + \epsilon_t \quad (2)$$

$$LNCO_{2t} = \alpha_0 + \alpha_1 LNTO_t + \alpha_2 LNFD_t + \alpha_3 LNGDP_t + \alpha_4 LNGDP^2{}_t + \epsilon_t \quad (3)$$

In equation 1, we established the functional relationship between environmental quality, trade openness, financial development and economic growth in Cameroon using the classical model. In equation 2, the model is expanded by taking the log of all the variables and in equation 3; the square of GDP is included in the model in other to find whether an inverted U-shape relationship exists between economic growth and environmental quality in Cameroon.

3.2 Data sources and variables description

The data used in this study are Cameroon annual time series data that runs for the period 1980 to 2016, sourced from World Development Indicators. The variable LNCO2t represent the log of environmental pollution, LNTOt is the log of trade openness, LNFDt represent the log of financial development and LNGDPt and LNGDP2t measure the log of income per capita and the square of income per capita, while ϵ_t is the white noise term, having zero mean and constant variance. Moreover, α_i (i = 0, 1, 2, 3, 4) are the presumed estimated parameters, assumed to have positive signs except α_4. The t in subscript denotes the time period, and the data is analyzed by E-Views 9.0 software.

3.3 Method of estimation

3.3.1 Unit root test

An important assumption underlying Classical Regression is that the variables must be (covariance) stationary, exhibits mean reversion in that it fluctuates around a constant long run mean. And has a finite variance that is time-invariant. When a time series is Non-Stationary, it violates at least one of the above assumptions and therefore the regression results could be spurious. We shall investigate the stationary properties of the time series: pollution, trade openness, financial development, and economic growth by employing the Dickey & Fuller (1979), Phillips & Peron (1988) tests.

3.3.2 Co-integration test

The Johansen & Juselius (1990) test is conducted to verify the relationship between the variables. In the case of co-integration, the ECM will be estimated to investigate the short-run and long-run dynamic of the variables. However, Granger & Newbolt (1974) have shown that when non-stationary series is detected, the co-integration test is necessary since differencing the variable only removes the long-run information. Hence, the co-integration test is one of the most important preliminary tests conducted after the unit roots test, especially when the series has a unit root at level. Also, Engle & Granger (1987) noted that before proceeding to test for co-integration, all variables should be integrated of the same order. The unit roots test shows that all the variables are non-stationary at level but become stationary at first difference.

Considering the fact that all the variables are integrated of the same order I(1), we went further to check for the long-run relationship between the variables, applying the Johansen-Julius (1990) Co-Integration Test having two likelihood ratios (LR), the trace statistics and Max-Eigen tests. In the case of co-integration, we will carry out the Granger causality tests based on Vector Error Correction

Model (VECM) and otherwise, we conduct the simple Vector Autoregression (VAR).

3.3.3 VEC Granger Causality Tests

The VEC Granger causality test is employed to investigate the causal relationship between the variables. In the presence of co-integrated among the variables, the Error Correction Model (ECM) is estimated to investigate the short-run and long-run dynamics between the variables in our present model. The Error Correction Terms (ECT) are derived from the co-integrating vectors obtain from the Johansen's multivariate test procedure. It is recalled that the ECT model is a modified version of the VAR also known as the restricted VAR. It is also known as the adjustment term and mostly help to bring any variables that deviate from equilibrium in the long-run.

4. Results and Descriptions

4.1 Unit Root Test

The unit root test is conducted to verify the stationarity of a time series variables. The presence of unit root implies that the variables are non- stationary in level. The results of Augmented Dickey Fuller (ADF) test and Philips Peron (PP) tests are shown in Table 1 for both tests without trend and with trend in level or first difference. The lag length three of each variable was selected using the Akaike's Information Criteria (AIC).

Table 1 The Results of Unit Root Test

Tests In level				
Variables	ADF		PP	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
$LNCO_2$	-1.59017	-3.37524	-3.10571	-3.41416
LNTO	-1.90264	-1.54167	-1.88915	-1.28924
LNFD	-1.86662	-0.4871	-1.57079	-0.70603
LNGDP	0.076092	-1.73597	-0.50299	-1.52841
$LNGDP^2$	-2.67352	-1.75789	-1.50087	-1.41866
Tests In First Difference				
Variables	ADF		PP	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
$\Delta LNCO_2$	-7.08848**	-5.86655**	-11.00520**	-14.67640**
Δ LNTO	-6.08787**	-7.50662**	-6.18554**	-7.09262**
Δ LNFD	-3.94455**	-4.28538**	-3.95702**	-4.21837*
Δ LNGDP	-3.41804*	-3.63083*	-3.45567*	-3.63341*
$\Delta LNGDP^2$	-3.34317*	-3.61990*	-3.39230*	-3.62140*

Notes: ** denotes 1% significant level; * denotes 5% significant level

The results show that the null hypothesis of the presence of unit root in each of the variables is accepted at the 5% level of significance. This signifies that the selected variables are non-stationary in level but become stationary at first difference at 1% and 5% level suggesting that all the variables become stationary. Therefore, it indicates that all the variables are integrated of order one I (1), giving room to conduct the co-integration tests.

4.2 Co-integration Test

The co-integration test is conducted to verify the existence of long run relationships among the variables: LNCO2, LNTO, LNFD, LNGDP2, using the Johansen's test of co-integration. The results as shown in Table 2 indicate that the null hypothesis of no co-integration among the variables is rejected as the Maximum Eigen value and trace statistics disclose that the variables are co-integrated at least at 5% level of significance. The trace and maximum Eigen value statistics further suggest that a long run relationship exists among the variables as the null hypothesis r = 0 is rejected at 1% level. This implies that the variables LNCO2, LNTO, LNFD, LNGDP and LNGDP2 are co-integrated in the long run.

The findings pinpoint that all the variables are significant in explaining the environmental quality in with the coefficients of all the variables, having correct signs except LNGDP and $LNGDP^2$ as shown in Table 2. Specifically, a 1% increase in LNTO leads to an increase in LNCO2 by 4.97%; a 1% increase in LNFD raises LNCO2 by about 0.25% and a 1% increase in $LNGDP^2$ increases pollution by 131.37% in the long run. Finally, a 1% increase in LNGDP decreases pollution with close to 264.48 % in the short run. This outcome is in line with those of Holtz-Eakin & Selden (1995), Alege & Ogundipe (2013) and Awad (2017).

From this result, it is settled that the EKC with an inverted U-shape is not relevant in Cameroon, instead a U-shape relationship does exist. This is because carbon dioxide is negatively related to economic growth but positively links to the square of economic growth. Also, the positive relationship between trade openness and carbon dioxide emissions, signifies that the pollution havens hypothesis is presence in Cameroon.

4.3 VEC Granger Causality Tests

We use the VECM residuals to carry out the Granger causality test. Table 3 below presents the result of Granger causality tests. The results in Table 3 suggest that the variables: GDP and GDP^2 cause CO_2 uni-directionally in the short-run with no feedback, with bidirectional causality running between GDP and FD, and GDP^2 and FD. Likewise, a unidirectional causality is noted between the pollution variable and trade openness, indicating that trade openness raises pollution in Cameroon.

Table 2 Results of the Johansen-Juselius Co-integration Tests

H0	Eigenvalue	Trace		Max-Eigen	
		Statistic	5% CV	Statistics	5% CV
r=0	0.774815	147.5297*	79.34145	50.68835*	37.16359
r≤1	0.733298	96.84137*	55.24578	44.93524*	30.81507
r≤2	0.590363	51.90612*	35.0109	30.34443*	24.25202
r≤3	0.440437	21.56170*	18.39771	19.74034*	17.14769
r≤4	0.05216	1.821354	3.841466	1.821354	3.841466

$LNCO_2$ = 4.9704LNTO + 0.2459LNFD - 264.48LNGDP + 131.38 $LNGDP^2$
(2.0769) (0.4429) (38.5302) (19.4178)

Notes: H_0:Null Hypothesis r:at most exist corresponding number of co-integrating equations CV: critical value *:denotes rejection of null hypothesis at 5% significant level and Notes: Standard errors in "( )" sign.

Table 3 The Results of VEC Granger Causality Tests

Dependent Variables	$\Delta LNCO_2$	ΔLNTO	ΔLNFD	ΔLNGDP	$\Delta LNGDP^2$	ECT[b]
$\Delta LNCO_2$	--	1.8596	4.7930	6.8688**	6.3553**	-0.4764*
	--	(0.3946)	(0.0910)	(0.0322)	(0.0417)	(-2.838)
ΔLNTO	6.5042**	--	0.1664	5.0194	5.1178	-0.03051
	(0.0387)	--	(0.9201)	(0.0813)	(0.0774)	(-1.1625)
ΔLNFD	11.7572*	2.3074	--	7.7963**	7.7690**	0.1608*
	(0.0028)	(0.3155)	--	(0.0203)	(0.0206)	(2.7841)
ΔLNGDP	5.2177	0.3041	8.2910**	--	16.4015*	-0.0443*
	(0.0736)	(0.8589)	(0.0158)	--	(0.0003)	(-4.3588)
$\Delta LNGDP^2$	5.2240	0.3059	8.2807**	17.3911*	--	-0.0885*
	(0.0734)	(0.8582)	(0.0159)	(0.0002)	--	(-4.3493)

Notes: *, ** indicate significance at 1% and 5 % level while the probabilities are in parenthesis. [b] The values in parenthesis is t-statistics.

4.4 Variance Decomposition Analysis

The results of the VECM indicate the exogeneity or endogeneity of a variable in the system and the direction of Granger-causality within the sample period. However, it does not provide us with the dynamic properties of the system (Masih, 2001). The analysis of the dynamic interactions among the variables in the post-sample period is conducted using the variance decompositions analysis. The response to pollution (LNCO2) will be decomposed to a one standard deviation innovation in the variables exports (LNTO), financial development (LNFD), economic growth (LNGDP) and economic growth in the long run (LNGDP2) within the twenty period horizons.

The results as shown in Table 4 below suggest that in the first period, 100% of the variance in pollution is explained by itself. In the 10th period, the variation in CO2 is explained by trade openness 17%, financial development at 9%, GDP at 22%, and LNGDP2 2%. In the 20th period, the variation in pollution is explained by trade openness 22%, financial development at about 8%, economic growth at 26%, and LNGDP2 at 1%. The result suggests that in the long-run, economic growth is the most determinant of pollution, followed by trade openness and financial development. This result pinpoints that as countries develop couple with globalization, more pollutions are emitted.

5. Conclusions and Policy Implications

The relationships between trade openness, financial development, economic growth, and carbon dioxide emissions are examined for the period 1980–2016, by employing a multivariate ctor error correction model. In addition to the co-integration analysis, the causality test was conducted, employing the Johansen tests and the dynamic interactions among the variables in the post-sample period were studied via the variance decomposition analysis.

The findings demonstrate the existence of a robust long-run relationship between the variables and environmental quality. This result pinpoints that all the variables are significant in explaining the environmental quality in Cameroon, with correct signs as expected apart from economic growth. Specifically, a 1% increase in trade openness leads to an increase in carbon dioxide emissions by 4.97 %; a 1% increase in financial development raises pollution emissions by about 0.25% and a 1% increase in economic growth augments environmental pollion by 131.37%. The causality results and variance decompositions further support the argument that economic growth exerts a positive causal effect on the environment. Precisely, we found a unidirectional causality running from economic growth to environmental quality with no feedback and bi-directionally to financial development.

Table 4 Decomposition of Forecast Error Variance of $LNCO_2$

Period	$LNCO_2$	LNTO	LNFD	LNGDP	$LNGDP^2$
1	100	0	0	0	0
2	72.35402	0.142983	9.88814	15.40169	2.21317
3	57.73046	5.855815	14.04453	19.66954	2.69965
5	55.10847	13.03759	11.45704	18.21847	2.17844
8	51.32449	15.73228	10.36044	20.86372	1.71907
9	49.96335	16.86890	9.97508	21.52817	1.66451
10	49.64492	17.27565	9.49545	21.94561	1.63836
14	45.91522	19.71517	8.61016	24.30289	1.45656
15	45.45618	20.08136	8.35970	24.66897	1.43379
16	44.89171	20.40961	8.19445	25.10309	1.40113
17	44.23524	20.83124	8.06202	25.50780	1.36370
18	43.61997	21.26997	7.91740	25.86383	1.32883
19	43.15473	21.62180	7.76465	26.16033	1.29850
20	42.77866	21.91239	7.62054	26.42030	1.26810

These results pinpoint that the environmental Kuznets hypothesis with an inverted U-shape does not exist in Cameroon instead it demonstrates that pollution turn to emerge with economic growth in the long run, a U-shape relationship. This finding has important implications for policy makers in a country, that is aspiring of becoming an emergent economy in the near future. Economic growth is quite vital for most nations but this study settled that economic growth emerges together with carbon dioxide emissions. It is therefore required that the government should implement sustainable policies that reduce environmental pollution. Since environmental quality is declining in Cameroon, policy makers should be mindful of the fact that the decline in the environmental quality may generate a negative externality to the economy thereby reducing productivity in the long run.

Also, we find that financial development is significant and positively related to carbon dioxide emissions. This imply that financial development acts as a stimulus in raising environmental pollution. It is therefore recommended for policy-makers to develop strategies that mitigate the spread of pollution through the practice of green and sustainable finance.

Moreover, a positive long-run relationship is found between trade openness and carbon dioxide emissions, which signifies that the pollution havens hypothesis is valid in this country. It is therefore commended that the government should develop policies that attract environmental friendly products to Cameroon. The main contribution of this paper is that for the first time an attempt is made to examine the dynamic relationships between trade openness, financial development, economic growth and pollution emissions in Cameroon. Despite the fact that the analysis in this paper may be specific to Cameroon, future studies should extend the econometric techniques to capture other less developed economies. As a limitation, we faced the problems of lack of data availability and perhaps in extending the sample size, better reseults could be achieved.

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