

TERRORISM AND REGIONAL INTEGRATION IN SUB-SAHARAN AFRICA THE CASE OF THE CFA FRANC ZONE

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To the extent that regional currency integration changes the costs of imported inputs used in the production of terror, it can change the supply of terror produced by rational terrorists. In this paper, we appeal to a theory of rational terrorism where a country's membership in a regional currency union conditions the cost of inputs that produce terror, and estimate the parameters of static and dynamic terrorism supply functions with Generalized Estimating Equation count data estimators for Sub-Saharan Africa between 1974 and 2006. Our parameter estimates reveal that regional currency integration has counter-terrorism benefits as countries with membership in the newly constituted CFA Franc Zone had fewer terrorism incidents relative to other Sub-Saharan African countries. Our parameter estimates also suggest that the CFAZ Franc Zone caused a decrease in terrorism. As terrorism constrains important drivers of economic growth, our results suggest that another potential channel by which regional currency integration improves living standards in Sub-Saharan Africa is through reducing terrorism.

JEL Classification: C23, F15, N17, O11, O47

Motivation

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- After the September 11, 2001 terrorist attacks on the World Trade Center and Pentagon in the USA, Sub-Saharan Africa has been increasingly recognized as a region warranting special counter-terrorism attention. (Abrahamsen, 2004; Cilliers, 2003).
- This attention is underscored by the fact that since the late 1980s, sub-state terrorist activity in countries such as Burundi, Democratic Republic of the Congo, Liberia and Sudan have resulted in the loss of almost a million lives and significant destruction of physical property (Cilliers, 2004).
- To the extent that regional currency integration lowers transaction costs for all economic activities and increases the gains to trade with member countries, regional currency integration, by changing the cost of importing terrorism inputs, could potentially have a negative or positive effect on terrorism in Sub-Saharan Africa.

- In this paper we examine the effects of membership in the CFA Franc Zone (CFAZ) on terrorism in Sub-Saharan Africa.
- We consider the time period 1974 - 2006 for which country-level terrorism incident data are available and which permits a consideration of the causal effects of country membership in CFAZ starting in 1999 when it was newly constituted by having all member country currencies pegged to the euro.
- Our inquiry contributes to a broad literature on the economic causes and consequences of terrorism (Abadie, 2006; Abadie and Gardeazabal, 2008; Chen and Siems, 2004; Gould and Klor, 2010). As we consider the extent to which terrorism in Sub-Saharan Africa is affected by regional currency integration, we add to the literature which views the decision to produce terror as a function of costs and benefits (Arce and Sandler, 2003, 2009; Brandt and Sandler, 2009; Elu, 2012; Sautter, 2010; Wintrobe, 2006).

Following Elu and Price (2011), assume terrorists are the self-interested *homo economicus* of standard economic theory (Caplan, 2006), where representative terrorist net utility is defined over the number of terrorism events N which he values at v , and is produced with two types of inputs: domestic inputs I'_i and foreign inputs I . Let domestic inputs cost k and following Ricci (2008), let foreign inputs cost $(\tau/e)k$ where τ represents the transaction associated with converting domestic currency into foreign currency, and e is the foreign exchange rate—the amount of domestic currency per unit of foreign currency.

The representative terrorist net utility maximum-value function is:

$$U(v, k'_i, (\tau/e)k) = \operatorname{argmax}_{(\sum k'_i l'_i, (\tau/e)kl, N) \geq 0} \quad vN - \sum k'_i l'_i - (\tau/e)kl$$

$$\text{s.t. } f(l'_i, l) \geq N$$

The production function $f(\cdot)$ is assumed to be continuous, and costs linear with $f'(\cdot) > 0$, strictly increasing, strictly quasiconcave, with $f(0,0) = 0$, and for all countries $\tau > 0$, and $e > 0$. Suppose further that the representative terrorist net utility maximum-value function is increasing in v , decreasing in $(k'_i, (\tau/e)k)$, and homogeneous of degree one, convex, and differentiable in $(v, k'_i, (\tau/e)k)$.

This establishes:

Proposition (The Optimal Supply of Terrorism and Regional Currency Integration). *If the transaction costs of imported terrorism inputs under regional currency integration are less than (greater than) the exchange rate, the optimal supply of terrorism decreases (increases).*

See paper for Proof.

- In general the implied causal nexus of the proposition implies that the effect regional currency integration on terrorism depends upon the extent to which it affects the costs of imported terrorist inputs.
- For example, if regionally integrated countries relative to non-integrated countries are better able monitor illegal money laundering, which constitutes a transaction cost on imported inputs for terrorists, regional currency integration could have a negative effect on terrorism.

- In the year 2000, the Inter-Governmental Action Group Against Money Laundering (GIABA) was established in Senegal—a CFAZ member country (Bolaji, 2010).
- To the extent that GIABA enables CFAZ to monitor illicit inter-country cash flows that could finance terrorism among CFAZ members, it could also possibly enforce GIABA money-laundering prerogatives in a manner that manages transaction costs relative to the exchange rate in a way that deters terrorism.
- This motivates our econometric strategy below. Given data on terrorist incidents, membership in CFAZ, and other terror inputs, we estimate the parameters of a terrorism supply function for Sub-Saharan Africa that permits an assessment of the proposition above.

Data and Empirical Methodology

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- Our dependent variable is terrorism incidents in Sub-Saharan Africa from the 2010 Global Terrorism DataBase compiled by the National Consortium for the Study and Responses to Terrorism (START).
- Our measure of belonging to the Central African Franc Zone (CFAZ) is dichotomous, and the member countries are those identified by Irving (1999).
- As of January 1, 1999 the currency arrangement among CFAZ member countries changed as the currency of these countries—the franc—was now pegged to the euro.
- We create dummy variables for a country's membership in : (1) CFAZ, and the sub-units: (2) West African Economic and Monetary Union (WAEMU), and (3) Economic and Monetary Union of Central Africa (CEMAC). WAEMU includes the countries of Benin, Burkina Faso, Cote d' Ivoire, Mali, Niger, Senegal and Togo. CEMAC includes the countries of Cameroon, Central African Republic, Chad, Congo Republic of, Equatorial Guinea, and Gabon.

Data and Empirical Methodology

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- As in Elu and Price (2011) we augment our empirical specifications with other inputs that may matter for the production of terrorism, with data from Penn World Table 6.3 (Heston, Summers, and Aten, 2009).
- Given that our measure of terrorism incidents in each Sub-Saharan African country is integer-valued, we posit that the number of terrorism incidents are realizations from a Negative Binomial distribution.
- The data also constitute repeated observations over time, rendering the possibility that for each country the number of terrorism incidents are correlated. This violates the independence assumption underlying Negative Binomial parameter estimation, and requires perhaps an erroneous specification of the source of individual country heterogeneity.
- As such, we estimate the parameters of Generalized Estimating Equations (GEE) specifications (Zeger, Liang, and Albert, 1988).

Data and Empirical Methodology

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A GEE specification is a semiparametric approach where for k explanatory variables and $j = 1, 2 \dots C$ possibly correlated clusters of observations on the number of terrorist incidents in country i (N_i), parameter estimates follow from solutions to a quasi-score function of the form:

$$U_k(\beta) = \sum_{j=1}^C \mathbf{G}'_i \mathbf{V}_i^{-1} (\mathbf{N}_i - \lambda_i) = 0$$

where $\mathbf{G}_i = \lambda_i / \beta$, and for scale parameter $\phi = 1$, $\mathbf{V}_i = [(A_i)^{1/2} R_i(\alpha) (A_i)^{1/2}] / \phi$. The \mathbf{A}_i are $T \times T$ diagonal matrices with $g(\mu_{it})$ as the t^{th} diagonal element, α is a vector of unknown parameters, and $R_i(\alpha)$ is the working correlation matrix. A Negative Binomial (NB) GEE specification follows from specifying $\lambda_i = h(\theta_i; \beta_i)$, and for dispersion parameter r , $N_i \sim NB(\lambda_i, \lambda_i[1 + r\lambda_i])$.

Data and Empirical Methodology

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- Parameter estimates from GEE provide measures of a population response to changing covariates.
- This is in contrast to simple Negative Binomial estimates that measure an observational unit response to changing covariates.
- GEE parameter estimates inform the extent to which the average propensity for terrorism incidents changes given variation in CFAZ membership change across all Sub-Saharan African countries.
- To the extent that this population average effect holds regardless of individual country changes in CFAZ membership over time, it is more relevant for assessing the effects of regional currency unions on terrorism in all of Sub-Saharan Africa, and not just for the countries that actually joined.

Data and Empirical Methodology

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- Our estimation of a Negative Binomial GEE specification will assume that for a given Sub-Saharan African country i , the correlation ρ between N_{it} and N_{it-1} is either autoregressive or stationary.
- We allow the order of autoregression and stationarity to range from 1 to 3, and specify the working correlation matrix accordingly.
- In particular let $\mathbf{R}_{jj'}$ be a working correlation matrix that includes for a given observation in a cluster the j' correlation between year j and j' for $j \neq j'$, then for an autoregressive process $\mathbf{R}_{jj^{t-1}} = \rho^{|j - \sum j^{t-1}|}$, and for order m stationarity $\mathbf{R}_{jj^{t-1}} = \rho^{|j - \sum j^{t-1}|}$ if $j - \sum j^{t-1} \leq m$, and zero otherwise.
- These correlation structures are in our view quite plausible given the data are repeated observations across time and particularly so in the case of our dynamic specification that includes the regressor N_{it-1} , as the error term is not likely to be independent and identically distributed.

- A terrorism incident summary of the countries in our sample is reported in Table 1 (**See Paper**). For the 41 Sub-Saharan African countries in our sample there were a total of 4,993 terrorism incidents for which 261 groups claimed responsibility for over the 1974 - 2006 time period.
- South Africa by far had the most terrorism incidents, and in all likelihood reflects the protracted conflict between black opposition groups and the government over white minority rule and apartheid.
- Terrorist groups affiliated with Islam claimed responsibility for terrorism in approximately 26 percent of Sub-Saharan countries—including Somalia.
- The non-Islamic sounding group names suggest that the majority of terrorist groups in Sub-Saharan Africa are belligerent tribal and opposition groups.
- Table 2 (**See Paper**) reports a summary of covariates utilized in our terrorism supply function specifications.

- Tables 3 - 4 report respectively, static and dynamic GEE population-averaged parameter estimates for a the terrorism supply function.
- The six specifications account for autocorrelation and stationarity with orders that range from 1 to 4 respectively, as convergence was not realized with order 2 autoregression and stationarity.
- The explanatory adequacy of each regression is assessed with a Wald chi-square distributed test for the null hypothesis that the exogenous explanatory variables have parameters that are jointly insignificant.
- As our specifications have different error specifications, we also report for each the Quasi Information Criterion (*QIC*) statistic (Cui, 2007; Pan, 2001). A minimum *QIC* test statistic is also a measure of fit, as it enables selection of the best specification in terms of minimum description length (Rissanen, 1978)—the specification that captures the most regularity of the data given uncertainty about the true specification.

Results

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- Given the possibility of reverse causality and endogeneity of a country's membership in CFAZ, we also report for the static and dynamic GEE specifications a test for the exogeneity of CFAZ—the extent to which a country's membership in CFAZ causes terrorism—based on the test proposed by Robins, Greenland, and Hu (1999).
- Our implementation of the Robins-Greenland-Hu test estimates the auxiliary OLS linear probability regression with robust standard errors. The difference between the tests in the static and dynamic specification differs in what is included in \mathbf{X}_t —the dynamic specification includes the one period lag of terrorism, whereas the static specification excludes it.
- To account for the possibility that terrorism declined in Sub-Saharan Africa overall after 1999—the year in which CFAZ membership was associated with currency being pegged to the euro—we add a dichotomous variable measuring years after 1999 to our specification of the terrorist supply function.

Table 3
Terrorism and Regional Integration In Sub-Saharan Africa (1974 - 2006)
GEE Population Average Negative Binomial Parameter Estimates:
Static Specification

Specification:	<i>AR1</i>	<i>AR2</i>	<i>AR3</i>	<i>Stationary (1)</i>	<i>Stationary (3)</i>	<i>Stationary (4)</i>
<i>Regressand</i> = Number of Terrorism Incidents						
<i>Regressors:</i>						
Constant	1.82 (.297) ^a	1.76 (.251) ^a	1.71 (.251) ^a	1.84 (.304) ^a	1.77 (.277) ^a	1.70 (.252) ^a
Real Gross Domestic Product Per Capita	.00037 (.00007) ^a	.00032 (.00006) ^a	.00033 (.00007) ^a	.00038 (.00007) ^a	.00035 (.00008) ^a	.00038 (.00006) ^a
Trade Openness	-.007 (.004) ^c	-.007 (.003) ^b	-.007 (.003) ^b	-.008 (.004) ^b	-.008 (.004) ^b	-.007 (.003) ^b
Total Population	.000005 (.000005)	.000008 (.000003) ^b	.000008 (.000003) ^a	.000004 (.000003)	.000007 (.000005) ^b	.000006 (.000003) ^b
Exchange Rate	.0001 (.00002) ^a	.0001 (.00002) ^a	.0001 (.00002) ^a	.0001 (.00002) ^a	.0001 (.00002) ^a	.0001 (.00001) ^a
Post-1999	-.1349 (.1981)	-.1948 (.2277)	-.1717 (.2328)	-.0983 (.2116)	-.0021 (.2883)	-.0763 (.1688)
CFAZ Membership	-.8069 (.2805) ^b	-.5243 (.2794) ^c	-.5243 (.2828) ^c	-.9011 (.2982) ^a	-.6011 (.3940)	-.6302 (.2509) ^b
<i>Diagnostics:</i>						
N	494	490	481	494	481	473
<i>Robins-Greenland-Hu Causality Test:</i> <i>E(CFAZ Terrorism) = 0</i>	.0000001 (.00009)					
χ^2_{k-1} : ($H_0: \beta_1 = \dots \beta_k = 0$)	260.63 ^a	116.43 ^a	122.46 ^a	293.90 ^a	86.29 ^a	156.99 ^a
<i>Quasi-Likelihood Information Criterion Statistic</i>	680.96	685.395	693.044	681.339	707.437	680.017

Standard errors in parentheses.

^a Significant at the .01 level

^b Significant at the .05 level

^c Significant at the .10 level

Notes: All standard errors are robust. Observations vary across the specifications as a result of estimation requiring per country observations to be equal to the number of lags in the error structure.

Table 4
Terrorism and Regional Integration In Sub-Saharan Africa (1974 - 2006)
GEE Population Average Negative Binomial Parameter Estimates:
Dynamic Specification

Specification:	<i>AR1</i>	<i>AR2</i>	<i>AR3</i>	<i>Stationary (1)</i>	<i>Stationary (3)</i>	<i>Stationary (4)</i>
<i>Regressand</i> = Number of Terrorism Incidents						
<i>Regressors:</i>						
Constant	1.88 (.233) ^a	1.86 (.224) ^a	1.83 (.231) ^a	1.88 (.234) ^a	1.85 (.236) ^a	1.84 (.228) ^a
Number of Terrorism Incident(s) _{t-1}	.0155 (.0029) ^a	.0098 (.0026) ^a	.0089 (.0027) ^a	.0156 (.0030) ^a	.0086 (.0027) ^a	.0100 (.0026) ^a
Real Gross Domestic Product Per Capita	.0001 (.00005) ^a	.0002 (.00005) ^a	.0002 (.00006) ^a	.0001 (.00005) ^b	.0002 (.00006) ^a	.0002 (.00006) ^a
Trade Openness	-.004 (.003)	-.005 (.002) ^b	-.005 (.002) ^b	-.004 (.003)	-.005 (.002) ^b	-.005 (.002) ^b
Total Population	.000003 (.000003)	.000005 (.000002) ^b	.000005 (.000003)	.000004 (.000003)	.000007 (.000003)	.000004 (.000003)
Exchange Rate	.00008 (.00002) ^a	.00009 (.00002) ^a	.00009 (.00002) ^a	.00008 (.00002) ^a	.00009 (.00002) ^a	.00009 (.00002) ^a
Post-1999	-.1228 (.1369)	-.1262 (.1531)	-.1485 (.1462)	-.1226 (.1377)	-.1112 (.1531)	-.1113 (.1289)
CFAZ Membership	-.7471 (.2542) ^b	-.5999 (.2233) ^b	-.5950 (.2398) ^b	-.7522 (.2554) ^a	-.6533 (.2599) ^b	-.6357 (.2365) ^b
<i>Diagnostics:</i>						
N	451	490	439	451	439	435
<i>Robins-Greenland-Hu Causality Test:</i> <i>E(CFAZ Terrorism) = 0</i>	-.00002 (.00008)					
χ^2_{k-1} : (H ₀ : $\beta_1 = \dots = \beta_k = 0$)	390.68 ^a	180.89 ^a	122.46 ^a	389.21 ^a	163.20 ^a	254.39 ^a
<i>Quasi-Likelihood Information Criterion Statistic</i>	524.981	547.975	551.116	525.147	555.017	544.109

Standard errors in parentheses.

^a Significant at the .01 level

^b Significant at the .05 level

^c Significant at the .10 level

Notes: All standard errors are robust. Observations vary across the specifications as a result of estimation requiring per country observations to be equal to the number of lags in the error structure.

Results

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- Across the static and dynamic specifications in Tables 3 - 4, the years after 1999 have a negative effect on terrorism but never significant.
- Membership in CFAZ is negative and significant effect on terrorism in all but one instance. However, for the minimum QIC specification which captures the most regularity in terrorism incidents in Table 4—the autoregressive of order 1 error specification—CFAZ does have negative and significant effect on terrorism.
- As the Robins-Greenland-Hu test supports the exogeneity of CFAZ membership, this suggests that in Sub-Saharan Africa, CFAZ membership caused terrorism to decline in member countries over the 1974 - 2006 time period.

Results

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- Overall, the parameter estimate for CFAZ membership is consistent with regional currency integration increasing the cost of formal inputs terrorist used to produce terror, and thus reducing the production of terror.
- As for the practical empirical significance of the CFAZ membership parameter estimate in the minimum *QIC* GEE specification, it suggests that if two countries in Sub-Saharan African differ in that one is a CFAZ member, and the other is not, the non-member country would have on average approximately 11 fewer terror incidents per year if it joined CFAZ.

Conclusions

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- Our parameter estimates reveal that CFAZ membership has a statistically significant, causal, and negative effect on terrorism in Sub-Saharan Africa.
- Empirically , our estimates suggest that CFAZ membership caused approximately 396 fewer terrorism incidents in Sub-Saharan Africa over the 1974 - 2006 time period.
- Our results suggest that the pro-growth policy menu for Sub-Saharan Africa should be expanded to include the formation of regional currency arrangements such as CFAZ.
- In general, our findings suggest that another potential channel by which regional currency integration can improve living standards in Sub-Saharan Africa is through its effects on lowering terrorism.