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Terrorism against American citizens in Africa: Related to poverty?

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Abstract

This paper analyses terrorism attacks against USA citizens in Africa from 1978 to 2002 using ITERATE data set. The fractional integration methodology is adopted. It is shown that attacks to USA citizens in Africa are persistent and perpetuated in countries characterised by poverty and low level of political and economic freedom. Policy implications are derived for countering acts of terrorism.

JEL classification: D79; H56

Keywords: Africa; Terrorism; Poverty; Time series; Persistence; Long memory

1. Introduction

Africa is the continent with the lowest terrorist casualties in the world after Asia, according to the ITERATE database. African terrorism casualties are most common in North African Islamic countries such as Egypt, Algeria and Libya, and in the Horn of Africa (Djibouti, Somalia, Ethiopia, Eritrea, Kenya and Tanzania). The terrorist attacks of August 7, 1998, on the US Embassies in

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Nairobi, Kenya and Dar es Salaam, Tanzania, and the attack in Mombassa in November 2002 drew attention to the targeting of American citizens by terrorist groups in Africa. This targeting is documented by the ITERATE data set, allowing for statistical analysis of these terrorist events. In this paper, we analyze the targeting of American citizens by terrorist groups in Africa, using some novel techniques based on fractional integration.

In spite of the relatively low incidence of terrorist attacks against US citizens in Africa, the time series demonstrate persistence, which is the focus of this study. Persistence in terrorist attacks was identified in Barros, Proença, Faria, and Gil-Alana (in press) when they analyzed terrorist attacks against US citizens in Europe. Based on this evidence, this paper looks at the characteristics of the persistence of such attacks against US citizens in Africa. The value of such research is that it could contribute towards policy formulation in the war against terrorism. The knowledge of the characteristics of attacks against US citizens helps designing and allocating resources in countering terrorism.

In this paper, we analyze the fractional integration of African terrorism against US citizens, estimating both univariate and multivariate models that account for both the deterrent and the political effects associated with curbing acts of terrorism. In so doing, the paper extends previous research in this field, Barros et al. (in press), cross validating the previous results.

The objective of this paper is threefold. Firstly, we examine the special characteristics of terrorism against US citizens in Africa by performing a descriptive analysis of the ITERATE data set. The results confirm that the highest percentage of attacks take place in poor countries. Secondly, we examine the univariate behavior of the series in terms of fractional integration to assess whether the series present a persistent pattern over time. Finally, we show that terrorism in Africa is related with poverty, but also with the level of political and economic freedom, and use long memory regression models to explain these relationships. Policy implications are derived for countering acts of terrorism.

Terrorism issues have been examined in a number of papers by Barros and Gil-Alana (2006), Barros, Passos and Gil-Alana (2006) and Barros et al. (in press), and issues related with economic freedom and poverty appear among others in Wall (1995), Vos (1998), Dakurah, Stephen, Davis, and Sampath, (2001), Salvatore (2004), Grimm (2005) and Cororaton and Cockburn (2006). However, papers relating terrorism and poverty are few, including Miguel, Satyanath, and Sergenti (2004) and Abadie (2004).

The paper is organized as follows. Section 2 presents the contextual setting, describing some of the special characteristics of terrorist attacks against US citizens in Africa. The theoretical framework is presented in Section 3. Section 4 describes the methodology used in the paper. Section 5 contains the hypotheses to be tested. In Section 6 we present the empirical results. Section 7 deals with policy implications. Finally, the concluding remarks appear in Section 8.

2. Terrorism against US citizens

Terrorist attacks are assumed to be random and perpetrated in populous areas. Based on this assumption, we should not expect to have more US citizens being victimized by terrorist attacks than citizens of other nations, a result that has been verified at the European level, Barros et al. (in press). However, in the 1960s, leftist groups usually targeted small and specific US targets. Contemporary Islamic terrorist groups target large audiences, but also seem to prefer US targets, according to the data. This media perception can be statistically tested with the ITERATE data

set, available from Mickolus (edwardmickolus@hotmail.com). The ITERATE data set identifies the number of US citizens victimized by terrorist attacks over time, making it possible to analyze the characteristics of the attacks against US citizens in Africa, which is the aim of the present paper. The ITERATE data set is the most commonly used data set in the analysis of terrorist incidents.

Terrorism in Africa (1978–2002) has particular characteristics, which are analyzed in this section. The highest number of victims took place in 1993. In that year, there were continuous attacks against US citizens, mainly in Somalia, but also in other countries. In 1993, in the last days of George Bush Senior's presidency, eighteen American soldiers were killed in Somalia after the US Marines had invaded the country in order to "restore hope", as they put it. Later on August 7, 1998, there were terrorist attacks on the US Embassies in Nairobi, Kenya, killing 224 people and injuring hundreds of others, mainly Kenyans, and in Dar es Salaam, Tanzania, killing 10 people and wounding 77. Finally, there was the attack in Mombassa in November 2002, killing 15 people. All of these greatly increased the toll of victims amongst US citizens, whilst other incidents happened in other years.

In Table 1, we have disaggregated the number of victims by country, showing the percentage of US victims for each country. We see that the highest number of victims corresponds to Somalia (30.98%), followed by Egypt (20.05%), Kenya (7.03%) and Niger and Sudan (6.77% each). Grouping the countries together on a geographical basis, the highest percentage of victims was found in East Africa (49.21%), followed by North Africa (32.03%), in the case of this latter group mainly due to the contribution of Egypt (Table 2).

In Table 2, the percentage of victims by terrorist group is shown. We can see that leftist groups and Islamic terrorist groups have been the main driving forces behind attacks on US citizens. As the leftist groups disappeared after the fall of the Soviet Union, we conclude that radical Islamic terrorist groups have substituted them.

Table 1
Percentage of US victims for each of the individual countries

Somalia	30.98%
Egypt	20.05%
Kenya	7.03%
Niger	6.77%
Sudan	6.77%
Ethiopia	3.90%
Liberia	3.64%
Sahara	2.60%
Uganda	2.60%
REP. South Africa	2.34%
Zimbawe–Rodhesia	2.08%
Angola	2.08%
Algeria	1.56%
Sierra Leone	1.30%
Mozambique	0.78%
Burundi	0.78%
Morocco	0.52%
Namibia	0.52%
Lesotho	0.52%
Chad	0.52%
Others	2.63%

Table 2
Percentage of US victims according to the terrorist group involved

Indeterminate Somalian guerrillas	23.93%
Unknown	18.78%
Aidid rebels (Somalia)	6.66%
PFL Palestine Liberation Front	3.93%
PFLP Popular Front Lib. Palestine	3.03%
Polisario	3.03%
Indeterminate Nigerians	2.72%
The Muslim Group al-Jama'a al Klamiyah (Egypt)	2.42%
Indeterminate Liberians	2.42%
Rwandan Rebels	2.42%
UNITA Liberation for Angola	2.42%
Ijah Tribe (Nigeria)	2.12%
Indeterminate Arab Palestine	1.81%
Takfir wa Hijra	1.51%
Liberation for Southern Sudan	1.51%
Revolutionary United Front	1.51%
Indeterminate Egyptian guerrillas	1.21%
National Union of Petroleum Workers	1.21%
Sudanese People's Liberation Army	1.21%
Indeterminate Sudanese guerrillas	0.90%
Liberian rebels	0.90%
Fedayeen Arab Cells	0.90%
Tigre People's Liberation Front	0.60%
ZIPRA/ZAPU (Zimbabwe)	0.60%
NRM MNR RENAMO	0.60%
Ethiopian Democratic Front	0.60%
Indeterminate Zimbabwean guerrillas	0.60%
Anzanian Liberation Army	0.60%
Black Consciousness Mov. of Azania	0.60%
Other small groups	9.09%

3. Theoretical framework

According to Collier and Hoeffler (2004) three economic factors are robust predictors of the outbreak of civil war: (i) the initial level of income, y_0; (ii) the rate of growth of income, $\dot{y}/y$; and (iii) the share of primary commodity exports in total exports. Ignoring the last variable we can write:

$$c = g\left(\frac{\dot{y}}{y}, y_0\right). \tag{1}$$

Generalizing this idea to model any kind of internal conflict in a given country, where c stands for internal conflict [political, tribal, regional, religious conflict], we may rewrite (1) as:

$$\dot{y} = f(c, y), \quad f_c < 0; \quad f_y > 0, \quad f_{cy} = 0. \tag{2}$$

Assuming that conflict-ridden countries become safe havens for terrorists, we can suppose that terrorist organizations operating in these countries target Americans and, as a consequence, we can write terrorist attacks (A) as an increasing function of conflicts:

$$A = m(c), \quad m_c > 0; \quad m_{cc} < 0. \tag{3}$$

Assuming that the function m has an inverse function [$m^{-1} = h$], we can rewrite (3) as:

$$c = h(A), \quad h_A > 0; \quad h_{AA} > 0. \tag{4}$$

The problem of a terrorist organization operating in a conflict-ridden country aiming at attacking American targets is the following:

$$\underset{A}{\text{Max}} \int_0^{\infty} v(A, c, y)\ \mathrm{e}^{-\theta t}\,\mathrm{d}t \qquad s.t.\ \ \dot{y} = f(c, y),\ y_0\ \text{ given}$$

where the function v captures the net benefits [total benefits minus total costs] of a terrorist attack and the positive parameter θ is the rate of time preference of terrorists. Substituting (4) into the representative terrorist organization problem yields:

$$\underset{A}{\text{Max}} \int_0^{\infty} V(A, y)\,\mathrm{e}^{-\theta t}\,\mathrm{d}t \quad \text{s.t.} \quad \dot{y} = F(A, y), \quad y_0\ \text{ given},$$

where $V(A, y) = v(A, h(A), y)$ and $F(A, y) = f(h(A), y)$. The properties of functions V and F are the following:

$$V_A > 0; \ \ V_{AA} < 0; \ \ V_y > 0; \ \ V_{Ay} = V_{yy} = 0,$$

and

$$F_A < 0; \quad F_{AA} = F_{Ay} = 0; \quad F_y > 0; \quad F_{yy} < 0.$$

In order to solve the terrorist organization problem using the Pontryagin maximum principle, we write the Hamiltonian of the problem:

$$H = V(A, y) + \lambda F(A, y). \tag{5}$$

The first order conditions are the following:

$$H_A = 0 \Rightarrow V_A + \lambda F_A = 0, \tag{6}$$

$$\dot{\lambda} - \theta\lambda = -H_y = -V_y - \lambda F_y \tag{7}$$

plus the transversality condition and the dynamic constraint of the terrorist organization problem.

Differentiating (6) with respect to time and using (7) yields a differential equation for the number of terrorist attacks against American targets in conflict-ridden countries:

$$\dot{A} = \frac{F_A}{V_{AA}} V_y - \frac{V_A}{V_{AA}} F_y + \frac{V_A}{V_{AA}} \theta. \tag{8}$$

In discrete terms we can rewrite (8) as $\dot{A} \approx A_t - A_{t-1}$, so as to express the actual number of terrorist attacks as a function of past attacks, income and the terrorist organization rate of time preference:

$$A_t = A(A_{t-1}, y, \theta). \tag{9}$$

From (9) it is easy to see that an increase in income leads to a fall in the number of terrorist attacks [since $(F_A/V_{AA})V_y - (V_A/V_{AA})F_y > 0$], which establishes the direct relationship between poverty and terrorism.

4. Hypotheses

Consider the hypothesis of a terrorist group who plans a terrorist attack against a USA citizen to display its grievance, having chosen a specific location, type of attack and targeted victims. This definition is based on the utility that the terrorist group receives from choosing these components compared with the utility received from alternative ones. The choice underlying the utility defines the following null hypotheses:

Hypothesis 1. (Persistence): Terrorism in Africa against USA citizens is persistent. This hypothesis is based on previous research in terrorism, Barros and Gil-Alana (2006) and Barros et al. (in press).

Hypothesis 2. (Poverty): Terrorism in Africa against USA citizens is more prevalent in poor countries, Miguel et al. (2004). Poverty as a source of terrorism has been identified by Krueger and Maleckova (2003) and Abadie (2004).

Hypothesis 3. (Economic and political freedom): Terrorism in Africa against USA citizens is more prevalent in countries with low economic and political freedom. This hypothesis is based on previous research on terrorism research, Krueger and Maleckova (2003) and Wall (1995).

The hypotheses outlined above are tested by means of the adoption of a fractionally integrated framework.

5. Methodology

We claim in this paper that the time series corresponding to the number of US victims of terrorism in Africa is persistent. To show this, we apply techniques based on fractional integration. We define an $I(0)$ process $\{x_t, t=0, \pm 1,\}$ as a covariance stationary process where the infinite sum of the autocovariances is finite. In such a context, we say that $\{x_t, t=0, \pm 1, \ldots\}$ is integrated of order d (and denoted by $x_t \approx I(d)$) if:

$$(1-L)^{d} x_t = u_t, \quad t = 1, 2, \ldots \tag{10}$$

where L is the lag operator (i.e. $Lx_t = x_{t-1}$), u_t is $I(0)$ and d can be any real number. The parameter d plays a crucial role in describing the time series dependence. Thus, the higher the d is, the higher is the level of association between observations. If $d>0$, the process is said to be long memory, as opposed to the cases of $d=0$ (short memory) or $d<0$ (anti-persistence). There exist several sources that might produce long memory processes. Aggregation is the usual argument: Robinson (1978) and Granger (1980) showed that fractionally integrated data could arise as a result of aggregation when (a) data are aggregated across heterogeneous autoregressive (AR) processes and (b) data involving heterogeneous dynamic relationships at the individual level are then aggregated to form the time series. Then, in the context of terrorism time series, aggregation of heterogeneous data can result from the different terrorist groups involved in attacks in different countries, with specific characteristics and different motivations for each case.

In this article, we use both parametric and semiparametric methods of estimating and testing the fractional differencing parameter d. Firstly, we present a parametric testing procedure developed by Robinson (1994), which permits us to test $I(d)$ statistical models in raw time series. Next, a semiparametric method (Robinson, 1995) will also be described. These two methods have several distinguishing features that make them particularly relevant in comparison with other procedures. They have a standard null limit behavior, unlike other methods for testing, for example, unit

roots, where the limit distribution has to be calculated numerically on the basis of a case-by-case simulation study. Moreover, the limit distribution in Robinson (1994) is unaffected by the inclusion of deterministic trends or the type of $I(0)$ disturbances used to specify the short run components of the series. Another attractive property of these procedures is that Gaussianity is not required, with a moment condition only of order two being required.

5.1. A parametric testing procedure

Robinson (1994) proposed a Lagrange Multiplier (LM) test of the null hypothesis:

$$H_0 : d = d_0 \tag{11}$$

in a model given by

$$y_t = \beta' z_t + x_t, \quad t = 1, 2, \ldots \tag{12}$$

and (10), for any real value d_0, where y_t is the observed time series; $\beta = (\beta_1, \ldots, \beta_k)$' is a $(kx1)$ vector of unknown parameters; and z_t is a $(kx1)$ vector of deterministic regressors that may include, for example, an intercept, (e.g. $z_t \equiv 1$), or an intercept and a linear time trend, (in the case of $z_t = (1,t)$'). The functional form of the test statistic (denoted by $\hat{r}$) is described in Robinson (1994). Based on the null hypothesis (11), he established that under certain regularity conditions:

$$\hat{r} \rightarrow_d N(0, 1) \text{ as } T \rightarrow \infty, \tag{13}$$

as well as establishing the Pitman efficiency of the tests against local departures from the null hypothesis.

5.2. A semiparametric estimation procedure

The Gaussian semiparametric estimate of Robinson (1995) is basically a local "Whittle estimate" in the frequency domain, based on a band of frequencies that degenerates to zero. The estimate ($\hat{d}$) is described in Robinson (1995), and under finiteness of the fourth moment and other mild conditions, it can be proved that:

$$\sqrt{m}(\hat{d} - d_0) \rightarrow_d N\left(0, \frac{1}{4}\right) \text{ as } T \rightarrow \infty,$$

where d_0 is the true value of d and with the sole additional requirement that the bandwidth number $m \rightarrow \infty$ slower than T.

6. The terrorism against US citizens in Africa

This section is divided into two parts. In the first one, we analyze the monthly evolution of the time series that is of interest to us here, using the methodology described in Section 5. In the final part of this section, we relate the terrorism series in Africa with some economic indicators and poverty.

6.1. Univariate analysis

The results of performing the semiparametric Whittle estimate developed by Robinson (1995) are shown in Fig. 1. We report the values of d for the whole range of values of the bandwidth

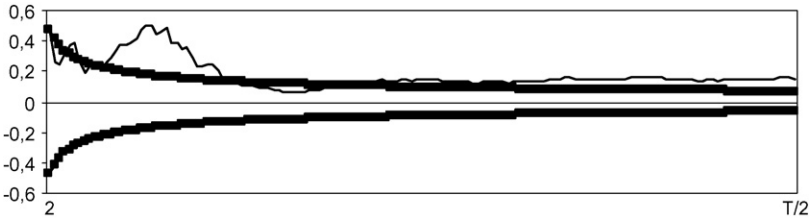

Fig. 1. Whittle semiparametric estimates of d based on Robinson (1995). The horizontal axis refers to the bandwidth number m. The vertical one refers to the estimate of d.

number m, along with the 95% confidence interval corresponding to the $I(0)$ hypothesis. It can be seen that practically all values are above the $I(0)$ interval, thus implying the existence of long memory.

Next, we try to be more specific about the appropriate modeling of the series and perform Robinson's (1994) parametric procedure. Denoting the time series by y_t, we proceed with the model,

$$y_t = \beta_0 + \beta_1 t + x_t, \quad (1 - L)^{\mathrm{d}} x_t = u_t,$$

testing H_0 (11) for d_0-values = 0, (0.01), 1, assuming that u_t is white noise and also weakly autocorrelated. In the latter case, we employ AR and Bloomfield (1973) disturbances. The latter is a non-parametric approach to modeling the $I(0)$ u_t that produces autocorrelations decaying in an exponential way as in the AR models.

In Table 3, we show the 95% confidence intervals of those values of d_0 where H_0 cannot be rejected. We observe that, in practically all cases, the values are above 0, thus rejecting the hypothesis of $I(0)$ stationarity. We see that the values are very similar for the three cases of no regressors, an intercept, and an intercept with a linear time trend, suggesting that these deterministic components might not be required when modeling this series. We also observe that, for all except the AR(2) disturbances, the intervals exclude the $I(0)$ case, once more suggesting long memory behavior. We have included in table (in parentheses, within the squared brackets) the value of d that produces (for each u_t and each z_t) the lowest statistics across d. This value should be an approximation to the maximum likelihood estimate. In all cases, the estimates are positive, ranging between 0.07 (AR(1) u_t with a linear time trend) and 0.16 (white noise u_t with an intercept).

In Table 4, we display, for each type of regressor and each type of disturbance, the model with the lowest statistic, along with the coefficients associated with the deterministic trends and disturbances. The two most interesting features observed in this table are that the coefficients associated with the time trend are found to be insignificantly different from zero, while the

Table 3
95% Confidence intervals of the non-rejection values of d using Robinson's (1994) tests

Disturbances	No regressors	An intercept	A linear trend
White noise	[0.09 (0.15) 0.21]	[0.09 (0.16) 0.24]	[0.09 (0.15) 0.24]
AR (1)	[0.01 (0.08) 0.19]	[0.01 (0.08) 0.19]	[0.02 (0.07) 0.19]
AR (2)	[−0.03 (0.09) 0.25]	[−0.04 (0.11) 0.26]	[−0.08 (0.09) 0.26]
Bloomfield (1)	[0.01 (0.09) 0.19]	[0.01 (0.09) 0.21]	[0.01 (0.08) 0.20]
Bloomfield (2)	[0.01 (0.12) 0.20]	[0.01 (0.14) 0.21]	[0.05 (0.12) 0.20]

Table 4
Selected models according to the lowest statistics in Table 3

u_t	Z_t	d	Test St.	β_0	β_1	τ_1	T_2
White noise	No regressors	**0.15**	−0.002	–	–	–	–
	Intercept	**0.16**	−0.093	**1.118 (2.37)**	–	–	–
	Lin. trend	**0.15**	−0.005	0.670 (0.87)	−.003 (−0.73)	–	–
AR(1)	No regressors	**0.08**	0.062	–	–	**0.112**	–
	Intercept	**0.08**	0.216	**1.174 (3.77)**	–	**0.114**	–
	Lin. trend	**0.07**	0.044	0.681 (1.24)	0.003 (1.07)	**0.112**	–
AR(2)	No regressors	**0.09**	0.059	–	–	**0.103**	−0.016
	Intercept	**0.11**	−0.037	**1.156 (3.18)**	–	**0.086**	−0.022
	Lin. trend	**0.09**	−0.025	0.596 (1.13)	0.003 (0.97)	**0.103**	−0.016
Bl. (1)	No regressors	**0.09**	0.015	–	–	**0.098**	–
	Intercept	**0.09**	−0.028	**1.168 (3.56)**	–	**0.109**	–
	Lin. Trend	**0.08**	0.069	0.681 (1.18)	0.003 (1.02)	**0.109**	–
Bl. (2)	No regressors	**0.12**	−0.018	–	–	**0.049**	−0.007
	Intercept	**0.14**	−0.044	**1.134 (2.67)**	–	**0.049**	−0.005
	Lin. Trend	**0.12**	−0.060	0.676 (1.00)	0.003 (0.84)	**0.049**	−0.007

Significant coefficients are in bold and *t*-ratios are in parentheses.

intercept seems to be required. As far as the $I(0)$ disturbances are concerned, only the AR(1) coefficient seems to be required.

Fig. 2 shows the impulse responses for the selected models above. We have considered the cases of white noise u_t with an intercept and AR (1 and 2) disturbances, also with an intercept. The impulse responses are very similar for the three cases and, in spite of the hyperbolic decay (due to the fractional structure), the decay is very fast. One year after the shock, the effect is almost negligible (lower than 2.5%).

6.2. *Terrorism and poverty*

The relationship between terrorism and poverty is an unresolved question in defence economics, (Krueger and Maleckova, 2003). Participation in terrorism is apparently unrelated or even positively related to an individual's income and education. Individuals from more privileged backgrounds are more likely to participate in terrorist attacks, (Krueger and Maleckova, 2003). Collier and Hoeffler (2004) find that the growth rate of GDP per capita is inversely related to the incidence of civil war.

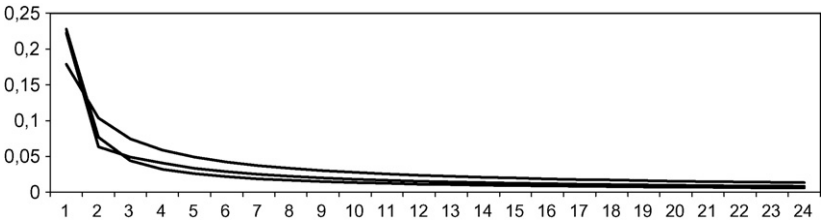

Fig. 2. Impulse response functions of the selected models.

From a time series viewpoint, there is evidence that poverty creates civil conflict which may fuel terrorism. Miguel et al. (2004) show that, for a sample of African countries, negative exogenous shocks to economic growth increase the likelihood of civil conflict. Alesina et al. (1996) suggest that poor economic conditions increase the probability of political coups (see also Kahn and Weiner, 2002). On the other hand, recent empirical studies have challenged the view that poverty creates terrorism. Examples of this viewpoint are the papers of Krueger and Laitin (2003), Piazza (in press) and Abadie (2004). These authors suggest that other variables, such as political or economic freedom, should be taken into account.

In Section 3, we proposed a theoretical model in which conflict-ridden countries are chosen by terrorists because of the lack of law enforcement and become safe havens for them. As civil conflict is linked to income and poverty, the model states that low-income countries are more likely to have civil conflicts and terrorists may take advantage of it using these countries as base for their attacks, in particular attacks against U.S. targets and citizens.

In this section, we test the model assessing whether poverty is a determinant of terrorist attacks against US citizens in Africa. We use once more the tests devised by Robinson (1994), but this time using as regressors four dummy variables corresponding to the economic level classification (World Bank, 2004). Thus, we now test H_0 (11) in the model,

$$y_t = \sum_{i=1}^{4} \gamma_i D_{it} + x_t, \quad (1-L)^d x_t = u_t, \tag{14}$$

where D_{it} takes the value 1 if there is a victim at time t in a country belonging to category 1 (Low Income Semiarid Countries) and 0 otherwise. D_{2t}, D_{3t} and D_{4t} are similar dummies referring, respectively to Low Income (group 2), Lower Middle Income (group 3) and Upper Middle Income (group 4) countries. Though not reported, it was obtained that only the first three dummy variables were significant, which correspond to the cases of Lower Income Semiarid, Lower Income, and Lower Middle Income countries. Including only these three regressors, the results are displayed in Table 5. An interesting feature observed here is that the order of integration of the series is substantially reduced when the dummies are taken into account. The values of d corresponding to the lowest statistics are now −0.02 with white noise u_t, −0.04 with AR(1) u_t, and −0.12 with AR(2) u_t, implying anti-persistent behavior in all cases. Thus, after desegregating the attacks by groups of countries according to an income level classification, the level of persistence is reduced, and the null hypothesis with short memory behavior cannot be rejected at standard significance levels. We also observe that the highest coefficients for the dummies correspond to the cases of Lower Income Semiarid and Lower Income countries.

Next, we relate terrorism in Africa with poverty and other economic factors. Firstly, we have created an artificial variable in trying to describe "*the standard of living in those countries affected by terrorism against the USA*". This variable was created as follows: firstly, we created five values

Table 5
Testing the order of integration with significant economic dummies

u_t	Confidence interval	γ_1	γ_2	γ_3	τ_1	τ_2
White noise	[−0.11, −0.02, 0.08]	**4.019 (7.732)**	**1.470 (3.608)**	**3.987 (7.537)**	–	–
AR (1)	[−0.27, −0.12, 0.03]	**4.359 (9.348)**	**1.230 (3.303)**	**4.202 (8.476)**	0.118	–
AR (2)	[−0.30, −0.04, 0.22]	**4.090 (8.048)**	**1.429 (3.572)**	**4.026 (7.722)**	0.060	−0.074

Significant coefficients are in bold and t-ratios are in parentheses.

Table 6
Testing the order of integration in a model with an intercept and a variable for economic factors

u_t	Confidence interval	β_0	β_1	τ_1	τ_2
White noise	[0.06, 0.12, 0.21]	**4.361 (4.289)**	**−1.501 (−3.401)**	–	–
AR (1)	[−0.06, 0.06, 0.21]	**3.478 (3.546)**	**−1.637 (−3.716)**	0.092	–
AR (2)	[−0.17, 0.06, 0.23]	**4.707 (4.712)**	**−1.648 (−3.767)**	0.092	0.007

Significant coefficients are in bold and *t*-ratios in parentheses.

(from 1 to 5) for the specific countries according to the World Bank (income). Then, for a given period of time, we calculated the value of the variable by using a weighted sum of the values, where the weights were the percentage of victims in a given country at that time. In the case of no victims in a given period, we chose a value of 2.18, which corresponded to the arithmetic mean of the values using all countries in Africa.

In Table 6 we replace the dummies in (14) by a constant and the variable just created as the regressor. We see that both the intercept and the slope coefficient are significant. Moreover, the coefficient associated with the "standard of living" variable is negative, thus implying a negative relationship between income level in Africa and terrorism against the USA. The values of d producing the lowest statistics are now 0.12 in the case of white noise and 0.06 with auto-correlated disturbances.

In Table 7, we have replaced the above variable by another, which is more specifically designed to describe the standard of living in the countries affected by terrorism against the USA. This variable was created on the basis of a Human Development Index (HDI) developed by the United Nations Development Programme (UNDP). This variable was introduced in the same way as in the previous table, i.e. using a weighted sum of the values at each period of time. If there were no victims in a given period, we chose an average value of the year for the whole continent.

The results obtained by including the HDI variable in our regression model are shown in Table 7. We see that the non-rejection values of d are very similar to those found in the previous case, ranging between −0.05 and 0.24. Moreover, both the intercept and the slope coefficient are statistically significant, while the HDI has a negative coefficient, once more implying a negative association between income in Africa and terrorism against US citizens in that continent.

Tables 8 and 9 are similar to Tables 6 and 7, but the "standard of living" and "HDI" variables have been replaced firstly (in Table 8) with an artificial variable, formed in the same way as in Table 6, with values for the countries now being shown according to the categories of economic freedom provided by the 2004 Index of Economic Freedom. In Table 9, we are more country-specific and use a weighted value with a chain-linked index across time, provided by the 2004 Annual Report on the Economic Freedom of the World.

Using the artificial variable based on the classification in the Index of Economic Freedom we can see that both coefficients remain significant for the three types of disturbances, and that

Table 7
Testing the order of integration in a model with an intercept and a variable for the Human Development Index

u_t	Confidence interval	β_0	β_1	τ_1	τ_2
White noise	[0.08, 0.14, 0.23]	**4.378 (3.975)**	**−0.007 (−3.183)**	–	–
AR (1)	[−0.02, 0.09, 0.23]	**4.521 (4.248)**	**−0.007 (−3.305)**	0.085	–
AR (2)	[−0.05, 0.09, 0.24]	**4.521 (4.186)**	**−0.007 (−3.257)**	0.105	−0.014

Significant coefficients are in bold and *t*-ratios in parentheses.

Table 8
Testing the order of integration in a model with an intercept and a variable for economic freedom

u_t	Confidence interval	β_0	β_1	τ_1	τ_2
White noise	[0.02, 0.09, 0.18]	**5.673 (6.774)**	**−1.704 (−5.797)**	–	–
AR (1)	[−0.08, 0.02, 0.14]	**6.052 (7.624)**	**−1.840 (−6.347)**	0.101	–
AR (2)	[−0.14, 0.04, 0.21]	**5.936 (7.381)**	**−1.798 (−6.176)**	0.085	−0.028

Significant coefficients are in bold and *t*-ratios in parentheses.

Table 9
Testing the order of integration in a model with an intercept and a variable for the Economic Freedom Index

u_t	Confidence interval	β_0	β_1	τ_1	τ_2
White noise	[0.08, 0.14, 0.23]	**3.409 (1.926)**	−0.516 (−1.323)	–	–
AR (1)	[0.00, 0.08, 0.18]	**3.636 (2.229)**	−0.560 (−1.537)	0.106	–
AR (2)	[−0.04, 0.09, 0.24]	**3.605 (2.178)**	−0.554 (−1.502)	0.105	−0.014

Significant coefficients are in bold and *t*-ratios in parentheses.

the coefficient associated with the "Economic Freedom" category is negative. If we replace that variable with the one provided by the "Report of Economic Freedom of the World", (Table 9), the coefficient associated with it remains negative although it is not significant at the 5% level, implying a smaller degree of association of this variable with terrorism in Africa.

7. Policy implications

This article examines the time series behavior of the number of US victims in Africa caused by terrorism over the period 1978–2002, using the ITERATE database. The highest number of victims took place in 1993. Somalia was the country with the highest proportion of attacks, followed by Egypt, Kenya, Niger and Sudan. Ranking the countries by income level, the highest proportion of attacks took place in Low Income Semiarid and Low Income countries, providing evidence of a positive relationship between African Islamic countries, poverty and terrorism against USA citizens at an aggregated level.

Moreover, focusing on the stochastic properties of the series the results indicate that the series is integrated of an order of about 0.10. Moreover, the null hypothesis of $I(0)$ was rejected in practically all cases in favor of positive orders of integration, signifying thus, long memory and hyperbolic decay autocorrelations. This means that terrorism against USA citizen in Africa is persistent and will likely continue to exist in the near future, validating Hypothesis 1. This result is in line with the findings in Barros and Gil-Alana (2006) and Barros et al. (in press).

Analysing the relationship between terrorism and economic activity, using long memory regression models, a negative relation between the standard of living in the countries affected by terrorism and the number of US victims is founded, implying a positive relationship between terrorism and poverty, as showed in our theoretical model and validating Hypothesis 2.

Using the level of economic freedom instead of income as an explanatory variable, the results also showed evidence of a negative relationship with terrorism, although this variable was found to be less significant at conventional statistical levels. These results validate Hypothesis 3.

The evidence suggests that terrorist groups target USA citizens in Africa. Despite only 8% of terrorist attacks in Africa result in US victims, this value is not random and therefore a policy should be devised to curb it. Somalia, Egypt, Kenya, Niger and Sudan are the countries were more

attacks are perpetuated against USA citizens, displaying a pattern were the relationship between poverty, lack of economic freedom, Islamism and terrorism are positively related. These attacks are persistent and will likely continue to exist in the near future.

What is the appropriate anti-terror policy suggested by our results? First, the US government has an interest in protecting its citizens from terrorist attacks. As Somalia, Egypt, Kenya, Niger and Sudan, are the places where it is expected USA citizens to be more exposed; there is room for cooperation between the US and these countries to improve security. Alternatively, this information should be available, informing USA citizens traveling to these countries of the perils they should expect and the cautionary behavior they should adopt. Second, the prevention and deterrence policies should take into account the evidence that terrorist attacks are progressively aggravating after 1985, as shown by Enders and Sandler (1993). This pattern is in line with the persistence identified in the terrorism series. This prevention should focus more on Islamic terrorist groups since they are in the present the most representative terrorist groups in Africa and elsewhere [Enders and Sandler (2006)] and also because of their revealed preference for bombing attacks with many casualties. However, the asymmetric targeting of the terrorism attacks against USA citizens in different African countries means that a common deterrence policy towards this threat will be difficult to achieve. Therefore a fine-tuning policy devised country by country should be adopted. Third, a policy to eliminate poverty in the long run should be adopted as a way to curb hate and grievance against the citizens of the leading capitalist country. Finally, policies to promote economic and political freedom – and thus good governance – in these countries should be adopted, as they are among the causes of terrorism attacks.

The general conclusion is that prevention and deterrence policies are needed to curb terrorism against USA citizens in Africa. This type of attacks will not vanish by itself due to the identified persistence of the series, and therefore a public policy is needed to curb it. This policy should be focused on African Islamic countries, developing political and economic freedom and promoting growth to remove some of the root causes of terrorism.

8. Conclusion

In this article, we have examined the time series behavior of US victims in Africa caused by terrorism for the period 1978–2002, using the ITERATE database. The paper was divided into three parts. In the first one, we presented some descriptive analysis about the time series analyzed. The results showed that the highest number of victims took place in 1993. Somalia was the country with the highest proportion of attacks, followed by Egypt, Kenya, Niger and Sudan. Ranking the countries by income level, the highest proportion of attacks took place in Low Income semi-arid and Low Income countries, providing evidence of a positive relationship between poverty and terrorism at an aggregated level.

In the second part of the paper, we focused on the stochastic properties of the series and concentrated on its degree of persistence by looking at its order of integration. We used fractional models and employed both parametric and semi-parametric techniques. The results in this part indicated that the series is integrated of order around 0.10. Moreover, the null hypothesis of $I(0)$ was rejected in favor of positive orders of integration. Thus, we found long memory and hyperbolic decay autocorrelations.

The final part of the paper deals with the relationship between terrorism and economic activity. Using long memory regression models, we found a negative relation between the standard of living in the countries affected by terrorism and the number of US victims, implying a positive

relationship between terrorism and poverty, as showed in our theoretical model. Using the level of economic freedom instead of income as an explanatory variable, the results also showed evidence of a negative relationship with terrorism, although this variable was found to be less significant at conventional statistical levels.

The present paper has limitations, and these limitations should be addressed in future research on this issue. First, it is not clear from this research whether terrorist groups target USA citizens or if they fell victims of the terrorist attack by random. The different intensity displayed in the data – as well the anecdotal evidence provided by media – makes the random hypothesis difficult to accept, but it is a hypothesis not discarded by the analysis. Second, we have not taken into account different colonial traditions. Finally, we have not taken into account the political regime that may encourage the attacks to USA citizens and are in someway separable from the religion tradition. Policy implications are derived from the results. More research is needed to confirm the present results.

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