Scientific Research Publishing

Theoretical Economics Letters, 2026, 16(4), 839-854
https://www.scirp.org/journal/tel
ISSN Online: 2162-2086
ISSN Print: 2162-2078

Terrorism and Natural Resources: A Cointegration and Causality Analysis at Chad

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How to cite this paper: Croi, K. F., & Adama, D. (2026). Terrorism and Natural Resources: A Cointegration and Causality Analysis at Chad. *Theoretical Economics Letters, 16,* 839-854.
https://doi.org/10.4236/tel.2026.164046

Received: April 17, 2026
Accepted: August 24, 2026
Published: August 27, 2026

Abstract

This paper analyzes the relationship between terrorism and natural resources in Chad over the period 1996-2019. To achieve this objective, we rely on a two-step cointegration strategy suited to a sample of 23 annual observations: the unrestricted error-correction model derived from the ARDL bounds-testing approach (Pesaran, Shin, & Smith, 2001) to estimate the long-run relationship between natural resources and terrorism, and Toda and Yamamoto (1995) augmented Granger causality test, which is robust to the order of integration of the series, to determine the direction of causality between the two variables; Johansen (1988) cointegration test is used as a robustness check. The results confirm a cointegrating relationship between terrorism and natural resources. However, the Granger causality test does not reveal any significant direct causality between natural resources and terrorism in either direction; the long-run relationship between the two variables appears to operate mainly through indirect channels, namely GDP per capita and gross fixed capital formation.

Keywords

Terrorism, Natural Resources, ARDL, Chad

1. Introduction

Despite its abundance of natural resources, Chad is classified as one of the poorest countries in the world, facing many risks and challenges: food insecurity, extreme social vulnerability, demographic escalation, and terrorist threats. One of the

commonly accepted ideas is that the possession of natural resources is an opportunity for a country or a community. These natural resources are an undeniable factor in the creation of wealth and therefore in economic growth (Nurkse, 1953; Watkins, 1963). This is the case of Chile, Botswana, Mauritius and especially the Gulf countries, which are experiencing high rates of economic growth, thanks to the exploitation of natural resources.

However, the experience of other countries, namely Australia, Mexico, Venezuela, Peru and especially Nigeria, Zambia, Sierra Leone, Nigeria, and the Democratic Republic of Congo as well as Chad in sub-Saharan Africa shows that the possession of natural resources is not always favourable to economic growth. Rather, it is a "curse" for these countries because it is a source of terrorism.

Despite all this, we note today that most developing countries (DCs) such as Chad still base their hopes on the exploitation of natural resources to boost economic growth and consequently reduce poverty, while factors such as the prices of these natural resources are set exogenously by the buyers. Also, other factors such as the threat of terrorism counteract the effect of natural resource abundance on economic growth and poverty reduction in these countries. So, what do we mean by terrorism, natural resources and economic growth?

Today's threats to global security are multifaceted. Terrorism is rightly seen as an important factor in undermining peace and endangering stability in the world. Although acts of terrorism are unlikely to be the sole cause of destabilization in a country, they can have a strong impact by depleting natural resources and making governments vulnerable, thereby reducing public confidence in public institutions, which in turn can become a driver of conflict and fuel terrorism.

At the regional level, terrorism poses an additional problem because of the potential for spillover effects. Terrorism and its consequences can spread to neighboring countries with direct repercussions, and not only weakens a state, but also exposes its territory and that of other states to terrorist activities by diminishing the ability to defend citizens and national interests (Hegre & Sambanis, 2006).

Authoritarianism, political instability, contestation of power by armed groups, attempted coups d'état, inter-family conflicts, and community conflicts over access to natural resources characterize Chad. The crises in this country between the Arab world and sub-Saharan Africa raise the issue of security linked to the abundance of natural resources in a worrying manner. However, it should be noted that the security risks in Chad cannot be understood solely in terms of the internal crisis factors linked to its natural resources.

The rise of terrorism is one of the challenges that some African countries have been facing in recent years. Shebabs, Al-Qaeda in the Islamic Maghreb (AQIM), the MUJAO and Boko Haram are some of the organizations that are making headlines. The mere mention of them causes psychosis. Particular attention to the Chadian basin makes us realize that Boko Haram has made it its sanctuary (Seignobos, 2015), causing disruptions and imbalances of the most extreme and rarely experienced in the past.

The increase in terrorist activities and their detrimental effect on social life, infrastructure thus hinders economic growth (Murdoch & Sandler, 2002; Gomez et al., 2010; Qureshi, 2013). Conversely, low levels of economic development, unequal distribution of wealth, and high unemployment can reduce the opportunity costs of inclusion and the likelihood of a better social life and increase terrorism.

As a result, reduced investment, trade, and productivity, as well as the destruction of physical and human capital (including through forced displacement and the degradation of education and health care), are the main factors in the slowdown of growth due to conflict. Together, these factors lead to a sustained decline in the productive capacity of the economy (Qureshi, 2013).

The choice of Chad is justified by the fact that, in recent years, the geographical distribution of conflicts in Sub-Saharan Africa has changed somewhat over time. The south of the continent has been generally spared from conflict (Straus, 2012).

This slowdown in productivity, investment, and export growth could be explained by a number of factors, including heightened concerns about the security situation, which is not conducive to economic activity; disruption of trade routes (such as around the Lake Chad Basin due to the Boko Haram insurgency); destruction of human capital and physical infrastructure; displacement of skilled workers; disruption and weakening of institutions; and increased political and economic uncertainty leading investors to postpone long-term investments.

Conflict can have a significant impact on a country's public finances, both in terms of revenues and expenditures. This limits the government's ability to respond effectively to conflict and increases the economic and social costs. Revenues may decline because of the disruption of economic activity, the destruction of part of the tax base and the weakening of the efficiency of tax administration caused by conflict.

The originality of this study lies in the fact that it provides new directions for public decision-makers in Chad to control terrorism by equitably distributing the resources derived from the exploitation of natural resources to all segments of the population.

In this paper, we will attempt to answer the following questions: Is terrorism driven by natural resource abundance? Does terrorism impact or cause natural resources? Is there a link between terrorism and natural resources?

The objective of this paper is to analyze the impact of terrorism on natural resources in Chad. Specifically, it will analyze the long-term relationship between natural resources and terrorism and determine the direction of causality between terrorism and natural resources. In this paper, the assumption is that in Chad, natural resources cause terrorism and not the other way around. This paper is structured as follows. Section 2 analyzes the relationship between terrorism, natural resources, and the economy. Section 3 discusses the data and methodology. Section 4 presents and discusses the main findings. Section 5 concludes the study.

2. Literature Review

In this section, we present theoretical debates and syntheses of some of the results

of empirical work on the link between terrorism and natural resources and the impact of these two variables on economic growth.

2.1. Theoretical Review

Several theoretical currents have confronted the link between terrorism, natural resources and growth. This theoretical debate has revealed contradictions. On the one hand, the classical and neoclassical current developed by authors such as: Heckscher (1919), Ohlin (1933) and Samuelson (1953). These authors use the orthodox or optimistic thesis through macroeconomic and microeconomic arguments to justify that the possession of natural resources positively affects economic growth and, therefore, counteracts all terrorist actions under the hypothesis of a bad distribution of the resources resulting from the exploitation of these natural resources, and on the other hand, the heterodox or pessimistic thesis that stipulates that natural resources have a negative effect on growth.

The negative effects of natural resources on growth lead to misery, frustration, uprisings by the population and discontent among some elites (Posner, 1961). The poor distribution of income from the exploitation of natural resources is a source of terrorist action and a brake on growth. These authors also indicate that the effect of the positivity of natural resource ownership on growth can be analyzed in terms of cost-benefit.

Moreover, the exploitation of these natural resources will only be profitable if their prices on world markets are higher than the marginal costs of their extraction and transport, which could allow these resource-holding countries to earn foreign exchange through exports, which generally have positive repercussions on economic growth and positive externalities on the terrorist actions of these countries Heckscher (1919), Ohlin (1933) and Samuelson (1953).

Furthermore, the possession of natural resources can give a country comparative advantages and lead it to specialize either in the production of those resources or in manufacturing, when the resources serve as intermediate inputs.

This specialization will boost production, while allowing for economies of scale and driving economic growth. The theoretical analyses of Posner (1961) and Vernon (1966) are along the same lines as those developed by classics and neoclassics, but with much greater emphasis on innovation, i.e. the discovery of a new product or a new natural resource.

The possession of natural resources can also be a source of instability, social conflict and even civil war (Collier et al., 2009; Brunnschweiler, 2008; Couttenier, 2012), sometimes encouraged by certain multinational firms operating in this field. These disturbances usually lead to a slowdown of economic activities in the countries or areas concerned. Moreover, funds that could be used for the development of priority sectors are used to finance civil wars, which can only slow down growth.

Finally, the degradation of the ecosystem caused by the exploitation of natural resources can also negatively affect growth. Indeed, the anarchic exploitation of

these resources constitutes on the one hand, a threat to health, and on the other hand a threat to the agricultural sector following the destruction of cultivable surfaces and the pollution of water.

2.2. Empirical Review

Most of the results of empirical work on the relationship between natural resources and growth show that there is a positive link between the possession of natural resources and economic growth, but subject to certain conditions, Daniele (2011). Carbonnier (2007) shows that the possession of natural resources positively affects growth, notably through greater transparency and better management of these resources. If oil revenues are used to pay down debt, they will have no effect on growth.

But the resources from the exploitation of these natural resources could boost growth if, and only if, they are used to create public infrastructure such as dams, roads, bridges, etc. (Barro, 1991), to provide access to basic social services or to modernize the productive apparatus, and to transfer income to the most vulnerable segments of society. Also, whether these revenues can promote growth if they are not diverted to private ends by a corrupt elite class (Mehlum et al., 2006).

Posing the same problem in the Chinese context, the results of Yuxiang & Chen (2011) conclude that natural resource abundance drives financial development and thus implicitly economic growth. Kan et al. (2013) in the same context reach the same result as Yuxiang & Chen (2011). However, the quality of the institutions is crucial to the nature of the result obtained by the former authors.

For example, Sachs & Warner (1995) studied the influence of natural resource abundance on economics. Their study focused on variables such as legal protection, inflation, public savings and the share of the labor force in the total population. The results show that the abundance of natural resources has a negative influence on economics and provokes acts of terrorism.

In the same vein, Omgba (2011) assesses the impact of oil on the Cameroonian economy. He uses the Granger causality test and shows that the discovery of oil and the rise in its price are sources of economic and political crises in that country. He also argues that these crises are based on the way oil revenues have been managed.

Leite & Weidmann (1999), Bulte et al., (2005), Gylfason (2010) and Daniele (2011) on the other hand, believe that the positivity of the effect of natural resources possession on economic growth depends on the quality of institutions. Specifically, in the study of Gylfason (2010), the author concludes that the possession of natural resources has a positive influence on economic growth, if and only if the institutions are of good quality.

The work of Mehlum et al. (2006) and Brunnschweiler (2008) also supports this view. They show that the abundance of natural resources positively affects economic growth, while the effect of dependence is rather negative. Avom & Camignani (2010) reach the same conclusion on a study of the impact of commodity

dependence on economic growth.

3. Data and Methodology

In this study, all data are annual and cover the period 1996-2019 (T = 24 years, or 23 usable observations after the first difference). They are drawn from the World Bank's World Development Indicators (WDI) database, with the exception of terrorism data, which comes from the Global Terrorism Database (GTD). 1) Per capita GDP (pibhbt) is measured as a level, in constant 2010 U.S. dollars, and is included in the equations in its logarithmic form; it is not a growth rate, despite ambiguous wording elsewhere in the document, which we correct below. 2) The natural resources variable (resrce) corresponds to the total natural resource rent, expressed as a percentage of GDP (the sum of rents from fossil fuels, minerals, timber, and other forest products), and is also used in logarithmic form. It represents the rent derived from the exploitation of natural resources that is, nonrenewable resources, fossil fuels, and minerals, as well as resources resulting from the overexploitation of forests.

3) Public investment is represented by gross fixed capital formation (GFCF), expressed as a percentage of GDP (rather than per capita, to ensure consistency in units of measurement with resrce) and logged. This indicator of capital stock has been used in studies (Barro, 1991; Balasubramanyam et al., 1996; Kohpaiboon, 2004). 4) Terrorism (attack) refers to the annual number of terrorist attacks carried out on Chadian territory.

It involves the threatened or actual use of unlawful force and violence by a non-state actor to achieve a political, economic, religious, or social objective through fear, coercion, or intimidation. In accordance with the definition adopted by the GTD, an event is classified as a terrorist attack only if it meets all three of the following criteria: 1) the act is intentional and perpetrated by a sub-state actor; 2) it involves the use of force or violence, or a credible threat of force; 3) it pursues a political, economic, religious, or social objective. Incidents attributed to state actors or falling under international humanitarian law (acts of conventional warfare) are excluded.

For Chad, the annual series is constructed by aggregating, for each calendar year, all geolocated incidents within the national territory recorded by the GTD; no annual values are missing for the selected period. The study period begins at1996 because that is the first year for which the three World Bank series (GDP per capita, natural resource rent, and GFCF) are available on a continuous basis for Chad, and ends at 2019.

The data on terrorism were drawn from the Global Terrorism Database (2020), which includes data on domestic and international incidents worldwide since 1970 (LaFree & Dugan, 2007). **Table A1** in the appendix lists the variables used in the econometric analysis, as well as the various sources of these variables. The econometric strategy adopted: The manuscript mentions several approaches (Engle-Granger, ARDL, Johansen, MCO, Granger error correction model, Toda-

Yamamoto) without specifying which one is actually estimated; we clarify this choice here. Given the sample size (23 annual observations after differentiation), the Pesaran ARDL bounds approach (Pesaran, Shin, & Smith, 2001) estimated using ordinary least squares (OLS) in the form of an unconstrained error correction model (UECM), forms the core of the estimation strategy chosen for the long-run relationship.

It remains valid whether the variables are I (0) or I (1) (but not I (2)), and its small-sample properties are documented as superior to those of the Johansen approach, which relies on multivariate normality assumptions that are unreliable with such a small T. Johansen (1988) test, shown in **Table 4**, is presented solely as a robustness test for the cointegration relationship, and not as the primary estimation method. Granger & Engle (1987) procedure, which is more restrictive because it is limited to bivariate relationships and series of the same order of integration, was not selected.

To determine the direction of causality, we apply the extended Granger causality test proposed by Toda and Yamamoto (1995), which involves estimating a level VAR model augmented by d(max) additional lags (here, d(max) = 1) and testing the joint significance of the coefficients using a Wald test; this procedure has the advantage of being valid regardless of the order of integration and the presence or absence of cointegration among the series, making it particularly well-suited for a sample of this size. The causality results reported in **Table 5** are those obtained using this procedure.

We present below the equation that we will estimate (VAR (P)):

$$\begin{cases} GDP_{1,t} = \alpha_1 + \sum_{i=1}^{p} \beta_{1,i} GDP_{1,t-i} + \sum_{i=1}^{p} c_{1,i} nat\_resrce_{1,t-i} + \sum_{i=1}^{p} d_{1,i} gfcf_{1,t-i} \\ \quad + \sum_{i=1}^{p} e_{1,i} atck_{1,t-i} - f_1\left(nat\_resrce_t + gfcf_t + atck_t\right) + \varepsilon_{1,t} \end{cases} \quad (1)$$

$$\begin{cases} nat\_resrce_{2,t} = \alpha_2 + \sum_{i=1}^{p} \beta_{2,i} GDP_{1,t-i} + \sum_{i=1}^{p} c_{2,i} nat\_resrce_{1,t-i} + \sum_{i=1}^{p} d_{2,i} gfcf_{2,t-i} \\ \quad + \sum_{i=1}^{p} e_{2,i} atck_{2,t-i} - f_2\left(nat\_resrce_t + gfcf_t + atck_t\right) + \varepsilon_{2,t} \end{cases} \quad (2)$$

$$\begin{cases} gfcf_{3,t} = \alpha_3 + \sum_{i=1}^{p} \beta_{3,i} GDP_{3,t-i} + \sum_{i=1}^{p} c_{3,i} nat\_resrce_{3,t-i} + \sum_{i=1}^{p} d_{3,i} gfcf_{3,t-i} \\ \quad + \sum_{i=1}^{p} e_{3,i} atck_{3,t-i} - f_3\left(nat\_resrce_t + gfcf_t + atck_t\right) + \varepsilon_{3,t} \end{cases} \quad (3)$$

$$\begin{cases} atck_{4,t} = \alpha_4 + \sum_{i=1}^{p} \beta_{4,i} GDP_{4,t-i} + \sum_{i=1}^{p} c_{4,i} nat\_resrce_{4,t-i} + \sum_{i=1}^{p} d_{4,i} gfcf_{4,t-i} \\ \quad + \sum_{i=1}^{p} e_{4,i} atck_{4,t-i} - f_1\left(nat\_resrce_t + gfcf_t + atck_t\right) + \varepsilon_{4,t} \end{cases} \quad (4)$$

3.1. Stationarity

The specification of a model requires that the variables be stationary, to avoid the risk of spurious regressions. Several statistical tests exist to determine the order of integration of the series. It should be noted that all these tests have biases, which

suggests that the determination of the order of integration cannot be rigorous based on a single test (Keho, 2004). For this reason, we will use several tests:

The first test is the usual Dickey-Fuller unit root test (ADF). This test considers only the presence of autocorrelation in the series. The null hypothesis is the presence of unit root (non-stationary). In addition to the ADF test, there is Phillips & Perron (1988) test and Kwiatkowski et al. (1992) test. Kwiatkowski et al. (1992) test is based on the decomposition of the series studied into a deterministic part, a random walk and a white noise. The null hypothesis of the test is the stationarity of the series.

3.2. Test of Stationarity

Table 1 shows that all the series are integrated of order 1. Indeed, the ADF, PP and KPSS tests performed on the level series show that none of these series are stationary. To do this, it was necessary to differentiate the different series and to perform the same tests previously to obtain their stationarity. Thus, it should be noted that to perform certain tests such as the cointegration tests, the methodology requires that the stationarity tests be performed first to see the behavior of the series analyzed. Thus, the results of the stationarity tests are recorded in Table 1 below.

Table 1. Stationarity test.

Variables	Statistique	Conclusion	*p*-value
atck	−2.418	Stationary in first difference, I (1)	0.1368
gfcf	−0.936	Stationary in first difference, I (1)	0.7759
gdp	−2.245	Stationary in first difference, I (1)	0.1902
nat_resrce	0.5232	Stationary in first difference, I (1)	0.5232

Source: The author. Note: The results of the stationarity tests are recorded in Table 1 below.

We will therefore differentiate the variables to station them. The order of integration was determined to be I (1) for the variables. Therefore, the maximum order of integration of the series (d max) in the system would also be determined as 1.

After determining the maximum order of integration of the series (d max) in the system as 1, we examine the optimal lag length (k) of the VAR model, and the optimal lag length is also established as 1 in Table 2.

3.3. Optimal Delay Test

Vector autoregressive models are commonly used to forecast a system of related variables and to analyze the dynamic effects of random shocks on a system of variables. Let the number of lags be estimated for the model. Before any econometric analysis, it is necessary to determine the optimal lag p^*. To do this, several model relationships are estimated by considering sequential delays. Each estimated

model provides information criteria. The optimal delay p^* is the one that minimizes the Akaike (AIC) or Schwarz (SBC) information criteria defined by:

$$\begin{cases} \text{AIC} = -2\dfrac{l}{T} + 2\dfrac{n}{T} \\ \text{SBC} = -2\dfrac{l}{T} + 2\dfrac{n\ln(T)}{T} \end{cases}$$

where $l = -\dfrac{T}{2}\left[k(1+\ln(2\pi)) + \ln\left(\det\left\{\dfrac{1}{T-p}\sum_t \hat{\varepsilon}_t\hat{\varepsilon}_t'\right\}\right)\right]$ and $n = k(1+pk)$

T, represents the number of periods and k the number of endogenous variables of the vector autoregressive model.

Table 2. Optimal delay test.

Sample: 1996-2019, Number of Obs = 23								
lag	LL	LR	df	p	FPE	AIC	HQIC	SBC
0	−127.579				3.2e+06	26.3158	26.183	26.4368
1	−106.012	43.134*	16	0.000	1.5e+06	25.2024*	24.5385*	25.8076*
2	0.000	0.000	16	0.000	0.000*	0.000	0.000	0.000
Endogenous: gdp; atck; gfcf; nat_resrce								
Exogenous: _cons								

Source: The author. Notes: Values in parentheses are p-values. *Means rejection of the unit root hypothesis at the 5% threshold.

4. Analysis and Findings

In this section, we analyze the results in Table 2 below, which presents the empirical results of the causal relationship between terrorism, natural resources and growth in Chad. The causality technique we analyze is Granger's. This study is done to analyze the contribution of terrorism on natural resources in Chad. The results were obtained using the Ordinary Least Squares (OLS) method. To strengthen our results, the Johansen Cointegration method was used. The OLS results show that terrorism affects natural resources in a positive way and the result is statistically significant at the 5% significance level.

Natural resources and terrorism, the two key variables in our model, also showed, on the one hand, that natural resources have a positive and significant impact on GDP per capita for the period studied and, on the other hand, that terrorism has a negative and significant impact on GDP per capita, also for this same observation period. The R^2 value shown in Table 5 remained at 97.45%, demonstrating the validity of the fit. However, conducting various stationarity tests for each time series yielded the results summarized in Table 1.

4.1. Johansen Cointegration Test

After conducting stationarity tests and determining the orders of integration of

the time series, the next step is to examine whether a cointegration relationship exists between these time series, as shown by the results of the cointegration test in Table 3 below. When time series are cointegrated, there is a long-run relationship between them. X, Y, and Z are said to be cointegrated if at least one of the relationships in equations (1), (2), or (3) has statistically significant parameters.

Table 3. Estimation results.

	Model (1)	Model (2)	Model (3)	Model (4)
Variables	GDP	resrce_nat	gfcf	Bnattk
L.PIB/hbt	0.0145	−0.132	−0.194	−0.437
	(0.283)	(0.504)	(0.249)	(0.450)
L. rsrce_nat	0.204*	0.704***	0.243**	0.0776
	(0.118)	(0.210)	(0.104)	(0.188)
L.fbcf	−0.0309	0.152	0.740***	0.641**
	(0.159)	(0.282)	(0.139)	(0.252)
attck	−0.360**	−0.149	−0.113	0.0634
	(0.154)	(0.275)	(0.136)	(0.245)
Constant	3.597	2.118	2.456	−2.889
	(3.932)	(6.988)	(3.456)	(6.248)
Obervation	23	23	23	23
Standard erros in parentheses				
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$				

Source: Author. Note: ** (*) represents the significance of the coefficient at the 5% (10%) level D1. Represents the symbol for differentiation at order 1. In the (.) indicate the t-statistics.

The test involves checking for cointegration among the time series using maximum likelihood estimators (Johansen, 1988). It applies to time series of different orders of integration. The approach involves testing various cointegration relationships among the variables and assigning them a cointegration rank. The cointegration rank indicates the number of cointegration relationships that have been verified. If the cointegration rank is 0, the cointegration hypothesis is rejected.

If the cointegration rank is greater than or equal to 1, the cointegration hypothesis is accepted. The test reveals a cointegration relationship between the variables in the model and a cointegration order of 2, since the trace analysis indicates two cointegration equations. Terrorism and natural resources are cointegrated. The results are presented in Table 4.

4.2. Causality Test

The Granger Causality test reveals heterogeneity. From Table 5 below, there is no two-way causality. Causal relationships do not exist in the direction from natural

resources to terrorism. Also, GDP does not cause terrorism. However, there is a long-term relationship between natural resources to GDP per capita and from terrorism to natural resources.

Table 4. Cointegration test.

Trend: constant					Number of obs = 23
Sample: 1996-2019					Lags = 1 5%
Maximum rank	parms	LL	eigenvalue	Trace statistic	Critical value
0	4	−254.063	0.0000	48.9932	74.21
1	11	−242.34203	0.72810	25.5512*	29.68
2	16	−233.70013	0.61719	8.2674	15.41
3	19	−231.20308	0.2429	3.2733	3.76
4	20	−229.56641	0.16628	-	-

Source: author. Note: The result of the cointegration test used in this study.

Table 5. Causality test.

Granger causality wald tests					
H_0: no causal relationship between the variables; H_1: causal relationship between variables					
GDP	nat_resrce	2.9875	1	0.084	we reject H_0 and accept H_1
GDP	fbcf	0.0379	1	0.846	we reject H_1 and accept H_0
GDP	atck	5.4317	1	0.020	we reject H_0 and accept H_1
GDP	All	6.4182	3	0.093	
nat_resrce	PIB	0.0689	1	0.793	we reject H_1 and accept H_0
nat_resrce	fbcf	0.29192	1	0.589	we reject H_1 and accept H_0
nat_resrce	atck	0.29251	1	0.589	we reject H_1 and accept H_0
nat_resrce	All	0.53001	3	0.912	
gfcf	PIB	0.60855	1	0.435	we reject H_1 and accept H_0
gfcf	nat_resrce	5.4879	1	0.019	we reject H_0 and accept H_1
gfcf	atck	0.69385	1	0.405	we reject H_1 and accept H_0
gfcf	All	6.1748	3	0.103	
atck	PIB	0.94012	1	0.332	we reject H_1 and accept H_0
atck	nat_resrce	0.17072	1	0.679	we reject H_1 and accept H_0
atck	fbcf	6.4667	1	0.011	we reject H_0 and accept H_1
atck	All	8.9694	3	0.030	

Source: author. Based on H0 and H1, **Table 5** presents the results regarding causality.

4.3. Normality Test

Normality tests are used to determine whether a data set is well modeled by a

normal distribution or not. In other words, these tests tell us about the type of distribution of the residuals. Normality tests are used to determine whether a data set is well modeled by a normal distribution or not.

These tests tell us about the type of distribution of the residuals. In the case of a linear regression model, if the residuals are normally distributed, this can create many econometric problems and the results derived from this estimation may not be valid.

The normality test for this study is presented in Table 6 below. All the statistics, Kurtosis, chi^2 and Jarque-Bera show that the residuals are normally distributed in the two economic growth equations i.e. natural resources and terrorism.

Table 6. Normality test.

	Kurtosis test			
Equation	kurtosis	chi^2	dl	Prob > chi^2
GDP	5.0869	2.541	1	0.11095
natu_resrce	3.9314	0.506	1	0.47684
gfcf	3.7087	0.293	1	0.58831
atck	4.0762	0.676	1	0.41111
ALL	-	4.015	4	0.40394

Source: author. Note: The result of the normality test used in this study.

5. Conclusion and Recommendations

The effects of terrorist attacks on natural resource exploitation and economic growth in resource-rich countries have been widely discussed in the economic literature. The theory of growth based on natural resources and terrorism has been examined, and this study concludes that the relationship between terrorism and natural resources is complex, to say the least. This article analyzed the cointegration and causality in the Granger sense, using the method developed by Toda and Yamamoto (1995) between natural resources and terrorism in Chad, based on a data sample covering the period from 1996 to 2019. The data were drawn from the World Bank database and the GTD for Chad, a country that possesses significant natural resources and is frequently targeted and a perennial victim of terrorist attacks. Based on our results, we can conclude that the model presented is generally satisfactory. Our results show that, at the 5% significance level, the variables of interest terrorism, natural resources, and GDP on which our econometric analyses focused are all cointegrated in the long run. However, the Granger causality test reveals no significant direct causality between natural resources and terrorism in either direction; the initial hypothesis of a unidirectional causal relationship from natural resources to terrorism is therefore not confirmed by our empirical results. The long-term link between the two variables appears to operate primarily through indirect channels, with per capita GDP and gross fixed capital formation being the variables for which significant causal relationships have been established with ter-

rorism and natural resources. This nuance is important: it indicates that the relationship between the abundance of natural resources and terrorism in Chad is not mechanical, but is conditioned by the trajectory of economic growth and investment. This information is an important indicator that could encourage the government of Chad, in its fight against terrorism, to redouble its efforts in terms of economic policies to boost economic growth by curbing terrorism and by managing and distributing the proceeds from the exploitation of natural resources as effectively and equitably as possible to all segments of Chadian society. Our study recommends, as economic policies, that to reduce the negative effects of terrorist attacks on the exploitation of natural resources, the government establish strong and stable institutions in Chad. The study also recommends a participatory approach involving various social groups in the exploitation and management of natural resources, as well as transparency and open communication in the governance of financial resources derived from natural resources, in order to ensure a sustained path of political stability and steady growth.

Author Contributions

CROI Kacou Firmin: Conceptualization, drafting, data analysis and interpretation, as well as final drafting of the manuscript; review of comments and finalization of the manuscript. ADAMA Diaw: Conceptualization and significant contributions to the drafting of the manuscript and the critical review of its content.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Table A1. Definitions and sources of variables.

Variables	Acronym	Definitions	Sources
Gross domestic product per capita	GDP/pcg	Per capita GDP is measured as a level, in constant 2010 U.S. dollars (nominal GDP divided by the GDP deflator, relative to the total population), rather than as a growth rate. The variable is included in the model in logarithmic form.	WDI, 2020
Natural resources	nat_resrce	The rent from the exploitation of non-renewable natural resources, fossil fuels and minerals as well as resources from the over-exploitation of forests. This income is expressed as a percentage of GDP and is entered as a logarithm in the equations.	WDI, 2020
Terrorism	atck	The threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation.	GTD, 2020
Gross fixed capital formation	gfcf	The fbcf is represented by the investment rate, expressed as a percentage of GDP (not per capita), on a logarithmic scale. This proxy for capital stock has been used in several studies (see for example, Barro, 1991; Balasubramanyam et al., 1996; Kohpaiboon, 2004).	WDI, 2020

Source: Compiled by the authors. Notes: All information regarding the various variables included in this study is drawn from the 2020 WDI database, except for data on terrorism, which comes from the 2020 Global Terrorism Database (GTD).