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Article

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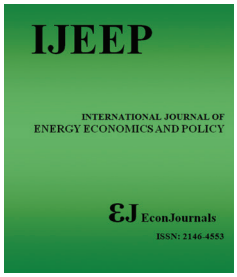

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Do Institutional Quality and Terrorism Affect the Natural Resources Rents?

Mehdi Abid[1]*, Habib Sekrafi[2], Ramzi Farhani[3], Zouheyr Gheraia[4], Hanane Abdelli[4]

[1]Department of Finance and Investment, College of Business, Jouf University, Skaka, Saudi Arabia, [2]Laboratory for the Valorization of Natural and Cultural Heritage (VPNC) University of Jendouba, Jendouba, Tunisia [3]Faculty of Economics and Management, Sousse University, Sousse, Tunisia, [4]Department of Business Management, College of Business, Jouf University, Skaka, Saudi Arabia. *Email: meabid@ju.edu.sa

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ABSTRACT

Despite the significant development observed in African countries' economies thanks to the exploitation of natural resources, this has had very little impact on the daily lives of the population. Africa is also characterized by an increase in violent extremism, that is, the political, ideological, social and economic forces that support and fuel terrorism. Thus, a better understanding of the relationship between the possession of natural resources, terrorist attacks and institutional quality is essential for policy makers. Indeed, although being endowed with natural resources constitutes one of the pillars of growth and development, it is also the main funding source for terrorist groups in African countries. Our study covers a sample of 47 African countries over a period from 1996 to 2017. The terrorism variable takes four measures: uncertain, domestic, transnational and total. The research is based on three estimators, namely Ordinary Least Squares (OLS), Random Effects (RE) and System GMM. The paper argues that any increase in terrorist attacks contributes to the reduction of natural resources rents. Also, a country's poor institutional quality contributes to poor exploitation of natural resources rents. Given the complementarities detected between terrorism, natural resources rents and institutional quality, improving institutional quality and reducing terrorism would lead to a better exploitation of natural resources.

Keywords: Natural Resources Rents, Terrorism, Institutional Quality, System-Generalized Method of Moments
JEL Classifications: G1; G15; G32

1. INTRODUCTION

The study of the relationship between natural resources and the level of development has been intense and has evolved over time. This relationship was considered positive in early research attempts (Nurkse, 1953; Rostow, 1960; Watkins, 1963). Indeed, the possession of natural resources contributes to human development (Lei et al., 2022; Pata, 2021; Zaidi et al., 2019), financial development (Mohamed Sghaier, 2021; Abid et al., 2022; Bunje et al., 2022), and economic development (Meng et al., 2022; Zhang et al., 2022; Usman et al., 2022; Jahanger et al., 2022).

In this perspective, Rostow (1961) considered the abundance of raw materials as a precondition for the "take-off" of the least developed countries towards industrial development. Balassa (1980) showed that natural resources contribute to industrial development by providing funds for physical capital formation and increasing the demand for industrial goods. Deaton (1999) argued that natural resources rents are a potential source of funds for physical capital accumulation. The author also showed that temporary price spikes offer tremendous profits that, if invested, can enhance future growth. More recently, Shahbaz et al. (2017) have shown that natural resources contribute to financial development and economic growth.

The second strand of the literature argued that natural resources hindered economic growth, hence the resource curse hypothesis (Matsuyama, 1992; Sachs and Warner, 2001). In

front of this ambiguity, new research avenues have shown that the so-called relationship between natural resources and development depends on other factors, mainly institutional quality (Lujala, 2010; Caselli et al., 2015; Berman et al., 2017; Khan et al., 2020). However, this vast literature neglected the interdependence between natural resources, environmental quality and terrorism, although the wealth of natural resources was argued.

With regard to the relationship between natural resources and terrorism, it was argued through different avenues. Initially, natural resources increase the value of the State to become a target of violence. Indeed, natural resources rents can be a source of financing for terrorist groups if these resources are controlled by a group (Wick and Bulte, 2006) or if the distribution of resources rents is perceived as unfair (Murshed and Gates, 2005; Humphreys, 2005; Østby et al., 2009). Second, natural resources wealth reduces the opportunity costs of rebellion and increases the likelihood of joining terrorist groups (Koubi et al., 2014). Finally, wealth can make separatism financially attractive (Collier and Hoeffler, 2005; Ross, 2006; Kirshblum et al., 2011).

On the basis of the interdependence between the previously analyzed variables, the objective of our study is to simultaneously examine the relationship between natural resources, institutional quality and terrorism. In essence, the study seeks to answer this empirical question: Do institutional quality and terrorism affect the total natural resources rents in Africa?

This study contributes to a broader literature on conflict and terrorism, particularly on the African continent. Thereby, the relations between terrorism and natural resources have led to a political ecology of war analyzing resource, environmental, pillage or secession wars linked to natural resources. A State that has hydrocarbon resources is more exposed to the risk of being the scene of armed conflict than a state that does not. Natural resources can provide the means to finance rebellions motivated by interests other than the resources themselves. They can, being concentrated in a delimited territory, encourage secessionist attempts. They lead to rentier behavior prohibiting or delaying strong institutions. The natural resources of the subsoil can, because of their abundance, stir up controls through violence. Thus, existing studies are limited to studying the relationship between natural resources and institutional quality on the one hand, and between institutional quality and terrorism on the other. However, studies that investigated the relationship between natural resource rents, institutional quality and terrorism at the same time are rare, leaving a gap for this study to fill.

The remaining sections of this study are organized as follows. The second section is devoted to a review of the literature and hypothesis development, while the data and methodology are discussed in the third section. The fourth section discusses the main empirical findings and finally the last section presents the conclusion with some implications.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Terrorism and Natural Resources Rents

Over the last two centuries, and particularly in recent decades, the volume and range of natural resources has considerably increased in terms of international trade. At 1 time, only the most valuable resources were shipped to distant markets. Today, almost all raw materials are traded in large quantities around the world, contributing to the rapid industrialization and development that characterizes modern economy. So, the inequality in the possession and distribution of natural resources on a planetary scale is a reality that all disciplines are today striving to grasp better and better because inequality has considerable consequences on development and on the spread of terrorist attacks. In the same perspective, it should be pointed out that the industrialized countries represent 10-11% of the world's population with almost 50% of the wealth created. In fact, the move of 90% of the poorest agents to the level of 10% requires the multiplication of resources by eight (Soherwordi et al., 2020). This unequal distribution of resources leads us to identify possible interventions, and the reasons why dependence on natural resources could have harmful effects. The first statistical study to find a relationship between natural resources and the risk of terrorism was published in 1998 (Collier and Hoeffler, 1998) and was updated in 2009 (Collier et al., 2009). It analyzed the large-scale civil wars that took place between 1960 and 2004, and showed that the risk of conflict increases considerably when resources are poorly distributed. In the studies by Fearon (2005) and Collier et al. (2004), the amplification of the unequal distribution of natural resources may be at the origin of the increase in the duration of conflicts. Indeed, according to Collier et al. (2004), a 10% increase in inequality may be responsible for a 12% increase in conflict. Thus, the natural resources curse syndrome contributes to independence, the financing of rebel groups and the isolation of governments from their electorates. According to the authors, the intrinsic value of a natural resource is a cause of conflict between interested parties. This explains why "oil" has always been a source of conflict wherever and whenever it is found. However, instability and terrorism are commonplace in many resource-dependent developing economies. Thus, in the example of the Democratic Republic of Congo (Chermak and Gruenewald, 2015), natural resources are at the heart of conflicts that are fueled by allowing the acquisition of arms. Natural resources are what is at stake in the war, because the region is controlled by the rebel groups, and due to the covetousness they generate, the trafficking and the financial benefits are ensured by the minerals, which makes rebel groups obtain arms and thus wage a long war. African countries, in particular the east of the Democratic Republic of Congo, have been transformed into theaters of civil war and disorganized, balkanized areas with ghost states and deeply degraded social classes. Thereby, in this context, natural resources have played an important role in the dynamics of the country's conflicts. They served to fuel the conflicts of the colonial era, as natural resources were the main purpose of captivity and exploitation. Poor governance in the distribution of natural resources rents contributes to an unequal distribution of income. Nevertheless, the political decision-makers exploit the resources rent for their own interest in order to maintain their

position. In a word, terrorism is more likely to occur where natural resources rents are unfairly distributed and not used to address the negative externalities that arise from them. Thus, the nature of the relationship between natural resources rents and development depends on the quality of institutions as confirmed by Andersen and Johnson (2014).

2.2. Natural Resources Rents and Institutional Quality

A growing body of research suggests that natural resources are more of a burden than a blessing. Nevertheless, the growth of countries with natural resources is on average slower than that of countries without natural resources. In a famous study in 1995, Sachs and Warner highlighted the existence of a statistically significant negative relationship between the share of primary exports in gross domestic product or in total exports and the growth rate. This phenomenon-known as the "resource curse"- is associated by researchers with the quality of the institutions that characterize each country.

Several analyses highlight the strong correlation between resources rents and the quality of institutions. Some studies assume natural resources rents as a catalyst for the degradation of institutional quality. Thus, according to Nwani and Adams (2021) and Adekoya et al. (2022), the combination of abundant natural endowment, ill-defined property rights and market imperfections leads agents to prefer predation activities to productive activities. Tornell and Lane (1999) and Torvik (2002) developed models that support this idea. Nevertheless, in the trade-off between predation and production, the presence of natural resources and/or an increase in their prices shifts the balance in favor of predation. Also, Ross (2001) highlighted a negative effect of primary exports on institutions, but this tends to decrease with the level of income and with the time since the country has been exporting minerals. Ades and Telle (1999) showed that natural resources rents stimulate increased corruptibility of bureaucrats and politicians. Acemoglu et al. (2004) argue that high resources rents make it easier for dictators to buy political challengers. Indeed, "the enormous wealth of natural resources in Congo (including 15% of the world's copper deposits, vast quantities of diamonds, zinc, gold, silver, oil and many other resources) has given Mobutu a steady stream of revenues to help maintain his power." Thereby, Jensen and Wantchekon (2004) found that resource abundance is not only an important determinant of democratic transition, but also partly explains the success of democratic consolidation in Africa. The idea is that resource dependence increases competition for State control, which can lead to political violence.

The second line of research considers the quality of institutions as a source of natural resources rents misuse. Nevertheless, the success of a resource-rich country like Botswana prompted researchers to study the quality of institutions, which plays a key role in the management of natural resources rents (Corrigan, 2014). Thus, when governments have less control over the quantities of natural resources, institutional quality becomes the only crucial factor in the results (El Anshasy and Katsaiti, 2013). However, strong institutions can turn a resource curse into a socio-political and economic blessing (Acemoglu et al., 2005).

In the same line of research, Sala-i-Martin and Subramanian (2013) showed that when institutional quality control increases, natural resources will no longer have a direct negative effect on growth. Mehlum et al. (2006) showed that if institutions are of good quality (conducive to productive activities), natural resources are conducive to growth. The institutional deficit is at the heart of the voracity model (Tornell and Lane, 1999), in which various social groups attempt to capture economic rents from resources exploitation.

2.3. Natural Resources, Institutional Quality and Terrorism

The nature of the relationship between natural resources rents, institutional quality and terrorism can be direct or indirect. Natural resources rents directly affect terrorism as in many cases they are the main source of financing for terrorist groups and one of the causes of civil unrest and extremism. In this sense, several empirical tests showed the dependence between the abundance of natural resources and internal conflicts (Ross, 2004; Collier and Hoeffler, 2005; Fearon, 2005; Lujala, 2010; Andersen and Aslaksen, 2013; Abid and Sekrafi, 2020). Collier and Hoeffler (2004) showed that the likelihood of facing a war is increasingly high when countries have abundant natural resources. Ajide et al. (2020) analyzed the effect of the political regime in explaining the relationship between natural resources and terrorism. Their results showed that natural resources rents have unconditional effects on transnational and total terrorism. Also, political regimes exert unconditional effects on domestic and total terrorism, with autocracy acting as an amplifying factor for the effect of natural resources rents on the number of terrorist attacks.

Natural resources rents can indirectly affect terrorism through the nature of the quality of institutions. Thus, corruption, political instability and lack of law enforcement account for the diversion of rents to terrorist groups. Also, poor-quality institutions increase the share of the informal sector, which in turn stimulates a surge in terrorist attacks. In this sense, Sekrafi et al. (2020) showed in a study on African countries that the informal sector represents the consequence of poor-quality institutions and is strongly positively correlated with the number of attacks. In order to further enrich the literature, we formulate the following hypotheses:

- H_1: The institutional quality significantly decreases natural resources rents in Africa
- H_2: Terrorism attacks significantly decrease natural resources rents
- H_3: Institutions play a significant role in mediating the relationship between terrorism and the natural resources rents

3. DATA AND METHODOLOGY

3.1. Data

Our empirical analysis covers a sample of 47 African countries over the period 1996-2017. The choice of this period is related to the availability of data for measures of institutional quality (IQ). Table 1 provides an overview of the variables used in our study and their sources. The list of selected countries is shown in the Appendix. The descriptive statistics for these different variables are summarized in Table 2. All the variables are transformed into

Table 1: Definitions of variables

Variables	Variable definitions (measurement)	Sources
TNRR	Total natural resources rents (% of GDP)	WDI (2020)
Uncertain terrorism	Number of uncertain terrorism incidents	GTD (2020)
Domestic terrorism	Number of domestic terrorism incidents	GTD (2020)
Transnational terrorism	Number of transnational terrorism incidents	GTD (2020)
Total terrorism	Number of total terrorism incidents	GTD (2020)
GDP	GDP per capita (constant 2000 US$)	WDI (2020)
Informal economy	Informal economy (% of GDP)	Medina and Schneider (2019)
Public debt	General government debt to GDP ratio (% of GDP)	WDI (2020)
Military expenditure	Military expenditure (% of central government expenditure)	WDI (2020)
TRO	trade openness, i.e., exports plus imports as percentage of GDP	WDI (2020)
POP	Population density is defined as the number of individuals per geographical unit	WDI (2020)
HDI	The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development	Our World in Data (2020)
Religious (RL)	The various religions that are included are: Animism, Baha'ism, Buddhism, Confucianism, Christianity, Hinduism, Islam, Jainism, Judaism, Shinto, Sikhism, Taoism, and Zoroastrianism	World Directory of Minorities
Control of Corruption	Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	WGI (2020)
Government Effectiveness	Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy.	WGI (2020)
Political Stability	measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism	WGI (2020)
Regulatory Quality	Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	WGI (2020)
Rule of Law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	WGI (2020)
Voice and Accountability	Reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	WGI (2020)

Table 2: Summary statistics

Variables	Mean	SD	Min	Max
Uncertain terrorism	6.219	29.524	1	546
Domestic terrorism	5.884	32.158	1	600
Transnational terrorism	2.946	10.324	1	155
NRR	13.825	12.859	0.001	84.228
Informal economy	40.769	12.560	9.821	89.224
lnpublicdet	3.974	0.905	−0.755	5.577
lnmilitaryexpenditure	0.632	0.829	−1.512	3.678
lnGDP	6.952	1.049	4.751	9.920
IQ	−8.62e−10	0.691	−1.638	2.218
TOP	67.70	25.42	21.34	165.87
HDI	0.65	0.548	0.228	0.939
POP	49.57	1.85	1.89	199.68
RL	0.124	0.231	0	1

the form of a natural logarithm through Principal Component Analysis (PCA), except for the institutional quality variable which is deduced from six indicators (Control of Corruption, Government Effectiveness, Political Stability, Regulatory Quality, Rule of Law, Voice and Accountability).

The average value of terrorism varies between 6.219, 5.884 and 2.94 for the uncertain, domestic and transnational, respectively. These endogenous variables represent the number of annual terrorist incidents recorded in a country in a given year. In order to avoid mathematical problems related to the transformation of zeros and the correction of the positive asymmetry of our data distribution, the study resumes the natural logarithm of terrorist incidents by adding the number one to the database (Asongu and Nwachukwu, 2017). Concerning the total natural resources rents (TNRR), the mean value is greater than the median value of 13.825% of the GDP. However, the maximum and the minimum values are reported as 84.228 and 0.001 as a GDP percentage, respectively.

The analysis of the mean and standard deviation of the variables in the model can be extended by analyzing both the correlation coefficients and the probability. Table 3 presents correlation among the variables under study. The results indicate that all the variables have moderate correlation on one another since their coefficients are <0.8. This reveals the absence of high multicollinearity among the variables. Explicitly, the coefficients of correlation in Table 3 range from 0.125 to 0.797. From the correlation matrix, Institutional quality and various terrorism indicators have negative and significant impact on total natural resources rents.

3.2. Methodology

In order to empirically analyze the relationship between natural resources rents, terrorism and institutional quality, the study is based on three econometric methods specific to panel data. The article discusses two static panel estimations: OLS estimator and fixed effects estimator; as well as a dynamic panel estimation: the method of generalized moments in systems (*System GMM*, Blundell and Bond, 1998).

Table 3: Correlation matrix

Variables	Uncertain terrorism	Domestic terrorism	Transnational terrorism	Total terrorism	TNRR	IQ
Uncertain terrorism	1.0000					
Domestic terrorism	0.742*** (0.000)	1.0000				
Transnational terrorism	0.658*** (0.001)	0.598*** (0.000)	1.0000			
Total terrorism	0.710*** (0.000)	0.776*** (0.000)	0.797*** (0.000)	1.0000		
TNRR	−0.125** (0.013)	−0.198** (0.024)	−0.130*** (0.006)	−0.167*** (0.002)	1.0000	
IQ	−0.419** (0.011)	−0.366** (0.035)	−0.285** (0.013)	−0.416** (0.034)	−0.215*** (0.002)	1.0000

P-values are in parenthesis. ***and **Indicate significance at 1 and 5% levels, respectively

The first method controls for country heterogeneity and thus for structural and time-stable variables that may have been omitted. Two tests are associated: The Hausman test, which allows us to choose between fixed and random specific effects, and the F-test, which accounts for the global significance of the specific effects introduced. The main econometric problem that arises when estimating a static panel model such as the Ordinary Least Squares (OLS) estimator or the Within (Fixed Effect) estimator is the endogeneity of the explanatory variables. Therefore, the static panel estimator yields biased and non-convergent estimators. To remedy this, we use the Generalized Moments (GMM) dynamic panel method. Estimates in the system GMM not only make it possible to take into account the countries' heterogeneity, but also to deal with the problem of the variables' heterogeneity, which necessarily arises when studying the relationship between terrorism, natural resources and institutional quality. The system GMM consists of combining for each period the equation in first differences with that in levels. In the first difference equation, the variables are then instrumented by their level values delayed by at least one period. On the other hand, in the level equation, the variables are instrumented by their primary differences (Arellano and Bover, 1995). The resulting system of equations is estimated simultaneously, using the Generalized Method of Moments. Blundell and Bond (1998) tested this method using Monte Carlo simulations. The authors found that the system GMM estimator is more efficient than the GMMs difference estimator (Arellano and Bond, 1991) which exploits only the moment conditions of the difference equation.

The efficiency of the GMM estimator is based on the validity of the following assumptions: (i) the instruments are well valid and (ii) the error terms are not autocorrelated. To test the validity of the lagged variables as instruments, Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) suggested using the Hansen/Sargan's over-identification tests. This work uses the Hansen test because it is effective in the presence of autocorrelation and heteroscedasticity problems (Roodman, 2007, Neanidis and Varvarigos, 2009). To verify the non-correlation hypothesis of the error terms, the study is based on the second order autocorrelation test because the first difference error term is correlated to the first order (Levine et al., 2000). The results that mainly underpin our conclusions are those of the system GMM estimator with two-step estimates according to the methodology proposed by Windmeijer (2005) to promote its robustness.

In order to study the impact of terrorism and institutional quality on the natural resource rents, the paper uses the Generalized Method of Moments in a two-step system. The equation of the economic model is given as follows:

$$TNRR_{it} = \alpha_0 + y_{i,t-1} + \alpha_1 Ter_{i,t} + \alpha_2 IQ_{i,t} + \sum_j \beta_j X_{j,i,t} + \mu_i + \theta_t + \varepsilon_{it} \quad (1)$$

$$TNRR_{it} - TNRR_{i,t-1} = \alpha_0 \left(TNRR_{i,t-1} - TNRR_{i,t-2}\right) + \alpha_1 \left(Ter_{i,t} - Ter_{i,t-1}\right) + \alpha_2 \left(IQ_{i,t} - IQ_{i,t-1}\right) + \sum_j \beta_j (X_{j,i,t} - X_{j,i,t-1} + (\theta_t - \theta_{t-1}) + \varepsilon_{it-1} \quad (2)$$

Where, $TNRR_{it}$ is the total natural resources rents in the country i at time t. $Ter_{i,t}$ is the terrorism variable (uncertain, domestic, transnational and total), $IQ_{i,t}$ is the institutional quality variable, X is a vector of control variables (GDP, informal economy, military spending, population, trade openness, human development index, religious and public debt). β_j and α_i are vectors of parameters to be estimated. μ_i, θ_t and ε_{it} are respectively: Country-specific effects, time-specific effects and an error term.

4. RESULTS AND DISCUSSION

This section analyzes the relationship between natural resources rents, terrorist attacks, and institutional quality for a panel of 47 African countries. In order to give a preliminary view of this relationship, the study uses three different methods: the Ordinary Least Squares (OLS), the Random Effects (RE), and the Generalized Method of Moments (GMM). The estimation results are presented in Table 4. This study begins with the simplest version of the model that seeks to test whether total natural resources rents can be influenced by terrorist attacks and institutional quality. Given the existence of different terrorism-sensitive measurement indicators, the estimate is made using uncertain, domestic, transnational and total terrorism.

Using different methods leads us to choose in a first step the best estimation method. Using the Ordinary Least Squares (OLS) method allowed us to draw the following conclusions: The coefficients have expected signs and are statistically significant at 1%. Similarly, the estimation results for the RE models show that our interest variable coefficient (domestic, transnational, uncertain and total) keeps the same expected sign. However, the results for both models indicate that the value of the coefficient of determination (R-squared) is extremely low, which indicates that errors in measurements and omitted variables are accounted

Table 4: Estimation results

Dependent variable: TNRR												
Variables	**OLS**				**Random effects**				**System GMM**			
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
Lag dependent variable									0.806 (0.000)***	0.781 (0.000)***	0.814 (0.000)***	0.797 (0.004)***
Uncertain terrorism	−0.107 (0.009)***				−0.059 (0.024)**				−0.194 (0.015)**			
Domestic terrorism		−0.180 (0.000)***				−0.012 (0.000)***				−0.239 (0.014)**		
Transnational terrorism			−0.130 (0.007)***				−0.055 (0.036)**				−0.248 (0.10)*	−0.096 (0.017)**
Total terrorism				−0.148 (0.000)***				−0.038 (0.000)***				
IQ	−0.308 (0.006)***	−0.307 (0.003)***	−0.293 (0.000)***	−0.308 (0.000)***	−0.044 (0.043)**	−0.029 (0.003)***	−0.023 (0.006)***	−0.041 (0.001)***	−0.394 (0.010)*	−0.239 (0.002)***	−0.232 (0.013)**	−0.250 (0.011)**
Diagnostic checking												
R^2	0.0157	0.0392	0.021	0.028	0.012	0.0081	0.0529	0.0042				
Breusche Pagan LM test	6.33 (0.011)**	4.55 (0.032)**	4.79 (0.025)**	6.17 (0.0130)**								
Hausman test					0.043 (0.832)	0.001 (0.952)	0.015 (0.925)	0.021 (0.872)				
Hansen Test for over-identifying restriction: P-value									0.417	0.428	0.510	0.405
Arellano-Bond Test for first order Autocorrelation: P-value									0.133	0.125	0.117	0.120
Arellano-Bond Test for second order Autocorrelation : P-value									0.211	0.413	0.204	0.197
No of Instruments									25	25		24
No of Countries	47	47	47	47	47	47	47	47	47	47		47
No of Observations	429	429	429	429	429	429	429	408	408	408		408

P-values are in parentheses. ***, ** and * indicate statistical significance at the 1, 5 and 10% levels, respectively. The difference equation is instrumented with the lagged levels, two periods, of the dependent variable and the levels equation with the difference lagged one period

for in the perturbations. Thus, the Breusch-Pagan LM test rejects the null hypothesis of no random effects. This means that the estimation results with the RE model are more robust than the estimation results with the OLS model. In this paper, the Hausman test is used to determine which of the regressions (fixed effects or random effects) is the most appropriate. The Hausman test shows a probability well above 5%. Although the estimators of the fixed-effects model are biased, it is preferable to keep the random effects model. However, standard econometric techniques such as the OLS or RE do not provide unbiased estimates because of variable endogeneity problems. In order to solve this problem, the study uses the system GMM method. Indeed, Blundell and Bond's (1998) system GMM combines the first difference equations with the level equations. The instruments in the first differences equation are expressed in level, and vice versa.

The results in Table 4 clearly confirm our basic assumption; the higher the number of terrorist attacks in a country, the lower the natural resources rents. All three terrorism indicators have negative coefficients and are statistically significant. For example, in column (1), if the number of uncertain attacks increases by one point, the total natural resources rents in GDP decrease by 0.19%. In column (2), an increase in the number of domestic attacks by one point leads to a reduction of 0.24% in rents. The results also confirm that the weaker the country's institutional quality (when the country's score is close to the lower bound −2.5), the lower the rents. So, the coefficients associated with the composite institutional quality variable are negative and significant at the 5% threshold. For example, in column (1), an increase of one point in the institutional quality indicator leads to a decrease of 0.39% in the natural resources rents. Thus, the results confirm that the diagnostic statistics are favorable. Hansen's over-identification test does not reject the validity of the instruments used. Other diagnostic tests reveal the absence of first-and second-order serial correlation (AR[1] and AR[2]). After analyzing the direct relationship between total natural resources rents, the numbers of attacks and institutional quality, the same control variables are introduced in this paper. The results of the estimates are given in (Table 5).

From the results in Table 5, the presence of lagged value of the dependent variable in each of the models is also justified since its value is significant in all the models. Specifically, previous values of total natural resources show positive and significant effect on current total natural resources. This signifies that the current total natural resources rent is directly linked to its historical values. This corroborates the studies of Couttenier (2012), Hordofa et al. (2022) and Li et al. (2022). In all the models on Table 5, especially models 1–3, all the terrorism proxies have a negative and significant effect on total natural resources rents. This indicates that an increase in terrorism attacks worsens natural resources rents in Africa. This is consistent with the findings of Ajide and Alimi (2021a); Alimi and Ajide (2021); Ajide and Alimi (2022), Ajide and Alimi (2021b). In terms of magnitude, transnational terrorism has more impact on total natural resources rents than other terrorism indicators used. In recent times, transnational terrorism is one of the top terrorism indicators responsible for the negative effects of total natural resources rents. Terrorism has significant impact on total natural resources rents in Africa due to the illegal extraction of natural resources by armed groups, which leads to permanent deterioration

Table 5: System GMM estimation with control variables

Dependent variable: TNRR			
Variables	**(1)**	**(2)**	**(3)**
Lag dependent variable	0.012 (0.000)***	0.034 (0.000)***	0.053 (0.000)***
Uncertain terrorism	−0.127 (0.000)***		
Domestic terrorism		−0.146 (0.000)***	
Transnational terrorism			−0.221 (0.001)***
IQ	−0.039 (0.031)**	−0.107 (0.000)***	−0.257 (0.061)*
IQ* Uncertain terrorism	−0.052 (0.000)***	−0.45 (0.000)***	−0.026 (0.001)***
IQ* Domestic terrorism	−0.020 (0.005)***	−0.017 (0.003)***	−0.014 (0.001)***
IQ* Transnational	−0.015 (0.002)***	−0.018 (0.001)***	−0.026 (0.000)***
GDP	0.108 (0.019)**	0.058 (0.013)**	0.088 (0.032)**
Lnpublicdet	−0.024 (0.000)***	−0.012 (0.000)***	−0.038 (0.000)***
Informal economy	−0.077 (0.005)***	−0.069 (0.000)***	−0.067 (0.001)***
Military expenditure	−0.032 (0.515)	−0.039 (0.476)	−0.037 (0.512)
TOP	0.031** (0.024)	0.007* (0.086)	0.121*** (0.000)
HDI	0.031** (0.024)	0.002** (0.011)	0.005** (0.045)
POP	−0.031** (0.024)	−0.041** (0.037)	−0.007* (0.087)
RL	−0.031** (0.024)	−0.007*** (0.006)	−0.091** (0.033)
Diagnostic checking			
Hansen Test for over-identifying restriction: P-value	0.147	0.230	0.206
Arellano-Bond Test for first order Autocorrelation: P-value	0.018	0.009	0.011
Arellano-Bond Test for second order Autocorrelation: P-value	0.559	0.447	0.366
No of Instruments	26	26	25
No of Countries	47	47	47
No of Observations	320	320	320

P-values are in parentheses. ***, ** and * indicate statistical significance at the 1, 5 and 10% levels, respectively. The difference equation is instrumented with the lagged levels, two periods, of the dependent variable and the levels equation with the difference lagged one period

of these natural resources. As observed by Dreher and Kreibaum (2016), in developing countries, especially countries in sub-Saharan Africa, natural resources are considered the main sources of illicit financial flows for terrorist groups. Further, institutional quality has positive and significant effect on total natural resources rents used in this study. This shows that weak institutional quality as recorded from the descriptive statistics worsens environmental quality by decreasing total natural resources rents. In addition, due to weak institutions, economic agents break the regulatory framework which leads to higher informal economy activities and lower natural resources rents respectively. Since institutions set the rules for economic agents and instill discipline in order to limit opportunistic behaviors among economic agents, weak institutions will make economic agents function in the shadow economy in order to finance terrorism to maximize their profit.

In contrast, the interactive effect of institutional quality and terrorism has a negative effect on total natural resources in Africa. This reveals that terrorism is larger in regions with weak institutional framework, thereby decreasing total natural resources. Intuitively, weak institutional quality may lead to the spread of terrorist operations and later to total natural resources deterioration.

Total natural resources rents represent the dependent variable. At the same time, informal economy, public debt, military spending, GDP, trade openness, human development index, population and religious are independent variables. Most of the variables have the expected signs and are highly statistically significant. The higher the GDP, trade openness and HDI, the higher the total natural resources, ceteris paribus. The higher the informal economy, public debt, population and religious, the lower the total natural resources, ceteris paribus. Military expenditure is not statistically significant; this is probably because it is already incorporated in public debt.

Finally, according to the results of the Sargan/Hansen over-identification tests, the hypothesis of validity of the instruments is accepted. The statistics of this test indicate that the instruments used are also valid. Similarly, the results of the auto-correlation tests lead us to accept the hypothesis of the absence of auto-correlation of order 1 and order 2 errors: AR(1) and AR(2) for all specifications.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study examines the relationship between natural resources rents, terrorism and institutional quality. The study covers 47 countries in Africa between 1996 and 2017. For robustness check, terrorism is proxied by three indicators, namely: Domestic, transnational and uncertain. The study uses a battery of estimation techniques (OLS, RE and system GMM) to achieve the stated objectives. The outcome of this study provides new insights into the nexus among natural resources rents, institutions and terrorism in developing countries especially Africa.

First, the outcome of this study reveals that institutional quality has a negative impact on total natural resources rents in the region. This implies that poor institutional quality leads to the spread of terrorism in Africa. Therefore, policymakers in the region need to improve governance indicators, since the African region performs poorly in the areas of democracy, civil liberties, and political governance. This is due, in general, to recent political instability, lack of fairness in elections, infringements of civil liberties and political rights, media dependence on politics, lack of security and political instability, persistent gender inequalities, poor management of political processes, and weak rule of law.

Secondly, all the terrorism proxies in Africa decrease natural resources rents. This implies that the illegal extraction of natural resources by armed groups leads to the militarization of ecologically sensitive and important areas, which in turn undermines the possibilities for environmental preservation, permanently destroys natural resources, and creates an environment conducive to serious human rights violations. Terrorism has environmental, societal, and economic consequences, including threats to security, the livelihoods of local communities, and the theft of natural capital on a national scale. Because it involves a complex set of elements-poor environmental governance, legal loopholes and laundering schemes used to benefit crime-it weakens state institutions and legitimate businesses and therefore represents an obstacle to sustainable development. In order to effectively combat violent extremism and radicalization, States have an obligation to take the necessary measures against terrorist attacks, namely: (i) Fostering a culture of transparency between citizens and government. To do this, the government will need to communicate to citizens its knowledge of the nature of the terrorist threat so that they better understand the need for specific measures. The role of law enforcement agencies is critical. They can share their knowledge and analysis of the threat to help governments and communities respond more effectively. (ii) Promoting dialogue and cooperation on issues related to the fight against terrorism, in particular through partnerships between public authorities and the private sector (business, industry, etc.), as well as civil society and the media. (iii) Promoting the implementation of the international legal framework against terrorism and strengthening international legal cooperation in criminal matters related to terrorism.

Third, the interactive effect of institutional quality and terrorism on total natural resources rents provides interesting results. The interactive term of institutional quality and terrorism has a decreasing effect on natural resources rents. This implies that the impact of terrorism through weak institutional quality is more felt on natural resources rents. Policymakers need to establish or strengthen existing regulatory bodies in order to curb harmful effect of terrorism on natural resources rents. Regulatory institutions need to be harmonized with those of the neighboring countries in the region so as to reduce the chance of a terrorist attack.

It is worth noting that this study contributes to literature by examining the effect of terrorism on total natural resources rents in Africa in the presence of institutional quality. Further, no known study from Africa has examined the moderating role of institutions in such relationship, thereby making our study unique.

However, this study is limited based on the availability of data on terrorism indicators. Further study can extend this data set to more recent years and consider other developing countries in a country-specific study.

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